PHILIPS

Data handbook

Electronic components and materials

Components and materials

Book C9 1984

Piezoelectric quartz devices

PIEZOELECTRIC QUARTZ DEVICES

DATA HANDBOOK SYSTEM

Our Data Handbook System comprises more than 60 books with specifications on electronic components, subassemblies and materials. It is made up of four series of handbooks:

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

The contents of each series are listed on pages iv to viii.

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

When ratings or specifications differ from those published in the preceding edition they are indicated with arrows in the page margin. Where application information is given it is advisory and does not form part of the product specification.

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ELECTRON TUBES (BLUE SERIES)

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T1 **Tubes for r.f. heating**

T2a **Transmitting tubes for communications, glass types**

T2b **Transmitting tubes for communications, ceramic types**

T3 **Klystrons, travelling-wave tubes, microwave diodes**

ET3 **Special Quality tubes, miscellaneous devices** (will not be reprinted)

T4 **Magnetrons**

T5 **Cathode-ray tubes**
Instrument tubes, monitor and display tubes, C.R. tubes for special applications

T6 **Geiger-Müller tubes**

T7 **Gas-filled tubes**
Segment indicator tubes, indicator tubes, dry reed contact units, thyratrons, industrial rectifying tubes, ignitrons, high-voltage rectifying tubes, associated accessories

T8 **Picture tubes and components**
Colour TV picture tubes, black and white TV picture tubes, colour monitor tubes for data graphic display, monochrome monitor tubes for data graphic display, components for colour television, components for black and white television and monochrome data graphic display

T9 **Photo and electron multipliers**
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T10 **Camera tubes and accessories**

T11 **Microwave semiconductors and components**

T12 **Vidicons and Newvicons**

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Small-signal germanium diodes, small-signal silicon diodes, voltage regulator diodes($<$ 1,5 W), voltage reference diodes, tuner diodes, rectifier diodes

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Rectifier diodes, voltage regulator diodes ($>$ 1,5 W), rectifier stacks, thyristors, triacs

S3 **Small-signal transistors**

S4a **Low-frequency power transistors and hybrid modules**

S4b **High-voltage and switching power transistors**

S5 **Field-effect transistors**

S6 **R.F. power transistors and modules**

S7 **Microminiature semiconductors for hybrid circuits**

S8 **Devices for optoelectronics**
Photosensitive diodes and transistors, light-emitting diodes, displays, photocouplers, infrared sensitive devices, photoconductive devices.

S9 **Power MOS transistors**

S10 **Wideband transistors and wideband hybrid IC modules**

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EXISTING SERIES

IC1 **Bipolar ICs for radio and audio equipment**

IC2 **Bipolar ICs for video equipment**

IC3 **ICs for digital systems in radio, audio and video equipment**

IC4 **Digital integrated circuits**
CMOS HE4000B family

IC5 **Digital integrated circuits – ECL**
ECL10 000 (GX family), ECL100 000 (HX family), dedicated designs

IC6 **Professional analogue integrated circuits**

IC7 **Signetics bipolar memories**

IC8 **Signetics analogue circuits**

IC9 **Signetics TTL logic**

IC10 **Signetics Integrated Fuse Logic (IFL)**

IC11 **Microprocessors, microcomputers and peripheral circuitry**

NEW SERIES

IC01N	**Radio, audio and associated systems** Bipolar, MOS	
IC02N	**Video and associated systems** Bipolar, MOS	
IC03N	**Telephony equipment** Bipolar, MOS	
IC04N	**HE4000B logic family** CMOS	
IC05N	**HE4000B logic family uncased integrated circuits** CMOS	(published 1984)
IC06N	**PC54/74HC/HCU/HCT logic families** HCMOS	
IC07N	**PC54/74HC/HCU/HCT uncased integrated circuits** HCMOS	
IC08N	**10K and 100K logic family** ECL	
IC09N	**54/74: STD, LS, S, F logic series** TTL	
IC10N	**Memories** MOS, TTL, ECL	
IC11N	**Analogue - industrial**	
IC12N	**Semi-custom gate arrays & cell libraries** ISL, ECL, CMOS	
IC13N	**Semi-custom integrated fuse logic** IFL series 20/24/28	
IC14N	**Microprocessors, microcontrollers & peripherals** Bipolar, MOS	

Note

Books available in the new series are shown with their date of publication.

COMPONENTS AND MATERIALS (GREEN SERIES)

The green series of data handbooks comprises:

C1 **Assemblies for industrial use**
PLC modules, PC20 modules, HNIL FZ/30 series, NORbits 60-, 61-, 90-series, input devices, hybrid ICs

C2 **Television tuners, video modulators, surface acoustic wave filters**

C3 **Loudspeakers**

C4 **Ferroxcube potcores, square cores and cross cores**

C5 **Ferroxcube for power, audio/video and accelerators**

C6 **Synchronous motors and gearboxes**

C7 **Variable capacitors**

C8 **Variable mains transformers**

C9 **Piezoelectric quartz devices**
Quartz crystal units, temperature compensated crystal oscillators, compact integrated oscillators, quartz crystal cuts for temperature measurements

C10 **Connectors**

C11 **Non-linear resistors**
Voltage dependent resistors (VDR), light dependent resistors (LDR), negative temperature coefficient thermistors (NTC), positive temperature coefficient thermistors (PTC)

C12 **Variable resistors and test switches**

C13 **Fixed resistors**

C14 **Electrolytic and solid capacitors**

C15 **Film capacitors, ceramic capacitors**

C16 **Permanent magnet materials**

C17 **Stepping motors and associated electronics**

C18 **D.C. motors**

C19 **Piezoelectric ceramics**

C20 **Wire-wound components**

QUARTZ CRYSTAL UNITS, GENERAL

SURVEY OF TYPES

Quartz crystals, economy range in RW-43 holder

frequency* kHz	lead length** mm	application	catalogue number	page
3000,000	12	general, e.g. microprocessors	4322 143/144	30
3276,800	12	timing (dividing ratio 2^{16} : 1 for 50 Hz)		
3440,000	12	general, e.g. microprocessors		
3440,000	12	general, e.g. microprocessors		
3547,000	12	video games		
3579,545	12	colour television		
3579,545	12	two-tone telephone dialling system		
3582,056	12	colour television, South America		
3686,400	12	general, e.g. microprocessors		
3686,400	12	general, e.g. microprocessors		
3750,000	12	video long play		
3840,000	12	general, e.g. microprocessors		
3932,160	12	timing (dividing ratio 2^{16} : 1 for 60 Hz)		
3997,676	12	general, e.g. microprocessors		
4000,000	12	general, e.g. digital tuners		
4000,000	12	colour television		
4000,000	12	clock control		
4000,000	12	colour television		
4096,000	12	timing (dividing ratio 2^{12} : 1 for 1000 Hz)		
4194,304	12	clock control		
4194,304	12	clock		
4194,304	12	clock		
4233,600	12	compact disc		
4233,600	12	compact disc		
4250,000	12	chrominance subcarrier SECAM-L system		
4406,250	12	chrominance subcarrier SECAM-L system		
4433,619	12	sub-carrier oscillator PAL-system		
4433,619	5	video cassette recorders		
4433,619	5	colour television		
4435,571	5	colour television		
4500,000	12	video long play		
4531,468	12	video long play		
4608,000	12	general, e.g. microprocessors		
4782,720	12	two-tone telephone dialling system (high acc.)		
4782,720	12	two-tone telephone dialling system		
4865,000	12	general, e.g. microprocessors		

table continues on next page.

* Quartz crystal units with other frequencies between 3000 and 16 000 kHz can be supplied on request.
** Unless otherwise indicated the lead length is 12 mm. Available on request: 5 mm.

Quartz crystals, economy range, continued

frequency* kHz	lead length** mm	application	catalogue number	page
4905,021	12	measuring equipment	4322 143/144.	30
4905,021	5	video cassette recorders		
4915,200	12	grammophone control system (high acc.)		
4915,200	12	grammophone control systems		
5000,000	12	television cameras		
5068,800	12	general, e.g. microprocessors		
5068,800	12	general, e.g. microprocessors		
5068,800	12	general, e.g. microprocessors		
5120,000	5	carradio		
5120,000	12	carradio		
5911,000	12	video games		
6000,000	12	teletext viewdata, video cassette recorders		
6000,000	5	teletext, viewdata, video cassette recorders		
6041,957	12	teletext (USA)		
6144,000	12	microprocessors		
6400,000	12	microprocessors		
7000,000	12	microprocessors		
7151,223	12	sub-carrier colour television		
7159,090	12	sub-carrier colour television		
7164,112	12	sub-carrier colour television		
8000,000	12	general, e.g. microprocessors		
8867,238	12	colour television, video cassette recorders		
8867,238	5	colour television, video cassette recorders		
9830,400	12	measuring systems		

Special types

High precision digital quartz temperature sensors in RW-43 holders in the frequency range of 4 to 20 MHz are described on page 36.

* Quartz crystal units with other frequencies between 3000 and 16 000 kHz can be supplied on request.
** Unless otherwise indicated the lead length is 12 mm. Available on request: 5 mm.

AT-cut quartz crystals for general frequency stabilization.

mode of vibration	frequency range MHz	holder			catalogue number	page
		type	housing	connections		
	3 to 10	RW-10	resistance welded	leads	4322 148	40
		RW-33	resistance welded	leads	4322 148	40
		RW-36	resistance welded	pins	4322 148	40
funda-mental	1 to 1,8	HC-6/U	solder sealed	pins	4322 152	46
	1,8 to 25	HC-27/U	all-glass	pins	4322 154	48
		HC-27 ext.	all-glass	pins	4322 154	48
		RW-33	resistance welded	leads	4322 149	42
		RW-36	resistance welded	pins	4322 149	42
	4,5 to 25	HC-26/U	all-glass	leads	4322 155	52
		HC-29/U	all-glass	pins	4322 155	52
		RW-42	resistance welded	pins	4322 156	35
		RW-43	resistance welded	leads	4322 156	35
	10 to 75	HC-27/U	all-glass	pins	4322 159	56
		RW-33	resistance welded	leads	4322 162	60
		RW-36	resistance welded	pins	4322 162	60
third overtone	17 to 75	RW-42	resistance welded	pins	4322 161	59
		RW-43	resistance welded	leads	4322 161	59
	20 to 75	HC-26/U	all-glass	leads	4322 160	58
		HC-29/U	all-glass	pins	4322 160	58
fifth overtone	50 to 125	HC-26/U	all-glass	leads	4322 166	62
		HC-27/U	all-glass	pins	4322 165	61
		HC-29/U	all-glass	pins	4322 166	62
		RW-33	resistance welded	leads	4322 168	64
		RW-36	resistance welded	pins	4322 168	64
		RW-42	resistance welded	pins	4322 167	63
		RW-43	resistance welded	leads	4322 167	63

Special types

funda-mental	1	HC-6/U	solder sealed	pins	4322 152 01241	47
	6,144	TO-39	resistance welded	leads	4322 150 00011	44
	21,480	RW-80	resistance welded	leads	4322 145 00011	38
third overtone	10 MHz high precision	HC-27/U	all-glass	pins	4322 159 00001	57

7th, 9th and 11th overtone crystals up to 250 MHz are available upon request.

INTRODUCTION

A quartz crystal unit consists of a quartz crystal element with electrodes, mounted in an enclosure with connecting pins or leads.

Units with pins are for mounting in sockets (not supplied by us) and those with leads are for printed-wiring board mounting. The usual lead-length is 12 mm which also permits flat mounting, whilst shorter leads (e.g. 5 mm) are for vertical mounting.

The quartz crystal element is a vibrating resonant plate which relies upon the piezoelectric effect to couple it to electrical circuits. The intrinsic properties of quartz make it a unique device for accurate and stable frequency control and selection. Although the properties of quartz (T.C., ageing, high Q-factor) are very stable, the ultimate performance of the element is largeley dependent on the environment and the associated electrical circuits. We strongly advise that a particular application be discussed with the crystal manufacturer at the earliest stage in any design.

Crystal elements are normally cut in the form of plates or bars. The dimensions of these elements and their orientation with respect to the axes of the crystal give the characteristic of the element. The dimensions are such that the mechanical resonance frequency equals the desired electrical frequency. There are a large number of crystal cuts but the most advantageous orientation is the so-called AT-cut. The frequency range that can be covered herewith is from 1 to 250 MHz. A practical range is from 1,8 to 125 MHz. The crystal element may vibrate in the frequency of a fundamental mode of vibration or in the third, fifth or higher overtone.
Our SC-cut quartz crystals are very suitable for use in ovens.
Several cuts specially for digital temperature measurements are applied as temperature sensors.

Note

All dimensional drawings are in mm unless otherwise indicated.

TERMS AND DEFINITIONS

in accordance with IEC 122-1

Resonance frequency f_r

The lower of the two frequencies of the crystal unit alone, under specified conditions, at which the electrical impedance of the crystal unit is resistive.

Anti-resonance frequency f_a

The higher of the two frequencies of a crystal unit alone, under specified conditions, at which the electrical impedance of the crystal unit is resistive.

Load resonance frequency f_L

One of the two frequencies of a crystal unit in association with a series or with a parallel load capacitance, under specified conditions, at which the electrical impedance of the combination is resistive. This frequency is the lower of the two frequencies when the load capacitance is in series and the higher when it is in parallel (see Fig. 2). For a given value of load capacitance (C_L), these frequencies are identical for all practical purposes and given by:

$$\frac{1}{f} = 2\pi \sqrt{\frac{L_1 C_1 (C_0 + C_L)}{C_1 + C_0 + C_L}}$$

Nominal frequency f_n

The frequency assigned by the specification of the crystal unit.

Working frequency f_w

The operational frequency of the crystal unit together with its associated circuits.

Overall tolerance

The maximum permissible deviation of the working frequency from nominal frequency due to a specific cause or a combination of causes.

Adjustment tolerance

The permissible deviation from the nominal frequency at the reference temperature under specified conditions.

Ageing tolerance

The permissible deviation due to time under specified conditions.

Tolerance over the temperature range

The permissible deviation over the temperature range with respect to the frequency at the specified refe-rance temperature.

Tolerance due to level of drive variation

The permissible deviation due to the variation of level of drive.

Operating temperature range	The range of temperatures as measured on the enclosure over which the crystal unit must function within the specified tolerances.
Operable temperature range	The range of temperatures as measured on the enclosure over which the crystal unit must function though not necessarily within the specified tolerances.
Reference temperature	The temperature at which certain crystal measurements are made. For controlled temperature units, the reference temperature is the mid-point of the controlled temperature range. For non-controlled temperature units, the reference temperature is normally $25 \pm 2\,^{o}C$.
Resonance resistance R_r	The resistance of the crystal unit alone at the resonance frequency f_r.
Load resonance resistance R_L	The resistance of the crystal unit in series with a stated external capacitance at the load resonance frequency f_L. Note: The value of R_L is related to the value of R_r by the following expression: $$R_L = R_r (1 + \frac{C_0}{C_L})^2$$
Level of drive	A measure of the conditions imposed upon the crystal unit expressed in terms of power dissipated. Note: 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 which determines the load resonance frequency f_L.
Ageing (long-term parameter variation)	The relation which exists between any parameter (e.g. resonance frequency) and time. Note: Such parameter variation is due to long-term changes in the crystal unit and is usually expressed in fractional parts per period of time.
Motional capacitance C_1	The capacitance of the motional (series) arm of the equivalent circuit.
Motional inductance L_1	The inductance in the motional (series) arm of the equivalent circuit.

ELECTRICAL PROPERTIES AND BEHAVIOUR

CRYSTAL UNIT EQUIVALENT CIRCUIT

The equivalent circuit, which has the same impedance as the unit in the immediate neighbourhood of resonance, is usually represented by an inductance, capacitance and resistance in series, this series branch being shunted by the capacitance between the terminals of the unit. The parameters of the series branch are usually given by L_1, C_1 and R_1. The parallel capacitance is given by C_0 (see Fig. 1).

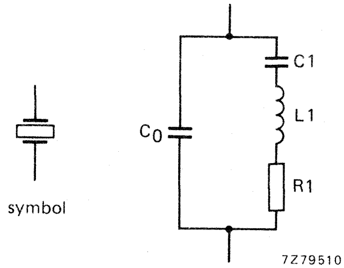


Fig. 1 Crystal unit equivalent circuit.

The parameters of the series branch are termed the "motional parameters" of the crystal unit. The parameter C_0 is termed the "parallel capacitance".

The equivalent circuit has two resonance frequencies at which the electrical impedance is resistive: the "resonance frequency f_r" and the "anti-resonance frequency f_a". The resistance of the equivalent circuit at the resonance frequency f_r is termed the "resonance resistance R_r".

For $R_1 \ll \frac{1}{\omega C_0}$ the following relations hold:

$$f_r = \frac{1}{2\pi\sqrt{L_1 C_1}} \qquad (1)$$

$$f_a = \frac{1}{2\pi\sqrt{L_1 \frac{C_1 C_0}{C_1 + C_0}}} \qquad (2)$$

$$R_r = R_1 \qquad (3)$$

LOAD CAPACITANCE AND FREQUENCY PULLING

During manufacture, definable limits are set to the accuracy of frequency. In an oscillator, a load capacitance C_L is required to trim the working frequency f_w to the nominal frequency f_n. Figure 2 shows the crystal unit equivalent circuit with a load capacitance in series and in parallel. Each combination has two resonance frequencies at which the electrical impedance of the circuit is resistive. The lower of the two frequencies, when the load capacitance is connected in series and the higher, when it is connected in parallel are termed "load resonance frequencies f_L". At the frequency f_L the resistance of the combination with the load capacitance in series is termed "load resonance resistance R_L".
For $R_1 \ll 1/\omega C_0$:

$$f_L = \frac{1}{2\pi\sqrt{L_1 \frac{C_1(C_0+C_L)}{C_1+(C_0+C_L)}}} \qquad (4)$$

$$\boxed{R_L = R_r\left(1+\frac{C_0}{C_L}\right)^2} \quad * \qquad (5)$$

For a given value of C_L the load resonance frequencies of the series and the parallel combinations are identical.
In practice, however, the parallel combination shown in Fig. 2c rarely occurs in an oscillator.
From equation (4) two second parameters of vital concern can be derived: the difference between load resonance frequency f_L and resonance frequency f_r, "Δf", and the relative change in frequency as a function of the change in load capacitance, termed "pulling sensitivity S".

"Δf"

$$\Delta f = f_L - f_r \qquad (6)$$

with f_L from equation (4)

$$\Delta f = \tfrac{1}{2} f_r \frac{C_1}{C_0+C_L} - \frac{\Delta f^2}{2 f_s} \qquad (7)$$

and to a close approximation

$$\boxed{\Delta f = \tfrac{1}{2} f_r \frac{C_1}{C_0+C_L}} \qquad (8)$$

Equation (8) greatly simplifies calculations and methods of measurement, whilst the error is negligible in nearly all cases.

* The resistance of the combination with the load capacitance in parallel is given by

$$R_{L\,par} = \frac{1}{R_1 \cdot \omega_r^2 (C_0+C_L)^2}$$

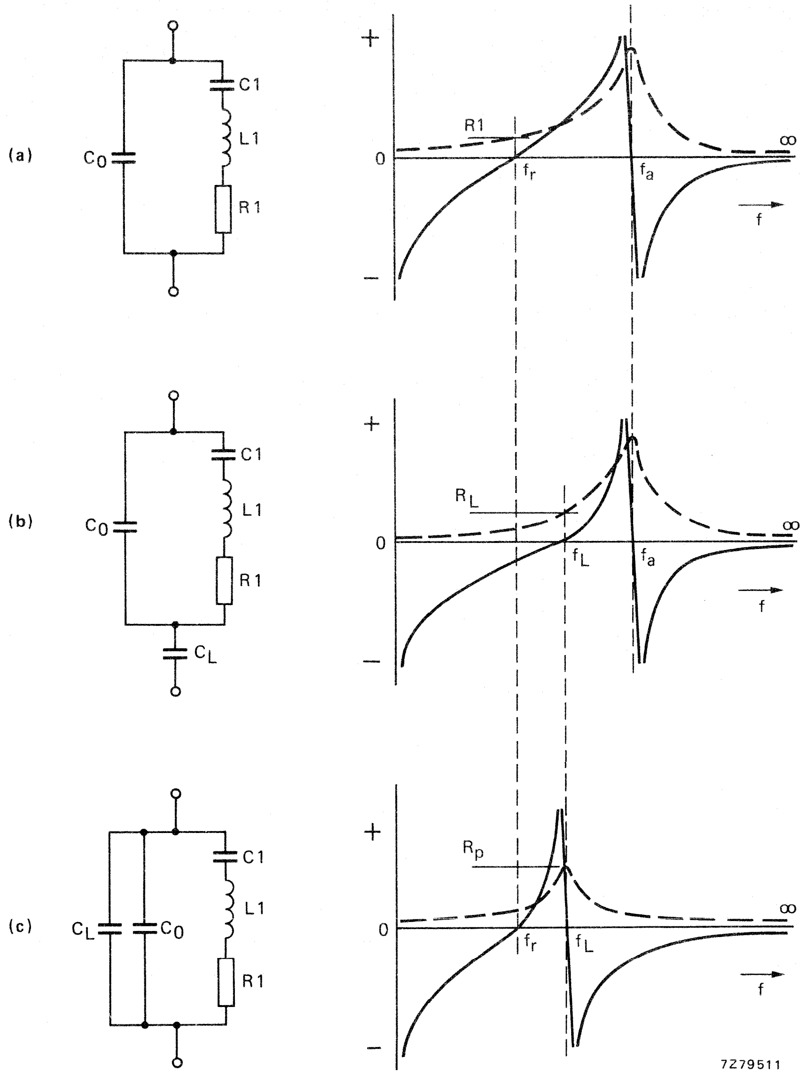


Fig. 2 Resonance, anti-resonance and load resonance frequency.
——— reactance
– – – resistance

Pulling sensitivity S

$$S = \frac{1}{f_L} \left(\frac{\delta f}{\delta C_L}\right)_{f = f_L} = + \frac{1}{f_L} \cdot \frac{\delta \Delta f}{\delta C_L}$$

with Δf from equation (8)

$$S = -\frac{1}{2} f_r \frac{C1}{(C_0 + C_L)^2} \cdot \frac{1}{f_L} \quad (9)$$

and to a close approximation

$$\boxed{S = -\frac{C1}{2(C_0 + C_L)^2}} \quad (10)$$

Standard values of load capacitance

The standard values of load capacitance for crystal units operating at the fundamental frequency of the mode are:

20 pF, 30 pF, 50 pF, 100 pF.

Note that in some countries 32 pF is still in use, but this value should not be considered as a standard value and its use is not recommended.

In special cases, load capacitances of the values 8, 12 and 15 pF may be used for fundamental mode crystal units.

Overtone crystals are often operated at series resonance. Where a load capacitance is used, it should be chosen from the following standard values:

8 pF, 12 pF, 15 pF, 20 pF, 30 pF.

The pulling sensitivity expressed in 10^{-6}/pF is a good measure for the frequency sensitivity as a function of load capacitance variations at the working frequency.
Figure 3 illustrates Δf and the pulling sensitivity S as a function of the load capacitance, for two quartz crystals having different C_1 values. It should be noted that a tolerance of ½ pF on a 20 pF load capacitance may lead to an error of $\pm 11.10^{-6}$.

Crystal (a)	Crystal (b)
f_r = 10 000,000 kHz	f_r = 10 000,000 kHz
C_0 = 5 pF	C_0 = 2 pF
C_1 = 28 fF	C_1 = 5,6 fF
C_L = 20 pF	C_L = 20 pF
f_L = 10 005,600 kHz	f_L = 10 001,273 kHz
S = $-22{,}4.10^{-6}$/pF	S = $-5{,}79.10^{-6}$/pF

Specified, or in special cases, measured Δf and S, as given for crystal (a) in Table 1, offer a simple direct guidance.

Table 1

nominal frequency $f_n = f_L$	10 000,000 kHz	
nominal load capacitance C_L	20 pF	
	specified	measured
Δf	5,600 kHz	5,700 kHz
pulling sensitivity S	$-22 \pm 2 \times 10^{-6}$/pF	$-22{,}4 \times 10^{-6}$/pF

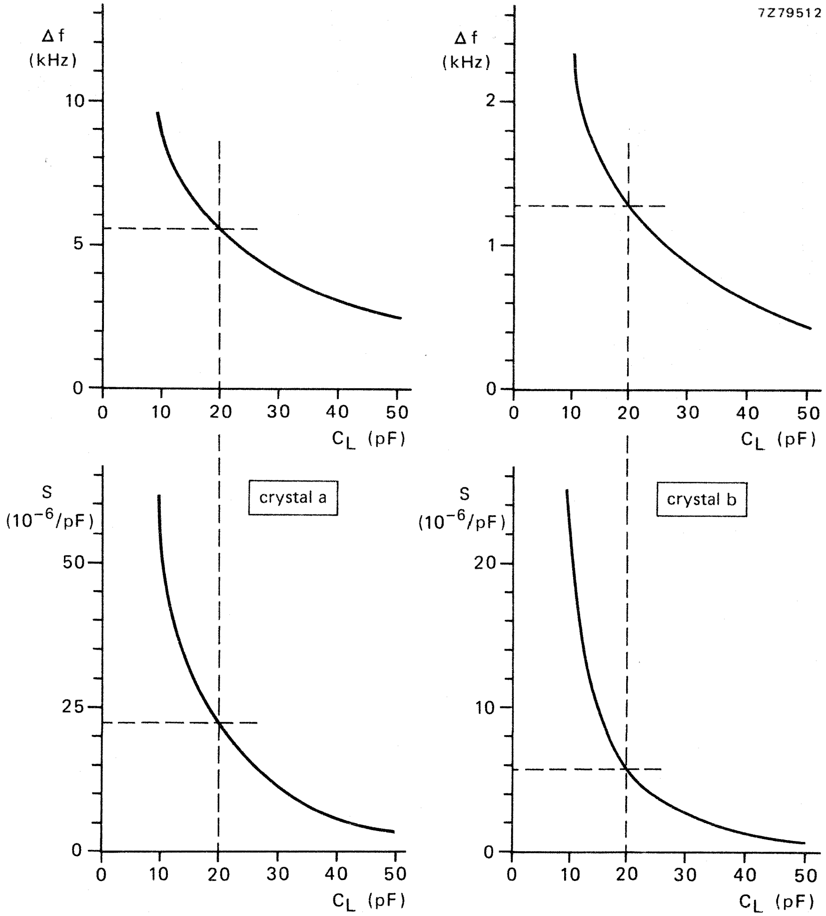


Fig. 3 Δf and pulling sensitivity as a function of the load capacitance. Tolerances on the parameters f_r, C_0 and C_1 are required for calculating the "Δf" and the "pullability at f_n".

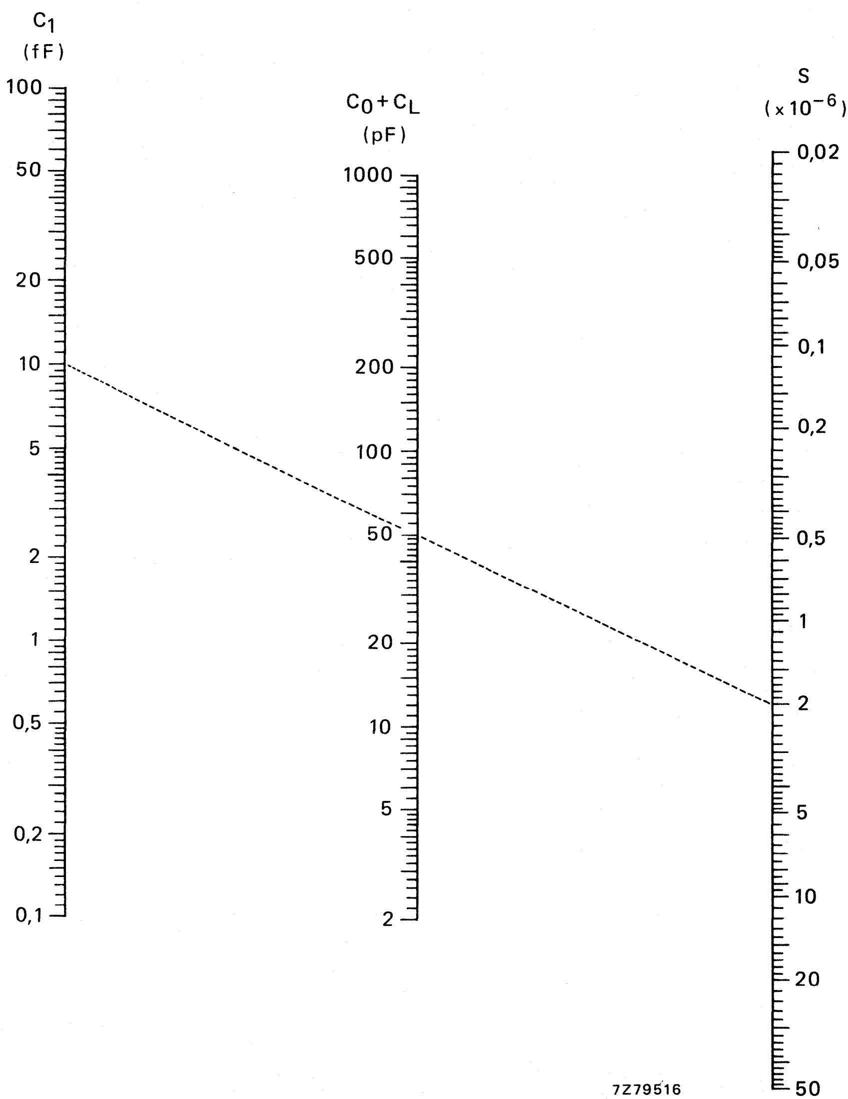


Fig. 4 Nomogram enabling the determination of the pulling sensitivity S.

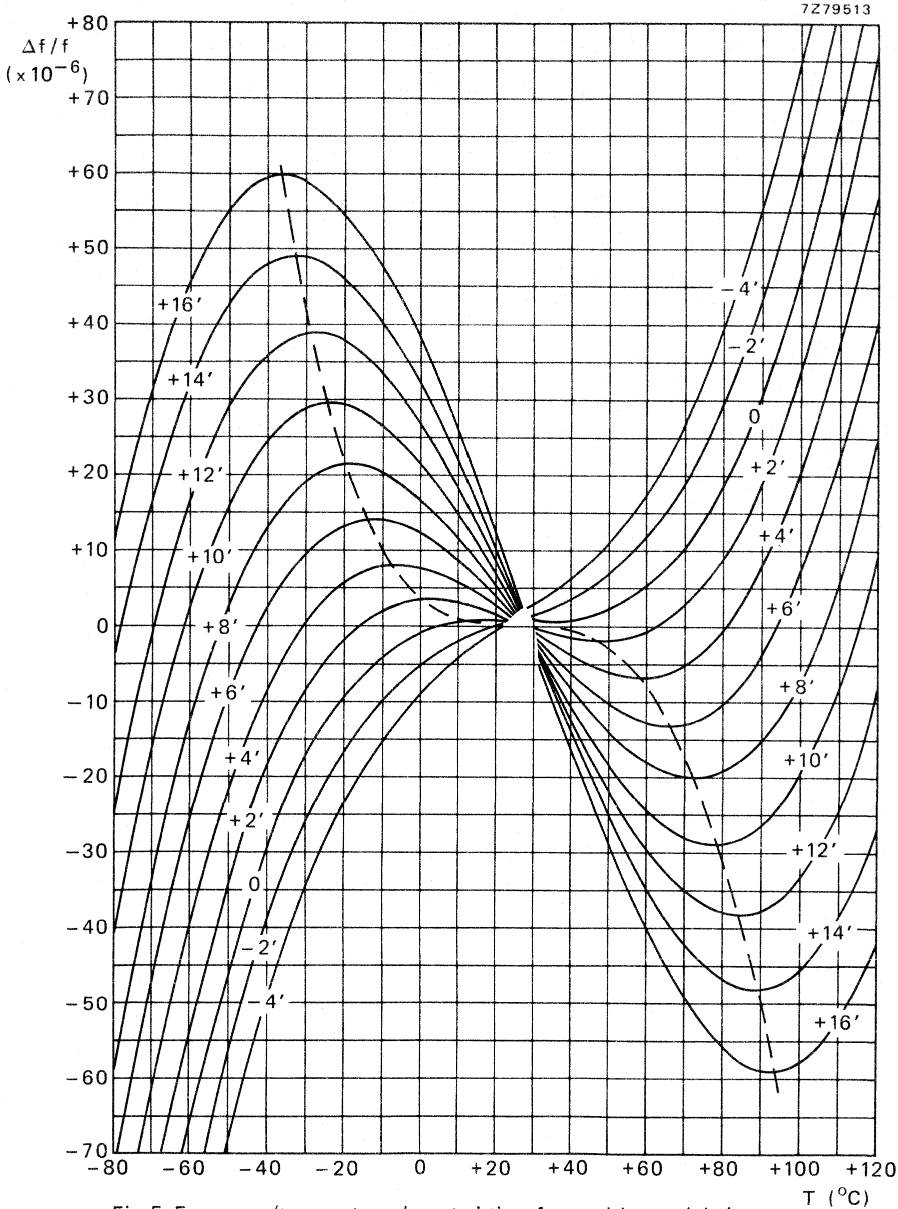


Fig. 5 Frequency/temperature characteristics of a special crystal design.

LEVEL OF DRIVE

The power dissipated in a crystal unit is termed "level of drive" and is usually expressed in mW. In the level of drive range 10^{-12} to 10^{-3} W the drive level dependency of the crystal unit characteristics is almost negligible. For drive level greater than approximately 0,5 mW, the crystal unit characteristics tend to change. For this reason the crystal unit characteristics are specified at a level of drive of 0,5 mW.

Low drive levels

When a crystal oscillator is switched on, there will initially be some noise in the circuit. The noise power, which depends on the circuit design and on the components used, will be in the region of 10^{-16} W. From this level, the oscillatory power builds up in the crystal unit, passing through a power range of approximately 12 decades to its maximum value. At the extremely low power levels that occur during build up of oscillation, the resonance resistance R_r may increase slightly. The crystal oscillator should, therefore, have sufficient loop gain to avoid start-up problems.

High drive levels

For applications requiring high stability, a drive level between 5 μW and 0,5 mW should be used. Drive levels greater that 0,5 mW should be avoided, and excessively high drive levels (greater than say 5 mW) may seriously affect the crystal's behaviour.

FREQUENCY/TEMPERATURE CHARACTERISTICS

The frequency drift as a function of temperature can be represented by a graph, the T.C. 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.

Figure 5 shows a number of frequency-temperature curves obtained from AT-cut crystals with various angles of cut α (from −4′ to + 16′ increasing angle of cut). The curves are symmetrical with respect to 27 °C, and it is not possible to shift this point. A temperature range which is fairly symmetrical with respect to 27 °C (e.g. 0 - 60 °C) will, therefore, result in the smallest frequency drift in that range. A small frequency drift over a wide temperature range, e.g. −40 to + 80 °C, will result in a quite steep temperature coefficient at room temperature.

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 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 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 preferred to those having a metal holder;

(b) low frequency crystals are favourable preferred to high frequency crystals having the same crystal cut;

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

CRYSTAL BEHAVIOUR IN AN OSCILLATOR

In the vicinity of resonance the impedance of a quartz crystal unit can be represented by a circle (see Fig. 6). The circle is shifted downwards with respect to the resistance axis over

$$X_0 = \frac{1}{2\pi f_r C_0}.$$

When a load capacitance is connected in series with the unit the shift is $X_0 + X_L$, where

$$X_L = \frac{1}{2\pi f_L C_L}.$$

The difference between anti-resonance frequency and resonance frequency

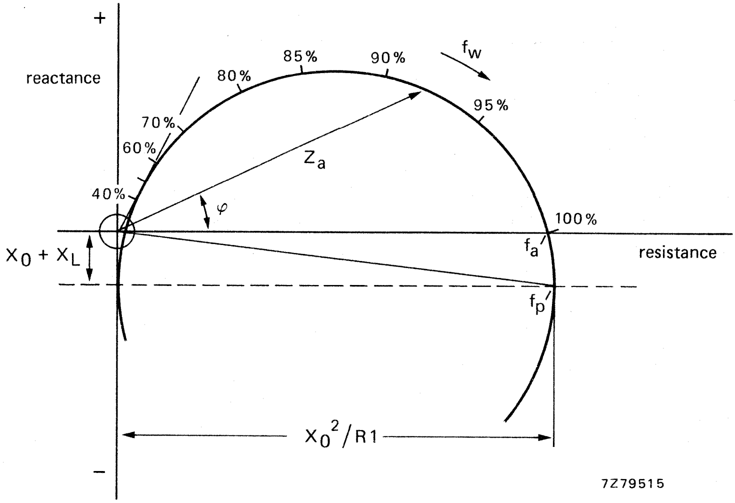
$$f_a - f_r \approx \frac{C_1}{2C_0} \cdot f_r \cdot \frac{C_L}{C_0 + C_L}$$

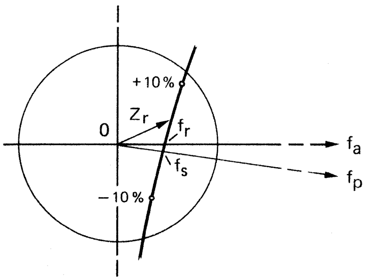
is assumed to be 100%.
It can be seen that the difference between the two frequencies, determined by the phase angle φ, disappears at f_w = 50%. The phase angle in the oscillator should be kept sufficiently small to avoid crystal unit operation in the uncertain 50% area (frequency switching).

Quartz crystal units for frequencies higher than 100 to 125 MHz (depending on type) have an impedance circle with a greater downwards shift, even to below the real axis. When the figure of merit given by

$$M = \frac{X_0}{R_1} = \frac{1}{(2\pi f_r)\, R_1\, C_0}$$

is less than approximately 5, the resonance frequency f_r is arbitrary.





Enlarged area around the zero point.

f_a = anti-resonance frequency
f_r = resonance frequency
f_s = series resonance frequency
f_w = working frequency
Z_r = impedance at working frequency

Fig. 6 Working frequency and impedance of a quartz crystal unit in the impedance diagram.

Indications for use

Keep phase deviations in the circuit sufficiently low to avoid crystal unit operation in the 50% working frequency area, in particular when phase variation is used for frequency pulling (P.L.L. system).

Ensure that amplification is sufficiently high, in particular when applying phase variation.

Keep crystal unit drive level low (generally ⩽ 0,5 mW), see Fig. 7.

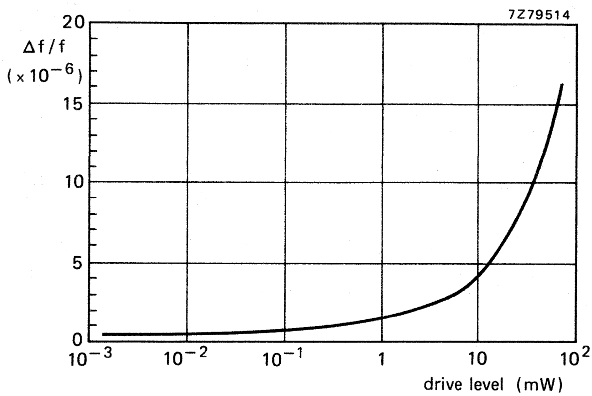


Fig. 7.

MEASURING PROCEDURES

Several methods of measuring quartz crystal units are in use.* Because different methods may give different results, our measuring procedure is given below. This is the *passive method with π-network* according to IEC publication 444. Further, the method is mentioned with *crystal test oscillator type 150A,* (make Saunders), which is recommended if a frequency correlation of 2 to 5 x 10^{-6} is tolerable. The accuracy of reproduction of the π-network method ranges between 10^{-6} and 10^{-8} depending on the type of crystal unit to be measured. The π-network method can be extended for measuring crystal unit parameters very accurately. This is achieved by a slight modification of the π-network, the use of precision reference resistors and two precision high-frequency load capacitors.

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 stable signal source (frequency synthesizer) 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.

For ease of operation, it is possible to phase-lock the system by feeding back the analogue output of the phase error (from zero) to control the precise frequency of the signal source (A.F.C. loop shown by dashed line).

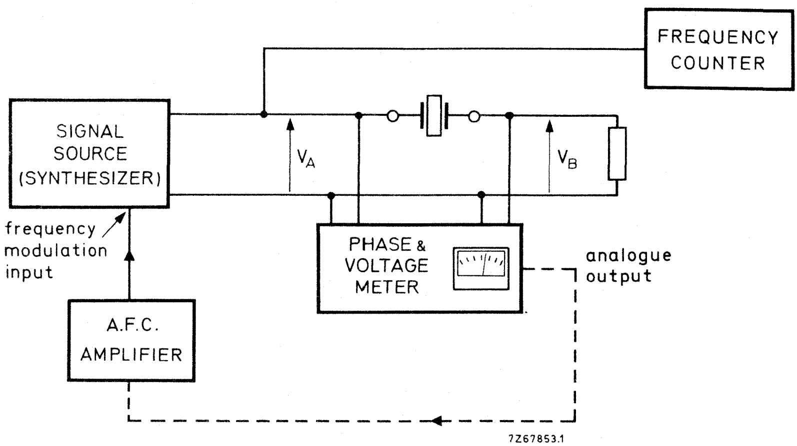


Fig. 1.

* The following measuring methods can be applied on request for the time the obsolete equipment is available:
Method using *Crystal Test Set, type TS193A* (British Military Standard).
Method using *Crystal Impedance Meter TS330/TSM* (U.S. Army Standard).
Method using *Crystal Impedance Meter TS683/TSM* (U.S. Army Standard).

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).

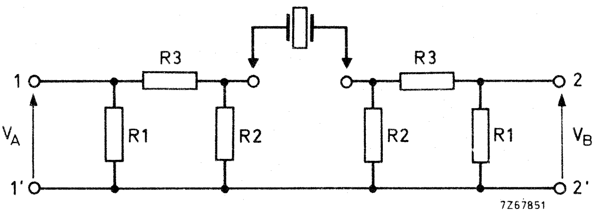


Fig. 2.

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.

Quartz crystal parameter measurements

A 5 pF trimming capacitor should be connected in parallel with each of the resistors R2 for accurate compensation of the transmission circuit. A shield is mounted between the contacting plates to reduce the capacitance between them. Two measuring procedures for crystal parameter measurement with the modified π-network are in use:

The C_L method

In general, this method is used for fundamental mode crystal units with frequencies up to 25 MHz.

Precision load capacitors are inserted in the π-network. Load resonance frequency and load resonance resistance can then be measured directly. C1 can be calculated.

The impedance method

Generally this method is used for higher frequencies up to approximately 125 MHz.

Phase and impedance are measured, all other parameters can be calculated by means of a computer.

Crystal shielding

Depending on the application, crystal shielding may give rise to frequency deviations, in particular for fundamental mode crystal units with a considerable pulling sensitivity.
In our procedure the metal enclosure of the crystal unit normally is not earthed. If, in special cases, earthing is required this should be mentioned in the specification for ordering.

METHOD WITH CRYSTAL TEST OSCILLATOR 150A AND PRINTER PROCESSOR 2000A

Initial calibration

The accuracy of the crystal test oscillator is for a considerable part determined by the alignment of the capacitance meter. Alignment and check of the capacitance meter by means of a stable precision 75 pF capacitor is recommended. For further particulars see 150 A manual.

QUARTZ CRYSTAL UNITS AS DIGITAL TEMPERATURE SENSOR

The most well-known applications of quartz crystal units are those where the crystal is used in oscillator and filter circuits, as a frequency-selective element with an extremely high Q-factor. By correct choice of the cutting angle of the vibrating plate, it is possible to obtain a very low TC over a limited temperature range.
Examples of such crystal cuts are: AT, BT, CT and GT cuts.

On the other hand, it is also possible to cut crystal plates in such a way that the resonance frequency is an almost linear function of the temperature. In fact, the very first discovered quartz crystal cut, the "Y-cut", was such a cut.
There are, however, some disadvantages which make this cut less suitable for temperature sensing.

How to use a quartz crystal unit as a temperature sensor

To be able to measure temperatures with a quartz crystal sensor, the device should be connected to an oscillator circuit which usually consists of one or two transistors or an integrated circuit.
The oscillator will produce an output signal whose frequency will change by -40 to $+80 \cdot 10^{-6}$/K, depending on the cutting angle. There are several possible ways of processing this signal as shown in Figs 1 to 4.

Thanks to the excellent stability, the low ageing and its 'digital' nature, resolutions of 0,01 K are easy to achieve without noise problems. This renders the device particular suitable for measurements of very small temperature differences as in distillation columns and flow meters.

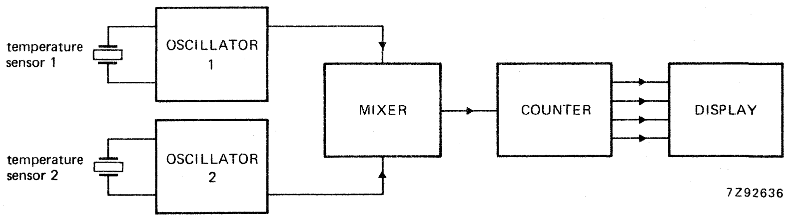


Fig. 1.

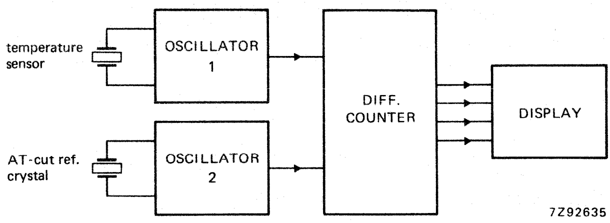


Fig. 2.

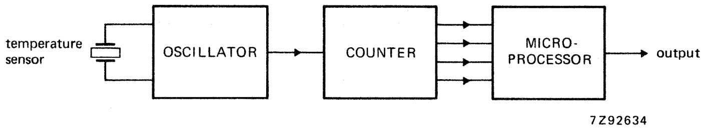


Fig. 3.

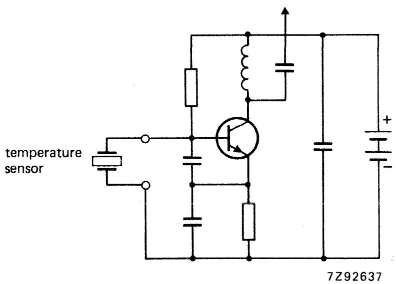


Fig. 4 Miniature wireless temperature sensor.

HOW TO SPECIFY A QUARTZ CRYSTAL UNIT

When ordering quartz crystal units for which a catalogue number (12 digits) has been fixed, please quote catalogue numbers as stated in this Data Handbook.

For quotation or ordering a quartz crystal unit which still has no complete catalogue number the supplier needs to know certain basic information. Please use the following check list.

Type of crystal unit	
Type of holder	
Nominal frequency	kHz
Mode of vibration	fundamental or $\frac{\text{third}}{\text{fifth}}$ overtone
Permissible deviation from nominal frequency (adjustment tolerance) at + 25 °C	$\times 10^{-6}$
Temperature range	from to °C
Frequency drift over specified temperature range	$\times 10^{-6}$
Circuit conditions:	
resonant frequency f_r or	kHz
load resonant frequency f_L and	kHz
load capacitance C_L	pF
maximum resonance resistance R_r or	Ω
maximum load resonance resistance R_L	Ω
Crystal unit equivalent parameters	
C_1	fF
C_0	pF
R_1	Ω
L_1	mH
Level of drive	mW
Ageing Δf/f per month or year	$\times 10^{-6}$
Mechanical requirements/tests	

MARKING

The marking on the unit includes 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 include the five last digits of the catalogue number. The last digit printed on the unit may, however, be different. Also a manufacturing date is stated, referring to the year and month of manufacture, e.g. 424 means the 24th week of 1984.

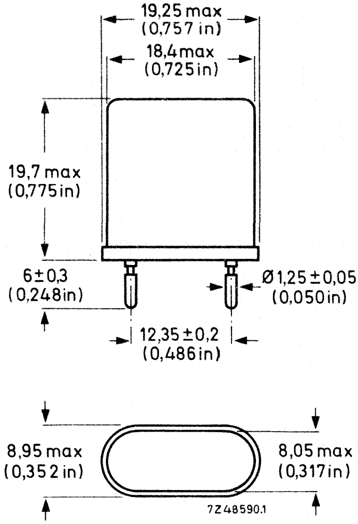
HOLDERS

ALL-GLASS HOLDERS

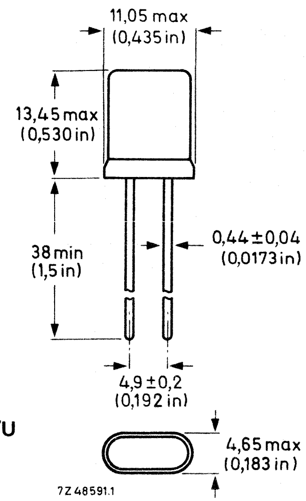
Dimensions in mm
(in inches between brackets)

HC-27/U

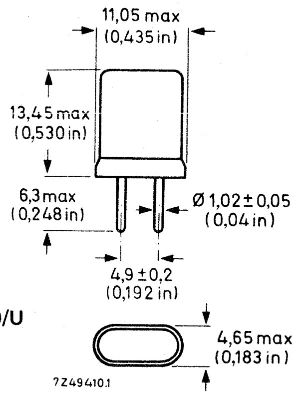
(IEC type DB is identical except for the height which is 26 mm max. instead of 19,7 max.).



HC-26/U

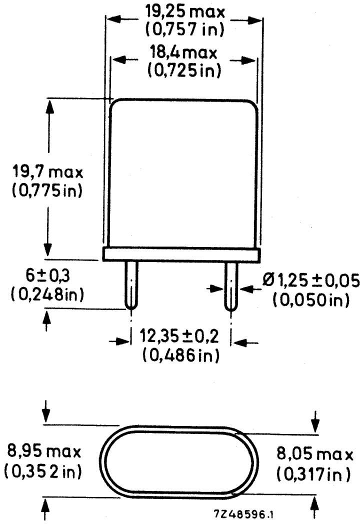


HC-29/U

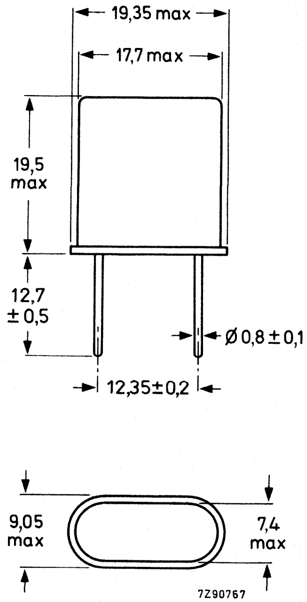


METAL HOLDERS

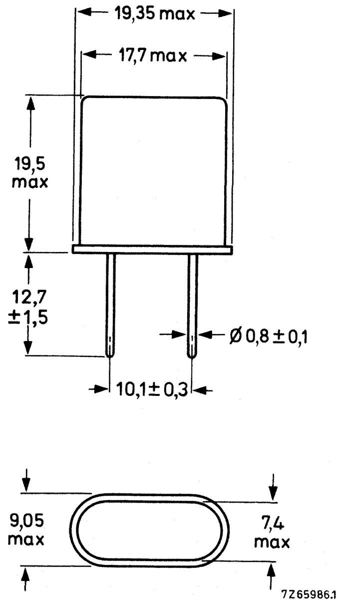
Dimensions in mm
(in inches between brackets)



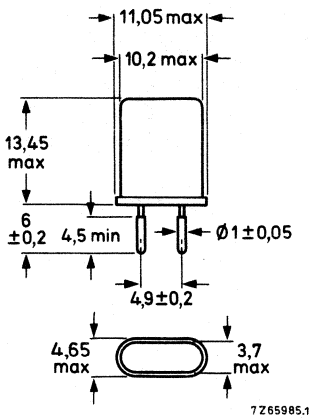
HC-6/U, solder sealed
RW-36, resistance welded



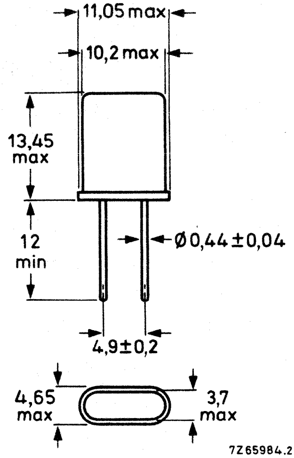
RW-33
resistance welded



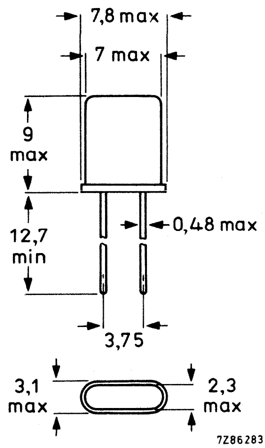
RW-10
resistance welded



RW-42
resistance welded



RW-43
resistance welded

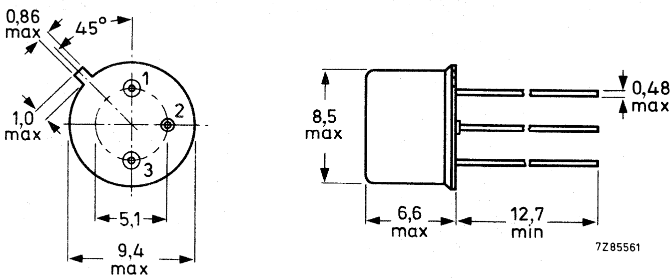


RW-80
resistance welded

TO-39

Resistance welded

Pin 2 is connected to the case.



CORRESPONDING IEC AND DIN TYPE NUMBERS

	IEC 122-3	DIN 45110
HC-6/U	AA	K1A
HC-26/U	CY	R2A
HC-27/U	DA	Q1A
HC-27/U, extended	DB	Q1B
HC-29/U	CZ	R1A
RW-10	DS	K4A
RW-33	–	–
RW-36	–	K3A
RW-42	DQ	M3A
RW-43	DP	M4A
RW-80	35/EB	N4B
TO-39	17/CK	T1A

QUARTZ CRYSTAL UNITS, ECONOMY TYPES

QUARTZ CRYSTAL UNITS
economy types in RW-43 holder

QUICK REFERENCE DATA

Nominal frequency	3000,000 to 16 000,000 kHz
Mode of vibration	fundamental
Type of holder	RW-43

APPLICATION

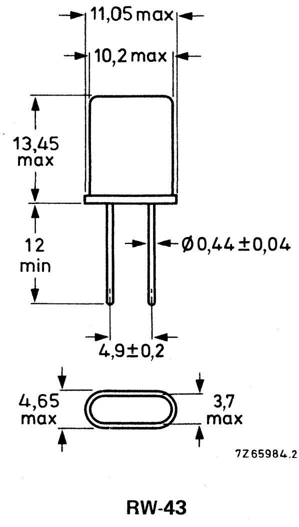
See Table 1.

DESCRIPTION

The unit consists of a metal-plated AT-cut quartz plate, mounted in a hermetically sealed resistance welded metal holder RW-43 and has two connecting leads. See also "general" section.

MECHANICAL DATA

Outlines



RW-43

Mass 2 g approximately

ELECTRICAL DATA

Unless otherwise specified the values apply at a temperature of 25 ± 2 °C and a level of drive of 0,5 mW related to 25 Ω.

Resonance resistance of unwanted response	> 2 R_r
Insulation resistance	max. 10^{10} Ω
Permissible d.c. voltage between leads	max. 100 V

See Table 1 for other parameters

TESTS AND REQUIREMENTS

IEC 122	IEC 68-2	test	procedures	requirements
2.5.17	Ba	aging	1000 h + 100 °C	$\Delta f_r \leq 5 \times 10^{-6}$ $\Delta R \leq 20\%$
2.5.12 2.5.13 2.5.14	Db	accelerated damp heat	+ 25 to + 55 °C, 6 cycles 95 to 100% R.H.	$\Delta f_r \leq 5 \times 10^{-6}$ $\Delta R \leq 20\%$
	Na	temperature cycling test	−40/+ 125 °C, 10 cycles, 1 h/cycle	$\Delta f_r \leq 5 \times 10^{-6}$ $\Delta R \leq 20\%$
2.5.2	Ea	shock	100g sawtooth 6 shocks, 3 directions	$\Delta f_r \leq 5 \times 10^{-6}$ $\Delta R \leq 20\%$
2.5.3	Fc	vibration	10-500-10 Hz, 10g 3 h, 3 directions	$\Delta f_r \leq 5 \times 10^{-6}$ $\Delta R \leq 20\%$
	Tb	resistance to soldering heat	3 s, 350 °C	$\leq 5 \times 10^{-6}$ $\leq 20\%$
2.5.6	Ub	bending of terminations	1 x 90°, 5 N	no visible damage
	Eb	bump	3000 bumps, 30g	$\Delta f_r \leq 5 \times 10^{-6}$ $\Delta R \leq 20\%$
	Ed	free fall	3 x 0,75 m on steel	$\Delta f_r \leq 5 \times 10^{-6}$ $\Delta R \leq 20\%$
	Q, Qk	sealing	16 h, 700 kPa He	$< 10^{-8}$ ncc/s He

Table 1

Specifications of quartz crystal units in RW-43 holder; economy range

f load resonance frequency kHz	adjustment tolerance < ± · 10^{-6}	C_L load capacitance pF	T temperature range °C	frequency tolerance < ± · 10^{-6}	R_r resonance resistance Ω	C_o static parallel capacitance pF
3000,000	40	20	–20 to + 70	30	150	4,0
3276,800	40	20	–20 to + 70	30	100	4,3
3440,000	40	20	–40 to + 80	30	100	4,3
3440,000	40	30	–40 to + 80	30	100	4,3
3547,000	30	30	–10 to + 60	20	100	4,5
3579,545	40	20	–20 to + 70	30	100	4,5
3579,545	5000	series	–20 to + 70	100	100	4,5
3582,056	40	20	–10 to + 60	25	100	4,5
3686,400	40	30	–10 to + 60	25	100	4,5
3686,400	20	series	–20 to + 70	40	100	4,5
3750,000	30	13	–10 to + 65	7	75	4,5
3840,000	20	30	–20 to + 70	50	75	4,6
3932,160	30	17	–40 to + 90	50	75	4,7
3997,676	40	20	0 to + 60	15	75	2,8
4000,000**	40	30	–10 to + 60	25	75	2,8
4000,000	40	20	–10 to + 60	25	75	2,8
4000,000	40	30	0 to + 60	15	75	2,8
4000,000	30	20	–10 to + 60	40	75	2,8
4096,000	50	20	–40 to + 90	50	60	5,0
4194,304	40	12	–10 to + 60	25	60	2,9
4194,304	40	11,4	–10 to + 60	25	60	2,9
4194,304**	50	20	–40 to + 80	50	90	2,9
4233,600	40	series	–20 to + 70	30	60	5,2
4233,600	40	30	–20 to + 70	30	60	5,2
4250,000	40	20	–10 to + 60	25	60	5,2
4406,250	40	20	–10 to + 60	25	60	5,4
4433,619**	40	20	–10 to + 60	25	60	5,5
4433,619**	40	20	+ 10 to + 55	15	60	5,5
4433,619**	40	20	–10 to + 60	25	60	5,5
4435,571	40	20	–10 to + 60	25	60	5,5
4500,000	30	13	–10 to + 65	7	60	5,6
4531,468	30	13	–10 to + 65	7	60	5,6
4608,000	30	series	0 to + 70	40	60	5,8
4782,720	40	series	–20 to + 70	30	60	5,7
4782,720	5000	series	–20 to + 70	100	60	5,7
4865,000	50	series	–20 to + 70	50	60	5,7

Table continues on next page.

* The standard lead length is 12 mm (5 mm on request). Types marked by * have a standard lead length of 5 mm.

** Preferred types.

C_1 motional capacitance fF	S pullability $> \cdot 10^{-6}$/pF	application	catalogue number 4322 143 or 4322 144 followed by
10,0	8	general, e.g. microprocessors	04411
13,5	7	timing (dividing ratio 2^{16} : 1 for 50 Hz)	04421
13,5	9	general, e.g. microprocessors	04571
13,5	4	general, e.g. mircroprocessors	04761
14,5	5	video games	04491
14,7	10	colour television	04391
14,7	—	two-tone telephone dialling system	04401
14,7	10	colour television, South America	04381
15,0	5	general, e.g. microprocessors	04371
15,0	—	general, e.g. microprocessors	04551
15,0	22	video long play	04431
15,4	5	general, e.g. microprocessors	04441
15,8	14	timing (dividing ratio 2^{16} : 1 for 60 Hz)	04671
11,0	7	general, e.g. microprocessors	04481
11,0	3	general, e.g. digital tuning	04091
11,0	9	colour television	04261
11,0	3	clock control	04271
11,0	9	colour television	04881
18,5	12	timing (dividing ratio 2^{12} : 1 for 1000 Hz)	04701
11,6	22	colour control	04071
11,6	24	clock	04081
11,6	9	clock	04471
16,7	—	compact disc	04461
16,7	6	compact disc	04561
16,7	12	chrominance subcarrier SECAM-L system	04361
20,5	15	chrominance subcarrier SECAM-L system	04351
20,6	12	sub-carrier oscillator PAL-system	04041
20,6	12	video cassette recording	04251*
20,6	12	colour television	04281*
20,6	12	colour television	04871*
18,4	22	video long play	04111
18,4	22	video long play	04121
22,0	—	general, e.g. microprocessor	04341
21,4	—	two-tone telephone dialling system (high acc.)	04031
21,4	—	two-tone telephone dialling system	04291
22,5	—	general, e.g. microprocessors	04781

Table 1

Specificationes of quartz crystal units in RW-43 holder; economy range

f load resonance frequency kHz	 adjustment tolerance < ± · 10^{-6}	C_L load capacitance pF	T temperature range °C	 frequency tolerance < ± · 10^{-6}	R_r resonance resistance Ω	C_o static parallel capacitance pF
4905,021	40	20	−20 to + 70	30	60	5,9
4905,021**	40	20	−20 to + 70	30	60	5,9
4915,200	20	30	+ 5 to + 45	20	60	3,2
4915,200	2000	30	+ 5 to + 45	20	60	3,2
5000,000	40	20	−20 to + 70	30	60	3,2
5068,800	40	20	−20 to + 70	30	60	3,2
5068,800	40	series	−20 to + 70	30	60	3,2
5068,800	20	series	−15 to + 70	30	60	3,2
5120,000	40	20	−20 to + 70	30	60	3,5
5120,000	40	20	−20 to + 70	30	60	3,5
5911,000	20	30	−10 to + 60	20	60	3,7
6000,000**	40	20	−20 to + 70	30	60	6,9
6000,000**	40	20	−20 to + 70	30	60	6,9
6041,957	40	20	−20 to + 70	30	60	6,9
6144,000	50	20	0 to + 70	50	60	3,8
6400,000	40	20	−20 to + 70	25	60	4,0
7000,000	40	20	−10 to + 60	30	60	4,2
7151,223	40	20	−10 to + 60	25	60	4,4
7159,090	40	20	−10 to + 60	25	60	4,4
7164,112	40	20	−20 to + 70	25	60	4,4
8000,000	40	20	−20 to + 70	25	60	5,0
8867,238**	40	20	−10 to + 60	25	60	5,5
8867,238	40	20	−10 to + 60	25	60	5,5
9830,400	50	series	0 to + 70	50	50	5,7

* The standard lead length is 12 mm (5 mm on request). Types marked by * have a standard lead length of 5 mm.

** Preferred types.

C_1 motional capacitance fF	S pullability $>\cdot 10^{-6}$/pF	application	catalogue number 4322 143 or 4322 144 followed by:
22,9	13	measuring equipment	04601
22,9	13	video cassette recording	04131*
13,6	5	grammophone control systems (high acc.)	04141
13,6	5	grammophone control systems	04201
13,8	12	television cameras	04151
14,0	12	general, e.g. microprocessors	04331
14,0	–	general, e.g. microprocessors	04451
14,0	–	general, e.g. microprocessors	04541
14,6	11	carradio	04161
14,6	11	carradio	04751*
16,5	6	video games	04521
27,6	17	teletext, viewdata, video cassette recording	04101
27,6	17	teletext, viewdata, video cassette recording	04531*
27,6	17	teletext (USA)	04591
17,0	12	microporcessors	04321
18,0	12	microprocessors	04311
19,2	12	microprocessors	04791
19,5	14	sub-carrier colour television	04171
19,5	14	sub-carrier colour television	04181
19,5	14	sub-carrier colour television	04191
21,0	15	general, e.g. microprocessors	04301
22,0	16	colour television, video cassette recording	04051
22,0	16	colour television, video cassette recording	04221*
25,3	–	measuring systems	04611

LOW COST HIGH PRECISION DIGITAL QUARTZ TEMPERATURE SENSORS

DESCRIPTION

The sensor consists of a metal-plated special T.C.-cut piezoelectric quartz plate, mounted in a hermetically-sealed, resistance-welded metal holder, with two leads. The holder is filled with a dry inert gas. The quartz plate oscillates in a fundamental thickness-shear mode. The resonance frequency is an almost linear function of the temperature. See also section "General".

Features

- no A/D conversion
- excellent linearity
- high stability, very low ageing
- wide temperature range
- high noise immunity
- easy calibration
- quantity production at low cost

APPLICATIONS

These sensors can be used in industrial temperature measurement and control, car electronics, flow meters, weather balloons, medical systems and in energy saving projects such as heat monitors and solar panels.

QUICK REFERENCE DATA

	economy design	special design	
Frequency range	4 to 20	1 to 25	MHz
Temperature range	−100 to + 150	−100 to + 300	°C
Temperature coefficient	−40 to + 80	−50 to + 85	x 10^{-6}/K
Linearity	< ± 2,5	< ± 1,5	%
Adjustment tolerance	< ± 150	< ± 50	x 10^{-6}
Thermal time constant	typ. 10	3 to 30	s
Type of holder	RW-43	RW-43; RW-80; HC-26/U HC-27/U; TO-39	

For additional details the supplier should be contacted.

QUARTZ CRYSTAL UNITS FOR GENERAL FREQUENCY STABILIZATION

QUARTZ CRYSTAL UNIT

QUICK REFERENCE DATA

Nominal frequency	21480,000 kHz
Mode of vibration	fundamental
Type of holder	RW-80

APPLICATION

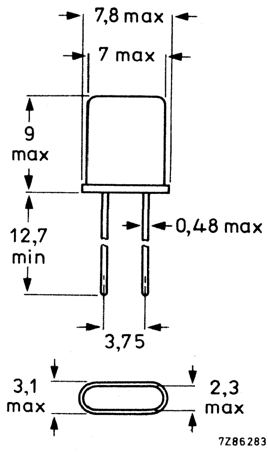
I.F. oscillator in small portable professional radio equipment, e.g. pagers.

DESCRIPTION

The unit consists of a metal-plated AT-cut quartz plate, mounted in a hermetically sealed resistance welded metal holder, provided with two connecting leads.

MECHANICAL DATA

Outlines



Mass 0,5 g approximately

Marking

The frequency in kHz, the last 5 digits of the catalogue number, and a code for the date of manufacture are stamped on the holder.

Mounting

The unit can be soldered directly onto a printed-wiring board.

ELECTRICAL DATA

Unless otherwise specified the values apply at a temperature of 25 ± 2 °C and a level of drive of 0,5 mW related to 25 Ω.

Load resonance frequency f_L load capacitance 32 pF	21480,000 kHz
Adjustment tolerance	± max. 15 x 10^{-6}
Tolerance over the temperature range of −5 to + 45 °C, with respect to + 25 °C	± max. 15 x 10^{-6}
Motional capacitance (C_1)	typ. 17,5 fF
Parallel capacitance (C_0)	typ. 4,6 pF
Resonance resistance	max. 40 Ω
Pullability $\left(-\frac{df}{dC}\right)$ at f_L with load capacitance variation	min. + 5 x 10^{-6} x f_L/pF
Maximum permissible d.c. voltage between terminations	100 V
Operating temperature range	−5 to + 45 °C

TESTS AND REQUIREMENTS

IEC 122	IEC 68-2	test	procedures	requirements
2.5.17	Ba	ageing	1000 h + 100 °C	$\Delta f_r \leqslant 5 \times 10^{-6}$. $\Delta R \leqslant 20\%$.
2.5.12 2.5.13 2.5.14	Db	accelerated damp heat	+ 25 to + 55 °C, 6 cycles 95 to 100% R.H.	$\Delta f_r \leqslant 5 \times 10^{-6}$. $\Delta R \leqslant 20\%$.
	Na	temperature cycling test	−40/+ 125 °C, 10 cycles, 1 h/cycle.	$\Delta f_r \leqslant 5 \times 10^{-6}$. $\Delta R \leqslant 20\%$.
2.5.2	Ea	shock	100g sawtooth 6 shocks, 3 directions	$\Delta f_r \leqslant 5 \times 10^{-6}$. $\Delta R \leqslant 20\%$.
2.5.3	Fc	vibration	10-500-10 Hz, 10g, 3 h, 3 directions	$\Delta f_r \leqslant 5 \times 10^{-6}$. $\Delta R \leqslant 20\%$.
	Tb	resistance to soldering heat	3 s, 350 °C.	$\leqslant 5 \times 10^{-6}$. $\leqslant 20\%$.
2.5.6	Ub	bending of terminations	1 x 90°, 5 N.	no visible damage.
	Eb	bump	3000 bumps, 30g	$\Delta f_r \leqslant 5 \times 10^{-6}$. $\Delta R \leqslant 20\%$.
	Ed	free fall	3 x 0,75 m on steel	$\Delta f_r \leqslant 5 \times 10^{-6}$. $\Delta R \leqslant 20\%$.

QUARTZ CRYSTAL UNITS

QUICK REFERENCE DATA

Frequency range	3 to 10 MHz
Mode of vibration	fundamental
Type of holder	RW-10, RW-33 or RW-36

MECHANICAL DATA

Outlines See general section "Holders".

Mass 4 g

ELECTRICAL DATA

Adjustment tolerance at + 25 °C	± 10 x 10^{-6}
Load capacitance C_L*	30 pF
Level of drive	0,5 mW
Motional capacitance C_1	see Fig. 1
Parallel capacitance C_0	see Fig. 1
Motional inductance L_1	see Fig. 1
Resonance resistance R_r	typ. 25 Ω
Frequency tolerance with respect to + 25 °C in temperature range:	
0 to + 60 °C	± max. 30 x 10^{-6}
–30 to + 80 °C	± max. 35 x 10^{-6}
+ 15 to + 45 °C	± max. 10 x 10^{-6}
Maximum permissible d.c. voltage between terminations	100 V
Ageing	within adjustment tolerance

* Data at other C_L values and for series resonance available on request.

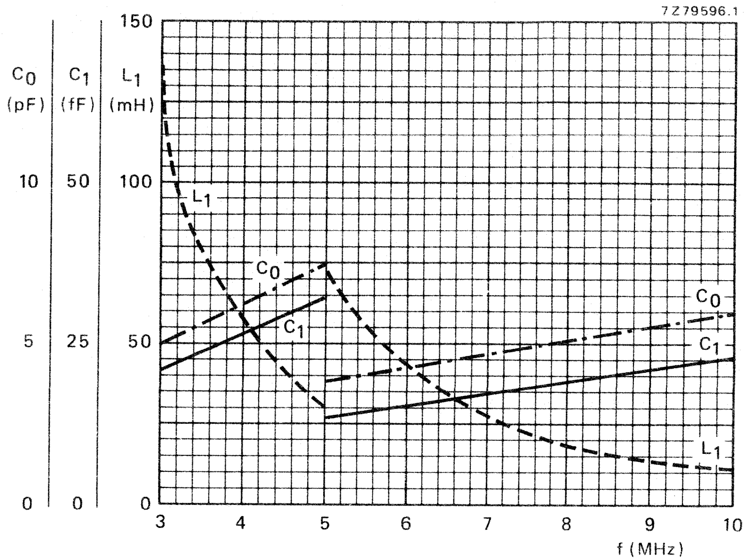


Fig. 1 Typical values for C_0, C_1 and L_1 as a function of frequency.

TESTS AND REQUIREMENTS

test	IEC-122 clause	IEC-68-2 test method	procedure	requirements
ageing	2.5.17	–	30 days + 85 °C	$\Delta f/f \leqslant 10 \times 10^{-6}$
acceleration	2.5.12 2.5.13 2.5.14	Db		$\Delta f/f \leqslant 10 \times 10^{-6}$ $R_{ins} > 20$ MΩ at 50 V (d.c.)
temperature cycling	–	Na	–20/+ 50 °C, 15 cycles, 1 h/cycle	$\Delta f/f \leqslant 5 \times 10^{-6}$
shock	2.5.2	Ea	100g sawtooth 6 directions, 1 blow/direction	$\Delta f/f \leqslant 5 \times 10^{-6}$ $\Delta R/R < 15\%$
vibration	2.5.3	Fc	10-55-10 Hz 2 hours*	$\Delta f/f \leqslant 5 \times 10^{-6}$ $\Delta R/R < 15\%$
soldering**	2.5.10	T		no visible damage, terminals well-tinned $\Delta f/f \leqslant 2 \times 10^{-6}$
bending of terminations**	2.5.6	Ub	1 x 90°, 5 N	no visible damage

* The batch is divided into 3 equal parts, each part is tested in 1 of the 3 perpendicular directions.
** Holder RW-10 only.

QUARTZ CRYSTAL UNITS

QUICK REFERENCE DATA

Frequency range	1,8 to 25 MHz
Mode of vibration	fundamental
Type of holder	RW-33 or RW-36

MECHANICAL DATA

Outlines See general section "Holders".

Mass 4 g

ELECTRICAL DATA

Adjustment tolerance at + 25 °C	$\pm 10 \times 10^{-6}$
Load capacitance C_L*	30 pF
Level of drive	0,5 mW
Motional capacitance C_1	5 to 30 fF
Parallel capacitance C_0	max. 7 pF
Resonance resistance R_r	see Table 1
Frequency tolerance in different temp. ranges with respect to + 25 °C	see Table 2
Maximum permissible d.c. voltage between terminations	100 V
Ageing	within adjustment tolerance

TESTS

Mechanical and climatic tests	according to MIL and IEC procedures

* Data at other C_L values and for series resonance available on request.

Table 1 Resonance resistance R_r

frequency MHz	max. R_r Ω
1,800000 – 1,999999	300
2,000000 – 2,249999	250
2,250000 – 3,749999	150
3,750000 – 4,999999	100
5,000000 – 6,999999	50
7,000000 – 9,999999	30
10,000000 – 25,000000	25

Table 2 Frequency tolerance in different temperature ranges with respect to + 25 °C

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

QUARTZ CRYSTAL UNIT

QUICK REFERENCE DATA

Nominal frequency	6144,000 kHz
Mode of vibration	fundamental
Type of holder	TO-39

APPLICATION

General, e.g. microprocessors.

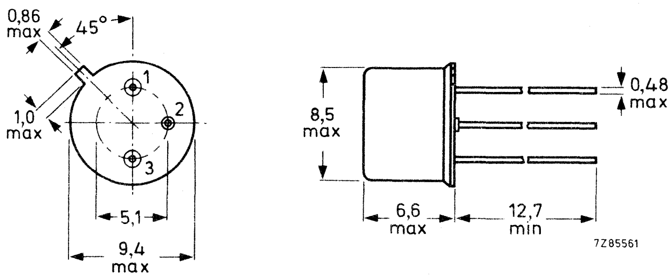
DESCRIPTION

The unit consists of a metal-plated AT-cut quartz plate, mounted in a hermetically sealed resistance welded metal holder, provided with two connecting leads.

MECHANICAL DATA

Outlines

Pin 2 is connected to the case.



Mass 0,8 g approximately

Marking

The frequency in kHz, the last 5 digits of the catalogue number, and a code for the date of manufacture are stamped on the holder.

Mounting

The unit can be soldered directly onto a printed-wiring board.

ELECTRICAL DATA

Unless otherwise specified the values apply at a temperature of 25 ± 2 °C and a level of drive of 0,5 mW related to 25 Ω.

Load resonance frequency f_L, load capacitance 20 pF	6144,000 kHz
Adjustment tolerance	± max. 25 x 10^{-6}
Tolerance over the temperature range of −10 to +60 °C, with respect to +25 °C	± max. 25 x 10^{-6}
Motional capacitance (C_1)	typ. 7,2 fF
Parallel capacitance (C_0)	typ. 2,2 pF
Resonance resistance	max. 75 Ω
Pullability $\left(-\frac{df}{dC}\right)$ at f_L with load capacitance variation	min. +6 x 10^{-6} x f_L/pF
Maximum permissible d.c. voltage between terminations	100 V
Operating temperature range	−10 to +60 °C

TESTS AND REQUIREMENTS

IEC 122	IEC 68-2	test	procedures	requirements
2.5.17	Ba	ageing	1000 h + 100 °C	$\Delta f_r \leq 5 \times 10^{-6}$. $\Delta R \leq 20\%$.
2.5.12 2.5.13 2.5.14	Db	accelerated damp heat	+25 to +55 °C, 6 cycles 95 to 100% R.H.	$\Delta f_r \leq 5 \times 10^{-6}$. $\Delta R \leq 20\%$.
	Na	temperature cycling test	−40/+125 °C, 10 cycles, 1 h/cycle.	$\Delta f_r \leq 5 \times 10^{-6}$. $\Delta R \leq 20\%$.
2.5.2	Ea	shock	100g sawtooth 6 shocks, 3 directions	$\Delta f_r \leq 5 \times 10^{-6}$. $\Delta R \leq 20\%$.
2.5.2	Fc	vibration	10-500-10 Hz, 10g, 3 h, 3 directions.	$\Delta f_r \leq 5 \times 10^{-6}$. $\Delta R \leq 20\%$.
	Tb	resistance to soldering heat	3 s, 350 °C.	$\leq 5 \times 10^{-6}$ $\leq 20\%$.
2.5.6	Ub	bending of terminations	1 x 90°, 5 N	no visible damage.
	Eb	bump	3000 bumps, 30g	$\Delta f_r \leq 5 \times 10^{-6}$. $\Delta R \leq 20\%$.
	Ed	free fail	3 x 0,75 m on steel	$\Delta f_r \leq 5 \times 10^{-6}$. $\Delta R \leq 20\%$.

QUARTZ CRYSTAL UNITS

QUICK REFERENCE DATA

Frequency range	1 to 1,8 MHz
Mode of vibration	fundamental
Type of holder	HC-6/U

MECHANICAL DATA

Outlines See general section "Holders".

Mass 4 g

ELECTRICAL DATA

Adjustment tolerance at + 25 °C	$\pm 20 \times 10^{-6}$
Load capacitance C_L*	30 pF
Level of drive	0,5 mW
Motional capacitance C_1	5 to 30 fF
Parallel capacitance C_0	max. 7 pF
Resonance resistance R_r	
1,000000 – 1,599999 MHz	max. 600 Ω
1,600000 – 1,799999 MHz	max. 300 Ω
Frequency tolerance in different temp. ranges with respect to + 25 °C	see Table
Maximum permissible d.c. voltage between terminations	100 V
Ageing	within adjustment tolerance

TESTS

Mechanical and climatic tests — according to MIL and IEC procedures

Table Frequency tolerance in different temperature ranges with respect to + 25 °C.

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

* Data at other C_L values and for series resonance available on request.

QUARTZ CRYSTAL UNIT

QUICK REFERENCE DATA

Nominal frequency	1000,000 kHz
Mode of vibration	fundamental
Type of holder	HC-6/U

MECHANICAL DATA

Outlines: see general section "Holders"

Mass: 4 g approximately

ELECTRICAL DATA

Unless otherwise specified the values apply at a temperature of 25 ± 2 °C and a level of drive of 0,5 mW related to 25 Ω.

Load resonance frequency f_L, load capacitance 30 pF	1000,000 kHz
Adjustment tolerance	± max. 20×10^{-6}
Tolerance over the temperature range of −20 to +70 °C, with respect to +25 °C	± max. 30×10^{-6}
Motional capacitance C_1	typ. 9 fF
Parallel capacitance C_0	typ. 3,5 pF
Resonance resistance R_r	max. 600 Ω
Pullability $-\frac{df}{dC}$ at f_L with load capacitance variation	min. $+4 \times 10^{-6} \times f_L$/pF
Maximum permissible d.c. voltage between terminations	100 V
Operating temperature range	−20 to +70 °C

Marking

The frequency in kHz, the last 5 digits of the catalogue number, and a code for the date of manufacture are stamped on the holder.

QUARTZ CRYSTAL UNITS

QUICK REFERENCE DATA

Frequency range	1,8 to 25 MHz
Mode of vibration	fundamental
Type of holder	
→ 1,8 to 2,3 MHz	HC-27/U, extended (26 mm)
2,4 to 25 MHz	HC-27/U

MECHANICAL DATA

Outlines See general section "Holders".

Mass 2,5 g

ELECTRICAL DATA

Adjustment tolerance at + 25 °C	± 10 x 10^{-6}
Load capacitance C_L*	30 pF
Level of drive	0,5 mW
Motional capacitance C_1	see Figs 1 to 4
Parallel capacitance C_0	max. 7 pF, see also Fig. 1
Motional inductance L_1	see Figs 1 to 4
Resonance resistance R_r	see Table 1
Frequency tolerance in different temperature ranges with respect to + 25 °C	see Table 2
Maximum permissible d.c. voltage between terminations	100 V
Ageing after 90 days non-operative at + 85 ± 2 °C	(−0,5 to + 1) x 10^{-6}

TESTS

Mechanical and climatic tests according to MIL and IEC procedures.

* Data at other C_L values and for series resonance available on request.

Table 1 Resonance resistance R_r

frequency MHz	max. R_r Ω
1,800000 – 1,869999	220
1,870000 – 1,999999	185
2,000000 – 2,119999	165
2,120000 – 2,249999	150
2,250000 – 2,599999	125
2,600000 – 2,999999	90
3,000000 – 3,399999	70
3,400000 – 3,749999	52
3,750000 – 3,999999	45
4,000000 – 4,999999	37
5,000000 – 6,999999	25
7,000000 – 9,999999	20
10,000000 – 14,999999	18
15,000000 – 25,000000	15

Table 2, Frequency tolerance in different temperature ranges with respect to + 25 °C

frequency range MHz	temperature range °C	frequency tolerance		
		class 0	class I	class II
1,8 to 25	–5/+ 45	± 5 x 10^{-6}	± 7,5 x 10^{-6}	± 10 x 10^{-6}
	–10/+ 50	± 7,5 x 10^{-6}	± 10 x 10^{-6}	± 15 x 10^{-6}
	–15/+ 70	± 10 x 10^{-6}	± 15 x 10^{-6}	± 20 x 10^{-6}
1,8 to 2,3	–55/+ 105	± 30 x 10^{-6}	± 35 x 10^{-6}	± 40 x 10^{-6}
2,3 to 7	–55/+ 105	± 32,5 x 10^{-6}	± 35 x 10^{-6}	± 40 x 10^{-6}
7 to 25	–55/+ 105	± 25 x 10^{-6}	± 30 x 10^{-6}	± 40 x 10^{-6}
1,8 to 25	T_{nom} ± 5		± 2,5 x 10^{-6}	± 5 x 10^{-6}

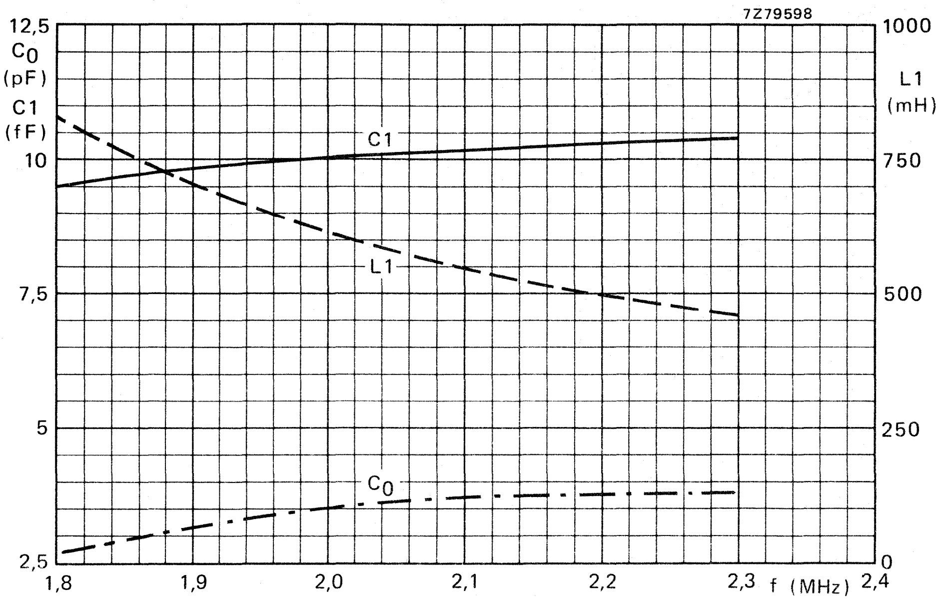


Fig. 1 Typical values for C_0, C_1 and L_1 for frequencies from 1,8 to 2,3 MHz.

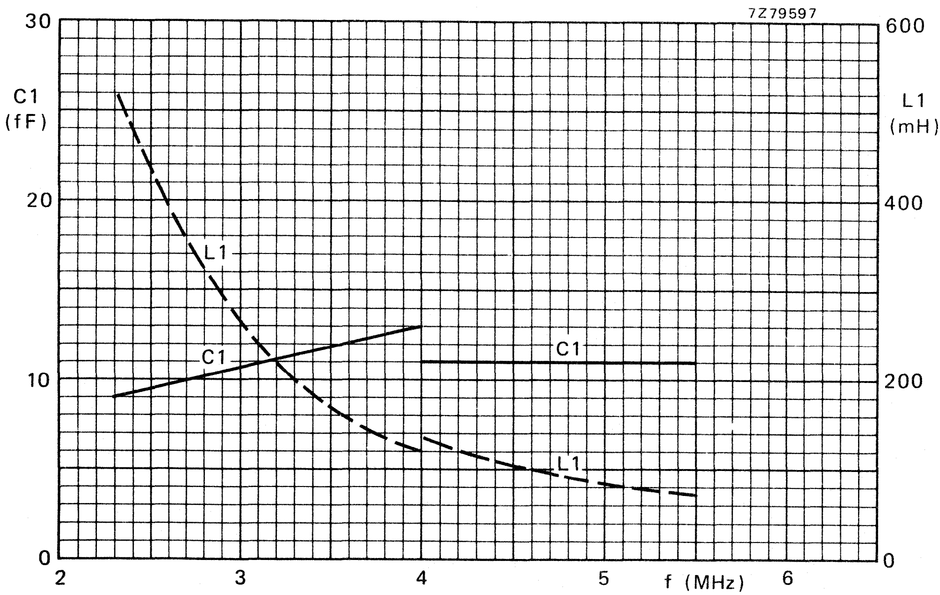


Fig. 2 Typical values for C_1 and L_1 for frequencies from 2,3 to 5,5 MHz.

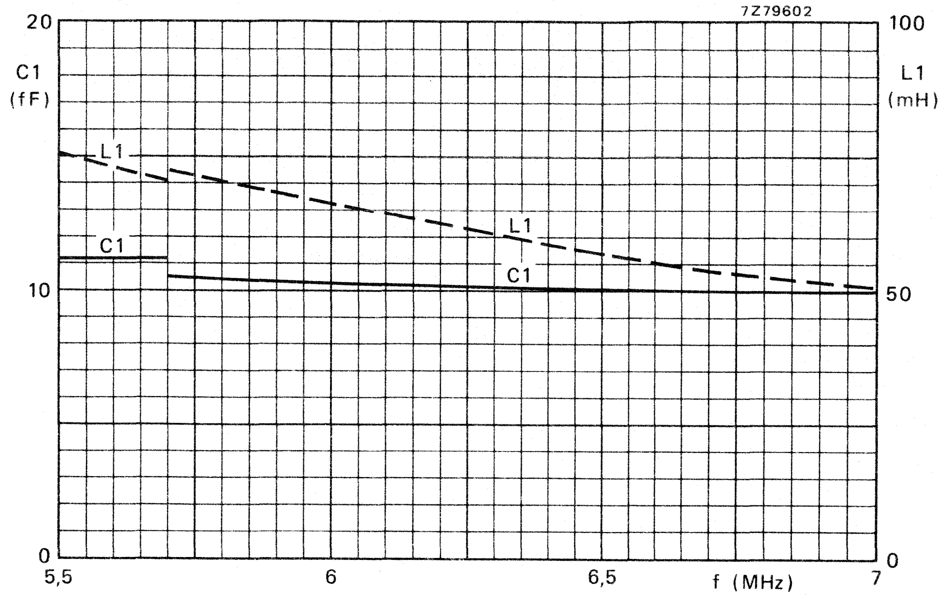


Fig. 3 Typical values for C_1 and L_1 for frequencies from 5,5 to 7 MHz.

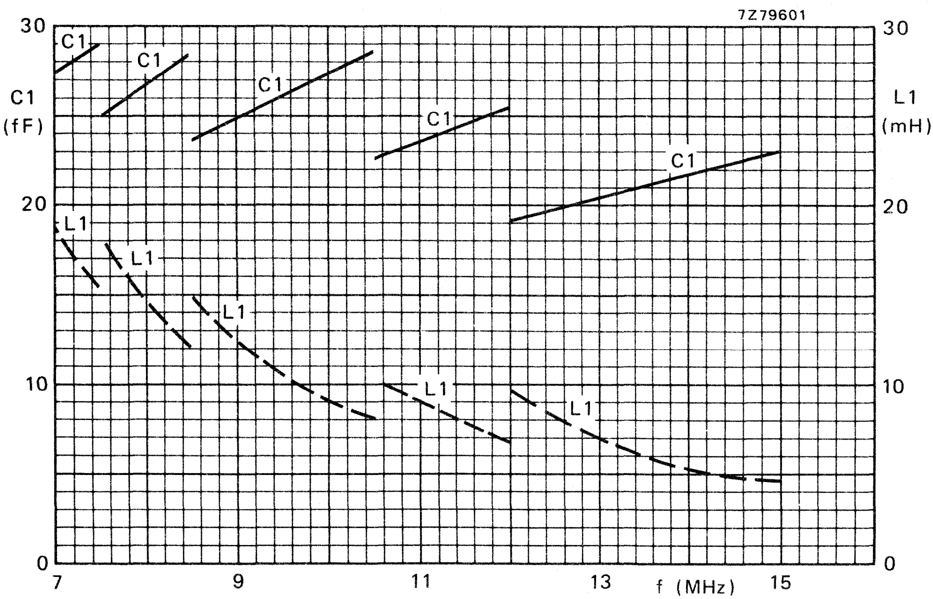


Fig. 4 Typical values for C_1 and L_1 for frequencies from 7 to 15 MHz.

QUARTZ CRYSTAL UNITS

QUICK REFERENCE DATA

Frequency range	4,5 to 25 MHz
Mode of vibration	fundamental
Type of holder	HC-26/U or HC-29/U

MECHANICAL DATA

Outlines See general section "Holders".

Mass 0,8 g

ELECTRICAL DATA

Adjustment tolerance at + 25 °C	± 10 x 10^{-6}
Load capacitance C_L*	30 pF
Level of drive	0,5 mW
Motional capacitance C_1	see Figs 1 and 2
Parallel capacitance C_0	see Figs 1 and 2
Motional inductance L_1	see Figs 1 and 2
Resonance resistance R_r	see Table 1
Frequency tolerance in different temperature ranges with respect to + 25 °C	see Table 2
Maximum permissible d.c. voltage between terminations	100 V
Ageing after 90 days non-operative at + 85 ± 2 °C	(–0,5 to + 1) x 10^{-6}

TESTS

Mechanical and climatic tests according to MIL and IEC procedures.

* Data at other C_L values and for series resonance available on request.

Table 1 Resonance resistance R_r

frequency MHz	max. R_r Ω
4,500000 – 4,749999	110
4,750000 – 5,999999	70
6,000000 – 6,999999	45
7,000000 – 9,999999	30
10,000000 – 14,999999	25
15,000000 – 25,000000	20

Table 2 Frequency tolerance in different temperature ranges with respect to + 25 °C

frequency range MHz	temperature range °C	frequency tolerance		
		class 0	class I	class II
4,5 to 25	–5/+ 45 –10/+ 50 –15/+ 70	± 5 x 10^{-6} ± 7,5 x 10^{-6} ± 10 x 10^{-6}	± 7,5 x 10^{-6} ± 10 x 10^{-6} ± 15 x 10^{-6}	± 10 x 10^{-6} ± 15 x 10^{-6} ± 20 x 10^{-6}
4,5 to 6 6 to 12 12 to 25	–55/+ 105 –55/+ 105 –55/+ 105	± 30 x 10^{-6} ± 32,5 x 10^{-6} ± 25 x 10^{-6}	± 40 x 10^{-6} ± 35 x 10^{-6} ± 30 x 10^{-6}	± 50 x 10^{-6} ± 40 x 10^{-6} ± 40 x 10^{-6}
4,5 to 25	T_{nom} ± 5		± 2,5 x 10^{-6}	± 5 x 10^{-6}

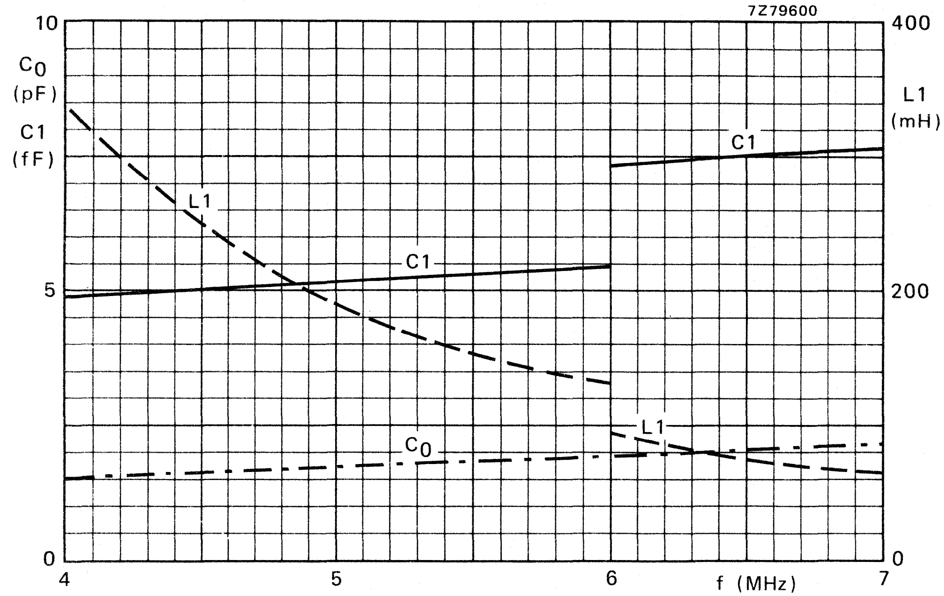


Fig. 1 Typical values of L_1, C_0 and C_1 for frequencies from 4 to 7 MHz.

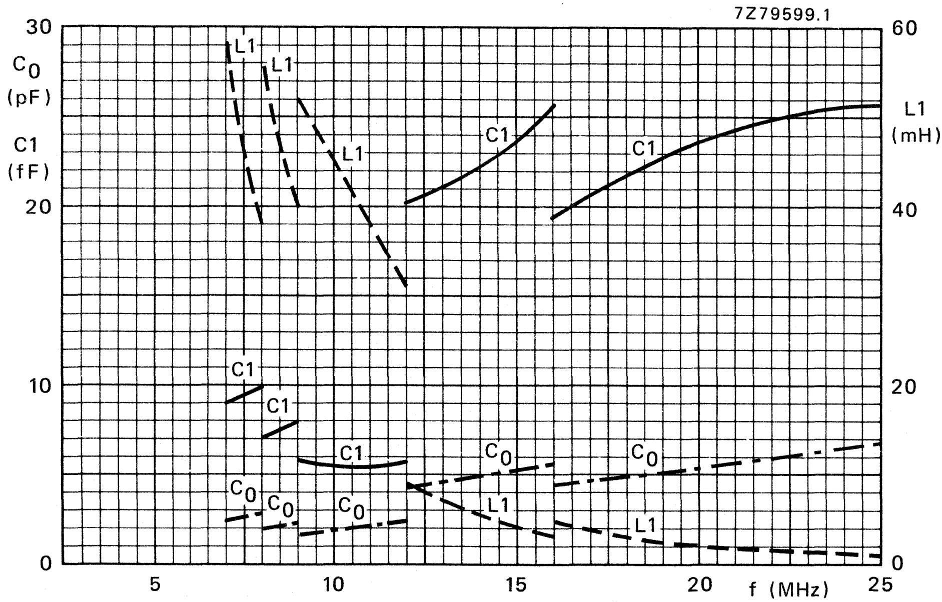


Fig. 2 Typical values of L_1, C_0 and C_1 for frequencies from 7 to 25 MHz.

QUARTZ CRYSTAL UNITS

QUICK REFERENCE DATA

Frequency range	4,5 to 25 MHz
Mode of vibration	fundamental
Type of holder	RW-42 or RW-43

MECHANICAL DATA

Outlines See general section "Holders".

Mass 1 g

ELECTRICAL DATA

Adjustment tolerance at + 25 °C	$\pm 10 \times 10^{-6}$
Load capacitance C_L *	30 pF
Level of drive	0,5 mW
Motional capacitance C_1	5 to 30 fF
Parallel capacitance C_0	max. 7 pF
Resonance resistance R_r	
4,5 to 7 MHz	max. 80 Ω
4 to 25 MHz	max. 40 Ω
Frequency tolerance in different temperature ranges with respect to + 25 °C	see Table
Maximum permissible d.c. voltage between terminations	100 V
Ageing	within adjustment tolerance

TESTS

Mechanical and climatic tests according to MIL and IEC procedures.

Table Frequency tolerance in different temperature ranges with respect to + 25 °C.

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

* Data at other C_L values and for series resonance available on request.

QUARTZ CRYSTAL UNITS

QUICK REFERENCE DATA

Frequency range	10 to 75 MHz
Mode of vibration	third overtone
Type of holder	HC-27/U

MECHANICAL DATA

Outlines See general section "Holders".

Mass 2,5 g

ELECTRICAL DATA

Adjustment tolerance at + 25 °C	± 10 x 10^{-6}
Level of drive	0,5 mW
Motional capacitance C_1	typ. 1,5 fF
Parallel capacitance C_0	max. 7 pF
Resonance resistance R_r	max. 40 Ω
Frequency tolerance in different temperature ranges with respect to + 25 °C	see Table
Maximum permissible d.c. voltage between terminations	100 V
Ageing after 90 days non-operative at + 85 ± 2 °C	(−0,5 to + 1) x 10^{-6}

TESTS

Mechanical and climatic tests according to MIL and IEC procedures.

Table Frequency tolerance in different temperature ranges with respect to + 25 °C

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

QUARTZ CRYSTAL UNIT

QUICK REFERENCE DATA

Nominal frequency	10,00000 MHz
Mode of vibration	third overtone
Type of holder	all-glass, HC-27/U

MECHANICAL DATA

Outlines See general section "Holders"

Mass 2,5 g approximately

ELECTRICAL DATA

Unless otherwise specified the values apply at a temperature of +25 ± 2 °C and a level of drive of 1 mA.*

Load resonance frequency f_L, load capacitance 75 pF**	10,000 00 MHz
Adjustment tolerance	± max. 5 x 10^{-6}
Tolerance over the temperature range of +69 to +71 °C, with respect to +70 °C	± max. 3 x 10^{-7}
Motional capacitance (C_1)	typ. 2,1 fF
Parallel capacitance (C_0)	typ. 5 pF
Motional inductance (L_1)	typ. 120 mH
Resonance resistance over the temperature range of −40 to +75 °C	max. 40 Ω
Maximum permissible d.c. voltage between terminations	100 V
Ageing	±5 x 10^{-8}/month
Operating temperature range	−40 to +75 °C

Stability of oscillator frequency. This depends on the crystal oven used. Stability figures of 1 x 10^{-6} to 1 x 10^{-7} can be achieved.

TESTS AND REQUIREMENTS

According to MIL-C-3098C.	$\Delta f/f$	± max. 3 x 10^{-6}
	$\Delta R/R$	± max. 15%

Marking

The frequency in kHz, the last 5 digits of the catalogue number, and a code for the date of manufacture are stamped on the holder.

Mounting

The unit is provided with pins for socket mounting.

* Influence of drive level on frequency is max. 2 x 10^{-8}/dB.
** Data at other C_L and for series resonance available on request.

QUARTZ CRYSTAL UNITS

QUICK REFERENCE DATA

Frequency range	20 to 75 MHz
Mode of vibration	third overtone
Type of holder	HC-26/U or HC-29/U

MECHANICAL DATA

Outlines See general section "Holders".

Mass 0,8 g

ELECTRICAL DATA

Adjustment tolerance at + 25 °C	± 10 x 10^{-6}
Level of drive	0,5 mW
Motional capacitance C_1	typ. 1,5 fF
Parallel capacitance C_0	max. 7 pF
Resonance resistance R_r	max. 30 Ω
Frequency tolerance in different temperature ranges with respect to + 25 °C	see Table
Maximum permissible d.c. voltage between terminations	100 V
Ageing after 90 days non-operative at + 85 ± 2 °C	(−0,5 to + 1) x 10^{-6}

TESTS

Mechanical and climatic tests according to MIL and IEC procedures.

Table Frequency tolerance in different temperature ranges with respect to + 25 °C

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

QUARTZ CRYSTAL UNITS

QUICK REFERENCE DATA

Frequency range	17 to 75 MHz
Mode of vibration	third overtone
Type of holder	RW-42 or RW-43

MECHANICAL DATA

Outlines See general section "Holders".

Mass 1 g

ELECTRICAL DATA

Adjustment tolerance at + 25 °C	$\pm 10 \times 10^{-6}$
Level of drive	0,5 mW
Motional capacitance C_1	typ. 1,5 fF
Parallel capacitance C_0	max. 7 pF
Resonance resistance R_r	max. 40 Ω
Frequency tolerance in different temperature ranges with respect to + 25 °C	see Table
Maximum permissible d.c. voltage between terminations	100 V
Ageing	within adjustment tolerance

TESTS

Mechanical and climatic tests according to MIL and IEC procedures.

Table Frequency tolerance in different temperature ranges with respect to + 25 °C

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

QUARTZ CRYSTAL UNITS

QUICK REFERENCE DATA

Frequency range	10 to 75 MHz
Mode of vibration	third overtone
Type of holder	RW-33 or RW-36

MECHANICAL DATA

Outlines See general section "Holders".

Mass 4 g

ELECTRICAL DATA

Adjustment tolerance at + 25 °C	$\pm 10 \times 10^{-6}$
Level of drive	0,5 mW
Motional capacitance C_1	typ. 1,5 fF
Parallel capacitance C_0	max. 7 pF
Resonance resistance R_r	max. 60 Ω
Frequency tolerance in different temperature ranges with respect to + 25 °C	see Table
Maximum permissible d.c. voltage between terminations	100 V
Ageing	within adjustment tolerance

TESTS

Mechanical and climatic tests according to MIL and IEC procedures.

Table Frequency tolerance in different temperature ranges with respect to + 25 °C

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

QUARTZ CRYSTAL UNITS

QUICK REFERENCE DATA

Frequency range	50 to 125 MHz
Mode of vibration	fifth overtone
Type of holder	HC-27/U

MECHANICAL DATA

Outlines See general section "Holders".

Mass 2,5 g

ELECTRICAL DATA

Adjustment tolerance at + 25 °C	$\pm$ 10 x 10^{-6}
Level of drive	0,5 mW
Motional capacitance C_1	typ. 0,5 fF
Parallel capacitance C_0	max. 7 pF
Resonance resistance R_r	max. 50 Ω
Frequency tolerance in different temperature ranges with respect to + 25 °C	see Table
Maximum permissible d.c. voltage between terminations	100 V
Ageing after 90 days non-operative at + 85 $\pm$ 2 °C	(−0,5 to + 1) x 10^{-6}

TESTS

Mechanical and climatic tests according to MIL and IEC procedures.

Table Frequency tolerance in different temperature ranges with respect to + 25 °C

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

QUARTZ CRYSTAL UNITS

QUICK REFERENCE DATA

Frequency range	50 to 125 MHz
Mode of vibration	fifth overtone
Type of holder	HC-26/U or HC-29/U

MECHANICAL DATA

Outlines See general section "Holders".

Mass 0,8 g

ELECTRICAL DATA

Adjustment tolerance at + 25 °C	$\pm$ 10 x 10^{-6}
Level of drive	0,5 mW
Motional capacitance C_1	typ. 0,5 fF
Parallel capacitance C_0	max. 7 pF
Resonance resistance R_r	
50 to 90 MHz	max. 50 Ω
90 to 125 MHz	max. 70 Ω
Frequency tolerance in different temperature ranges with respect to + 25 °C	see Table
Maximum permissible d.c. voltage between terminations	100 V
Ageing after 90 days non-operative at + 85 $\pm$ 2 °C	(−0,5 to + 1) x 10^{-6}

TESTS

Mechanical and climatic tests according to MIL and IEC procedures.

Table Frequency tolerance in different temperature ranges with respect to + 25 °C

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

QUARTZ CRYSTAL UNITS

QUICK REFERENCE DATA

Frequency range	50 to 125 MHz
Mode of vibration	fifth overtone
Type of holder	RW-42 or RW-43

MECHANICAL DATA

Outlines See general section "Holders".

Mass 1 g

ELECTRICAL DATA

Adjustment tolerance at + 25 °C	$\pm 10 \times 10^{-6}$
Level of drive	0,5 mW
Motional capacitance C_1	typ. 0,5 fF
Parallel capacitance C_0	max. 7 pF
Resonance resistance R_r	
50 to 90 MHz	max. 60 Ω
90 to 125 MHz	max. 80 Ω
Frequency tolerance in different temperature ranges with respect to + 25 °C	see Table
Maximum permissible d.c. voltage between terminations	100 V
Ageing	within adjustment tolerance

TESTS

Mechanical and climatic tests according to MIL and IEC procedures.

Table Frequency tolerance in different temperature ranges with respect to + 25 °C

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

QUARTZ CRYSTAL UNITS

QUICK REFERENCE DATA

Frequency range	50 to 125 MHz
Mode of vibration	fifth overtone
Type of holder	RW-33 or RW-36

MECHANICAL DATA

Outlines See general section "Holders".

Mass 4 g

ELECTRICAL DATA

Adjustment tolerance at + 25 °C	$\pm 10 \times 10^{-6}$
Level of drive	0,5 mW
Motional capacitance C_1	typ. 0,5 fF
Parallel capacitance C_0	max. 7 pF
Resonance resistance R_r	20 to 100 Ω
Frequency tolerance in different temperature ranges with respect to + 25 °C	see Table
Maximum permissible d.c. voltage between terminations	100 V
Ageing	within the adjustment tolerance

TESTS

Mechanical and climatic tests according to MIL and IEC procedures.

Table Frequency tolerance in different temperature ranges with respect to + 25 °C

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

TEMPERATURE COMPENSATED CRYSTAL OSCILLATORS

TYPE SELECTION

frequency range MHz	temperature range °C	frequency tolerance x 10^{-6}	supply voltage 12 V ± . . %	adjustment facility	catalogue number	page
4 to 15	0 to + 50	± 1	20	none	4322 190 2	67
	−10 to + 60	± 1,5	20		4322 190 1	
	−20 to + 70	± 2	20		4322 190 0	
4,5 to 15	0 to + 50	± 1	20	external variable capacitor	4322 191 2	71
	−10 to + 60	± 1,5	20		4322 191 1	
	−20 to + 70	± 2	20		4322 191 0	
4,5 to 15	0 to + 50	± 1	20	external variable resistor	4322 192 2	75
	−10 to + 60	± 1,5	20		4322 192 1	
	−20 to + 70	± 2	20		4322 192 0	
20 to 50	0 to + 50	± 1	2	external variable capacitor	4322 195 0	79
	−20 to + 70	± 2	2		4322 195 1	
	0 to + 50	± 2	10		4322 195 2	
	−20 to + 70	± 3	10		4322 195 3	

TEMPERATURE COMPENSATED CRYSTAL OSCILLATOR

QUICK REFERENCE DATA

Catalogue numbers	4322 190 0	4322 190 1	4322 190 2	
Frequency range	4,5 to 15*	4,5 to 15	4,5 to 15	MHz
Frequency tolerance	$\pm 2 \times 10^{-6}$	$\pm 1,5 \times 10^{-6}$	$\pm 1 \times 10^{-6}$	
Temperature range	−20 to + 70	−10 to + 60	0 to + 50	°C
Supply voltage	+ 12	+ 12	+ 12	V

APPLICATION

Temperature compensated crystal oscillators (TCXOs) 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

Outlines

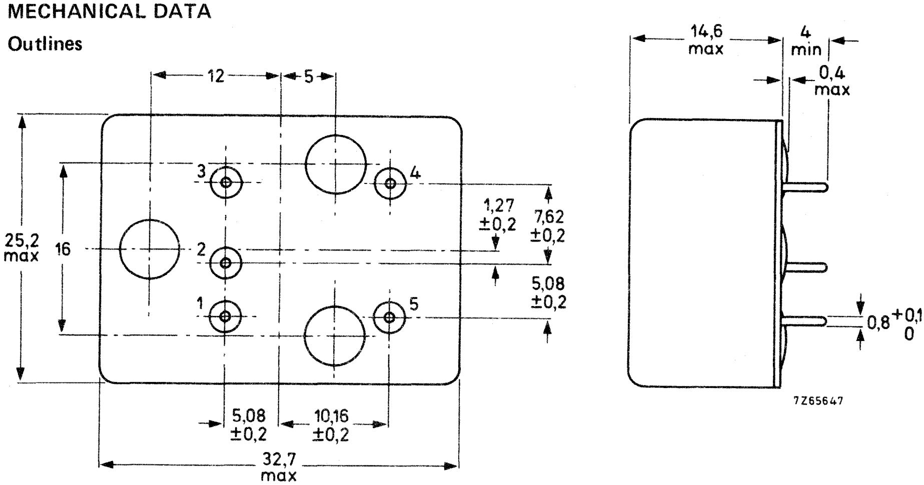


Fig. 1.

* Complete 12-digit catalogue numbers have been fixed for TCXOs for the following frequencies:

 5 MHz : 4322 190 00011
10 MHz : 4322 190 00001
Catalogue numbers for TCXOs with other frequencies will be fixed upon request.

Mass

25 g approximately

Marking

The units are provided with a label showing the following information:

TCXO	Type 4322 190
Frequency	MHz
Δf 25 °C	Hz
Range	°C
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
Power consumption		max. 200 mW
Frequency range		4,5 - 15 MHz
Frequency tolerance/temperature range at specified V_s, Z_L, and at a temp. rate of max. 1 K/min.		
→ cat. numbers 4322 190 0	−20 to + 70 °C	$\pm 2 \times 10^{-6}$
cat. numbers 4322 190 1	−10 to + 60 °C	$\pm 1{,}5 \times 10^{-6}$
cat. numbers 4322 190 2	0 to 50 °C	$\pm 1 \times 10^{-6}$
Ageing		$\pm 1 \times 10^{-6}$ per year
Correction on aging 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
Storage temperature range		−25 to + 85 °C

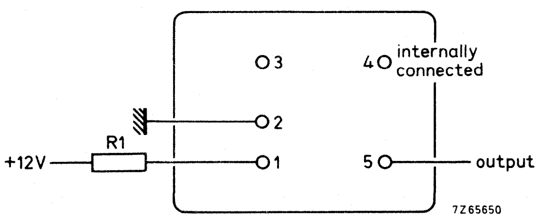


Fig. 2 Connection diagram.

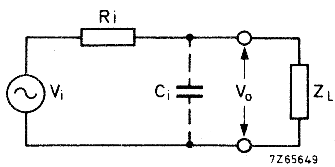


Fig. 3 Equivalent circuit.

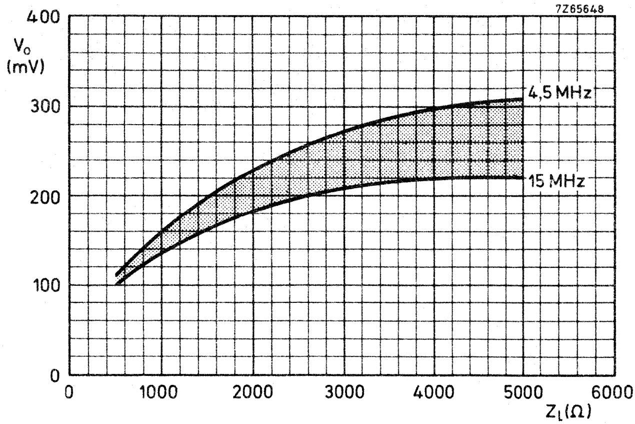


Fig. 4 Output voltage as a function of load impedance (typical values).

ENVIRONMENTAL TESTS AND REQUIREMENTS

IEC 68-2 test method	test	procedure	requirements
Ea	shock	50g, 1 x, in 6 directions	$\Delta f/f$ max. 5×10^{-7}
Fc	vibration	10 to 500 Hz, 10g, in 3 directions, 30 min per direction	$\Delta f/f$ max. 5×10^{-7}
Tb	resistance to soldering heat	260 ± 5 °C, 10 ± 1 s	$\Delta f/f$ max. 5×10^{-7}
Db	climatic		$\Delta f/f$ max. 5×10^{-7}

Note

Other specifications for TCXOs with respect to temperature range and for frequency tolerance can be made avilable on request.

TEMPERATURE COMPENSATED CRYSTAL OSCILLATOR

QUICK REFERENCE DATA

Catalogue numbers	4322 191 0	4322 191 1	4322 191 2	
Frequency range	4,5 to 15*	4,5 to 15	4,5 to 15	MHz
Frequency tolerance	$\pm 2 \times 10^{-6}$	$\pm 1,5 \times 10^{-6}$	$\pm 1 \times 10^{-6}$	
Temperature range	−20 to + 70	−10 to + 60	0 to + 50	°C
Supply voltage	+ 12	+ 12	+ 12	V
Frequency is adjustable by external variable capacitor				

APPLICATION

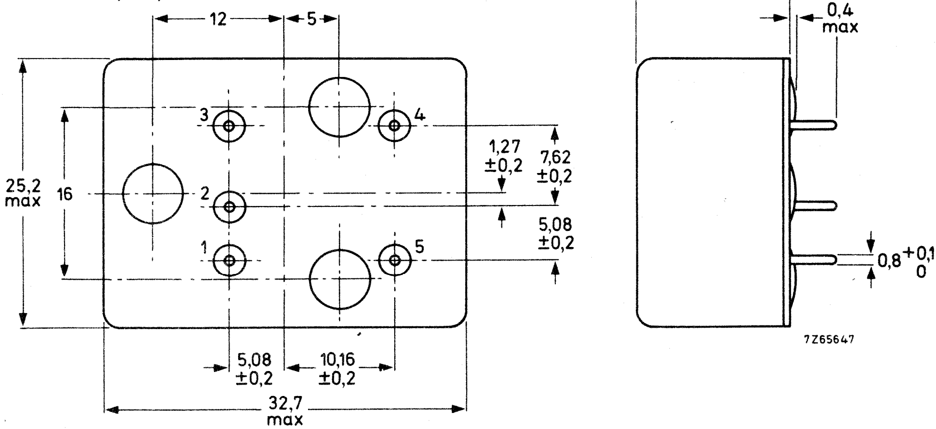
Temperature compensated crystal oscillators (TCXOs) are used in mobilophones, electronic timing devices, measuring equipment, synthesizers, etc.

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



* Complete 12-digit catalogue numbers have been fixed for TCXOs for the following frequencies:

5 MHz : 4322 191 00011	4,194304 MHz : 4322 191 00031
10 MHz : 4322 191 00001	4,433619 MHz : 4322 191 00041

Catalogue numbers for TCXOs with other frequencies will be fixed upon request.

Mass

25 g approximately

Marking

The units are provided with a label showing the following information:

TCXO	Type 4322 191
Frequency	MHz
Δf 25 °C	Hz
Range	°C
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
Power consumption		max. 200 mW
Frequency range		4,5 – 15 MHz
Frequency tolerance/temperature range after adjustment (see note), at specified V_s, Z_L and at a temperature rate of max. 1 K/min.		
cat. numbers 4322 191 0	–20 to + 70 °C	± 2 x 10^{-6}
cat. numbers 4322 191 1	–10 to + 60 °C	± 1,5 x 10^{-6}
cat. numbers 4322 191 2	0 to 50 °C	± 1 x 10^{-6}
Ageing		± 1 x 10^{-6} per year
Correction on aging influence		± 2 x 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
Storage temperature range		–25 to + 85 °C

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 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 ± min. 2 x 10^{-6} is still available to correct ageing influences.

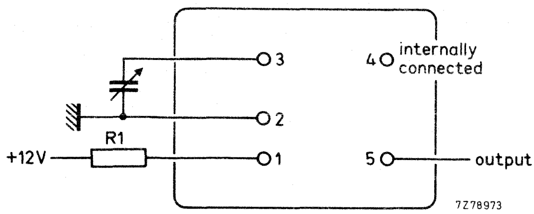


Fig. 2 Connection diagram.

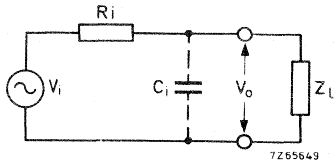


Fig. 3 Equivalent circuit.

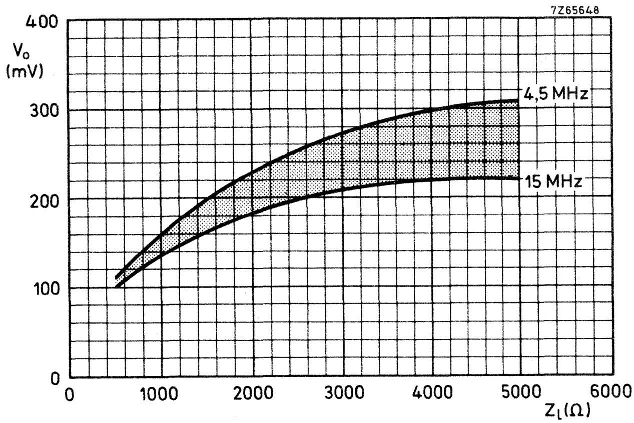


Fig. 4 Output voltage as a function of load impedance (typical values).

ENVIRONMENTAL TESTS AND REQUIREMENTS

IEC 68-2 test method	test	procedure	requirements
Ea	shock	50g, 1 x, in 6 directions	$\Delta f/f$ max. 5×10^{-7}
Fc	vibration	10 to 500 Hz, 10g, in 3 directions 30 min per direction	$\Delta f/f$ max. 5×10^{-7}
Tb	resistance to soldering heat	260 ± 5 °C, 10 ± 1 s	$\Delta f/f$ max. 5×10^{-7}
Db	climatic		$\Delta f/f$ max. 5×10^{-7}

Note

Other specifications for TCXOs with respect to temperature range and for frequency tolerance can be made available on request.

TEMPERATURE COMPENSATED CRYSTAL OSCILLATOR

QUICK REFERENCE DATA

Catalogue numbers	4322 192 0	4322 192 1	4322 192 2	
Frequency range	4,5 to 15*	4,5 to 15	4,5 to 15	MHz
Frequency tolerance	$\pm 2 \times 10^{-6}$	$\pm 1,5 \times 10^{-6}$	$\pm 1 \times 10^{-6}$	
Temperature range	−20 to +70	−10 to +60	0 to +50	°C
Supply voltage	+12	+12	+12	V
Frequency is adjustable by external variable resistor				

APPLICATION

Temperature compensated crystal oscillators (TCXOs) 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

Outlines

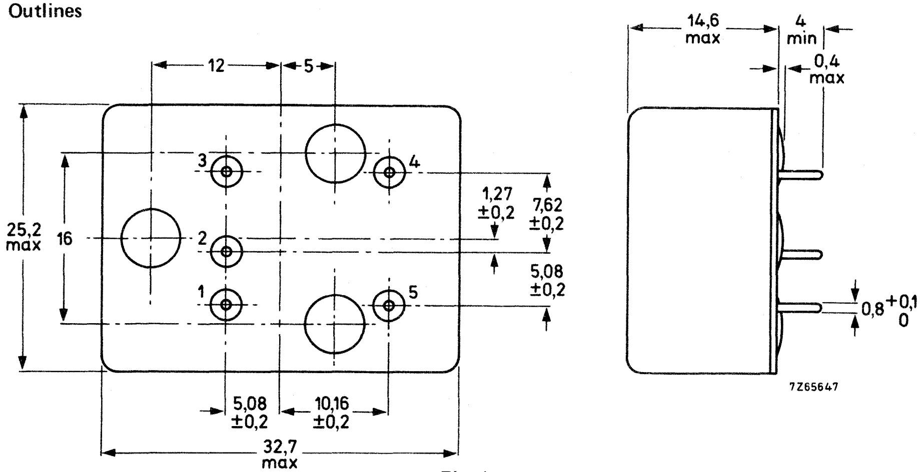


Fig. 1.

* Complete 12-digit catalogue number has been fixed for TCXOs for the following frequencies.

10 MHz: 4322 192 00001
Catalogue numbers for TCXOs with other frequencies will be fixed upon request.

Mass

25 g approximately

Marking

The units are provided with a label showing the following information:

TCXO	Type 4322 192
Frequency Δf 25 °C Range No.	MHz Hz °C

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
Power consumption	max. 200 mW
Frequency range	4,5 – 15 MHz
Frequency tolerance/temperature range after adjustment (see note), at specified V_s, Z_L, and at a temperature rate of max. 1 K/min.	
cat. numbers 4322 192 0 . . . . –20 to + 70°	± 2 x 10^{-6}
cat. numbers 4322 192 1 . . . . –10 to + 60°	± 1,5 x 10^{-6}
cat. numbers 4322 192 2 . . . . 0 to 50°	± 1 x 10^{-6}
Ageing	± 1 x 10^{-6} per year
Correction on ageing influence	± 2 x 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
Storage temperature range	–25 to + 85 °C

Note

It is not guaranteed that the nominal frequency occurs at room temperature. The nominal frequency can be shifted by connecting a variable resistor of 2 kΩ 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 ± min. 2 x 10^{-6} is still available to correct ageing influences.

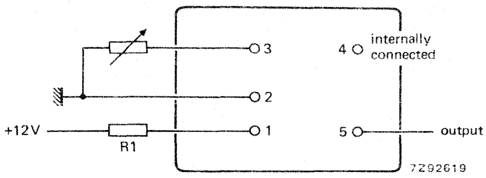


Fig. 2 Connection diagram.

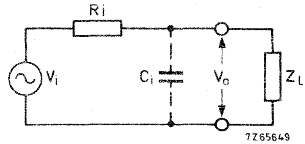


Fig. 3 Equivalent circuit.

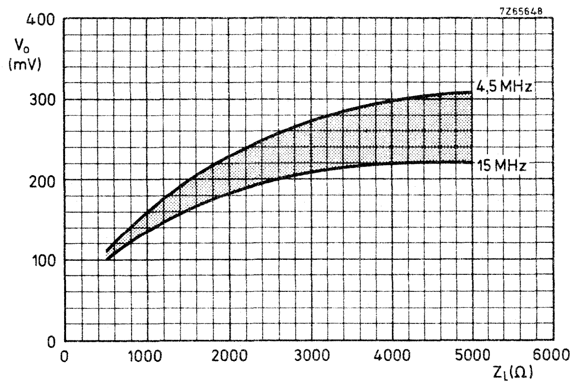


Fig. 4 Output voltage as a function of load impedance (typical values).

ENVIRONMENTAL TESTS AND REQUIREMENTS

IEC 68-2 test method	test	procedure	requirements
Ea	shock	50g, 1 x, in 6 directions	$\Delta f/f$ max. 5 x 10^{-7}
F	vibration	10 to 500 Hz, 10g, in 3 directions 30 min per direction	$\Delta f/f$ max. 5 x 10^{-7}
T	soldering		
D	climatic		$\Delta f/f$ max. 5 x 10^{-7}

Note

Other specifications for TCXOs with respect to temperature range and for frequency tolerance can be made available on request.

TEMPERATURE COMPENSATED CRYSTAL OSCILLATOR

QUICK REFERENCE DATA

Catalogue numbers	4322 195 0	4322 195 1	4322 195 2	4322 195 3	
Frequency range	20 to 50	20 to 50	20 to 50	20 to 50	MHz
Frequency tolerance	$\pm 1 \times 10^{-6}$	$\pm 2 \times 10^{-6}$	$\pm 2 \times 10^{-6}$	$\pm 3 \times 10^{-6}$	
Temperature range	0 to + 50	−20 to + 70	0 to + 50	−20 to + 70	°C
Supply voltage	12 V ± 2%	12 V ± 2%	12 V ± 10%	12 V ± 10%	

Frequency is adjustable by external variable capacitor

APPLICATION

Temperature compensated crystal oscillators (TCXOs) 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

Outlines

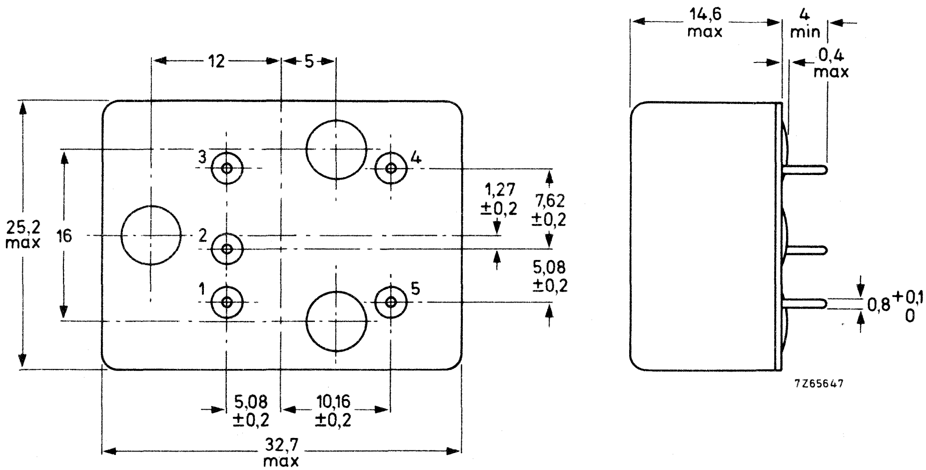


Fig. 1.

Mass

25 g approximately

Marking

The units are provided with a label showing the following information:

TCXO	Type 4322 195
Frequency	MHz
Δf 25 °C	Hz
Range	°C
No.	

ELECTRICAL DATA

Supply voltage, V_s, see Fig. 2		
cat. numbers 4322 195 0 . . . . and 4322 195 1		+ 12 V ± max. 2%
cat. numbers 4322 195 2 . . . . and 4322 195 3		+ 12 V ± max. 10%
Power consumption		typ. 160 mW, max. 180 mW
Frequency range		20 to 50 MHz
Frequency tolerance/temperature range after adjustment (see note), at specified V_s, Z_L, and at a temperature rate of 1 K/min		see also Fig. 4
cat. numbers 4322 195 0	0 to + 50 °C	$\pm 1 \times 10^{-6}$
cat. numbers 4322 195 1	−20 to + 70 °C	$\pm 2 \times 10^{-6}$
cat. numbers 4322 195 2	0 to 50 °C	$\pm 2 \times 10^{-6}$
cat. numbers 4322 195 3	−20 to + 70 °C	$\pm 3 \times 10^{-6}$
Ageing		$\pm 1 \times 10^{-6}$ per year
Correction on ageing influence		$\pm > 2 \times 10^{-6}$, see note
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 Fig. 5
Storage temperature range		−25 to + 85 °C

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. 20 pF externally between pins 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 ± min. 2×10^{-6} is still available to correct aging influences.

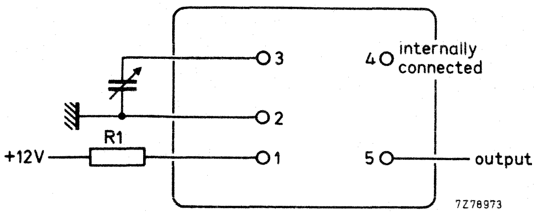


Fig. 2 Connection diagram.
R1 = 390 Ω

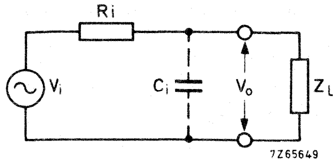


Fig. 3 Equivalent circuit.

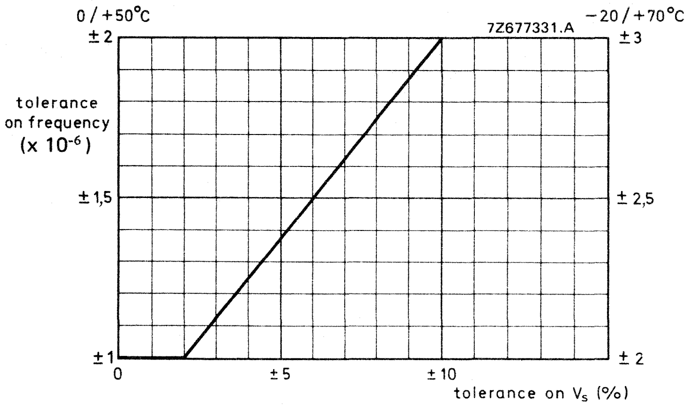


Fig. 4 Frequency tolerance as a function of the tolerance on supply voltage.

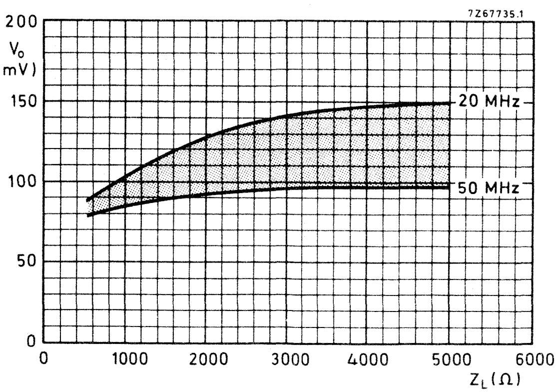


Fig. 5 Output voltage as a function of load impedance (typical values).

ENVIRONMENTAL TESTS AND REQUIREMENTS

IEC 68-2 test method	test	procedure	requirements
Ea	shock	50g, 1 x, in 6 directions	$\Delta f/f$ max. 5×10^{-7}
Fc	vibration	10 to 500 Hz, 10g, in 3 directions, 30 min per direction	$\Delta f/f$ max. 5×10^{-7}
Tb	resistance soldering heat	260 ± 5 °C, 10 ± 1 s	$\Delta f/f$ max. 5×10^{-7}
Db	climatic		$\Delta f/f$ max. 5×10^{-7}

Note

Other TCXO specifications concerning supply voltage, temperature range and frequency tolerance can be made available on request.

DIGITAL TEMPERATURE COMPENSATED OSCILLATOR (DTCXO)

QUICK REFERENCE DATA

Frequency range	4,5 to 15 MHz
Stability	$\leqslant \pm 5 \times 10^{-7}$
Supply voltage	5 V ± 5%
Output	10 x LPS TTL (2 x TTL)

APPLICATION

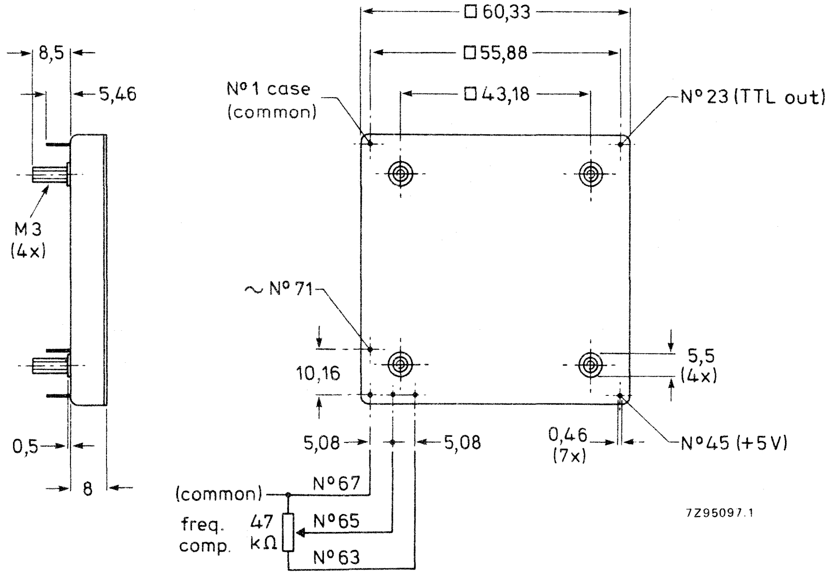
DTCXOs are used in communication and measuring equipment for which a very high stability is required at low power consumption.

DESCRIPTION

A DTCXO comprises a quartz crystal oscillator, a quartz crystal temperature measuring device together with an electronic compensation network which is digitally controlled.

MECHANICAL DATA

Outlines



Mass: ≈ 70 g

Marking

The frequency in MHz, the stability, the temperature range, the catalogue number, date code (month/year) and the connecting circuit are printed on a label which is stuck to the holder.

Mounting

The unit can be mounted on a printed circuit board and/or secured by 4 bolts M3.

ELECTRICAL DATA

Frequency range	4,5 to 15 MHz
Stability	$\leqslant \pm 5 \times 10^{-7}$
Temperature range	−40 to + 85 °C
Storage temperature range	−55 to + 125 °C
Ageing	$\leqslant 1{,}5 \times 10^{-6}$ during 10 years at 85 °C adjustable by an external resistor of 47 kΩ
Supply voltage	5 V ± 5%
Supply current	max. 25 mA; typ. 20 mA
Output	10 x LPS TTL, (2 x TTL)
Duty cycle	40 to 60%
Stability versus supply variation	$\leqslant 1.10^{-7}$
Time to reach a stability within $\pm 5 \times 10^{-7}$ at switch on	< 1 s

ENVIRONMENTAL TESTS AND REQUIREMENTS

IEC 68-2 test method	test	procedure	requirements
Ea	shock	50g, 1 x, in 6 directions	$\Delta f/f$ max. 2×10^{-7}
Fc	vibration	10 to 500 Hz, 10g, in 3 directions, 30 min per direction	$\Delta f/f$ max. 2×10^{-7}
Tb	resistance to soldering heat	260 ± 5 °C, 10 ± 1 s	$\Delta f/f$ max. 2×10^{-7}
Db	climatic		$\Delta f/f$ max. 2×10^{-7}

COMPACT INTEGRATED OSCILLATORS

COMPACT INTEGRATED OSCILLATORS

QUICK REFERENCE DATA

Frequency range	1,0 to 20 MHz
Frequency tolerance, all effects included	$\pm$ 100 x 10^{-6}
Operating temperature range	0 to + 70 °C
Supply voltage	5 V $\pm$ 10%
Load	up to 10 standard TTL

APPLICATION

Due to their small size and hermetical sealing the oscillators can be supplied in microprocessors, measuring equipment, medical equipment, electronic timing devices, etc.

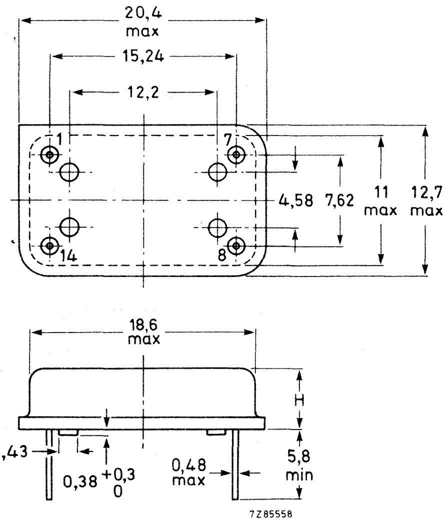
DESCRIPTION

A compact integrated oscillator comprises a quartz crystal and a thin film hybrid oscillator circuit. The metal housing is filled with dry nitrogen and hermetically sealed. The unit is provided with four connecting pins having a spacing compatible with 14-pin DIL packages.

MECHANICAL DATA

Outlines

pin 1 = not connected, can be made available for cable input on special request.
pin 7 = ground, 0 V*
pin 8 = output
pin 14 = supply, + 5 V



H = 4,9 mm.

* The case can be connected to pin 7 for shielding, on special request.

Marking

The units are marked as follows:

- frequency in kHz
- last five digits of catalogue number
- code for month and year of manufacture

Mounting

Soldering conditions — max. 260 °C, max. 10 s

ELECTRICAL DATA

Supply voltage	V_{CC}	+ 5 V ± 10%
Supply current		
1 to 4 MHz	I_{CC}	typ. 30 mA; max. 55 mA
4 to 20 MHz	I_{CC}	typ. 14 mA; max. 25 mA
Frequency range		1,0 to 20 MHz
Frequency tolerance		$\pm 100 \times 10^{-6}$

This tolerance includes:
Initial calibration tolerance at 25 °C; change in operating temperature (0 to + 70 °C); change in supply voltage; change in load; change in environmental conditions and ageing.

Output characteristics

low level voltage (V_{CC} = 4,5 V; I_{OL} = 16 mA)	V_{OL} = max. 0,4 V
high level voltage (V_{CC} = 4,5 V; I_{OH} = −0,8 mA)	V_{OH} = min. 2,4 V
short circuit current (1 s max; V_{CC} = 5,5 V)	I_{OS} = max. −55 mA
rise time* (0,5 V to 2,4 V)	max. 15 ns
fall time* (2,4 to 0,5 V)	max. 15 ns
symmetry* (1,4 V; 25 °C)	better than 40/60

* At 16 mA sink, 0,4 mA source current, 20 pF load capacitance

Start-up time	typ. 5 ms; max. 50 ms
Temperature range	
operating	0 to + 70 °C
storage	−55 to + 125 °C

AVAILABLE TYPES

Catalogue numbers of 12 digits are fixed per contract, but the following preferred types have been fixed.

1,0 MHz	4322 199 00111	4,0 MHz	4322 199 00161
1,5 MHz	4322 199 00121	4,9152 MHz	4322 199 00171
2,0 MHz	4322 199 00131	6,0 MHz	4322 199 00181
3,0 MHz	4322 199 00141	8,0 MHz	4322 199 00191
3,6864 MHz	4322 199 00151	10,0 MHz	4322 199 00201

Special types

Compact integrated oscillators with smaller frequency- or symmetry tolerances or other special requirements are available upon request.
Please consult your supplier for further information.

TEST AND REQUIREMENTS

Essentially all tests are carried out along the lines of IEC publication 68-2, "Recommended basic climatic and mechanical robustness testing procedure for electronic components". Ageing and visual inspection are according to MIL.

Table 1

IEC 68 test method	test	procedure	requirements
Aa, Ba	storage	16 h, 125 °C/2 h, –55 °C	no failures
Db	accelerated damp heat	+ 25 °C to + 55 °C 6 cycles	$\Delta f \leqslant 5 \times 10^{-6}$
Ea Ed	shock free fall	100 g sawtooth, 6 shocks, 3 directions 250 mm on wood	} $\Delta f \leqslant 5 \times 10^{-6}$
Fc	vibration	frequency 10 - 500 Hz, acceleration 20 g, three directions, 30 min.	no damage $\Delta f \leqslant 5 \times 10^{-6}$
Na	temperature cycling	1 h, –40 °C/1 h, + 85 °C 10 cycles	no damage $\Delta f \leqslant 5 \times 10^{-6}$
Q_c, Q_x	sealing	16 h, 700 kPa He	$< 1 \times 10^{-8}$ ncc/s
T	soldering	solderability: max. 10 s, 260 °C thermal shock: 3 s, 350 °C	good tinning no damage $\Delta f \leqslant 5 \cdot 10^{-6}$
Ub	bending of terminations	load 5 N, method 1	no visible damage no leaks

Table 2

MIL test method	test	method	requirements
MIL-0-55310/16	ageing	30 days, 70 °C continuous	$\Delta f \leqslant 1,5 \times 10^{-6}$
MIL-Std-883	visual inspection	2017.1	by agreement with customer

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