PHILIPS

Data handbook

PHILIPS

Electronic components and materials

Components and materials

Part 9 March 1976

Piezoelectric quartz devices

PIEZOELECTRIC QUARTZ DEVICES

Part 9 **March 1976**

DATA HANDBOOK SYSTEM

Our Data Handbook System is a comprehensive source of information on electronic components, subassemblies and materials; it is made up of three series of handbooks each comprising several parts.

ELECTRON TUBES	**BLUE**
SEMICONDUCTORS AND INTEGRATED CIRCUITS	**RED**
COMPONENTS AND MATERIALS	**GREEN**

The several parts contain all pertinent data available at the time of publication, and each is revised and reissued periodically.

Where ratings or specifications differ from those published in the preceding edition they are pointed out by arrows. Where application information is given it is advisory and does not form part of the product specification.

If you need confirmation that the published data about any of our products are the latest available, please contact our representative. He is at your service and will be glad to answer your inquiries.

ELECTRON TUBES (BLUE SERIES)

This series consists of the following parts, issued on the dates indicated.

Part 1a	**Transmitting tubes for communication and Tubes for r.f. heating Types PE05/25 ÷ TBW15/125**	**December 1975**
Part 1b	**Transmitting tubes for communication** **Tubes for r.f. heating** **Amplifier circuit assemblies**	**January 1976**
Part 2	**Microwave products** Communication magnetrons Magnetrons for microwave heating Klystrons Travelling-wave tubes Diodes Triodes T-R Switches Microwave Semiconductor devices Isolators Circulators	**October 1974**
Part 3	**Special Quality tubes;** **Miscellaneous devices**	**January 1975**
Part 4	**Receiving tubes**	**March 1975**
Part 5a	**Cathode-ray tubes**	**April 1975**
Part 5b	**Camera tubes; Image intensifier tubes**	**May 1975**
Part 6	**Products for nuclear technology** **Photodiodes** Channel electron multipliers Geiger-Mueller tubes Neutron tubes N.B. Photomultiplier tubes and Photo diodes will be issued in Part 9	**July 1975**
Part 7	**Gas-filled tubes** Voltage stabilizing and reference tubes Counter, selector, and indicator tubes Trigger tubes Switching diodes Thyratrons Ignitrons Industrial rectifying tubes High-voltage rectifying tubes	**August 1975**
Part 8	**TV Picture tubes**	**October 1975**

SEMICONDUCTORS AND INTEGRATED CIRCUITS (RED SERIES)

This series consists of the following parts, issued on the dates indicated.

Part 1a Rectifier diodes, thyristors, triacs — **March 1976**

Rectifier diodes
Voltage regulator diodes (> 1,5 W)
Transient suppressor diodes
Rectifier stacks
Thyristors
Triacs

Part 1b Diodes — **October 1975**

Small signal germanium diodes
Small signal silicon diodes
Special diodes
Voltage regulator diodes (< 1,5 W)
Voltage reference diodes
Tuner diodes

Part 2 Low frequency transistors — **December 1975**

Part 3 High frequency and switching transistors — **October 1974**

Part 4a Special semiconductors — **November 1974**

Transmitting transistors
Microwave devices
Field-effect transistors
Dual transistors
Microminiature devices for thick- and thin-film circuits

Part 4b Devices for optoelectronics — **December 1974**

Photosensitive diodes and transistors
Light emitting diodes
Photocouplers
Infrared sensitive devices
Photoconductive devices

Part 5 Linear integrated circuits — **March 1975**

Part 6 Digital integrated circuits — **April 1974**

DTL (FC family)
CML (GX family)
MOS (FD family)
MOS (FE family)

COMPONENTS AND MATERIALS (GREEN SERIES)

This series consists of the following parts, issued on the dates indicated.

Part 1 — Functional units, Input/output devices, Peripheral devices — **November 1975**

High noise immunity logic FZ/30-Series
Circuit blocks 40-Series and CSA70
Counter modules 50-Series
NORbits 60-Series, 61-Series
Circuit blocks 90-Series
Input/output devices
Hybrid integrated circuits
Peripheral devices

Part 2a — Resistors — **February 1976**

Fixed resistors
Variable resistors
Voltage dependent resistors (VDR)
Light dependent resistors (LDR)
Negative temperature coefficient thermistors (NTC)
Positive temperature coefficient thermistors (PTC)
Test switches

Part 2b — Capacitors — **April 1976**

Electrolytic and solid capacitors
Paper capacitors and film capacitors
Ceramic capacitors
Variable capacitors

Part 3 — Radio, Audio, Television — **February 1975**

FM tuners
Loudspeakers
Television tuners and aerial input assemblies
Components for black and white television
Components for colour television

Part 4a — Soft ferrites — **April 1975**

Ferrites for radio, audio and television
Beads and chokes
Ferroxcube potcores and square cores
Ferroxcube transformer cores

Part 4b — Piezoelectric ceramics, Permanent magnet materials — **May 1975**

Part 5 — Ferrite core memory products — **July 1975**

Ferroxcube memory cores
Matrix planes and stacks
Core memory systems

Part 6 — Electric motors and accessories — **September 1975**

Small synchronous motors
Stepper motors
Miniature direct current motors

Part 7 — Circuit blocks — **September 1971**

Circuit blocks 100 kHz-Series
Circuit blocks 1-Series
Circuit blocks 10-Series
Circuit blocks for ferrite core memory drive

Part 8 — Variable mains transformers — **July 1975**

Part 9 — Piezoelectric quartz devices — **March 1976**

Part 10 — Connectors — **November 1975**

Quartz crystal units

SURVEY OF TYPES

→ Types for general frequency stabilization

crystal cut	frequency range (MHz)	holder		type
AT (fundamental)	1,8 - 20	metal	- HC-6/U , RW-36	4322 152
	7 - 20	metal	- HC-18/U, HC-25/U RW-43 , RW-42	4322 153
	2,3 - 20	all-glass	- HC-27/U	4322 154
	4,5 - 20	all-glass	- HC-26/U, HC-29/U	4322 155
AT (third overtone)	10 - 61	metal	- HC-6/U , RW-36	4322 157
	17 - 61	metal	- HC-18/U, HC-25/U RW-43 , RW-42	4322 158
	10 - 61	all-glass	- HC-27/U	4322 159
	20 - 61	all-glass	- HC-26/U, HC-29/U	4322 160
AT (fifth overtone)	50 - 87	metal	- HC-6/U , RW-36	4322 163
	50 - 87	metal	- HC-18/U, HC-25/U RW-43 , RW-42	4322 164
	50 - 87	all-glass	- HC-27/U	4322 165
	50 - 87	all-glass	- HC-26/U, HC-29/U	4322 166

→ Types for special applications

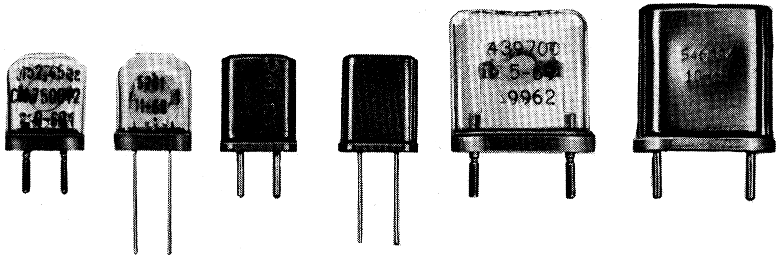
application	holder	data	crystal cut	catalogue number
colour television	RW10	4, 433 619 MHz	AT	4322 152 01101
clock	RW10	4, 194 304 MHz	AT	4322 152 01371
high precision	HC-27/U	10, 000 000 MHz third overtone	AT	4322 159 00001 *)
steering of models	HC-6/U RW-36	27, 125 MHz, 0/+60 °C total tolerance ± 1000 x 10^{-6} series resonance	AT	4322 157 00010
		40, 68 MHz, 0/+60 °C total tolerance ± 500 x 10^{-6} series resonance	AT	4322 157 00020
		13, 56 MHz, 0/+60 °C total tolerance ± 500 x 10^{-6} C_L = 30 pF in parallel	AT	4322 152 01300
measuring equipment	HC-6/U	1 MHz -20/+70 °C	AT	4322 152 01240
	HC-6/U RW-36	4, 5 5, 5 6, 75 10, 7 Total tol. ± 100 x 10^{-6} C_L = 30 pF in parallel	AT	4322 152 01280 01250 01290 01260

For further data see data sheets of relevant type.

*) Full data included.

INTRODUCTION

RZ 29452-2



A quartz crystal unit consists of a quartz crystal element with electrodes, mounted in a glass or metal holder having connecting pins or leads.

In a quartz crystal unit the piezoelectric characteristics of quartz have been used to obtain a component that is equivalent to a stable resonance circuit with a very high Q-factor.

Crystal elements are normally in the form of plates or bars cut from natural or synthetic quartz. The dimensions of these elements and their orientation with respect to the axes of the crystal give the characteristics of the element. A number of orientations ("crystal cuts") are favourable, e.g. in view of temperature dependence or for particular ranges of resonance frequency.

The most advantageous orientation is the so-called AT cut. The frequency range that theoretically can be covered is approximately 1 to 250 MHz. A practical range is from 2 to 100 MHz.

The dimensions given to the crystal element are such that the mechanical resonance frequency equals the desired electrical resonance frequency as perfectly as possible. The crystal element may vibrate in the frequency of a fundamental mode of vibration, or in the third or fifth overtone of the fundamental frequency.

In the vicinity of resonance the electrical behaviour of a quartz crystal unit can be adequately described with reference to the simple equivalent circuit of Fig. 1.

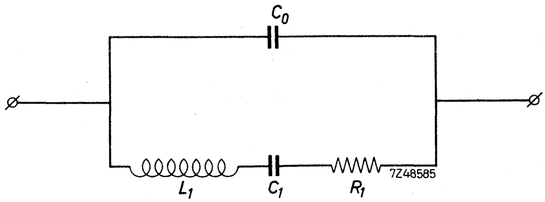


Fig. 1

The inductance L_1, the capacitance C_1 and the resistance R_1 are piezoelectric phenomena, and are therefore said to form the motional branch of the unit. C_0 is the static capacitance between the electrodes.

LOAD CAPACITANCE AND FREQUENCY PULLING

During manufacture definable limits are set to the accuracy of frequency. A load capacitor C_L is required to trim the crystal to working frequency.

For the calculation of the degree of frequency pulling that is possible, it will be assumed that the loss resistance of the crystal unit is zero. This greatly simplifies the calculation and hardly influences the result. The thus simplified equivalent circuit is depicted in Fig.2. The reactance X of this circuit as a function of frequency is shown in Fig. 3.

When the crystal unit is connected in series to a capacitance C_L, the total impedance will be:

$$Z_S = jX + jX_{C_L}$$

which means that series resonance ($Z_S = 0$) will occur at the frequency at which:

$$X = -X_{C_L}$$

(It is assumed that this is the case in point A of Fig. 3.)

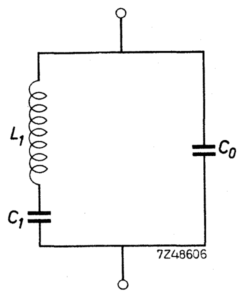


Fig.2

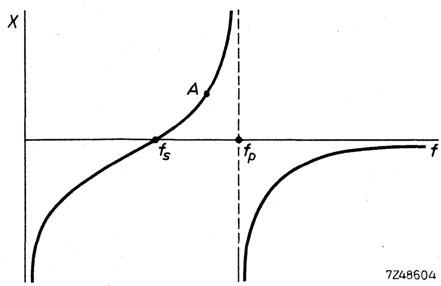


Fig.3

When the crystal unit is connected in parallel to a capacitance C_L, the total impedance will be:

$$Z_p = \frac{jX \cdot jX_{C_L}}{jX + jX_{C_L}},$$

which means that parallel resonance (Z_p = infinite) will occur at the frequency at which:

$$jX + jX_{C_L} = 0 \text{ and, again, } X = -X_{C_L}$$

(point A of Fig. 3 for same value of C_L as in the first case).

It can be seen that the formula for the series resonance frequency (f_s') of the series combination will be identical to that for the parallel resonance frequency of the parallel combination (f_p').
This formula is most easily derived from the case of resonance with a parallel capacitance C_L (at which Z_p = infinite), and reads:

$$(\omega_p')^2 = \frac{1}{L_1C_1}\left(1 + \frac{C_1}{C_o + C_L}\right) = (\omega_s')^2 = \omega^2,$$

Now the frequency change as a function of the external capacitance variation can be found. Differentiation gives:

$$2\omega . \Delta\omega = -\frac{1}{L_1C_1} \cdot \frac{C_1}{(C_o + C_L)^2} . \Delta C_L,$$

and working out this equation results in

$$\Delta f = -\frac{1}{8\pi^2 f L_1 (C_o + C_L)^2} . \Delta C_L.$$

This formula can be used, without the introduction of appreciable errors, as long as ΔC_L is smaller than 0,1 C_L.

The relative change in frequency $\Delta f/f$ resulting from a capacitance decrease is larger than that resulting from an identical increase.

A suitable, though not quite exact formula for larger capacitance variations is the following:

$$f_2 - f_1 = -\frac{C_{L2} - C_{L1}}{8\pi^2 f L_1 (C_{L1} + C_o)(C_{L2} + C_o)}$$

It should be recognised that changes in external capacitance are accompanied by two other effects: the E.P.R. or the E.S.R. will vary, and the current flowing through the crystal will vary.

FREQUENCY/TEMPERATURE CHARACTERISTICS

The frequency drift as a function of temperature can be represented by a graph, the TC curve or drift characteristic . In the case of AT cuts, the relation of drift and temperature is approximated by a cubic curve; the drift characteristic of the other cuts is parabolic in shape.

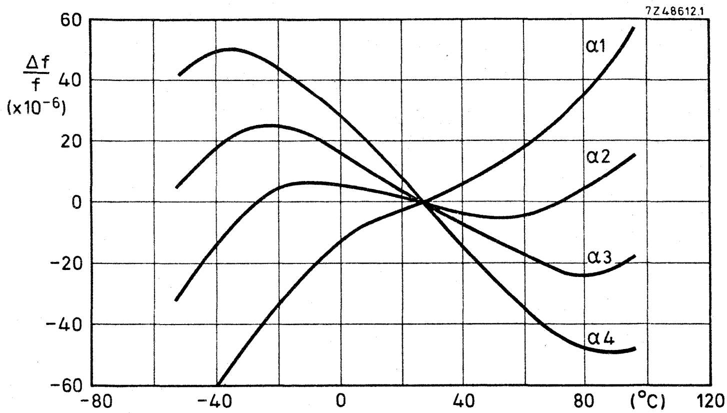


Fig. 4

Fig. 4 shows a number of frequency-temperature curves obtained from AT-cut crystals with various angles α of cut (from $\alpha 1$ to $\alpha 4$ increasing angle of cut). The curves are symmetric with respect to 27 °C, and it is not possible to shift this point. A temperature range which is fairly symmetric with respect to 27 °C (e.g. 0 - 60 °C) will, therefore, result in the smallest frequency drift in that range.

It will be evident that, for AT-cut crystals, the angle of cut and its accuracy are decisive for the frequency drift over a given temperature range.

ADVANTAGES OF ALL-GLASS HOLDERS

Crystal units with all-glass holders show the following advantages over those with metal holders:

(a) a lower series resistance, which also means a higher E.P.R. and Q-factor, thanks to the fact that glass holders are evacuated giving less mechanical damping;

(b) better performance under adverse climatic conditions;

(c) a higher frequency stability.

AGEING

A non-reversible, mostly gradual change with time in resonance frequency is called (an effect of) ageing. Only where a very good long-term stability is required should ageing be of consequence. It should be borne in mind that (with a view to ageing only):

(a) crystal units having an all-glass holder are favourable compared with those having a metal holder

(b) low frequency crystals are favourable compared with high frequency crystals having the same crystal cut

(c) overtone crystals are favourable compared with fundamental crystals for the same frequency (or fifth overtone compared with third overtone crystals).

DEFINITIONS

in accordance with IEC122—1

Nominal frequency	The frequency assigned by the specification of the crystal unit.
Working frequency (f_w)	The frequency generated by the combination of oscillator and crystal unit.
Frequency tolerance	The maximum permissible deviation of the working frequency from a given frequency due to a specific cause, or a combination of causes. Note: The tolerances normally used are: - accuracy of adjustment (this is the deviation from the nominal frequency at the reference temperature under specified conditions) - ageing (this is the maximum deviation due to the lapse of time only under specified conditions) - tolerance over the temperature range (this is the deviation from the frequency at the specified reference temperature measured over the temperature range
Series resonance frequency (f_s)	The frequency defined by $f_s = \frac{1}{2\pi\sqrt{L_1C_1}}$ (see fig. 1)
Resonance frequency (f_r)	The lower of the two frequencies of the crystal unit alone or with a series load reactance under specified conditions, the electrical impedance being resistive.
Anti-resonance frequency (f_a)	The higher of the two frequencies in the vicinity of a resonance at which the electrical impedance of the crystal unit is resistive.
Parallel resonance frequency (f_p)	The frequency defined by $f_p = \frac{1}{2\pi\sqrt{L_1\frac{C_1C_0}{C_1+C_0}}}$

Operating temperature range	The range of temperature as measured on the holder, over which the crystal unit will function within the specified tolerances.
Operable temperature range	The range of temperature as measured on the holder, over which the crystal unit will function though not necessarily within the specified tolerances.
Equivalent series resistance (E.S.R.)	The impedance of the crystal unit alone or in series with a stated external reactance at the frequency (f_r).
Equivalent parallel resistance (E.P.R.)	The impedance of the crystal unit alone or in parallel with a stated external capacitance at the frequency (f_a).
Level of drive	A measure of the conditions imposed upon the crystal unit expressed in terms of power dissipated. In special cases the level of drive may be specified in terms of crystal current or voltage.
Unwanted response	A state of resonance of a crystal vibrator other than that associated with the working frequency.
Load capacitance (C_L)	The effective external capacitance associated with the crystal unit to determine the resonance frequency of the combination crystal unit and capacitor.

MEASURING PROCEDURES

A number of methods to measure quartz crystals are in use. It is important to know the applied method. Quartz crystals can be measured in accordance with one of the four standard test methods described below. Our crystals are measured in accordance with method 2, 3 or 4, as mentioned in the individual data sheet of the type concerned. Measurement in accordance with method 1 can be made on request, and will gradually become our standard method.

1. Passive method with π network (IEC).
2. Method using Crystal Test Set, type TS193A (British Military Standard)
3. Method using Crystal Impedance Meter TS330/TSM (U.S. Army Standard)
4. Method using Crystal Impedance Meter TS683/TSM (U.S. Army Standard)

The methods 2, 3 and 4 have limitations and are not to be recommended., where a frequency correlation better than 2 to 5 ppm is required between customer and manufacturers. The π-network method, which is fully described and specified in IEC recommendations, Publication 444 has become an international standard for the measurement of crystal frequency at resonance; it has a resolution and accuracy better than ± 0,5 ppm.

PASSIVE METHOD WITH π – NETWORK (IEC)

The principle of this method is very simple. With the equipment shown in the block diagram of Fig. 1, a signal source (stable Signal generator or Frequency synthesiser) is adjusted to the frequency at which the signal has zero phase change when passing through the crystal as measured by the Phase meter; this frequency (measured with the Frequency counter) is then the resonance frequency of the crystal.
To relax the stability requirements on the signal source, it is possible to phase-lock the system by feeding the analogue output of the phase error (from zero) back to control the precise frequency of the signal source (A.F.C. loop shown by dashed line).

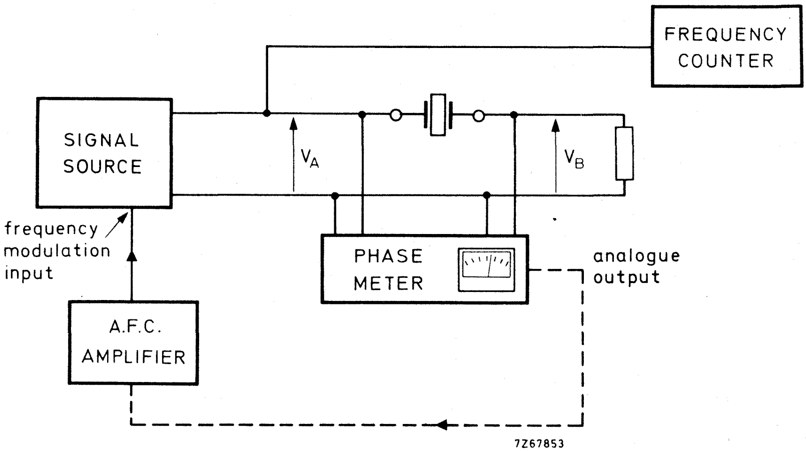


Fig. 1

π - network

The first departure which must be made from the simple system of Fig. 1 is the test jig for holding the crystal. The test jig consists of two π-connected resistive pads, carefully manufactured to represent a pure, constant resistance, which is frequency insensitive at the terminals of the quartz crystal (see Fig. 2).

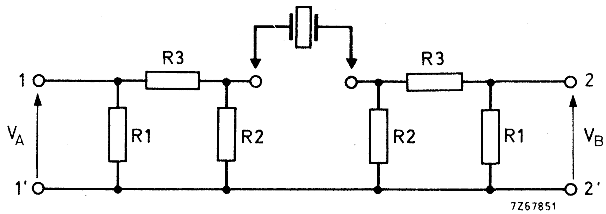


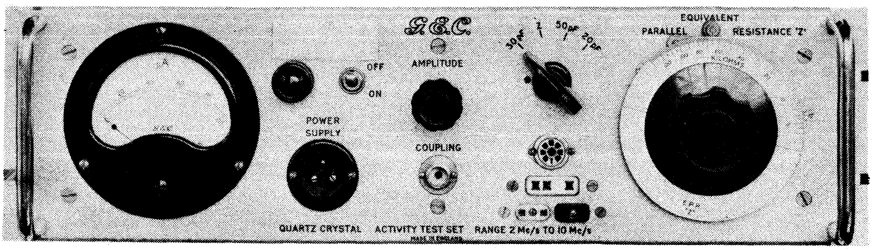
Fig. 2

The function of the input and output 'pads' is twofold:
(a) to match the crystal impedance to the associated equipment,
(b) to attenuate reflections from the associated equipment.

For further particulars consult IEC recommendations, Publication 444.

BRITISH TEST SET TS-193A

RZ 9607-1



The set (model QC57) is suitable for measuring the frequency and the equivalent parallel resistance of crystal units at frequencies of 1 - 20 MHz.
The measuring procedures are as follows.

Measuring the working frequency

Connect test set to frequency counter and measure the frequency as follows:

a. Turn knob (2) fully counter-clockwise.

b. Move switch (1) to "on" position and allow the set to warm up for 15 minutes.

c. Set knob (3) at specified load capacitance.

d. Insert the crystal in the appropriate socket (4).

e. Turn knob (2) clockwise until μA meter indicates the specified grid current value.

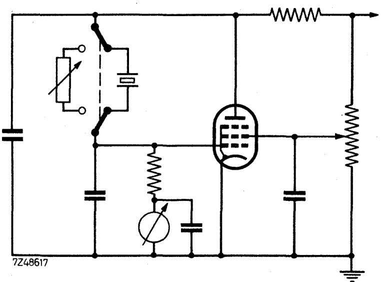
f. Measure the frequency.

Measuring the E.P.R.

Carry out the above points a, b, c and d.
Then proceed as follows:

e. Set knob (3) in position Z.

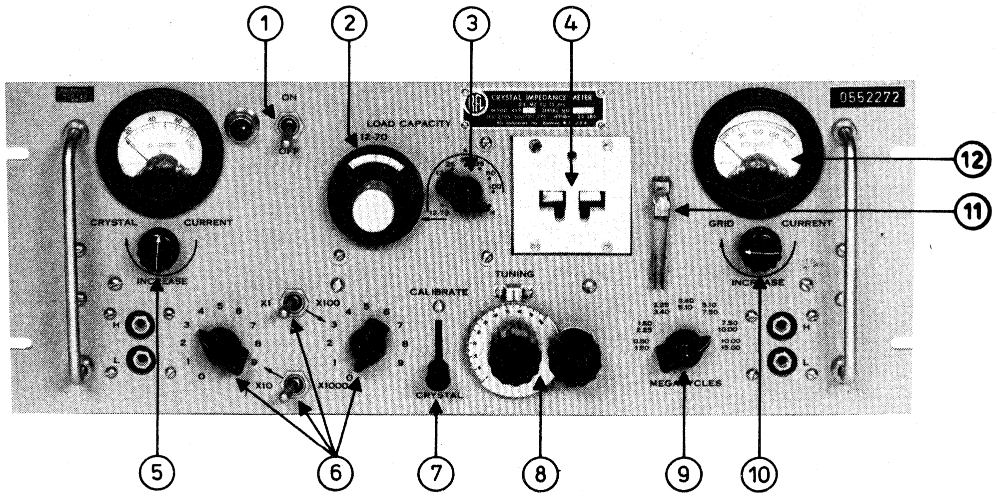
f. Turn knob E.P.R. 'Z' until μA-meter indicates the specified grid current value again.
The number of kilohms indicated by the dial of knob E.P.R. 'Z' represents the equivalent parallel resistance at the specified load capacitance.



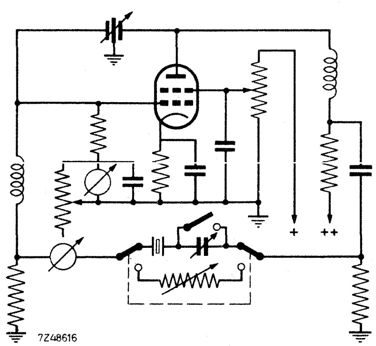
Basic diagram

U.S. TEST SET TS - 330/TSM

730924 - 11 - 01



The set (model 459) is suitable for measuring the frequency and the equivalent series resistance of crystal units at frequencies of 1 - 15 MHz. Resistance decades are incorporated to replace the crystal impedance at series resonance, or the crystal impedance in series with a capacitive load at antiresonance.



Basic diagram

There are two cases:

1. No capacitance connected in series with the crystal.
2. A capacitance of a given value is connected in series with the crystal.

1. Series resonance operation

a. Turn knob (5) fully counter-clockwise and knob (10) fully clockwise.

b. Move switch (1) to "on" position.
Allow the set to warm up for 15 minutes.

c. Move knob (3) to position "R".

d. Move switch (7) to position "calibrate".

e. With knobs (6) adjust resistor decade to rejection value of crystal resistance.

f. Turn knob (5) until meter (12) indicates approx. 50 μA.

g. With knobs (8) and (9) adjust to required frequency (which is mostly the nominal frequency).

h. Move switch (7) to position "crystal".

i. Place the tuning resistance (value specified on the relevant data sheet) into the crystal socket of the test set and connect the differential millivoltmeter (see the relevant section below).

j. Adjust the voltage drop to the specified value with knob (5) and the differential mV-meter.
If necessary, turn knob (10) a little counter-clockwise to keep the deflection of meter (12) within the scale.

k. Move switch (7) to position "calibrate".

l. Adjust frequency to nominal value ± 0, 1% with knob (8).
If the adjusting frequency (step g) was not the nominal frequency, omit step m.

m. Check the load and, if necessary, correct it to steps h, i and j.
Also repeat steps k and l. In most cases one correction will be sufficient.

n. With switch (7) in position "calibrate", adjust meter (12) to a convenient reading (e.g. 50 μA) with knob (10).

o. Move switch (7) to position "crystal".

p. Insert crystal under test into socket (4) and read off meter (12).
The meter must indicate a higher value than that adjusted in step n.

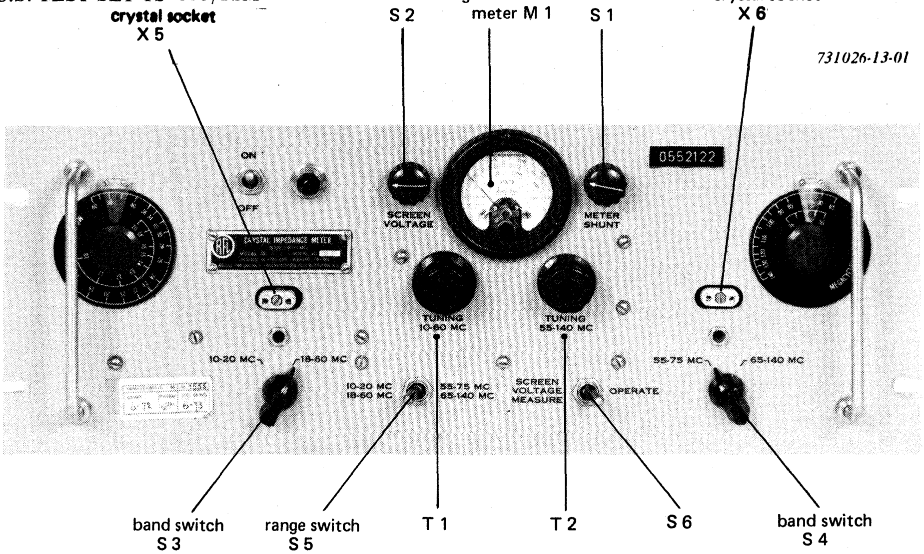
q. Read off the frequency from a counter connected to the test set.

r. To determine the crystal resistance, remember the reading of meter (12), see step p.
Move switch (7) to position "calibrate" and with knob (6) adjust resistor decade so that meter (12) indicates the same value as in step p (when switch (7) was in position "crystal"). Crystal series resistance is then equal to that of the above decade resistor.

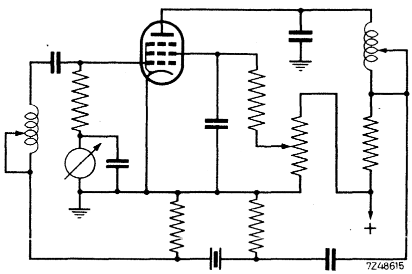
2. **Operation with series load capacitance**

Same operation as above except that switch (3) or switches (3) and (2) are to be adjusted to the required load capacitance between steps o and p.

U.S. TEST SET TS-683/TSM



The set (model 531) is suitable for measuring the frequency and the equivalent series resistance of crystal units at frequencies of 10 - 140 MHz. Separate resistors are used to replace the crystal impedance.



Basic diagram

Measuring procedure

a. Move the "on-off" switch to the "on" position.
   Allow the set to warm up for 15 minutes.

b. Set range switch "S5" at the required frequency range (covering the nominal frequency of the crystal under test).

c. Set band switch S3 or S4 at the same frequency range as S5.

Note: By agreement frequencies between 55 and 65 MHz are measured in the 55 to 75 MHz range, and frequencies of 65 MHz and higher are measured in the 65 to 140 MHz range.

d. Adjust tuning dial to nominal crystal frequency by means of knob "tuning 10-60 MHz" (T1) or "tuning 55-140 MHz" (T2).

e. Insert an intermediate socket equipped with the prescribed tuning resistor (see article specification) into the crystal socket X5 or X6.
If range switch S5 points to the left, X5 socket must be used.
If it points to the right use X6.

f. Move S1 to extreme clockwise position and adjust meter M1 indication to approx. 50 μA by means of S2.

g. Adjust frequency indicated by counter to approximately nominal value by means of knob T1 or T2.

h. Remove the resistor from X5 or X6.

i. Connect the probe of the differential mV meter (see relevant section below) equipped with the prescribed tuning resistor, to socket (X5 or X6) determined in step e.

j. Adjust the voltage drop across the resistor to the value specified in the relevant data sheet, with S2.

k. Remove the probe from socket X5 or X6.

l. Repeat step e.

m. Turn knob T1 or T2 so that the frequency differs no more than 0, 1% from the nominal value.

n. Check the load and, if necessary, correct it to steps i and j.
Also repeat steps e and m then. In most cases one correction will be sufficient.

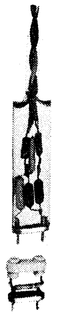
o. Replace the tuning resistor in socket X5 or X6 by a resistor with the rejection value of the crystal. Adjust grid current meter M1 to a convenient reading by means of S1 (e.g. to 50 μA).

p. Replace the resistor by the crystal and read off meter M1. The meter reading is to exceed that obtained with the rejection value resistor in step o.

q. Read off the frequency from a counter, connected to the test set.

r. The series resistance value of the crystal (activity) can be determined as follows:
Remember the grid current value indicated by meter M1 when crystal is inserted in X5 or X6.
Replace crystal by a resistor giving the same M1 reading.
The crystal series resistance is equal to that of the above resistor.

DIFFERENTIAL MILLIVOLTMETER



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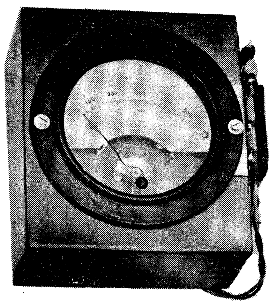


C 65495

With a view to present-day tolerances, it is impossible to obtain sufficiently comparable results with various oscillators if the level of drive of the crystal is not exactly known, even when the oscillators are built up quite identically.

In the specification MIL-C-3098, the level of drive is specified in milliamps of crystal current at a given resistance, and also in milliwatts.

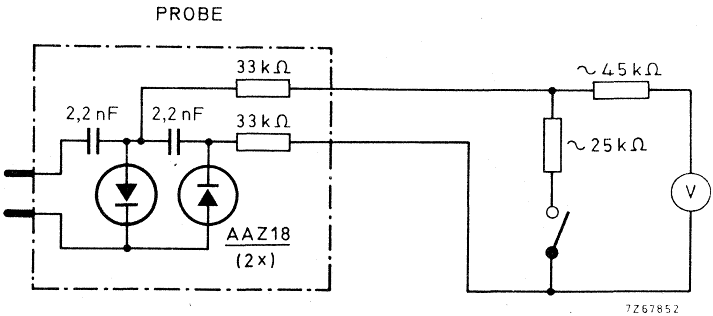


Fig. 3

Particularly when the U.S. test set TS-330/TSM is used, it will be found that the reading of small crystal currents may give rise to appreciable inaccuracies resulting in frequency differences. Measuring the voltage with respect to earth at either side of the crystal in such a set also proved insufficient due to the self-inductances of the connecting leads. For these reasons the differential millivoltmeter under discussion was designed to allow the voltage to be measured across the tuning resistor independently of earth. It can be used in conjunction with both the U.S. test sets TS-330 and TS-683.

The HF part, indicated in Fig. 3 by a dotted line, is in the form of a probe. It comprises a diode circuit acting as a voltage doubler, and two 33 kΩ resistors moulded in an epoxy resin. The base of holder type HC-6/U is employed for the terminals.
A number of intermediate sockets are used as shunts with various values for the rated level of drive to be measured. They consist of a socket, soldered on to another base HC-6/U, and a carbon resistor (e.g. 40 Ω) connected between the pins. The probe is inserted into one of these intermediate sockets and, by interchanging sockets with different resistance values, the best suitable shunt resistance for a given case can be applied very quickly.

A flex connects the d.c. side of the probe to the meter which, in our case, has a range of up to 10 μA and an internal resistance of 2000 Ω. In consequence of a series resistance of 45 kΩ, the full scale deflection corresponds to 500 mV. The measuring range can be extended to 1000 mV by applying a shunt resistance to the meter circuit with a push-button switch *).

It goes without saying that the actual resistance values required depend on the diodes and, consequently, the probe should not be interchanged without re-calibrating the meter. For this reason, probe and meter are fixed together.

The meter is calibrated in the conventional way by comparison with a h.f. voltmeter and a sine wave of about 1 MHz, whose amplitude is varied - one side may be earthed during calibration. When calibrated at 1 MHz, the meter is correct for the frequency range covered by the quartz crystal units mentioned in the data sheets.

*) Sensitivity can be improved by using a differential amplifier between probe and meter circuit. Circuit diagram available on request.

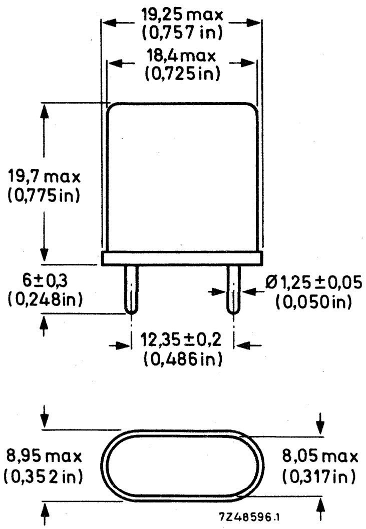
HOLDERS

METAL AND ALL-GLASS HOLDERS

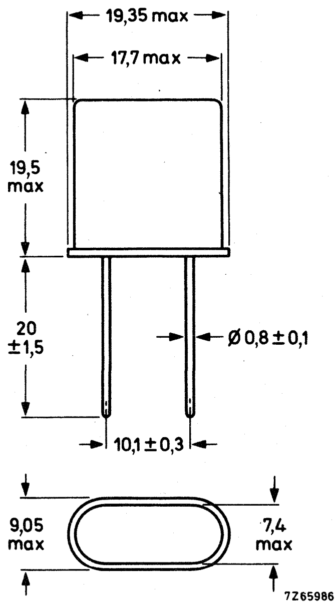
The following holders state the nominal frequency by means of 7 (or 8) figures, in kHz in the case of fundamental crystals and in MHz in the case of overtone crystals.
Other figures on the faces constitute registration numbers that relate to the date and series of manufacture.

Metal holders

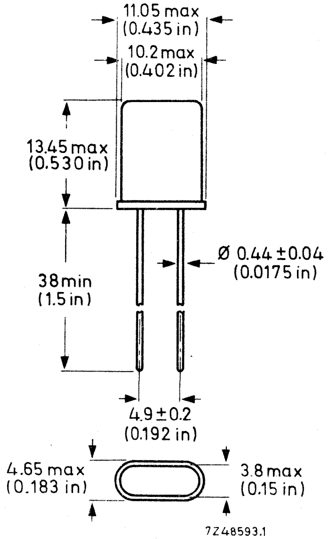
Dimensions in mm
(in inches between brackets)



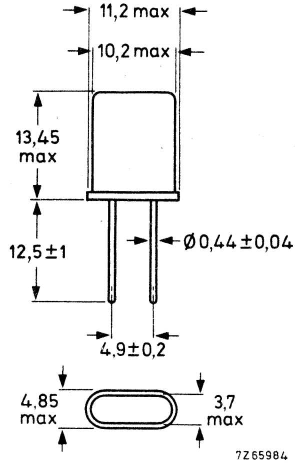
HC-6/U, solder sealed
RW-36, resistance welded



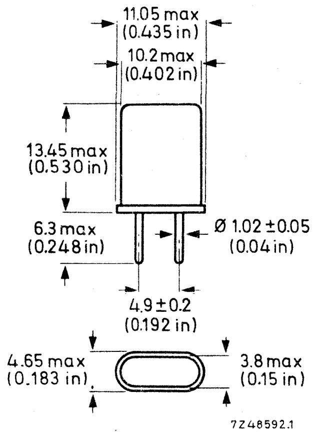
RW - 10
resistance welded



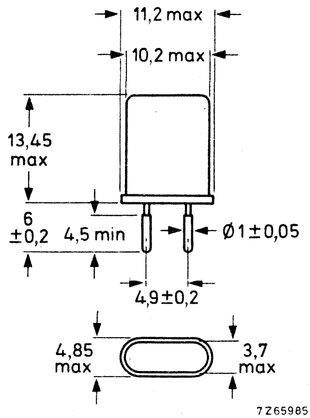
HC-18/U
solder sealed



RW - 43
resistance welded

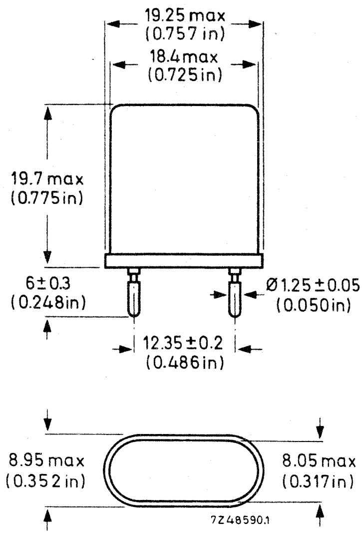


HC-25/U
solder sealed

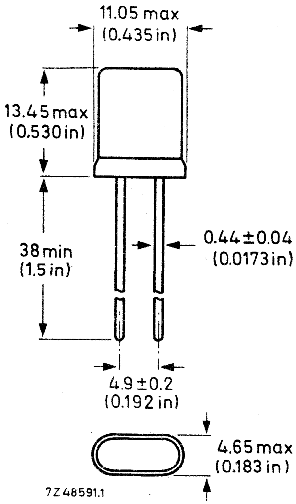


RW - 42
resistance welded

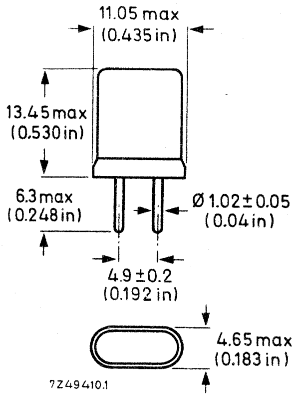
Glass holders



HC-27/U



HC-26/U



HC-29/U

HOW TO ORDER

The quartz crystal units can be obtained in accordance with a specification of the (total) frequency tolerance or with a specification of the accuracy of adjustment and the frequency drift separately.

When applying for quotation or when ordering please state:

1. nominal frequency	... kHz, mode of vibration:	fundamental third fifth
2. a. frequency tolerance	... x 10^{-6}, or	
b. accuracy of adjustment	... x 10^{-6}, and	
frequency drift	... x 10^{-6}.	

3. temperature range
4. a. series resonance, or

   b. load capacitance in parallel/in series with the unit: ... pF.
5. type of holder.

For non-listed types, please apply in the same manner and submit oscillator circuit with description.

QUARTZ CRYSTAL UNITS

QUICK REFERENCE DATA	
Frequency range	1, 8 - 20 MHz
Mode of vibration	fundamental
Types of holder	metal; HC-6/U (MIL), RW-36

APPLICATION

These units are used for frequency stabilization.
They are generally used in series or parallel resonance oscillators.

DESCRIPTION

The units consist of a metal-plated AT-cut quartz plate, mounted in a hermetically sealed metal holder, provided with 2 connecting pins.

MECHANICAL AND ENVIRONMENTAL DATA

Dimensions in mm
(in inches between brackets)

Outlines

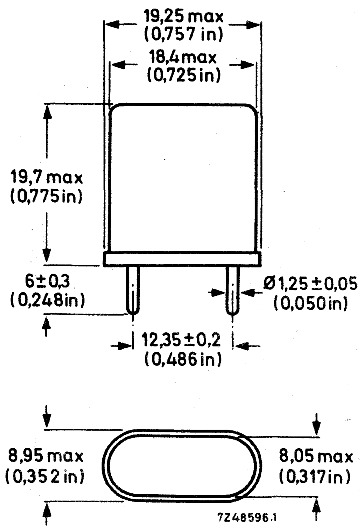


Fig. 1. HC-6/U
RW-36

Mass

With both types of holder approximately 4 g.

Marking

If a special marking is not requested, marking will be done as stated under "Holders" in the general section.

Shock and vibration tests

According to RCS271 and MIL-C-3098B.

Climatic tests

According to MIL-C-3098B.

ELECTRICAL DATA

Table 1, Frequency tolerance

frequency range	temperature range	frequency tolerance		
		class 0	class I	class II
1,8 - 20 MHz	-5/ +45 °C -10/ +50 °C -15/ +70 °C	$\pm 25 \times 10^{-6}$ $\pm 27,5 \times 10^{-6}$ $\pm 30 \times 10^{-6}$	$\pm 27,5 \times 10^{-6}$ $\pm 30 \times 10^{-6}$ $\pm 35 \times 10^{-6}$	$\pm 30 \times 10^{-6}$ $\pm 35 \times 10^{-6}$ $\pm 40 \times 10^{-6}$
1,8 - 2,3 MHz 2,3 - 4 MHz 4 - 20 MHz	-55/+105 °C -55/+105 °C -55/+105 °C	$\pm 50 \times 10^{-6}$ $\pm 52,5 \times 10^{-6}$ $\pm 45 \times 10^{-6}$	$\pm 55 \times 10^{-6}$ $\pm 55 \times 10^{-6}$ $\pm 50 \times 10^{-6}$	$\pm 60 \times 10^{-6}$ $\pm 60 \times 10^{-6}$ $\pm 60 \times 10^{-6}$

Table 2, Frequency drift

frequency range	temperature range	frequency drift		
		class 0	class I	class II
1,8 - 20 MHz	-5/ +45 °C -10/ +50 °C -15/ +70 °C	$\pm 5 \times 10^{-6}$ $\pm 7,5 \times 10^{-6}$ $\pm 10 \times 10^{-6}$	$\pm 7,5 \times 10^{-6}$ $\pm 10 \times 10^{-6}$ $\pm 15 \times 10^{-6}$	$\pm 10 \times 10^{-6}$ $\pm 15 \times 10^{-6}$ $\pm 20 \times 10^{-6}$
1,8 - 2,3 MHz 2,3 - 4 MHz 4 - 20 MHz	-55/+105 °C -55/+105 °C -55/+105 °C	$\pm 30 \times 10^{-6}$ $\pm 32,5 \times 10^{-6}$ $\pm 25 \times 10^{-6}$	$\pm 35 \times 10^{-6}$ $\pm 35 \times 10^{-6}$ $\pm 30 \times 10^{-6}$	$\pm 40 \times 10^{-6}$ $\pm 40 \times 10^{-6}$ $\pm 40 \times 10^{-6}$
1,8 - 20 MHz	$T_{nom} \pm 5$ °C	$\pm 5 \times 10^{-6}$		

Accuracy of adjustment $\pm 20 \times 10^{-6}$ (to be combined with any of the frequency drift figures quoted)

Parallel capacitance	max. 7 pF
Max. permissible d.c. voltage between the pins	100 V

Parallel load capacitance

Working frequency	to be measured with the British Military Test Set TS 193, the parallel capacitance being set at 30 pF and the grid current at 50 μA for the frequency range 1.8 - 15 MHz and at 20 μA for 15 - 20 MHz.
Minimum equivalent parallel resistance	
for 1.8 - 10 MHz	according to Fig.2, the parallel capacitance set at 30 pF and the grid current at 50 μA.
for 10 - 20 MHz	according to Fig.3, the parallel capacitance set at 20 pF and the grid current at 50 μA for 10 - 15 MHz, and at 20 μA for 15 - 20 MHz.

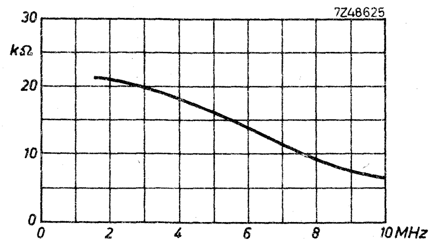


Fig.2

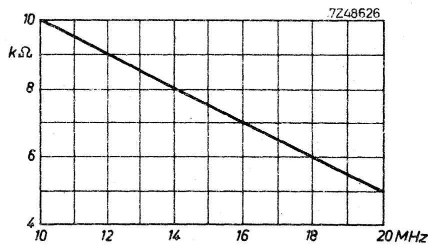


Fig.3

Series load capacitance

Working frequency	to be measured with the American Military Test Sets TS-330/TSM for the frequency range 1.8 - 10 MHz and TS-683/TSM for the frequency range 10 - 20 MHz. The series capacitance to be set at 32 pF and the set being tuned in accordance with Table 3 or 4 (Table 4 applies to oven-controlled units).

Maximum equivalent series resistance

at a series capacitance of 32 pF, and at

1.800000 - 1.999999 MHz	550 Ω
2.000000 - 2.249999 MHz	500 Ω
2.250000 - 2.999999 MHz	320 Ω
3.000000 - 3.749999 MHz	175 Ω
3.750000 - 4.749999 MHz	120 Ω
4.750000 - 5.999999 MHz	75 Ω
6.000000 - 7.499999 MHz	50 Ω
7.500000 - 9.999999 MHz	35 Ω
10.000000 - 20.000000 MHz	25 Ω

Series resonance

Working frequency — to be measured with the American Military Test Sets TS-330/TSM for the frequency range 1.8 - 10 MHz and TS-683/TSM for the frequency range 10 - 20 MHz, without a series capacitance, the set to be tuned in accordance with Table 3 or 4, (Table 4 applies to oven-controlled units).

Maximum series resistance at

1.800000 - 1.999999 MHz	300 Ω
2.000000 - 2.249999 MHz	250 Ω
2.250000 - 3.749999 MHz	150 Ω
3.750000 - 4.999999 MHz	100 Ω
5.000000 - 6.999999 MHz	50 Ω
7.000000 - 9.999999 MHz	30 Ω
10.000000 - 20.000000 MHz	25 Ω

Tuning conditions for the test sets:

Table 3

test set	nominal frequency (MHz)	tuning frequency (MHz)	tuning resistance (Ω)	voltage drop (mV)	level of drive *) (mW)
TS330	1,800000 - 2,259999	2	50	750	10 ± 2
	2,260000 - 3,409999	3	100	1000	10 ± 2
	3,410000 - 5,109999	nominal	45	675	10 ± 2
	5,110000 - 7,509999	nominal	25	500	10 ± 2
	7,510000 - 9,999999	nominal	16	400	10 ± 2
TS683	10,000000 - 15,000000	nominal	13	260	5 ± 1
	15,000001 - 20,000000	nominal	22	330	5 ± 1

Table 4 (oven-controlled units)

test set	nominal frequency (MHz)	tuning frequency (MHz)	tuning resistance (Ω)	voltage drop (mV)	level of drive *) (mW)
TS330	1,800000 - 2,259999	2	50	500	5 ± 1
	2,260000 - 3,409999	3	50	500	5 ± 1
	3,410000 - 5,109999	nominal	50	500	5 ± 1
	5,110000 - 7,509999	nominal	22	330	5 ± 1
	7,510000 - 9,999999	nominal	13	260	5 ± 1
TS683	10,000000 - 15,000000	nominal	11	165	2,5 ± 0,5
	15,000001 - 20,000000	nominal	22	230	2,5 ± 0,5

Passive method with π-network

The working frequency may also be measured according to the passive method with π-network. Level of drive, generally, 0,5 mW.

*) Measurements at lower level of drive (within the limits of the specified test set) can be made on request.

QUARTZ CRYSTAL UNITS

QUICK REFERENCE DATA	
Frequency range	7 - 20 MHz
Mode of vibration	fundamental
Types of holder	metal; HC-18/U (MIL), RW-43 HC-25/U (MIL), RW-42

APPLICATION

These units are used for frequency stabilization.
They are generally used in series or parallel resonance oscillators.

DESCRIPTION

The units consist of a metal-plated AT-cut quartz plate, mounted in a hermetically sealed metal holder, provided with 2 connecting leads (HC-18/U and RW-43) or 2 connecting pins (HC-25/U and RW-42).

MECHANICAL AND ENVIRONMENTAL DATA

Dimensions in mm
(in inches between brackets)

Outlines

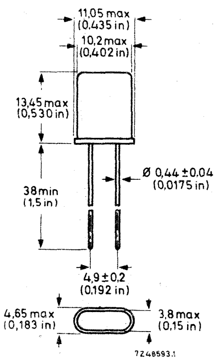


Fig. 1a. HC-18/U

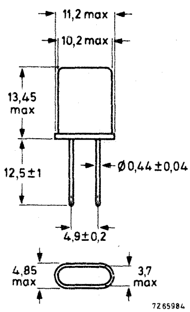


Fig. 1b. RW-43

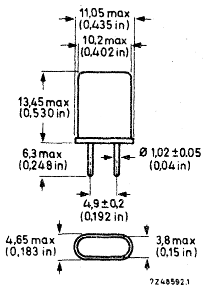


Fig. 2a. HC-25/U

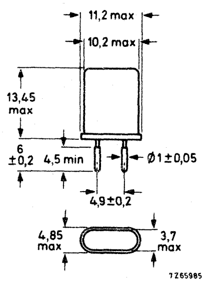


Fig. 2b. RW-42

Mass

With any of the four holders approximately 1 g.

Marking

If a special marking is not requested, marking will be done as stated under "Holders" in the general section.

Shock and vibration tests

According to RCS 271 and MIL-C-3098B.

Climatic tests

According to MIL-C-3098B.

ELECTRICAL DATA

Table 1, Frequency tolerance

temperature range	frequency tolerance		
	class 0	class I	class II
-5/ +45 °C	$\pm 25 \times 10^{-6}$	$\pm 27,5 \times 10^{-6}$	$\pm 30 \times 10^{-6}$
-10/ +50 °C	$\pm 27,5 \times 10^{-6}$	$\pm 30 \times 10^{-6}$	$\pm 35 \times 10^{-6}$
-15/ +70 °C	$\pm 30 \times 10^{-6}$	$\pm 35 \times 10^{-6}$	$\pm 40 \times 10^{-6}$
-55/+105 °C	$\pm 45 \times 10^{-6}$	$\pm 50 \times 10^{-6}$	$\pm 60 \times 10^{-6}$

Table 2, Frequency drift

temperature range	frequency drift		
	class 0	class I	class II
-5/ +45 °C	$\pm 5 \times 10^{-6}$	$\pm 7,5 \times 10^{-6}$	$\pm 10 \times 10^{-6}$
-10/ +50 °C	$\pm 7,5 \times 10^{-6}$	$\pm 10 \times 10^{-6}$	$\pm 15 \times 10^{-6}$
-15/ +70 °C	$\pm 10 \times 10^{-6}$	$\pm 15 \times 10^{-6}$	$\pm 20 \times 10^{-6}$
-55/+105 °C	$\pm 25 \times 10^{-6}$	$\pm 30 \times 10^{-6}$	$\pm 40 \times 10^{-6}$
$T_{nom} \pm 5$ °C	$\pm 5 \times 10^{-6}$		

Accuracy of adjustment: $\pm 20 \times 10^{-6}$ (to be combined with any of the frequency drift figures quoted)

Parallel capacitance: max. 7 pF

Maximum permissible d.c. voltage between the pins: 100 V

Parallel load capacitance

Working frequency — to be measured with the British Military Test Set TS-193, the parallel capacitance being set at 30 pF and the grid current at 50 μA for the frequency range 7 - 15 MHz and at 20 μA for 15 - 20 MHz.

Minimum equivalent parallel resistance

for 7 - 10 MHz — according to Fig.3, the parallel capacitance set at 30 pF, and the grid current at 50 μA

for 10 - 20 MHz — according to Fig.4, the parallel capacitance set at 20 pF, and the grid current at 50 μA for 10 - 15 MHz, and at 20 μA for 15 - 20 MHz.

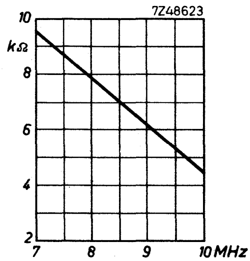


Fig.3

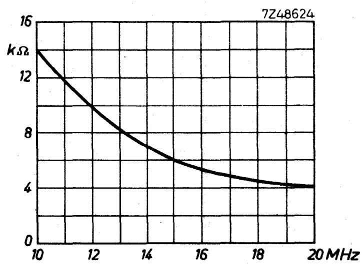


Fig.4

Series load capacitance

Working frequency — to be measured with the American Military Test Sets TS-330/TSM for the frequency range 7 - 10 MHz and TS-683/TSM for the frequency range 10 - 20 MHz.
The series capacitance to be set at 32 pF and the set being tuned in accordance with Table 3 or 4, (Table 4 applies to oven-controlled units).

Maximum equivalent series resistance

at a series capacitance of 32 pF

7.000000 - 8.199999 MHz	60 Ω
8.200000 - 9.999999 MHz	45 Ω
10.000000 - 20.000000 MHz	35 Ω

Series resonance

Working frequency — to be measured with the American Military Test Sets TS-330/TSM for the frequency range 7 - 10 MHz and TS-683/TSM for the frequency range 10 - 20 MHz, without a series capacitance.
The set to be tuned in accordance with Table 3 or 4.
(Table 4 applies to oven-controlled units.)

Maximum series resistance at

7,000000 - 8,199999 MHz	40 Ω
8,200000 - 9,999999 MHz	30 Ω
10,000000 - 20,000000 MHz	25 Ω

Tuning conditions for the test sets:

Table 3

test set	nominal frequency (MHz)	tuning frequency (MHz)	tuning resistance (Ω)	voltage drop (mV)	level of drive *) (mW)
TS330	7,000000 - 7,509999	nominal	25	500	10 ± 2
	7,510000 - 9,999999	nominal	16	400	10 ± 2
TS683	10,000000 - 15,000000	nominal	13	260	5 ± 1
	15,000001 - 20,000000	nominal	22	330	5 ± 1

Table 4 (oven-controlled units)

test set	nominal frequency (MHz)	tuning frequency (MHz)	tuning resistance (Ω)	voltage drop (mV)	level of drive *) (mW)
TS330	7,000000 - 7,509999	nominal	25	350	5 ± 1
	7,510000 - 9,999999	nominal	16	300	5 ± 1
TS683	10,000000 - 15,000000	nominal	13	180	2,5 ± 0,5
	15,000001 - 20,000000	nominal	22	235	2,5 ± 0,5

Passive method with π-network

→ The working frequency may also be measured according to the passive method with π-network. Level of drive, generally, 0,5 mW.

→ *) Measurements at lower level of drive (within the limits of the specified test set) can be made on request.

QUARTZ CRYSTAL UNITS

QUICK REFERENCE DATA	
Frequency range	1.8 - 20 MHz
Mode of vibration	fundamental
Type of holder	
for 1.8 - 2.3 MHz	all glass/26 mm
2.3 - 20 MHz	all glass HC-27/U (MIL)

APPLICATION

These units are used for frequency stabilisation in circuits, in which a high stability and a low series resistance are required.
They are generally used in series or parallel resonance oscillators.
Example: oscillator circuits in communication equipment with narrow channel spacing.

DESCRIPTION

The units consist of a metal plated AT-cut quartz plate, mounted in a hermetically sealed evacuated glass holder, provided with 2 connecting pins.

MECHANICAL AND ENVIRONMENTAL DATA.

Dimensions in mm
(in inches between brackets)

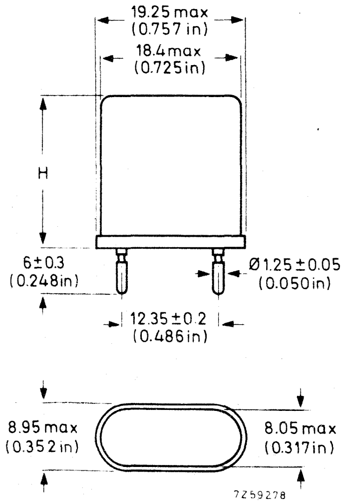


Fig. 1. For all glass/26 mm type
H = max. 26 mm (1.023 in)
for all glass HC-27/U
H = max. 19.7 mm (0.775 in)

Mass

Approximately 2, 5 g

Marking

If a special marking is not requested, marking will be done as stated under "Holders" in the general section.

Shock and vibration tests

According to MIL-C-3098E.

Climatic tests

According to MIL-C-3098E.

ELECTRICAL DATA

Table 1, Frequency tolerance

frequency range	temperature range	frequency tolerance		
		class 0	class 1	class II
1, 8 - 20 MHz	-5/ +45 °C -10/ +50 °C -15/ +70 °C	$\pm 15 \times 10^{-6}$ $\pm 17,5 \times 10^{-6}$ $\pm 20 \times 10^{-6}$	$\pm 17,5 \times 10^{-6}$ $\pm 20 \times 10^{-6}$ $\pm 25 \times 10^{-6}$	$\pm 20 \times 10^{-6}$ $\pm 25 \times 10^{-6}$ $\pm 30 \times 10^{-6}$
1, 8 - 2, 3 MHz 2, 3 - 7 MHz 7 - 20 MHz	-55/+105 °C -55/+105 °C -55/+105 °C	$\pm 40 \times 10^{-6}$ $\pm 42,5 \times 10^{-6}$ $\pm 35 \times 10^{-6}$	$\pm 45 \times 10^{-6}$ $\pm 45 \times 10^{-6}$ $\pm 40 \times 10^{-6}$	$\pm 50 \times 10^{-6}$ $\pm 50 \times 10^{-6}$ $\pm 50 \times 10^{-6}$

Table 2, Frequency drift

frequency range	temperature range	frequency drift		
		class 0	class I	class II
1, 8 - 20 MHz	-5/ +45 °C -10/ +50 °C -15/ +70 °C	$\pm 5 \times 10^{-6}$ $\pm 7,5 \times 10^{-6}$ $\pm 10 \times 10^{-6}$	$\pm 7,5 \times 10^{-6}$ $\pm 10 \times 10^{-6}$ $\pm 15 \times 10^{-6}$	$\pm 10 \times 10^{-6}$ $\pm 15 \times 10^{-6}$ $\pm 20 \times 10^{-6}$
1, 8 - 2, 3 MHz 2, 3 - 7 MHz 7 - 20 MHz	-55/+105 °C -55/+105 °C -55/+105 °C	$\pm 30 \times 10^{-6}$ $\pm 32,5 \times 10^{-6}$ $\pm 25 \times 10^{-6}$	$\pm 35 \times 10^{-6}$ $\pm 35 \times 10^{-6}$ $\pm 30 \times 10^{-6}$	$\pm 40 \times 10^{-6}$ $\pm 40 \times 10^{-6}$ $\pm 40 \times 10^{-6}$
1, 8 - 20 MHz	$T_{nom} \pm 5$ °C		$\pm 2,5 \times 10^{-6}$	$\pm 5 \times 10^{-6}$

Accuracy of adjustment $\pm 10 \times 10^{-6}$
(to be combined with any of the frequency drift figures quoted)

Parallel capacitance C_0	max. 7 pF; typical values for 1.8 - 2.3 MHz are given in Fig.4.
Inductance L_1	typical values for 1.8 - 15 MHz are given in Figs.4 to 7
Dynamic capacitance C_1	typical values for 1.8 - 15 MHz are given in Figs.4 to 7
Change in frequency as a result of ageing	$-0.5/+1 \times 10^{-6}$, after 90 days at 85 ± 2 °C, non-operative.
Maximum permissible d.c.voltage between the pins	100 V

Parallel load capacitance

Working frequency	measured with the British Military Test Set TS 193, the parallel capacitance being set at 30 pF and the grid current at 20 μA.
Minimum equivalent parallel resistance	
for 1.8 - 10 MHz	according to Fig.2, the parallel capacitance set at 30 pF, and the grid current at 20 μA.
for 10 - 20 MHz	according to Fig.3, the parallel capacitance set at 20 pF, and the grid current at 20 μA.

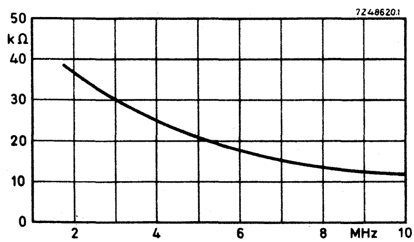


Fig. 2

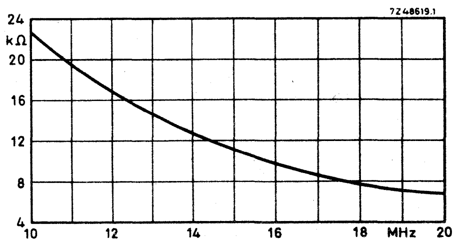


Fig. 3

Series load capacitance

Working frequency	to be measured with the American Military Test Sets TS-330/TSM for the frequency range 1.8 - 10 MHz and TS-683/TSM for the frequency range 10 - 20 MHz The series capacitance to be set at 32 pF and the set being tuned in accordance with Table 3 or 4 (Table 4 applies to oven-controlled units).

Maximum equivalent series resistance

at a series capacitance of 32 pF :

1.800000 -	1.869999	MHz	300 Ω
1.870000 -	1.999999	MHz	290 Ω
2.000000 -	2.119999	MHz	270 Ω
2.120000 -	2.249999	MHz	245 Ω
2.250000 -	2.599999	MHz	195 Ω
2.600000 -	2.999999	MHz	150 Ω
3.000000 -	3.399999	MHz	110 Ω
3.400000 -	3.749999	MHz	90 Ω
3.750000 -	3.999999	MHz	75 Ω
4.000000 -	4.999999	MHz	60 Ω
5.000000 -	6.999999	MHz	35 Ω
7.000000 -	9.999999	MHz	24 Ω
10.000000 -	14.999999	MHz	22 Ω
15.000000 -	20.000000	MHz	20 Ω

Series resonance

Working frequency — to be measured with the American Military Test Sets TS-330/TSM for the frequency range 1.8 - 10 MHz and TS-683/TSM for the frequency range 10 - 20 MHz, without a series capacitance.
The set to be tuned in accordance with Table 3 or 4 (Table 4 applies to oven-controlled units).

Maximum series resistance at

1.800000 -	1.869999	MHz	220 Ω
1.870000 -	1.999999	MHz	185 Ω
2.000000 -	2.119999	MHz	165 Ω
2.120000 -	2.249999	MHz	150 Ω
2.250000 -	2.599999	MHz	125 Ω
2.600000 -	2.999999	MHz	90 Ω
3.000000 -	3.399999	MHz	70 Ω
3.400000 -	3.749999	MHz	52 Ω
3.750000 -	3.999999	MHz	45 Ω
4.000000 -	4.999999	MHz	37 Ω
5.000000 -	6.999999	MHz	25 Ω
7.000000 -	9.999999	MHz	20 Ω
10.000000 -	14.999999	MHz	18 Ω
15.000000 -	20.000000	MHz	15 Ω

Tuning conditions for the test sets

Table 3

test set	nominal frequency (MHz)	tuning frequency (MHz)	tuning resistance (Ω)	voltage drop (mW)	level of drive *) (mW)
TS330	1, 800000 - 2, 249999	nominal	50	750	10 ± 2
	2, 250000 - 3, 399999	nominal	40	600	10 ± 2
	3, 400000 - 5, 099999	nominal	25	500	10 ± 2
	5, 100000 - 7, 499999	nominal	14	350	10 ± 2
	7, 500000 - 9, 999999	nominal	11	330	10 ± 2
TS683	10, 000000 - 15, 000000	nominal	13	260	5 ± 1
	15, 000001 - 20, 000000	nominal	10	220	5 ± 1

Table 4 (oven-controlled units)

test set	nominal frequency (MHz)	tuning frequency (MHz)	tuning resistance (Ω)	voltage drop (mW)	level of drive *) (mW)
TS330	1, 800000 - 2, 249999	nominal	50	500	5 ± 1
	2, 250000 - 3, 399999	nominal	50	500	5 ± 1
	3, 400000 - 5, 099999	nominal	22	330	5 ± 1
	5, 100000 - 7, 499999	nominal	13	260	5 ± 1
	7, 500000 - 9, 999999	nominal	13	260	5 ± 1
TS683	10, 00000 - 15, 000000	nominal	11	165	2, 5 ± 0, 5
	15, 00001 - 20, 000000	nominal	10	160	2, 5 ± 0, 5

Passive method with π-network

The working frequency may also be measured according to the passive method with π-network. Level of drive, generally, 0, 5 mW.

*) Measurements at lower level of drive (within the limits of the specified test set) can be made on request.

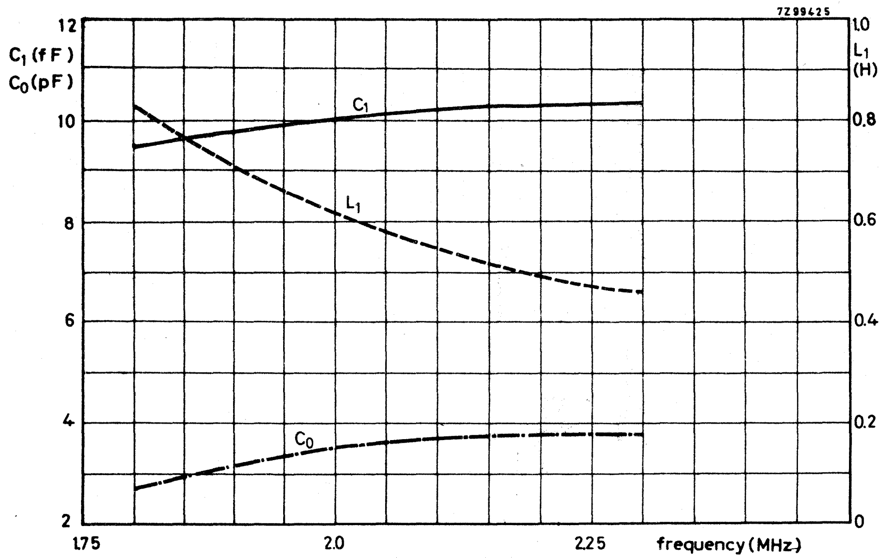


Fig.4 Typical values for C_0, C_1 and L_1 for frequencies from 1.8 to 2.3 MHz

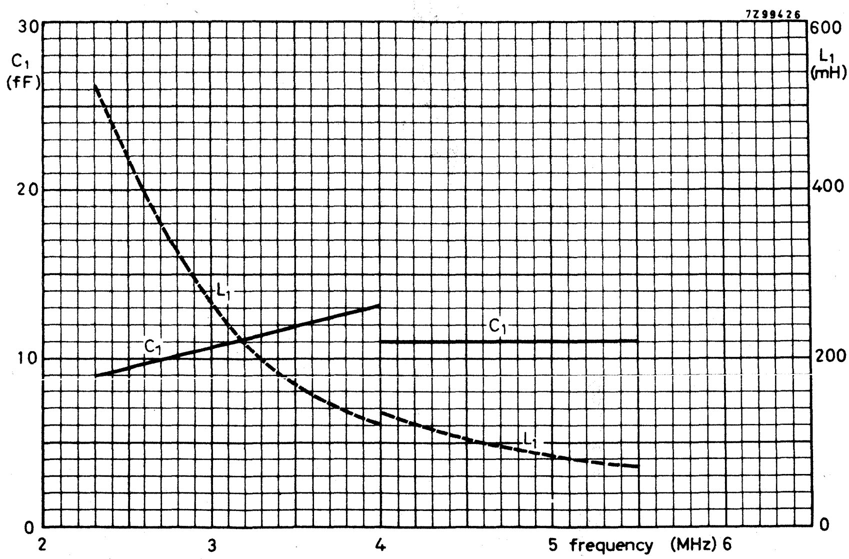


Fig.5 Typical values for C_1 and L_1 for frequencies from 2.3 to 5.5 MHz

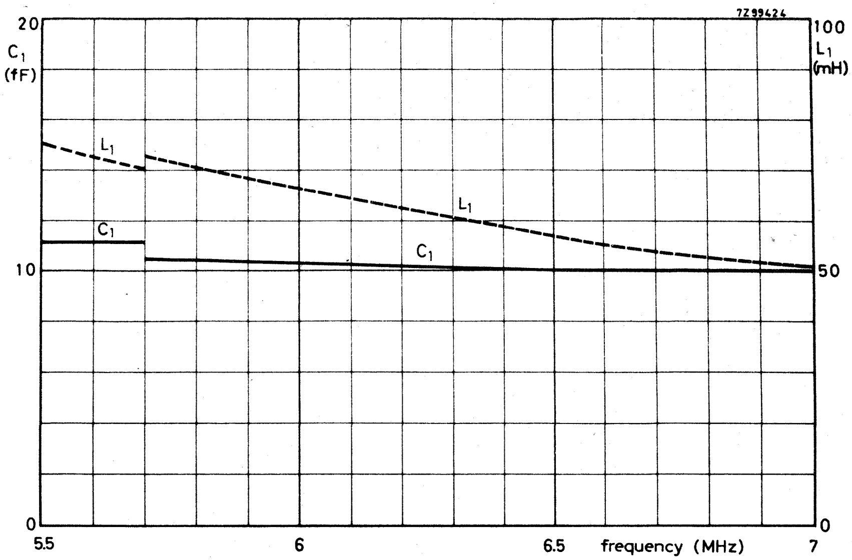


Fig.6 Typical values for C_1 and L_1 for frequencies from 5.5 to 7 MHz

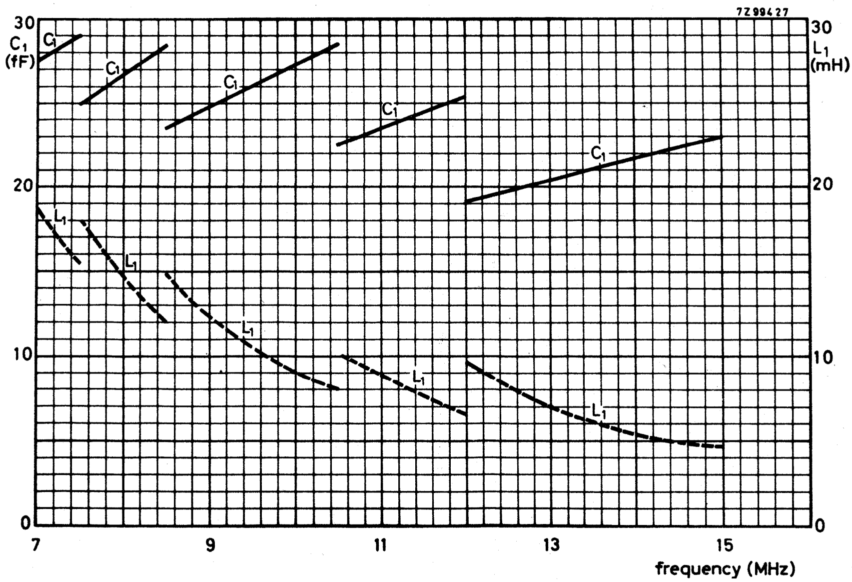


Fig.7 Typical values for C_1 and L_1 for frequencies from 7 to 15 MHz

QUARTZ CRYSTAL UNITS

QUICK REFERENCE DATA	
Frequency range	4.5 - 20 MHz
Mode of vibration	fundamental
Type of holder	all glass HC-26/U (MIL) or HC-29/U (MIL)

APPLICATION

These units are used for frequency stabilisation in circuits, in which a high stability and a low series resistance are required.
They are generally used in series or parallel resonance oscillators.
Example: oscillator circuits in communication equipment with narrow channel spacing.

DESCRIPTION

The units consist of a metal plated AT-cut quartz plate, mounted in a hermetically sealed evacuated glass holder type HC-26/U provided with two connecting leads or type HC-29/U provided with two connecting pins.

MECHANICAL AND ENVIRONMENTAL DATA

Dimensions in mm
(in inches between brackets)

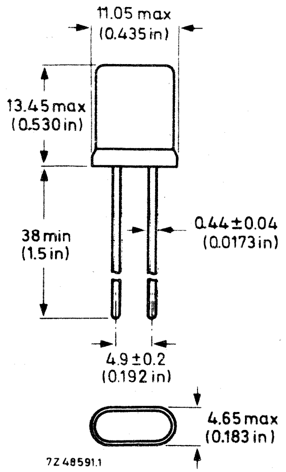


Fig.1.
HC-26/U

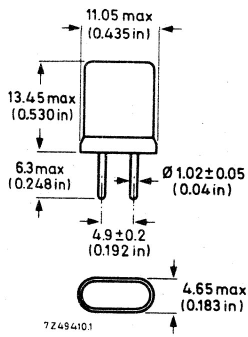


Fig.2
HC-29/U

Mass

With both types of holder approximately 0, 8 g.

Marking

If a special marking is not requested, marking will be done as stated under "Holders" in the general section.

Shock and vibration tests: According to MIL-C-3098E.

Climatic tests : According to MIL-C-3098E.

ELECTRICAL DATA

Table 1, Frequency tolerance

frequency range	temperature range	frequency tolerance		
		class 0	class I	class II
4, 5 - 20 MHz	$-5/+45\ ^oC$ $-10/+50\ ^oC$ $-15/+70\ ^oC$	$\pm 15 \times 10^{-6}$ $\pm 17,5 \times 10^{-6}$ $\pm 20 \times 10^{-6}$	$\pm 17,5 \times 10^{-6}$ $\pm 20 \times 10^{-6}$ $\pm 25 \times 10^{-6}$	$\pm 20 \times 10^{-6}$ $\pm 25 \times 10^{-6}$ $\pm 30 \times 10^{-6}$
4, 5 - 6 MHz 6 - 12 MHz 12 - 20 MHz	$-55/+105\ ^oC$ $-55/+105\ ^oC$ $-55/+105\ ^oC$	$\pm 40 \times 10^{-6}$ $\pm 42,5 \times 10^{-6}$ $\pm 35 \times 10^{-6}$	$\pm 50 \times 10^{-6}$ $\pm 45 \times 10^{-6}$ $\pm 40 \times 10^{-6}$	$\pm 60 \times 10^{-6}$ $\pm 50 \times 10^{-6}$ $\pm 50 \times 10^{-6}$

Table 2, Frequency drift

frequency range	temperature range	frequency drift		
		class 0	class I	class II
4, 5 - 20 MHz	$-5/+45\ ^oC$ $-10/+50\ ^oC$ $-15/+70\ ^oC$	$\pm 5 \times 10^{-6}$ $\pm 7,5 \times 10^{-6}$ $\pm 10 \times 10^{-6}$	$\pm 7,5 \times 10^{-6}$ $\pm 10 \times 10^{-6}$ $\pm 15 \times 10^{-6}$	$\pm 10 \times 10^{-6}$ $\pm 15 \times 10^{-6}$ $\pm 20 \times 10^{-6}$
4, 5 - 6 MHz 6 - 12 MHz 12 - 20 MHz	$-55/+105\ ^oC$ $-55/+105\ ^oC$ $-55/+105\ ^oC$	$\pm 30 \times 10^{-6}$ $\pm 32,5 \times 10^{-6}$ $\pm 25 \times 10^{-6}$	$\pm 40 \times 10^{-6}$ $\pm 35 \times 10^{-6}$ $\pm 30 \times 10^{-6}$	$\pm 50 \times 10^{-6}$ $\pm 40 \times 10^{-6}$ $\pm 40 \times 10^{-6}$
4, 5 - 20 MHz	$T_{nom.} \pm 5\ ^oC$		$\pm 2,5 \times 10^{-6}$	$\pm 5 \times 10^{-6}$

Accuracy of adjustment $\pm 10 \times 10^{-6}$ (to be combined with any of the frequency drift figures quoted).

Parallel capacitance C_0 Inductance L_1 Dynamic capacitance C_1	typical values for 4.5 - 7 MHz: see Fig.6 7 - 20 MHz: see Fig.7
Change in frequency as a result of ageing	$-0.5/+1 \times 10^{-6}$, after 90 days at 85 ±2 °C, non-operative
Maximum permissible d.c. voltage between terminals	100 V

Parallel load capacitance

Working frequency	measured with the British Military Test Set TS 193, the parallel capacitance being set at 30 pF and the grid current at 20 μA.
Minimum equivalent parallel resistance for 4.5 - 7 MHz	according to Fig.3, the parallel capacitance set at 30 pF and the grid current at 20 μA.
for 7 - 10 MHz	according to Fig.4, the parallel capacitance set at 20 pF and the grid current at 20 μA.
for 10 - 20 MHz	according to Fig.5, the parallel capacitance set at 20 pF and the grid current at 20 μA.

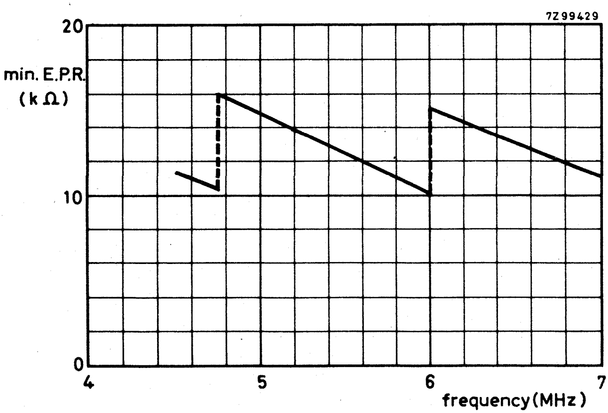


Fig. 3

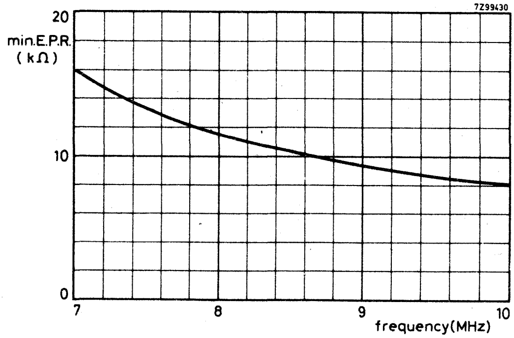


Fig. 4

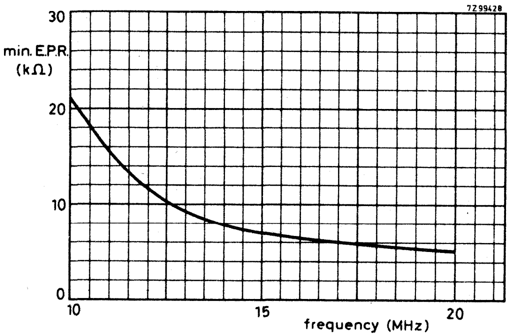


Fig. 5

Series load capacitance

Working frequency — to be measured with the American Military Test Sets TS330/TSM for the frequency range 4,5 - 10 MHz, and TS683/TSM for the frequency range 10 - 20 MHz, the series capacitance to be set at 32 pF and the set being tuned in accordance with Table 3 or 4. (Table 4 applies to oven-controlled units.)

Maximum equivalent series resistance

at a series capacitance of 32 pF, and at

4,500000 - 4,749999 MHz	120 Ω
4,750000 - 5,999999 MHz	75 Ω
6,000000 - 6,999999 MHz	50 Ω
7,000000 - 9,999999 MHz	30 Ω
10,000000 - 11,999999 MHz	30 Ω
12,000000 - 12,999999 MHz	30 Ω
13,000000 - 20,000000 MHz	25 Ω

Tuning conditions for the test sets:

Table 3

test set	nominal frequency (MHz)	tuning resistance (Ω)	voltage drop (mV)	level of drive *) (mW)
TS330	4,500000 - 5,099999	50	350	2,5 ± 0,5
	5,100000 - 6,999999	22	235	2,5 ± 0,5
	7,000000 - 7,499999	22	330	5 ± 1
	7,500000 - 9,999999	13	260	5 ± 1
TS683	10,000000 - 15,000000	13	260	5 ± 1
	15,000001 - 20,000000	10	220	5 ± 1

Table 4 (oven-controlled units)

test set	nominal frequency (MHz)	tuning resistance (Ω)	voltage drop (mV)	level of drive *) (mW)
TS330	4,500000 - 5,099999	50	350	2,5 ± 0,5
	5,100000 - 6,999999	22	235	2,5 ± 0,5
	7,000000 - 7,499999	22	235	2,5 ± 0,5
	7,500000 - 9,999999	13	185	2,5 ± 0,5
TS683	10,000000 - 15,000000	13	185	2,5 ± 0,5
	15,000001 - 20,000000	10	156	2,5 ± 0,5

Series resonance

Working frequency — to be measured with the American Military Test Sets TS330/TSM for the frequency range 4,5 - 10 MHz, and TS683/TSM for the frequency range 10 - 20 MHz, without a series capacitance, the set to be tuned in accordance with Table 5 or 6.
(Table 6 applies to oven-controlled units.)

Maximum series resistance at

4,500000 - 4,749999 MHz	110 Ω
4,750000 - 5,999999 MHz	70 Ω
6,000000 - 6,999999 MHz	45 Ω
7,000000 - 9,999999 MHz	30 Ω
10,000000 - 14,999999 MHz	25 Ω
15,000000 - 20,000000 MHz	20 Ω

*) Measurements at lower level of drive (within the limits of the specified test set) can be made on request.

Tuning conditions for the test sets:

Table 5

test set	nominal frequency (MHz)	tuning resistance (Ω)	voltage drop (mV)	level of drive *) (mW)
TS330	4,500000 - 5,099999	50	350	2,5 ± 0,5
	5,100000 - 6,999999	22	235	2,5 ± 0,5
	7,000000 - 7,499999	25	350	5 ± 1
	7,500000 - 9,999999	16	288	5 ± 1
TS683	10,000000 - 15,000000	13	260	5 ± 1
	15,000001 - 20,000000	12	240	5 ± 1

Table 6 (oven-controlled units)

test set	nominal frequency (MHz)	tuning resistance (Ω)	voltage drop (mV)	level of drive *) (mW)
TS330	4,500000 - 5,099999	50	350	2,5 ± 0,5
	5,100000 - 6,999999	22	235	2,5 ± 0,5
	7,000000 - 7,499999	25	250	2,5 ± 0,5
	7,500000 - 9,999999	16	205	2,5 ± 0,5
TS683	10,000000 - 15,000000	13	185	2,5 ± 0,5
	15,000001 - 20,000000	12	170	2,5 ± 0,5

Passive method with π-network

→ The working frequency may also be measured according to the passive method with π-network. Level of drive, generally, 0,5 mW.

→ *) Measurements at lower level of drive (within the limits of the specified test set) can be made on request.

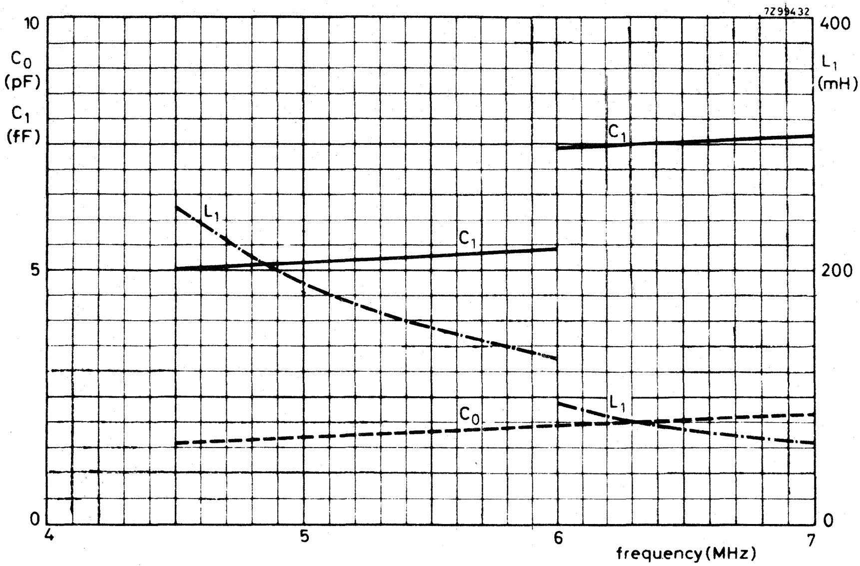


Fig. 6. Typical values of L_1, C_0 and C_1 for frequencies from 4.5 to 7 MHz.

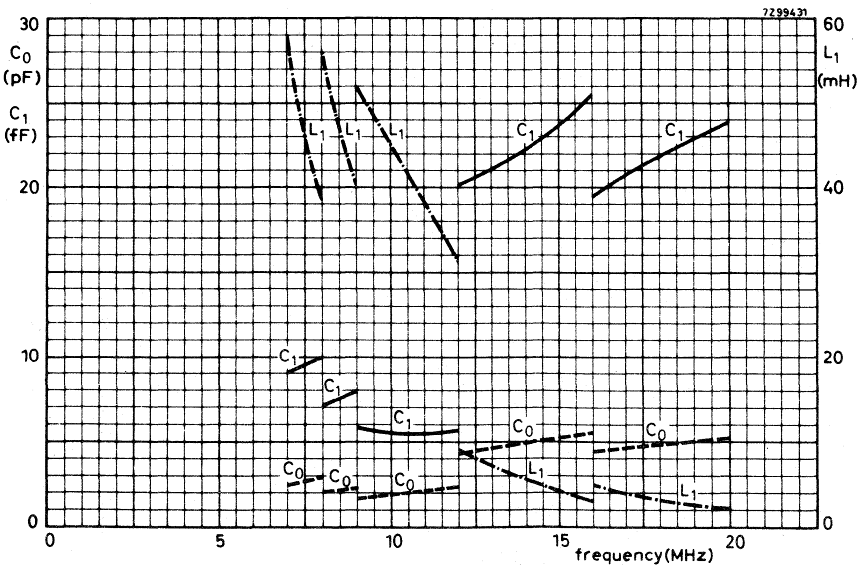


Fig. 7. Typical values of L_1, C_0 and C_1 for frequencies from 7 to 20 MHz.

QUARTZ CRYSTAL UNITS

QUICK REFERENCE DATA	
Frequency range	10 - 61 MHz
Mode of vibration	third overtone
Types of holder	metal; HC-6/U (MIL), RW-36

APPLICATION

These units are used for frequency stabilization.
They are generally used at series resonance.

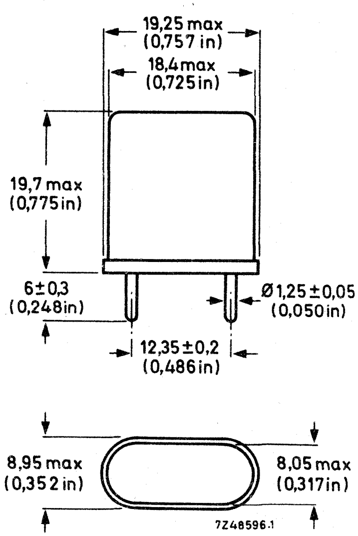
DESCRIPTION

The units consist of a metal-plated AT-cut quartz plate, mounted in a hermetically sealed metal holder, provided with two connecting pins.

MECHANICAL AND ENVIRONMENTAL DATA

Dimensions in mm
(in inches between brackets)

Outlines



Mass

Approximately 4 g.

Marking

If a special marking is not requested, marking will be done as stated under "Holders" in the general section.

Shock and vibration tests

According to MIL-C-3098B.

Climatic tests

According to MIL-C-3098B.

ELECTRICAL DATA

Table 1, Frequency tolerance

temperature range	frequency tolerance		
	class 0	class I	class II
-5/ +50 °C	±25 x 10^{-6}	±27,5 x 10^{-6}	±30 x 10^{-6}
-10/ +60 °C	±27,5 x 10^{-6}	±30 x 10^{-6}	±35 x 10^{-6}
-20/ +70 °C	±30 x 10^{-6}	±33 x 10^{-6}	±40 x 10^{-6}
-55/+105 °C	±45 x 10^{-6}	±50 x 10^{-6}	±60 x 10^{-6}

Table 2, Frequency drift

temperature range	frequency drift		
	class 0	class I	class II
-5/ +50 °C	± 5 x 10^{-6}	± 7,5 x 10^{-6}	±10 x 10^{-6}
-10/ +60 °C	± 7,5 x 10^{-6}	±10 x 10^{-6}	±15 x 10^{-6}
-20/ +70 °C	±10 x 10^{-6}	±13 x 10^{-6}	±20 x 10^{-6}
-55/+105 °C	±25 x 10^{-6}	±30 x 10^{-6}	±40 x 10^{-6}
$T_{nom.}$± 5 °C	±5 x 10^{-6}		

Accuracy of adjustment ±20 x 10^{-6} (to be combined with any of the frequency drift figures quoted)

Working frequency (series resonance) — to be measured with the American Military Test Set TS-683/TSM without a series capacitance, the set being tuned in accordance with Table 3 or 4. (Table 4 applies to oven-controlled units.)

Maximum series resistance

10 - 15 MHz	60 Ω
15 - 61 MHz	40 Ω

Tuning conditions for the test set:

Table 3

nominal frequency (MHz)	tuning resistance (Ω)	voltage drop (mV)	level of drive *) (mW)
10,000000 - 14,999999	60	490	4 ± 0,8
15,000000 - 24,999999	40	400	4 ± 0,8
25,000000 - 61,000000	40	280	2 ± 0,4

Table 4 (oven-controlled units)

nominal frequency (MHz)	tuning resistance (Ω)	voltage drop (mV)	level of drive *) (mW)
10,000000 - 14,999999	60	350	2 ± 0,4
15,000000 - 24,999999	40	280	2 ± 0,4
25,000000 - 61,000000	40	200	1 ± 0,2

Parallel capacitance — max. 7 pF

Maximum permissible d.c. voltage between the pins — 100 V

Passive method with π-network

The working frequency may also be measured according to the passive method with π-network. Level of drive, generally, 0,5 mW.

*) Measurements at lower level of drive (within the limits of the specified test set) can be made on request.

QUARTZ CRYSTAL UNITS

QUICK REFERENCE DATA	
Frequency range	17 - 61 MHz
Mode of vibration	third overtone
Types of holder	metal; HC-18/U (MIL), RW-43 HC-25/U (MIL), RW-42

APPLICATION

These units are used for frequency stabilization.
They are generally used at series resonance.

DESCRIPTION

The units consists of a metal-plated AT-cut quartz plate, mounted in a hermetically sealed metal holder, provided with 2 connecting leads (HC-18/U and RW-43) or pins (HC-25/U and RW-42).

MECHANICAL AND ENVIRONMENTAL DATA

Dimensions in mm
(in inches between brackets)

Outlines

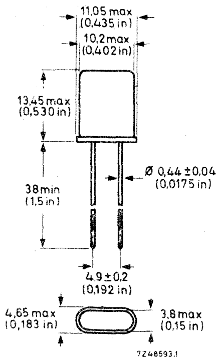


Fig. 1a. HC-18/U

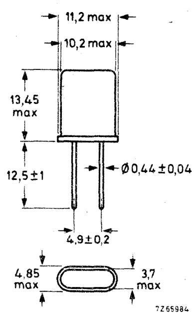


Fig. 1b. RW-43

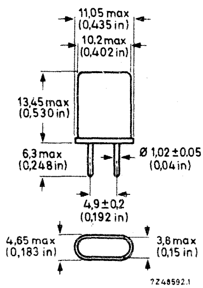


Fig. 2a. HC-25/U

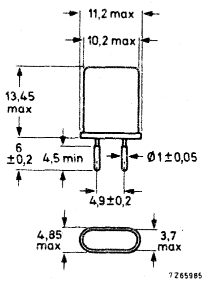


Fig. 2b. RW-42

Mass

With any of the four holders approximately 1 g.

Marking

If a special marking is not requested, marking will be done as stated under "Holders" in the general section.

Shock and vibration tests

According to MIL-C-3098B.

Climatic tests

According to MIL-C-3098B

ELECTRICAL DATA

Table 1, Frequency tolerance

temperature range	frequency tolerance		
	class 0	class I	class II
−5/ +50 °C	$\pm 25 \times 10^{-6}$	$\pm 27,5 \times 10^{-6}$	$\pm 30 \times 10^{-6}$
−10/ +60 °C	$\pm 27,5 \times 10^{-6}$	$\pm 30 \times 10^{-6}$	$\pm 35 \times 10^{-6}$
−20/ +70 °C	$\pm 30 \times 10^{-6}$	$\pm 33 \times 10^{-6}$	$\pm 40 \times 10^{-6}$
−55/+105 °C	$\pm 45 \times 10^{-6}$	$\pm 50 \times 10^{-6}$	$\pm 60 \times 10^{-6}$

Table 2, Frequency drift

temperature range	frequency drift		
	class 0	class I	class II
−5/ +50 °C	$\pm 5 \times 10^{-6}$	$\pm 7,5 \times 10^{-6}$	$\pm 10 \times 10^{-6}$
−10/ +60 °C	$\pm 7,5 \times 10^{-6}$	$\pm 10 \times 10^{-6}$	$\pm 15 \times 10^{-6}$
−20/ +70 °C	$\pm 10 \times 10^{-6}$	$\pm 13 \times 10^{-6}$	$\pm 20 \times 10^{-6}$
−55/+105 °C	$\pm 25 \times 10^{-6}$	$\pm 30 \times 10^{-6}$	$\pm 40 \times 10^{-6}$
$T_{nom} \pm 5$ °C	$\pm 5 \times 10^{-6}$		

Accuracy of adjustment $\pm 20 \times 10^{-6}$
(to be combined with any of the frequency drift figures quoted)

Working frequency (series resonance)	to be measured with the American Military Test Set TS-683/TSM, without a series capacitance, the set being tuned in accordance with Table 3 or 4. (Table 4 applies to oven-controlled units.)
Maximum series resistance	40 Ω

Tuning conditions of the test set:

Table 3

nominal frequency (MHz)	tuning resistance (Ω)	voltage drop (mV)	level of drive *) (mW)
17,000000 - 24,999999	40	400	4 ± 0,8
25,000000 - 61,000000	40	280	2 ± 0,4

Table 4 (oven-controlled units)

nominal frequency (MHz)	tuning resistance (Ω)	voltage drop (mV)	level of drive *) (mW)
17,000000 - 24,999999	40	280	2 ± 0,4
25,000000 - 61,000000	40	200	1 ± 0,2

Parallel capacitance	max. 7 pF
Maximum permissible d.c. voltage between pins	100 V

Passive method with π-network

The working frequency may also be measured according to the passive method with π-network. Level of drive, generally, 0,5 mW.

*) Measurements at lower level of drive (within the limits of the specified test set) can be made on request.

QUARTZ CRYSTAL UNITS

QUICK REFERENCE DATA	
Frequency range	10 - 61 MHz
Mode of vibration	third overtone
Type of holder	all glass, HC-27/U (MIL)

APPLICATION

These units are used for frequency stabilisation in circuits, in which a high stability and a low series resistance are required.
They are generally used at series resonance.
Example: oscillator circuits in communication equipment with narrow channel spacing.

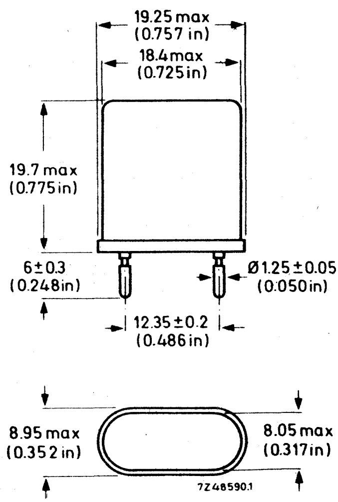
DESCRIPTION

The units consist of a metal plated AT-cut quartz plate, mounted in a hermetically sealed, evacuated glass holder, provided with 2 connecting pins.

MECHANICAL AND ENVIRONMENTAL DATA

Dimensions in mm

(in inches between brackets)



Mass

Approximately 2,5 g.

Marking

If a special marking is not requested, marking will be done as stated under "Holders" in the general section.

Shock and vibration tests

According to MIL-C-3098E.

Climatic tests

According to MIL-C-3098E.

ELECTRICAL DATA

Table 1, Frequency tolerance

temperature range	frequency tolerance		
	class 0	class I	class II
-5/ +50 °C	± 15 x 10^{-6}	± 17,5 x 10^{-6}	± 20 x 10^{-6}
-10/ +60 °C	± 17,5 x 10^{-6}	± 20 x 10^{-6}	± 25 x 10^{-6}
-20/ +70 °C	± 20 x 10^{-6}	± 23 x 10^{-6}	± 30 x 10^{-6}
-55/+105 °C	± 35 x 10^{-6}	± 40 x 10^{-6}	± 50 x 10^{-6}

Table 2, Frequency drift

temperature range	frequency drift		
	class 0	class I	class II
-5/ +50 °C	± 5 x 10^{-6}	± 7,5 x 10^{-6}	± 10 x 10^{-6}
-10/ +60 °C	± 7,5 x 10^{-6}	± 10 x 10^{-6}	± 15 x 10^{-6}
-20/ +70 °C	± 10 x 10^{-6}	± 13 x 10^{-6}	± 20 x 10^{-6}
-55/+105 °C	± 25 x 10^{-6}	± 30 x 10^{-6}	± 40 x 10^{-6}
T_{nom} ± 5 °C		± 2,5 x 10^{-6}	± 5 x 10^{-6}

Accuracy of adjustment ± 10 x 10^{-6}
(to be combined with any of the frequency drift figures quoted)

Working frequency (series resonance)	to be measured with the American Military Test Set TS-683/TSM, without a series capacitance, the set being tuned in accordance with Table 3 or 4. (Table 4 applies to oven-controlled units.)
Maximum series resistance	
10 - 15 MHz	40 Ω
15 - 61 MHz	20 Ω

Tuning conditions for the test set:

Table 3

nominal frequency (MHz)	tuning resistance (Ω)	voltage drop (mV)	level of drive *) (mW)
10,000000 - 14,999999	20	290	4 ± 0,8
15,000000 - 24,999999	10	200	4 ± 0,8
25,000000 - 61,000000	10	140	2 ± 0,4

Table 4 (oven-controlled units)

nominal frequency (MHz)	tuning resistance (Ω)	voltage drop (mV)	level of drive *) (mW)
10,000000 - 14,999999	20	200	2 ± 0,4
15,000000 - 24,999999	10	140	2 ± 0,4
25,000000 - 61,000000	10	100	1 ± 0,2

Parallel capacitance	max. 7 pF
Change in frequency as a result of ageing	$-0,5/+1 \times 10^{-6}$, after 90 days at 85 ± 2 °C, non-operative
Maximum permissible d.c. voltage between the pins	100 V

Passive method with π-network

The working frequency may also be measured according to the passive method with π-network. Level of drive, generally, 0,5 mW.

*) Measurements at lower level of drive (within the limits of the specified test set) can be made on request.

10 MHz, THIRD-OVERTONE QUARTZ CRYSTAL UNIT in all-glass holder HC-27/U

Application	in oscillators for SSB systems or secondary standards
Crystal cut	AT
Version	metal-plated

The crystal unit fulfils the following specification:

1) Nominal frequency — 10 MHz, third overtone.

2) Accuracy of adjustment — At a temperature of 70 °C ±1 °C the accuracy of adjustment is better than $\pm 5.10^{-6}$ at a current of 1 mA and a series load capacitance (C_L) of 75 pF. The influence of the drive level on the frequency is $\leqq 2.10^{-8}$ per dB. The working frequency can be adjusted to the nominal value by a variation of C_L by +75 to −25 pF.

3) Frequency drift — In the temperature range of +69 to +71 °C the frequency drift is $\leqq \pm 0.3 \cdot 10^{-6}$ measured at series resonance.

4) Ageing — Frequency change due to ageing $< \pm 5.10^{-8}$/month.

5) Series resonance — <40 Ω in the temperature range −40 to +75 °C, measured in test set TS-683/TSM according to MIL-C-3098B, CR-23/U.

6) Unwanted modes — In the temperature range −40 to 75 °C both the frequency and the series resistance as a function of the temperature do not show any discontinuities.

7) Holder — HC-27/U.

8) Mechanical tests — Shock and vibration according to MIL-C-3098C. The frequency change due to these tests is $< 3.10^{-6}$ and the change of the series resistance is < 15 %.

9) Oscillator circuit — The crystal unit can only prove its properties in a well designed circuit, such as that of Fig.1. Fig.2 gives a lay-out of this circuit on a p.w.-board.

Stability of oscillator

The stability of the oscillator frequency depends on the crystal oven used. A stability figure of 1.10^{-6} or even 1.10^{-7} can be achieved.

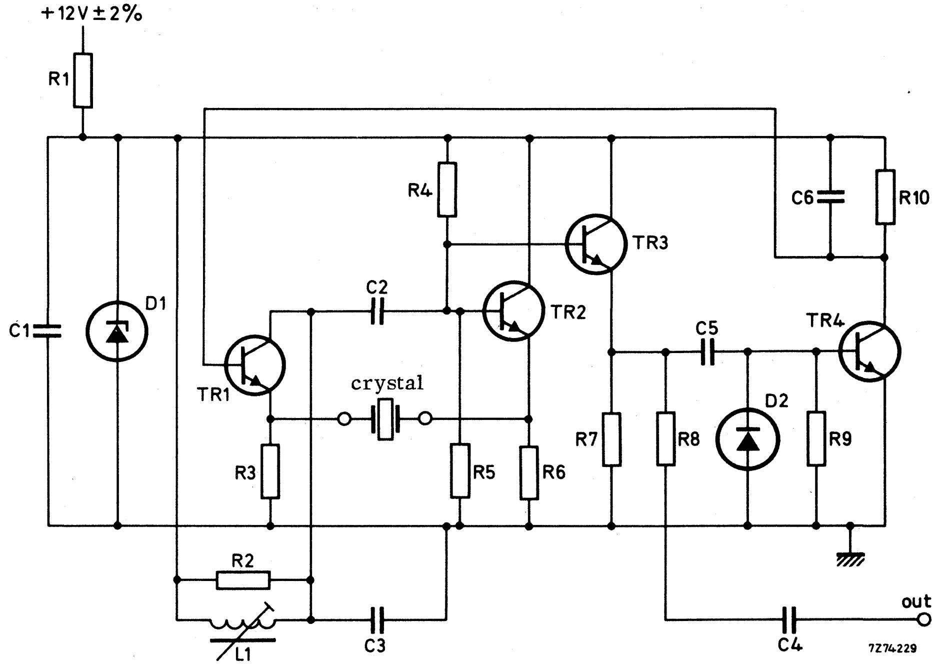
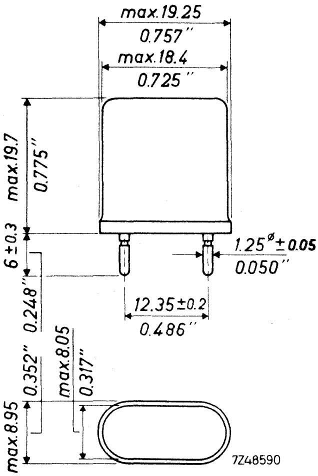


Fig. 1

All resistors ± 5%

R 1 =	390 Ω	R 8	= 2200 Ω	C1 =	10000 pF
R 2 =	2500 Ω	R 9	= 27000 Ω	C2 =	1000 pF
R 3 =	1500 Ω	R 10	= 10000 Ω	C3 =	25 pF
R 4 =	10000 Ω	D1	= BZX79 C7V5	C4 =	1000 pF
R 5 =	5600 Ω	D2	= BAY38	C5 =	150 pF
R 6 =	1200 Ω	TR 1, 2, 3, 4	= BSX19	C6 =	1000 pF
R 7 =	680 Ω			L1 =	13 μH


max.19.25
0.757"
max.18.4
0.725"
max.19.7
0.775"
6 ±0.3
0.248"
1.25ø ±0.05
0.050"
12.35 ±0.2
0.486"
0.352"
max.8.05
0.317"
max.8.95
7Z48590

QUARTZ CRYSTAL UNITS

QUICK REFERENCE DATA	
Frequency range	20 - 61 MHz
Mode of vibration	third overtone
Type of holder	all glass, HC-26/U (MIL) or HC-29/U (MIL)

APPLICATION

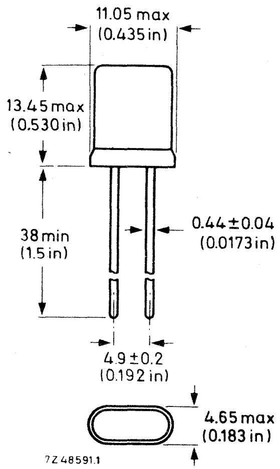
These units are used for frequency stabilisation in circuits, in which a high stability and a low series resistance are required.
They are generally used at series resonance.
Example: oscillator circuits in communication equipment with narrow channel spacing.

DESCRIPTION

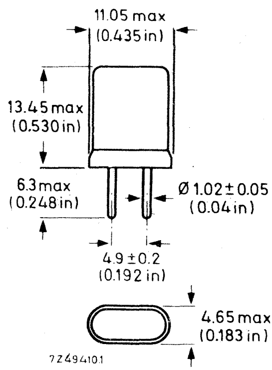
The units consist of a metal plated AT-cut quartz plate, mounted in a hermetically sealed, evacuated glass holder.
Holder type HC-26/U is provided with 2 connecting leads, type HC-29/U with 2 connecting pins.

MECHANICAL AND ENVIRONMENTAL DATA

Dimensions in mm
(in inches between brackets)



HC-26/U



HC-29/U

Mass

With both types of holder approximately 0, 8 g.

Marking

If a special marking is not requested, marking will be done as stated under "Holders" in the general section.

Shock and vibration tests

According to MIL-C-3098C.

Climatic tests

According to MIL-C-3098C.

ELECTRICAL DATA

Table 1, Frequency tolerance

temperature range	frequency tolerance		
	class 0	class I	class II
-5/ +50 °C	$\pm 15 \times 10^{-6}$	$\pm 17,5 \times 10^{-6}$	$\pm 20 \times 10^{-6}$
-10/ +60 °C	$\pm 17,5 \times 10^{-6}$	$\pm 20 \times 10^{-6}$	$\pm 25 \times 10^{-6}$
-20/ +70 °C	$\pm 20 \times 10^{-6}$	$\pm 23 \times 10^{-6}$	$\pm 30 \times 10^{-6}$
-55/+105 °C	$\pm 35 \times 10^{-6}$	$\pm 40 \times 10^{-6}$	$\pm 50 \times 10^{-6}$

Table 2, Frequency drift

temperature range	frequency drift		
	class 0	class I	class II
-5/ +50 °C	$\pm 5 \times 10^{-6}$	$\pm 7,5 \times 10^{-6}$	$\pm 10 \times 10^{-6}$
-10/ +60 °C	$\pm 7,5 \times 10^{-6}$	$\pm 10 \times 10^{-6}$	$\pm 15 \times 10^{-6}$
-20/ +70 °C	$\pm 10 \times 10^{-6}$	$\pm 13 \times 10^{-6}$	$\pm 20 \times 10^{-6}$
-55/+105 °C	$\pm 25 \times 10^{-6}$	$\pm 30 \times 10^{-6}$	$\pm 40 \times 10^{-6}$
$T_{nom} \pm 5$ °C		$\pm 2,5 \times 10^{-6}$	$\pm 5 \times 10^{-6}$

Accuracy of adjustment $\pm 10 \times 10^{-6}$
(to be combined with any of the frequency drift figures quoted)

Working frequency (series resonance)	to be measured with the American Military Test Set TS-683/TSM, without a series capacitance, the set being tuned in accordance with Table 3.
Maximum series resistance	30 Ω
Tuning conditions for the test set:	

Table 3

nominal frequency (MHz)	tuning resistance Ω	voltage drop (mV)	level of drive *) (mW)
20,000000 - 61,000000	20	200	2 ± 0,4
oven-controlled units 20,000000 - 61,000000	20	140	1 ± 0,2

Parallel capacitance	max. 7 pF
Change in frequency as a result of ageing	$-0,5/+1 \times 10^{-6}$, after 90 days at 85 ± 2 °C, non-operative
Maximum permissible d.c. voltage between the pins	100 V

Passive method with π-network

The working frequency may also be measured according to the passive method with π-network. Level of drive, generally, 0,5 mW.

*) Measurements at lower level of drive (within the limits of the specified test set) can be made on request.

QUARTZ CRYSTAL UNITS

QUICK REFERENCE DATA	
Frequency range	50 - 87 MHz
Mode of vibration	fifth overtone
Types of holder	metal; HC-6/U (MIL), RW-36

APPLICATION

These units are used for frequency stabilization.
They are generally used at series resonance.

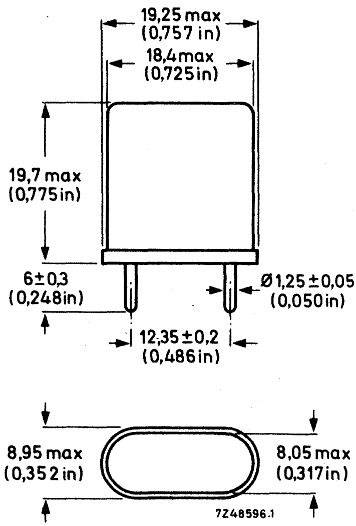
DESCRIPTION

The units consist of a metal-plated AT-cut quartz plate, mounted in a hermetically sealed metal holder, provided with 2 connecting pins.

MECHANICAL AND ENVIRONMENTAL DATA

Dimensions in mm
(in inches between brackets)

Outlines



Mass

With both types of holder approximately 4 g.

Marking

If a special marking is not requested, marking will be done as stated under "Holders" in the general section.

Shock and vibration tests

According to MIL-C-3098B.

Climatic tests

According to MIL-C-3098B.

ELECTRICAL DATA

Table 1, Frequency tolerance

temperature range	frequency tolerance		
	class 0	class I	class II
-5/ +50 °C	±25 x 10^{-6}	±27,5 x 10^{-6}	±30 x 10^{-6}
-10/ +60 °C	±27,5 x 10^{-6}	±30 x 10^{-6}	±35 x 10^{-6}
-20/ +70 °C	±30 x 10^{-6}	±33 x 10^{-6}	±40 x 10^{-6}
-55/+105 °C	±45 x 10^{-6}	±50 x 10^{-6}	±60 x 10^{-6}

Table 2, Frequency drift

temperature range	frequency drift		
	class 0	class I	class II
-5/ +50 °C	± 5 x 10^{-6}	± 7,5 x 10^{-6}	±10 x 10^{-6}
-10/ +60 °C	± 7,5 x 10^{-6}	±10 x 10^{-6}	±15 x 10^{-6}
-20/ +70 °C	±10 x 10^{-6}	±13 x 10^{-6}	±20 x 10^{-6}
-55/+105 °C	±25 x 10^{-6}	±30 x 10^{-6}	±40 x 10^{-6}
T_{nom} ± 5 °C		± 5 x 10^{-6}	

Accuracy of adjustment ±20 x 10^{-6}
(to be combined with any of the frequency drift figures quoted)

Working frequency (series resonance) — to be measured with the American Military Test Set TS-683/TSM, without a series capacitance, the set being tuned in accordance with Table 3.

Maximum series resistance — 60 Ω

Tuning conditions for the test set:

Table 3

nominal frequency (MHz)	tuning resistance (Ω)	voltage drop (mV)	level of drive *) (mW)
50,000000 - 87,000000	60	350	2 ± 0,4
oven-controlled units 50,000000 - 87,000000	60	240	1 ± 0,2

Parallel capacitance — max. 7 pF

Maximum permissible d.c. voltage between the pins — 100 V

Passive method with π-network

The working frequency may also be measured according to the passive method with π-network. Level of drive, generally, 0,5 mW.

*) Measurements at lower level of drive (within the limits of the specified test set) can be made on request.

QUARTZ CRYSTAL UNITS

QUICK REFERENCE DATA	
Frequency range	50 - 87 MHz
Mode of vibration	fifth overtone
Types of holder	metal; HC-18/U (MIL), RW-43 HC-25/U (MIL), RW-42

APPLICATION

These units are used for frequency stabilization.
They are generally used at series resonance.

DESCRIPTION

The units consist of a metal-plated AT-cut quartz plate, mounted in a hermetically sealed metal holder.
Holder types HC-18/U and RW-43 are provided with 2 connecting leads, types HC-25/U and RW-42 with 2 connecting pins.

MECHANICAL AND ENVIRONMENTAL DATA

Dimensions in mm
(in inches between brackets)

Outlines

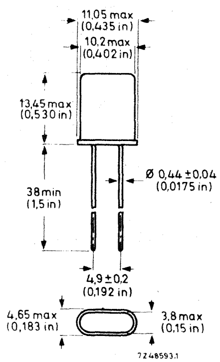


Fig. 1a. HC-18/U

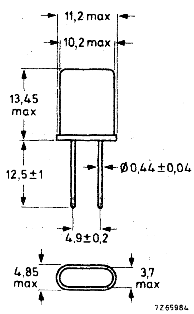


Fig. 1b. RW-43

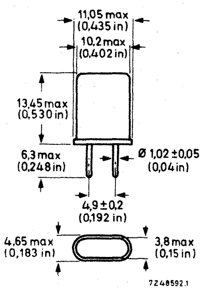


Fig. 2a. HC-25/U

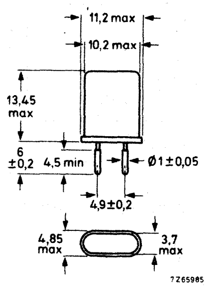


Fig. 2b. RW-42

Mass

With any of the four types of holder approximately 1 g.

Marking

If a special marking is not requested, marking will be done as stated under "Holders" in the general section.

Shock and vibration tests

According to MIL-C-3098B.

Climatic tests

According to MIL-C-3098B.

ELECTRICAL DATA

Table 1, Frequency tolerance

temperature range	frequency tolerance		
	class 0	class I	class II
-5/ +50 °C	$\pm 25 \times 10^{-6}$	$\pm 27,5 \times 10^{-6}$	$\pm 30 \times 10^{-6}$
-10/ +60 °C	$\pm 27,5 \times 10^{-6}$	$\pm 30 \times 10^{-6}$	$\pm 35 \times 10^{-6}$
-20/ +70 °C	$\pm 30 \times 10^{-6}$	$\pm 33 \times 10^{-6}$	$\pm 40 \times 10^{-6}$
-55/+105 °C	$\pm 45 \times 10^{-6}$	$\pm 50 \times 10^{-6}$	$\pm 60 \times 10^{-6}$

Table 2, Frequency drift

temperature range	frequency drift		
	class 0	class I	class II
-5/ +50 °C	$\pm 5 \times 10^{-6}$	$\pm 7,5 \times 10^{-6}$	$\pm 10 \times 10^{-6}$
-10/ +60 °C	$\pm 7,5 \times 10^{-6}$	$\pm 10 \times 10^{-6}$	$\pm 15 \times 10^{-6}$
-20/ +70 °C	$\pm 10 \times 10^{-6}$	$\pm 13 \times 10^{-6}$	$\pm 20 \times 10^{-6}$
-55/+105 °C	$\pm 25 \times 10^{-6}$	$\pm 30 \times 10^{-6}$	$\pm 40 \times 10^{-6}$
$T_{nom} \pm 5$ °C		$\pm 5 \times 10^{-6}$	

Accuracy of adjustment $\pm 20 \times 10^{-6}$
(to be combined with any of the frequency drift figures quoted)

Working frequency (series resonance): to be measured with the American Military Test Set TS-683/TSM, without a series capacitance, the set being tuned in accordance with Table 3.

Maximum series resistance: 60 Ω

Tuning conditions for the test set:

Table 3

nominal frequency (MHz)	tuning resistance (Ω)	voltage drop (mV)	level of drive *) (mW)
50,000000 - 87,000000	60	350	2 ± 0,4
oven-controlled units 50,000000 - 87,000000	60	240	1 ± 0,2

Parallel capacitance: max. 7 pF

Maximum permissible d.c. voltage between the pins: 100 V

Passive method with π-network

The working frequency may also be measured according to the passive method with π-network. Level of drive, generally, 0,5 mW.

*) Measurements at lower level of drive (within the limits of the specified test set) can be made on request.

QUARTZ CRYSTAL UNITS

QUICK REFERENCE DATA	
Frequency range	50 - 87 MHz
Mode of vibration	fifth overtone
Type of holder	all glass, HC-27/U

APPLICATION

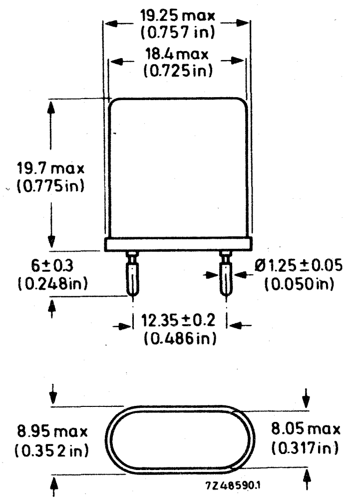
These units are used for frequency stabilisation in circuits, in which a high stability and a low series resistance are required.
They are generally used at series resonance.
Example: oscillator circuits in communication equipment with narrow channel spacing.

DESCRIPTION

The units consist of a metal plated AT-cut quartz plate, mounted in a hermetically sealed, evacuated glass holder, provided with 2 connecting pins.

MECHANICAL AND ENVIRONMENTAL DATA

Dimensions in mm
(in inches between brackets)



Mass

Approximately 2,5 g.

Marking

If a special marking is not requested, marking will be done as stated under "Holders" in the general section.

Shock and vibration tests

According to MIL-C-3098C.

Climatic tests

According to MIL-C-3098C.

ELECTRICAL DATA

Table 1, Frequency tolerance

temperature range	frequency tolerance		
	class 0	class I	class II
-5/ +50 °C	± 15 x 10^{-6}	± 17,5 x 10^{-6}	± 20 x 10^{-6}
-10/ +60 °C	± 17,5 x 10^{-6}	± 20 x 10^{-6}	± 25 x 10^{-6}
-20/ +70 °C	± 20 x 10^{-6}	± 23 x 10^{-6}	± 30 x 10^{-6}
-55/+105 °C	± 35 x 10^{-6}	± 40 x 10^{-6}	± 50 x 10^{-6}

Table 2, Frequency drift

temperature range	frequency drift		
	class 0	class I	class II
-5/ +50 °C	± 5 x 10^{-6}	± 7,5 x 10^{-6}	± 10 x 10^{-6}
-10/ +60 °C	± 7,5 x 10^{-6}	± 10 x 10^{-6}	± 15 x 10^{-6}
-20/ +70 °C	± 10 x 10^{-6}	± 13 x 10^{-6}	± 20 x 10^{-6}
-55/+105 °C	± 25 x 10^{-6}	± 30 x 10^{-6}	± 40 x 10^{-6}
T_{nom} ± 5 °C		± 2,5 x 10^{-6}	± 5 x 10^{-6}

Accuracy of adjustment ± 10 x 10^{-6}
(to be combined with any of the frequency drift figures quoted)

Working frequency (series resonance) — to be measured with the American Military Test Set TS-683/TSM, without a series capacitance, the set being tuned in accordance with Table 3.

Maximum series resistance — 50 Ω

Tuning conditions for the test set:

Table 3

nominal frequency (MHz)	tuning resistance (Ω)	voltage drop (mV)	level of drive *) (mW)
50,000000 - 87,000000	60	350	2 ± 0,4
oven-controlled units 50,000000 - 87,000000	60	240	1 ± 0,2

Parallel capacitance — max. 7 pF

Change in frequency as a result of ageing — $-0,5/+1 \times 10^{-6}$, after 90 days at 85 ± 2 °C, non-operative

Maximum permissible d.c. voltage between the pins — 100 V

<u>Passive method with π-network</u>

The working frequency may also be measured according to the passive method with π-network. Level of drive, generally, 0,5 mW.

*) Measurements at lower level of drive (within the limits of the specified test set) can be made on request.

QUARTZ CRYSTAL UNITS

QUICK REFERENCE DATA	
Frequency range	50 - 87 MHz
Mode of vibration	fifth overtone
Type of holder	all glass, HC-26/U (MIL) or HC-29/U (MIL)

APPLICATION

These units are used for frequency stabilisation in circuits, in which a high stability and a low series resistance are required.
They are generally used at series resonance.
Example: oscillator circuits in communication equipment with narrow channel spacing.

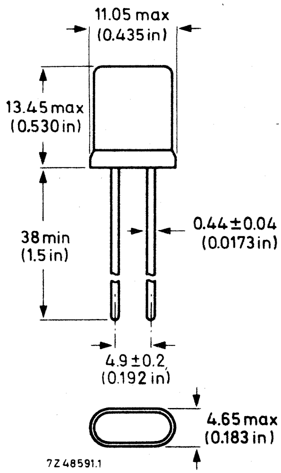
DESCRIPTION

The units consist of a metal plated AT-cut quartz plate, mounted in a hermetically sealed evacuated glass holder.
Holder type HC-26/U is provided with 2 connecting leads, type HC-29/U with 2 connecting pins.

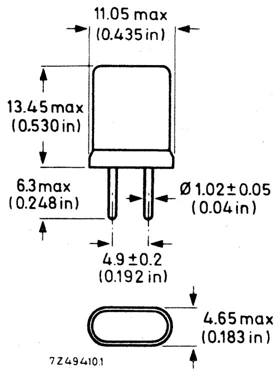
MECHANICAL AND ENVIRONMENTAL DATA

Dimensions in mm

(in inches between brackets)



HC-26/U



HC-29/U

Green Binder, Tab 11

Mass

With both types of holder approximately 0, 8 g.

Marking

If a special marking is not requested, marking will be done as stated under "Holders" in the general section.

Shock and vibration tests

According to MIL-C-3098C.

Climatic tests

According to MIL-C-3098C.

ELECTRICAL DATA

Table 1, Frequency tolerance

temperature range	frequency tolerance		
	class 0	class I	class II
-5/ +50 °C	± 15 x 10^{-6}	± 17,5 x 10^{-6}	± 20 x 10^{-6}
-10/ +60 °C	± 17,5 x 10^{-6}	± 20 x 10^{-6}	± 25 x 10^{-6}
-20/ +70 °C	± 20 x 10^{-6}	± 23 x 10^{-6}	± 30 x 10^{-6}
-55/+105 °C	± 35 x 10^{-6}	± 40 x 10^{-6}	± 50 x 10^{-6}

Table 2, Frequency drift

temperature range	frequency drift		
	class 0	class I	class II
-5/ +50 °C	± 5 x 10^{-6}	± 7,5 x 10^{-6}	± 10 x 10^{-6}
-10/ +60 °C	± 7,5 x 10^{-6}	± 10 x 10^{-6}	± 15 x 10^{-6}
-20/ +70 °C	± 10 x 10^{-6}	± 13 x 10^{-6}	± 20 x 10^{-6}
-55/+105 °C	± 25 x 10^{-6}	± 30 x 10^{-6}	± 40 x 10^{-6}
T_{nom} ± 5 °C		± 2,5 x 10^{-6}	± 5 x 10^{-6}

Accuracy of adjustment ± 10 x 10^{-6}
(to be combined with any of the frequency drift figures quoted)

Working frequency (series resonance) — to be measured with the American Military Test Set TS-683/TSM, without a series capacitance, the set being tuned in accordance with Table 3.

Maximum series resistance — 50 Ω

Tuning conditions for the test set:

Table 3

nominal frequency (MHz)	tuning resistance (Ω)	voltage drop (mV)	level of drive *) (mW)
50,000000 - 87,000000	60	350	2 ± 0,4
oven-controlled units 50,000000 - 87,000000	60	240	1 ± 0,2

Parallel capacitance — max. 7 pF

Change in frequency as a result of ageing — $-0,5/+1 \times 10^{-6}$, after 90 days at 85 ± 2 °C, non-operative

Maximum permissible d.c. voltage between the pins — 100 V

Passive method with π-network

The working frequency may also be measured according to the passive method with π-network. Level of drive, generally, 0,5 mW.

*) Measurements at lower level of drive (within the limits of the specified test set) can be made on request.

Temperature compensated crystal oscillators

SURVEY OF TYPES

Temperature range −20 to +70 °C

frequency range (MHz)	frequency tolerance	adjustable with external trimmer	basic catalogue number
4,5 - 15	±2. 10^{-6}		4322 190
4,5 - 15	±2. 10^{-6}	x	4322 191

TEMPERATURE COMPENSATED CRYSTAL OSCILLATOR

QUICK REFERENCE DATA	
Frequency range	4,5 - 15 MHz *)
Frequency tolerance	$\pm 2 \times 10^{-6}$
Temperature range	−20 to + 70 °C
Ageing	$\pm 1 \times 10^{-6}$ per year
Correction on ageing (fixed step)	typ. -2×10^{-6}

APPLICATION

Temperature compensated crystal oscillators (TCXO's) are used in mobilophones, electronic timing devices, measuring equipment, synthesizers, etc.

DESCRIPTION

A TCXO module comprises a quartz crystal oscillator, and a thermally controlled circuit that compensates for frequency changes over the whole temperature range.
The metal housing is filled with dry nitrogen and hermetically sealed.
The unit is provided with 5 connecting pins which are arranged to fit printed-wiring boards with a grid pitch of 2,54 mm (see Fig. 1).

MECHANICAL DATA

Dimensions (mm) and terminal location

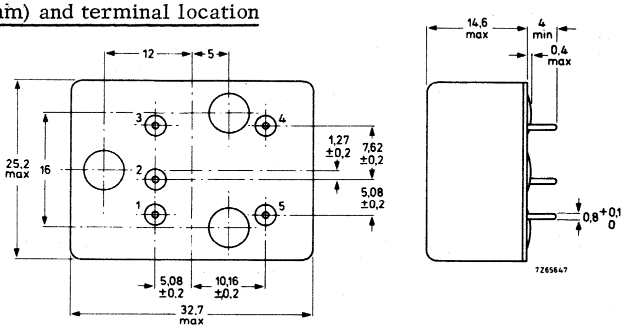


Fig. 1

*) A 5 MHz TCXO can be ordered under catalogue number 4322 190 00010,
an 8 MHz TCXO can be ordered under catalogue number 4322 190 00020,
a 10 MHz TCXO can be ordered under catalogue number 4322 190 00000.
TCXO's with other frequencies can be ordered under number 4322 190 stating the required frequency.

Weight

25 g approximately

Marking

The units are provided with a label showing the connection diagram (Fig. 2) and the following information:

Firm name	TCXO	4322 190
Frequency	kHz	
No .…./…..		

ELECTRICAL DATA

Supply voltage, V_S	+12 V ± 10% via R_1 = 470 Ω (see Fig. 2) +12 V ± 20% via R_1 = 330 Ω
Input power	max. 200 mW
Frequency range	4,5 - 15 MHz
Frequency tolerance at specified V_S, Z_L, T_{amb}	$\pm 2 \times 10^{-6}$
Ageing	$\pm 1 \times 10^{-6}$ per year
Correction on ageing influence by connecting pin 3 to pin 2	$-2^{+1}_{-0,5} \times 10^{-6}$
Internal resistance, R_i	2800 Ω ± 5%
Internal capacitance, C_i	5,5 pF ± 5%
Internal voltage source, V_i	600 mV ± 40%
Load impedance, Z_L	min. 500 Ω
Output voltage, V_o	see Figs 3 and 4
Temperature range, T_{amb}	−20 to + 70 °C

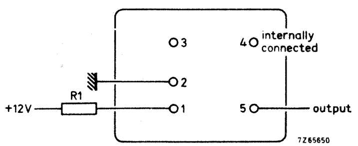


Fig. 2 Connection diagram

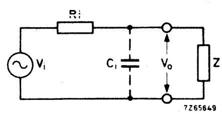


Fig. 3 Equivalent circuit

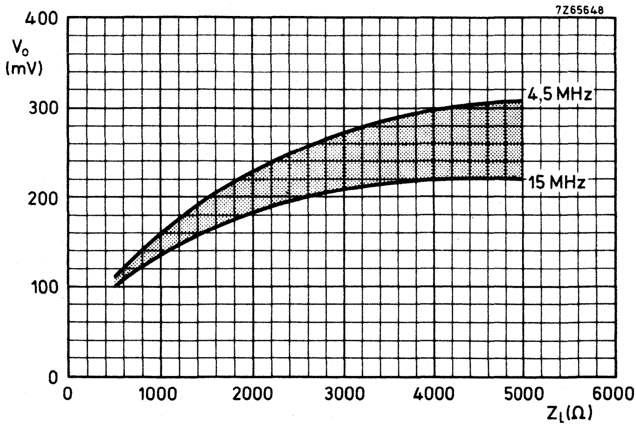


Fig. 4

ENVIRONMENTAL TESTS AND REQUIREMENTS

IEC68-2 test method	test	procedure	requirements
Ea	shock	50g, 1x, in 6 directions	$\Delta f/f$ max. 5×10^{-7}
F	vibration	10 to 500 Hz, 10g, in 3 directions, 30 min per direction	$\Delta f/f$ max. 5×10^{-7}
T	soldering		
D/IV	climatic		$\Delta f/f$ max. 5×10^{-7}

Note: Other specifications for TCXO's with respect to temperature range and for frequency drift tolerance can be made available on request.

TEMPERATURE COMPENSATED CRYSTAL OSCILLATOR

QUICK REFERENCE DATA	
Frequency range	4,5 - 15 MHz *)
Frequency tolerance	$\pm 2 \times 10^{-6}$
Temperature range	-20 to $+70$ °C
Ageing	$\pm 1 \times 10^{-6}$ per year
Frequency is adjustable with external trimmer	

APPLICATION

Temperature compensated crystal oscillators (TCXO's) are used in mobilophones, electronic timing devices, measuring equipment, synthesizers, etc.

DESCRIPTION

A TCXO module comprises a quartz crystal oscillator, and a thermally controlled circuit that compensates for frequency changes over the whole temperature range. The metal housing is filled with dry nitrogen and hermetically sealed.
The unit is provided with 5 connecting pins which are arranged to fit printed-wiring boards with a grid pitch of 2,54 mm (see Fig. 1).

MECHANICAL AND ENVIRONMENTAL DATA

Dimensions (mm) and terminal location

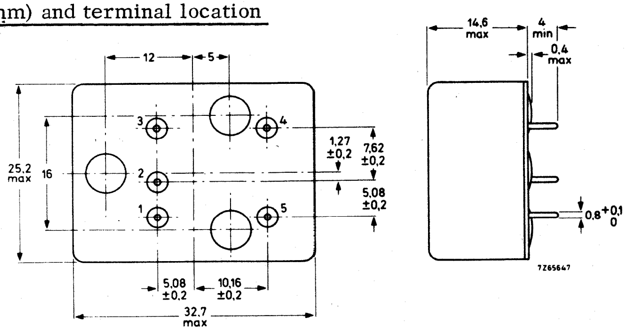


Fig. 1

*) A 5 MHz TCXO can be ordered under catalogue number 4322 191 00011,
an 8 MHz TCXO can be ordered under catalogue number 4322 191 00021,
a 10 MHz TCXO can be ordered under catalogue number 4322 191 00001
TCXO's with other frequencies can be ordered under number 4322 191 stating the required frequency.

Weight

25 g approximately

Marking

The units are provided with a label showing the connection diagram (Fig. 2) and the following information:

Firm name	TCXO	4322 191
Frequency	kHz	
No	...../.....	
Δf 25 °C	Hz	

ELECTRICAL DATA

Supply voltage, V_s	+12 V ± 10% via R_1 = 470 Ω (see Fig. 2) +12 V ± 20% via R_1 = 330 Ω
Input power	max. 200 mW
Frequency range	4,5 - 15 MHz
Frequency tolerance after adjustment (see Note), at specified V_s, Z_L, T_{amb}	$\pm 2 \times 10^{-6}$
Ageing	$\pm 1 \times 10^{-6}$ per year
Correction on ageing influence	$\pm 2 \times 10^{-6}$ (see Note below)
Internal resistance, R_i	2800 Ω ± 5%
Internal capacitance, C_i	5,5 pF ± 5%
Internal voltage source, V_i	600 mV ± 40%
Load impedance, Z_L	min. 500 Ω
Output voltage, V_o	see Figs 3 and 4
Temperature range, T_{amb}	-20 to + 70 °C

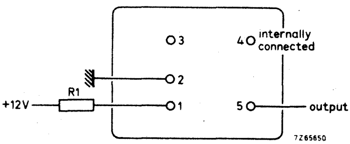


Fig. 2 Connection diagram

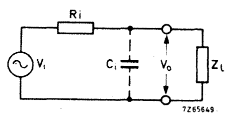


Fig. 3 Equivalent circuit

Note:

It is not guaranteed that the nominal frequency occurs at room temperature.
The nominal frequency can be shifted by connecting a variable capacitor of max. 60 pF (e.g. 2222 809 07011) externally between pin 2 and 3.
For optimum stability over the whole temperature range the oscillator should be adjusted at room temperature to a frequency which deviates from the nominal one by an amount mentioned as "Δf 25 °C ... Hz" on the label on the module.
After this adjustment a trimming range of $\pm 2 \times 10^{-6}$ is still available to correct ageing influences.

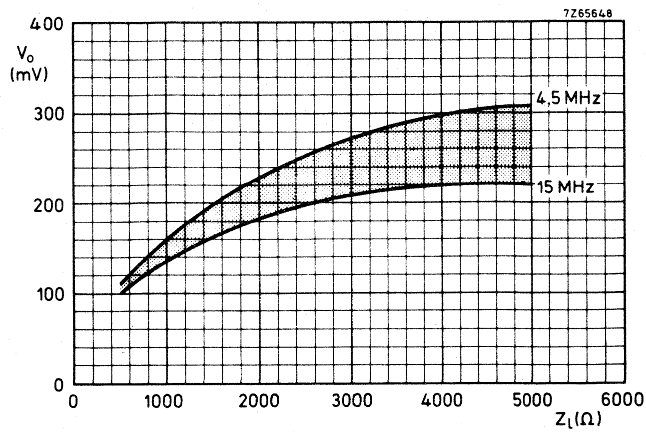


Fig. 4

ENVIRONMENTAL TESTS AND REQUIREMENTS

IEC68-2 test method	test	procedure	requirements
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T	soldering		
D/IV	climatic		$\Delta f/f$ max. 5×10^{-7}

Note: Other specifications for TCXO's with respect to temperature range and for frequency drift tolerance can be made available on request.

Crystal filters

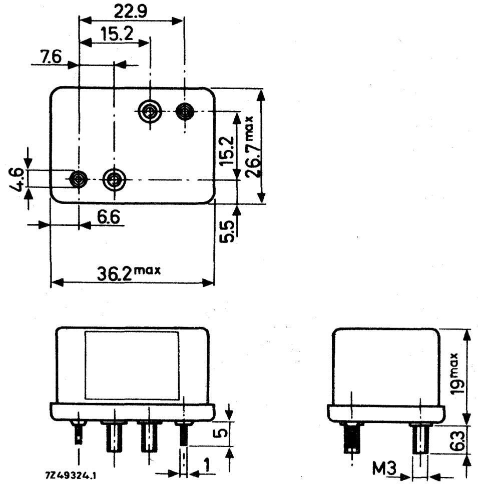
SURVEY OF TYPES

Mid-band frequency 10,7 MHz
Stop-band discrimination 90 dB

channel spacing (kHz)	pass-band width (kHz)	terminating impedances (Ω // pF)	dimensions [1] (mm)	catalogue number
± 25	± 7,5 at 3 dB	910//25	36 x 27 x 19 40 x 18 x 19	2722 172 00021 2722 172 00051
± 20	± 6 at 3 dB ± 6 at 6 dB	825//25 825//25	36 x 27 x 19 40 x 18 x 19	2722 172 00061 2722 172 00071

[1]) Size of can without stud and pins

10.7 MHz CRYSTAL FILTER
for 25 kHz channel spacing

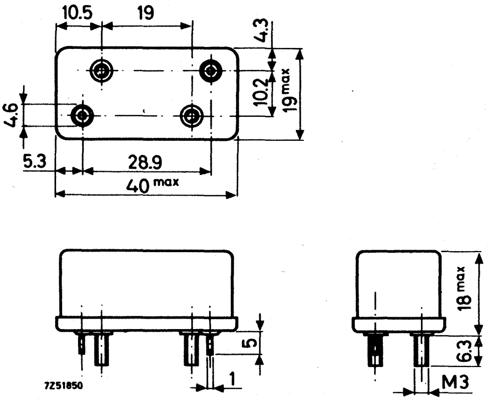


Dimensions in mm

mm	inches
1	0.04
4.6	0.18
5	0.2
5.5	0.22
6.3	0.25
6.6	0.26
7.6	0.300
15.2	0.600
19	0.75
22.9	0.900
26.7	1.05
36.2	1.42

Mid-band frequency	10.7 MHz
Insertion loss	< 3.5 dB
Min. pass-band width (3 dB)	± 7.5 kHz
Pass-band ripple	< 2 dB
Stop-band discrimination	> 70 dB at ± 17.5 kHz
	> 90 dB at ± 25 kHz
	maintained over at least ± 300 kHz
Terminating impedances	910 Ω ± 15% in parallel with 25 pF ±1.5 pF
Maximum input level	10 mW
Operating temperature range	−40 to +80 °C
Environment specification	DEF.5011/H6 and G.P.3
Finish	hot-tin dipped
Earth connection	through the studs

10.7 MHz CRYSTAL FILTER
for 25 kHz channel spacing



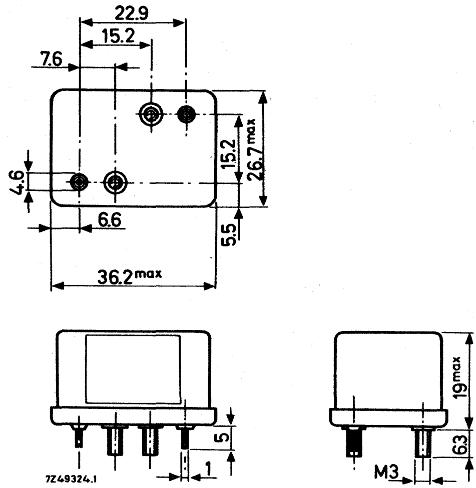
Dimensions in mm

mm	inches
1	0.04
4.3	0.17
4.6	0.18
5	0.2
5.3	0.21
6.3	0.25
10.2	0.400
10.5	0.41
18	0.71
19	0.75
28.9	1.140
40	1.57

Mid-band frequency	10.7 MHz
Insertion loss	< 3.5 dB
Min. pass-band width (3 dB)	± 7.5 kHz
Pass-band ripple	< 2 dB
Stop-band discrimination	> 70 dB at ±17.5 kHz, > 90 dB at and beyond ±25 kHz
Terminating impedances	910 Ω ±15% in parallel with 25 ±1.5 pF
Maximum input level	10 mW
Operating temperature range	−40 to +80 °C
Environment specification	DEF. 5011/H6 and G.P.3
Finish	hot-tin dipped
Earth connection	through the studs

10.7 MHz CRYSTAL FILTER

for 20 kHz channel spacing



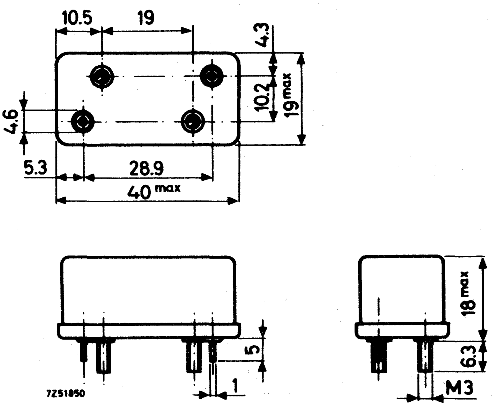
mm	inches
1	0.04
4.6	0.18
5	0.2
5.5	0.22
6.3	0.25
6.6	0.26
7.6	0.300
15.2	0.600
19	0.75
22.9	0.900
26.7	1.05
36.2	1.42

Dimensions in mm

Mid-band frequency	10.7 MHz
Insertion loss	< 2.5 dB
Min. pass-band width (6 dB)	± 6 kHz
Pass-band ripple	< 2 dB
Stop-band discrimination	> 70 dB at ± 15 kHz, > 90 dB at and beyond ± 18 kHz
Terminating impedances	825 Ω ± 15% in parallel with 25 ± 1.5 pF
Maximum input level	10 mW
Operating temperature range	−40 to +80 °C
Environment specification	DEF.5011/H6 and G.P.3
Finish	hot-tin dipped
Earth connection	through the studs

10.7 MHz CRYSTAL FILTER

for 20 kHz channel spacing



Dimensions in mm

mm	inches
1	0.04
4.3	0.17
4.6	0.18
5	0.2
5.3	0.21
6.3	0.25
10.2	0.400
10.5	0.41
18	0.71
19	0.75
28.9	1.140
40	1.57

Mid-band frequency	10.7 MHz
Insertion loss	< 2.5 dB
Min. pass-band width (3 dB)	± 6 kHz
Pass-band ripple	< 2 dB
Stop-band discrimination	> 70 dB at ± 15 kHz
	> 90 dB at and beyond 18 kHz
Terminating impedances	825 Ω ± 15% in parallel with 25±1.5 pF
Maximum input level	10 mW
Operating temperature range	−40 to + 80 °C
Environment specification	DEF. 5011/H6 and G.P.3
Finish	hot-tin dipped
Earth connection	through the studs

A	Quartz crystal units
B	Temperature compensated crystal oscillators
C	Crystal filters

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