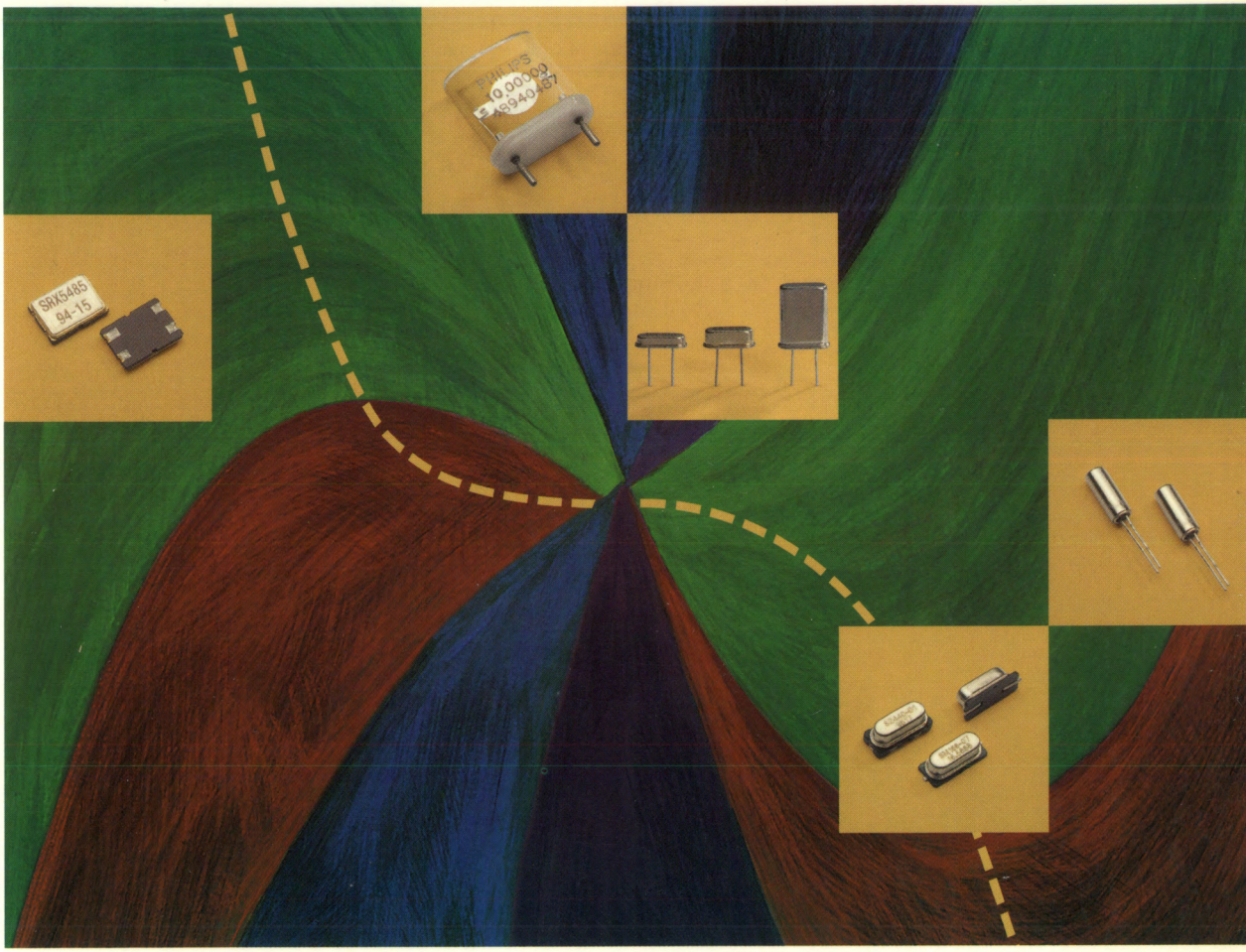
PASSIVE COMPONENTS

Quartz Crystals



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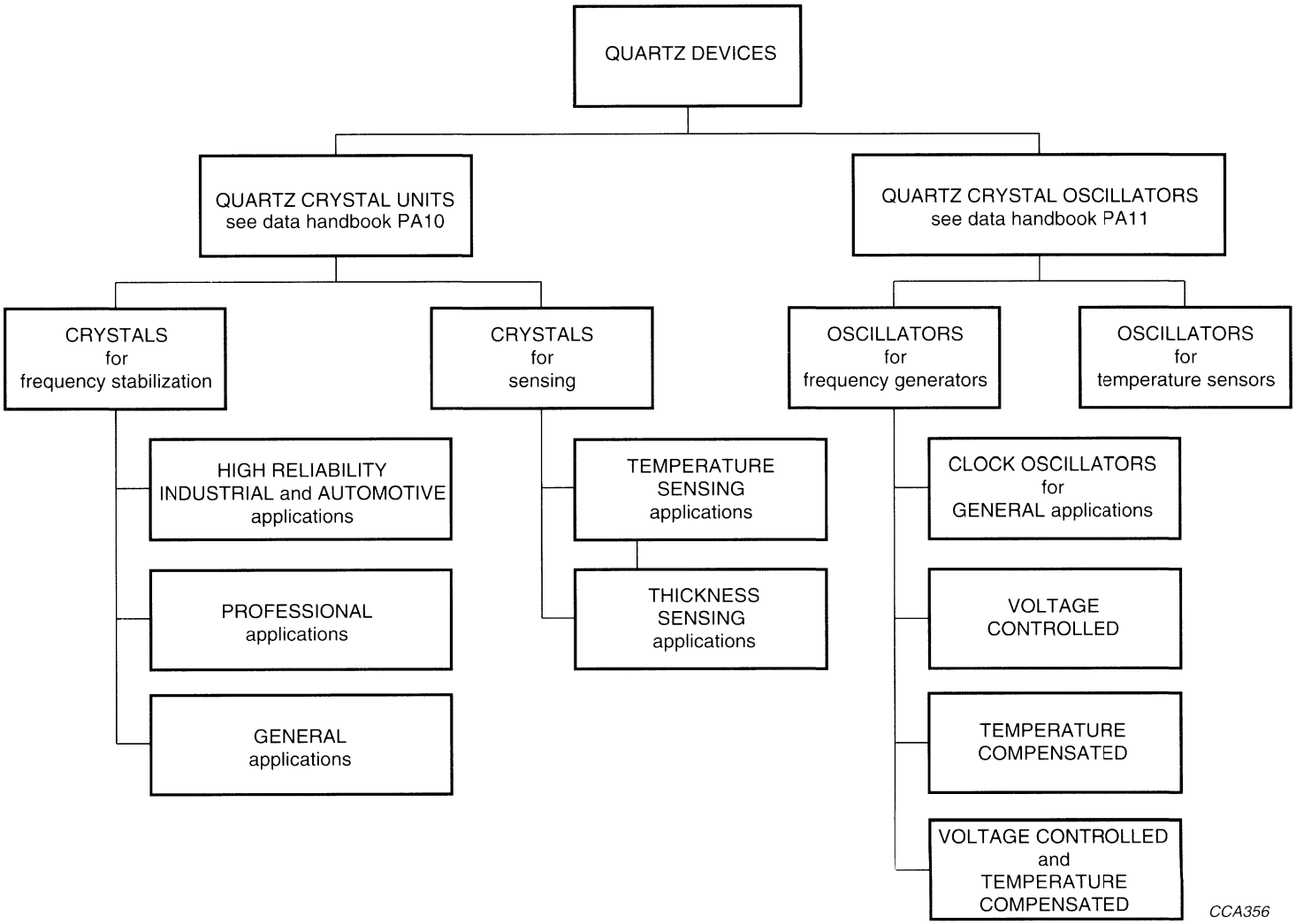
QUARTZ DEVICES
QUARTZ CRYSTAL UNITS
see data handbook PA10
QUARTZ CRYSTAL OSCILLATORS
see data handbook PA11
CRYSTALS
for
frequency stabilization
CRYSTALS
for
sensing
OSCILLATORS
for
frequency generators
OSCILLATORS
for
temperature sensors
HIGH RELIABILITY
INDUSTRIAL and AUTOMOTIVE
applications
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Quartz Crystals

CONTENTS

DEFINITIONS

Data sheet status	
Objective specification	This data sheet contains target or goal specifications for product development.
Preliminary specification	This data sheet contains preliminary data; supplementary data may be published later.
Product specification	This data sheet contains final product specifications.
Application information	
Where application information is given, it is advisory and does not form part of the specification.	

LIFE SUPPORT APPLICATIONS

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SELECTION GUIDE

SELECTION GUIDE AND INDEX OF CATALOGUE NUMBERS

Table 1 Quartz Crystal Units for frequency stabilization; see notes 1 and 2

HOLDER TYPE	FREQUENCY RANGE (MHz)	MODE OF VIBRATION	CATALOGUE NUMBER	PAGE
General				
HC-49/U	1.8 to 27.0	fundamental	9922 520 0....	66
	20.0 to 75.0	third overtone	9922 520 3....	66
	75.0 to 125.0	fifth overtone		
	125.0 to 175.0	seventh overtone		
HC-49/L; HC-49/S	3.5 to 28.0	fundamental (AT)	9922 520 2....	81
	26.0 to 50.0	fundamental (BT)		
	29.0 to 66.0	third overtone (AT)	9922 520 6....	81
HC-45/U	6.0 to 25.0	fundamental	9922 521 0....	92
	24.0 to 80.0	third overtone		
	80.0 to 125.0	fifth overtone		
	125.0 to 200.0	seventh overtone		
General (Surface Mountable Devices SMD)				
HC-49/SMD	3.5 to 28.0	fundamental (AT)	9922 522 00...	36
	26.0 to 50.0	fundamental (BT)		
	29.0 to 66.0	third overtone (AT)		
HC-49/SMD-like	3.0 to 27.0	fundamental	9922 522 40...	43
	20.0 to 75.0	third overtone		
HC-45/SMD-like	8.0 to 24.0	fundamental	9922 522 20...	53
	24.0 to 75.0	third overtone		
Ceramic SMD (NKS-7)	8.0 to 30.0	fundamental	9922 523 0....	24
	30.0 to 72.0	third overtone		
HFX Ceramic SMD	30.0 to 250.0	fundamental	9922 523 2....	30
High Reliability Industrial and Automotive				
HC-49/U	3.0 to 27.0	fundamental	9922 520 4....	131
	20.0 to 75.0	third overtone		
HC-45/U	8.0 to 24.0	fundamental	9922 521 2....	143
	24.0 to 75.0	third overtone		
High Reliability Industrial and Automotive (Surface Mountable Devices SMD)				
HC-45/SMD-like	8.0 to 24.0	fundamental	9922 522 22...	118
	24.0 to 75.0	third overtone		
HC-49/SMD-like	3.0 to 27.0	fundamental	9922 522 42...	108
	20.0 to 75.0	third overtone		

Quartz crystals — Selection guide

HOLDER TYPE	FREQUENCY RANGE (MHz)	MODE OF VIBRATION	CATALOGUE NUMBER	PAGE
Professional (Surface Mountable Devices SMD)				
HC-49/SMD-like	2.4 to 27.0	fundamental	9922 522 43...	158
	16.8 to 75.0	third overtone		
	50.0 to 125.0	fifth overtone		
HC-45/SMD-like	6.0 to 30.0	fundamental	9922 522 23...	168
	24.0 to 90.0	third overtone		
	60.0 to 150.0	fifth overtone		
Professional (Metal holders)				
HC-50/U	2.4 to 27.0	fundamental	9922 520 8....	181
	16.8 to 75.0	third overtone		
	50.0 to 125.0	fifth overtone		
	125.0 to 175.0	seventh overtone		
HC-49/U	2.4 to 27.0	fundamental	9922 520 5....	181
	16.8 to 75.0	third overtone	9922 520 7....	181
	50.0 to 125.0	fifth overtone		
	125.0 to 175.0	seventh overtone		
HC-45/U	6.0 to 30.0	fundamental	9922 521 6....	198
	24.0 to 90.0	third overtone	9922 521 7....	198
	60.0 to 150.0	fifth overtone		
	125.0 to 200.0	seventh overtone		
HC-33/U; HC-36/U	1.8 to 25.0	fundamental	9922 529 900..	234
	10.0 to 75.0	third overtone		
	50.0 to 125.0	fifth overtone		
HFX Tubular	30.0 to 250.0	fundamental	9922 524 0....	213
Professional (All-Glass holders)				
HC-27/U	1.8 to 25.0	fundamental	9922 527 0....	227
	10.0 to 75.0	third overtone	9922 527 2....	227
	50.0 to 125.0	fifth overtone		
HC-26/U; HC-29/U	4.5 to 25.0	fundamental	9922 526 0....	219
	20.0 to 75.0	third overtone	9922 526 3....	219
	50.0 to 125.0	fifth overtone		

Notes

1. In previous years a different code number system (4322 ... .) has been used. Existing products may still be delivered under that code number system.
2. Frequencies up to 250 MHz including higher modes of vibration, are available on special request only.

Table 2 Quartz Crystal Units and Blanks for sensing applications

HOLDER TYPE	FREQUENCY RANGE (MHz)	MODE OF VIBRATION	CATALOGUE NUMBER	PAGE
Temperature sensing (Metal holders or Surface Mountable Devices SMD)				
HC-49/U	4.0 to 25.0	fundamental	9922 529 801..	242
HC-45/U	8.0 to 25.0	fundamental	9922 529 802..	251
Temperature sensing (All-glass holders)				
HC-29/U	4.0 to 25.0	fundamental	9922 526 2....	259
HC-26/U	4.0 to 25.0	fundamental		
Thickness sensor element				
Naked blank	4.0 to 9.5	fundamental	9922 529 800..	266

CROSS REFERENCE OF HOLDER TYPES

Corresponding IEC, DIN and MIL Type Numbers; see note 1

HOLDER TYPE	IEC 122-3	DIN 45110	MIL 3098	OTHERS
HC-6/U	AA	K1A	HC-6/U	–
HC-26/U	CY	R2A	HC-26/U	–
HC-27/U	DA	Q1A	HC-27/U	–
HC-27/U, extended	DB	Q1B	HC-28/U	–
HC-29/U	CZ	R1A	HC-29/U	–
HC-33/U	DZ	K6B	HC-51/U	–
HC-36/U	DN	K3A	HC-48/U	–
HC-45/U	EB; EK	N4B	HC-52/U	UM-1
HC-49/U9	–	–	–	–
HC-49/L	–	–	–	–
HC-49/S	CU 0.1 A	–	–	–
HC-49/U11	EH	M4B	HC-49/U	HC-43/U
HC-49/U13	DP	M4C	HC-49/U	HC-18U
HC-50/U13	DQ	M3C	HC-42/U	–

Note

1. Corresponding numbers may have different sealing techniques.

GENERAL INTRODUCTION

INTRODUCTION

For practical reasons, technical information on piezoelectric quartz devices is divided into two handbooks which have the following titles:

PA10 - Quartz crystals

PA11 - Quartz oscillators.

A quartz crystal consists of a quartz crystal element with electrodes, mounted in a hermetically sealed holder with connecting pins or leads. Quartz crystals are normally used in oscillator and filter circuits.

The quartz crystal element is a vibrating resonant plate which relies upon the piezoelectric effect to couple it to electrical circuits. Crystal elements are normally cut in the form of plates. 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 is from 1 to 250 MHz. The crystal element may vibrate in the fundamental vibration mode or in the third, fifth or higher overtone. Special cuts for temperature sensors used in digital temperature measurement equipment, are also available.

The intrinsic properties of quartz make it a unique device for accurate and stable frequency control and selection. As the properties of quartz (temperature coefficient, ageing, high Q factor) are very stable, the ultimate performance of the element is largely dependent on the environment and the associated electrical circuits. The design of an oscillator requires high technical skill to give the maximum possible efficiency out of the connection between the crystal and the circuit. A range of oscillator circuits have been designed for all kinds of applications with an optimum pack of specifications. It is advised that any particular application should be discussed with the crystal manufacturer at the earliest possible stage of the design.

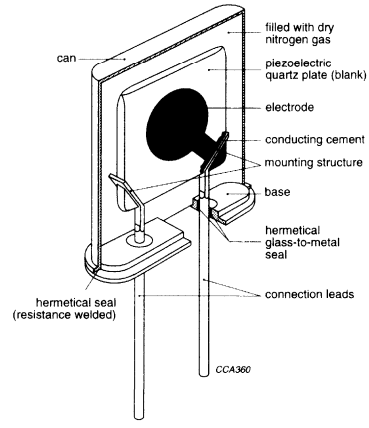


Fig.1 Section of a quartz crystal unit (metal holder: HC-49/U).

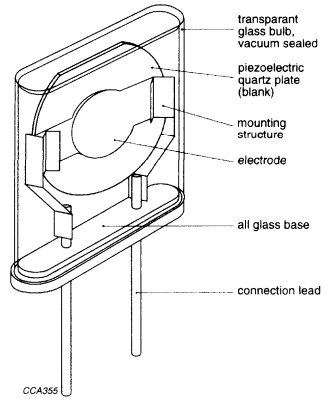


Fig.2 Section of a quartz crystal unit (glass holder: HC-26/U).

TERMS AND DEFINITIONS IN ACCORDANCE WITH IEC 122-1

Resonance frequency (f_r)

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

Anti-resonance frequency (f_a)

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

Load resonance frequency (f_L)

One of the two frequencies of a quartz crystal in association with a series or 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.4). 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_{nom})

The frequency assigned by the specification of the quartz crystal.

Working frequency (f_w)

The operational frequency of the quartz crystal 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 ($\Delta f/f_{nom}$)

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

Ageing tolerance

The permissible deviation (of the working frequency) from its initial value, observed with the passage of time under specified conditions.

Tolerance over the temperature range

The permissible deviation over the temperature range with respect to the frequency at the specified reference temperature.

Operating temperature range (T_{oper})

The range of temperatures as measured on the holder over which the quartz crystal must function within the specified tolerances.

Operable temperature range (T_{op})

The range of temperatures as measured on the holder over which the quartz crystal must function within though not necessarily within the specified tolerances.

Reference temperature (T_{ref})

The temperature at which certain crystal measurements are made. For controlled temperature crystals, the reference temperature is the mid-point of the controlled temperature range, for example +70 °C. For non-temperature controlled crystals, the reference temperature is normally 25 ±2 °C.

Resonance resistance (R_r)

The resistance of the quartz crystal alone at the resonance frequency (f_r).

Load resonance resistance (R_L)

The resistance of the quartz crystal 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:

$$R_L = R_r \left(1 + \frac{C_0}{C_L}\right)^2$$

Drive level dependent resonance resistance (R_{dld})

Maximum resonance resistance value in a specified range of drive level, over 10^{-16} W to 10^{-4} W.

Level of drive

A value of the amplitude of motion imposed upon the quartz crystal expressed in terms of dissipated power.

Note: In special cases, the level of drive may be specified in terms of crystal current or voltage.

Unwanted response (R_n)

A state of resonance of a crystal vibrator other than that associated with the working frequency, expressed in the ratio R_n/R_r or in dB (being 20log R_n/R_r).

Load capacitance (C_L)

The effective external capacitance associated with the quartz crystal which determines the load resonance frequency (f_L).

Motional capacitance (C_1)

The capacitance of the motional (series) arm of the equivalent circuit.

Shunt capacitance (C_0)

The capacitance in parallel with the motional arm of the equivalent circuit.

Motional inductance (L_1)

The induction of the motional (series) arm of the equivalent circuit.

ELECTRICAL PROPERTIES AND BEHAVIOUR

Quartz crystal equivalent circuit

The equivalent circuit, which has the same impedance as the quartz crystal 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.3).

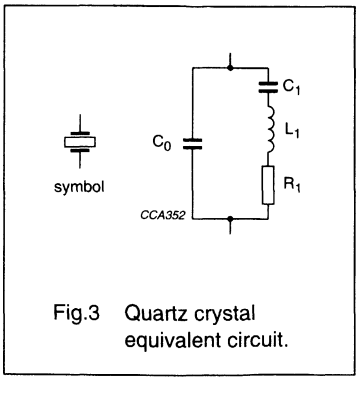


Fig.3 Quartz crystal equivalent circuit.

The parameters of the series branch are termed the 'motional parameters' of the quartz crystal.
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 $R_1 < \frac{1}{\omega C_0}$

the following relationships hold:

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

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

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

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_{nom}). Figure 4 shows the quartz crystal equivalent circuit with a load capacitance in series and 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 resistance is connected in series and the higher with the load connected in parallel, are termed 'load resonance frequencies' (f_L). At these frequencies the resistance of the combination with the load capacitance in series is termed 'load resonance resistance' (R_L).

For

$$R_1 < \frac{1}{\omega C_0}$$

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

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

For a given value of C_L the load resonance frequencies of the series and parallel combination are identical. In practice, however, the parallel combination shown in Fig.4 (c) rarely occurs in an oscillator. From equation (4) another two parameters of vital concern can be derived: the difference (Δf_L) between load resonance frequency (f_L) and resonance frequency (f_r), termed 'load resonance frequency offset':

$$\Delta f_L = f_L - f_r \quad (6)$$

respectively the 'fractional load resonance offset':

$$D_L = \frac{f_L - f_r}{f_r} = \frac{C_1}{2(C_0 + C_L)} \quad (7)$$

and the sensitivity of load resonance frequency with respect to load capacitance variations, termed 'pulling sensitivity':

$$S = \frac{1}{f_L} \times \frac{\Delta f_L}{\Delta C_L} = \frac{1}{f_r} \times \frac{\Delta f_L}{\Delta C_L} = \frac{\Delta D_L}{\sqrt{\Delta C_L}} = \frac{C_1}{2(C_0 + C_L)^2} \quad (8)$$

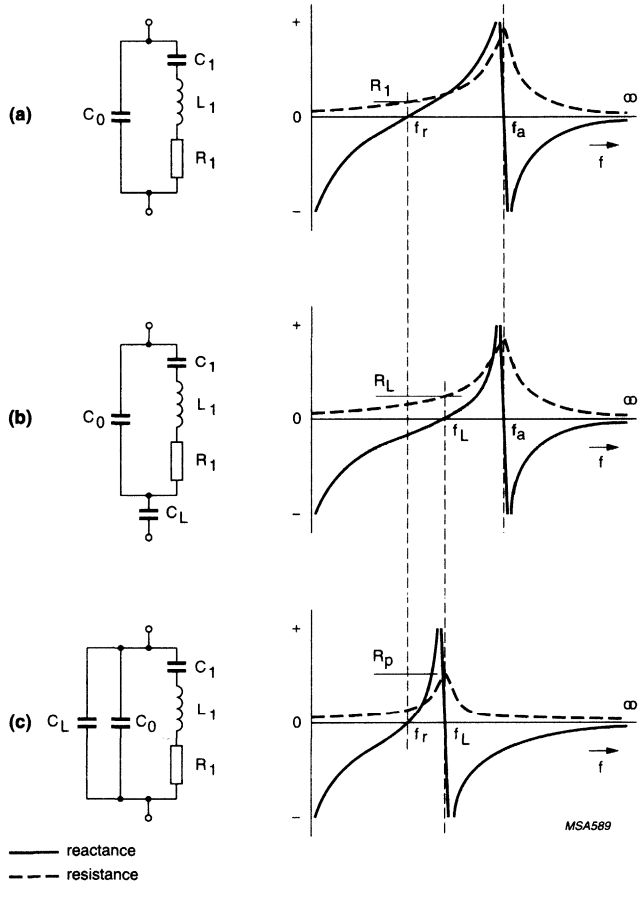


Fig.4 Resonance, anti-resonance and load resonance frequency.

Standard values of load capacitance

The standard values of load capacitance for quartz crystals operating at the fundamental frequency of the mode are:

15 pF, 20 pF, 30 pF and 50 pF.

Load capacitances of the values 8 pF, 10 pF, 12 pF and 18 pF may also be used for fundamental mode quartz crystals.

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

In special cases, load capacitance values of 5 pF upwards are available in a narrow distribution.

Overtone quartz crystals are often operated at series resonance. Where a load capacitance is used, it should be chosen from the above mentioned values.

Pulling Sensitivity (S)

The pulling sensitivity expressed in ppm/pF is a good measure for the frequency sensitivity as a function of load capacitance variations at the working frequency. Figure 5 illustrates the load capacitance, for two quartz crystals having different C_1 and C_0 values it should be noted that a tolerance of 0.5 pF on a 20 pF load capacitance may lead to an error of ±11 ppm. For low values of C_L the pulling sensitivity is increased, which means that the frequency is more strongly dependent on the external parameters of the oscillating circuit.

Table 1 Quartz crystal parameters (see Fig.5)

QUARTZ CRYSTAL a	QUARTZ CRYSTAL b
f_r = 9 994.400 kHz(1)	f_r = 9 998.727 kHz(1)
C_0 = 5.0 pF(1)	C_0 = 2.0 pF(1)
C_1 = 28 pF(1)	C_1 = 5.6 fF(1)
C_L = 20 pF	C_L = 20 pF
f_L = 10 000.000 kHz	f_L = 10000.000 kHz
S = −22.4 ppm/pF	S = −5.79 ppm/pF

Note

1. Tolerances on the parameters f_r, C_0 and C_1 are required for calculating the 'Δf' and the 'pullability at f_{nom}'.

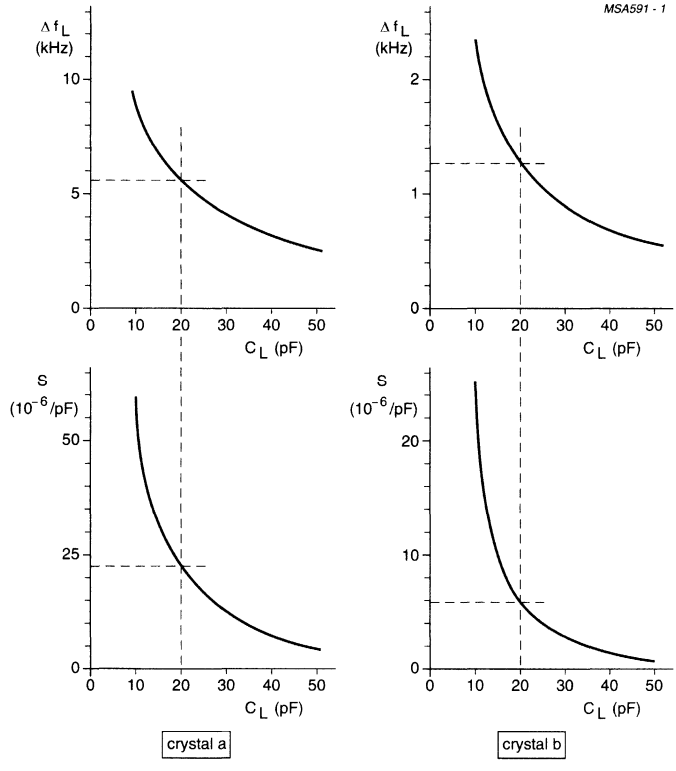


Fig.5 Change in frequency (Δf_L) and pulling sensitivity (S) as a function of the load capacitance.

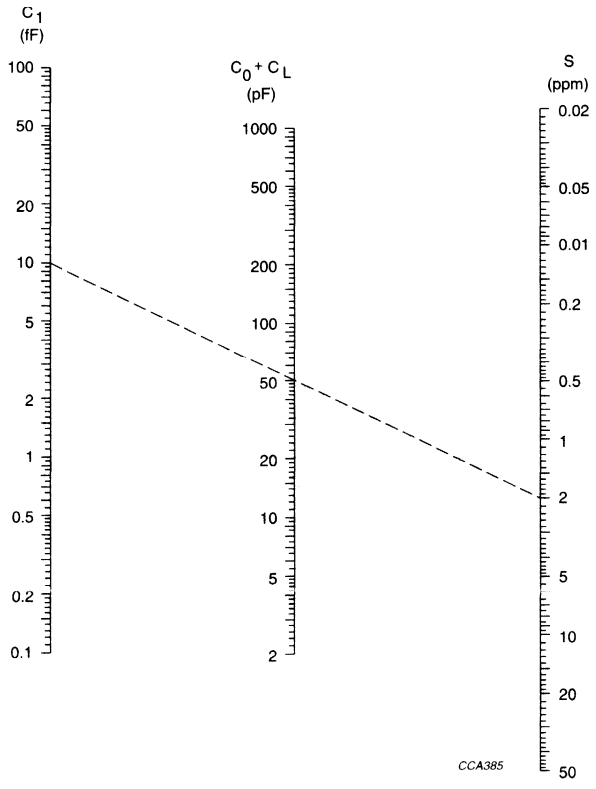


Fig.6 Nomogram enabling the determination of pulling sensitivity (S).

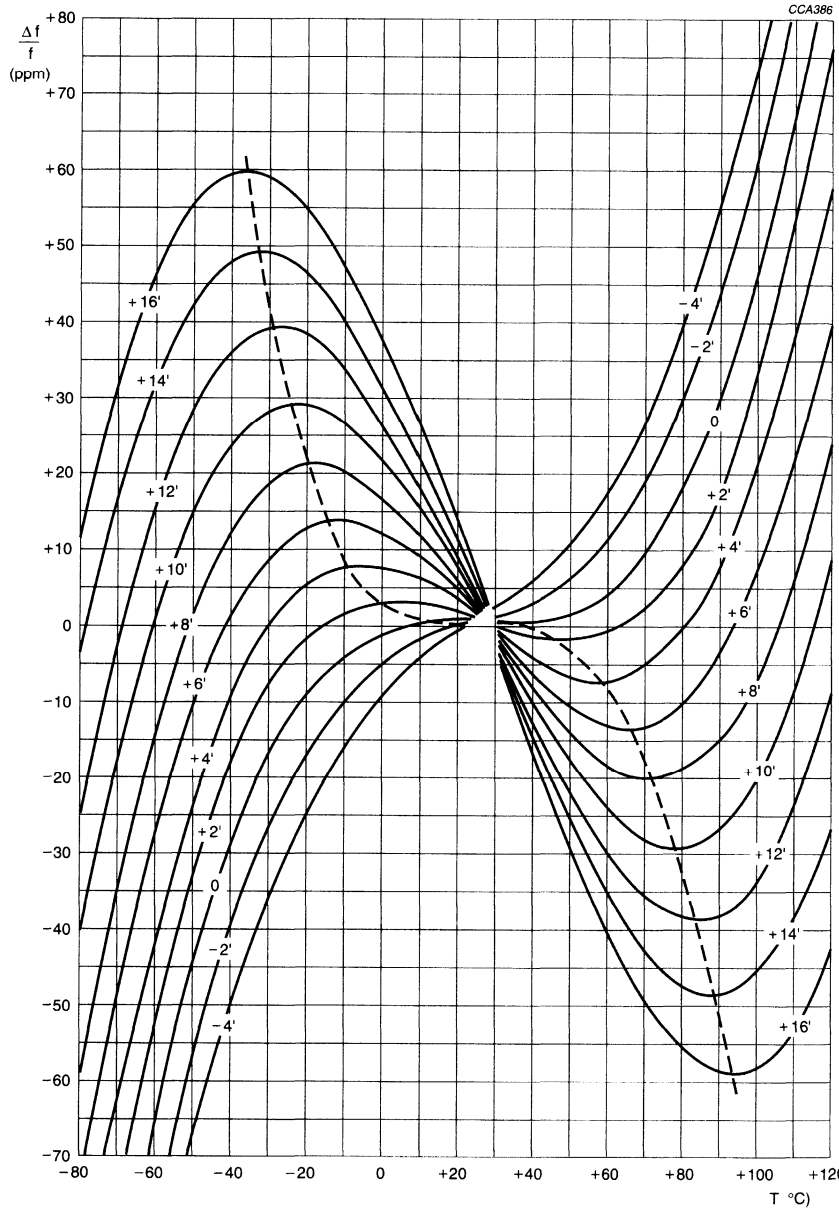


Fig.7 Examples of frequency-temperature characteristics of AT-cuts as a function of the cutting angle.

Level of drive

The power dissipated in a quartz crystal is termed 'level of drive' and is usually expressed in mW. In the level of drive range 10^{-12} to 10^{-4} W the drive level dependency of the crystal characteristics is almost negligible. For drive levels greater than approximately 0.1 mW, the crystal characteristics tend to change. For this reason the crystal characteristics are specified at drive levels of 0.05 mW to 0.5 mW depending on the crystal type.

Low drive levels

When a quartz 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 quartz crystal, 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 quartz crystal oscillator should, therefore, have sufficient loop gain to avoid start-up problems. Typically, a negative resistance of three times the specified $R_{r(max)}$ value is sufficient.

High drive levels

For applications requiring high stability, a drive level between 5 μW and 100 μW should be used. Drive levels exceeding 0.5 μW should be avoided, and excessively high drive levels (exceeding 5 mW) may seriously affect the quartz crystal's behaviour (see Fig. 9).

Frequency/temperature characteristics

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

Figure 7 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 approximately +27 °C.

A temperature range which is fairly symmetrical with respect to 27 °C (e.g. 0 to 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 fairly steep temperature coefficient at room temperature.

Advantages of all-glass holders

Quartz crystals with all-glass holders show the following advantages over those with metal holders:

1. A lower ageing rate.
2. A lower series resistance, which also means a higher Q-factor, due to the fact that glass holders are evacuated giving less mechanical damping.
3. Better performance under adverse climatic conditions.
4. Smaller adjusting tolerances.

Ageing

A gradual change in resonance frequency with time 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):

1. Quartz crystals with an all-glass holder have a lower ageing rate than metal sealed crystals.
2. Low frequency crystals are preferred to high frequency crystals.
3. Overtone crystals are preferred to fundamental crystals for the same frequency.

Crystal behaviour in an oscillator

In the vicinity of resonance, the impedance of a quartz crystal can be represented by a circle (see Fig.8). The circle is shifted downwards with respect to the resistance axis over:

$$X_0 = \frac{1}{2\pi f_r C_0} \qquad (9)$$

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

$$X_L = \frac{1}{2\pi f_L C_L} \qquad (10)$$

The difference between anti-resonance frequency and resonance frequency

$$f_a - f_r \approx \frac{C_1}{2C_0} \times f_r \times \frac{C_L}{C_0 + C_L} \qquad (11)$$

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 quartz crystal operation in the uncertain area above 50% (frequency switching).

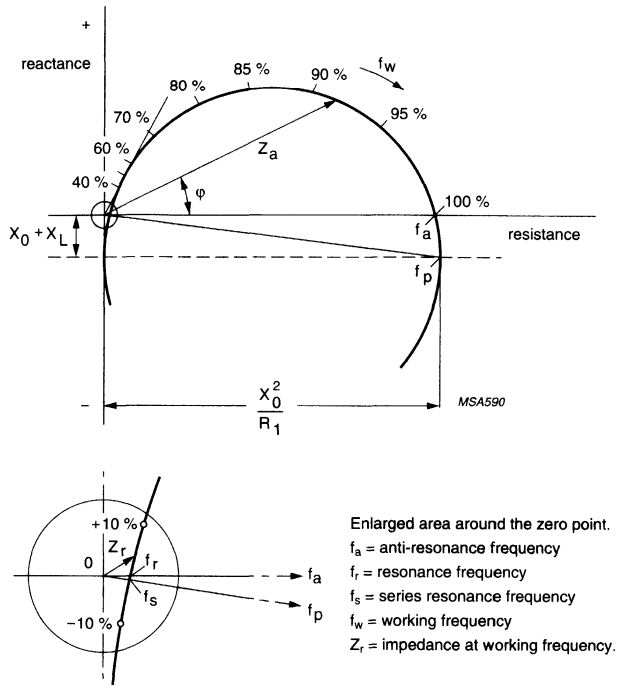


Fig.8 Working frequency and impedance of a quartz crystal in the impedance diagram.

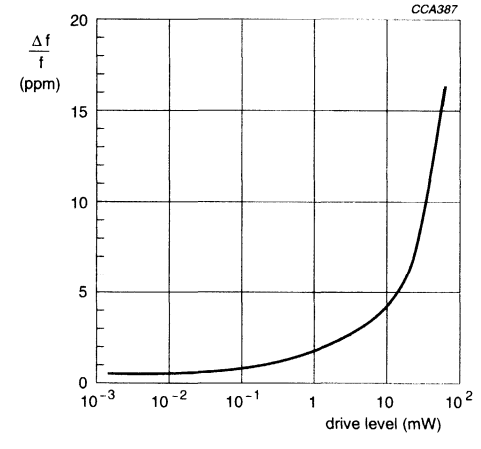


Fig.9 Quartz crystal drive level.

Quartz crystals 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

$$M = \frac{X_0}{R_1} = \frac{1}{(2\pi f_r) R_1 C_0} \qquad (12)$$

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

Indications for use

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

Ensure that the amplification is sufficiently high, particularly when applying phase variation.

Keep quartz crystal drive level low (generally ≤0.5 mW; preferably ≤0.1 mW), (see Fig.9).

MEASURING PROCEDURES

Several methods of measuring quartz crystals are in use. Because different methods may give various results, refer to the test block diagram of Fig.10.

This is the passive method with π-network in accordance with IEC publication 444. The accuracy of reproduction of the π-network method ranges between 10^{-6} and 10^{-8} for frequency measurements, depending on the type of quartz crystal to be measured.

Passive method with π-network (IEC 444)

The principle of this method is very simple. With the equipment shown in Fig.10, 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.

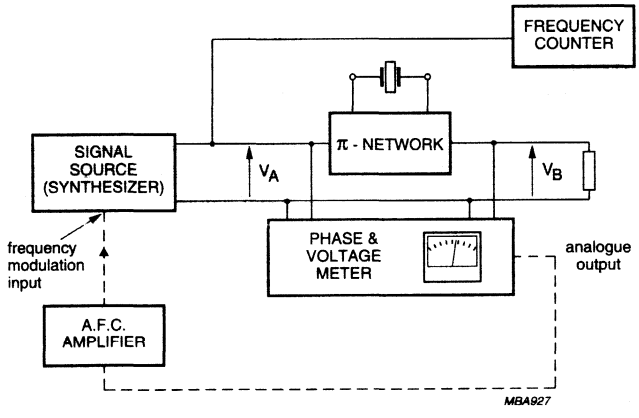


Fig.10 Test equipment block diagram.

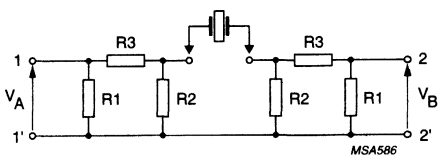


Fig.11 Test jig.

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 (AFC loop shown by dashed line).

Measuring methods can also be applied by using the following equipment if it is available:

SAUNDERS Test Set, type 150 (A, B, C).

Crystal Test Set, type TS193A (British Military Standard).

Crystal Impedance Meter TS330/TSM (U.S. Army Standard).

Crystal Impedance Meter TS683/TSM (U.S. Army Standard).

A π-network test jig is used to connect the quartz crystal to the measuring equipment (see Fig.11). This 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.

The function of the input and output 'pads' is twofold:

1. To match the crystal impedance to the associated equipment.
2. To attenuate reflections from the associated equipment.

For further information consult IEC recommendations, Publication 444.

Crystal shielding

Depending on the application, crystal shielding may give rise to frequency deviations, in particular for fundamental mode quartz crystals with a considerable pulling sensitivity.

In our procedure the metal enclosure of the quartz crystal is normally not earthed. If, in special cases, earthing is required this should be mentioned in the specification for ordering.

MOUNTING

Quartz crystals provided with pins (such as HC-6/U, HC-27/U, HC-29/U and HC-50/U) are for mounting in sockets.

Quartz crystals with leads are for mounting on printed-circuit boards. There are basically two methods: horizontal and vertical mounting. Horizontal (flat) mounting gives better mechanical stability whilst vertical mounting uses less printed-circuit board space. To prevent permanent damage of quartz crystals during mounting operations, some precautions have to be taken:

- Glass feed-throughs are rather vulnerable so avoid excessive forces on the leads which can cause breakage. If cutting of the leads is necessary, use suitable tools to prevent shock waves in the leads.
- If bending of the leads is necessary e.g. in the event of flat mounting, make the bend at least 2 mm away from the body with a bending radius >0.5 mm.
- Note that, especially when the component is vertically mounted, the first mm of tinned leads away from the body are not guaranteed for use. When mounting on thin printed-circuit boards (e.g. 0.7 mm), the use of spacers is recommended.

Specially designed for surface mounting, there are two constructions in HC-45/U-SMD and HC-49/U-SMD.

All crystal types are designed such that they withstand all commonly used soldering techniques, see Chapter *"Tests and requirements"* in the individual data sheets. Exposing the crystal units to high temperatures for a prolonged time, however, should be avoided.

For utmost mechanical stability and electrical reproducibility, metal types can be supplied with a third (top) lead which serves both as a ground wire and a three-point attachment to the printed circuit board.

QUARTZ CRYSTAL UNITS AS DIGITAL TEMPERATURE SENSORS

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.

In addition, it is also possible to cut crystal plates so that the resonance frequency is an almost linear function of the temperature. It should be noted, that the first quartz crystal cut to be discovered was in fact a 'Y- cut'. However, there are some disadvantages which make this cut unsuitable for temperature sensing, therefore special cuts have been introduced, depending on the application.

How to use a quartz crystal unit as a temperature sensor

In order 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 $+80 \times 10^{-6}$/K, depending on the cutting angle. There are several ways of processing this signal. Due to excellent stability, low ageing and its 'digital' nature, resolutions of 0.001 K are easily achieved without noise problems. This renders the device especially suitable for measurements of very small temperature differences as in distillation columns and flow meters.

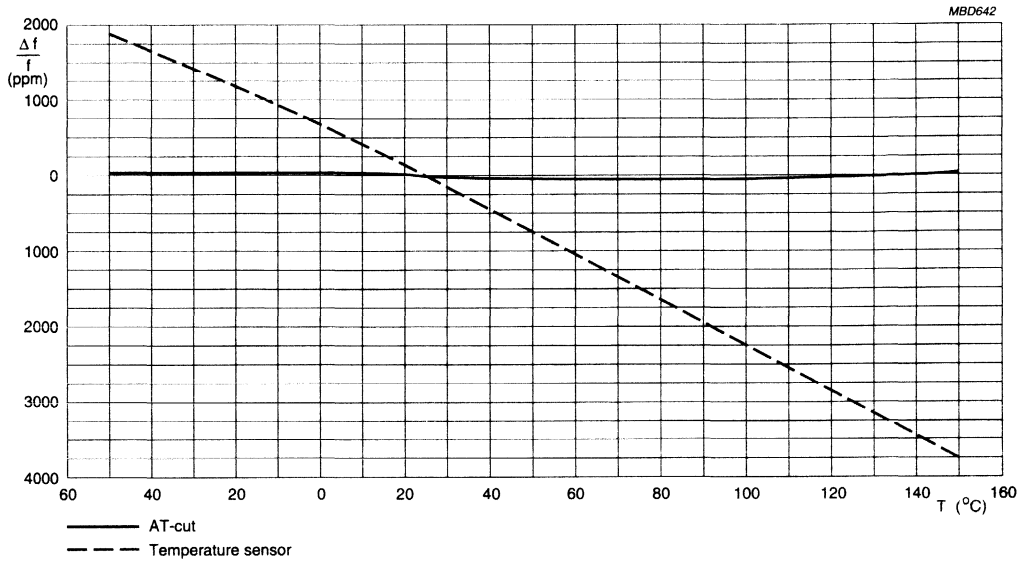


Fig.12 Frequency change as a function of temperature.

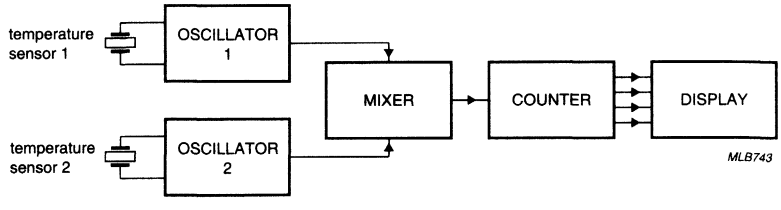


Fig.13 Typical temperature sensing circuit with two sensors.

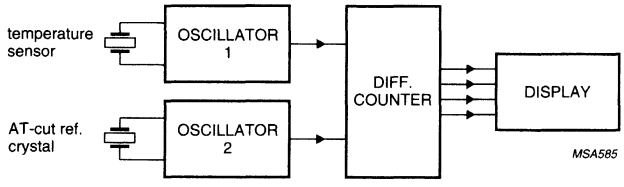


Fig.14 Typical temperature sensing circuit with one sensor and one reference crystal.

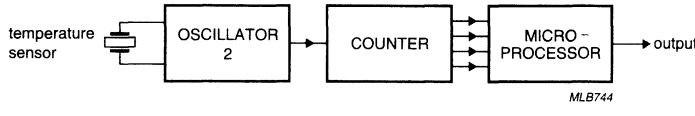


Fig.15 Typical temperature sensing circuit with one sensor and one microprocessor.

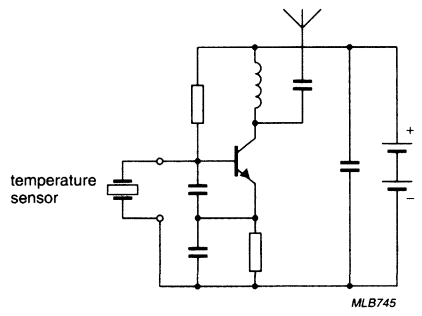


Fig.16 Miniature wireless temperature sensing circuit.

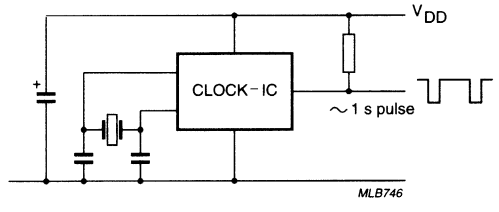


Fig.17 Crystal oscillator in a clock integrated circuit.

HOW TO SPECIFY A QUARTZ CRYSTAL UNIT

General product information

Nominal frequency	f_{nom}	kHz	
Enclosure type		style	
12NC group	9922	series	
Customer	.....		
Application	.....		
Related IC-type	.....		
Date		.....	

Electrical characteristics

Resonance frequency	f_r/f_l	kHz	
Mode of vibration	fundamental; 3rd; 5th and 7th overtones		
Level of drive	P	µW (100 µW)	
Reference temperature	T_{ref}	C (+25 °C)	
Load capacitance	C_L	pF/series resonance	
Adjustment tolerance (at T_{ref})	ΔF ±	ppm	
Resonance resistance	$R_{r\,(max)}$	Ω	
Motional capacitance	C_1	fF	±.....%
Motional inductance	L_1	mH	±.....%
Parallel capacitance	C_0	pF	±.....%
Ageing requirement	ΔF ±	ppm per year	
Spurious requirement	.....		
DLD requirement	$R_{r\,dld}$	Ω	
Operating temperature range	T ..... to	°C	
Frequency stability	±	ppm	
Frequency stability in	..... ±	ppm	
Storage temperature range	T ..... to	°C	

Mechanical characteristics

Connecting leads	standard / cut to	mm	
Marking	[		] first line
	[		] second line
	[		] third line
	[		] optional line
Packaging method	bulk/tape-reel/ammopack/blister tape		
.....	.....		

Special requirements

....

....

Remarks

GENERAL APPLICATIONS

Quartz crystals - general applications
Ceramic SMD (NKS-7)

9922 523 0.... series

FEATURES

- Rugged AT-cut crystal construction
- Extremely small SMT package
- Available on tape and reel.

APPLICATIONS

- Disk drives
- PCMCIA-cards
- Personal computers
- Hand-held products
- Surface mount, densely-populated printed-circuit board applications.

DESCRIPTION

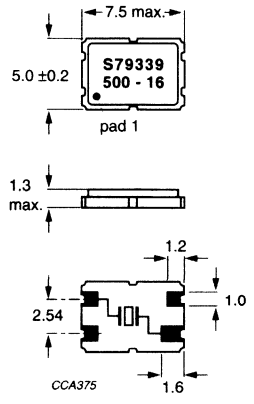
The NKS7 Series incorporates a sub-miniature AT-cut strip crystal resonator housed in a standard 5 × 7 mm ceramic package.

QUICK REFERENCE

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT
f_{nom}	nominal frequency:				
	fundamental mode	8.0	–	30.0	MHz
	third overtone	30.0	–	72.0	MHz
T_{oper}	operating temperature	–20	–	+70	°C
T_{op}	operable temperature	–40	–	+85	°C
$\Delta f/f_{nom}$	adjustment tolerance	–	±50	–	ppm
$\Delta f/f_{25}$	frequency stability over temperature range: –20 to +70 °C with respect to T_{amb} = 25 °C	–	±50	–	ppm

MECHANICAL DATA

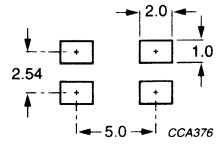
Package outline



Dimensions in mm.

Fig.1 Style 1: Ceramic SMD (NKS-7).

Recommended pad layout



Dimensions in mm.

Fig.2 Ceramic SMD (NKS-7).

Reflow soldering guide

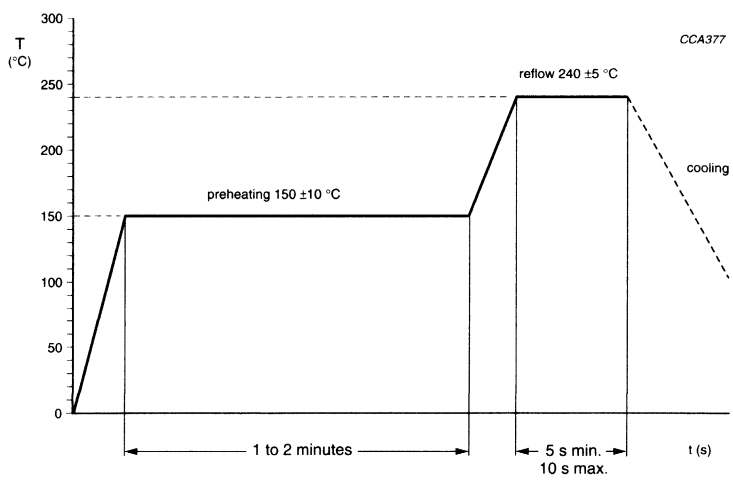
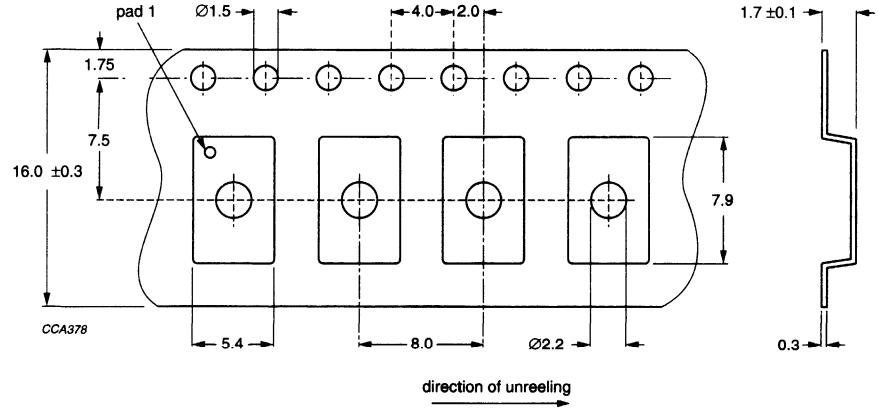


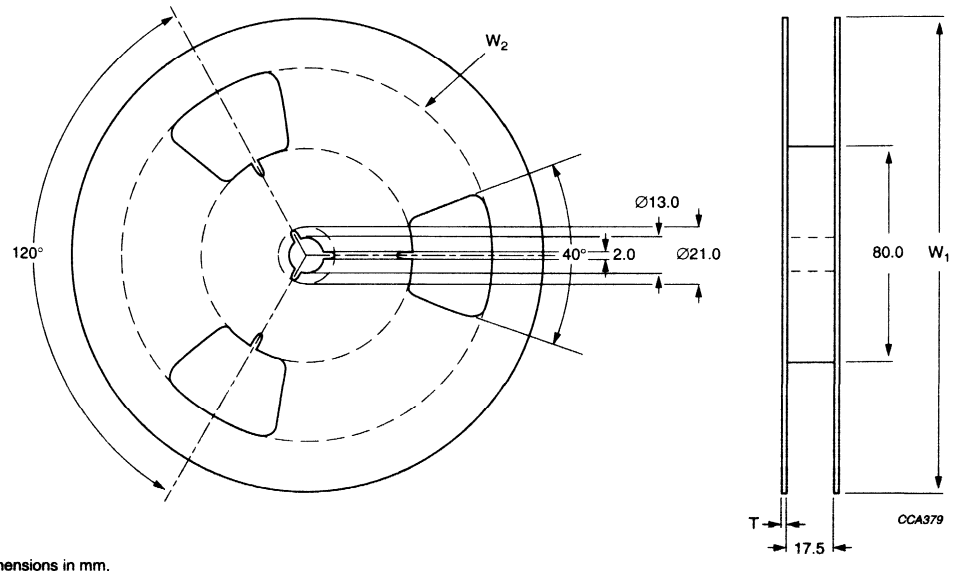
Fig.3 Reflow soldering.

Tape and reel data



Dimensions in mm.

Fig.4 Blister tape.



Dimensions in mm.
For dimensions see Table 1.

Fig.5 Reel dimensions.

Table 1 Reel dimensions; see Fig.5.

TAPE WIDTH (mm)	W_1 (mm)	W_2 (mm)	N (mm)	T (mm)	T_1 (mm)
16	178	140	80	1.8	17.5

PACKAGING AND QUANTITIES

Table 2 Ceramic SMD (NKS-7)

STYLE	PACKAGING	QUANTITY
1	blister tape on reel	1000 units per box

STANDARD MARKING[1]

- Line 1: PH, followed by the manufacturing date code (last three digits of week code)
- Line 2: Last five digits of catalogue number.

MASS

Typical mass: 0.3 g.

(1) Special marking on product and/or package is available on request.

ELECTRICAL DATA

Valid at T_{amb} = 25 ± 2 °C and a nominal drive level of 100 µW into 25 Ω unless otherwise specified. Measuring system: π-network in accordance with *"IEC 444"* recommendations.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
f_{nom}	nominal frequency	fundamental	8.0	–	30.0	MHz
		third overtone	30.0	–	72.0	MHz
$\Delta f/f_{nom}$	adjustment tolerance		–	±50	–	ppm
R_r	resonance resistance	see note 1 and Table 3	–	–	–	Ω
C_L	load capacitance	see note 2	16	20	32; ∞	pF
T_{oper}	operating temperature		–20	–	+70	°C
T_{op}	operable temperature		–40	–	+85	°C
$\Delta f/f_{25}$	frequency stability over temperature range, with respect to T_{amb} = 25 °C		–	±50	–	ppm
R_r (T)	resonance resistance over temperature range	see note 1 and Table 3	available from R_r upwards			Ω
C_1	motional capacitance		–	–	–	fF
C_0	parallel capacitance		–	–	7	pF
S	pulling sensitivity		$S = -0.5\ C_1 / (C_0 + C_L)^2$			ppm/pF
$\Delta f/f$	ageing	first year	–	–	±5	ppm

Notes

1. All resistance values are measured in series resonance. Load resonance measurement available on request.
2. Values available on request.

Table 3 Effective series resonance

FREQUENCY RANGE (MHz)	SERIES RESONANCE	
	MAX.	UNIT
8 to 16	60	Ω
16 to 30	30	Ω
30 to 40	80	Ω
40 to 72	70	Ω

TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with MIL and IEC Standards.

Table 4 Test procedures and requirements

IEC 68-2 METHOD	TEST	PROCEDURE	REQUIREMENTS
Ed	free fall	3 times on hard wood; height of fall (h): 750 mm	$\Delta f/f \leq \pm 5$ ppm
Fc	vibration	frequency 10 to 55 to 10 Hz; sweep period 1 to 2 minutes; amplitude 1.5 mm, 3 directions; 60 minutes/direction	$\Delta f/f \leq \pm 5$ ppm
	resistance to reflow soldering	rise 10 K/s; dwell 2 min/150 °C; rise 10 K/s; dwell 10 s max 240 °C; cool down	$\Delta f/f \leq \pm 10$ ppm
MIL Standard			
MECHANICAL TESTS			
202	solvent resistance	method 215	
883	solderability	method 2003	
ENVIRONMENTAL TESTS			
883	gross leak	method 1015	condition C
883	fine leak	method 1014 ($<5 \times 10^{-8}$ ATM cc/sec)	condition A2
883	thermal shock	method 1011	condition A
883	moisture resistance	method 1004	

Quartz crystals - HFX ceramic SMD 9922 523 2.... series

FEATURES

- Very high frequencies in fundamental mode
- Stringent process control for highly reliable operation
- Photolithographic processing in automated facility
- Compact SMD package, weld seal
- AT-cut.

APPLICATIONS

- Telecommunications
- Wireless RF applications
- Video, graphics
- VCXO's
- Low jitter, high frequency oscillators
- Ultra low power oscillators and transmitters
- Micro-miniature modules.

DESCRIPTION

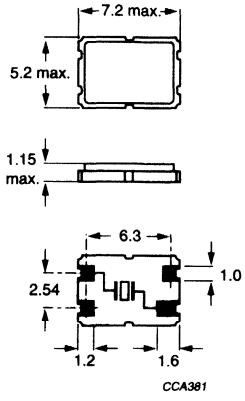
Crystals in the HFX Series are rugged, very high frequency miniature AT-cut resonators housed in seam-welded ceramic SMD packages. Tab-Mesa Technology (TmT™) is used to achieve fundamental resonators to 250 MHz.

QUICK REFERENCE DATA

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT
f_{nom}	nominal frequency: fundamental mode	30.0	–	250.0	MHz
T_{oper}	operating temperature	–20	–	+70	°C
T_{op}	operable temperature	–40	–	+85	°C
$\Delta f/f_{nom}$	adjustment tolerance	±25	±50	±100	ppm
$\Delta f/f_{25}$	frequency stability over temperature range: –20 to 70 °C with respect to T_{amb} = 25 °C	±10	±25	± 50	ppm
$\Delta f/f$	ageing over 10 years at 25 °C	–	±15	–	ppm

MECHANICAL DATA

Package outlines



Dimensions in mm.

Fig.1 Style 1: HFX in box.

PACKAGING AND QUANTITIES

Table 1 HFX ceramic

STYLE	PACKAGING	QUANTITY	DIMENSIONS OF BOX (mm)		
			LENGTH	WIDTH	HEIGHT
1	in box	100 to 1000 units per box	200	125	45

STANDARD MARKING(1)

The products are marked with 2 lines:

- Line 1: PH, followed by the manufacturing date code (last four digits of week code in accordance with UN-D1120)
- Line 2: last five digits of catalogue number.

MASS

Typical mass: 0.3 g.

(1) Special marking on product and/or package is available on request.

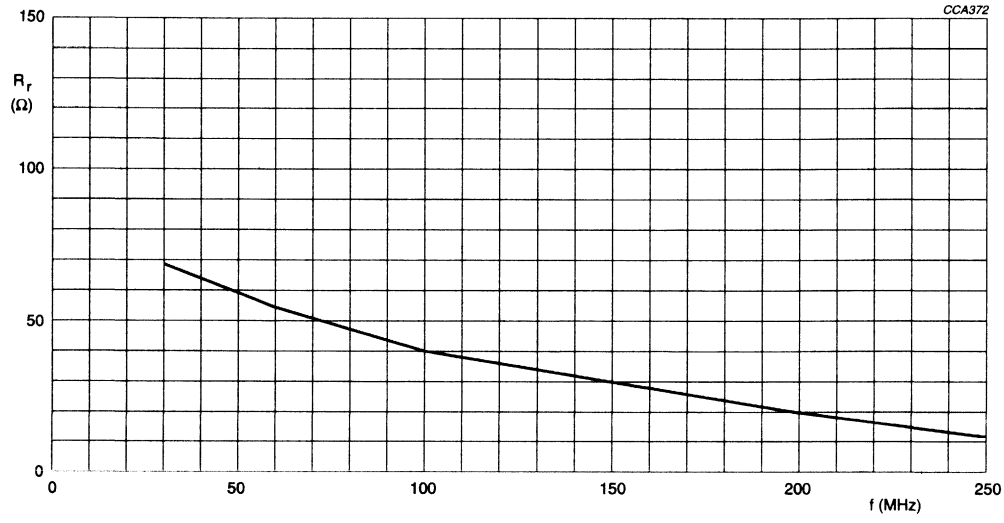
ELECTRICAL DATA

Valid at T_{amb} = 25 ±2 °C and a nominal drive level of into 25 Ω unless otherwise specified. Maximum drive level is 500 μW. Measuring system: π-network in accordance with *"IEC 444"* recommendations.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
f_{nom}	nominal frequency	fundamental	30.0	–	250.0	MHz
$\Delta f/f_{nom}$	adjustment tolerance		±25	±50	±100	ppm
R_r	resonance resistance	see note 1	see Fig.2			Ω
C_L	load capacitance	see note 2	4	20	∞	pF
T_{oper}	operating temperature		–20	–	+70	°C
T_{op}	operable temperature		–40	–	+85	°C
$\Delta f/f_{25}$	frequency stability over temperature range with respect to T_{amb} = 25 °C	see note 3	±10	±25	±50	ppm
R_r (T)	resonance resistance over temperature range	see note 1	available from R_r upwards; see Fig.2			Ω
C_1	motional capacitance		see Fig.3			fF
C_0	parallel capacitance		see Fig.4			pF
$\Delta f/f$	ageing	10 years at T_{amb} = 25 °C	–	±15	–	ppm

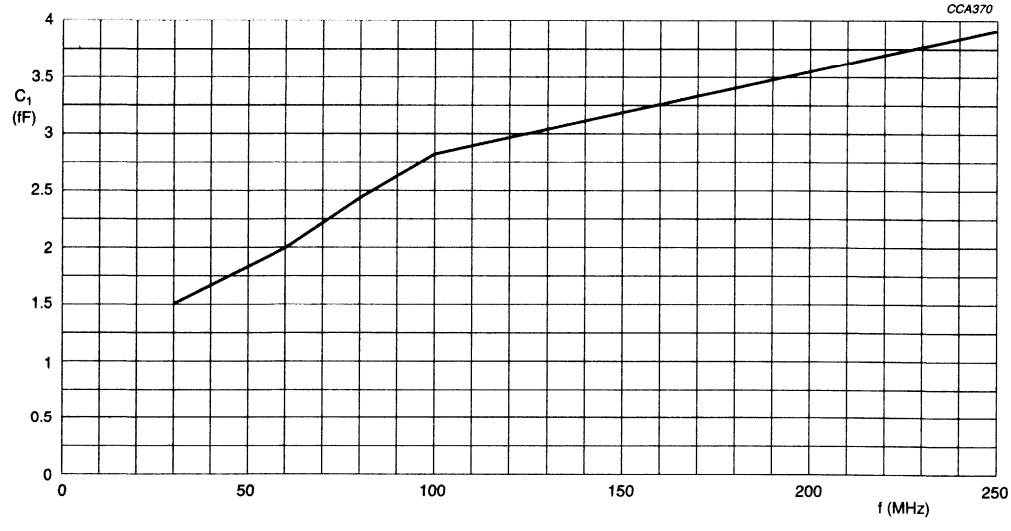
Notes

1. All resistance values are measured in series resonance. Load resonance measurement available on request.
2. Values available on request.
3. Frequency measurement in temperature range is performed in series resonance. Measurement of load resonance frequency can be performed on request.



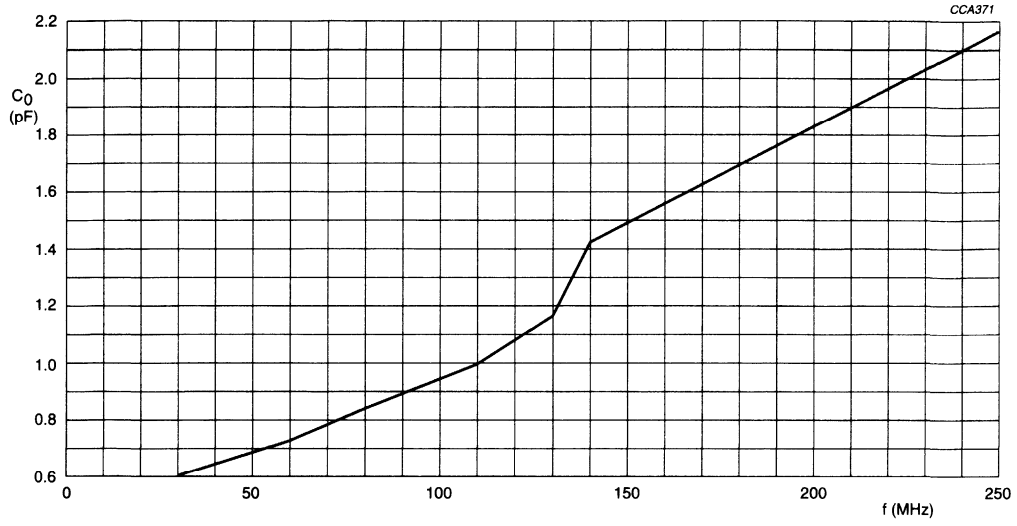
Values shown represent crystals that are designed primarily for clocking applications.
Crystals with higher C_1 values for use in VCXO applications are available on request.

Fig.2 Typical effective series resistance as a function of frequency.



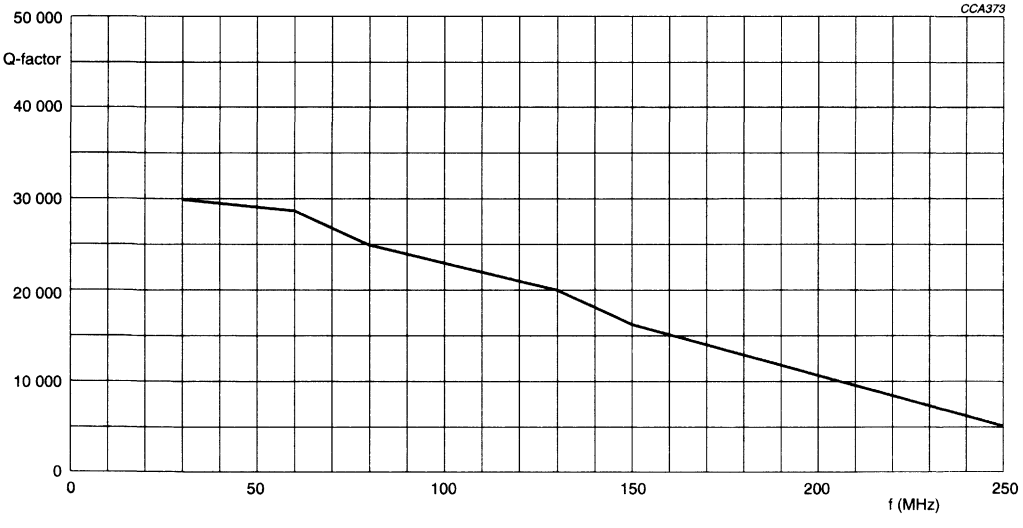
Values shown represent crystals that are designed primarily for clocking applications.
Crystals with higher C_1 values for use in VCXO applications are available on request.

Fig.3 Typical motional capacitance C_1 as a function of frequency.



Values shown represent crystals that are designed primarily for clocking applications.
Crystals with higher C_1 values for use in VCXO applications are available on request.

Fig.4 Typical parallel capacitance C_0 as a function of frequency.



Values shown represent crystals that are designed primarily for clocking applications.
Crystals with higher C_1 values for use in VCXO applications are available on request.

Fig.5 Typical Q-factor as a function of frequency.

TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with *"MIL-Standards 202 and 883"*.

Table 2 Test procedures and requirements

MIL STANDARD	TEST	PROCEDURE	REQUIREMENTS
Mechanical tests			
883	shock	method 1014	condition C
883	vibration	method 2007	condition A
202	terminal strength	method 211	conditions A and C
202	solvent resistance	method 215	
883	solderability	method 2003	
	resistance to reflow soldering	preheat 150 °C, 60 s; reflow 240 °C, 10 s	$\Delta f/f \leq \pm 10$ ppm
Environmental tests			
883	gross leak	method 1014	condition C
883	fine leak	method 1014 ($<5 \times 10^{-8}$ ATM cc/sec)	condition A2
883	thermal shock	method 1011	condition A
883	moisture resistance	method 1004	

Quartz crystals - general applications HC-49/SMD

9922 522 00... series

FEATURES

- Ultra low profile with a height from 3 to 5 mm.
- Manufactured in a clean room environment on a highly automated production line giving a high level of reliability and uniformity.

  This results in very low belt and field reject levels and a low DLD (start-up resistance). It contributes to a consistent product quality level of the applications that involve these crystals.
- Available in several styles and packaging methods.

  Fits in most assembling environments.

APPLICATIONS

- E.D.P.
- Mobile telecom
- Audio/Video
- Portable equipment.

DESCRIPTION

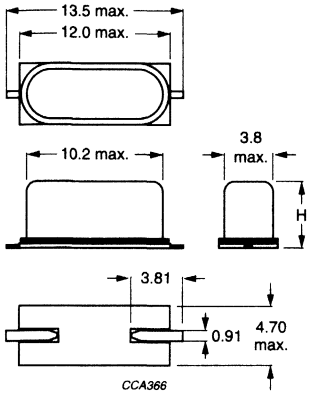
The unit consists of a silver-plated AT-cut or BT-cut quartz strip, encapsulated in a nitrogen-filled metal holder. The low profile holder is hermetically sealed by resistance-welding and packaged for surface mounting in various configurations.

QUICK REFERENCE DATA

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT
f_{nom}	nominal frequency range:				
	fundamental mode AT	3.5	–	28.0	MHz
	fundamental mode BT	26.0	–	50.0	MHz
	third overtone AT	29.0	–	66.0	MHz
T_{oper}	operating temperature	−40	–	+85	°C
T_{op}	operable temperature	−55	–	+125	°C
$\Delta f/f_{nom}$	adjustment tolerance	±15	±50	–	ppm
$\Delta f/f_{25}$	frequency stability over temperature range: −20 to +70 °C with respect to T_{amb} = 25 ±2 °C	±10	±50	–	ppm
$\Delta f/f$	ageing over 10 years at 25 °C	±5	–	±10	ppm

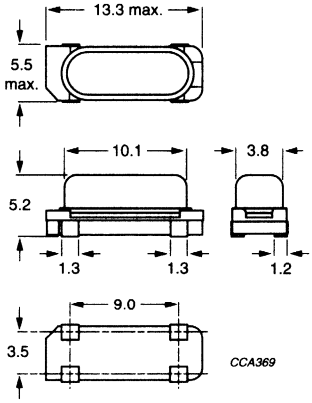
MECHANICAL DATA

Package outlines



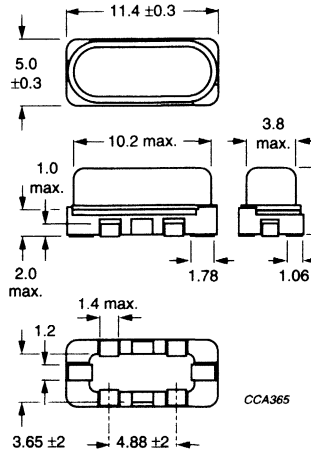
Dimensions in mm.

Fig.1 Style 1.



Dimensions in mm.

Fig.2 Style 2.



Dimensions in mm.

Fig.3 Style 3.

Table 1 Product height; see Figs 1, 2 and 3

PRODUCT HEIGHT (mm)	MINIMUM FREQUENCY (MHz)	
	FUNDAMENTAL MODE	THIRD OVERTONE
Style 1 = 3.3; note 1	7.3 to 50.0	29.0 to 66.0
Styles 2 and 3 = 4.2; note 2		
Style 1 = 4.7; note 1	3.5 to 50.0	26.0 to 66.0
Styles 2 and 3 = 5.2; note 2		

Notes

1. Style 1 is complete with a low-cost surface-mount adaptor.
2. Styles 2 and 3 have precision-moulded bases and a universal contact configuration.

Lead configurations

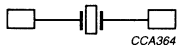


Fig.4 Style 1.

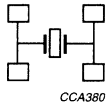


Fig.5 Style 2.

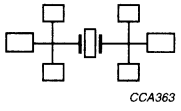


Fig.6 Style 3.

Recommended pad layout

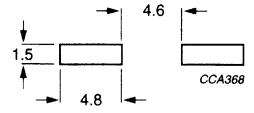


Fig.7 Style 1.

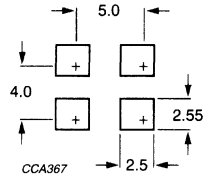


Fig.8 Style 3.

PACKAGING AND QUANTITIES

Table 2 HC-49/SMD holders

STYLE	PACKAGING	QUANTITY	DIMENSIONS OF BOX (mm)		
			LENGTH	WIDTH	HEIGHT
1, 2 and 3	in box	maximum 1000 units per box	200	125	70
	on tape on reel (tape size: 12 mm)	1000 units per reel, in box	338	338	38

STANDARD MARKING(1)

- Line 1: frequency in kHz (fundamental mode) or in MHz (overtone); PH
- LIne 2: last five digits of catalogue number followed by the manufacturing date code (last four digits of week code in accordance with UN-D1120).

MASS AND LEADS

Typical mass: 1.0 g.

The leads are finished with Sn60Pb40 on a nickel underplate.

The first 1 mm from the body is not guaranteed for soldering.

(1) Special marking on product and/or package is available on request.

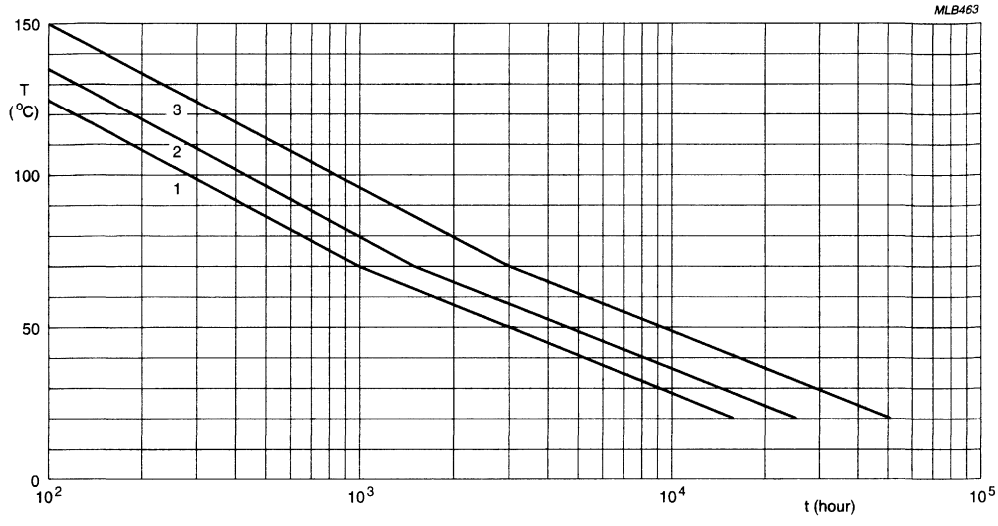
ELECTRICAL DATA

Valid at an ambient temperature T_{amb} = 25 ±2 °C and a nominal drive level of 100 μW into 25 Ω unless otherwise specified. Measuring system: π-network in accordance with *"IEC 444"* recommendations.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
f_{nom}	nominal frequency; note 1	fundamental (AT-cut)	3.5	–	28.0	MHz
		fundamental (BT-cut)	26.0	–	50.0	MHz
		third overtone (AT-cut)	29.0	–	66.0	MHz
$\Delta f/f_{nom}$	adjustment tolerance	see specific 12NC	–	±50	–	ppm
R_r	resonance resistance	see note 2	–	–	–	Ω
C_L	load capacitance	see note 2	5	–	∞	pF
T_{oper}	operating temperature	see specific 12NC	–40	–	+85	°C
T_{op}	operable temperature		–40	–	+125	°C
$\Delta f/f_{25}$	frequency stability over temperature range, with respect to T_{amb} = 25 °C	see notes 2 and 3	±10	±50	–	ppm
R_r (T)	resonance resistance over temperature range	see note 2	available from R_r upwards			Ω
C_1	motional capacitance	see specific 12NC	–	–	–	fF
	tolerance		±20	–	–	%
C_o	parallel capacitance	see specific 12NC	–	–	7	pF
	tolerance		±20		–	%
$\Delta f/f$	ageing	10 years at T_{amb} = 25 °C; see Figs 9 and 10	±5	–	±10	ppm
R_{ins}	insulation resistance	DC test voltage = 100 V	500	–	–	MΩ

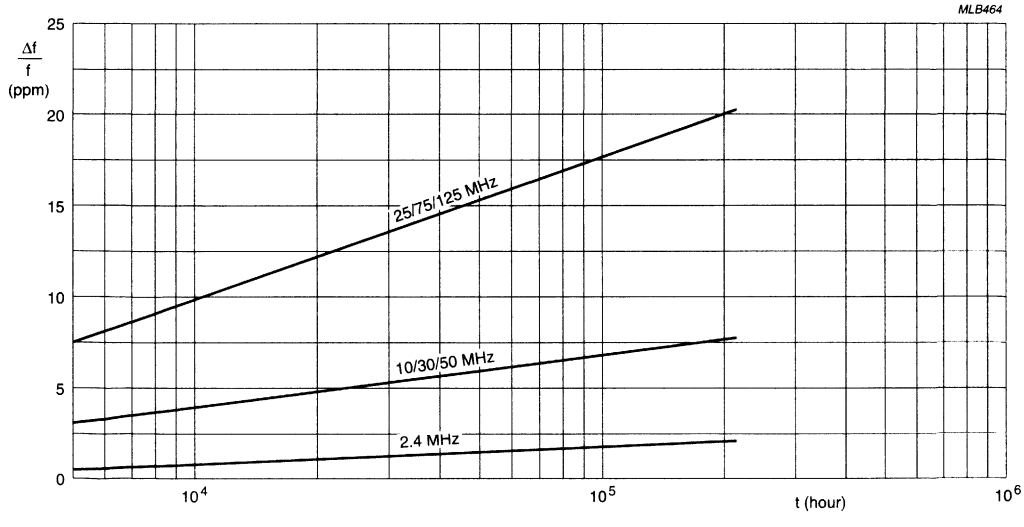
Notes

1. A specific value should be chosen within the given range.
2. All resistance values are measured in series resonance:
   a) See specific 12NC for actual values.
   b) Load resonance measurement is available on request.
3. Frequency measurement in temperature range is performed in series resonance if not requested otherwise:
   a) See specific 12NC for actual values.
   b) BT-cuts have a frequency stability of +0 to –100 ppm from –20 °C to +70 °C.



Curve 1 = 1000 hours at 70 °C.
Curve 2 = 720 hours at 85 °C.
Curve 3 = 240 hours at 130 °C.

Fig.9 Time/temperature relation at which ageing is approximately equivalent.



Fundamental, third and fifth overtones.
Necessary pre-ageing can be calculated using Fig.9.

Fig.10 Typical frequency ageing as a function of time at 25 °C, **without pre-ageing of crystals.**

TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with IEC publication 68-2, *"Recommended basic climatic and mechanical robustness testing procedure for electronic components"* and IEC publication 1178-1, *"Generic specification for quartz crystal units"*.

Table 3 Test procedures and requirements; note 1

IEC 68-2 METHOD	TEST	PROCEDURE	REQUIREMENTS
Ba	ageing	1000 hours at 70 °C	$\Delta f/f \leq \pm 5$ ppm
Db	accelerated damp heat	+25 to +55 °C; 6 cycles at RH >95%	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Ea	shock	100 g; half sinewave; 6 directions; 1 blow/direction	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Eb	bump	4000 bumps of 40 g	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Ed	free fall	3 times on hard wood; for height of fall (h) see Table 4	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Fc	vibration	frequency 10 to 500 to 10 Hz; acceleration 10 g; 3 directions; 30 minutes/direction	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Na	temperature cycling test	−40 to +85 °C; 10 cycles; 0.1 hour/cycle	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Q	sealing (method 1)	16 hours; 700 kPa He	$< 1 \times 10^{-8}$ ncc/s He
Ta	solderability	235 ±5 °C; 2 ±0.5 s; flux 600 (activated)	≥90%, except for 1 mm from body; no visible damage, no leaks
Tb	resistance to reflow soldering	rise 3 K/s; dwell 45 s/150 °C; rise 7 K/s up to 255 °C; cool down	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Ub	bending of terminations	1 × 90°; 5 N	no visible damage, no leaks

Note

1. Test table including MIL-specs (*"MIL-Std 883"* and *"MIL-Std 202"*) can be provided upon request.

Table 4 Height of fall

h (mm)	FREQUENCY RANGE (MHz)	
	FUNDAMENTAL MODE	THIRD OVERTONE
750	3.5 to 16.0	29.0 to 48.0
500	16.1 to 28.0 (50.0)	48.1 to 66.0

Quartz crystals - general applications HC-49/SMD-like

9922 522 40... series

FEATURES

- Produced on an automatic production line which guarantees a high level of uniformity
- Low resistance values
- High pullability values.

APPLICATIONS

- TV colour decoders
- TV teletext
- TV digital sound
- Video cassette recorders (VCR)
- Audio
- CD players
- CD-I players
- DCC players
- Telephony
- Domestic appliances
- Microprocessors.

DESCRIPTION

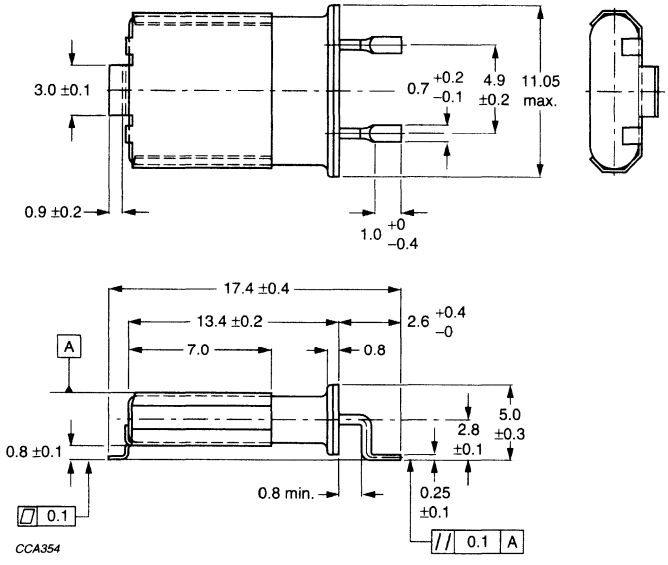
The unit consists of a silver-plated AT-cut quartz plate, encapsulated in a nitrogen-filled metal holder. The holder is hermetically sealed by resistance welding and provided with connections for surface mounting.

QUICK REFERENCE DATA

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT
f_{nom}	nominal frequency:				
	fundamental mode	3.0	–	27.0	MHz
	third overtone	20.0	–	75.0	MHz
T_{oper}	operating temperature	–40	–	+130	°C
T_{op}	operable temperature	–40	–	+155	°C
$\Delta f/f_{nom}$	adjustment tolerance	±10	±30	–	ppm
$\Delta f/f_{25}$	frequency stability over temperature range: –20 to +70 °C with respect to T_{amb} = 25 °C	–	±30	–	ppm
C_1	motional capacitance tolerance	±10	–	–	%
C_0	parallel capacitance tolerance	+10	–	–	%
$\Delta f/f$	ageing over 10 years at 25 °C	±5	–	±10	ppm

MECHANICAL DATA

Package outlines



Dimensions in mm.

Fig.1 Style 1: HC-49/U17-SMD/Clip I.

Recommended pad layout

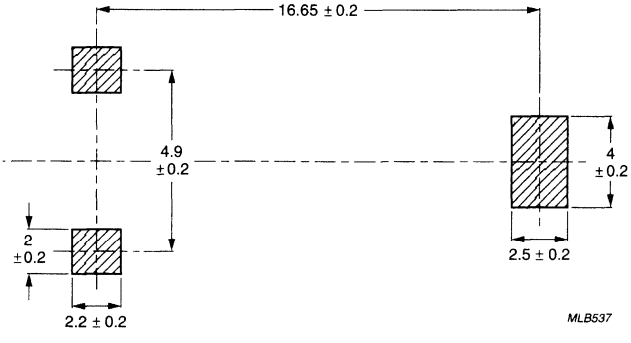
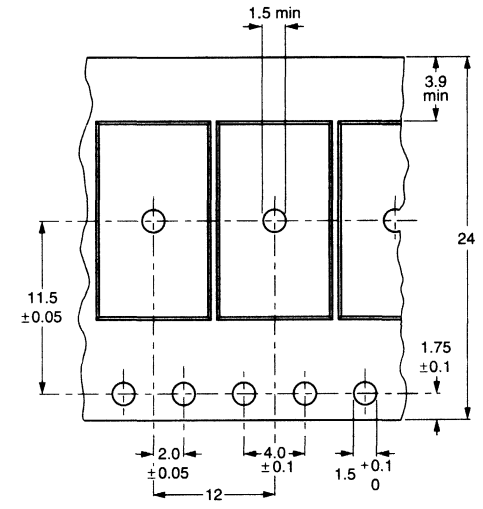
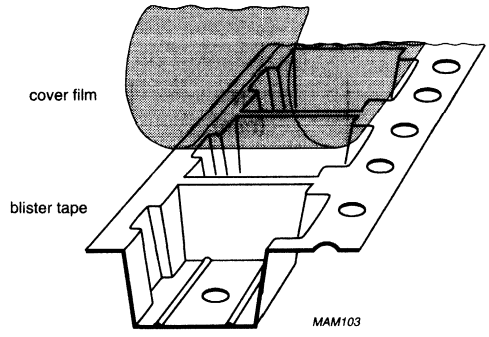


Fig.2 HC-49/U SMD/Clip I.

Tape and reel data



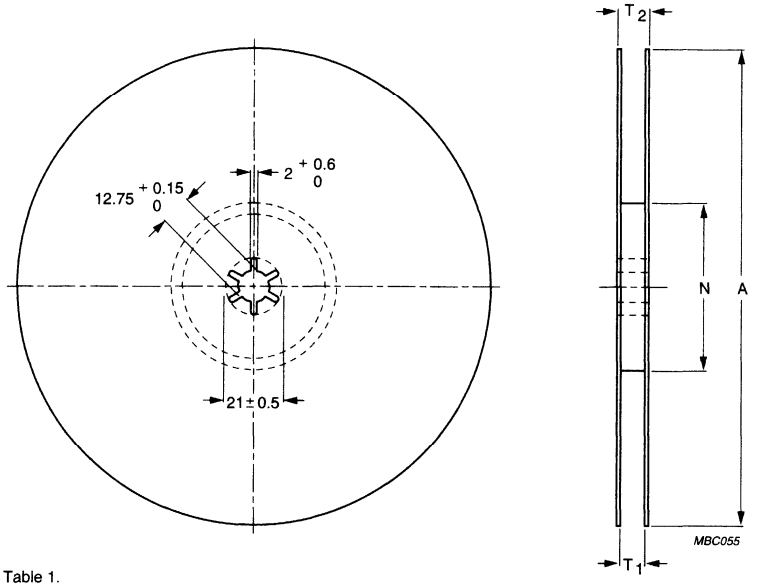


Dimensions in mm.
Crystal connections are adjacent to sprocket holes.
Cumulative pitch error: ≤0.2 mm over 10 pitches.

Total tape height of tape with top film: 5.8 mm maximum.
Tape thickness: 0.3 mm.
The blister is made of conductive polystyrene. Taping is performed in accordance with *"IEC 286-3"*.
Leader: minimum 400 mm including 100 mm sealed with empty compartments.
Trailer: minimum 160 mm sealed with empty compartments.

Pocket dimensions:
Length = 18.3 ±0.1 mm
Width = 11.4 ±0.1 mm
Depth = 5.6 +0.05/–0 mm.

Fig.3 Blister tape.



Dimensions in mm.
For dimensions see Table 1.

Fig.4 Reel dimensions.

Table 1 Reel dimensions; see Fig.4

TAPE WIDTH (mm)	A (mm)	N (mm)	T_1 (mm)	T_2 (mm)
24	330	62 ±1.5	24.4 +0.2/–0	28.4 ±0.2

PACKAGING AND QUANTITIES

STYLE	PACKAGING	QUANTITY	DIMENSIONS OF BOX (mm)		
			LENGTH	WIDTH	HEIGHT
1	blister tape on reel	700 units per reel	338	338	38
	box	700 units per box	200	125	70

STANDARD MARKING(1)

- Line 1: PHILIPS
- Line 2: frequency in kHz (fundamental mode) or in MHz (overtone)
- LIne 3: last five digits of catalogue number followed by the manufacturing date code (last three digits of week code).

MASS AND LEADS

Typical mass: 1.2 g.

The leads are finished with Sn99Cu1 on a nickel underplate.

The first 1 mm from the body is not guaranteed for soldering.

(1) Special marking on product and/or package is available on request.

ELECTRICAL DATA

Valid at T_{amb} = 25 ± 2 °C and a nominal drive level of 100 µW into 25 Ω unless otherwise specified. Measuring system: π-network in accordance with *"IEC 444"* recommendations.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
f_{nom}	nominal frequency	fundamental	3.0	–	27.0	MHz
		third overtone	20.0	–	75.0	MHz
$\Delta f/f_{nom}$	adjustment tolerance		±10	±30	–	ppm
R_r	resonance resistance	see notes 1 and 2	–	–	–	Ω
C_L	load capacitance	see note 2	5	20	∞	pF
T_{oper}	operating temperature		–40	–	+130	°C
T_{op}	operable temperature		–40	–	+155	°C
$\Delta f/f_{25}$	frequency stability over temperature range, with respect to T_{amb} = 25 °C		see Table 2, class 2			ppm
R_r (T)	resonance resistance over temperature range	see notes 1 and 2	available from R_r upwards			Ω
C_1	motional capacitance					fF
	tolerance		±10	–	–	%
C_0	parallel capacitance					pF
	tolerance		±10	–	–	%
S	pulling sensitivity		$S = -0.5\ C_1 / (C_0 + C_L)^2$			ppm/pF
R_n	resonance resistance of unwanted response (spurious)	fundamental mode; f_{nom} ±20%	2 R_r (T)	–	–	Ω
			+6	–	–	dB
		overtones; f_{nom} ±200 kHz	2 R_r (T)	–	–	Ω
			+6	–	–	dB
R_{dld}	drive level dependency, being the resonance resistance in the drive level range	drive level range 10^{-16} W to 10^{-4} W; note 1	see note 2			Ω
R_{ins}	insulation resistance	DC test voltage = 100 V	500	–	–	MΩ
$\Delta f/f$	ageing	see Figs 5 and 6	±5	–	±10	ppm

Notes

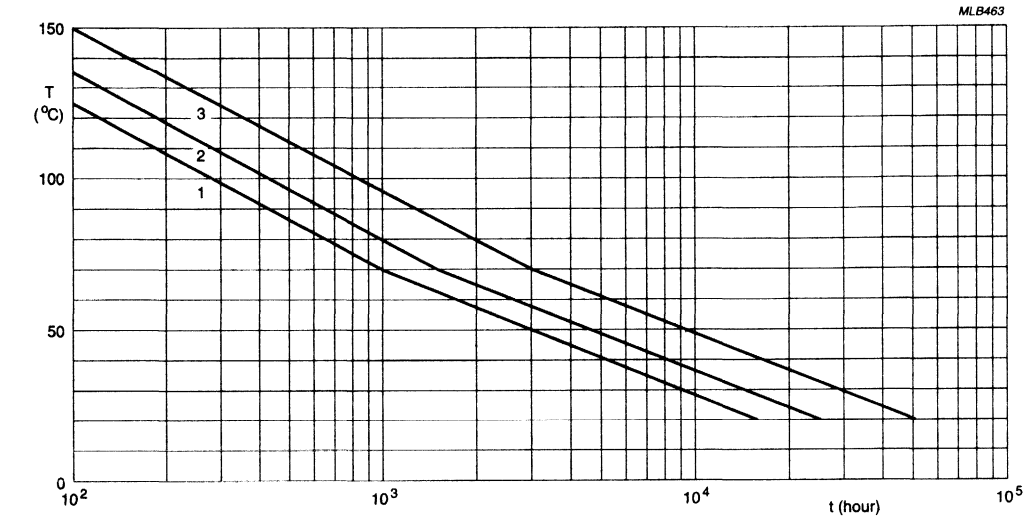
1. All resistance values are measured in series resonance. Load resonance measurement available on request.
2. Values available on request.

Table 2 Frequency stability with temperature variation (available maximum values)

TEMPERATURE RANGE[1] (°C)	FREQUENCY STABILITY (ppm)		
	CLASS 0	CLASS 1	CLASS 2
+20/+30	±1.0	±1.5	±2.0
0/+50	±5.0	±7.5	±10.0
−10/+60	±7.5	±10.0	±15.0
−20/+70	±10.0	±15.0	±20.0
−30/+80	±12.5	±20.0	±25.0
−40/+90	±17.5	±25.0	±30.0
−55/+105	±25.0	±30.0	±40.0
−40/+130	–	±50.0	±80.0

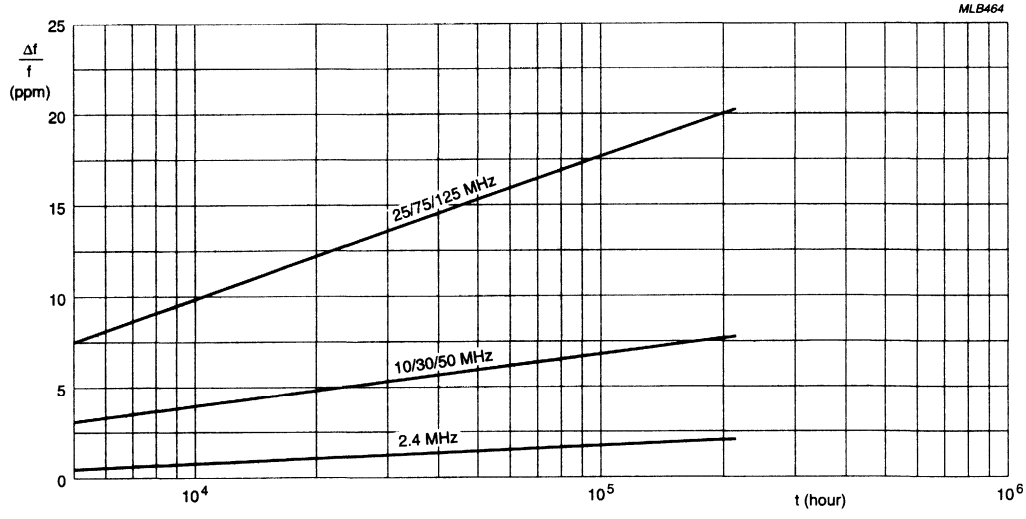
Note

1. To obtain the same stability at frequencies below 8.0 MHz, the upper temperature limit is 10 °C lower.



Curve 1 = 1000 hours at 70 °C.
Curve 2 = 720 hours at 85 °C.
Curve 3 = 240 hours at 130 °C.

Fig.5 Time/temperature relation at which ageing is approximately equivalent.



Fundamental, third and fifth overtones.
Necessary pre-ageing can be calculated using Fig.5.

Fig.6 Typical frequency ageing as a function of time at 25 °C, **without pre-ageing of crystals.**

TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with IEC publication 68-2, *"Recommended basic climatic and mechanical robustness testing procedure for electronic components"* and IEC publication 1178-1, *"Generic specification for quartz crystal units"*

Table 3 Test procedures and requirements; note 1

IEC 68-2 METHOD	TEST	PROCEDURE	REQUIREMENTS
Ba	ageing	1000 hours at 70 °C	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Db	accelerated damp heat	+25 to +55 °C; 6 cycles at RH >95%	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Ea	shock; note 2	100 g; half sinewave; 6 directions; 1 blow/direction	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Eb	bump; note 2	4000 bumps of 40 g	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Ed	free fall; note 2	3 times on hard wood; for height of fall (h) see Table 4	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Fc	vibration	frequency 10 to 500 to 10 Hz; acceleration 10 g; 3 directions; 30 minutes/direction	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Na	temperature cycling test	−40 to +85 °C; 10 cycles; 0.1 hour/cycle	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Q	sealing (method 1)	16 hours; 700 kPa He	$<1 \times 10^{-8}$ ncc/s He
Ta	solderability	235 ±5 °C; 2 ±0.5 s; flux 600 (activated); optional steam pre-heat 8 hours. This reflects at least 36 months of storage at room conditions	≥90%, except for 1 mm from body; no visible damage, no leaks
Tb	resistance to reflow soldering	rise 10 K/s; dwell 2 min/160 °C; rise 10 K/s up to 280 °C; cool down	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater

IEC 68-2 METHOD	TEST	PROCEDURE	REQUIREMENTS
Other applicable tests			
Xa	resistance to solvents; note 3: Bio-Act EC7®; Neutropon P3® and Saxin P3®; Meta Clean 820®; Lonco 446®; Isopropanol cleaning solvent; Dowanol DPM® (glass crystals only)	in accordance with *"IEC 68-2-45"*, *"IEC 653"* (immersion time 5 minutes) and *"MIL 202 E215"*. At ambient temperature and ultrasonic frequency (40 kHz)	no degradation of marking

Notes

1. Test table including MIL-specs (*"MIL-Std 883"* and *"MIL-Std 202"*) can be provided upon request.
2. Mechanical tests to be performed on units clamped to a printed-circuit board for the total unit height.
3. Bio-Act is a registered trademark of Petroform.
   Neutropon P3 and Saxin P3 are registered trademarks of Henkel.
   Meta Clean 820 is a registered trademark of Mavom.
   Lonco 447 is a registered trademark of London Chemical Co.
   Dowanol DPM is a registered trademark of Dow Chemical.

Table 4 Height of fall

h (mm)	PRODUCT LENGTH (mm)	FREQUENCY RANGE[1] (MHz)	
		FUNDAMENTAL MODE	THIRD OVERTONE
750	17	3.0 to 7.50	20.0 to 22.50
500	17	7.51 to 10.0	22.51 to 30.0
250	17	10.1 to 27.0	30.1 to 75.0

Note

1. Standard values. Actual designs can be made to obtain higher or lower values.

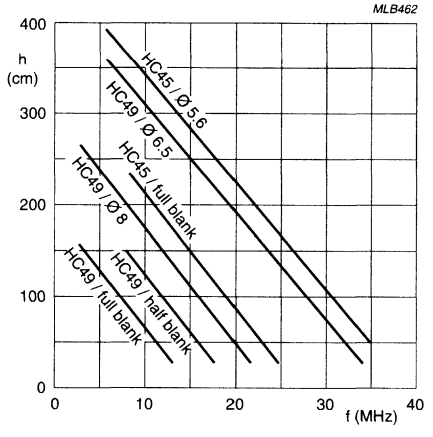


Fig.7 Typical height of fall values (3× on hard wood) for various quartz blank and holder combinations. 'Full' and 'half' blanks refer to rectangular quartz designs; '∅' designates circular quartz designs and the appropriate diameter.

Quartz crystals - general applications HC-45/SMD-like

9922 522 20... series

FEATURES

- Small dimensions
- High mechanical stability
- Automated production line for high level of uniformity.

APPLICATIONS

- Personal computers
- Microprocessors
- Portable equipment.

DESCRIPTION

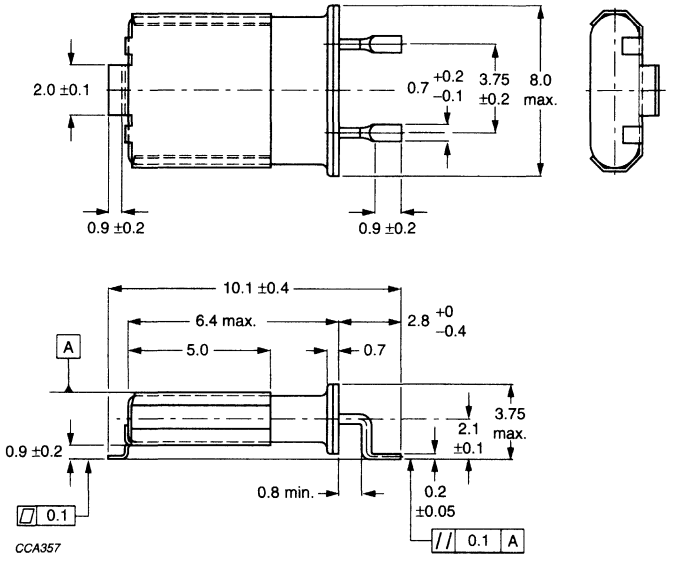
The unit consists of a silver-plated AT-cut quartz plate, encapsulated in a nitrogen-filled metal holder. The holder is hermetically sealed by resistance welding and provided with connections for surface mounting.

QUICK REFERENCE DATA

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT
f_{nom}	nominal frequency:				
	fundamental mode	8.0	–	24.0	MHz
	third overtone	24.0	–	75.0	MHz
T_{oper}	operating temperature	–40	–	+130	°C
T_{op}	operable temperature	–55	–	+155	°C
$\Delta f/f_{nom}$	adjustment tolerance	±10	±30	–	ppm
$\Delta f/f_{25}$	frequency stability over temperature range: –20 to +70 °C with respect to T_{amb} = 25 °C	–	±30	–	ppm
C_1	motional capacitance tolerance	±10	–	–	%
C_0	parallel capacitance tolerance	±10	–	–	%
$\Delta f/f$	ageing over 10 years at 25 °C	±5	–	±10	ppm

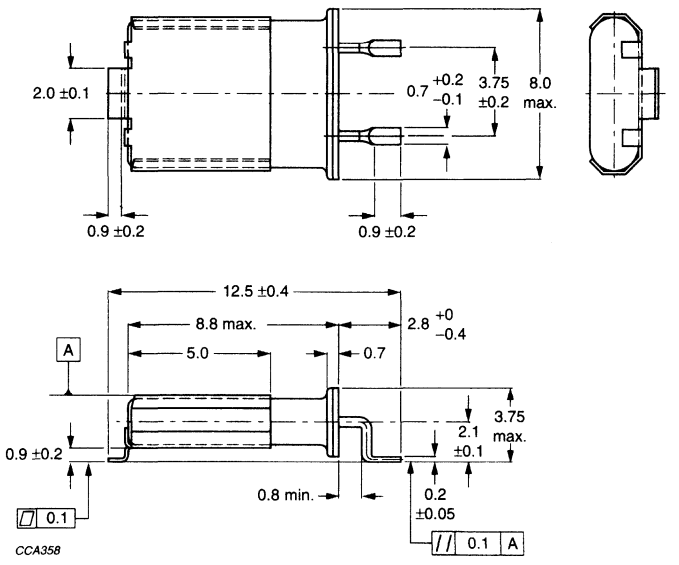
MECHANICAL DATA

Package outlines



Dimensions in mm.

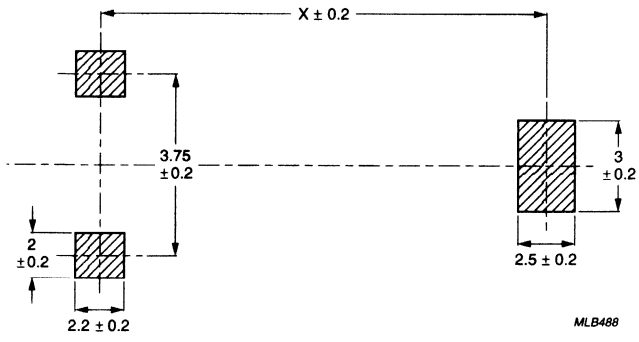
Fig.1 Style 1: HC-45/U10-SMD/Clip I.



Dimensions in mm.

Fig.2 Style 2: HC-45/U12-SMD/Clip I.

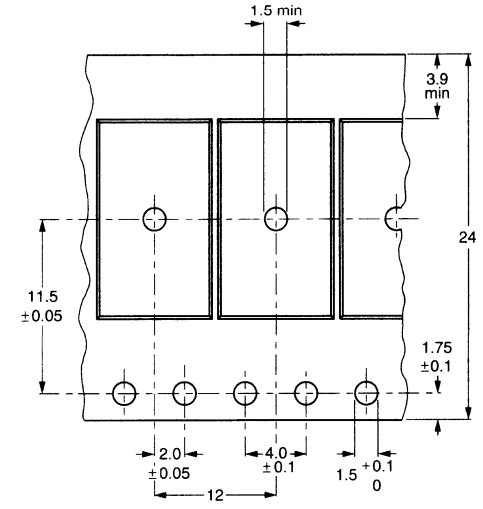
Recommended pad layout

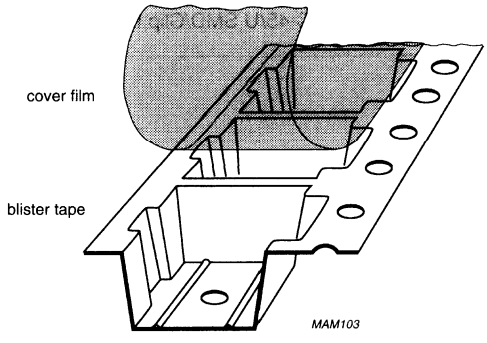


Dimensions in mm.
HC-45/U10: X = 9.2.
HC-45/U12: X = 11.6.

Fig.3 HC-45/U SMD/Clip I.

Tape and reel data



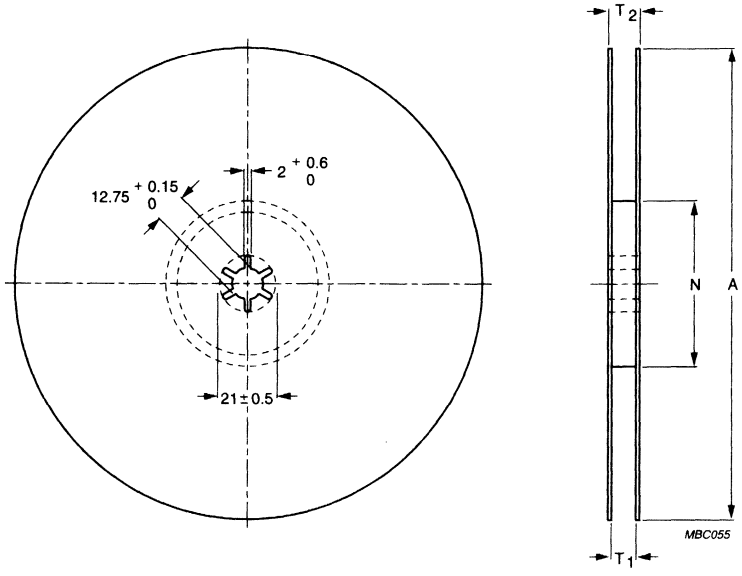


Dimensions in mm.
Crystal connections are adjacent to sprocket holes.
Cumulative pitch error: ≤0.2 mm over 10 pitches.

Total tape height of tape with top film: 4.5 mm maximum.
Tape thickness: 0.3 mm.
The blister is made of conductive polystyrene. Taping is performed in accordance with *"IEC 286-3"*.
Leader: minimum 400 mm including 100 mm sealed with empty compartments.
Trailer: minimum 160 mm sealed with empty compartments.

Pocket dimensions:
Length = 13.1 ±0.1 mm
Width = 8.3 ±0.1 mm
Depth = 4.3 +0.05/−0 mm.

Fig.4 Blister tape.



Dimensions in mm.
For dimensions see Table 1.

Fig.5 Reel dimensions.

Table 1 Reel dimensions; see Fig.5

TAPE WIDTH (mm)	A (mm)	N (mm)	T_1 (mm)	T_2 (mm)
24	286	62 ±1.5	24.4 +0.2/–0	28.4 ±0.2

PACKAGING AND QUANTITIES

STYLE	PACKAGING	QUANTITY	DIMENSIONS OF BOX (mm)		
			LENGTH	WIDTH	HEIGHT
1	blister tape on reel	1000 units per reel	298	295	42
	blister tray	6 units per reel	315	155	67

STANDARD MARKING(1)

- Line 1: PHILIPS
- Line 2: frequency in kHz (fundamental mode) or in MHz (overtone)
- LIne 3: last five digits of catalogue number followed by the manufacturing date code (last three digits of week code).

MASS AND LEADS

Typical mass: 0.5 g.

The leads are finished with Sn99Cu1 or Sn60Pb40 on a nickel underplate.

The first 1 mm from the body is not guaranteed for soldering.

(1) Special marking on product and/or package is available on request.

ELECTRICAL DATA

Valid at T_{amb} = 25 ±2 °C and a nominal drive level of 100 µW into 25 Ω unless otherwise specified. Measuring system: π-network in accordance with *"IEC 444"* recommendations.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
f_{nom}	nominal frequency	fundamental	8.0	–	24.0	MHz
		third overtone	24.0	–	75.0	MHz
$\Delta f/f_{nom}$	adjustment tolerance	10 mm length	±20	±30	–	ppm
		12 mm length	±10	±30	–	ppm
R_r	resonance resistance	see note 1	see Figs 6 and 8			Ω
C_L	load capacitance	see note 2	5	20	∞	pF
T_{oper}	operating temperature		–40	–	+130	°C
T_{op}	operable temperature		–55	–	+155	°C
$\Delta f/f_{25}$	frequency stability over temperature range, with respect to T_{amb} = 25 °C		see Table 2, class 2			ppm
R_r (T)	resonance resistance over temperature range	see note 1	available from R_r upwards			Ω
C_1	motional capacitance		see Figs 7 and 9			fF
	tolerance		±10	–	–	%
C_0	parallel capacitance		see Figs 7 and 9			pF
	tolerance		±10	–	–	%
S	pulling sensitivity		$S = -0.5\ C_1 / (C_0 + C_L)^2$			ppm/pF
R_n	resonance resistance of unwanted response (spurious)	fundamental mode; f_{nom} ±20%	2 R_r (T)	–	–	Ω
			+6	–	–	dB
		overtones; f_{nom} ±200 kHz	2 R_r (T)	–	–	Ω
			+6	–	–	dB
R_{dld}	drive level dependency, being the resonance resistance in the drive level range	drive level range 10^{-16} W to 10^{-4} W; note 1	see note 2			Ω
R_{ins}	insulation resistance	DC test voltage = 100 V	500	–	–	MΩ
Δf/f	ageing	see Figs 10 and 11	±5	–	±10	ppm

Notes

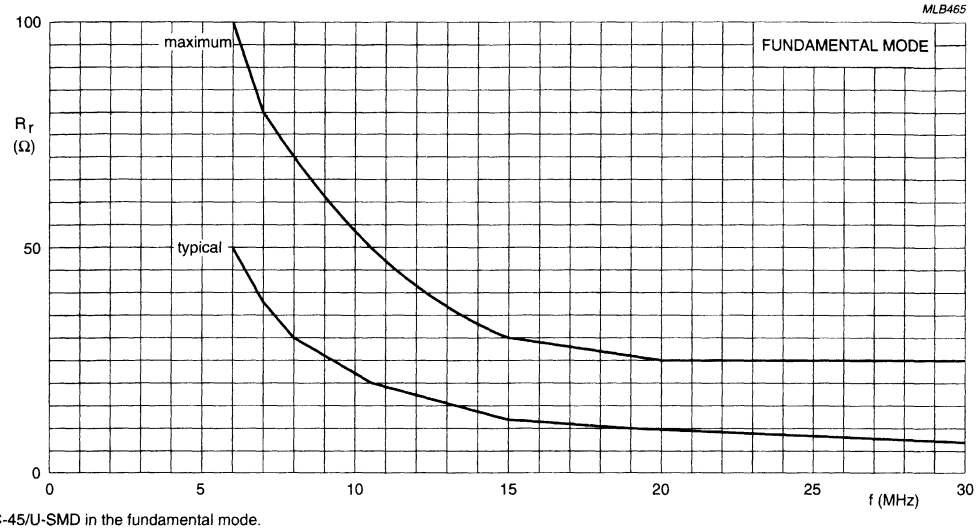
1. All resistance values are measured in series resonance. Load resonance measurement available on request.
2. Values available on request.

Table 2 Frequency stability with temperature variation (available maximum values)

TEMPERATURE RANGE[1] (°C)	FREQUENCY STABILITY (ppm)		
	CLASS 0	CLASS 1	CLASS 2
+20/+30	±1.0	±1.5	±2.0
0/+50	±5.0	±7.5	±10.0
−10/+60	±7.5	±10.0	±15.0
−20/+70	±10.0	±15.0	±20.0
−30/+80	±12.5	±20.0	±25.0
−40/+90	±17.5	±25.0	±30.0
−55/+105	±25.0	±30.0	±40.0
−40/+130	–	±50.0	±80.0

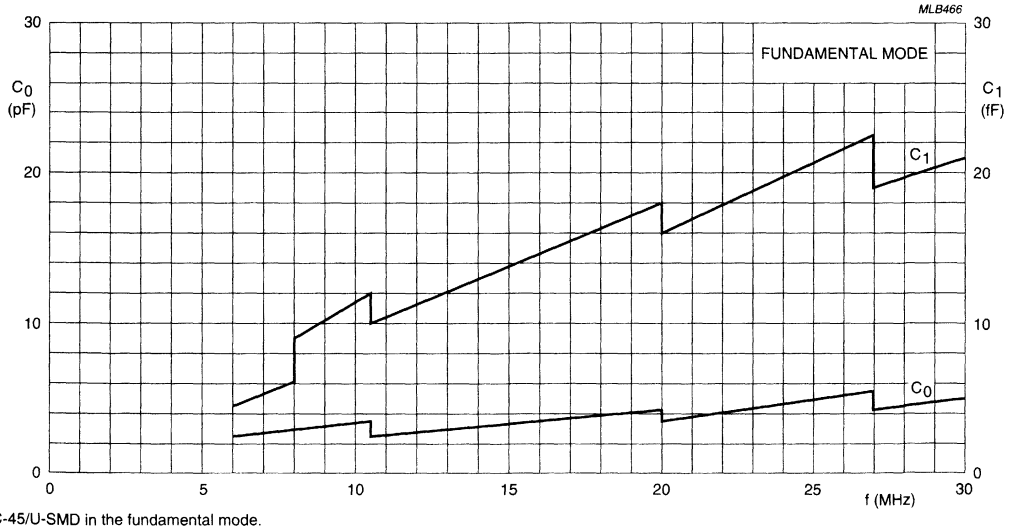
Note

1. To obtain the same stability at frequencies below 8.0 MHz, the upper temperature limit is 10 °C lower.



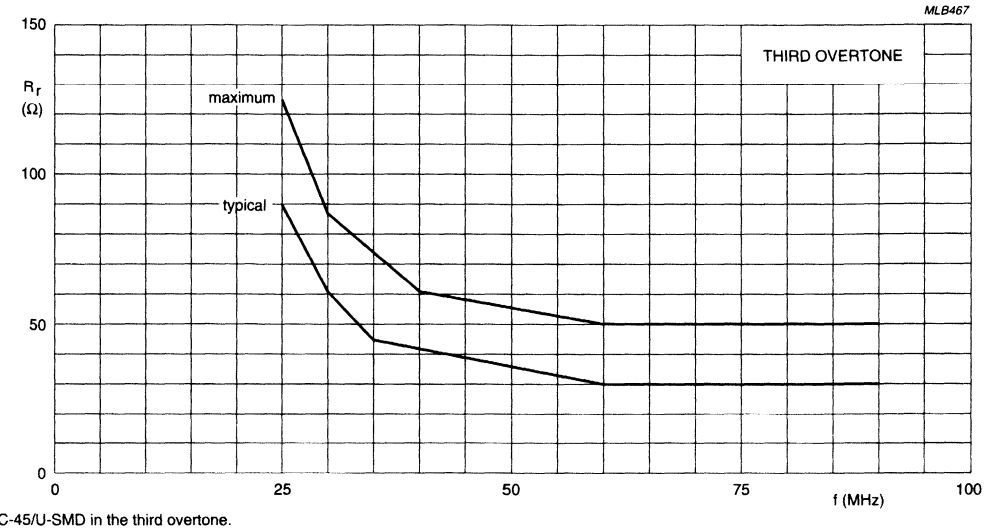
HC-45/U-SMD in the fundamental mode.
Values at 25 °C.
Other values available by extrapolating in combination with C_0 and C_1 values.

Fig.6 Resonance resistance R_r as a function of resonance frequency, for crystals in 12 mm product length (involving large quartz blanks).



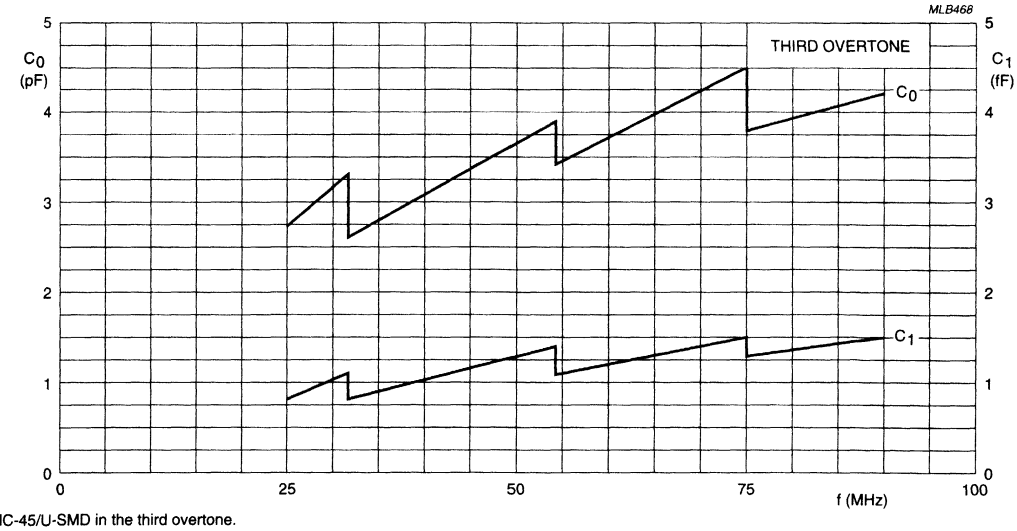
HC-45/U-SMD in the fundamental mode.
Typical values at 25 °C.
Other values available by extrapolation of the curve segments.

Fig.7 Motional capacitance C_1 and parallel capacitance C_0 as a function of resonance frequency, for crystals in 12 mm product length (involving large quartz blanks).



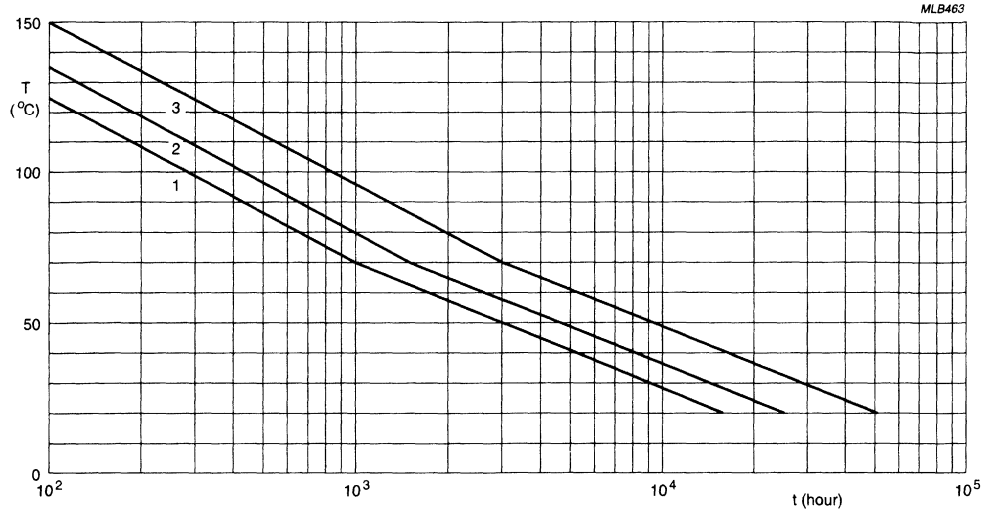
HC-45/U-SMD in the third overtone.
Values at 25 °C.
Other values available by extrapolating in combination with C_0 and C_1 values.

Fig.8 Resonance resistance R_r as a function of resonance frequency, for crystals in 12 mm product length (involving large quartz blanks).



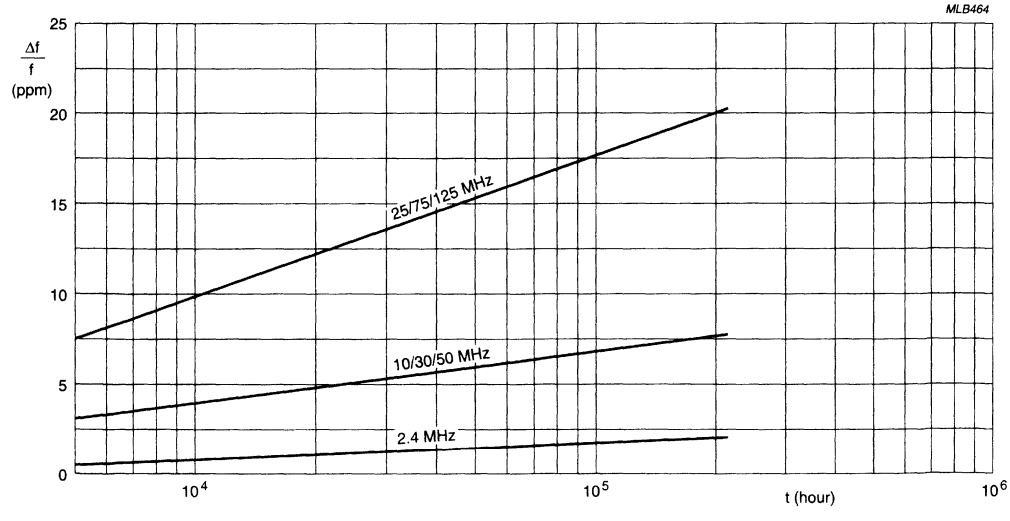
HC-45/U-SMD in the third overtone.
Typical values at 25 °C.
Other values available by extrapolation of the curve segments.

Fig.9 Motional capacitance C_1 and parallel capacitance C_0 as a function of resonance frequency, for crystals in 12 mm product length (involving large quartz blanks).



Curve 1 = 1000 hours at 70 °C .
Curve 2 = 720 hours at 85 °C.
Curve 3 = 240 hours at 130 °C.

Fig.10 Time/temperature relation at which ageing is approximately equivalent.



Fundamental, third and fifth overtones.
Necessary pre-ageing can be calculated using Fig.10.

Fig.11 Typical frequency ageing as a function of time at 25 °C, **without pre-ageing of crystals.**

TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with IEC publication 68-2, *"Recommended basic climatic and mechanical robustness testing procedure for electronic components"* and IEC publication 1178-1, *"Generic specification for quartz crystal units"*.

Table 3 Test procedures and requirements; note 1

IEC 68-2 METHOD	TEST	PROCEDURE	REQUIREMENTS
Ba	ageing	1000 hours at 70 °C	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Db	accelerated damp heat	+25 to +55 °C; 6 cycles at RH >95%	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Ea	shock; note 2	100 g; half sinewave; 6 directions; 1 blow/direction	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Eb	bump; note 2	4000 bumps of 40 g	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Ed	free fall; note 2	3 times on hard wood; for height of fall (h) see Table 4	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Fc	vibration	frequency 10 to 500 to 10 Hz; acceleration 10 g; 3 directions; 30 minutes/direction	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Na	temperature cycling test	−40 to +85 °C; 10 cycles; 0.1 hour/cycle	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Q	sealing (method 1)	16 hours; 700 kPa He	$<1 \times 10^{-8}$ ncc/s He
Ta	solderability	235 ±5 °C; 2 ±0.5 s; flux 600 (activated); optional steam pre-heat 8 hours. This reflects at least 36 months of storage at room conditions	≥90%, except for 1 mm from body; no visible damage, no leaks
Tb	resistance to reflow soldering	rise 10 K/s; dwell 2 min/160 °C; rise 10 K/s up to 280 °C; cool down	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater

IEC 68-2 METHOD	TEST	PROCEDURE	REQUIREMENTS
Other applicable tests			
Xa	resistance to solvents; note 3: Bio-Act EC7®; Neutropon P3® and Saxin P3®; Meta Clean 820®; Lonco 446®; Isopropanol cleaning solvent; Dowanol DPM® (glass crystals only)	in accordance with *"IEC 68-2-45"*, *"IEC 653"* (immersion time 5 minutes) and *"MIL 202 E215"*. At ambient temperature and ultrasonic frequency (40 kHz)	no degradation of marking

Notes

1. Test table including MIL-specs (*"MIL-Std 883"* and *"MIL-Std 202"*) can be provided upon request.
2. Mechanical tests to be performed on units clamped to a printed-circuit board for the total unit height.
3. Bio-Act is a registered trademark of Petroform.
   Neutropon P3 and Saxin P3 are registered trademarks of Henkel.
   Meta Clean 820 is a registered trademark of Mavom.
   Lonco 447 is a registered trademark of London Chemical Co.
   Dowanol DPM is a registered trademark of Dow Chemical.

Table 4 Height of fall

h (mm)	PRODUCT LENGTH (mm)	FREQUENCY RANGE[1] (MHz)	
		FUNDAMENTAL MODE	THIRD OVERTONE
750	10	8.0 to 12.0	24.0 to 36.0
750	12	8.0 to 16.0	24.0 to 48.0
500	10	12.1 to 20.0	36.1 to 60.0
500	12	16.1 to 24.0	48.1 to 75.0
250	10	20.1 to 24.0	60.1 to 75.0

Note

1. Standard values. Actual designs can be made to obtain higher or lower values.

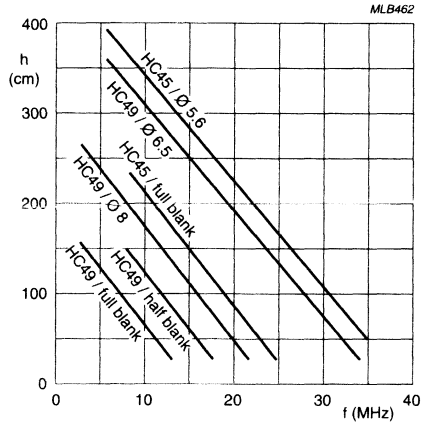


Fig.12 Typical height of fall values (3× on hard wood) for various quartz blank and holder combinations. 'Full' and 'half' blanks refer to rectangular quartz designs; '∅' designates circular quartz designs and the appropriate diameter.

Quartz crystals - general applications HC-49/U

9922 520 0/3.... series

FEATURES

- The units are mass produced on an automatic production line which guarantees a high level of reliability as well as a high level of uniformity. The quartz design yields low resistance and high pullability values.
- The units are available in several styles and packaging methods.

APPLICATIONS

- TV colour decoders
- TV teletext
- TV digital sound
- Video cassette recorders (VCR)
- Audio
- CD players
- CDI players
- DCC players
- Telephony
- Domestic appliance control
- Microprocessors
- Traffic control
- Weather balloons
- Medical systems
- Military applications
- Communication systems
- Agrarian applications
- Machine control
- Environmental applications.

DESCRIPTION

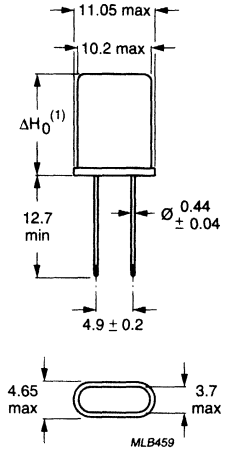
The unit consists of a silver-plated AT-cut quartz plate, encapsulated in a nitrogen-filled metal holder. The holder is hermetically sealed by resistance-welding and provided with connecting leads (HC-49/U).

QUICK REFERENCE DATA

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT
f_{nom}	nominal frequency:				
	fundamental mode	1.8	–	27.0	MHz
	third overtone	20.0	–	75.0	MHz
	fifth overtone	75.0	–	125.0	MHz
	seventh overtone	125.0	–	175.0	MHz
$\Delta f/f_{nom}$	adjustment tolerance	±10	±30	–	ppm
$\Delta f/f_{25}$	frequency stability over temperature range from −20 to +70 °C with respect to T_{amb} = 25 °C	–	±30	–	ppm
C_1	motional capacitance tolerance	10	–	–	%
C_0	parallel capacitance tolerance	10	–	–	%
$\Delta f/f$	ageing over 10 years at 25 °C	±5	–	±10	ppm

MECHANICAL DATA

Package and box outlines



Dimensions in mm.
Dimensions without (optional) vinyl shrink sleeve.
(1) For ΔH_0 see Table 1.

Fig.1 Style 1: HC-49/U in box.

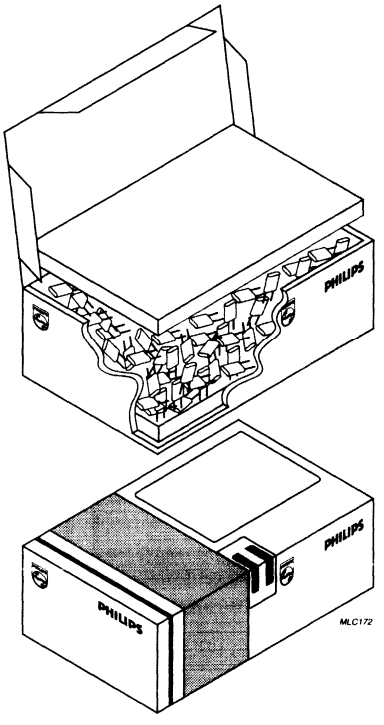


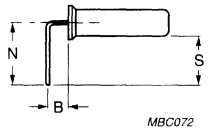
Fig.2 Box outline.

Table 1 Product height; notes 1 and 2

MAXIMUM PRODUCT HEIGHT ΔH_0 (mm)	FREQUENCY RANGE (MHz)	
	FUNDAMENTAL MODE	THIRD OVERTONE
9.6	8.0 to 27.0	24.0 to 75.0
11.0	8.0 to 27.0	24.0 to 75.0
13.4	all frequencies	

Notes

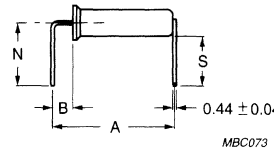
1. Available lead length: up to 13 mm.
2. Lead length tolerance (for Style 1):
   a) $H_2 > 3$ mm: ±0.5 mm
   b) $H_2 \leq 3$ mm: ±0.2 mm.



Dimensions in mm.

STYLE 4	N	B	S
a	7.0 ±0.6	2.5 ±0.6	5.2 ±0.6
b	8.0 ±0.6	2.0 ±0.6	6.2 ±0.6
c	9.7 ±0.6	3.0 ±0.6	7.9 ±0.6

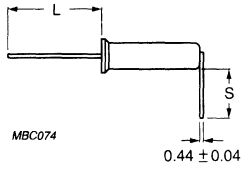
Fig.3 Style 4: HC-49/U on tray in box.



The third lead is symmetric, ±0.5 mm with respect to the other leads.
Dimensions in mm.

STYLE 5	N	B	A	S
a	5.7 ±1.0	1.5	15.2 ±0.2	3.9 ±1.0
b	5.9 ±1.0	4.1	17.8 ±0.2	4.1 ±1.0
c	10.2 ±1.0	3.3	16.5 ±0.2	8.4 ±1.0
d	5.7 ±1.0	1.9	15.6 ±0.2	3.9 ±1.0

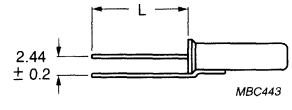
Fig.4 Style 5: HC-49/U on tray in box.



The third lead is symmetric, ±0.5 mm with respect to the other leads.
Dimensions in mm.

STYLE 6	L	S
a	13.2 ±0.5	4.5 ±1.0
b	13.2 ±0.5	10.0 ±1.0
c	5.0 ±0.5	19.5 ±1.0
d	13.2 ±0.5	19.5 ±1.0

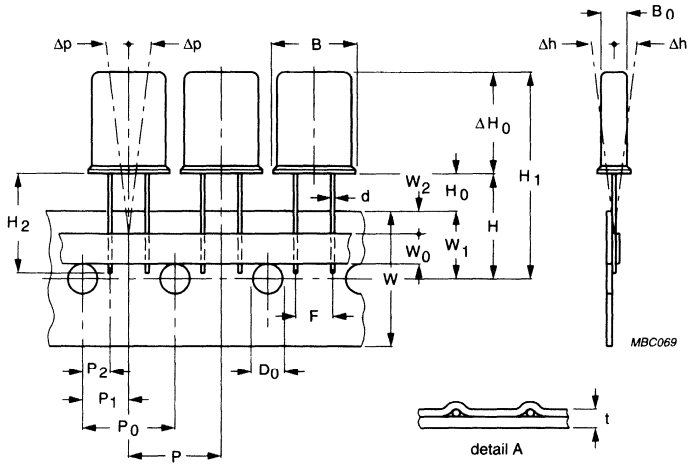
Fig.5 Style 6: HC-49/U on tray in box.



L: min. 12.7 mm; max. 13.0 mm.
The third lead is symmetric, ±0.5 mm with respect to the other leads.
Dimensions in mm.

Fig.6 Style 7: HC-49/U on tray in box.

Taping data

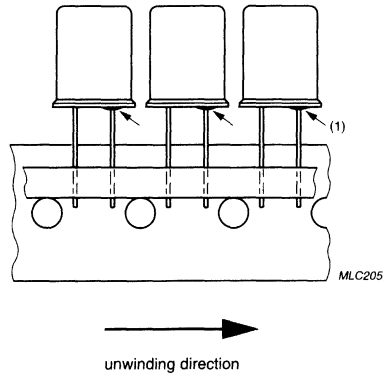


For dimensions see Table 2.

Fig.7 Style 2: HC-49/U on tape.

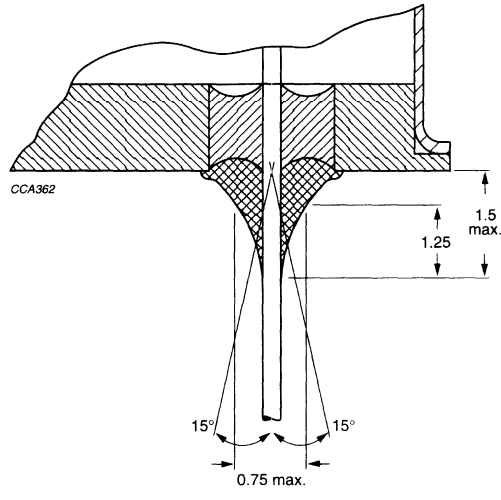
Table 2 Taping dimensions (without the insulation plate) in accordance with *"IEC 286-2"*; see Fig.7

SYMBOL	PARAMETER	VALUE	TOLERANCE	UNIT
B_0	body thickness	4.43	±0.05	mm
B	body width	10.75	±0.1	mm
Δh	component alignment vertical to tape plane	–	±2	mm
Δp	component alignment in tape plane	–	±1.3	mm
d	lead wire diameter	0.44	±0.04	mm
F	lead-to-lead	4.9	–	mm
P	pitch of components	12.7	±1	mm
P_0	feed-hole pitch	12.7	±0.3	mm
P_2	feed-hole centre to lead	3.9	±0.7	mm
P_1	feed-hole centre to component centre	6.35	±0.3	mm
D_0	feed-hole diameter	4.0	±0.2	mm
H	distance of component from tape centre, option	16.0/18.5	+2/0	mm
H_0	minimum component base to tape top	7.0	–	mm
H_2	lead length	12.7	±0.5	mm
W	carrier tape width	18.0	+1/–0.5	mm
W_0	maximum hold-down tape width, option	7.0/13.0	–	mm
W_1	feed-hole position	9.0	+0.75/–0.5	mm
W_2	maximum hold-down tape position	3.0	–	mm
t	maximum total tape thickness	0.9	–	mm



Style 11a is taped in ammopack; see Fig.10.
Style 11b is taped on reel; see Fig.11.
(1) Lead connected to metal case.

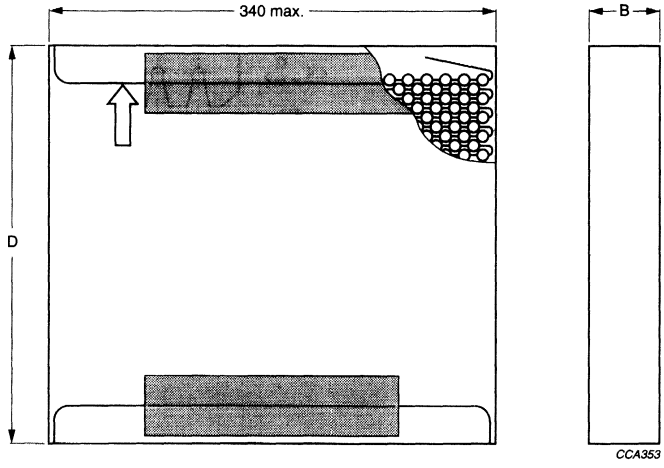
Fig.8 Style 11 taped units with one lead connected to case, otherwise as Style 2 (see Fig.7).



Dimensions in mm.
The electrical resistance shall be <5 Ω after 2 times 15° bending of the lead.
Coverage of glass bead by silver adhesive is a minimum of 40%.

Fig.9 Detailed drawing of the connection between the lead and base.

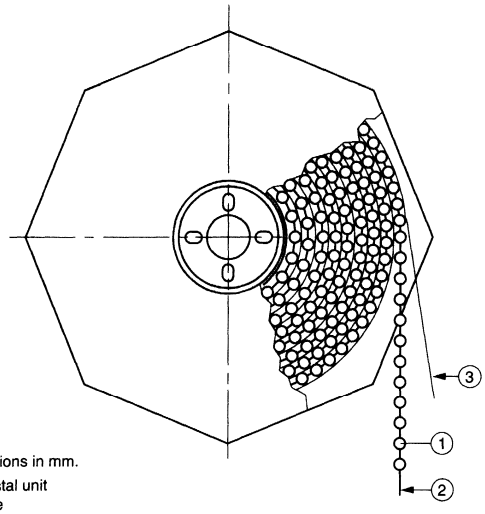
Ammopack and reel data

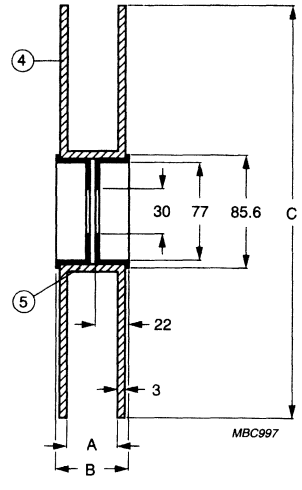


Dimensions in mm.
B = 46 mm max.
D = 185 mm max.

Style 3a is with insulation plate; see Fig.12.

Fig.10 Style 2a, 3a and 11a units on tape in ammopack.





Dimensions in mm.

1 = crystal unit
2 = tape
3 = paper
4 = flange
5 = cylinder

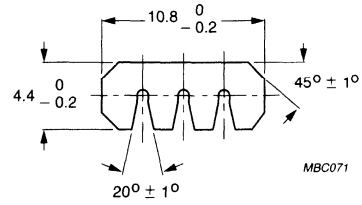
A = 45 mm
B = 55 mm max.
C = 355 mm max.

Style 3b is with insulation plate; see Fig.12.

Fig.11 Style 2b, 3b and 11b units on tape on reel.

Insulation plate

Style 3 units are equipped with an insulation plate (see Fig.12) at the unit base. The insulation plate is made of PEEK (polyetherketone) in 0.25 mm thickness and resistant to soldering heat tests.



Dimensions in mm.

Fig.12 Insulation plate outline for Style 3.

PACKAGING AND QUANTITIES

Table 3 HC-49/U holder

STYLE	PACKAGING	QUANTITY	DIMENSIONS OF BOX (mm)		
			LENGTH	WIDTH	HEIGHT
1	in box	maximum 1000 units per box	200	125	70
	in blister	24 units per blister, 8 blisters per box			
	on tray in box	100 units per tray, 1 or 10 trays in box			
2a, 3a and 11a	on tape in ammopack	1000 units per pack, in box	340	185	46
2b, 3b and 11b	on tape on reel	1000 units per reel, in box	361	367	61
4, 5, 6, 7	on tray in box	100 units per tray per box	380	90	168
5c	on tray in box	50 units per tray, 10 trays per box, minimum 2 boxes	380	90	168

STANDARD MARKING(1)

- Line 1: PHILIPS
- Line 2: frequency in kHz (fundamental mode) or in MHz (overtone)
- Line 3: last five digits of catalogue number followed by the manufacturing date code (last four digits of week code in accordance with the *"Philips Concern calendar system UN-D 1120"*).

MASS AND LEADS

Typical mass: 1.2 g.

The leads are finished with Sn99Cu1 or Sn60Pb40 on a nickel underplate.

The first 1 mm from the body is not guaranteed for soldering.

(1) Special marking on product and/or package is available on request.

ELECTRICAL DATA

Valid at T_{amb} = 25 ±2 °C and a nominal drive level of 100 μW into 25 Ω unless otherwise specified. Measuring system: π-network in accordance with *"IEC 444"* recommendations.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
f_{nom}	nominal frequency	fundamental	1.8	–	27.0	MHz
		third overtone	20.0	–	75.0	MHz
		fifth overtone	75.0	–	125.0	MHz
		seventh overtone	125.0	–	175.0	MHz
$\Delta f/f_{nom}$	adjustment tolerance	see note 1	±10	±30	–	ppm
R_r	resonance resistance	see notes 1 and 2	see Figs 13 and 16			Ω
C_L	load capacitance	see note 1	5	20	∞	pF
T_{oper}	operating temperature	see note 1	–40	–	+130	°C
T_{op}	operable temperature		–40	–	+155	°C
$\Delta f/f_{25}$	frequency stability over temperature range, with respect to T_{amb} = 25 °C	see note 1	see Table 4			ppm
R_r (T)	resonance resistance over temperature range	see notes 1 and 2	available from R_r upwards			Ω
C_1	motional capacitance	see note 1	see Figs 14 and 17			fF
	tolerance		±10	–	–	%
C_0	parallel capacitance	see note 1	see Figs 15 and 18			pF
	tolerance		±10	–	–	%
$\Delta f/f$	ageing	10 years at 25 °C; see Figs 19 and 20	±5	–	10	ppm

Notes

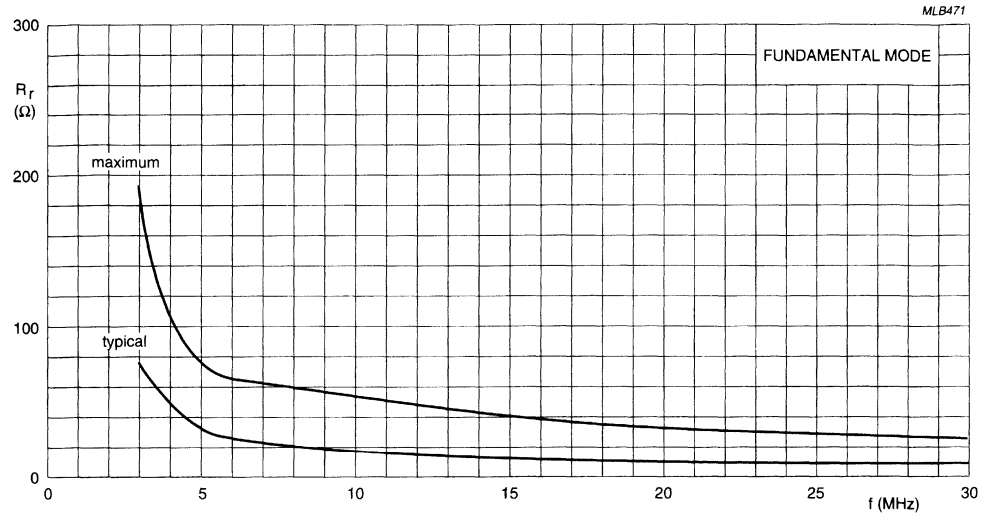
1. Values available on request.
2. All resistance values are measured in series resonance, load resonance measurement available on request.

Table 4 Frequency stability with temperature variation

TEMPERATURE RANGE[1] (°C)	MAX. FREQUENCY STABILITY (ppm)	
	CLASS 2 (best available values)	DEFAULT
+20/+30	±2.0	±4
0/+50	±10.0	±20
–10/+60	±15.0	±25
–20/+70	±20.0	±30
–30/+80	±25.0	±40
–40/+90	±30.0	±55
–55/+105	±40.0	±80
–40/+130	±80.0	–

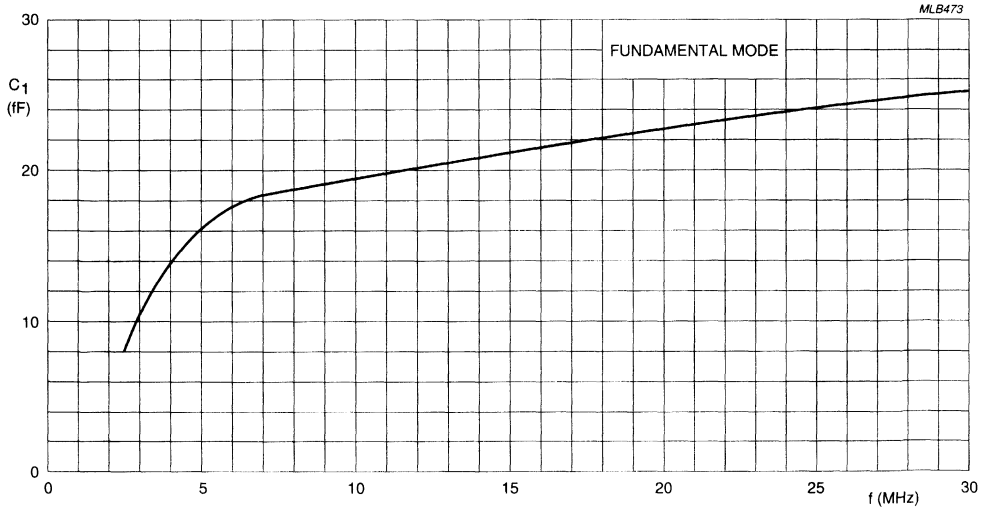
Note

1. To obtain the same stability at frequencies below 8.0 MHz, the upper temperature limit is 10 °C lower.



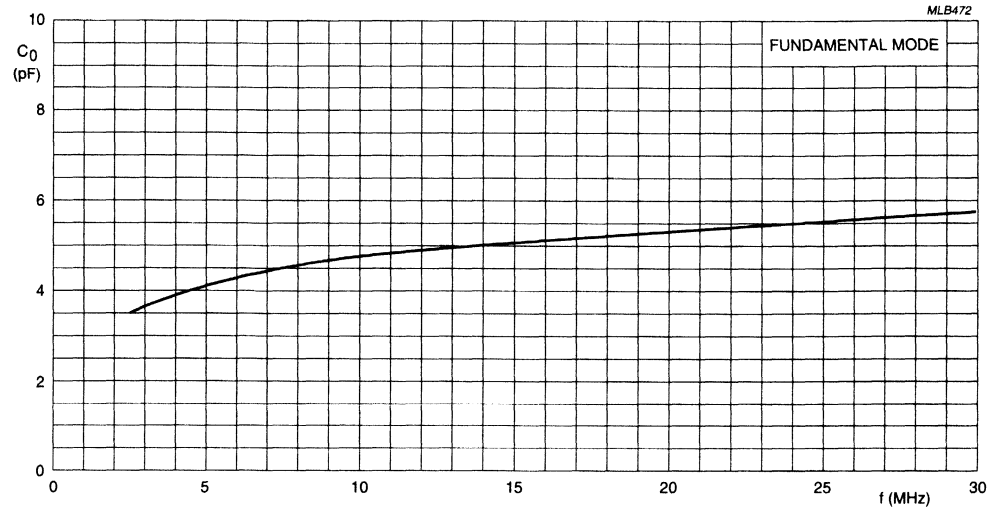
HC-49/U in the fundamental mode.
Values at 25 °C.

Fig.13 Resonance resistance R_r as a function of resonance frequency.



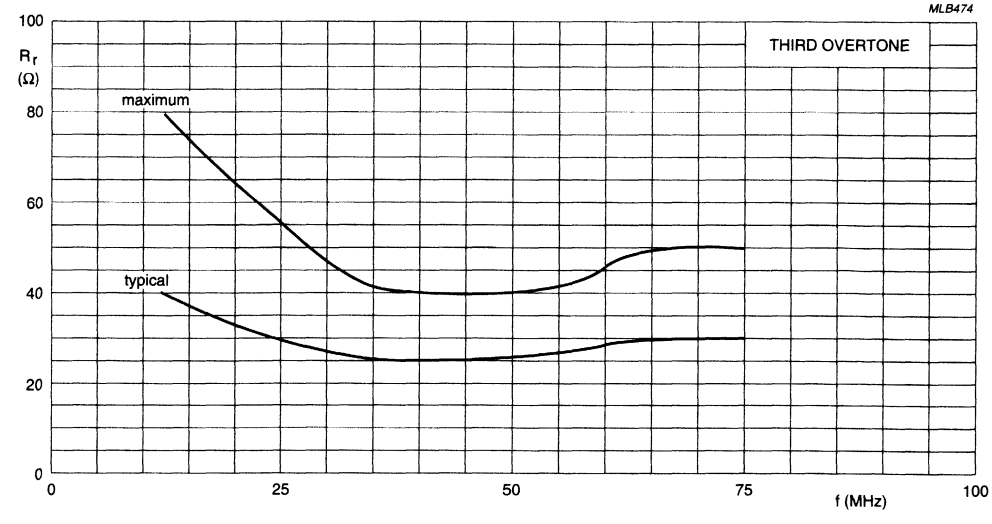
HC-49/U in the fundamental mode.
Typical values at 25 °C.

Fig.14 Motional capacitance C_1 as a function of resonance frequency.



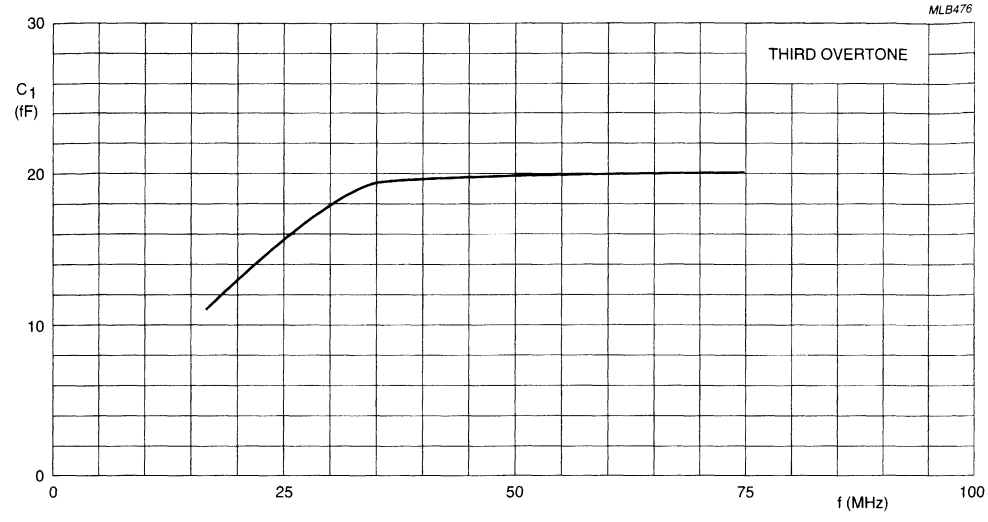
HC-49/U in the fundamental mode.
Typical values at 25 °C.

Fig.15 Parallel capacitance C_0 as a function of resonance frequency.



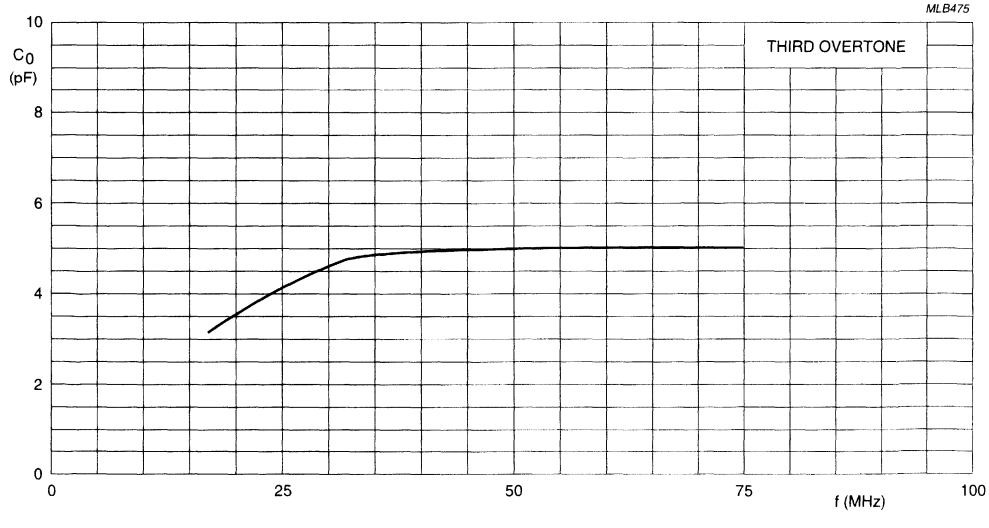
HC-49/U in the third overtone.
Values at 25 °C.

Fig.16 Resonance resistance R_r as a function of resonance frequency.



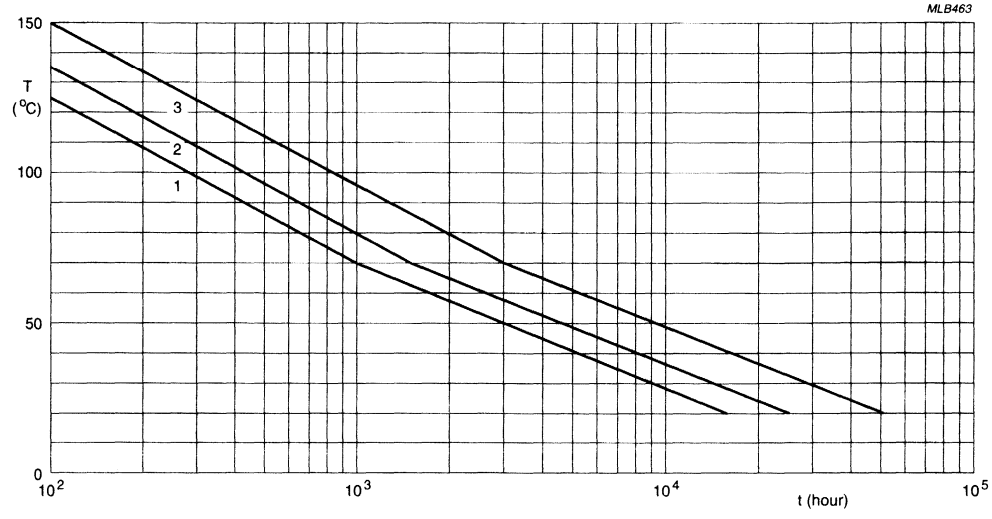
HC-49/U in the third overtone.
Typical values at 25 °C.

Fig.17 Motional capacitance C_1 as a function of resonance frequency.



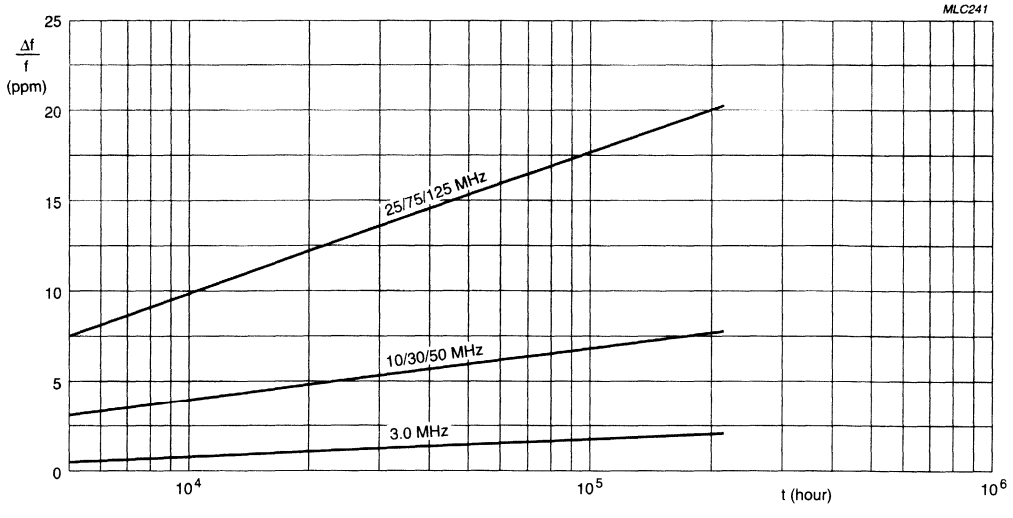
HC-49/U in the third overtone.
Typical values at 25 °C.

Fig.18 Parallel capacitance C_0 as a function of resonance frequency.



Curve 1 = 1000 hours at 70 °C.
Curve 2 = 720 hours at 85 °C.
Curve 3 = 240 hours at 130 °C.

Fig.19 Time/temperature relation at which ageing is approximately equivalent.



Fundamental, third and fifth overtones.
Necessary pre-ageing can be calculated using Fig.19.

Fig.20 Typical frequency ageing as a function of time at 25 °C, **without pre-ageing of crystals.**

TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with IEC publication 68-2, *"Recommended basic climatic and mechanical robustness testing procedure for electronic components"* and IEC publication 1178-1, *"Generic specification for quartz crystal units"*.

Table 5 Test procedures and requirements; note 1

IEC 68-2 METHOD	TEST	PROCEDURE	REQUIREMENTS
Ba	ageing	1000 hours at 70 °C	$\Delta f/f \leq \pm 5$ ppm
Db	accelerated damp heat	+25 to +55 °C; 6 cycles at RH >95%	$\Delta f/f \leq \pm 5$ ppm $\Delta R_r \pm 5\ \Omega$ or ±20% whichever is the greater
Ea	shock	100 g; half sinewave; 6 directions; 1 blow/direction	$\Delta f/f \leq \pm 5$ ppm $\Delta R_r \pm 5\ \Omega$ or ±20% whichever is the greater
Eb	bump	4000 bumps of 40 g	$\Delta f/f \leq \pm 5$ ppm $\Delta R_r \pm 5\ \Omega$ or ±20% whichever is the greater
Ed	free fall	3 times on hard wood; for height of fall (h) see Table 6	$\Delta f/f \leq \pm 5$ ppm $\Delta R_r \pm 5\ \Omega$ or ±20% whichever is the greater
Fc	vibration	frequency 10 to 500 to 10 Hz; acceleration 10 g; 3 directions; 30 minutes/direction	$\Delta f/f \leq \pm 5$ ppm $\Delta R_r \pm 5\ \Omega$ or ±20% whichever is the greater
Na	temperature cycling test	−40 to +85 °C; 10 cycles; 0.1 hour/cycle	$\Delta f/f \leq \pm 5$ ppm $\Delta R_r \pm 5\ \Omega$ or ±20% whichever is the greater
Q	sealing (method 1)	16 hours; 700 kPa He	$<1 \times 10^{-8}$ ncc/s He
Ta	solderability	235 ±5 °C; 2 ±0.5 s; flux 600 (activated); option: steam pre-heat for 8 hours. This reflects at least 36 months of storage at room temperature	≥90%, except for 1 mm from body; no visible damage, no leaks
Tb	resistance to soldering heat	350 ±5 °C; 3.5 ±0.5 s	$\Delta f/f \leq \pm 5$ ppm $\Delta R_r \pm 5\ \Omega$ or ±20% whichever is the greater
Ub	bending of leads	1 × 90°; 5 N	no visible damage

IEC 68-2 METHOD	TEST	PROCEDURE	REQUIREMENTS
Other applicable tests			
Xa	resistance to solvents; note 2: Bio-Act EC7®; Neutropon P3® and Saxin P3®; Meta Clean 820®; Lonco 446®; Isopropanol cleaning solvent; Dowanol DPM® (glass crystals only)	in accordance with *"IEC 68-2-45"*, *"IEC 653"* (immersion time 5 minutes) and *"MIL 202 E215"*. At ambient temperature and ultrasonic frequency (40 kHz)	no degradation of marking

Notes

1. Test table including MIL-specs (*"MIL-Std 883"* and *"MIL-Std 202"*) can be provided upon request.
2. Bio-Act is a registered trademark of Petroform.
   Neutropon P3 and Saxin P3 are registered trademarks of Henkel.
   Meta Clean 820 is a registered trademark of Mavom.
   Lonco 447 is a registered trademark of London Chemical Co.
   Dowanol DPM is a registered trademark of Dow Chemical.

Table 6 Height of fall

h (mm)	FREQUENCY RANGE[1] (MHz)	
	FUNDAMENTAL MODE	THIRD OVERTONE
750	1.8 to 7.5	20.00 to 22.5
500	7.51 to 10.0	22.51 to 30.0
250	10.10 to 27.0	30.10 to 75.0

Note

1. Standard values. Actual designs can be made to obtain higher or lower values.

PREFERRED TYPES

Table 7 Preferred type list for standard crystals in a HC-49/U holder

FREQUENCY (kHz)	CATALOGUE NUMBER (12NC)	LOAD CAPACITANCE (C_L) (pF)	APPLICATION	RELATED ICs
3575.611	9922 520 00383	series	one-chip colour decoder PAL-M	TDA836X
3575.611	9922 520 00413	18.0	BCTV video processor PAL-M	TDA91XX
3579.545	9922 520 00382	series	one-chip colour decoder NTSC	TDA836X
3579.545	9922 520 00412	18.0	BCTV video processor NTSC	TDA91XX
3582.056	9922 520 00381	series	one-chip colour decoder PAL-M	TDA836X
3582.056	9922 520 00411	18.0	BCTV video processor PAL-M	TDA91XX
4000.000	4322 143 04093	30.0	digital tuning; general purpose	TSA6060
4194.304	4322 143 04073	11.4	car locks	PCF117XC
4433.619	9922 520 00384	series	one-chip colour decoder PAL B/G	TDA836X
4433.619	4322 143 04043	20.0	colour encoder PAL B/G	TDA8501
4433.619	9922 520 00414	18.0	BCTV video processor PAL B/G	TDA91XX
6000.000	4322 143 04101	20.0	teletext video processor	SAA5231/5243
7159.090	4322 143 04181	20.0	colour decoder NTSC	TDA3566A
8192.000	9922 520 00193	15.0	one-chip NICAM stereo sound decoder	SAA7283
8867.238	4322 143 04051	20.0	colour decoder PAL B/G	TDA3566A
10000.000	9922 520 00429	20.0	TV stereo/dual sound processor I^2C	TDA8415/16/17
11700.000	9922 520 00203	15.0	one-chip NICAM stereo sound decoder	SAA7283
12000.000	9922 520 00076	20.0	general purpose, microprocessor	
13104.000	9922 520 00202	15.0	one-chip NICAM stereo sound decoder	SAA7283
13875.000	4322 143 05331	20.0	teletext video processor	SAA5191/5231
24576.000	9922 520 30009	8.0	digital CCIR decoder	
26800.000	9922 520 30004	8.0	digital square pixel decoder	
27000.000	9922 520 30003	20.0	VIP teletext	SAA5246A

Quartz crystals - general applications HC-49/L and HC-49/S

9922 520 2/6.... series

FEATURES

- Ultra low profile (height 3.5 and 2.5 mm) which allows for a very compact design of equipment
- Manufactured in a clean-room environment on a highly automated production line with a high level of reliability and uniformity.

  This results in very low belt and field reject levels and a low DLD (start-up resistance). It contributes to a consistent product quality level in applications that incorporate these crystals.
- Available in several styles and packaging methods to fit in most assembly environments.

APPLICATIONS

- E.D.P.
- Mobile telecom
- Audio/Video
- Portable equipment.

DESCRIPTION

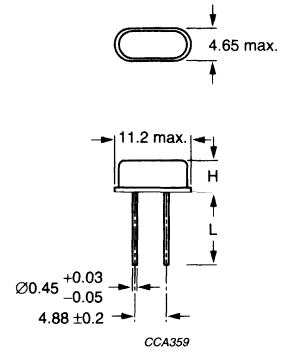
The unit consists of a silver-plated AT-cut quartz strip, encapsulated in a nitrogen-filled metal holder. The low profile holder is hermetically sealed by resistance-welding and provided with connecting leads.

QUICK REFERENCE DATA

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT
f_{nom}	nominal frequency range:				
	fundamental mode AT	3.5	–	28.0	MHz
	fundamental mode BT	26.0	–	50.0	MHz
	third overtone AT	29.0	–	66.0	MHz
T_{oper}	operating temperature	–40	–	+85	°C
T_{op}	operable temperature	–40	–	+125	°C
$\Delta f/f_{nom}$	adjustment tolerance	±15	±50	–	ppm
$\Delta f/f_{25}$	frequency stability over temperature range: –20 to +70 °C with respect to T_{amb} = 25 ±2 °C	±10	±50	–	ppm
C_1	motional capacitance tolerance	±20	–	–	%
C_0	parallel capacitance tolerance	±20	–	–	%
$\Delta f/f$	ageing over 10 years at 25 °C	±5	–	±10	ppm

MECHANICAL DATA

Package and box outlines



Dimensions in mm.
(1) For ΔH_0 see Table 1.

Fig.1 Style 1: HC-49/L in box.

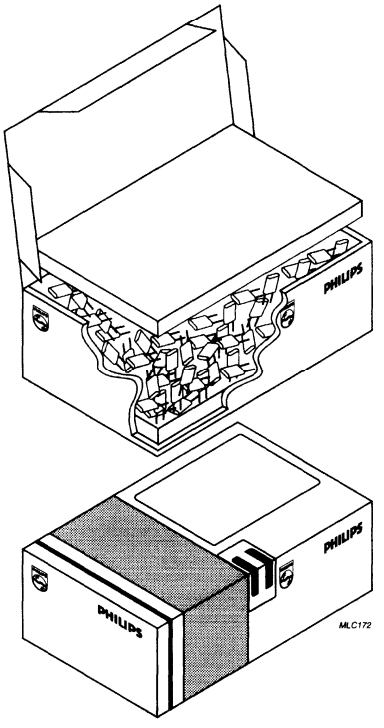


Fig.2 Box outline.

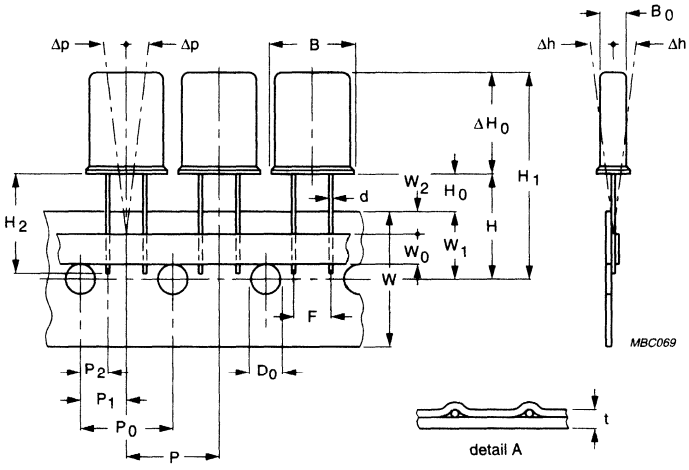
Table 1 Product height; notes 1 and 2

MAXIMUM PRODUCT HEIGHT ΔH_0 (mm)	MINIMUM FREQUENCY (MHz)	
	FUNDAMENTAL MODE	THIRD OVERTONE
2.5 (for type HC-49/L)	7.3 to 50.0	29.0 to 66.0
3.5 (for type HC-49/S)	3.5 to 50.0	26.0 to 66.0

Notes

1. Available lead length from 0.5 mm up to 20.0 mm.
2. Lead length tolerance:
   a) Lead length L < 3.0 mm: ±0.2 mm
   b) Lead length L from 3.0 to 13.0 mm: ±0.5 mm
   c) Lead length L 20.0 mm: ±1.0 mm.

Taping data

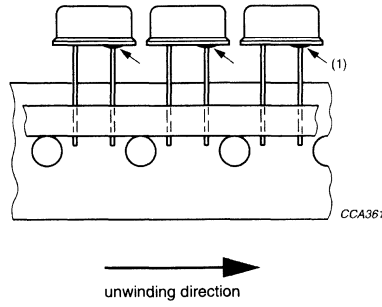


For dimensions see Table 2.

Fig.3 Style 2a and 2b: HC-49/L and HC-49/S on tape.

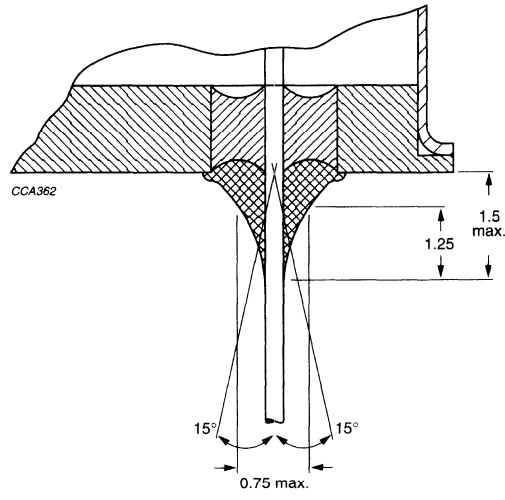
Table 2 Taping dimensions (without the insulation plate) in accordance with *"IEC 286-2"*; see Fig.3

SYMBOL	PARAMETER	VALUE	TOLERANCE	UNIT
B_0	maximum body thickness	4.65	–	mm
B	body width	11.2	–	mm
Δh	component alignment vertical to tape plane	–	±2.0	mm
Δp	component alignment in tape plane	–	±1.3	mm
d	lead wire diameter	0.44	±0.04	mm
F	lead-to-lead	4.9	–	mm
P	pitch of components	12.7	±1.0	mm
P_0	feed-hole pitch	12.7	±0.3	mm
P_2	feed-hole centre to lead	3.9	±0.7	mm
P_1	feed-hole centre to component centre	6.35	±0.3	mm
D_0	feed-hole diameter	4.0	±0.2	mm
H	distance of component from tape centre	18.0	+2/0	mm
H_0	minimum component base to tape top	9.0	–	mm
H_2	lead length	20.0	±0.5	mm
W	carrier tape width	18.0	+1/–0.5	mm
W_0	maximum hold-down tape width, options	7.0/13.0	–	mm
W_1	feed-hole position	9.0	+0.75/–0.5	mm
W_2	maximum hold-down tape position	3.0	–	mm
t	maximum total tape thickness	0.9	–	mm



Style 11a is taped in ammopack; see Fig.6.
Style 11b is taped on reel; see Fig.7.
(1) Lead connected to metal case.

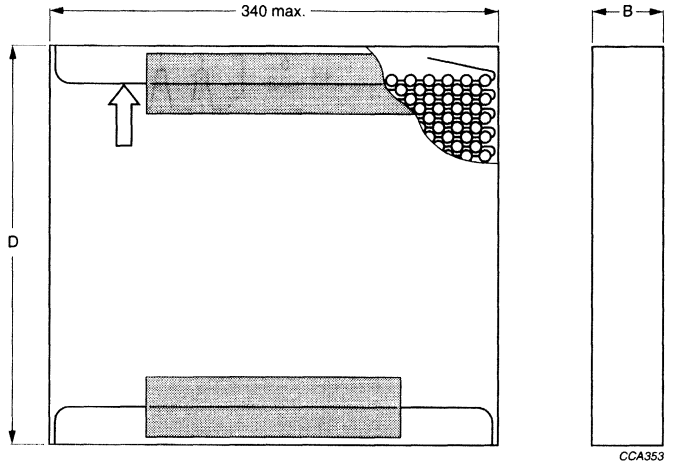
Fig.4 Style 11 taped units with one lead connected to case, otherwise as Style 2 (see Fig.3).



Dimensions in mm.
The electrical resistance shall be <5 Ω after 2 times 15° bending of the lead.
Coverage of glass bead by silver adhesive is a minimum of 40%.

Fig.5 Detailed drawing of the connection between the lead and base.

Ammopack and reel data

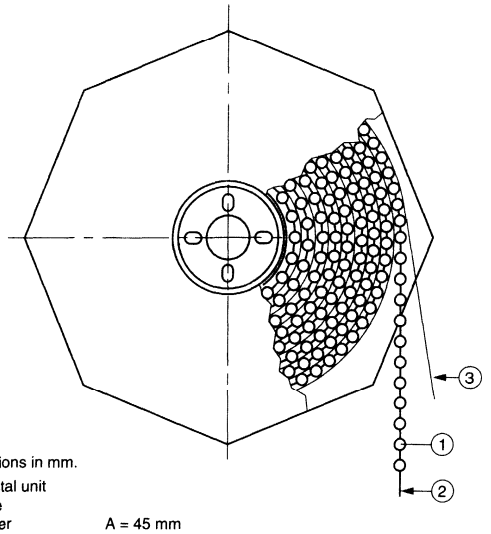


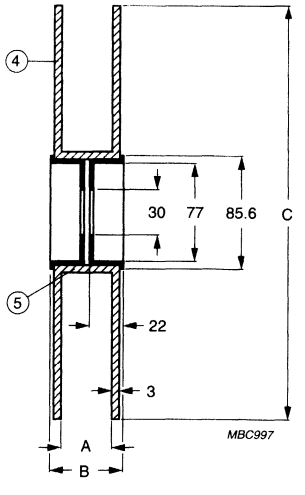
Dimensions in mm.

B = 46 mm max.
D = 185 mm max.

Style 3a is with insulation plate; see Fig.8.

Fig.6 Style 2a, 3a and 11a units on tape in ammopack.





Dimensions in mm.

1 = crystal unit
2 = tape
3 = paper
4 = flange
5 = cylinder

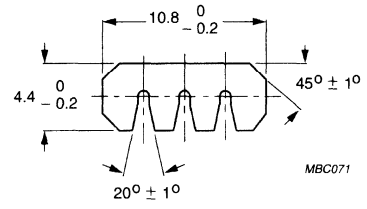
A = 45 mm
B = 55 mm max.
C = 355 mm max.

Style 3b is with insulation plate; see Fig.8.

Fig.7 Style 2b, 3b and 11b units on tape on reel.

Insulation plate

Style 3 units are equipped with an insulation plate (see Fig.8) at the unit base. The insulation plate is made of PEEK (polyetherketone) in 0.25 mm thickness and resistant to soldering heat tests.



Dimensions in mm.

Fig.8 Insulation plate outline for Style 3.

PACKAGING AND QUANTITIES

Table 3 HC-49/L holder

STYLE	PACKAGING	QUANTITY	DIMENSIONS OF BOX (mm)		
			LENGTH	WIDTH	HEIGHT
1	in box	maximum 1000 units per box	200	125	70
	in blister	24 units per blister, 8 blisters per box	315	155	67
2a, 3a and 11a	on tape in ammopack	1000 units per pack, in box	340	185	46
2b, 3b and 11b	on tape on reel	1000 units per reel, in box	361	61	367

STANDARD MARKING(1)

- Line 1: frequency in kHz (fundamental mode) or in MHz (overtone); PH
- LIne 2: last five digits of catalogue number followed by the manufacturing date code (last four digits of week code in accordance with UN-D1120).

MASS AND LEADS

Typical mass: 0.8 g.

The leads are finished with Sn60Pb40 on a nickel underplate.

The first 1 mm from the body is not guaranteed for soldering.

(1) Special marking on product and/or package is available on request.

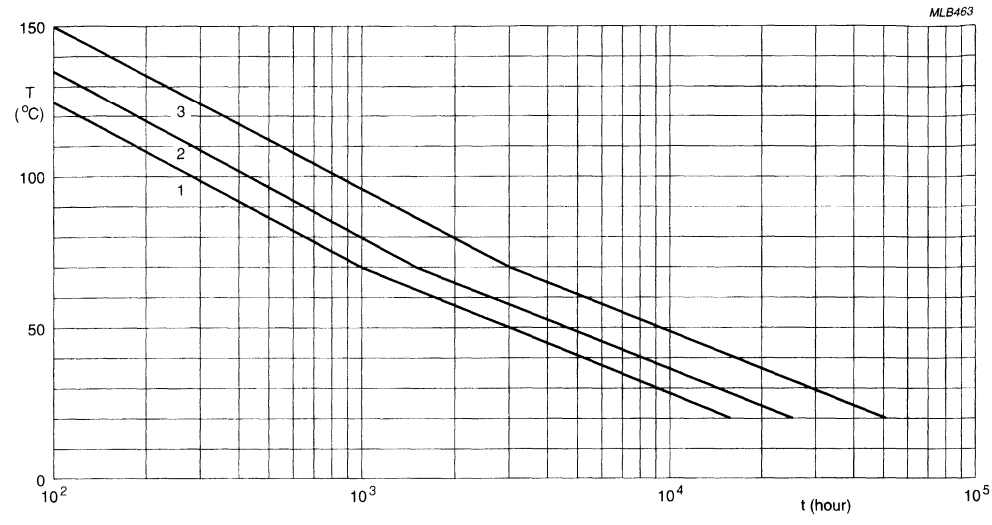
ELECTRICAL DATA

Valid at an ambient temperature T_{amb} = 25 ±2 °C and a nominal drive level of 100 µW into 25 Ω unless otherwise specified. Measuring system: π-network in accordance with *"IEC 444"* recommendations.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
f_{nom}	nominal frequency; note 1	fundamental (AT-cut)	3.5	–	28.0	MHz
		fundamental (BT-cut)	26.0	–	50.0	MHz
		third overtone (AT-cut)	29.0	–	66.0	MHz
$\Delta f/f_{nom}$	adjustment tolerance	see specific 12NC	–	±50	–	ppm
R_r	resonance resistance	see note 2	–	–	–	Ω
C_L	load capacitance	see note 2	5	–	∞	pF
T_{oper}	operating temperature	see specific 12NC	–40	–	+85	°C
T_{op}	operable temperature		–40	–	+125	°C
$\Delta f/f_{25}$	frequency stability over temperature range, with respect to T_{amb} = 25 °C	see notes 2 and 3	±10	±50	–	ppm
R_r (T)	resonance resistance over temperature range	see note 2	available from R_r upwards			Ω
C_1	motional capacitance	see specific 12NC	–	–	–	fF
	tolerance		±20	–	–	%
C_o	parallel capacitance	see specific 12NC	–	–	7	pF
	tolerance		±20		–	%
$\Delta f/f$	ageing	10 years at T_{amb} = 25 °C	±5	–	±10	ppm
R_{ins}	insulation resistance	DC test voltage = 100 V	500	–	–	MΩ

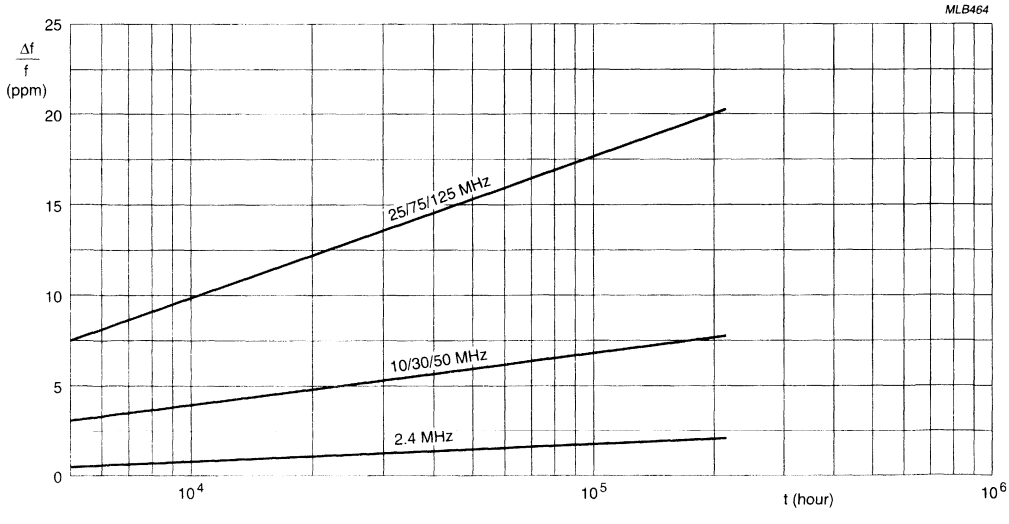
Notes

1. A specific value should be chosen within the given range.
2. All resistance values are measured in series resonance:
   a) See specific 12NC for actual values.
   b) Load resonance measurement is available on request.
3. Frequency measurement in temperature range is performed in series resonance if not requested otherwise:
   a) See specific 12NC for actual values.
   b) BT-cuts have a frequency stability of +0 to –100 ppm from –20 °C to +70 °C.



Curve 1 = 1000 hours at 70 °C.
Curve 2 = 720 hours at 85 °C.
Curve 3 = 240 hours at 130 °C.

Fig.9 Time/temperature relation at which ageing is approximately equivalent.



Fundamental, third and fifth overtones.
Necessary pre-ageing can be calculated using Fig.9.

Fig.10 Typical frequency ageing as a function of time at 25 °C, **without pre-ageing of crystals.**

TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with IEC publication 68-2, *"Recommended basic climatic and mechanical robustness testing procedure for electronic components"* and IEC publication 1178-1, *"Generic specification for quartz crystal units"*.

Table 4 Test procedures and requirements; note 1

IEC 68-2 METHOD	TEST	PROCEDURE	REQUIREMENTS
Ba	ageing	1000 hours at 70 °C	$\Delta f/f \leq \pm 5$ ppm
Db	accelerated damp heat	+25 to +55 °C; 6 cycles at RH >95%	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Ea	shock	100 g; half sinewave; 6 directions; 1 blow/direction	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Eb	bump	4000 bumps of 40 g	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Ed	free fall	3 times on hard wood; for height of fall (h) see Table 5	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Fc	vibration	frequency 10 to 500 to 10 Hz; acceleration 10 g; 3 directions; 30 minutes/direction	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Na	temperature cycling test	−40 to +85 °C; 10 cycles; 0.1 hour/cycle	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Q	sealing (method 1)	16 hours; 700 kPa He	$< 1 \times 10^{-8}$ ncc/s He
Ta	solderability	235 ±5 °C; 2 ±0.5 s; flux 600 (activated)	≥90%, except for 1 mm from body; no visible damage, no leaks
Tb	resistance to soldering heat	350 ±5 °C; 3.5 ±0.5 s	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Ub	bending of terminations	1 × 90°; 5 N	no visible damage, no leaks

IEC 68-2 METHOD	TEST	PROCEDURE	REQUIREMENTS
Other applicable tests			
Xa	resistance to solvents; note 2: Bio-Act EC7®; Neutropon P3® and Saxin P3®; Meta Clean 820®; Lonco 446®; Isopropanol cleaning solvent; Dowanol DPM® (glass crystals only)	in accordance with *"IEC 68-2-45"*, *"IEC 653"* (immersion time 5 minutes) and *"MIL 202 E215"*. At ambient temperature and ultrasonic frequency (40 kHz)	no degradation of marking

Notes

1. Test table including MIL-specs (*"MIL-Std 883"* and *"MIL-Std 202"*) can be provided upon request.
2. Bio-Act is a registered trademark of Petroform.
   Neutropon P3 and Saxin P3 are registered trademarks of Henkel.
   Meta Clean 820 is a registered trademark of Mavom.
   Lonco 447 is a registered trademark of London Chemical Co.
   Dowanol DPM is a registered trademark of Dow Chemical.

Table 5 Height of fall

h (mm)	FREQUENCY RANGE[1] (MHz)		
	FUNDAMENTAL MODE	THIRD OVERTONE	FIFTH OVERTONE
750	2.4 to 16.0	20.0 to 48.0	50.0 to 80.0
500	16.1 to 27.0	48.1 to 75.0	80.1 to 125.0

Note

1. Typical values. Actual designs can be made to obtain higher or lower values.

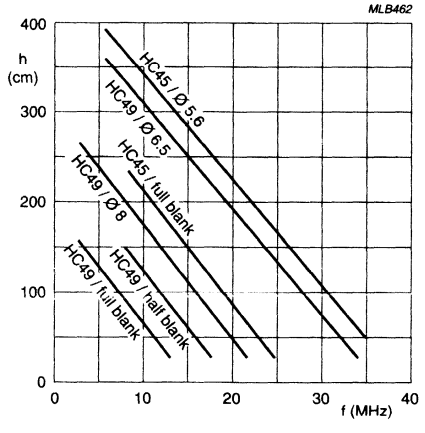


Fig.11 Typical height of fall values (3× on hard wood) for various quartz blank and holder combinations. 'Full' and 'half' blanks refer to rectangular quartz designs; '∅' designates circular quartz designs and the appropriate diameter.

Quartz crystals - general applications HC-45/U

9922 521 0.... series

FEATURES

- Small dimensions
- High mechanical stability
- Automated production line for a high level of uniformity.

APPLICATIONS

- Personal computers
- Microprocessors
- Portable equipment.

DESCRIPTION

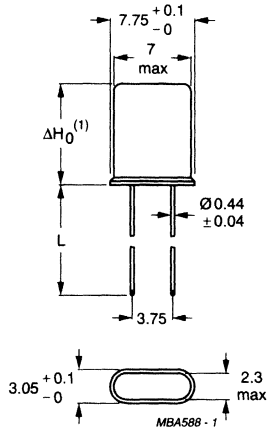
The unit consists of a silver-plated AT-cut quartz plate, encapsulated in a nitrogen-filled metal holder. The holder is hermetically sealed by resistance-welding and provided with two connecting leads.

QUICK REFERENCE DATA

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT
f_{nom}	nominal frequency:				
	fundamental mode	6.0	–	25.0	MHz
	third overtone	24.0	–	80.0	MHz
	fifth overtone	80.0	–	125.0	MHz
	seventh overtone	125.0	–	200.0	MHz
T_{oper}	operating temperature	–40	–	+105	°C
T_{op}	operable temperature	–55	–	+155	°C
$\Delta f/f_{nom}$	adjustment tolerance	± 5	±30	–	ppm
$\Delta f/f_{25}$	frequency stability over temperature range: –20 to +70 °C with respect to T_{amb} = 25 ±2 °C	–	±30	–	ppm
C_1	motional capacitance tolerance	±10	–	–	%
C_0	parallel capacitance tolerance	±10	–	–	%
$\Delta f/f$	ageing over 10 years at 25 °C	±5	–	±10	ppm

MECHANICAL DATA

Package outlines



Dimensions in mm.

(1) For ΔH_0 see Table 1.

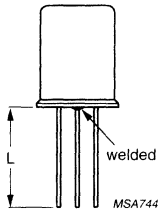
Fig.1 Style 1: HC-45/U in box.

Table 1 Product height and lead length; notes 1 and 2

MAXIMUM HEIGHT ΔH_0 (mm)	MAXIMUM LEAD LENGTH L (mm)	FREQUENCY RANGE (MHz)	
		FUNDAMENTAL MODE	THIRD OVERTONE
6.4	20.0	8.0 to 24.0	32.0 to 70.0
8.0	20.0	6.0 to 25.0	24.0 to 80.0
8.8	20.0	all frequencies	

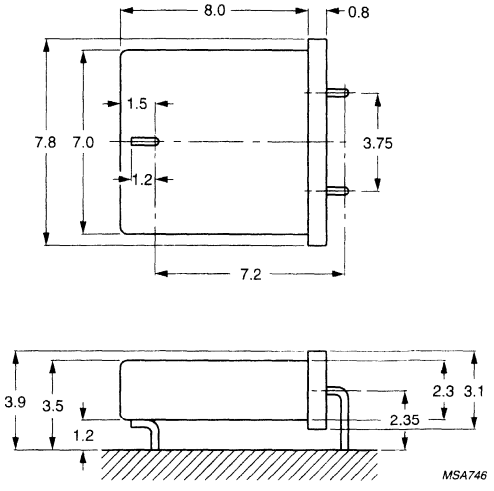
Notes

1. Lead length tolerances L for Style 1:
   a) Lead length (H_2) > 3 mm: ±0.5 mm
   b) Lead length (H_2) ≤ 3 mm: ±0.2 mm.
2. Lead diameters 0.44 ±0.04 mm or 0.35 ±0.05 mm optional.



L: min. 12.7 mm; max. 13.0 mm.

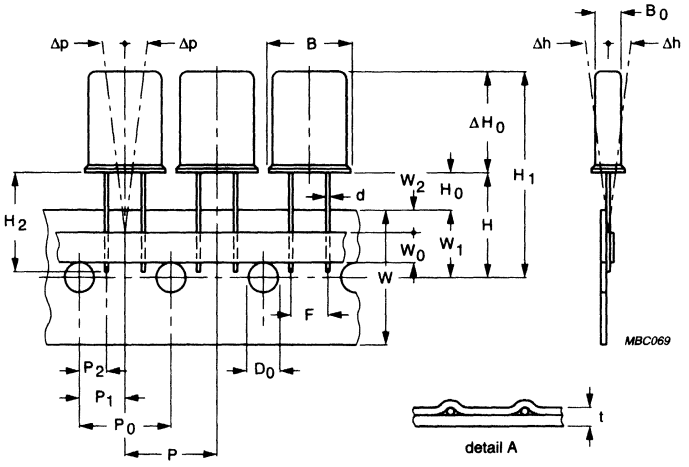
Fig.2 Style 4: HC-45/U in box.



Dimensions in mm.

Fig.3 Style 5: HC-45/U in box.

Taping data



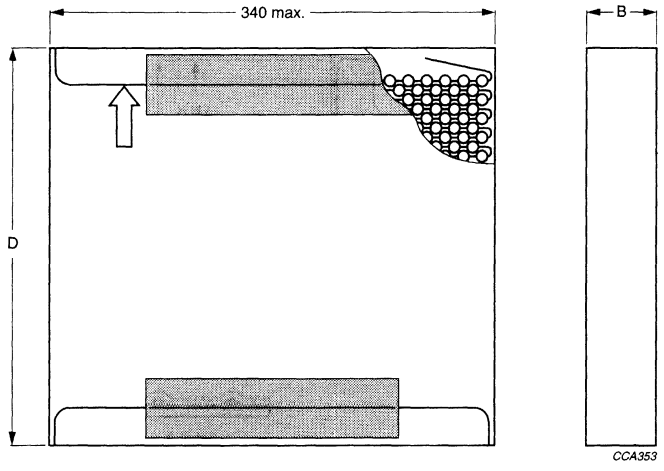
For dimensions see Table 2.

Fig.4 Style 2: HC-45/U on tape.

Table 2 Taping dimensions (without the insulation plate) in accordance with *"IEC 286-2"*; see Fig.4

SYMBOL	PARAMETER	VALUE	TOLERANCE	UNIT
B_0	body thickness	3.1	+0.05	mm
B	body width	7.8	+0.05	mm
Δh	component alignment vertical to tape plane	0	±2.0	mm
Δp	component alignment in tape plane	0	±1.3	mm
d	lead wire diameter, option	0.44/0.35	±0.04/±0.05	mm
F	lead-to-lead distance	3.75	–	mm
P	pitch of components	12.7	±1.0	mm
P_0	feed-hole pitch	12.7	±0.3	mm
P_2	feed-hole centre to lead	4.45	±0.7	mm
P_1	feed-hole centre to component centre	6.35	±0.3	mm
D_0	feed-hole diameter	4.0	±0.2	mm
H	distance of component from tape centre	18.0	+2/0	mm
H_0	minimum component base to tape top	9.0	–	mm
H_2	lead length	20.	±0.5	mm
W	carrier tape width	18.0	+1/–0.5	mm
W_0	maximum hold-down tape width, option	7.0/13.0	–	mm
W_1	feed-hole position	9.0	+0.75/–0.5	mm
W_2	maximum hold-down tape position	3.0	–	mm
t	maximum total tape thickness	0.9	–	mm

Ammopack and reel data

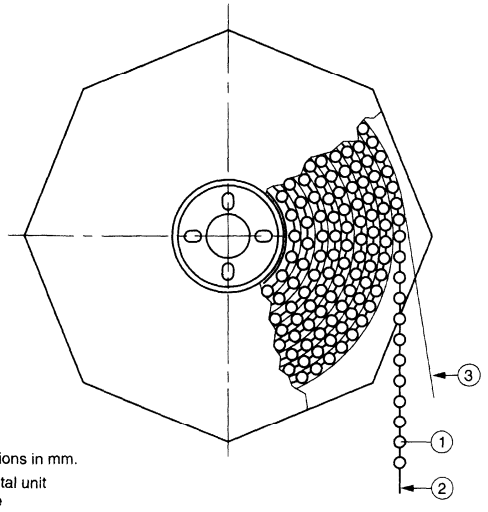


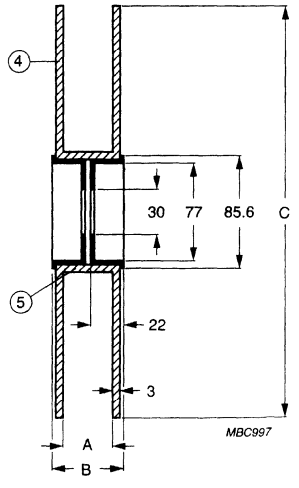
Dimensions in mm.

B = 46 mm max.
D = 185 mm max.

Style 3a is with insulation plate; see Fig.7.

Fig.5 Style 2a, and 3a units on tape in ammopack.





Dimensions in mm.

1 = crystal unit
2 = tape
3 = paper
4 = flange
5 = cylinder

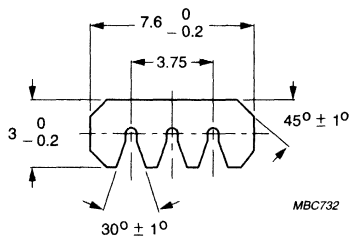
A = 45 mm
B = 55 mm max.
C = 355 mm max.

Style 3b is with insulation plate; see Fig.7.

Fig.6 Style 2b and 3b units on tape on reel.

Insulation plate

Style 3 units are equipped with an insulation plate (see Fig.7) at the unit base. The insulation plate is made of PEEK (polyetherketone) in 0.25 mm thickness and resistant to soldering heat tests.



Dimensions in mm.

Fig.7 Insulation plate outline for Style 3.

PACKAGING AND QUANTITIES

Table 3 HC-45/U holder

STYLE	PACKAGING	QUANTITY	DIMENSIONS OF BOX (mm)		
			LENGTH	WIDTH	HEIGHT
1	in box	maximum 1000 units per box	200	125	45
	in blister	24 units per blister. 8 blisters per box	315	155	67
2a and 3a	on tape in ammopack	1000 units per pack, in box	340	185	46
2b and 3b	on tape on reel	1000 units per reel, in box	283	283	60
4 and 5	in box	1000 units per box	380	90	168

STANDARD MARKING(1)

- Line 1: PHILIPS
- Line 2: frequency in kHz (fundamental mode) or in MHz (overtone)
- LIne 3: last five digits of catalogue number followed by the manufacturing date code (last four digits of week code in accordance with UN-D1120).

MASS AND LEADS

Typical mass: 0.4 g.

The leads are finished with either Sn99Cu1, Sn60Pb40 or a gold finish on a nickel underplate.

The first 1 mm from the body is not guaranteed for soldering.

(1) Special marking on product and/or package is available on request.

ELECTRICAL DATA

Valid at T_{amb} = 25 ±2 °C and a nominal drive level of 100 μW into 25 Ω unless otherwise specified. Measuring system: π-network in accordance with *"IEC 444"* recommendations.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
f_{nom}	nominal frequency	fundamental	6.0	–	25.0	MHz
		third overtone	24.0	–	80.0	MHz
		fifth overtone	80.0	–	125.0	MHz
		seventh overtone	125.0	–	200.0	MHz
$\Delta f/f_{nom}$	adjustment tolerance		±10	±30	–	ppm
		6.4 mm height	±20	±30	–	ppm
R_r	resonance resistance	see note 1	see Figs 8, 10 and 12			Ω
C_L	load capacitance	fundamental mode; note 2	5	20	∞	pF
		overtones; note 2	5	∞	–	pF
T_{oper}	operating temperature		–40	–	+105	°C
T_{op}	operable temperature		–40	–	+155	°C
$\Delta f/f_{25}$	frequency stability over temperature range	T_{amb} = 25 °C	see Table 4, class 2			ppm
R_r (T)	resonance resistance over temperature range	see note 1	available from R_r upwards			Ω
C_1	motional capacitance		see Figs 9, 11 and 13			fF
	tolerance		±10	–	–	%
C_0	parallel capacitance		see Figs 9, 11 and 13			pF
	tolerance		±10	–	–	%
S	pulling sensitivity		$S = -0.5\ C_1 / (C_0 + C_L)^2$			ppm/pF
R_n	resonance resistance of unwanted response (spurious)	fundamental mode; f_{nom} ±20%	2 R_r (T)	–	–	Ω
			+6	–	–	dB
		overtones; f_{nom} ±200 kHz	2 R_r (T)	–	–	Ω
			+6	–	–	dB
R_{did}	drive level dependency, being the resonance resistance in the drive level range	drive level range 10^{-16} W to 10^{-4} W; note 3	see note 2			Ω
R_{ins}	insulation resistance	DC test voltage = 100 V	500	–	–	MΩ
Δf/f	ageing	10 years at T_{amb} = 25 °C; see Figs 14 and 15	±5	–	±10	ppm

Notes

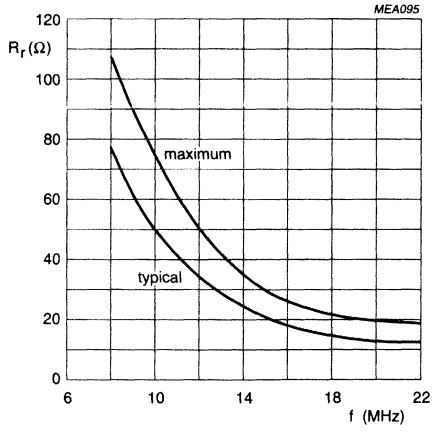
1. All resistance values are measured in series resonance, other values available on request.
2. Values available from R_r upwards.
3. Values available on request.

Table 4 Frequency stability with temperature variation (available maximum values).

TEMPERATURE RANGE[1] (°C)	FREQUENCY STABILITY (ppm)		
	CLASS 0	CLASS 1	CLASS 2
+20/+30	±1.0	±1.5	±2.0
0/+50	±5.0	±7.5	±10.0
−10/+60	±7.5	±10.0	±15.0
−20/+70	±10.0	±15.0	±20.0
−30/+80	±12.5	±20.0	±25.0
−40/+90	±17.5	±25.0	±30.0
−55/+105	±25.0	±30.0	±40.0
−40/+130	–	±50.0	±80.0

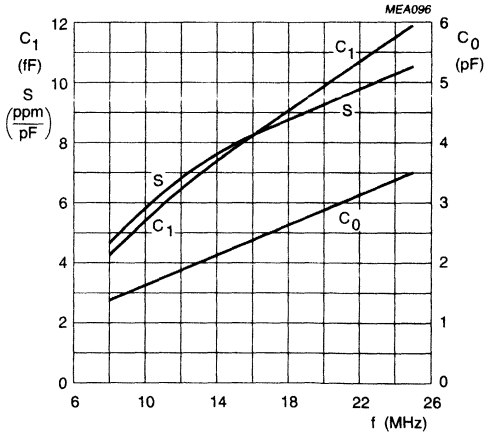
Note

1. To obtain the same stability at frequencies below 8.0 MHz, the upper temperature limit is 10 °C lower.



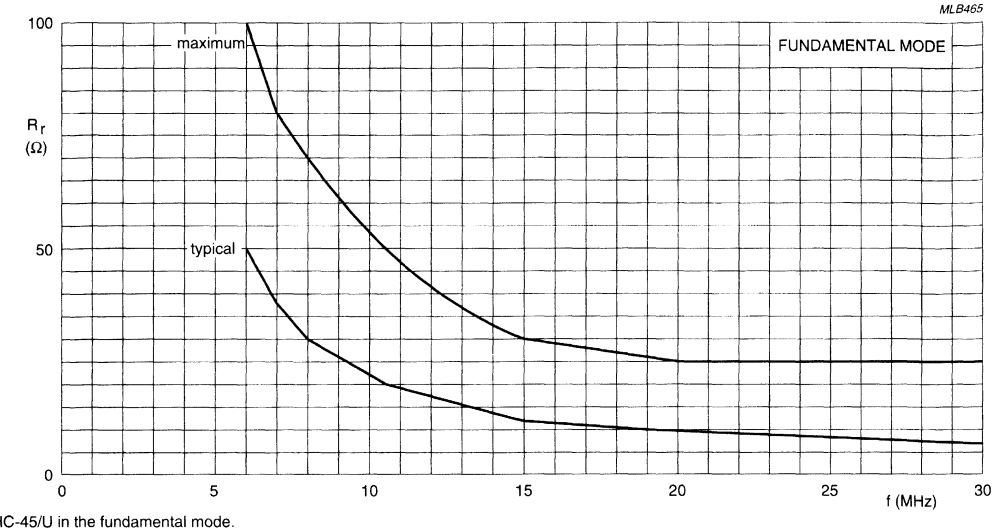
R_r at 25 °C.
HC-45/U crystals in 6 mm product height (involving small blanks).

Fig.8 Resonance resistance R_r as a function of resonance frequency.



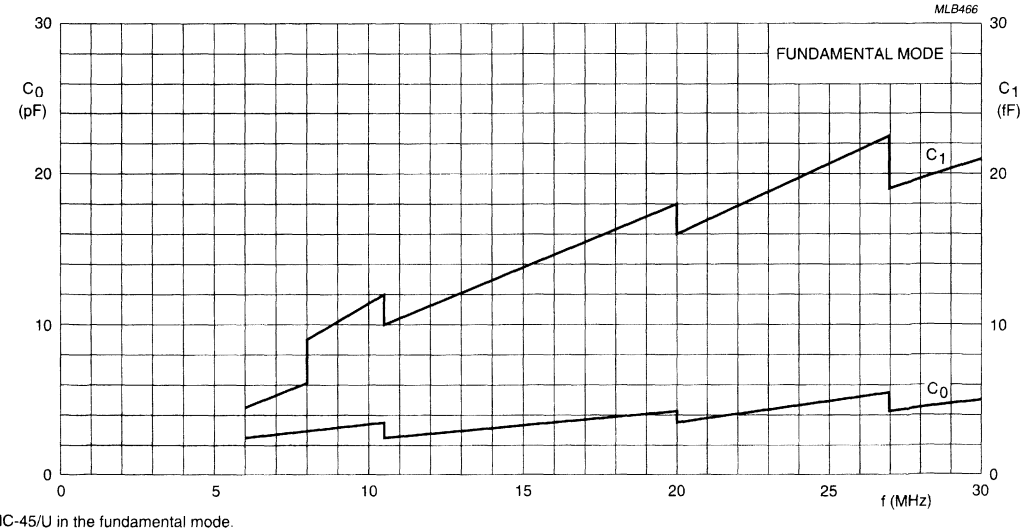
R_r at 25 °C.
HC-45/U crystals in 6 mm product height (involving small blanks).

Fig.9 Motional capacitance C_1, parallel capacitance C_0 and pulling sensitivity S (assuming C_L = 20 pF) as a function of resonance frequency.



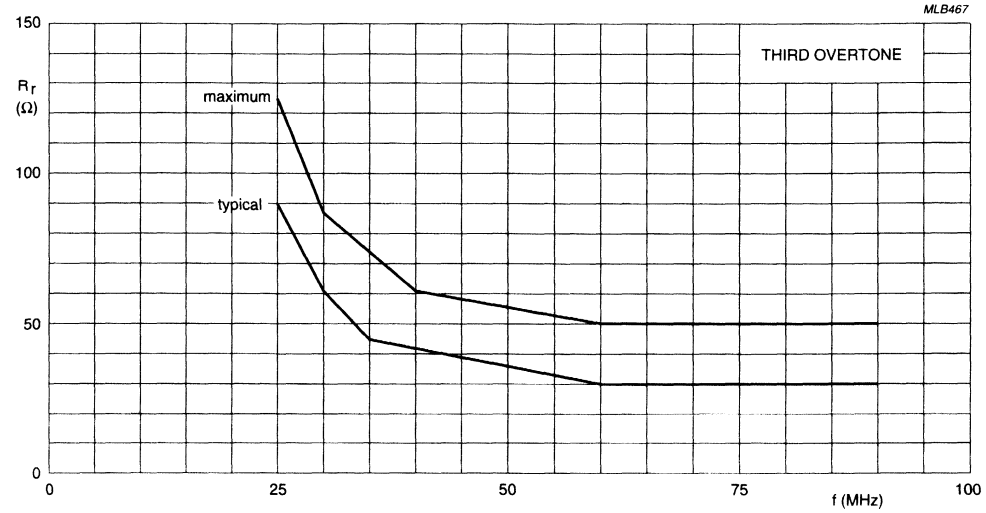
HC-45/U in the fundamental mode.
Values at 25 °C.
Other values available by extrapolation with C_0 and C_1 values.

Fig.10 Resonance resistance R_r as a function of resonance frequency, for HC-45/U crystals in 8 mm product height (involving large quartz blanks).



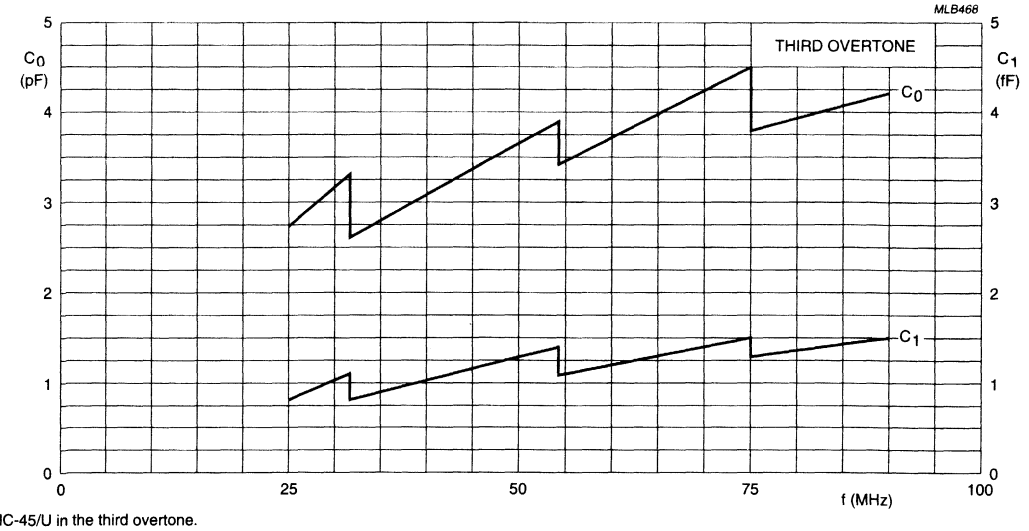
HC-45/U in the fundamental mode.
Typical values at 25 °C.
Other values available by extrapolation of the curve segments.

Fig.11 Motional capacitance C_1 and parallel capacitance C_0 as a function of resonance frequency, for HC-45/U crystals in 8 mm product height (involving large quartz blanks).



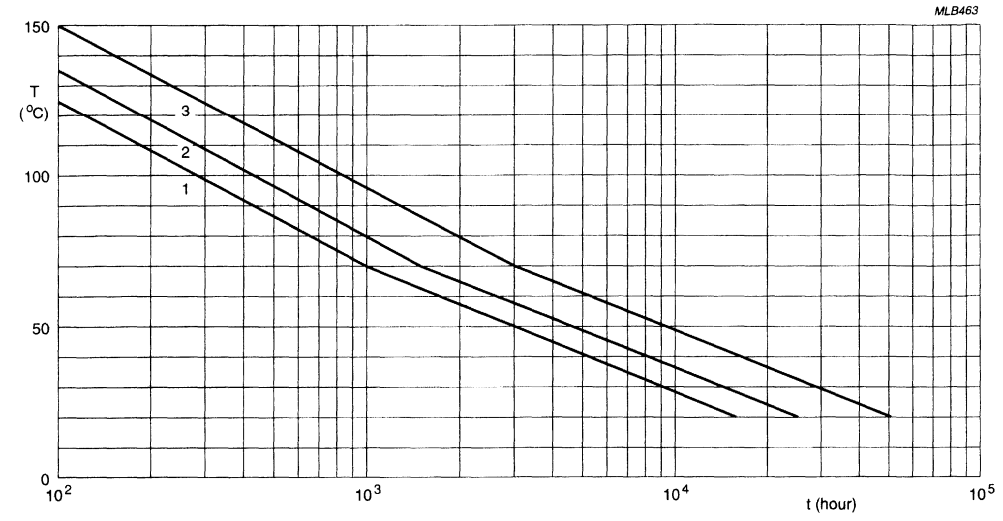
HC-45/U in the third overtone.
Values at 25 °C.
Other values available by extrapolation with C_0 and C_1 values.

Fig.12 Resonance resistance R_r as a function of resonance frequency, for HC-45/U crystals in 8 mm product height (involving large quartz blanks).



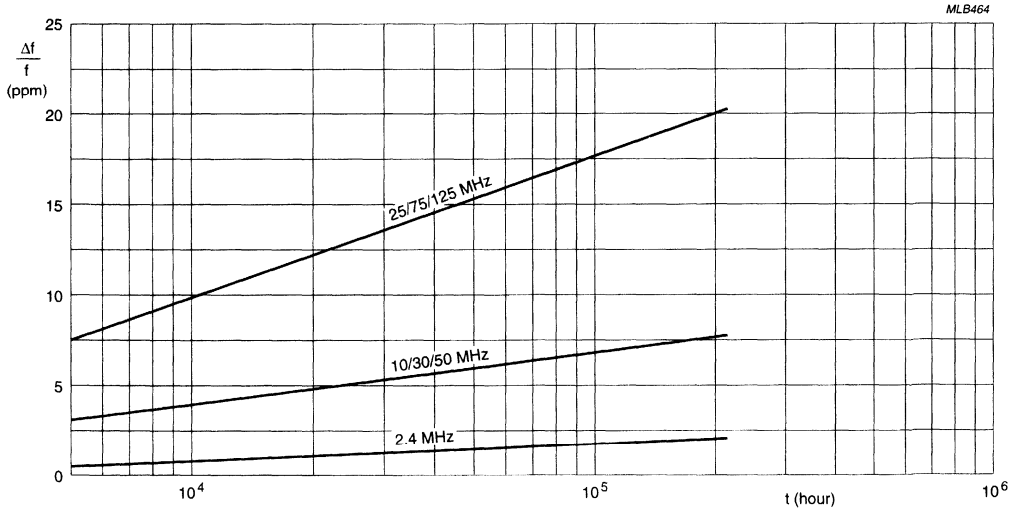
HC-45/U in the third overtone.
Typical values at 25 °C.
Other values available by extrapolation with C_0 and C_1 values.

Fig.13 Motional capacitance C_1 and parallel capacitance C_0 as a function of resonance frequency, for HC-45/U crystals in 8 mm product height (involving large quartz blanks).



Curve 1 = 1000 hours at 70 °C.
Curve 2 = 720 hours at 85 °C.
Curve 3 = 240 hours at 130 °C.

Fig.14 Time/temperature relation at which ageing is approximately equivalent.



Fundamental, third and fifth overtones.
Necessary pre-ageing can be calculated using Fig.14.

Fig.15 Typical frequency ageing as a function of time at 25 °C, **without pre-ageing of crystals.**

TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with IEC publication 68-2, *"Recommended basic climatic and mechanical robustness testing procedure for electronic components"* and IEC publication 1178-1, *"Generic specification for quartz crystal units"*.

Table 5 Test procedures and requirements; note 1

IEC 68-2 METHOD	TEST	PROCEDURE	REQUIREMENTS
Ba	ageing	1000 hours at 70 °C	$\Delta f/f \leq \pm 5$ ppm
Db	accelerated damp heat	+25 to +55 °C; 6 cycles at RH >95%	$\Delta f/f \leq \pm 5$ ppm $\Delta R_r \pm 5\ \Omega$ or ±20% whichever is the greater
Ea	shock	100 g; half sinewave; 6 directions; 1 blow/direction	$\Delta f/f \leq \pm 5$ ppm $\Delta R_r \pm 5\ \Omega$ or ±20% whichever is the greater
Eb	bump	4000 bumps of 40 g	$\Delta f/f \leq \pm 5$ ppm $\Delta R_r \pm 5\ \Omega$ or ±20% whichever is the greater
Ed	free fall	3 times on hard wood; for height of fall (h) see Table 6	$\Delta f/f \leq \pm 5$ ppm $\Delta R_r \pm 5\ \Omega$ or ±20% whichever is the greater
Fc	vibration	frequency 10 to 500 to 10 Hz; acceleration 10 g; 3 directions; 30 minutes/direction	$\Delta f/f \leq \pm 5$ ppm $\Delta R_r \pm 5\ \Omega$ or ±20% whichever is the greater
Na	temperature cycling test	−40 to +85 °C; 10 cycles; 0.1 hour/cycle	$\Delta f/f \leq \pm 5$ ppm $\Delta R_r \pm 5\ \Omega$ or ±20% whichever is the greater
Q	sealing (method 1)	16 hours; 700 kPa He	$<1 \times 10^{-8}$ ncc/s He
Ta	solderability	235 ±5 °C; 2 ±0.5 s; flux 600 (activated)	≥90%, except for 1 mm from body; no visible damage, no leaks
Tb	resistance to soldering heat	350 ±5 °C; 3.5 ±0.5 s	$\Delta f/f \leq \pm 5$ ppm $\Delta R_r \pm 5\ \Omega$ or ±20% whichever is the greater
Ub	bending of terminations	1 × 90°; 5 N	no visible damage, no leaks

IEC 68-2 METHOD	TEST	PROCEDURE	REQUIREMENTS
Other applicable tests			
Xa	resistance to solvents; note 2: Bio-Act EC7®; Neutropon P3® and Saxin P3®; Meta Clean 820®; Lonco 446®; Isopropanol cleaning solvent; Dowanol DPM® (glass crystals only)	in accordance with *"IEC 68-2-45"*, *"IEC 653"* (immersion time 5 minutes) and *"MIL 202 E215"*. At ambient temperature and ultrasonic frequency (40 kHz)	no degradation of marking

Notes

1. Test table including MIL-specs (*"MIL-Std 883"* and *"MIL-Std 202"*) can be provided upon request.
2. Bio-Act is a registered trademark of Petroform.
   Neutropon P3 and Saxin P3 are registered trademarks of Henkel.
   Meta Clean 820 is a registered trademark of Mavom.
   Lonco 447 is a registered trademark of London Chemical Co.
   Dowanol DPM is a registered trademark of Dow Chemical.

Table 6 Height of fall

h (mm)	PRODUCT HEIGHT (mm)	FREQUENCY RANGE(1) (MHz)	
		FUNDAMENTAL MODE	THIRD OVERTONE
750	6.4	8.0 to 12.0	24.0 to 36.0
750	8.0 and 8.8	8.0 to 16.0	36.1 to 48.0
500	6.4	12.1 to 20.0	36.1 to 60.0
500	8.0 and 8.8	16.1 to 24.0	48.1 to 75.0
250	6.4	20.1 to 24.0	60.1 to 75.0

Note

1. Standard values. Actual designs can be made to obtain higher or lower values.

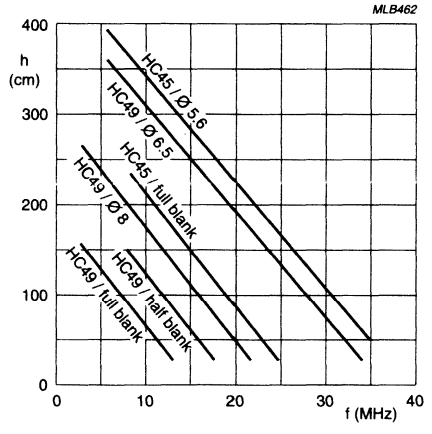


Fig.16 Typical height of fall values (3× on hard wood) for various quartz blank and holder combinations. 'Full' and 'half' blanks refer to rectangular quartz designs; 'Ø' designates circular quartz designs and the appropriate diameter.

HIGH RELIABILITY INDUSTRIAL AND AUTOMOTIVE APPLICATIONS

Quartz crystals - High Reliability industrial and automotive HC-49/SMD-like

9922 522 42... series

FEATURES

- High mechanical stability
- High electrical reliability
- Automated production line for high level of uniformity
- Additional procedures followed to ensure operation under severe environmental conditions
- Low resistance values
- High pullability values.

APPLICATIONS

- Car electronics
- Traffic control
- Computers
- Communication systems
- Control and measuring equipment
- Machine control
- Audio and video electronics
- Domestic appliance control.

DESCRIPTION

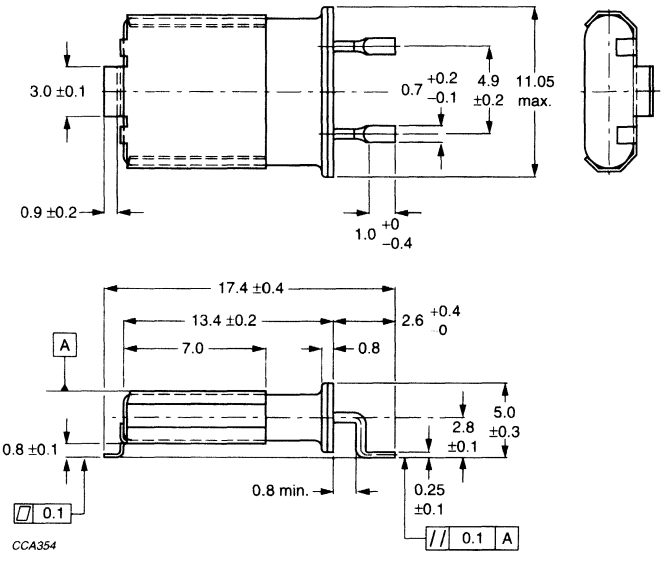
The unit consists of a silver-plated AT-cut quartz plate, encapsulated in a nitrogen-filled metal holder. The holder is hermetically sealed by resistance welding and provided with connections for surface mounting.

QUICK REFERENCE

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT
f_{nom}	nominal frequency:				
	fundamental mode	3.0	–	27.0	MHz
	third overtone	20.0	–	75.0	MHz
T_{oper}	operating temperature	–40	–	+130	°C
T_{op}	operable temperature	–40	–	+155	°C
$\Delta f/f_{nom}$	adjustment tolerance	±10	±30	–	ppm
$\Delta f/f_{25}$	frequency stability over temperature range: –40 to +130 °C with respect to T_{amb} = 25 °C	–	±80	–	ppm
C_1	motional capacitance tolerance	±10	–	–	%
C_0	parallel capacitance tolerance	±10	–	–	%
$\Delta f/f$	ageing over 10 years at 25 °C	±5	–	±10	ppm

MECHANICAL DATA

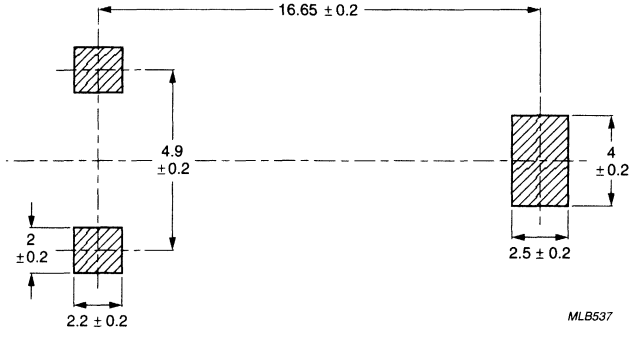
Package outlines



Dimensions in mm.

Fig.1 Style 1: HC-49/U17-SMD/Clip I.

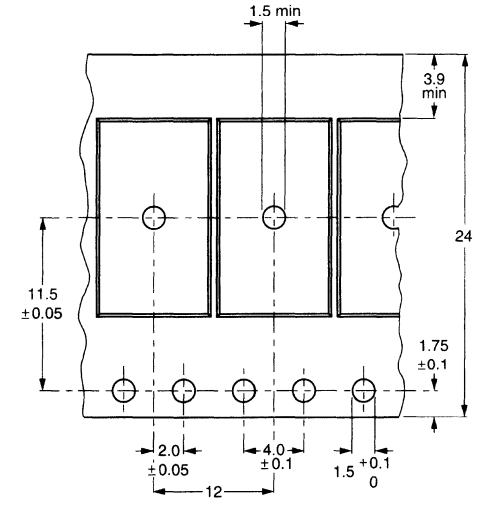
Recommended pad layout

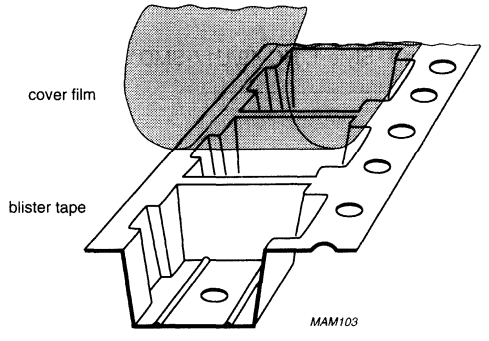


Dimensions in mm.

Fig.2 HC-49/U SMD/Clip I.

Tape and reel data





Dimensions in mm.
Crystal connections are adjacent to sprocket holes.
Cumulative pitch error: ≤0.2 mm over 10 pitches.

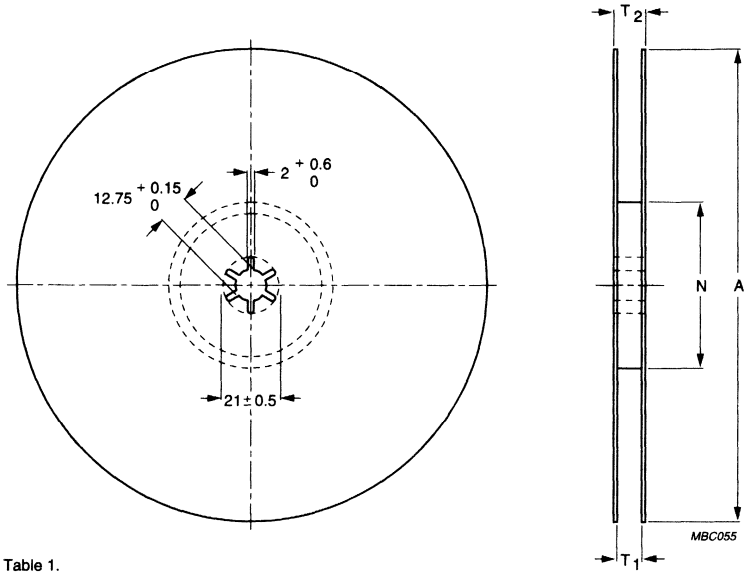
Total tape height of tape with top film: 5.8 mm maximum.
Tape thickness: 0.3 mm.
The blister is made of conductive polystyrene. Taping is performed in accordance with *"IEC 286-3"*.
Leader: minimum 400 mm including 100 mm sealed with empty compartments.
Trailer: minimum 160 mm sealed with empty compartments.

Pocket dimensions:
Length = 18.3 ±0.1 mm
Width = 11.4 ±0.1 mm
Depth = 5.6 +0.05/–0 mm.

Fig.3 Blister tape.

Quartz crystals - High Reliability industrial and automotive HC-49/SMD-like

9922 522 42... series



Dimensions in mm.
For dimensions see Table 1.

Fig.4 Reel dimensions.

Table 1 Reel dimensions; see Fig.4

TAPE WIDTH (mm)	A (mm)	N (mm)	T_1 (mm)	T_2 (mm)
24	330	62 ±1.5	24.4 +0.2/–0	28.4 ±0.2

PACKAGING AND QUANTITIES

STYLE	PACKAGING(1)	QUANTITY	DIMENSIONS OF BOX (mm)		
			LENGTH	WIDTH	HEIGHT
1	blister tape on reel	700 units per reel	338	338	38
	box	700 units per box	200	125	70

Note

1. The packaging of HR automotive products has an additional label showing the ordering data.

STANDARD MARKING(1)

- Line 1: PHILIPS
- Line 2: frequency in kHz (fundamental mode) or in MHz (overtone)
- LIne 3: last five digits of catalogue number followed by the manufacturing date code (last three digits of week code).

MASS AND LEADS

Typical mass: 1.2 g.

The leads are finished with Sn99Cu1 on a nickel underplate.

The first 1 mm from the body is not guaranteed for soldering.

(1) Special marking on product and/or package is available on request.

ELECTRICAL DATA

Valid at T_{amb} = 25 ± 2 °C and a nominal drive level of 100 µW into 25 Ω unless otherwise specified. Measuring system: π-network in accordance with *"IEC 444"* recommendations.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
f_{nom}	nominal frequency	fundamental	3.0	–	27.0	MHz
		third overtone	20.0	–	75.0	MHz
$\Delta f/f_{nom}$	adjustment tolerance		±10	±30	–	ppm
R_r	resonance resistance	see note 1				Ω
C_L	load capacitance	see note 2	±5	±20	∞	pF
T_{oper}	operating temperature		–40	–	+130	°C
T_{op}	operable temperature		–40	–	+155	°C
$\Delta f/f_{25}$	frequency stability over temperature range, with respect to T_{amb} = 25 °C		see Table 2, class 2			ppm
R_r (T)	resonance resistance over temperature range	see note 1	available from R_r upwards			Ω
C_1	motional capacitance		see specific 12NC			fF
	tolerance		±10	–	–	%
C_0	parallel capacitance		see specific 12NC			pF
	tolerance		±10	–	–	%
S	pulling sensitivity		$S = -0.5\ C_1 / (C_0 + C_L)^2$			ppm/pF
R_n	resonance resistance of unwanted response (spurious)	fundamental mode; f_{nom} ±20%	2 R_r (T)	–	–	Ω
			+6	–	–	dB
		overtones; f_{nom} ±200 kHz	2 R_r (T)	–	–	Ω
			+6	–	–	dB
R_{dld}	drive level dependency, being the resonance resistance in the drive level range	drive level range 10^{-16} W to 10^{-4} W; note 1	see note 2			Ω
R_{ins}	insulation resistance	DC test voltage = 100 V	500	–	–	MΩ
Δf/f	ageing	see Figs 5 and 6	±5	–	±10	ppm

Notes

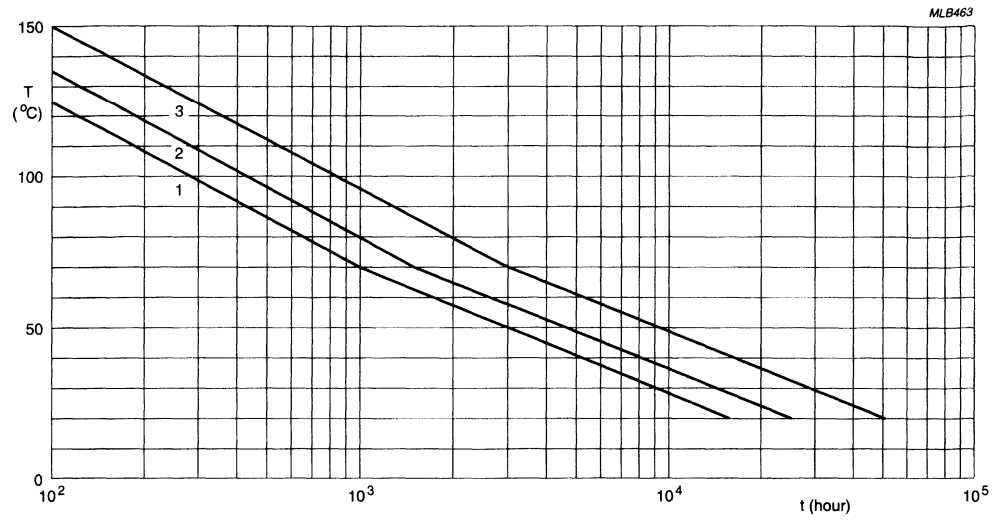
1. All resistance values are measured in series resonance, other values available on request.
2. Values available on request.

Table 2 Frequency stability with temperature variation (available maximum values)

TEMPERATURE RANGE[1] (°C)	FREQUENCY STABILITY (ppm)		
	CLASS 0	CLASS 1	CLASS 2
+20/+30	±1.0	±1.5	±2.0
0/+50	±5.0	±7.5	±10.0
−10/+60	±7.5	±10.0	±15.0
−20/+70	±10.0	±15.0	±20.0
−30/+80	±12.5	±20.0	±25.0
−40/+90	±17.5	±25.0	±30.0
−55/+105	±25.0	±30.0	±40.0
−40/+130	–	±50.0	±80.0

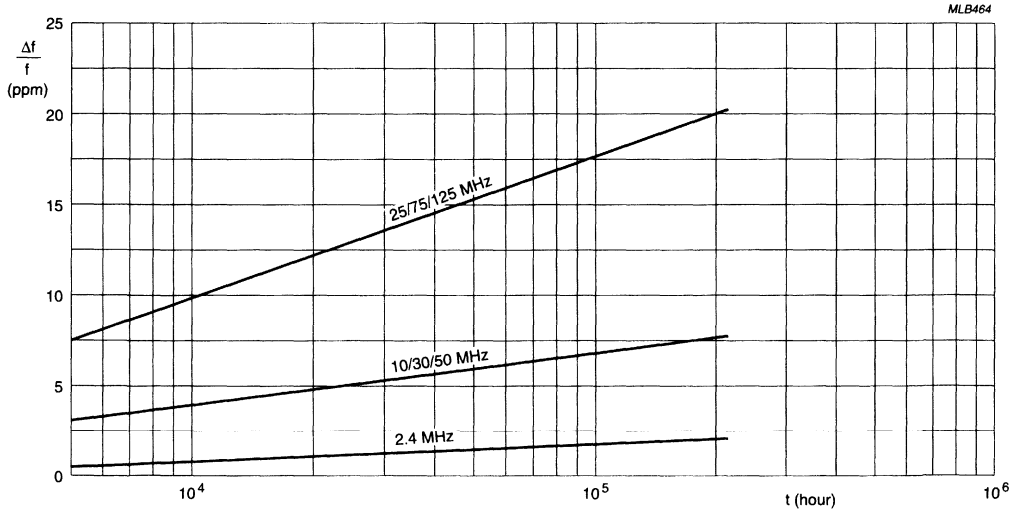
Note

1. To obtain the same stability at frequencies below 8.0 MHz, the upper temperature limit is 10 °C lower.



Curve 1 = 1000 hours at 70 °C.
Curve 2 = 720 hours at 85 °C.
Curve 3 = 240 hours at 130 °C.

Fig.5 Time/temperature relation at which ageing is approximately equivalent.



Fundamental, third and fifth overtones.
Necessary pre-ageing can be calculated using Fig.5.

Fig.6 Typical frequency ageing as a function of time at 25 °C, **without pre-ageing of crystals.**

TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with IEC publication 68-2, *"Recommended basic climatic and mechanical robustness testing procedure for electronic components"* and IEC publication 1178-1, *"Generic specification for quartz crystal units"*

Table 3 Test procedures and requirements

IEC 68-2 METHOD	TEST	PROCEDURE	REQUIREMENTS
Ba	ageing		
	HR industrial types	1000 hours at +70 °C	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
	HR automotive types	250 hours at +130 °C	$\Delta f/f \leq \pm 20$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Db	accelerated damp heat	+25 °C to +55 °C; 6 cycles at RH >95%	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Ea	shock; note 1	100 g half sine; 6 directions; 1 blow per direction	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Eb	bump; note 1	4000 bumps of 40 g	
Ed	free fall; note 1	10 times on hard wood; for height of fall (h) see Table 4	
Fc	vibration	frequency 10 to 500 to 10 Hz; 3 directions	
	HR industrial types	acceleration 10 g; 30 minutes per direction	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
	HR automotive types	acceleration 40 g; 80 hours (total)	$\Delta f/f \leq \pm 20$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Na	temperature cycling test		
	HR industrial types	−40 to +85 °C; 10 cycles; 6 minutes per cycle	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
	HR automotive types	−40 to +150 °C; 500 cycles; 30 minutes per cycle t_1 = 15 min.; t_2 = 6 s	$\Delta f/f \leq \pm 20$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Q	sealing (method 1)	16 hours; 700 kPa He	$< 1 \times 10^{-8}$ ncc/s He
Ta	solderability	235 ±5 °C; 2 ±0.5 s; flux 600 (activated); optional steam pre-heat 8 hours. This reflects at least 36 months of storage at room conditions	≥90% on the flat lead part; no visible damage, no leaks

IEC 68-2 METHOD	TEST	PROCEDURE	REQUIREMENTS
Tb	resistance to reflow soldering	rise 10 K/s; dwell 2 min/160 °C; rise 10 K/s up to 280 °C; cool down	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Other applicable tests			
Xa	resistance to solvents; note 2: Bio-Act EC7®; Neutropon P3® and Saxin P3®; Meta Clean 820®; Lonco 446®; Isopropanol cleaning solvent; Dowanol DPM® (glass crystals only)	in accordance with *"IEC 68-2-45"*, *"IEC 653"* (immersion time 5 minutes) and *"MIL 202 E215"*. At ambient temperature and ultrasonic frequency (40 kHz)	no degradation of marking

Notes

1. Mechanical tests to be performed on units clamped to a printed-circuit board for the total unit height.
2. Bio-Act is a registered trademark of Petroform.
   Neutropon P3 and Saxin P3 are registered trademarks of Henkel.
   Meta Clean 820 is a registered trademark of Mavom.
   Lonco 447 is a registered trademark of London Chemical Co.
   Dowanol DPM is a registered trademark of Dow Chemical.

Table 4 Height of fall

h (mm)	PRODUCT LENGTH (mm)	FREQUENCY RANGE[1] (MHz)	
		FUNDAMENTAL MODE	THIRD OVERTONE
1000	17	3.0 to 12.0	20.0 to 36.0
500	17	21.1 to 16.0	36.1 to 48.0
250	17	16.1 to 27.0	30.1 to 75.0

Note

1. Standard values. Actual designs can be made to obtain higher or lower values.

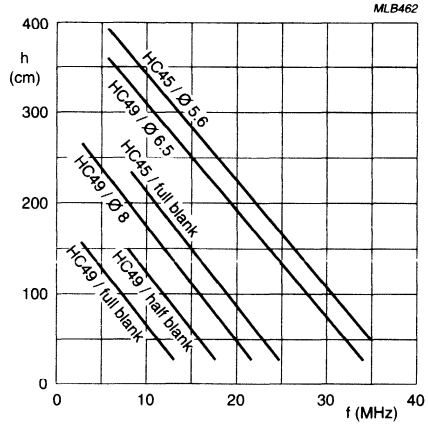


Fig.7 Typical height of fall values (3× on hard wood) for various quartz blank and holder combinations. 'Full' and 'half' blanks refer to rectangular quartz designs; '∅' designates circular quartz designs and the appropriate diameter.

Quartz crystals - High Reliability industrial and automotive HC-45/SMD-like

9922 522 22... series

FEATURES

- Small dimensions
- Outstanding electrical performance
- High mechanical and electrical stability
- Automated production for a high level of uniformity
- Additional procedures followed to ensure operation under severe environmental conditions.

APPLICATIONS

- Car electronics
- Personal computers, high reliability
- Portable equipment, high reliability.

DESCRIPTION

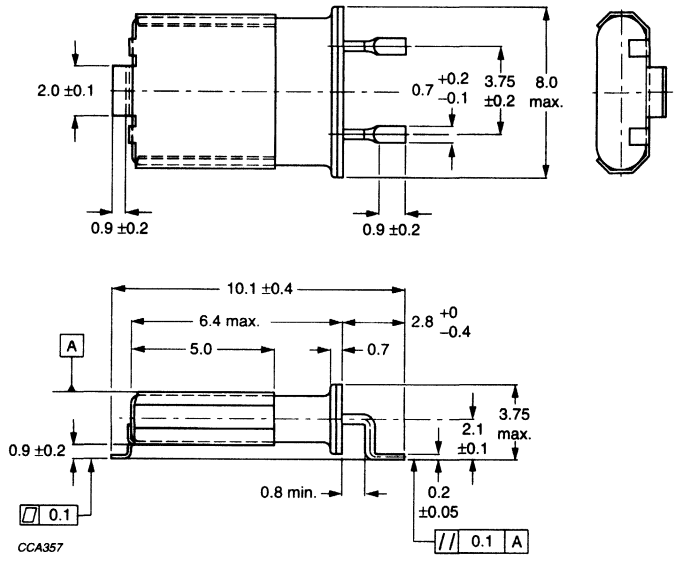
The unit consists of a silver-plated AT-cut quartz plate, encapsulated in a nitrogen-filled metal holder. The holder is hermetically sealed by resistance welding and provided with connections for surface mounting.

QUICK REFERENCE

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT
f_{nom}	nominal frequency:				
	fundamental mode	8.0	–	24.0	MHz
	third overtone	24.0	–	75.0	MHz
T_{oper}	operating temperature	–40	–	+130	°C
T_{op}	operable temperature	–55	–	+155	°C
$\Delta f/f_{nom}$	adjustment tolerance	±10	±30	–	ppm
$\Delta f/f_{25}$	frequency stability over temperature range: –40 to 130 °C with respect to T_{amb} = 25 °C	–	±80	–	ppm
C_1	motional capacitance tolerance	±10	–	–	%
C_0	parallel capacitance tolerance	±10	–	–	%
$\Delta f/f$	ageing over 10 years at 25 °C	±5	–	±10	ppm

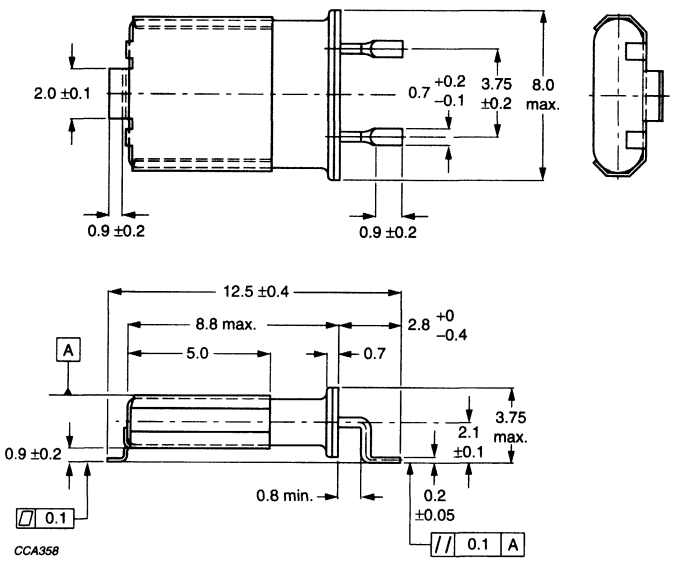
MECHANICAL DATA

Package outlines



Dimensions in mm.

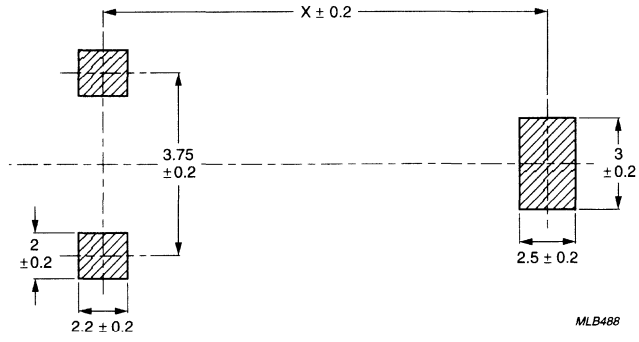
Fig.1 Style 1: HC-45/U10-SMD/Clip I.



Dimensions in mm.

Fig.2 Style 2: HC-45/U12-SMD/Clip I.

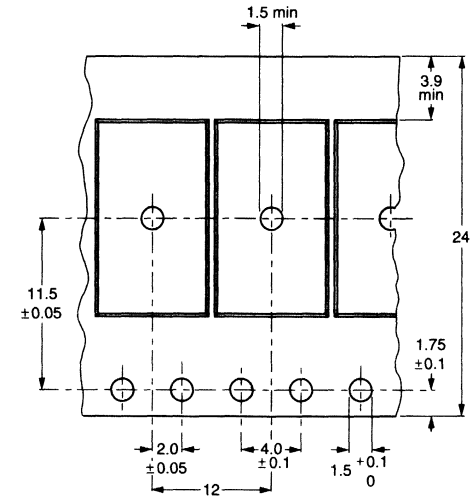
Recommended pad layout

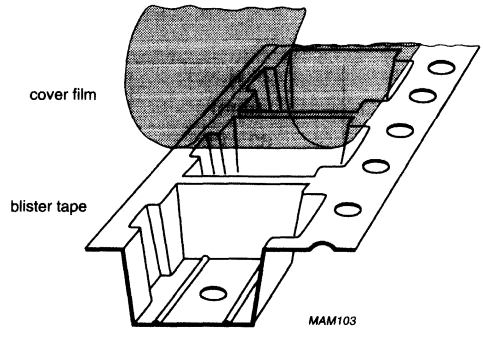


Dimensions in mm.
HC-45/U10: X = 9.2.
HC-45/U12: X = 11.6.

Fig.3 HC-45/U SMD/Clip I.

Tape and reel data



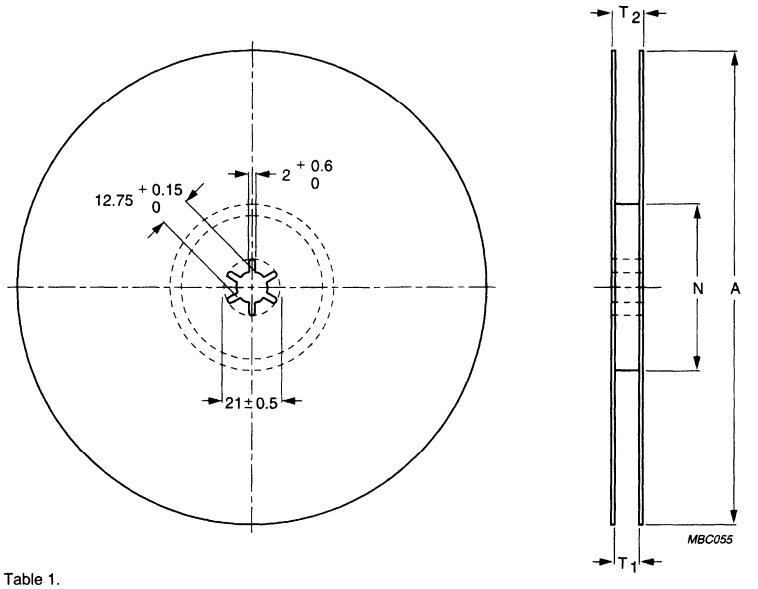


Dimensions in mm.
Crystal connections are adjacent to sprocket holes.
Cumulative pitch error: ≤0.2 mm over 10 pitches.

Total tape height of tape with top film: 4.5 mm maximum.
Tape thickness: 0.3 mm.
The blister is made of conductive polystyrene. Taping is performed in accordance with *"IEC 286-3"*.
Leader: minimum 400 mm including 100 mm sealed with empty compartments.
Trailer: minimum 160 mm sealed with empty compartments.

Pocket dimensions:
Length = 13.1 ±0.1 mm
Width = 8.3 ±0.1 mm
Depth = 4.3 +0.05/–0 mm.

Fig.4 Blister tape.



Dimensions in mm.
For dimensions see Table 1.

Fig.5 Reel dimensions.

Table 1 Reel dimensions; see Fig.5

TAPE WIDTH (mm)	A (mm)	N (mm)	T_1 (mm)	T_2 (mm)
24	286	62 ±1.5	24.4 +0.2/–0	28.4 ±0.2

PACKAGING AND QUANTITIES

STYLE	PACKAGING(1)	QUANTITY	DIMENSIONS OF BOX (mm)		
			LENGTH	WIDTH	HEIGHT
1	blister tape on reel	1000 units per reel	298	295	42
	blister tray	6 units per tray	315	155	67

Note

1. The packaging of HR automotive products has an additional label showing the ordering data.

STANDARD MARKING(1)

- Line 1: PHILIPS
- Line 2: frequency in kHz (fundamental mode) or in MHz (overtone)
- LIne 3: last five digits of catalogue number followed by the manufacturing date code (last three digits of week code).

MASS AND LEADS

Typical mass: 0.5 g.

The leads are finished with Sn99Cu1 or Sn60Pb40 on a nickel underplate.

The first 1 mm from the body is not guaranteed for soldering.

(1) Special marking on product and/or package is available on request.

Quartz crystals - High Reliability industrial and automotive HC-45/SMD-like

9922 522 22... series

ELECTRICAL DATA

Valid at T_{amb} = 25 ±2 °C and a nominal drive level of 100 µW into 25 Ω unless otherwise specified. Measuring system: π-network in accordance with *"IEC 444"* recommendations.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
f_{nom}	nominal frequency	fundamental	8.0	–	30.0	MHz
		third overtone	24.0	–	75.0	MHz
$\Delta f/f_{nom}$	adjustment tolerance	10 mm length	±20	±30	–	ppm
		12 mm length	±10	±30	–	ppm
R_r	resonance resistance	see note 1	see Figs 6 and 8			Ω
C_L	load capacitance	see note 2	5	20	∞	pF
T_{oper}	operating temperature		–40	–	+130	°C
T_{op}	operable temperature		–55	–	+155	°C
$\Delta f/f_{25}$	frequency stability over temperature range, with respect to T_{amb} = 25 °C		see Table 2, class 2			ppm
R_r (T)	resonance resistance over temperature range	see note 1	available from R_r upwards			Ω
C_1	motional capacitance		see Figs 7 and 9			fF
	tolerance		±10	–	–	%
C_0	parallel capacitance		see Figs 7 and 9			pF
	tolerance		±10	–	–	%
S	pulling sensitivity		$S = -0.5\ C_1 / (C_0 + C_L)^2$			ppm/pF
R_n	resonance resistance of unwanted response (spurious)	fundamental mode; f_{nom} ±20%	2 R_r (T)	–	–	Ω
			+6	–	–	dB
		overtones; f_{nom} ±200 kHz	2 R_r (T)	–	–	Ω
			+6	–	–	dB
R_{dld}	drive level dependency, being the resonance resistance in the drive level range	drive level range 10^{-16} W to 10^{-4} W; note 1	see note 2			Ω
R_{ins}	insulation resistance	DC test voltage = 100 V	500	–	–	MΩ
$\Delta f/f$	ageing	see Figs 10 and 11	±3	–	±5	ppm

Notes

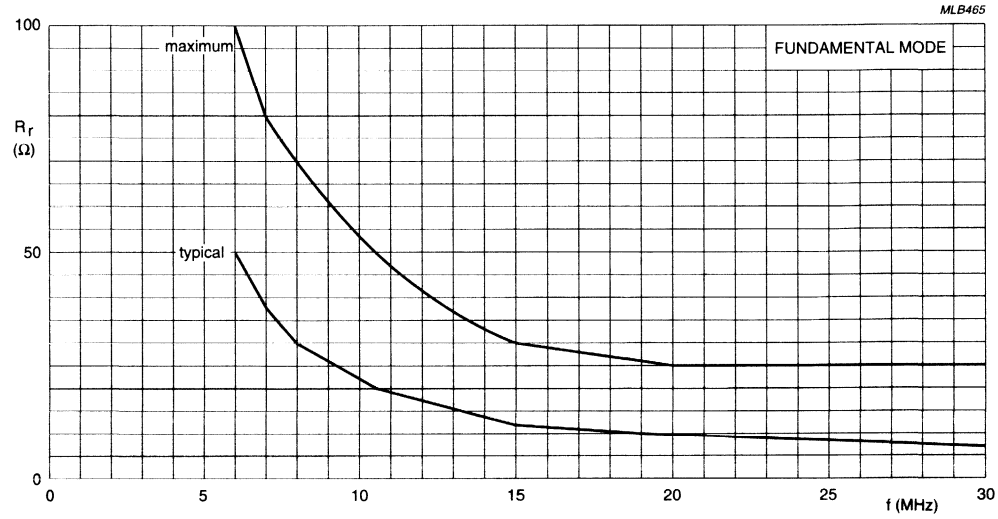
1. All resistance values are measured in series resonance. Load resonance measurement available on request.
2. Values available on request.

Table 2 Frequency stability with temperature variation (available maximum values).

TEMPERATURE RANGE[1] (°C)	FREQUENCY STABILITY (ppm)		
	CLASS 0	CLASS 1	CLASS 2
+20/+30	±1.0	±1.5	±2.0
0/+50	±5.0	±7.5	±10.0
−10/+60	±7.5	±10.0	±15.0
−20/+70	±10.0	±15.0	±20.0
−30/+80	±12.5	±20.0	±25.0
−40/+90	±17.5	±25.0	±30.0
−55/+105	±25.0	±30.0	±40.0
−40/+130	–	±50.0	±80.0

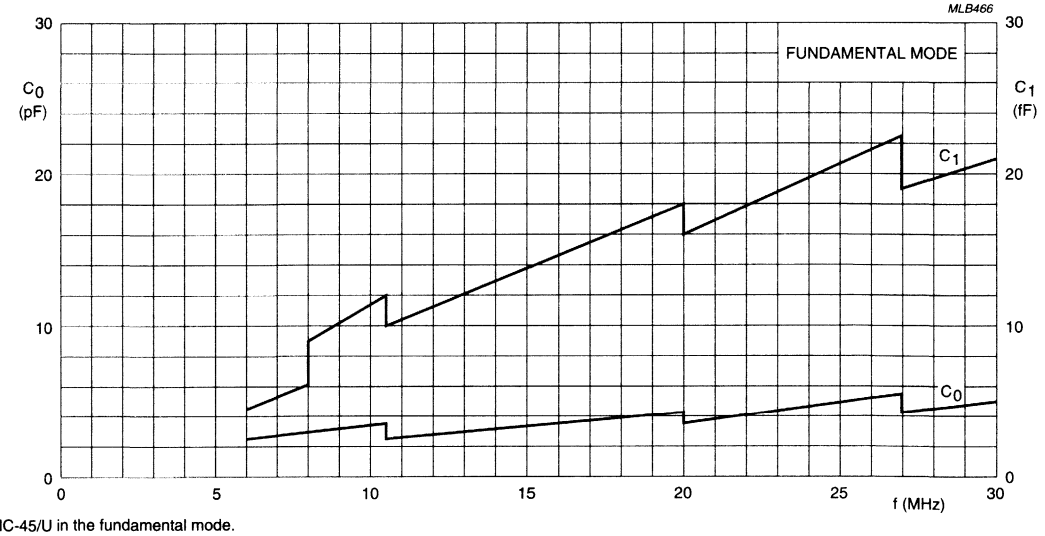
Note

1. To obtain the same stability at frequencies below 8.0 MHz, the upper temperature limit is 10 °C lower.



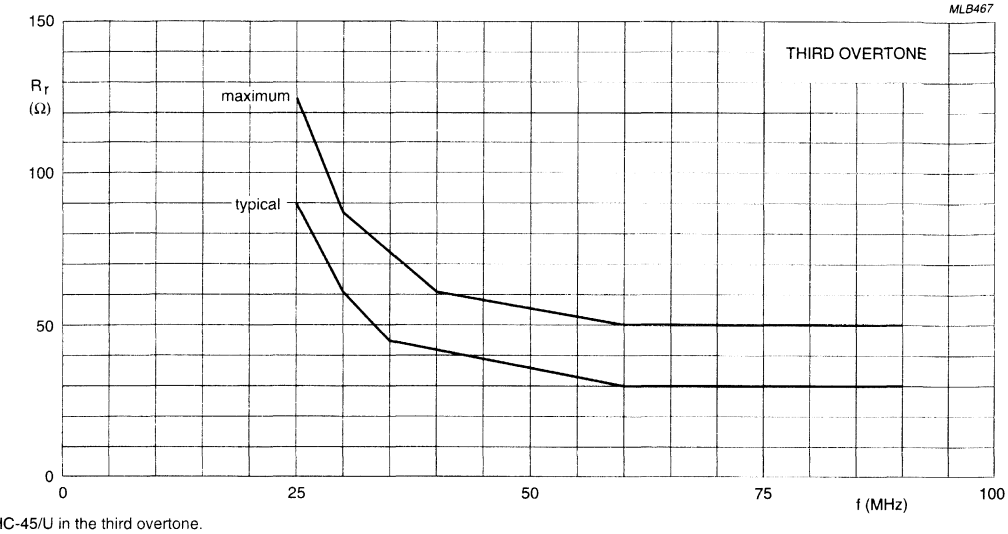
HC-45/U in the fundamental mode.
Values at 25 °C.
Other values available by extrapolation with C_0 and C_1 values.

Fig.6 Resonance resistance R_r as a function of resonance frequency, for HC-45/U crystals in 12 mm product length (involving large quartz blanks).



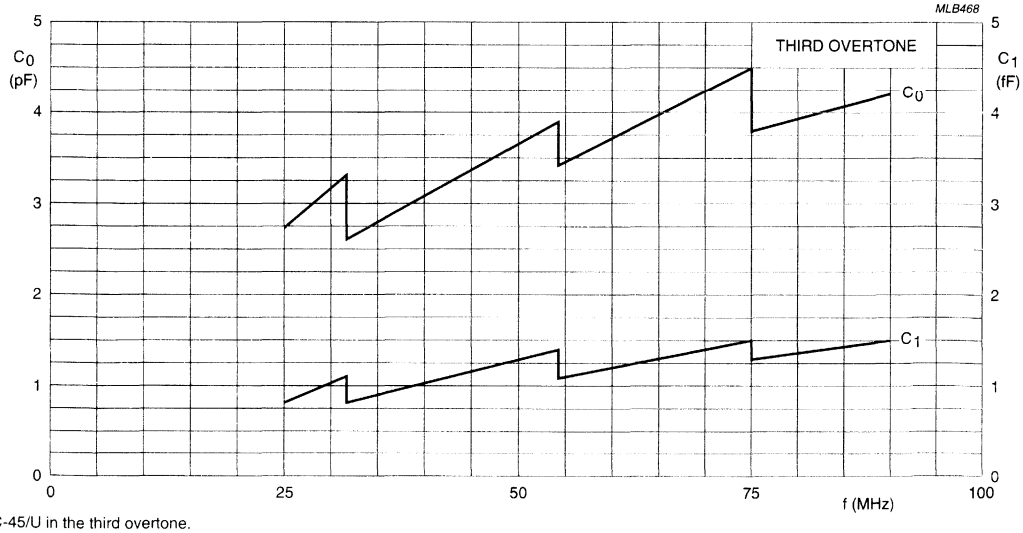
HC-45/U in the fundamental mode.
Typical values at 25 °C.
Other values available by extrapolation of the curve segments.

Fig.7 Motional capacitance C_1 and parallel capacitance C_0 as a function of resonance frequency, for HC-45/U crystals in 12 mm product length (involving large quartz blanks).



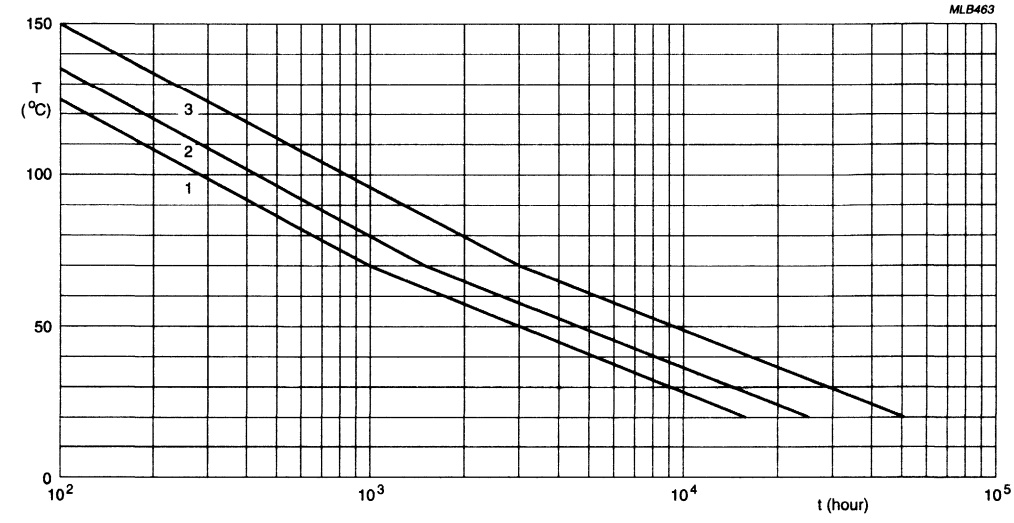
HC-45/U in the third overtone.
Values at 25 °C.
Other values available by extrapolation with C_0 and C_1 values.

Fig.8 Resonance resistance R_r as a function of resonance frequency, for HC-45/U crystals in 12 mm product length (involving large quartz blanks).



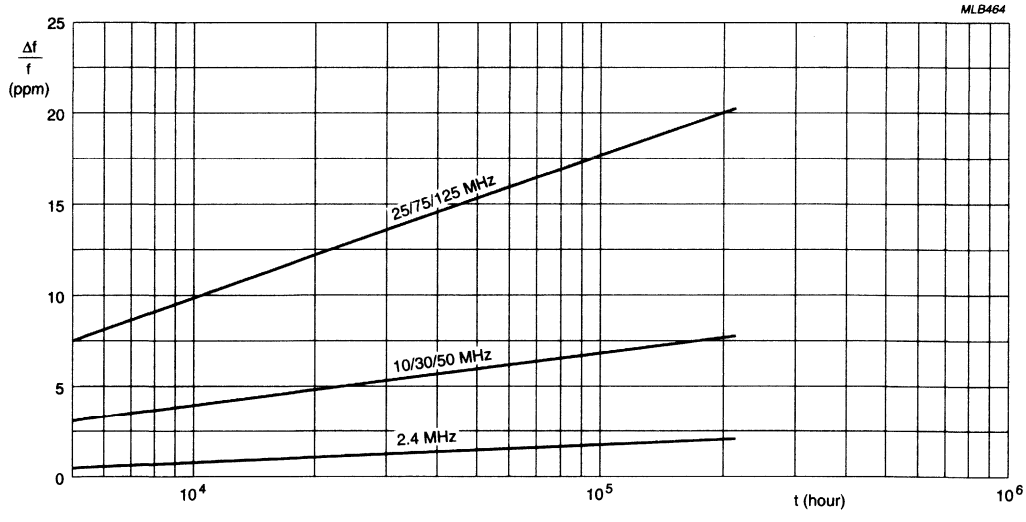
HC-45/U in the third overtone.
Typical values at 25 °C.
Other values available by extrapolation with C_0 and C_1 values.

Fig.9 Motional capacitance C_1 and parallel capacitance C_0 as a function of resonance frequency, for HC-45/U crystals in 12 mm product length (involving large quartz blanks).



Curve 1 = 1000 hours at 70 °C.
Curve 2 = 720 hours at 85 °C.
Curve 3 = 240 hours at 130 °C.

Fig.10 Time/temperature relation at which ageing is approximately equivalent.



Fundamental, third and fifth overtones.
Necessary pre-ageing can be calculated using Fig.10.

Fig.11 Typical frequency ageing as a function of time at 25 °C, **without pre-ageing of crystals.**

TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with IEC publication 68-2, *"Recommended basic climatic and mechanical robustness testing procedure for electronic components"* and IEC publication 1178-1, *"Generic specification for quartz crystal units"*.

Table 3 Test procedures and requirements; note 1

IEC 68-2 METHOD	TEST	PROCEDURE	REQUIREMENTS
Ba	ageing		
	HR industrial types	1 000 hours at +70 °C	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
	HR automotive types	250 hours at +130 °C	$\Delta f/f \leq \pm 40$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Db	accelerated damp heat	+25 °C to +55 °C; 6 cycles at RH >95%	$\Delta f/f \leq 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Ea	shock; note 2	100 g half sine; 6 directions; 1 blow per direction	$\Delta f/f \leq 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Eb	bump; note 2	4000 bumps of 40 g	$\Delta f/f \leq 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Ed	free fall; note 2	10 times on hard wood; for height of fall (h) see Table 4	$\Delta f/f \leq 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Fc	vibration	frequency 10 to 500 to 10 Hz; 3 directions	
	HR industrial types	acceleration 10 g; 30 minutes per direction	$\Delta f/f \leq 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
	HR automotive types	acceleration 40 g; 80 hours (total)	$\Delta f/f \leq 20$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Na	temperature cycling test		
	HR industrial types	−40 to +85 °C; 10 cycles; 6 minutes per cycle	$\Delta f/f \leq 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
	HR automotive types	−40 to +150 °C; 500 cycles; 30 minutes per cycle t_1 = 15 min.; t_2 = 6 s	$\Delta f/f \leq 20$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Q	sealing (method 1)	16 hours; 700 kPa He	$<1 \times 10^{-8}$ ncc/s He

IEC 68-2 METHOD	TEST	PROCEDURE	REQUIREMENTS
Ta	solderability	235 ±5 °C; 2 ±0.5 s; flux 600 (activated); optional steam pre-heat 8 hours. This reflects at least 36 months of storage at room conditions	≥90% except for 1 mm from body no visible damage, no leaks
Tb	resistance to soldering heat	350 ±5 °C; 3.5 ±0.5 s	$\Delta f/f \leq 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Ub	bending of terminations	1 x 90°; load 5 N	no visible damage, no leaks
Other applicable tests			
Xa	resistance to solvents; note 3: Bio-Act EC7®; Neutropon P3® and Saxin P3®; Meta Clean 820®; Lonco 446®; Isopropanol cleaning solvent; Dowanol DPM® (glass crystals only)	in accordance with *"IEC 68-2-45"*, *"IEC 653"* (immersion time 5 minutes) and *"MIL 202 E215"*. At ambient temperature and ultrasonic frequency (40 kHz)	no degradation of marking

Notes

1. Test table including MIL-specs (*"MIL-Std 883"* and *"MIL-Std 202"*) can be provided upon request.
2. Mechanical tests to be performed on units clamped to a printed-circuit board for the total unit height.
3. Bio-Act is a registered trademark of Petroform.
   Neutropon P3 and Saxin P3 are registered trademarks of Henkel.
   Meta Clean 820 is a registered trademark of Mavom.
   Lonco 447 is a registered trademark of London Chemical Co.
   Dowanol DPM is a registered trademark of Dow Chemical.

Table 4 Height of fall

h (mm)	PRODUCT HEIGHT (mm)	FREQUENCY RANGE[1] (MHz)	
		FUNDAMENTAL MODE	THIRD OVERTONE
1000	6.4	8.0 to 12.0	24.0 to 36.0
750	8.0 and 8.8	8.0 to 16.0	24.0 to 48.0
500	6.4	12.1 to 20.0	36.1 to 60.0
500	8.0 and 8.8	16.1 to 24.0	48.1 to 75.0
250	6.4	20.1 to 24.0	60.1 to 75.0

Note

1. Standard values. Actual designs can be made to obtain higher or lower values.

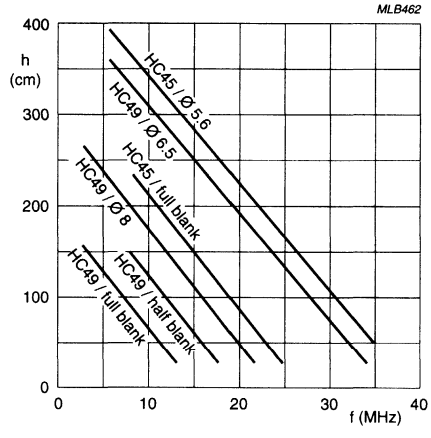


Fig.12 Typical height of fall values (3× on hard wood) for various quartz blank and holder combinations. 'Full' and 'half' blanks refer to rectangular quartz designs; '∅' designates circular quartz designs and the appropriate diameter.

Quartz crystals - High Reliability industrial and automotive HC-49/U

9922 520 4.... series

FEATURES

- High mechanical stability
- High electrical reliability
- Automated production line for a high level of uniformity
- Additional procedures followed to ensure operation under severe environmental conditions
- Low resistance values
- High pullability values.

APPLICATIONS

- Car electronics
- Medical systems
- Professional computers
- Communication systems
- Control and measuring equipment
- Heavy-duty appliance electronics
- Professional audio and video electronics.

DESCRIPTION

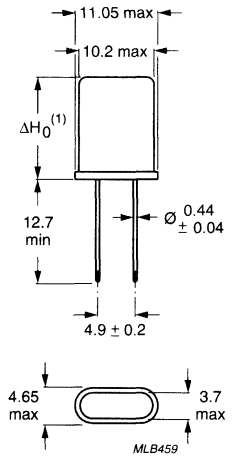
The unit consists of a silver-plated AT-cut quartz plate, encapsulated in a nitrogen-filled metal holder. The holder is hermetically sealed by resistance welding and provided with connecting leads.

QUICK REFERENCE DATA

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT
f_{nom}	nominal frequency range:				
	fundamental	3.0	–	27.0	MHz
	third overtone	20.0	–	75.0	MHz
T_{oper}	operating temperature	–40	–	+130	°C
T_{op}	operable temperature	–40	–	+155	°C
$\Delta f/f_{nom}$	adjustment tolerance	±10	±30	–	ppm
$\Delta f/f_{25}$	frequency stability over temperature range: –40 to 130 °C with respect to T_{amb} = 25 °C	–	±80	–	ppm
C_1	motional capacitance tolerance	±10	±20	–	%
C_0	parallel capacitance tolerance	±10	±20	–	%
$\Delta f/f$	ageing over 10 years at 25 °C	±5	–	±10	ppm

MECHANICAL DATA

Package and box outlines



Dimensions in mm.
(1) For ΔH_0 see Table 1.

Fig.1 Style 1: HC-49/U in box.

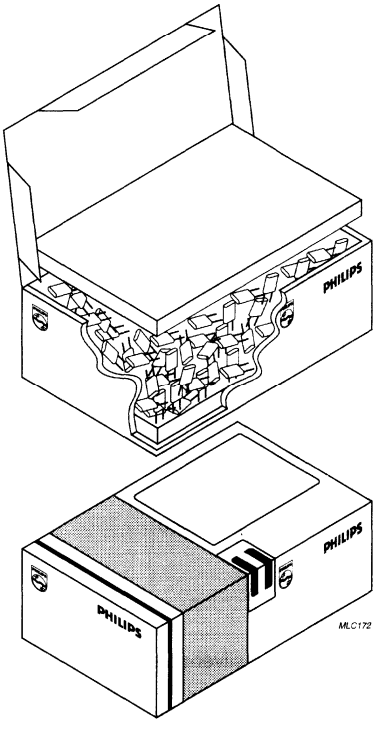


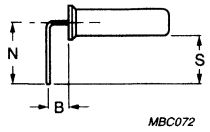
Fig.2 Box outline.

Table 1 Product height; notes 1 and 2

MAXIMUM PRODUCT HEIGHT ΔH_0 (mm)	MINIMUM FREQUENCY (MHz)	
	FUNDAMENTAL MODE	THIRD OVERTONE
9.6	8.0 to 27.0	24.0 to 75.0
11.0	8.0 to 27.0	24.0 to 75.0
13.4	3.0 to 27.0	20.0 to 75.0

Notes

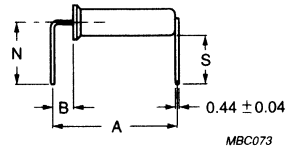
1. Available lead length from: up to 13 mm.
2. Lead length tolerance (for Style 1):
   a) Lead length (H_2) > 3 mm: ± 0.5 mm
   b) Lead length (H_2) ≤ 3 mm: ± 0.2 mm.



Dimensions in mm.

STYLE 4	N	B	S
a	7.0 ±0.6	2.5 ±0.6	5.2 ±0.6
b	8.0 ±0.6	2.0 ±0.6	6.2 ±0.6
c	9.7 ±0.6	3.0 ±0.6	7.9 ±0.6

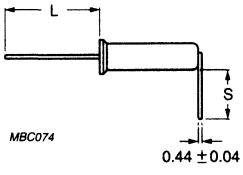
Fig.3 Style 4: HC-49/U on tray in box.



The third lead is symmetric, ±0.5 mm with respect to the other leads.
Dimensions in mm.

STYLE 5	N	B	A	S
a	5.7 ±1.0	1.5	15.2 ±0.2	3.9 ±1.0
b	5.9 ±1.0	4.1	17.8 ±0.2	4.1 ±1.0
c	10.2 ±1.0	3.3	16.5 ±0.2	8.4 ±1.0
d	5.7 ±1.0	1.9	15.6 ±0.2	3.9 ±1.0

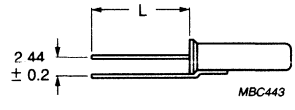
Fig.4 Style 5: HC-49/U on tray in box.



The third lead is symmetric, ±0.5 mm with respect to the other leads.
Dimensions in mm.

STYLE 6	L	S
a	13.2 ±0.5	4.5 ±1.0
b	13.2 ±0.5	10.0 ±1.0
c	5.0 ±0.5	19.5 ±1.0
d	13.2 ±0.5	19.5 ±1.0

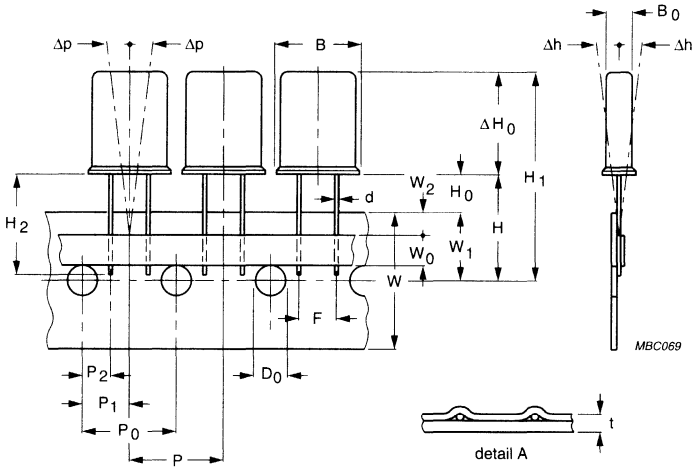
Fig.5 Style 6: HC-49/U on tray in box.



L: min. 12.7 mm; max. 13.0 mm.
The third lead is symmetric, ±0.5 mm with respect to the other leads.
Dimensions in mm.

Fig.6 Style 7: HC-49/U on tray in box.

Taping data

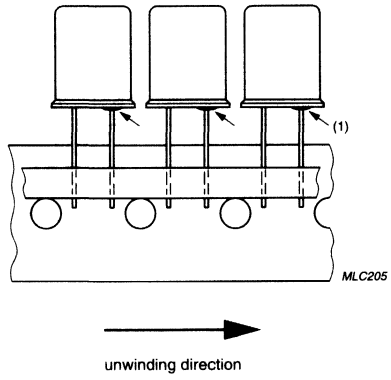


For dimensions see Table 2.

Fig.7 Style 2: HC-49/U on tape.

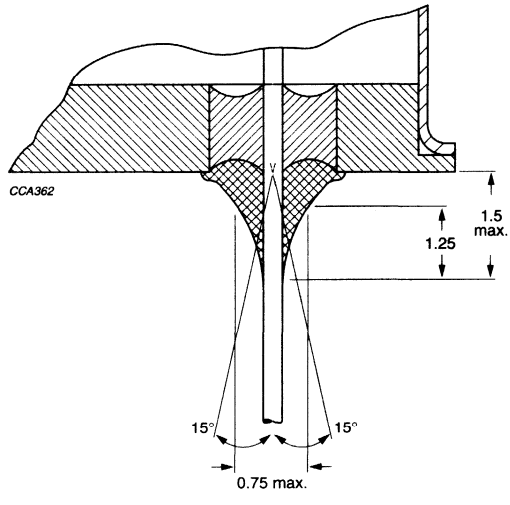
Table 2 Taping dimensions (without the insulation plate) in accordance with *"IEC 286-2"*; see Fig.7

SYMBOL	PARAMETER	VALUE	TOLERANCE	UNIT
B_0	body thickness	4.43	+0.05	mm
B	body width	10.75	±0.1	mm
Δh	component alignment vertical to tape plane	0	±2.0	mm
Δp	component alignment in tape plane	0	±1.3	mm
d	lead wire diameter	0.44	±0.04	mm
F	lead-to-lead distance	4.9	–	mm
P	pitch of components	12.7	±1.0	mm
P_0	feed-hole pitch	12.7	±0.3	mm
P_2	feed-hole centre to lead	3.9	±0.7	mm
P_1	feed-hole centre to component centre	6.35	±0.3	mm
D_0	feed-hole diameter	4.0	±0.2	mm
H	distance of component from tape centre	16.0	+2/0	mm
H_0	minimum component base to tape top	7.0	–	mm
H_2	lead length	12.7	±0.5	mm
W	carrier tape width	18.0	+1/–0.5	mm
W_0	maximum hold-down tape width	7.0	–	mm
W_1	feed-hole position	9.0	+0.75/–0.5	mm
W_2	maximum hold-down tape position	3.0	–	mm
t	maximum total tape thickness	0.9	–	mm



Style 11a is taped in ammopack; see Fig.10.
Style 11b is taped on reel; see Fig.11.
(1) Lead connected to metal case.

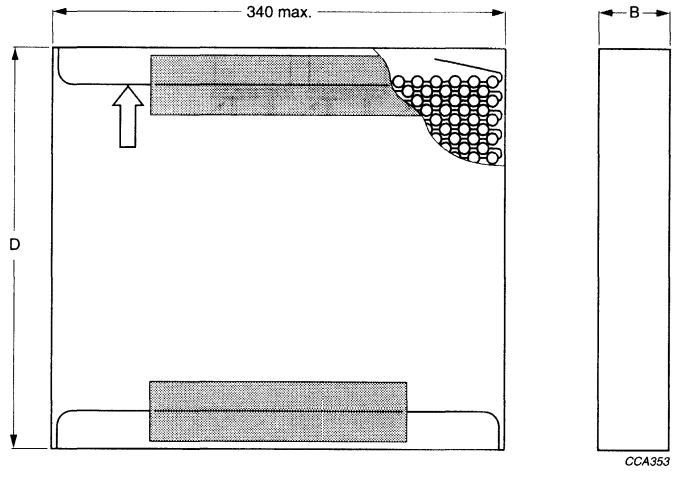
Fig.8 Style 11 taped units with one lead connected to case, otherwise as Style 2 (see Fig.7).



Dimensions in mm.
The electrical resistance shall be <5 Ω after 2 times 15° bending of the lead.
Coverage of glass bead by silver adhesive is a minimum of 40%.

Fig.9 Detailed drawing of the connection between the lead and base.

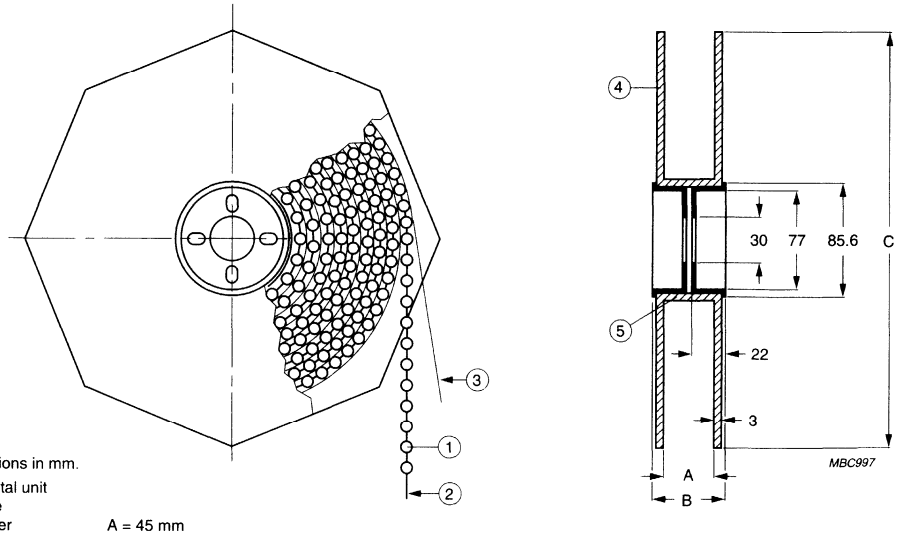
Ammopack and reel data



Dimensions in mm.
B = 46 mm max.
D = 185 mm max.

Style 3a is with insulation plate; see Fig.12.

Fig.10 Style 2a, 3a and 11a units on tape in ammopack.



Dimensions in mm.
1 = crystal unit
2 = tape
3 = paper
4 = flange
5 = cylinder

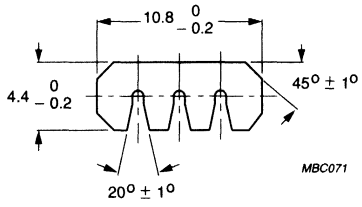
A = 45 mm
B = 55 mm max.
C = 355 mm max.

Style 3b is with insulation plate; see Fig.12.

Fig.11 Style 2b, 3b and 11b units on tape on reel.

Insulation plate

Style 3 units are equipped with an insulation plate (see Fig.12) at the unit base. The insulation plate is made of PEEK (polyetherketone) in 0.25 mm thickness and resistant to soldering heat tests.



Dimensions in mm.

Fig.12 Insulation plate outline for Style 3.

PACKAGING AND QUANTITIES

Table 3 HC-49/U holder

STYLE	PACKAGING(1)	QUANTITY	DIMENSIONS OF BOX (mm)		
			LENGTH	WIDTH	HEIGHT
1	in box	maximum 1000 units per box	200	125	70
	in blister	24 units per blister, 8 blisters per box			
	on tray in box	100 units per tray, 1 or 10 trays in box			
2a, 3a and 11a	on tape in ammopack	1000 units per pack, in box	340	185	46
2b, 3b and 11b	on tape on reel	1000 units per reel, in box	367	361	61
4, 5, 6 and 7	on tray in box	100 units per tray; 10 trays per box	380	90	168
5c		50 units per tray; 10 trays per box, minimum 2 boxes			

Note

1. The packaging of HR automotive products has an additional label showing the ordering data.

STANDARD MARKING(1)

- Line 1: PHILIPS
- Line 2: frequency in kHz (fundamental mode) or in MHz (overtone)
- LIne 3: last five digits of catalogue number followed by the manufacturing date code (last four digits of week code in accordance with UN-D1120).

MASS AND LEADS

Typical mass: 1.2 g.

The leads are finished with Sn99Cu1 on a nickel underplate.

The first 1 mm from the body is not guaranteed for soldering.

(1) Special marking on product and/or package is available on request.

ELECTRICAL DATA

Valid at an ambient temperature T_{amb} = 25 ±2 °C and a nominal drive level of 100 µW into 25 Ω unless otherwise specified. Measuring system: π-network in accordance with *"IEC 444"* recommendations.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
f_{nom}	nominal frequency	fundamental	3.0	–	27.0	MHz
		third overtone	20.0	–	75.0	MHz
$\Delta f/f_{nom}$	adjustment tolerance	see specific 12NC	±10	±30	–	ppm
R_r	resonance resistance	see note 2	–	–	–	Ω
C_L	load capacitance	see note 2	5	20	∞	pF
T_{oper}	operating temperature	see specific 12NC	−40	–	+130	°C
T_{op}	operable temperature		−40	–	+155	°C
$\Delta f/f_{25}$	frequency stability over temperature range, with respect to T_{amb} = 25 °C	see note 2	75	100	150	ppm
R_r (T)	resonance resistance over temperature range	see note 2	available from R_r upwards			Ω
C_1	motional capacitance	see specific 12NC	–	–	–	fF
	tolerance		±10	±20	–	%
C_o	parallel capacitance	see specific 12NC	–	–	–	pF
	tolerance		±10	±20	–	%
S	pulling sensitivity		$S = -0.5\ C_1 / (C_0 + C_L)^2$			ppm/pF
R_n	resonance resistance of unwanted response (spurious)	fundamental mode; f_{nom} ±20%	2 R_r (T)	–	–	Ω
			+6	–	–	dB
		overtones; f_{nom} ±200 kHz	2 R_r (T)	–	–	Ω
			+6	–	–	dB
R_{dld}	drive level dependency, being the resonance resistance in the drive level range	drive level range 10^{-16} W to 10^{-4} W; note 2	see note 3			Ω
R_{ins}	insulation resistance	DC test voltage = 100 V	500	–	–	MΩ
$\Delta f/f$	ageing	10 years at T_{amb} = 25 °C	±5	–	±10	ppm

Notes

1. A specific value should be chosen within the given range.
2. All resistance values are measured in series resonance:
   a) See specific 12NC for actual values.
   b) Load resonance measurement is available on request.
3. Frequency measurement in temperature range is performed in series resonance if not requested otherwise:
   a) See specific 12NC for actual values.

Quartz crystals - High Reliability industrial and automotive HC-49/U

9922 520 4.... series

CHARACTERISTICS PER CRYSTAL: FUNDAMENTAL MODE "1"; THIRD OVERTONE "3"

Measured at +25 ±2 °C at a drive level of 0.5 mW into 25 Ω unless otherwise specified. Measuring system: π-network in accordance with *"IEC 444"*. For some crystals, the old numbering series (4322 143) may still apply, see characteristics table.

CATALOGUE NUMBER	f_n (kHz)	MODE	C_L (pF)	T_o (°C)	$\Delta f/f_n$ ($\times 10^{-6}$)	$\Delta f/f_{25}$ ($\times 10^{-6}$)	R_{rT} (Ω)
4322 143 05131	4000.000	1	30	–40/+130	±30	±80	100
9922 520 40006	4000.000	1	20	–40/+115	±30	±80	100
9922 520 40002	4194.304	1	20	–40/+130	±30	±75	80
4322 143 05161	6000.000	1	20	–40/+115	±30	±80	60
4322 143 04241	6144.000	1	20	–40/+115	±30	±80	60
4322 143 04951	7372.800	1	20	–40/+115	±30	±80	60
9922 520 40024	8000.000	1	20	–40/+130	±30	±100	50
9922 520 40026	10000.000	1	20	–40/+130	±30	±100	40
9922 520 40027	12000.000	1	20	–40/+130	±30	±100	40
9922 520 40028	24000.000	3	20	–40/+130	±30	±100	75
9922 520 40029	27000.000	3	20	–40/+130	±30	±100	60
9922 520 40031	28000.000	3	20	–40/+130	±30	±100	60
9922 520 40032	36864.000	3	22	–40/+130	±30	±100	50
9922 520 40033	40000.000	3	20	–40/+130	±30	±100	50

Key to symbols

f_n = nominal frequency

C_L = load capacitance

T_o = operating temperature range

$\Delta f/f_n$ = adjustment tolerance at 25 °C

$\Delta f/f_{25}$ = frequency stability over temperature range, with respect to the frequency at 25 °C

R_{rT} = resonance resistance over the operating temperature range, maximum value, measured in series resonance.

Derivatives

R_n = resonance resistance of unwanted response: $2 \times R_{rT}$ Ω (–6 dB), for fundamental mode

S = pulling sensitivity: $\dfrac{-C_1}{2(C_0 + C_L)^2}$

TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with IEC publication 68-2, *"Recommended basic climatic and mechanical robustness testing procedure for electronic components"* and IEC publication 1178-1, *"Generic specification for quartz crystal units"*.

Table 4 Test procedures and requirements

IEC 68-2 METHOD	TEST	PROCEDURE	REQUIREMENTS
Ba	ageing		
	HR industrial types	1000 hours at +70 °C	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
	HR automotive types	250 hours at +130 °C	$\Delta f/f \leq \pm 20$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Db	accelerated damp heat	+25 °C to +55 °C; 6 cycles at RH >95%	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Ea	shock; note 1	100 g half sine; 6 directions; 1 blow per direction	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Eb	bump; note 1	4000 bumps of 40 g	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Ed	free fall; note 1	10 times on hard wood; for height of fall (h) see Table 5	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Fc	vibration	frequency 10 to 500 to 10 Hz; 3 directions	
	HR industrial types	acceleration 10 g; 30 minutes per direction	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
	HR automotive types	acceleration 40 g; 80 hours (total)	$\Delta f/f \leq \pm 20$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Na	temperature cycling test		
	HR industrial types	−40 °C to +85 °C; 10 cycles; 6 minutes per cycle	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
	HR automotive types	−40 °C to +150 °C; 500 cycles; 30 minutes per cycle t_1 = 15 min.; t_2 = 6 s	$\Delta f/f \leq \pm 20$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Q	sealing (method 1)	16 hours; 700 kPa He	$<1 \times 10^{-8}$ ncc/s He

IEC 68-2 METHOD	TEST	PROCEDURE	REQUIREMENTS
Ta	solderability	235 ±5 °C; 2 ±0.5 s; flux 600 (activated); optional steam pre-heat 8 hours. This reflects at least 36 months of storage at room conditions	≥90% except for 1 mm from body no visible damage, no leaks
Tb	resistance to soldering heat	350 ±5 °C; 3.5 ±0.5 s	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Ub	bending of terminations	1 x 90°; load 5 N	no visible damage, no leaks
Other applicable tests			
Xa	resistance to solvents; note 2: Bio-Act EC7®; Neutropon P3® and Saxin P3®; Meta Clean 820®; Lonco 446®; Isopropanol cleaning solvent; Dowanol DPM® (glass crystals only)	in accordance with *"IEC 68-2-45"*, *"IEC 653"* (immersion time 5 minutes) and *"MIL 202 E215"*. At ambient temperature and ultrasonic frequency (40 kHz)	no degradation of marking

Notes

1. Mechanical tests to be performed on units clamped to a printed circuit board for the total unit height.
2. Bio-Act is a registered trademark of Petroform.
   Neutropon P3 and Saxin P3 are registered trademarks of Henkel.
   Meta Clean 820 is a registered trademark of Mavom.
   Lonco 447 is a registered trademark of London Chemical Co.
   Dowanol DPM is a registered trademark of Dow Chemical.

Table 5 Height of fall

h (mm)	FREQUENCY RANGE[1] (MHz)	
	FUNDAMENTAL MODE	THIRD OVERTONE
1000	3.0 to 12.0	20.0 to 36.0
500	12.1 to 16.0	36.1 to 48.0
250	16.1 to 27.0	48.1 to 75.0

Note

1. Standard values. Actual designs can be made to obtain higher or lower values.

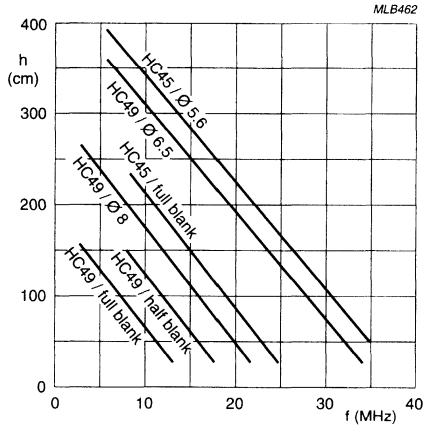


Fig.13 Typical height of fall values (3× on hard wood) for various quartz blank and holder combinations. 'Full' and 'half' blanks refer to rectangular quartz designs; '∅' designates circular quartz designs and the appropriate diameter.

Quartz crystals - High Reliability industrial and automotive HC-45/U

9922 521 2.... series

FEATURES

- Small dimensions
- High mechanical stability
- High electrical reliability
- Automated production for a high level of uniformity
- Additional procedures followed to ensure operation under severe environmental conditions.

APPLICATIONS

- Car electronics
- Personal computers, high reliability
- Portable equipment, high reliability.

DESCRIPTION

The unit consists of a silver-plated AT-cut quartz plate, encapsulated in a nitrogen-filled metal holder. The holder is hermetically sealed by resistance-welding and provided with two connecting leads.

QUICK REFERENCE DATA

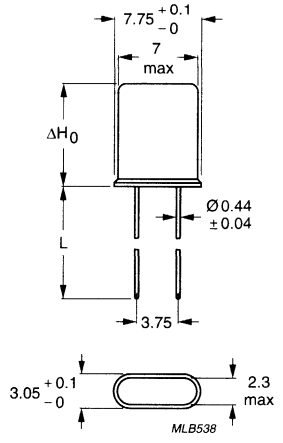
SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT
f_{nom}	nominal frequency:				
	fundamental mode	8.0	–	24.0	MHz
	third overtone	24.0	–	75.0	MHz
T_{oper}	operating temperature	–40	–	+130	°C
T_{op}	operable temperature	–55	–	+155	°C
$\Delta f/f_{nom}$	adjustment tolerance	±10	±30	–	ppm
$\Delta f/f_{25}$	frequency stability over temperature range: –40 to +130 °C with respect to T_{amb} = 25 °C	–	±80	–	ppm
C_1	motional capacitance tolerance	±10	–	–	%
C_0	parallel capacitance tolerance	±10	–	–	%
$\Delta f/f$	ageing over 10 years at 25 °C	±5	–	±10	ppm

Quartz crystals - High Reliability industrial and automotive HC-45/U

9922 521 2.... series

MECHANICAL DATA

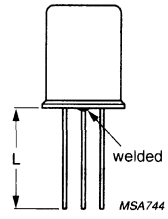
Package outlines



Dimensions in mm.

(1) For ΔH_0 see Table 1.

Fig.1 Style 1: HC-45/U in box.



L: min. 12.7 mm; max. 13.0 mm.

Fig.2 Style 4: HC-45/U in box.

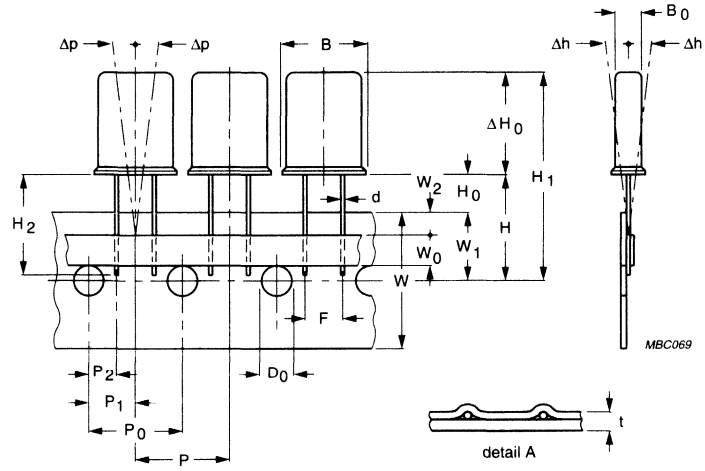
Table 1 Product height and lead length; note 1

MAXIMUM HEIGHT ΔH_0 (mm)	MAXIMUM LEAD LENGTH L (mm)	FREQUENCY RANGE (MHz)	
		FUNDAMENTAL MODE	THIRD OVERTONE
6.4	20.0	8.0 to 24.0	32.0 to 70.0
8.0	20.0	8.0 to 24.0	24.0 to 70.0
8.8	20.0	8.0 to 24.0	24.0 to 70.0

Note

1. Lead length tolerance for Style 1:
   a) Lead length (H_2) > 3 mm: ±0.5 mm
   b) Lead length (H_2) ≤ 3 mm: ±0.2 mm.

Taping data



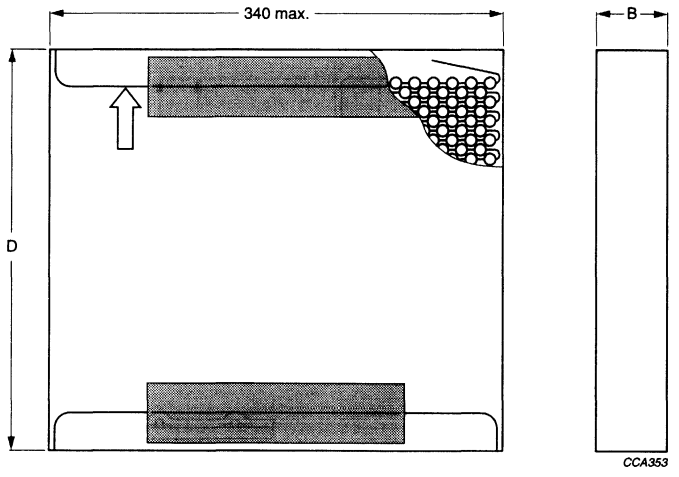
For dimensions see Table 2.

Fig.3 Style 2a and 2b: HC-45/U on tape.

Table 2 Taping dimensions (without the insulation plate) in accordance with *"IEC 286-2"*; see Fig.3

SYMBOL	PARAMETER	VALUE	TOLERANCE	UNIT
B_0	maximum body thickness	3.1	±0.05	mm
B	body width	7.8	±0.05	mm
Δh	component alignment vertical to tape plane	–	±2.0	mm
Δp	component alignment in tape plane	–	±1.3	mm
d	lead wire diameter	0.44	±0.04	mm
F	lead-to-lead	3.75	–	mm
P	pitch of components	12.7	±1.0	mm
P_0	feed-hole pitch	12.7	±0.3	mm
P_2	feed-hole centre to lead	4.5	±0.7	mm
P_1	feed-hole centre to component centre	6.35	±0.3	mm
D_0	feed-hole diameter	4.0	±0.2	mm
H	distance of component from tape centre	18.0	+2/0	mm
H_0	minimum component base to tape top	9.0	–	mm
H_2	lead length	20.0	±0.5	mm
W	carrier tape width	18.0	+1/–0.5	mm
W_0	maximum hold-down tape width	7.0	–	mm
W_1	feed-hole position	9.0	+0.75/–0.5	mm
W_2	maximum hold-down tape position	3.0	–	mm
t	maximum total tape thickness	0.9	–	mm

Ammopack and reel data

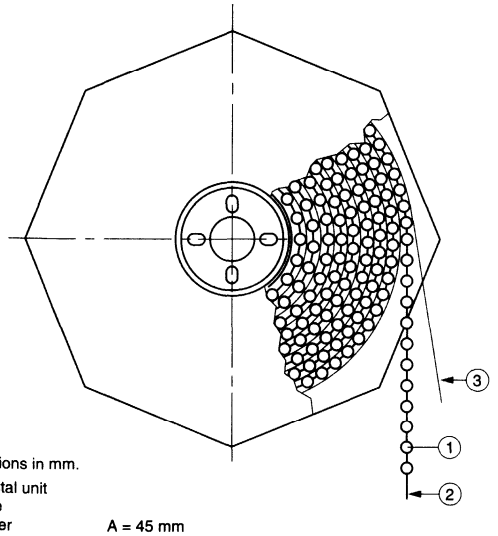


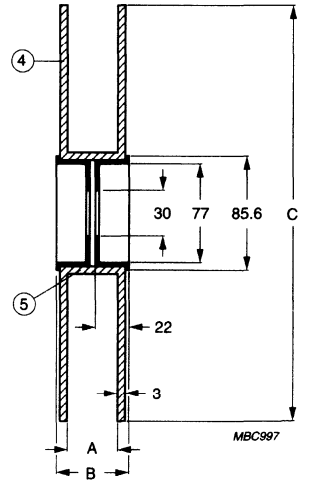
Dimensions in mm.

B = 46 mm max.
D = 185 mm max.

Style 3a is with insulation plate; see Fig.6.

Fig.4 Style 2a and 3a units on tape in ammopack.





Dimensions in mm.

1 = crystal unit
2 = tape
3 = paper
4 = flange
5 = cylinder

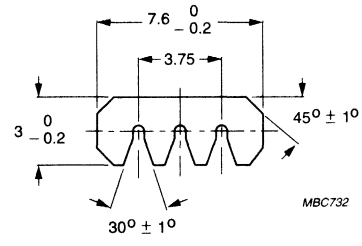
A = 45 mm
B = 55 mm max.
C = 355 mm max.

Style 3b is with insulation plate; see Fig.6.

Fig.5 Style 2b and 3b units on tape on reel.

Insulation plate

Style 3 units are equipped with an insulation plate (see Fig.6) at the unit base. The insulation plate is made of PEEK (polyetherketone) in 0.25 mm thickness and resistant to soldering heat tests.



Dimensions in mm.

Fig.6 Insulation plate outline for Style 3.

PACKAGING AND QUANTITIES

Table 3 HC-45/U holder

STYLE	PACKAGING(1)	QUANTITY	DIMENSIONS OF BOX (mm)		
			LENGTH	WIDTH	HEIGHT
1	in box	maximum 1000 units per box	200	125	45
2a and 3a	on tape in ammopack	1000 units per pack, in box	340	185	46
2b and 3b	on tape on reel	1000 units per reel, in box	283	283	60
4	in box	1000 units per box	380	90	168

Note

1. The packaging of HR automotive products has an additional label showing the ordering data.

STANDARD MARKING(1)

- Line 1: PHILIPS
- Line 2: frequency in kHz (fundamental mode) or in MHz (overtone)
- LIne 3: last five digits of catalogue number followed by the manufacturing date code (last four digits of week code in accordance with UN-D1120).

MASS AND LEADS

Typical mass: 0.4 g.

The leads are finished with Sn99Cu1 on a nickel underplate.

The first 1 mm from the body is not guaranteed for soldering.

(1) Special marking on product and/or package is available on request.

Quartz crystals - High Reliability industrial and automotive HC-45/U

9922 521 2.... series

ELECTRICAL DATA

Valid at T_{amb} = 25 ±2 °C and a nominal drive level of 100 µW into 25 Ω unless otherwise specified. Measuring system: π-network in accordance with *"IEC 444"* recommendations.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
f_{nom}	nominal frequency	fundamental	8.0	–	24.0	MHz
		third overtone	24.0	–	75.0	MHz
$\Delta f/f_{nom}$	adjustment tolerance		±10	±30	–	ppm
		6.4 mm height	±20	±30	–	ppm
R_r	resonance resistance	see note 1	see Figs 7, 9 and 11			Ω
C_L	load capacitance	fundamental mode; note 2	5	20	∞	pF
		overtones; note 2	5	∞	–	pF
T_{oper}	operating temperature		–40	–	+130	°C
T_{op}	operable temperature		–40	–	+155	°C
$\Delta f/f_{25}$	frequency stability over temperature range	T_{amb} = 25 °C	see Table 4, class 2			ppm
R_r (T)	resonance resistance over temperature range	see note 1	available from R_r upwards			Ω
C_1	motional capacitance		see Figs 8, 10 and 12			fF
	tolerance		±10	–	–	%
C_0	parallel capacitance		see Figs 8, 10 and 12			pF
	tolerance		±10	–	–	%
S	pulling sensitivity		$S = -0.5\ C_1 / (C_0 + C_L)^2$			ppm/pF
R_n	resonance resistance of unwanted response (spurious)	fundamental mode; f_{nom} ±20%	2 R_r (T)	–	–	Ω
			+6	–	–	dB
		overtones; f_{nom} ±200 kHz	2 R_r (T)	–	–	Ω
			+6	–	–	dB
R_{did}	drive level dependency, being the resonance resistance in the drive level range	drive level range 10^{-16} W to 10^{-4} W; note 1	see note 2			Ω
R_{ins}	insulation resistance	DC test voltage = 100 V	500	–	–	MΩ
$\Delta f/f$	ageing	10 years at T_{amb} = 25 °C; see Figs 13 and 14	±5	–	±10	ppm

Notes

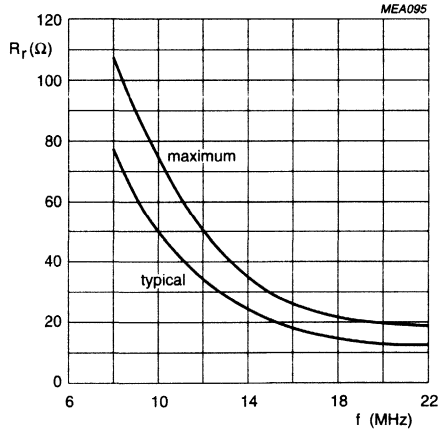
1. All resistance values are measured in series resonance, other values available on request.
2. Values available on request.

Table 4 Frequency stability with temperature variation (available maximum values).

TEMPERATURE RANGE[1] (°C)	FREQUENCY STABILITY (ppm)		
	CLASS 0	CLASS 1	CLASS 2
+20/+30	±1.0	±1.5	±2.0
0/+50	±5.0	±7.5	±10.0
−10/+60	±7.5	±10.0	±15.0
−20/+70	±10.0	±15.0	±20.0
−30/+80	±12.5	±20.0	±25.0
−40/+90	±17.5	±25.0	±30.0
−55/+105	±25.0	±30.0	±40.0
−40/+130	–	±50.0	±80.0

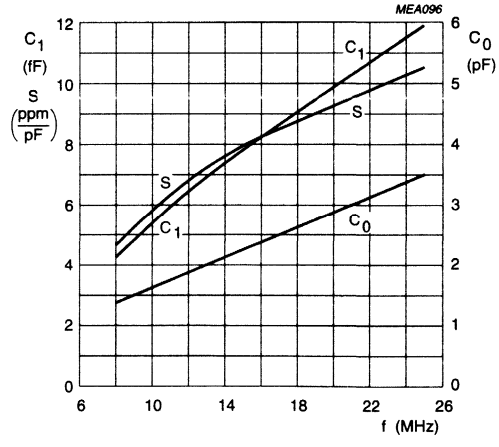
Note

1. To obtain the same stability at frequencies below 8.0 MHz, the upper temperature limit is 10 °C lower.



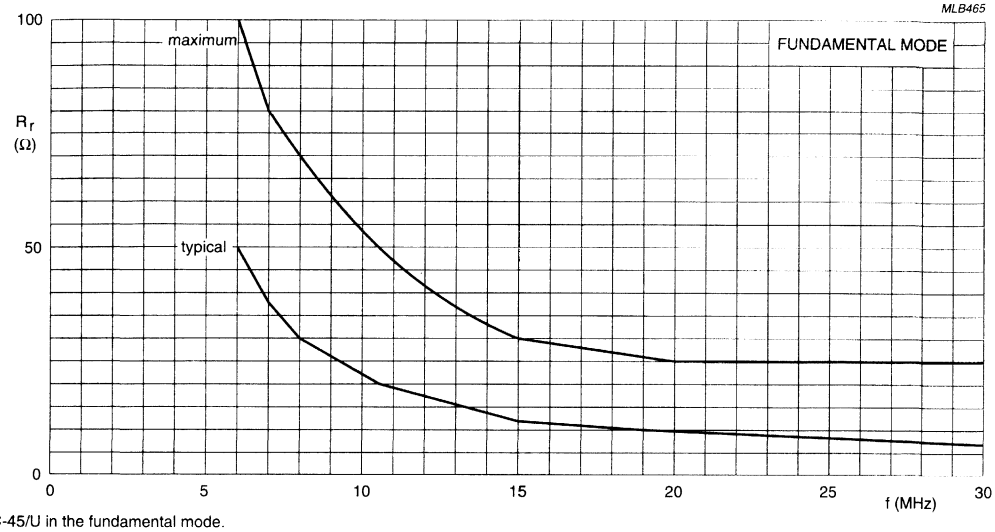
R_r at 25 °C.
HC-45/U crystals in 6.4 mm product height (involving small blanks).

Fig.7 Resonance resistance R_r as a function of resonance frequency.



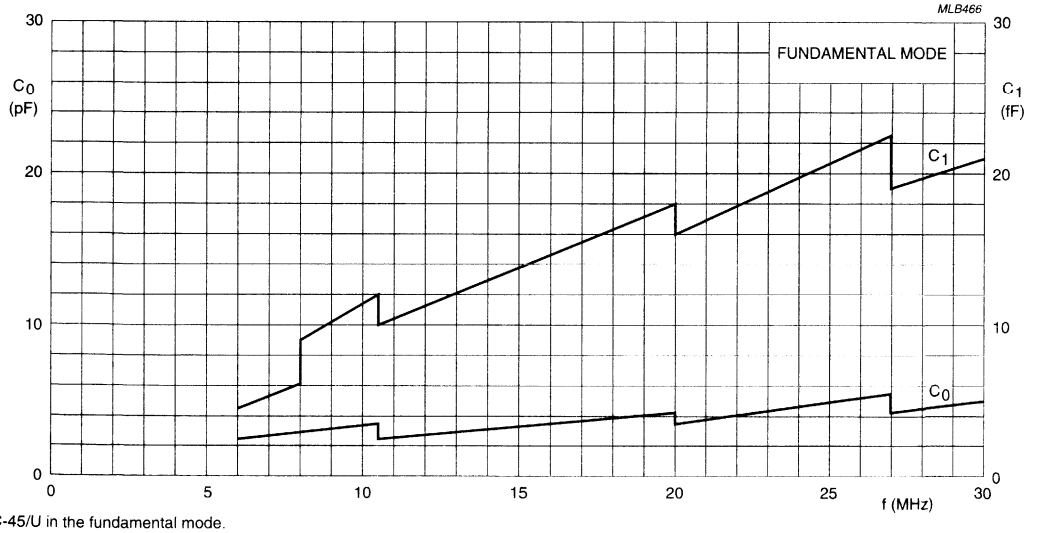
R_r at 25 °C.
HC-45/U crystals in 6.4 mm product height (involving small blanks).

Fig.8 Motional capacitance C_1, parallel capacitance C_0 and pulling sensitivity S (assuming C_L = 20 pF) as functions of resonance frequency.



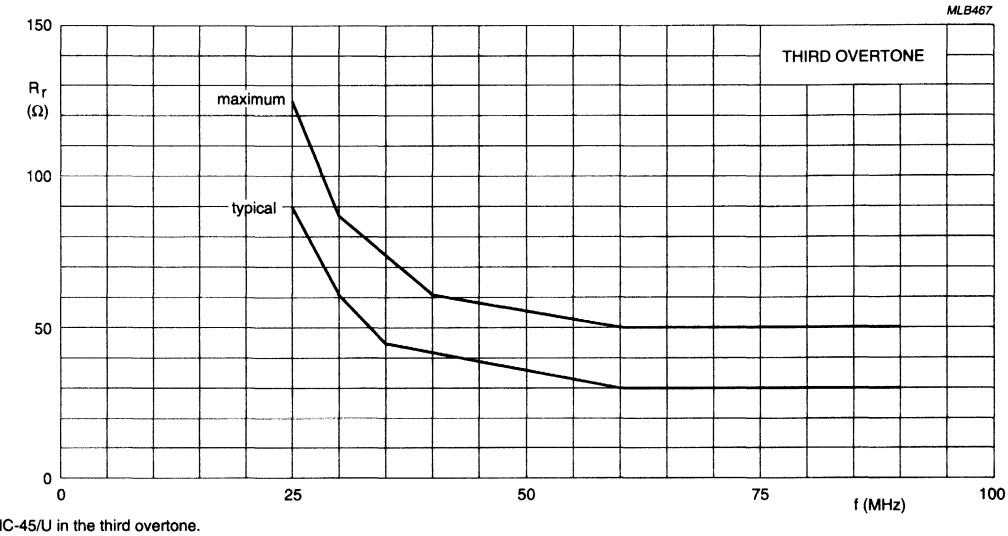
HC-45/U in the fundamental mode.
Values at 25 °C.
Other values available by extrapolation with C_0 and C_1 values.

Fig.9 Resonance resistance R_r as a function of resonance frequency, for HC-45/U crystals in 8 mm product height (involving large quartz blanks).



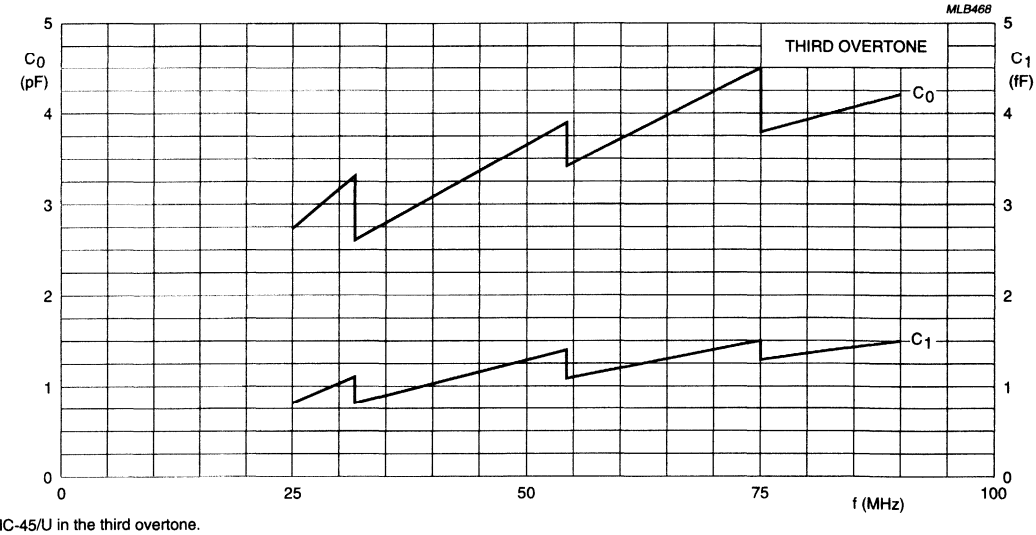
HC-45/U in the fundamental mode.
Typical values at 25 °C.
Other values available by extrapolation of the curve segments.

Fig.10 Motional capacitance C_1 and parallel capacitance C_0 as a function of resonance frequency, for HC-45/U crystals in 8 mm product height (involving large quartz blanks).



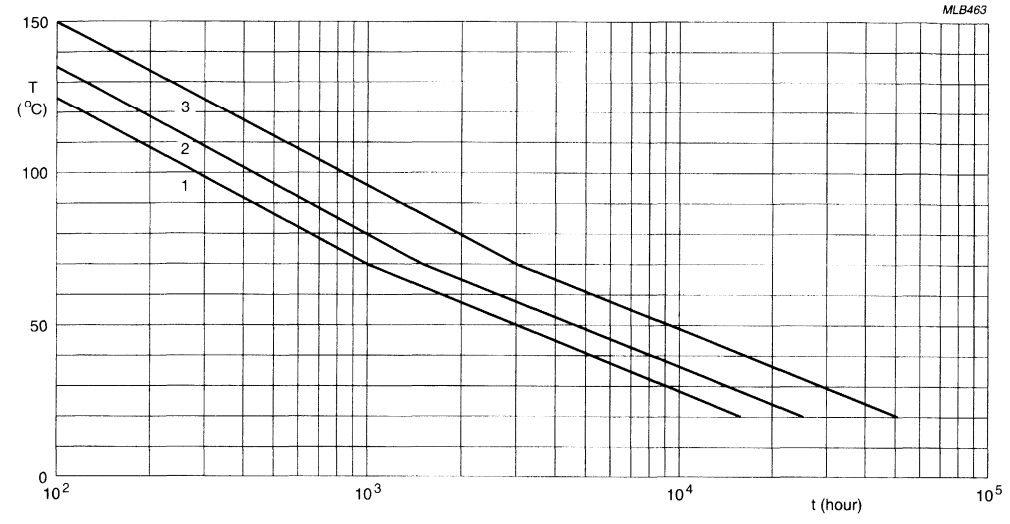
HC-45/U in the third overtone.
Values at 25 °C.
Other values available by extrapolation with C_0 and C_1 values.

Fig.11 Resonance resistance R_r as a function of resonance frequency, for HC-45/U crystals in 8 mm product height (involving large quartz blanks).



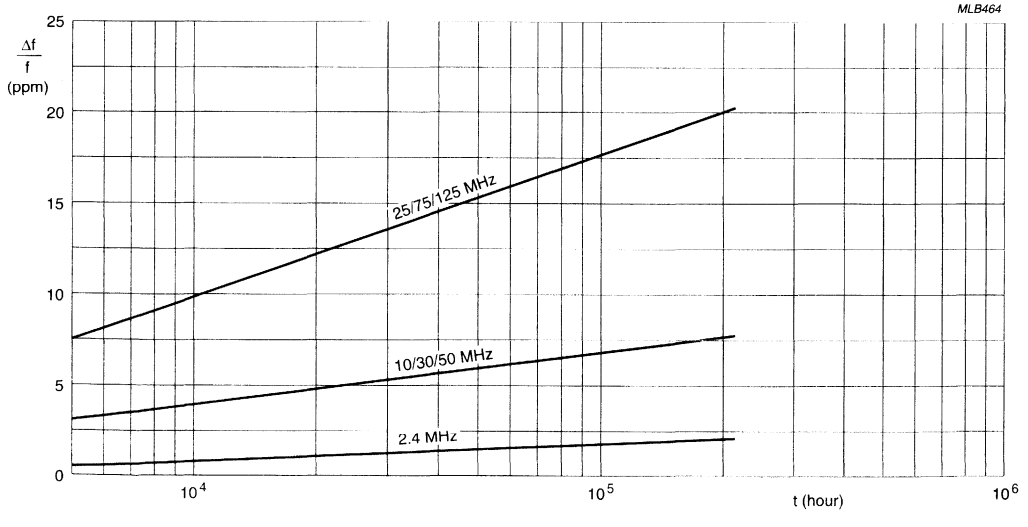
HC-45/U in the third overtone.
Typical values at 25 °C.
Other values available by extrapolation with C_0 and C_1 values.

Fig.12 Motional capacitance C_1 and parallel capacitance C_0 as a function of resonance frequency, for HC-45/U crystals in 8 mm product height (involving large quartz blanks).



Curve 1 = 1000 hours at 70 °C.
Curve 2 = 720 hours at 85 °C.
Curve 3 = 240 hours at 130 °C.

Fig.13 Time/temperature relation at which ageing is approximately equivalent.



Fundamental, third and fifth overtones.
Necessary pre-ageing can be calculated using Fig.13.

Fig.14 Typical frequency ageing as a function of time at 25 °C, **without pre-ageing of crystals.**

TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with IEC publication 68-2, *"Recommended basic climatic and mechanical robustness testing procedure for electronic components"* and IEC publication 1178-1, *"Generic specification for quartz crystal units"*.

Table 5 Test procedures and requirements; note 1

IEC 68-2 METHOD	TEST	PROCEDURE	REQUIREMENTS
Ba	ageing		
	HR industrial types	1 000 hours at +70 °C	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
	HR automotive types	250 hours at +130 °C	$\Delta f/f \leq \pm 40$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Db	accelerated damp heat	+25 °C to +55 °C; 6 cycles at RH >95%	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Ea	shock; note 2	100 g half sine; 6 directions; 1 blow per direction	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Eb	bump; note 2	4000 bumps of 40 g	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Ed	free fall; note 2	10 times on hard wood; for height of fall (h) see Table 6	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Fc	vibration	frequency 10 to 500 to 10 Hz; 3 directions	
	HR industrial types	acceleration 10 g; 30 minutes per direction	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
	HR automotive types	acceleration 40 g; 80 hours (total)	$\Delta f/f \leq \pm 20$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Na	temperature cycling test		
	HR industrial types	−40 to +85 °C; 10 cycles; 6 minutes per cycle	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
	HR automotive types	−40 to +150 °C; 500 cycles; 30 minutes per cycle t_1 = 15 min.; t_2 = 6 s	$\Delta f/f \leq \pm 20$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Q	sealing (method 1)	16 hours; 700 kPa He	$<1 \times 10^{-8}$ ncc/s He

IEC 68-2 METHOD	TEST	PROCEDURE	REQUIREMENTS
Ta	solderability	235 ±5 °C; 2 ±0.5 s; flux 600 (activated); optional steam pre-heat 8 hours. This reflects at least 36 months of storage at room conditions	≥90% except for 1 mm from body no visible damage, no leaks
Tb	resistance to soldering heat	350 ±5 °C; 3.5 ±0.5 s	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Ub	bending of terminations	1 x 90°; load 5 N	no visible damage, no leaks
Other applicable tests			
Xa	resistance to solvents; note 3: Bio-Act EC7®; Neutropon P3® and Saxin P3®; Meta Clean 820®; Lonco 446®; Isopropanol cleaning solvent; Dowanol DPM® (glass crystals only)	in accordance with *"IEC 68-2-45"*, *"IEC 653"* (immersion time 5 minutes) and *"MIL 202 E215"*. At ambient temperature and ultrasonic frequency (40 kHz)	no degradation of marking

Notes

1. Test table including MIL-specs (*"MIL-Std 883"* and *"MIL-Std 202"*) can be provided upon request.
2. Mechanical tests to be performed on units clamped to a printed-circuit board for the total unit height.
3. Bio-Act is a registered trademark of Petroform.
   Neutropon P3 and Saxin P3 are registered trademarks of Henkel.
   Meta Clean 820 is a registered trademark of Mavom.
   Lonco 447 is a registered trademark of London Chemical Co.
   Dowanol DPM is a registered trademark of Dow Chemical.

Table 6 Height of fall

h (mm)	PRODUCT HEIGHT (mm)	FREQUENCY RANGE[1] (MHz)	
		FUNDAMENTAL MODE	THIRD OVERTONE
1000	6.4	8.0 to 12.0	24.0 to 36.0
750	8.0 and 8.8	8.0 to 16.0	24.0 to 48.0
500	6.4	12.1 to 20.0	36.1 to 60.0
500	8.0 and 8.8	16.1 to 24.0	48.1 to 75.0
250	6.4	20.1 to 24.0	60.1 to 75.0

Note

1. Standard values. Actual designs can be made to obtain higher or lower values.

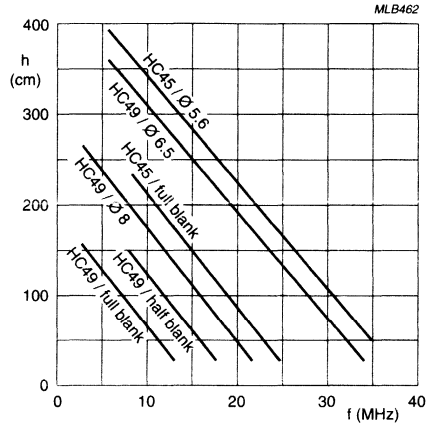


Fig.15 Typical height of fall values (3× on hard wood) for various quartz blank and holder combinations. 'Full' and 'half' blanks refer to rectangular quartz designs; '∅' designates circular quartz designs and the appropriate diameter.

PROFESSIONAL APPLICATIONS

Quartz crystals - professional applications HC-49/SMD-like

9922 522 43... series

FEATURES

- Outstanding electrical performance
- Low resistance values
- High pullability values
- High mechanical and electrical stability
- Low ageing.

APPLICATIONS

- Microprocessors
- Traffic control
- Weather balloons
- Medical systems
- Military applications
- Communication systems
- Agrarian applications
- Machine control
- Environmental applications.

DESCRIPTION

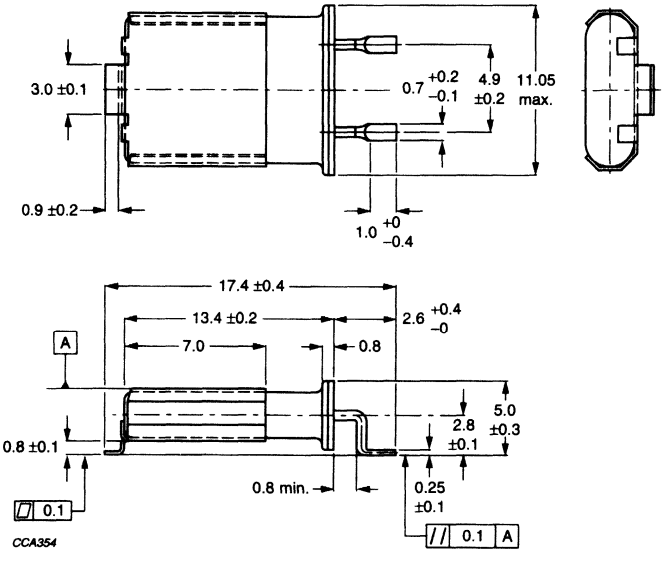
The unit consists of a silver-plated AT-cut quartz plate, encapsulated in a nitrogen-filled metal holder. The holder is hermetically sealed by resistance welding and provided with connections for surface mounting.

QUICK REFERENCE

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT
f_{nom}	nominal frequency:				
	fundamental mode	2.4	–	27.0	MHz
	third overtone	16.8	–	75.0	MHz
	fifth overtone	50.0	–	125.0	MHz
T_{oper}	operating temperature	–40	–	+105	°C
T_{op}	operable temperature	–55	–	+155	°C
$\Delta f/f_{nom}$	adjustment tolerance	±5	±10	–	ppm
$\Delta f/f_{25}$	frequency stability over temperature range: –20 to +70 °C with respect to T_{amb} = 25 °C:				
	class 0	–	±10	–	ppm
	class 1	–	±15	–	ppm
	class 2	–	±20	–	ppm
C_1	motional capacitance tolerance	±5	±10	–	%
C_0	parallel capacitance tolerance	±5	±10	–	%
$\Delta f/f$	ageing over 10 years at 25 °C	±3	–	±5	ppm

MECHANICAL DATA

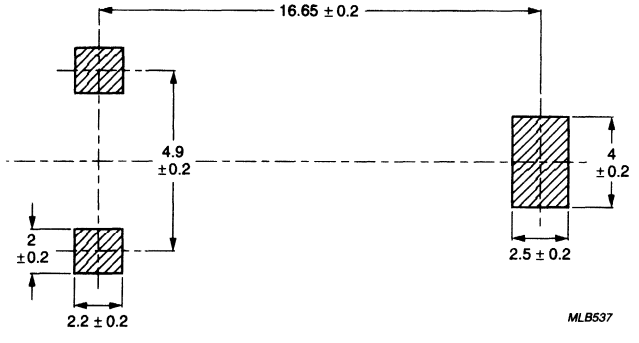
Package outlines



Dimensions in mm.

Fig.1 Style 1: HC-49/U17-SMD/Clip I.

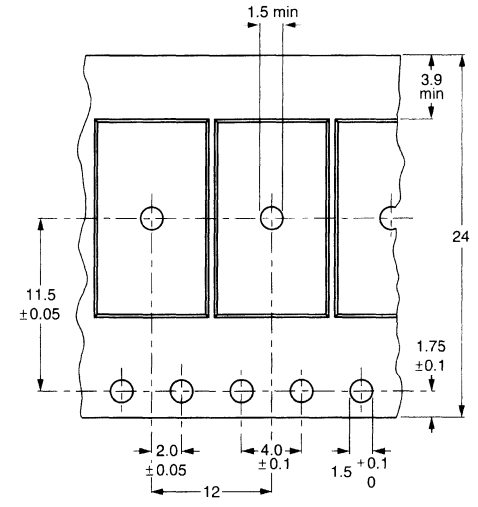
Recommended pad layout

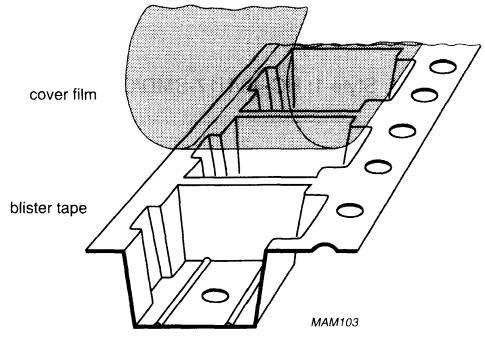


Dimensions in mm.

Fig.2 HC-49/U-SMD/Clip I.

Tape and reel data



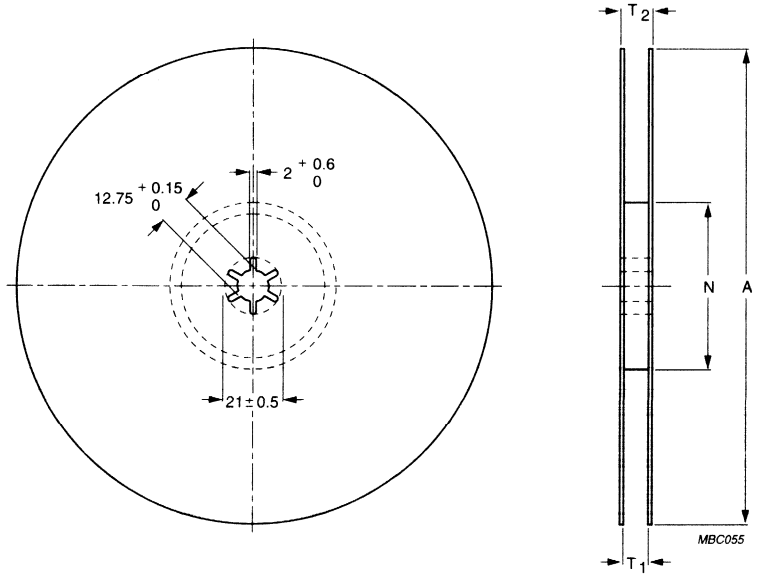


Dimensions in mm.
Crystal connections are adjacent to sprocket holes.
Cumulative pitch error: ≤0.2 mm over 10 pitches.

Total tape height of tape with top film: 5.8 mm maximum.
Tape thickness: 0.3 mm.
The blister is made of conductive polystyrene. Taping is performed in accordance with *"IEC 286-3"*.
Leader: minimum 400 mm including 100 mm sealed with empty compartments.
Trailer: minimum 160 mm sealed with empty compartments.

Pocket dimensions:
Length = 18.3 ±0.1 mm
Width = 11.4 ±0.1 mm
Depth = 5.6 +0.05/–0 mm.

Fig.3 Blister tape.



Dimensions in mm.
For dimensions see Table 1.

Fig.4 Reel dimensions.

Table 1 Reel dimensions; see Fig.4

TAPE WIDTH (mm)	A (mm)	N (mm)	T_1 (mm)	T_2 (mm)
24	330	62 ±1.5	24.4 +0.2/–0	28.4 ±0.2

PACKAGING AND QUANTITIES

STYLE	PACKAGING	QUANTITY	DIMENSIONS OF BOX (mm)		
			LENGTH	WIDTH	HEIGHT
1	blister tape on reel	700 units per reel	338	338	38
	blister tray	700 units per box	200	125	70

STANDARD MARKING(1)

- Line 1: PHILIPS
- Line 2: frequency in kHz (fundamental mode) or in MHz (overtone)
- LIne 3: last five digits of catalogue number followed by the manufacturing date code (last three digits of week code).

MASS AND LEADS

Typical mass: 1.2 g.

The leads are finished with either Sn99Cu1 or Sn60Pb40 on a nickel underplate.

The first 1 mm from the body is not guaranteed for soldering.

(1) Special marking on product and/or package is available on request.

Quartz crystals - professional applications HC-49/SMD-like

9922 522 43... series

ELECTRICAL DATA

Valid at T_{amb} = 25 ± 2 °C and a nominal drive level of 100 μW into 25 Ω unless otherwise specified. Measuring system: π-network in accordance with *"IEC 444"* recommendations.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
f_{nom}	nominal frequency	fundamental	2.4	–	27.0	MHz
		third overtone	16.8	–	75.0	MHz
		fifth overtone	50.0	–	125.0	MHz
$\Delta f/f_{nom}$	adjustment tolerance		±5	±10	–	ppm
R_r	resonance resistance	see note 1	–	–	–	Ω
C_L	load capacitance	see note 2	5	20	∞	pF
T_{oper}	operating temperature		−40	–	+105	°C
T_{op}	operable temperature		−55	–	+155	°C
$\Delta f/f_{25}$	frequency stability over temperature range, with respect to T_{amb} = 25 °C		see Table 2			ppm
R_r (T)	resonance resistance over temperature range	see note 1	available from R_r upwards			Ω
C_1	motional capacitance					fF
	tolerance		±5	±10	–	%
C_0	parallel capacitance					pF
	tolerance		±5	±10	–	%
S	pulling sensitivity		$S = -0.5\ C_1 / (C_0 + C_L)^2$			ppm/pF
R_n	resonance resistance of unwanted response (spurious)	fundamental mode; f_{nom} ±20%	2 R_r (T)	–	–	Ω
			+6	–	–	dB
		overtones; f_{nom} ±200 kHz	2 R_r (T)	–	–	Ω
			+6	–	–	dB
R_{dld}	drive level dependency, being the resonance resistance in the drive level range	drive level range 10^{-16} W to 10^{-4} W; note 1	see note 2			Ω
R_{ins}	insulation resistance	DC test voltage = 100 V	500	–	–	MΩ
$\Delta f/f_{nom}$	total frequency stability with respect to f_{nom}	including temperature range and ageing	see Table 2			ppm
	frequency hysteresis or discontinuity		–	–	1	ppm
$\Delta f/f$	ageing	see Figs 5 and 6	±3	–	±5	ppm

Notes

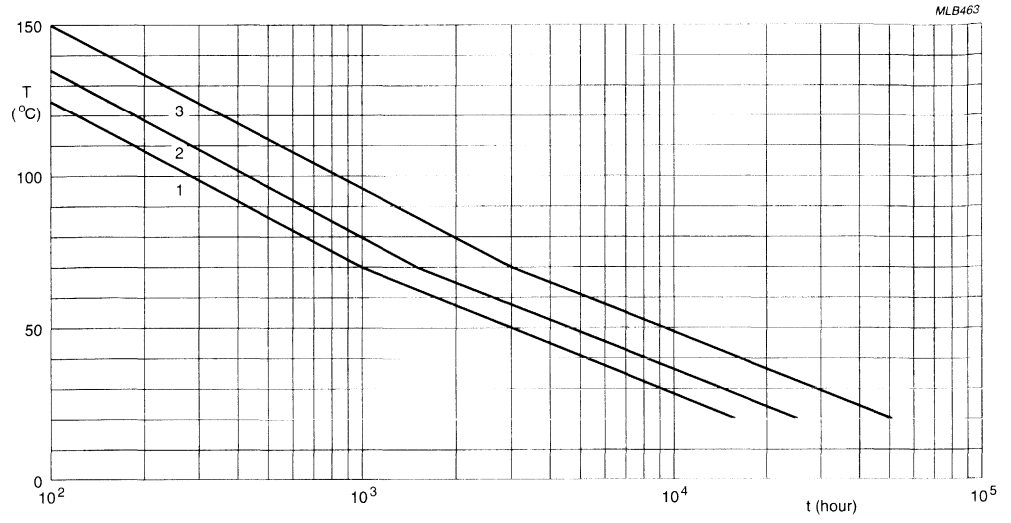
1. All resistance values are measured in series resonance. Load resonance measurement is available on request.
2. Values available on request.

Table 2 Frequency stability with temperature variation (available maximum values)

TEMPERATURE RANGE[1] (°C)	FREQUENCY STABILITY (ppm)		
	CLASS 0	CLASS 1	CLASS 2
+20/+30	±1.0	±1.5	±2.0
0/+50	±5.0	±7.5	±10.0
−10/+60	±7.5	±10.0	±15.0
−20/+70	±10.0	±15.0	±20.0
−30/+80	±12.5	±20.0	±25.0
−40/+90	±17.5	±25.0	±30.0
−55/+105	±25.0	±30.0	±40.0
−40/+130	−	±50.0	±80.0

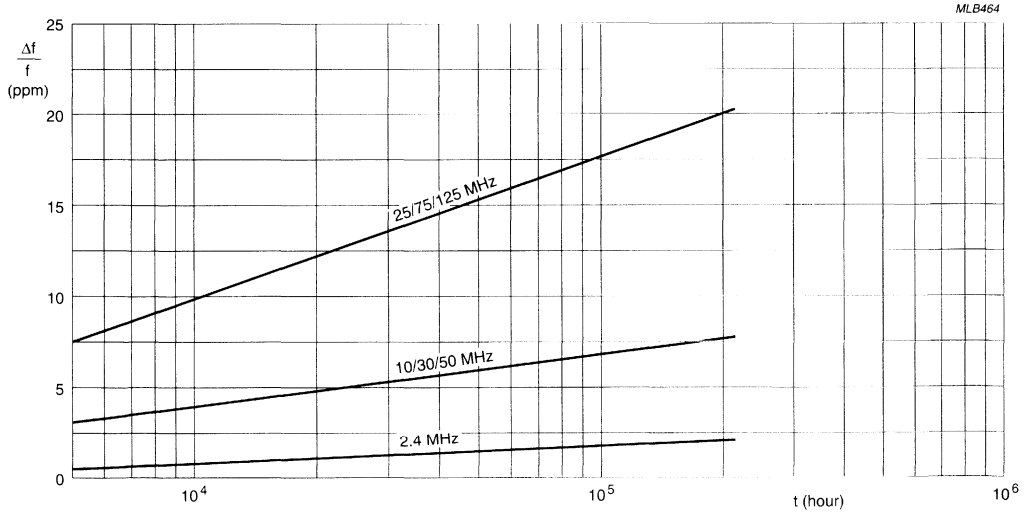
Note

1. To obtain the same stability at frequencies below 8.0 MHz, the upper temperature limit is 10 °C lower.



Curve 1 = 1000 hours at 70 °C.
Curve 2 = 720 hours at 85 °C.
Curve 3 = 240 hours at 130 °C.

Fig.5 Time/temperature relation at which ageing is approximately equivalent.



Fundamental, third and fifth overtones.
Necessary pre-ageing can be calculated using Fig.5.

Fig.6 Typical frequency ageing as a function of time at 25 °C, **without pre-ageing of crystals.**

TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with IEC publication 68-2, *"Recommended basic climatic and mechanical robustness testing procedure for electronic components"* and IEC publication 1178-1, *"Generic specification for quartz crystal units"*.

Table 3 Test procedures and requirements; note 1

IEC 68-2 METHOD	TEST	PROCEDURE	REQUIREMENTS
Ba	ageing	1000 hours at 70 °C	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Db	accelerated damp heat	+25 to +55 °C; 6 cycles at RH >95%	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Ea	shock; note 2	100 g; half sinewave; 6 directions; 1 blow/direction	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Eb	bump; note 2	4000 bumps of 40 g	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Ed	free fall; note 2	3 times on hard wood; for height of fall (h) see Table 4	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Fc	vibration	frequency 10 to 500 to 10 Hz; acceleration 10 g; 3 directions; 30 minutes/direction	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Na	temperature cycling test	−40 to +85 °C; 10 cycles; 0.1 hour/cycle	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Q	sealing (method 1)	16 hours; 700 kPa He	$<1 \times 10^{-8}$ ncc/s He
Ta	solderability	235 ±5 °C; 2 ±0.5 s; flux 600 (activated); optional steam pre-heat 8 hours. This reflects at least 36 months of storage at room conditions	≥90%, on the flat lead part; no visible damage, no leaks
Tb	resistance to reflow soldering	rise 10 K/s; dwell 2 min/160 °C; rise 10 K/s up to 280 °C; cool down	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater

IEC 68-2 METHOD	TEST	PROCEDURE	REQUIREMENTS
Other applicable tests			
Xa	resistance to solvents; note 3: Bio-Act EC7®; Neutropon P3® and Saxin P3®; Meta Clean 820®; Lonco 446®; Isopropanol cleaning solvent; Dowanol DPM® (glass crystals only)	in accordance with *"IEC 68-2-45"*, *"IEC 653"* (immersion time 5 minutes) and *"MIL 202 E215"*. At ambient temperature and ultrasonic frequency (40 kHz)	no degradation of marking

Notes

1. Test table including MIL-specs (*"MIL-Std 883"* and *"MIL-Std 202"*) can be provided upon request.
2. Mechanical tests to be performed on units clamped to a printed-circuit board for the total unit height.
3. Bio-Act is a registered trademark of Petroform.
   Neutropon P3 and Saxin P3 are registered trademarks of Henkel.
   Meta Clean 820 is a registered trademark of Mavom.
   Lonco 447 is a registered trademark of London Chemical Co.
   Dowanol DPM is a registered trademark of Dow Chemical.

Table 4 Height of fall

h (mm)	PRODUCT LENGTH (mm)	FREQUENCY RANGE[1] (MHz)		
		FUNDAMENTAL MODE	THIRD OVERTONE	FIFTH OVERTONE
750	17	2.4 to 16.0	20.0 to 48.0	50.0 to 80.0
500	17	16.1 to 27.0	48.1 to 75.0	80.1 to 125.0

Note

1. Standard values. Actual designs can be made to obtain higher or lower values.

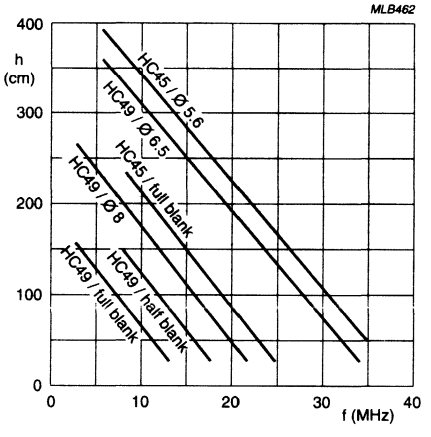


Fig.7 Typical height of fall values (3× on hard wood) for various quartz blank and holder combinations. 'Full' and 'half' blanks refer to rectangular quartz designs; 'Ø' designates circular quartz designs and the appropriate diameter.

Quartz crystals - professional applications HC-45/SMD-like

9922 522 23... series

FEATURES

- Small dimensions
- Outstanding electrical performance
- High mechanical and electrical stability
- Low ageing.

APPLICATIONS

- Microprocessors
- Traffic control
- Weather balloons
- Medical systems
- Military applications
- Communication systems
- Agrarian applications
- Machine control
- Environmental applications.

DESCRIPTION

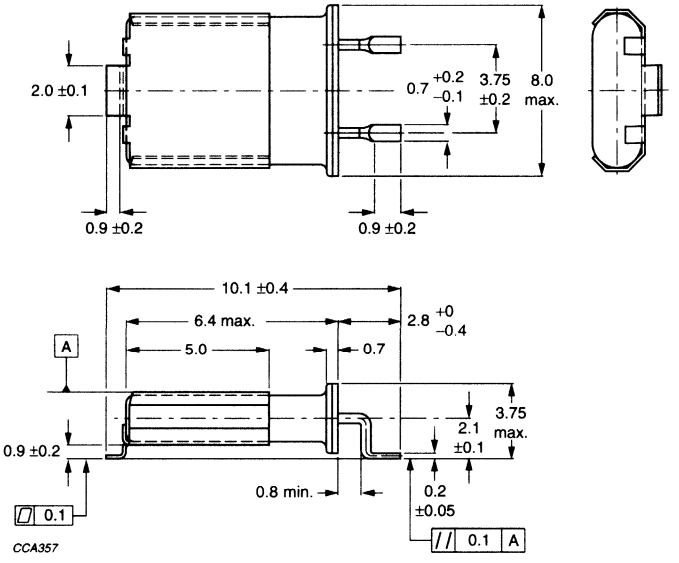
The unit consists of a silver-plated AT-cut quartz plate, encapsulated in a nitrogen-filled metal holder. The holder is hermetically sealed by resistance welding and provided with connections for surface mounting.

QUICK REFERENCE

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT
f_{nom}	nominal frequency:				
	fundamental mode	6.0	–	30.0	MHz
	third overtone	24.0	–	90.0	MHz
	fifth overtone	60.0	–	150.0	MHz
T_{oper}	operating temperature	–40	–	+105	°C
T_{op}	operable temperature	–55	–	+155	°C
$\Delta f/f_{nom}$	adjustment tolerance	±5	±30	–	ppm
$\Delta f/f_{25}$	frequency stability over temperature range: –20 to +70 °C with respect to T_{amb} = 25 °C:				
	class 0	–	±10	–	ppm
	class 1	–	±15	–	ppm
	class 2	–	±20	–	ppm
C_1	motional capacitance tolerance	±5	±10	–	%
C_0	parallel capacitance tolerance	±5	±10	–	%
$\Delta f/f$	ageing over 10 years at 25 °C	±3	–	±5	ppm

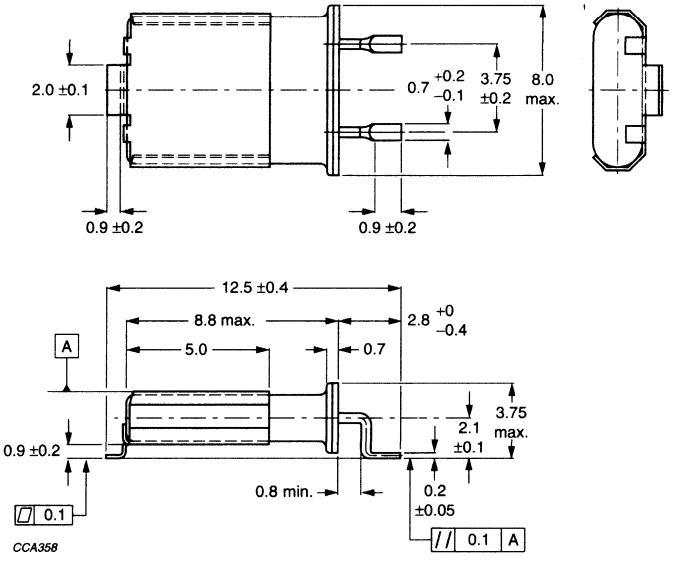
MECHANICAL DATA

Package outlines



Dimensions in mm.

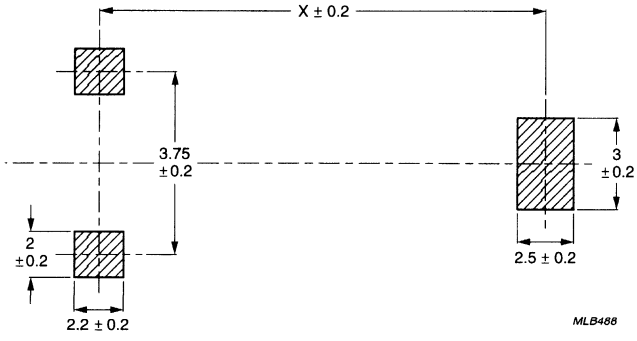
Fig.1 Style 1: HC-45/U10-SMD/Clip I.



Dimensions in mm.

Fig.2 Style 2: HC-45/U12-SMD/Clip I.

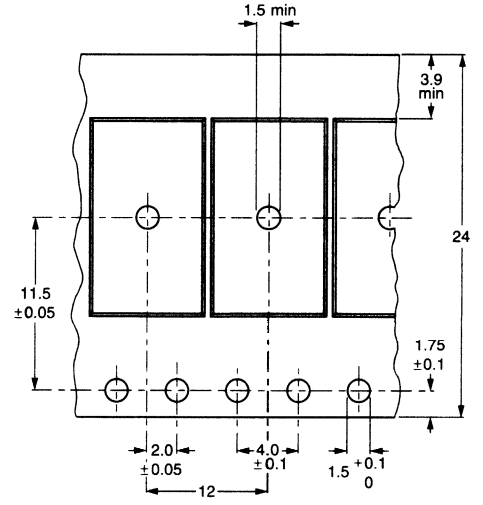
Recommended pad layout

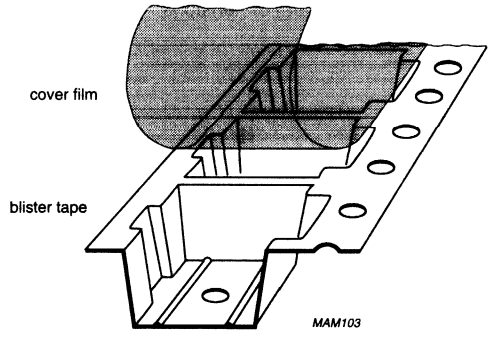


Dimensions in mm.
HC-45/U10: X = 9.2.
HC-45/U12: X = 11.6.

Fig.3 HC-45/U-SMD/Clip I.

Tape and reel data



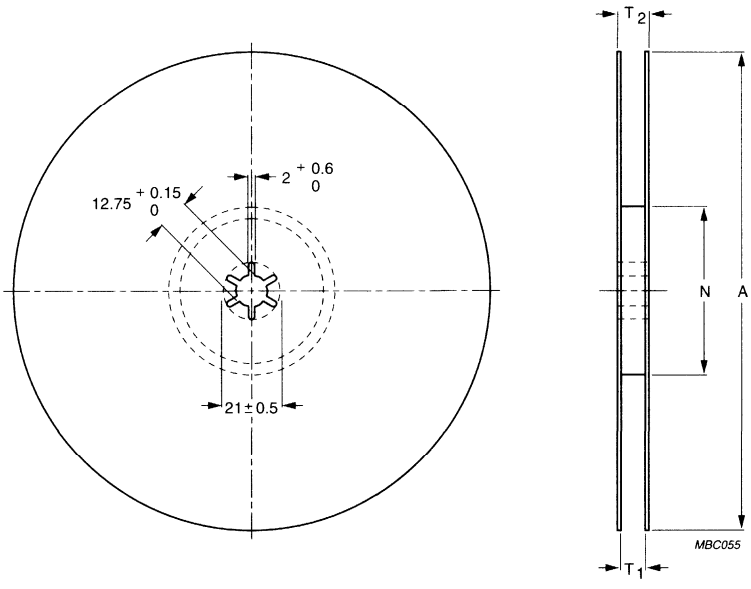


Dimensions in mm.
Crystal connections are adjacent to sprocket holes.
Cumulative pitch error: ≤0.2 mm over 10 pitches.

Total tape height of tape with top film: 4.5 mm maximum.
Tape thickness: 0.3 mm.
The blister is made of conductive polystyrene. Taping is performed in accordance with *"IEC 286-3"*.
Leader: minimum 400 mm including 100 mm sealed with empty compartments.
Trailer: minimum 160 mm sealed with empty compartments.

Pocket dimensions:
Length = 13.1 ±0.1 mm
Width = 8.3 ±0.1 mm
Depth = 4.3 +0.05/–0 mm.

Fig.4 Blister tape.



Dimensions in mm.
For dimensions see Table 1.

Fig.5 Reel dimensions.

Table 1 Reel dimensions; see Fig.5

TAPE WIDTH (mm)	A (mm)	N (mm)	T_1 (mm)	T_2 (mm)
24	286	62 ±1.5	24.4 +0.2/–0	28.4 ±0.2

PACKAGING AND QUANTITIES

STYLE	PACKAGING	QUANTITY	DIMENSIONS OF BOX (mm)		
			LENGTH	WIDTH	HEIGHT
1	blister tape on reel	1000 units per reel	298	295	42
	blister tray	6 units per tray	315	155	67

STANDARD MARKING(1)

- Line 1: PHILIPS
- Line 2: frequency in kHz (fundamental mode) or in MHz (overtone)
- Line 3: last five digits of catalogue number followed by the manufacturing date code (last three digits of week code).

MASS AND LEADS

Typical mass: 0.5 g.

The leads are finished with Sn99Cu1 or Sn60Pb40 on a nickel underplate.

The first 1 mm from the body is not guaranteed for soldering.

(1) Special marking on product and/or package is available on request.

Quartz crystals - professional applications HC-45/SMD-like

9922 522 23... series

ELECTRICAL DATA

Valid at T_{amb} = 25 ± 2 °C and a nominal drive level of 100 μW into 25 Ω unless otherwise specified. Measuring system: π-network in accordance with *"IEC 444"* recommendations.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
f_{nom}	nominal frequency	fundamental	6.0	–	30.0	MHz
		third overtone	24.0	–	90.0	MHz
		fifth overtone	60.0	–	150.0	MHz
$\Delta f/f_{nom}$	adjustment tolerance	10 mm length	±20	±30	–	ppm
		12 mm length	±5	±30	–	ppm
R_r	resonance resistance	see note 1	see Figs 6 and 8			Ω
C_L	load capacitance	see note 2	5	20	∞	pF
T_{oper}	operating temperature		–40	–	+105	°C
T_{op}	operable temperature		–55	–	+155	°C
$\Delta f/f_{25}$	frequency stability over temperature range, with respect to T_{amb} = 25 °C		see Table 2			ppm
R_r (T)	resonance resistance over temperature range	see note 1	available from R_r upwards			Ω
C_1	motional capacitance		see Figs 7 and 9			fF
	tolerance		±5	±10	–	%
C_0	parallel capacitance		see Figs 7 and 9			pF
	tolerance		±5	±10	–	%
S	pulling sensitivity		$S = -0.5\ C_1 / (C_0 + C_L)^2$			ppm/pF
R_n	resonance resistance of unwanted response (spurious)	fundamental mode; f_{nom} ±20%	2 R_r (T)	–	–	Ω
			+6	–	–	dB
		overtones; f_{nom} ±200 kHz	2 R_r (T)	–	–	Ω
			+6	–	–	dB
R_{dld}	drive level dependency, being the resonance resistance in the drive level range	drive level range 10^{-16} W to 10^{-4} W; note 1	see note 2			Ω
R_{ins}	insulation resistance	DC test voltage = 100 V	500	–	–	MΩ
$\Delta f/f_{nom}$	total frequency stability with respect to f_{nom}	including temperature range and ageing	see Table 2			ppm
	frequency hysteresis or discontinuity		–	–	1	ppm
Δf/f	ageing	see Figs 10 and 11	±3	–	±5	ppm

Notes

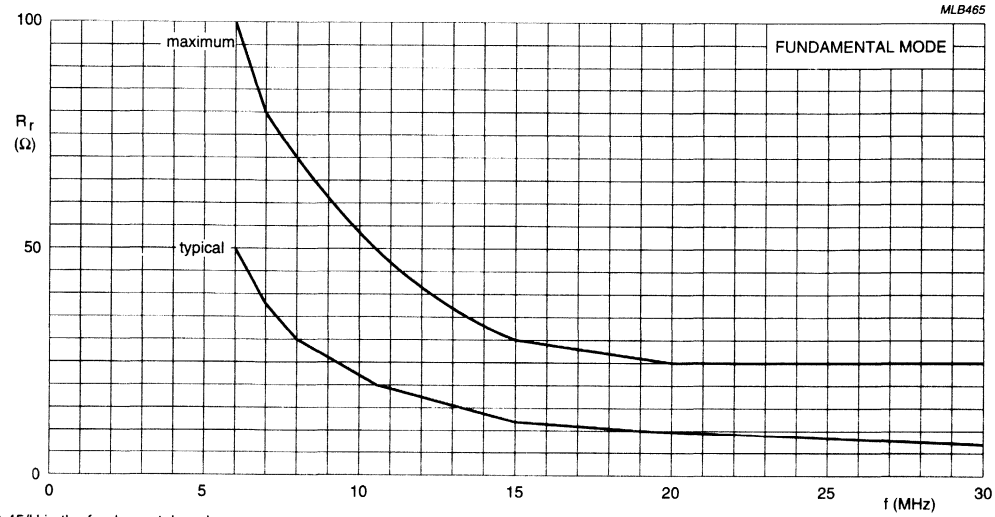
1. All resistance values are measured in series resonance. Load resonance measurement available on request.
2. Values available on request.

Table 2 Frequency stability with temperature variation (available maximum values)

TEMPERATURE RANGE[1] (°C)	FREQUENCY STABILITY (ppm)		
	CLASS 0	CLASS 1	CLASS 2
+20/+30	±1.0	±1.5	±2.0
0/+50	±5.0	±7.5	±10.0
−10/+60	±7.5	±10.0	±15.0
−20/+70	±10.0	±15.0	±20.0
−30/+80	±12.5	±20.0	±25.0
−40/+90	±17.5	±25.0	±30.0
−55/+105	±25.0	±30.0	±40.0
−40/+130	–	±50.0	±80.0

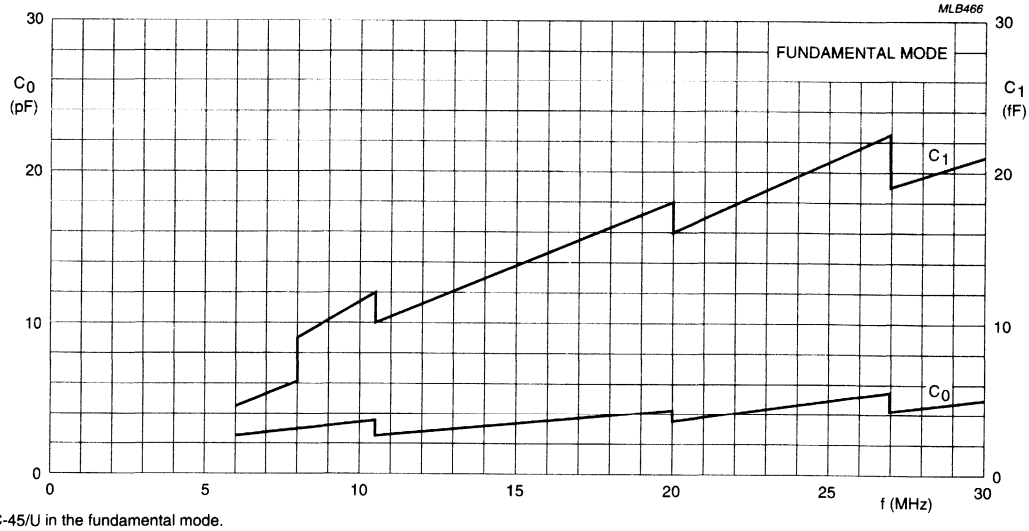
Note

1. To obtain the same stability at frequencies below 8.0 MHz, the upper temperature limit is 10 °C lower.



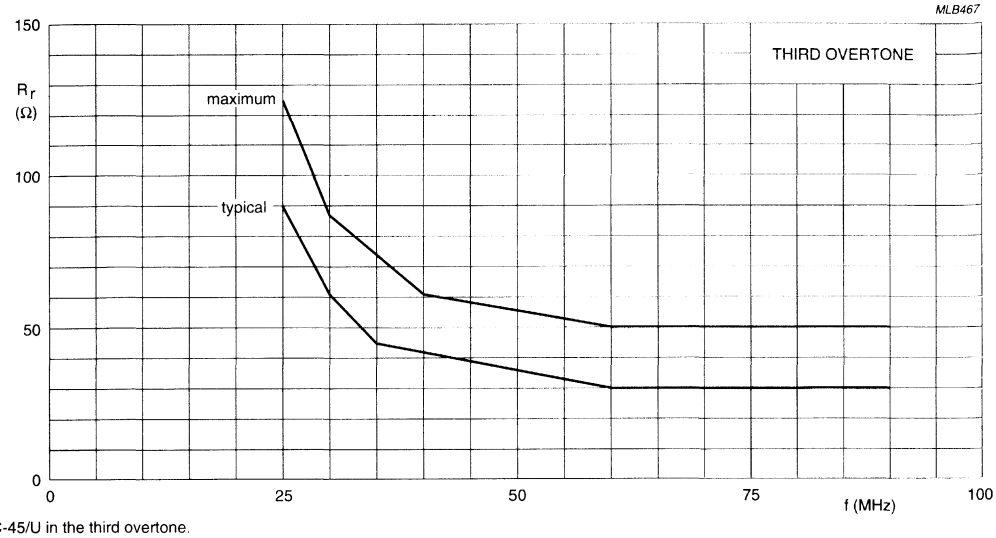
HC-45/U in the fundamental mode.
Values at 25 °C.
Other values available by extrapolation with C_0 and C_1 values.

Fig.6 Resonance resistance R_r as a function of resonance frequency, for HC-45/U crystals in 12 mm product length (involving large quartz blanks).



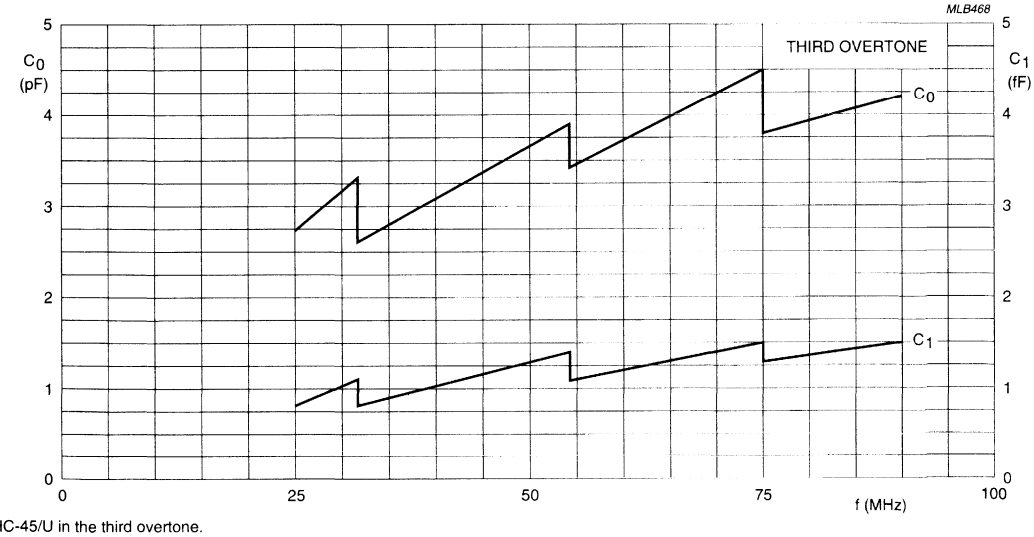
HC-45/U in the fundamental mode.
Typical values at 25 °C.
Other values available by extrapolation of the curve segments.

Fig.7 Motional capacitance C_1 and parallel capacitance C_0 as a function of resonance frequency, for HC-45/U crystals in 12 mm product length (involving large quartz blanks).



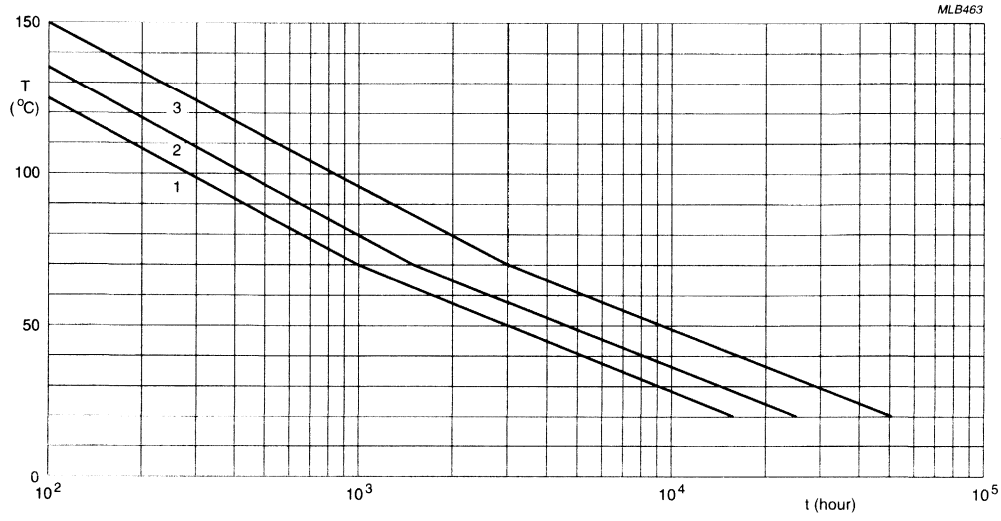
HC-45/U in the third overtone.
Values at 25 °C.
Other values available by extrapolation with C_0 and C_1 values.

Fig.8 Resonance resistance R_r as a function of resonance frequency, for HC-45/U crystals in 12 mm product length (involving large quartz blanks).



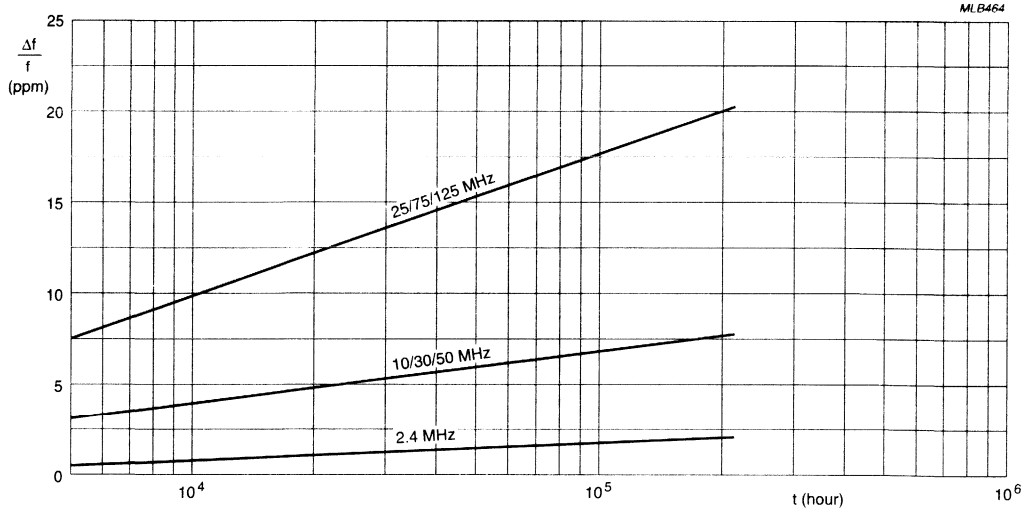
HC-45/U in the third overtone.
Typical values at 25 °C.
Other values available by extrapolation with C_0 and C_1 values.

Fig.9 Motional capacitance C_1 and parallel capacitance C_0 as a function of resonance frequency, for HC-45/U crystals in 12 mm product length (involving large quartz blanks).



Curve 1 = 1000 hours at 70 °C.
Curve 2 = 720 hours at 85 °C.
Curve 3 = 240 hours at 130 °C.

Fig.10 Time/temperature relation at which ageing is approximately equivalent.



Fundamental, third and fifth overtones.
Necessary pre-ageing can be calculated using Fig.10.

Fig.11 Typical frequency ageing as a function of time at 25 °C, **without pre-ageing of crystals.**

TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with IEC publication 68-2, *"Recommended basic climatic and mechanical robustness testing procedure for electronic components"* and IEC publication 1178-1, *"Generic specification for quartz crystal units"*.

Table 3 Test procedures and requirements; note 1

IEC 68-2 METHOD	TEST	PROCEDURE	REQUIREMENTS
Ba	ageing	1000 hours at 70 °C	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Db	accelerated damp heat	+25 to +55 °C; 6 cycles at RH >95%	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Ea	shock; note 2	100 g; half sinewave; 6 directions; 1 blow/direction	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Eb	bump; note 2	4000 bumps of 40 g	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Ed	free fall; note 2	3 times on hard wood; for height of fall (h) see Table 4	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Fc	vibration	frequency 10 to 500 to 10 Hz; acceleration 10 g; 3 directions; 30 minutes/direction	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Na	temperature cycling test	−40 to +85 °C; 10 cycles; 0.1 hour/cycle	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Q	sealing (method 1)	16 hours; 700 kPa He	$<1 \times 10^{-8}$ ncc/s He
Ta	solderability	235 ±5 °C; 2 ±0.5 s; flux 600 (activated); optional steam pre-heat 8 hours. This reflects at least 36 months of storage at room conditions	≥90%, except for 1 mm from body; no visible damage, no leaks
Tb	resistance to reflow soldering	rise 10 K/s; dwell 2 min/160 °C; rise 10 K/s up to 280 °C; cool down	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater

IEC 68-2 METHOD	TEST	PROCEDURE	REQUIREMENTS
Other applicable tests			
Xa	resistance to solvents; note 3: Bio-Act EC7®; Neutropon P3® and Saxin P3®; Meta Clean 820®; Lonco 446®; Isopropanol cleaning solvent; Dowanol DPM® (glass crystals only)	in accordance with *"IEC 68-2-45"*, *"IEC 653"* (immersion time 5 minutes) and *"MIL 202 E215"*. At ambient temperature and ultrasonic frequency (40 kHz)	no degradation of marking

Notes

1. Test table including MIL-specs (*"MIL-Std 883"* and *"MIL-Std 202"*) can be provided upon request.
2. Mechanical tests to be performed on units clamped to a printed-circuit board for the total unit height.
3. Bio-Act is a registered trademark of Petroform.
   Neutropon P3 and Saxin P3 are registered trademarks of Henkel.
   Meta Clean 820 is a registered trademark of Mavom.
   Lonco 447 is a registered trademark of London Chemical Co.
   Dowanol DPM is a registered trademark of Dow Chemical.

Table 4 Height of fall

h (mm)	PRODUCT LENGTH (mm)	FREQUENCY RANGE[1] (MHz)		
		FUNDAMENTAL MODE	THIRD OVERTONE	FIFTH OVERTONE[2]
750	10	8.0 to 12.0	24.0 to 36.0	–
750	12	6.0 to 16.0	24.0 to 48.0	–
500	10	12.1 to 20.0	36.1 to 60.0	60.0 to 80.0
500	12	16.1 to 30.0	48.1 to 90.0	80.1 to 150.0
250	10	20.1 to 24.0	60.1 to 75.0	–

Notes

1. Standard values. Actual designs can be made to obtain higher or lower values.
2. In 12 mm length only.

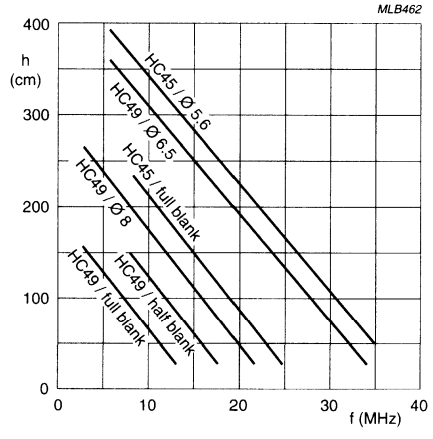


Fig.12 Typical height of fall values (3× on hard wood) for various quartz blank and holder combinations. 'Full' and 'half' blanks refer to rectangular quartz designs; '∅' designates circular quartz designs and the appropriate diameter.

Quartz crystals - professional applications HC-49/U and HC-50/U

9922 520 5/7.... series 9922 520 8.... series

FEATURES

- Outstanding electrical performance
- High mechanical stability
- Low resistance and high pullability values.

APPLICATIONS

- Microprocessors
- Traffic control
- Weather balloons
- Medical systems
- Military applications
- Communication systems
- Agrarian applications
- Machine control
- Environmental applications.

DESCRIPTION

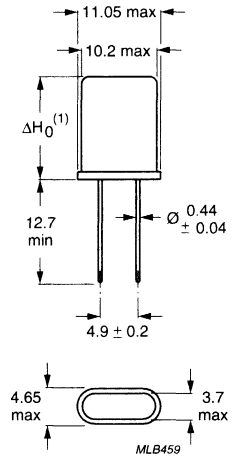
The unit consists of a silver-plated AT-cut quartz plate, encapsulated in a nitrogen-filled metal holder. The holder is hermetically sealed by resistance-welding and provided with connecting leads (HC-49/U) or pins (HC-50/U).

QUICK REFERENCE DATA

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT
f_{nom}	nominal frequency range:				
	fundamental mode	2.4	–	27.0	MHz
	third overtone	16.8	–	75.0	MHz
	fifth overtone	50.0	–	125.0	MHz
	seventh overtone	125.0	–	175.0	MHz
T_{oper}	operating temperature	–40	–	+105	°C
T_{op}	operable temperature	–55	–	+155	°C
$\Delta f/f_{nom}$	adjustment tolerance	±5	±10	–	ppm
$\Delta f/f_{25}$	frequency stability over temperature range:				
	class 0	–	±10	–	ppm
	class 1	–	±15	–	ppm
	class 2	–	±20	–	ppm
C_1	motional capacitance tolerance	± 5	±10	–	%
C_0	parallel capacitance tolerance	± 5	±10	–	%
$\Delta f/f$	ageing over 10 years at 25 °C	± 3	–	± 5	ppm

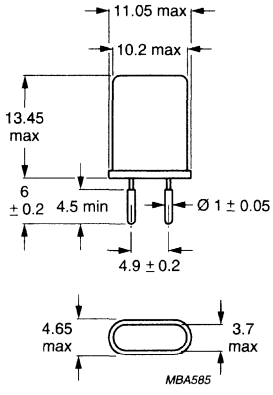
MECHANICAL DATA

Package outlines



Dimensions in nm.
(1) For ΔH_0 see Table 1.

Fig.1 Style 1: HC-49/U in box.



Dimensions in mm.

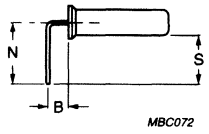
Fig.2 Style 10: HC-50/U in box.

Table 1 Product height; notes 1, 2 and 3

MAXIMUM PRODUCT HEIGHT ΔH_0 (mm)	MINIMUM FREQUENCY (MHz)		
	FUNDAMENTAL MODE	THIRD OVERTONE	FIFTH OVERTONE
9.6	4.5 to 27.0	20.0 to 75.0	50.0 to 125.0
11.0	4.5 to 27.0	16.8 to 75.0	50.0 to 125.0
13.4	all frequencies		

Notes

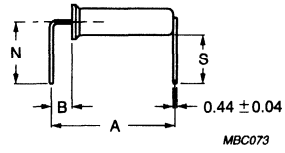
1. Available lead length: up to 13 mm.
2. Lead length tolerance for Style 1:
   a) Lead length > 3 mm: ±0.5 mm
   b) Lead length ≤ 3 mm: ±0.2 mm.
3. Dimensions without vinyl shrink sleeve.



Dimensions in mm.

STYLE 4	N	B	S
a	7.0 ±0.6	2.5 ±0.6	5.2 ±0.6
b	8.0 ±0.6	2.0 ±0.6	6.2 ±0.6
c	9.7 ±0.6	3.0 ±0.6	7.9 ±0.6

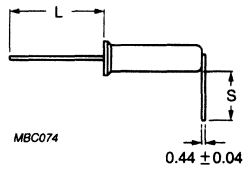
Fig.3 Style 4: HC-49/U on tray in box.



The third lead is symmetric, ±0.5 mm with respect to the other leads.
Dimensions in mm.

STYLE 5	N	B	A	S
a	5.7 ±1.0	1.5	15.2 ±0.2	3.9 ±1.0
b	5.9 ±1.0	4.1	17.8 ±0.2	4.1 ±1.0
c	10.2 ±1.0	3.3	16.5 ±0.2	8.4 ±1.0
d	5.7 ±1.0	1.9	15.6 ±0.2	3.9 ±1.0

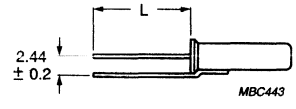
Fig.4 Style 5: HC-49/U on tray in box.



The third lead is symmetric, ±0.5 mm with respect to the other leads.
Dimensions in mm.

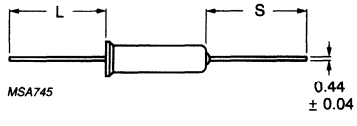
STYLE 6	L	S
a	13.2 0.5	4.5 1.0
b	13.2 0.5	10.0 1.0
c	5.0 0.5	19.5 1.0
d	13.2 0.5	19.5 1.0

Fig.5 Style 6: HC-49/U on tray in box.



L: min. 12.7 mm; max. 13.0 mm.
The third lead is symmetric, ±0.5 mm with respect to the other leads.
Dimensions in mm.

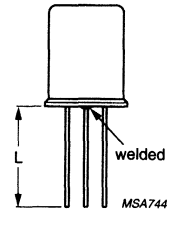
Fig.6 Style 7: HC-49/U on tray in box.



The third lead is symmetric, ±0.5 mm with respect to the other leads.
Dimensions in mm.

STYLE 8	L	S
a	13.2 ±0.5	16.0 ±1.0
b	5.0 ±0.5	16.0 ±1.0

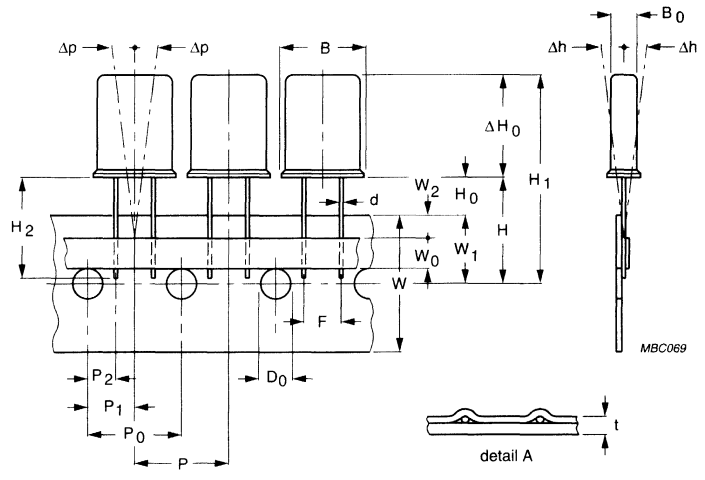
Fig.7 Style 8: HC-49/U on tray in box.



L: min. 12.7 mm; max. 13.0 mm.
The third lead is symmetric, ±0.5 mm with respect to the other leads.

Fig.8 Style 9: HC-49/U on tray in box.

Taping data

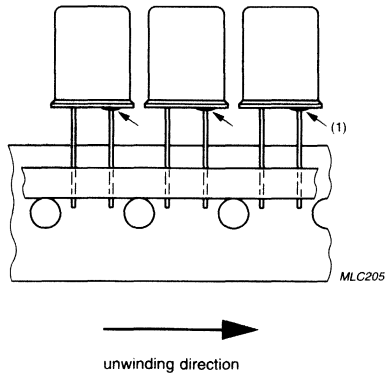


For dimensions see Table 2.

Fig.9 Style 2: HC-49/U on tape.

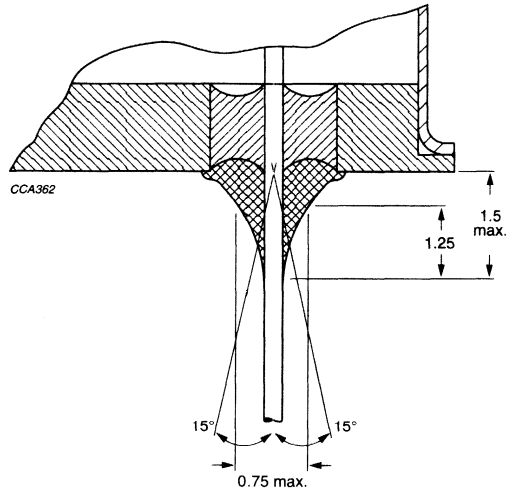
Table 2 Taping dimensions (without the insulation plate) in accordance with *"IEC 286-2"*; see Fig.9.

SYMBOL	PARAMETER	VALUE	TOLERANCE	UNIT
B_0	body thickness	4.43	±0.05	mm
B	body width	10.75	±0.1	mm
Δh	component alignment vertical to tape plane	–	±2	mm
Δp	component alignment in tape plane	–	±1.3	mm
d	lead wire diameter	0.44	±0.04	mm
F	lead-to-lead	4.9	–	mm
P	pitch of components	12.7	±1	mm
P_0	feed-hole pitch	12.7	±0.3	mm
P_2	feed-hole centre to lead	3.9	±0.7	mm
P_1	feed-hole centre to component centre	6.35	±0.3	mm
D_0	feed-hole diameter	4.0	±0.2	mm
H	distance of component from tape centre	16.0	+2/0	mm
H_0	minimum component base to tape top	7.0	–	mm
H_2	lead length	13.2	±0.5	mm
W	carrier tape width	18.0	+1/–0.5	mm
W_0	maximum hold-down tape width	7.0	–	mm
W_1	feed-hole position	9.0	+0.75/–0.5	mm
W_2	maximum hold-down tape position	3.0	–	mm
t	maximum total tape thickness	0.9	–	mm



Style 11a is taped in ammopack; see Fig.12.
Style 11b is taped on reel; see Fig.13.

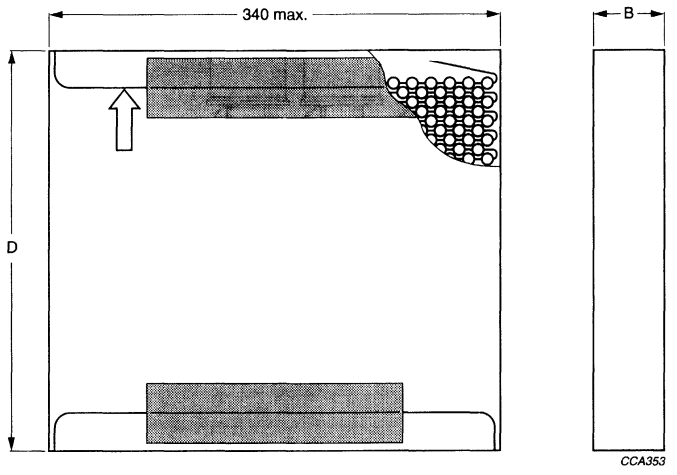
Fig.10 Style 11 taped units with one lead connected to case, otherwise as Style 2 (see Fig.9).



Dimensions in mm.
The electrical resistance shall be <5 Ω after 2 times 15° bending of the lead.
Coverage of glass bead by silver adhesive is a minimum of 40%.

Fig.11 Detailed drawing of the connection between the lead and base.

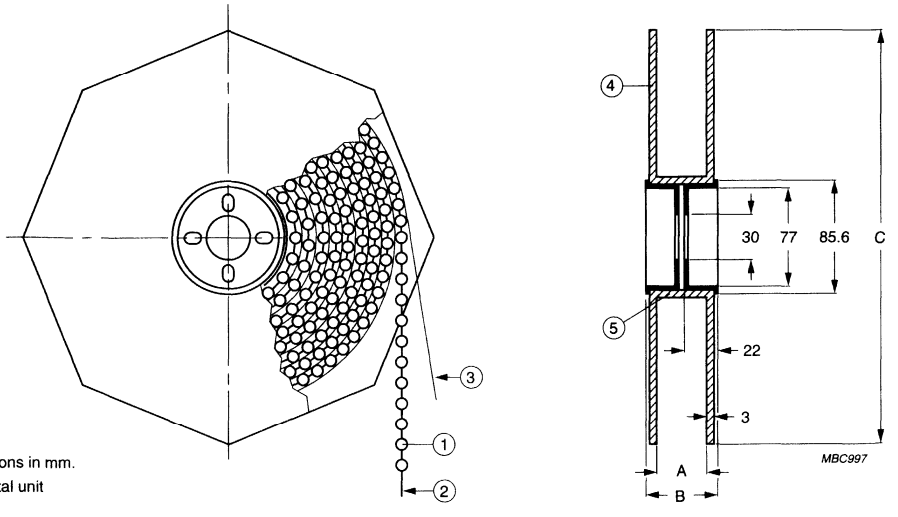
Ammopack and reel data



Dimensions in mm.
B = 46 mm max.
D = 185 mm max.

Style 3a is with insulation plate; see Fig.14.

Fig.12 Style 2a, 3a and 11a units on tape in ammopack.



Dimensions in mm.

1 = crystal unit
2 = tape
3 = paper
4 = flange
5 = cylinder

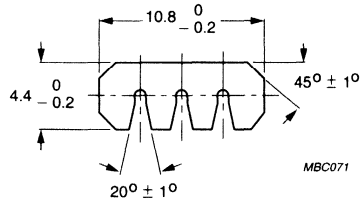
A = 45 mm
B = 55 mm max.
C = 355 mm max.

Style 3b is with insulation plate; see Fig.14.

Fig.13 Style 2b, 3b and 11b units on tape on reel.

Insulation plate

Style 3 units are equipped with an insulation plate (see Fig.14) at the unit base. The insulation plate is made of PEEK (polyetherketone) in 0.25 mm thickness and resistant to soldering heat tests.



Dimensions in mm.

Fig.14 Insulation plate outline for Style 3.

PACKAGING AND QUANTITIES

Table 3 HC-49/U holder

STYLE	PACKAGING	QUANTITY	DIMENSIONS OF BOX (mm)		
			LENGTH	WIDTH	HEIGHT
1	in box	maximum 1000 units per box	200	125	70
	in blister	24 units per blister, 8 blisters per box	315	155	67
	on tray in box	100 units per tray, 1 tray in box	380	92	33
		10 trays per box	380	92	168
2a, 3a and 11a	on tape in ammopack	1000 units per pack, in box	340	185	46
2b, 3b and 11b	on tape on reel	1000 units per reel, in box	361	367	61
4, 5, 6, 7, 8 and 9	in blister	24 units per blister	380	90	168
	in box	1000 units per box			
	on tray in box	100 units per tray; 1 or 10 trays per box			
5c	on tray in box	50 units per tray; 10 trays per box, minimum 2 boxes	380	90	168
10	in blister in box	24 units per blister	315	155	12

STANDARD MARKING(1)

- Line 1: PHILIPS
- Line 2: frequency in kHz (fundamental mode) or in MHz (overtone)
- LIne 3: last five digits of catalogue number followed by the manufacturing date code (last four digits of week code in accordance with UN-D1120).

MASS AND LEADS

Typical mass: 1.2 g.

The leads are finished with either Sn99Cu1, Sn60Pb40 or a gold finish on a nickel underplate.

The first 1 mm from the body is not guaranteed for soldering.

(1) Special marking on product and/or package is available on request.

ELECTRICAL DATA

Valid at an ambient temperature T_{amb} = 25 ±2 °C and a nominal drive level of 100 µW into 25 Ω unless otherwise specified. Measuring system: π-network in accordance with *"IEC 444"* recommendations.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
f_{nom}	nominal frequency	fundamental	2.4	–	27.0	MHz
		third overtone	16.8	–	75.0	MHz
		fifth overtone	50.0	–	125.0	MHz
$\Delta f/f_{nom}$	adjustment tolerance		±5	±10	–	ppm
R_r	resonance resistance	see note 1	see Figs 15, 18 and 21			Ω
C_L	load capacitance	fundamental mode; note 2	5	20	∞	pF
		overtones; note 2	5	∞	–	pF
T_{oper}	operating temperature		–40	–	+105	°C
T_{op}	operable temperature		–55	–	+155	°C
$\Delta f/f_{25}$	frequency stability over temperature range, with respect to T_{amb} = 25 °C		see Table 4			ppm
R_r (T)	resonance resistance over temperature range	see note 1	available from R_r upwards			Ω
C_1	motional capacitance		see Figs 16, 19 and 22			fF
	tolerance		±5	±10	–	%
C_o	parallel capacitance		see Figs 17, 20 and 23			pF
	tolerance		±5	±10	–	%
S	pulling sensitivity		$S = -0.5\ C_1 / (C_0 + C_L)^2$			ppm/pF
R_n	resonance resistance of unwanted response (spurious)	fundamental mode; f_{nom} ±20%	2 R_r (T)	–	–	Ω
			+6	–	–	dB
		overtones; f_{nom} ±200 kHz	2 R_r (T)	–	–	Ω
			+6	–	–	dB
R_{dld}	drive level dependency, being the resonance resistance in the drive level range	drive level range 10^{-16} W to 10^{-4} W; note 1	see note 2			Ω
R_{ins}	insulation resistance	DC test voltage = 100 V	500	–	–	MΩ
	frequency hysteresis or curve fit		–	–	1	ppm
$\Delta f/f$	ageing	10 years at T_{amb} = 25 °C; see Figs 24 and 25	±3	–	±5	ppm

Notes

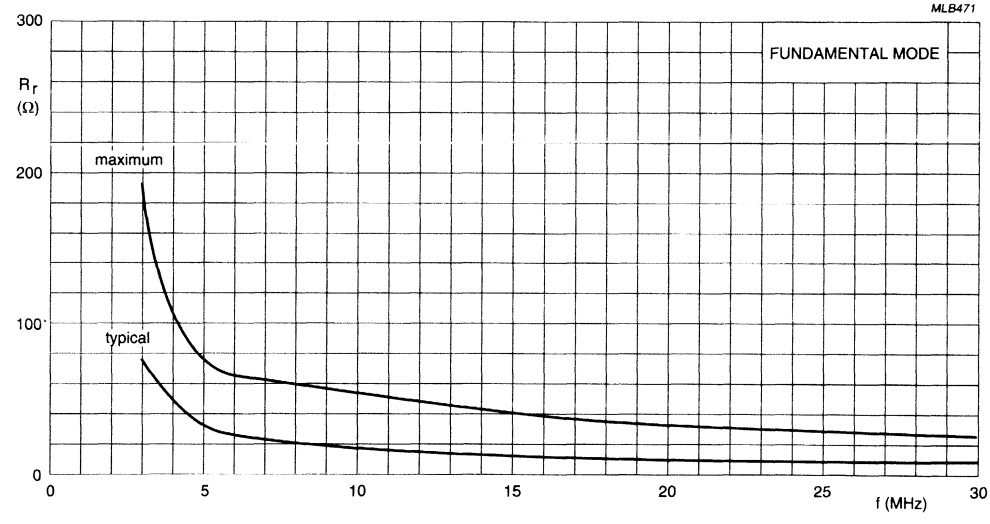
1. All resistance values are measured in series resonance, other values available on request.
2. Values available on request.

Table 4 Frequency stability with temperature variation (available maximum values)

TEMPERATURE RANGE[1] (°C)	FREQUENCY STABILITY (ppm)		
	CLASS 0	CLASS 1	CLASS 2
+20/+30	±1.0	±1.5	±2.0
0/+50	±5.0	±7.5	±10.0
−10/+60	±7.5	±10.0	±15.0
−20/+70	±10.0	±15.0	±20.0
−30/+80	±12.5	±20.0	±25.0
−40/+90	±17.5	±25.0	±30.0
−55/+105	±25.0	±30.0	±40.0
−40/+130	–	±50.0	±80.0

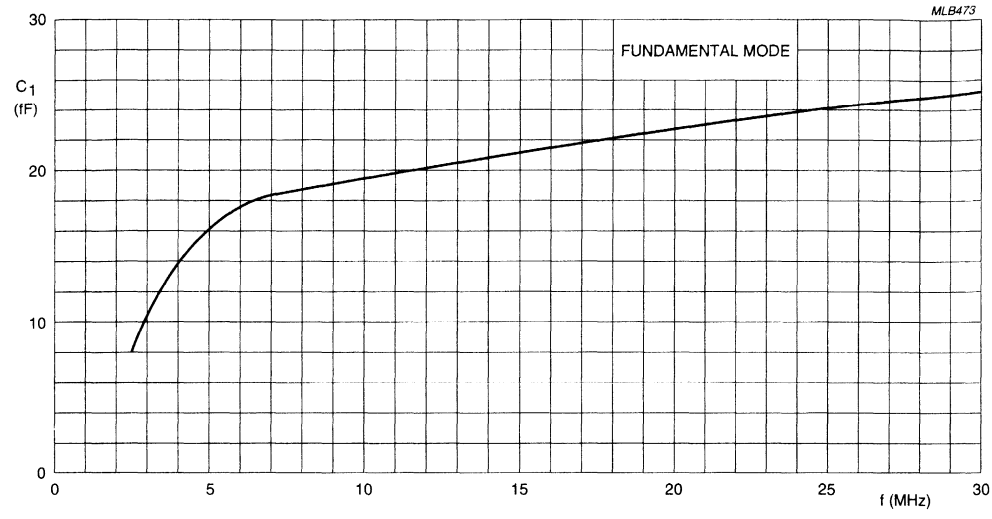
Note

1. To obtain the same stability at frequencies below 8.0 MHz, the upper temperature limit is 10 °C lower.



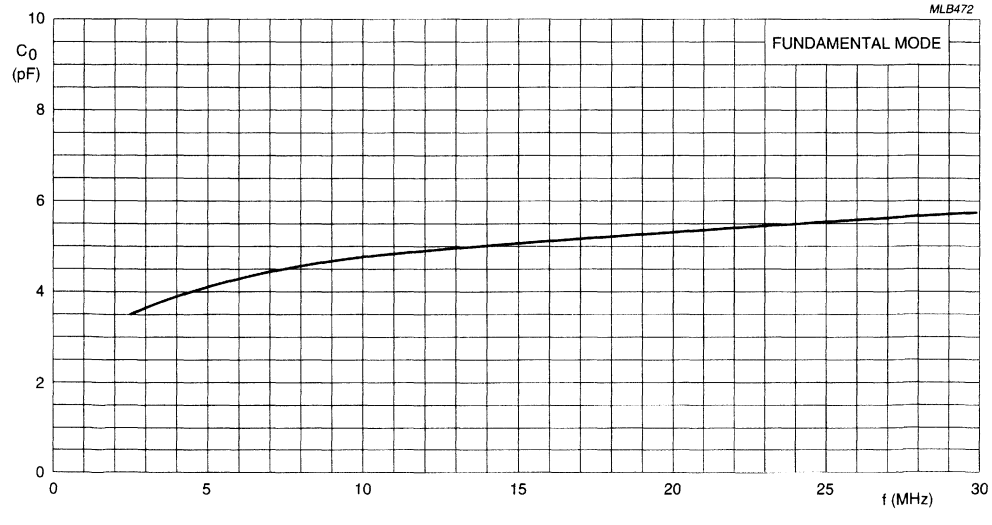
HC-49/U in the fundamental mode.
Values at 25 °C.
Other values available by extrapolation with C_0 and C_1 values.

Fig.15 Resonance resistance R_r as a function of resonance frequency.



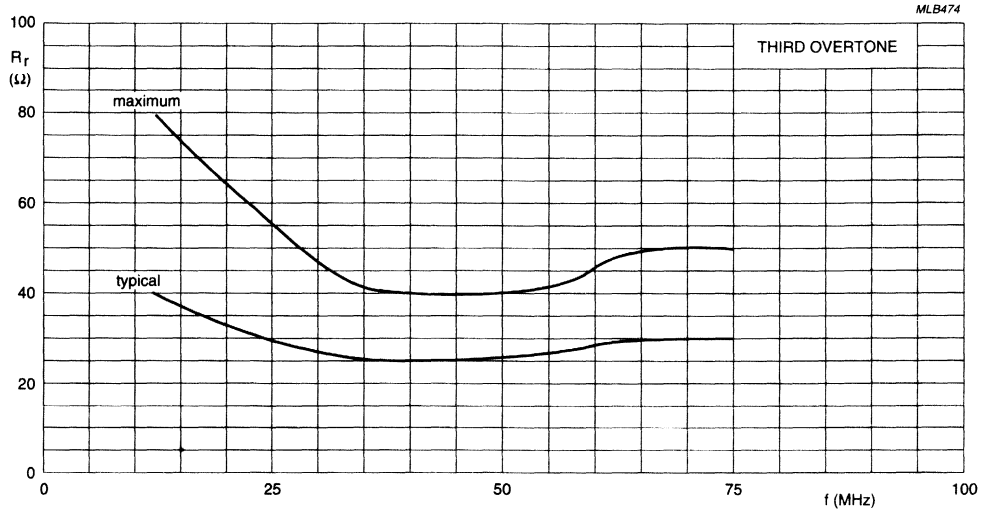
HC-49/U in the fundamental mode.
Typical values at 25 °C.
Other values available by extrapolation of the curve segments.

Fig.16 Motional capacitance C_1 as a function of resonance frequency.



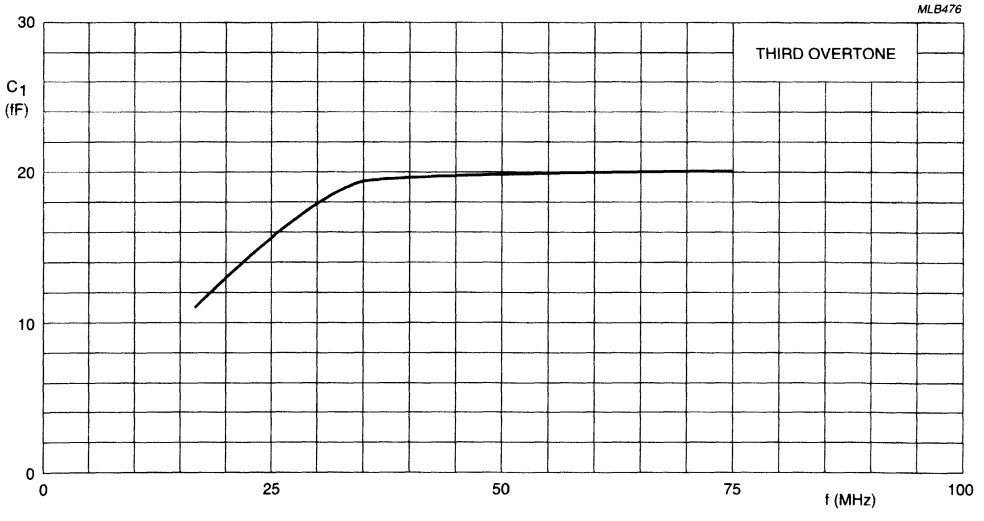
HC-49/U in the fundamental mode.
Typical values at 25 °C.
Other values available by extrapolation of the curve segments.

Fig.17 Parallel capacitance C_0 as a function of resonance frequency.



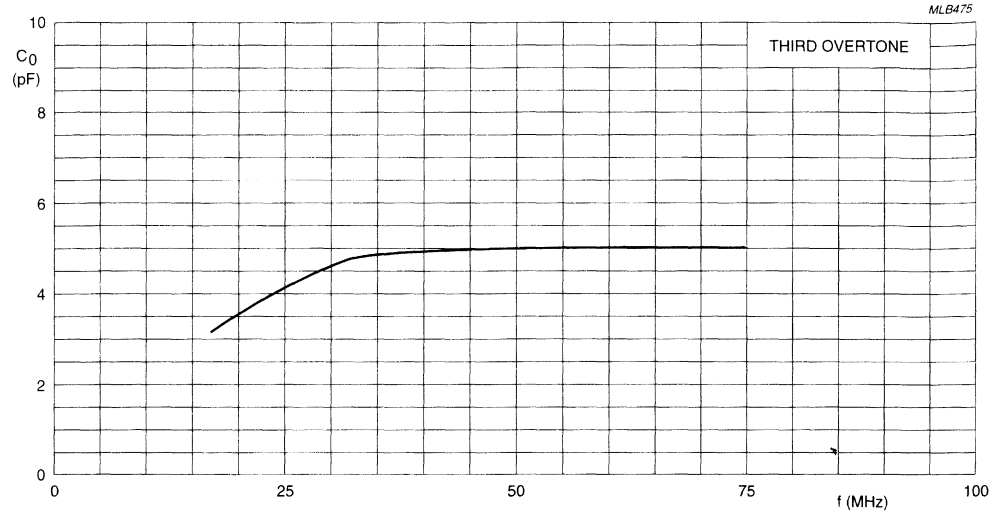
HC-49/U in the third overtone.
Values at 25 °C.
Other values available by extrapolation with C_0 and C_1 values.

Fig.18 Resonance resistance R_r as a function of resonance frequency.



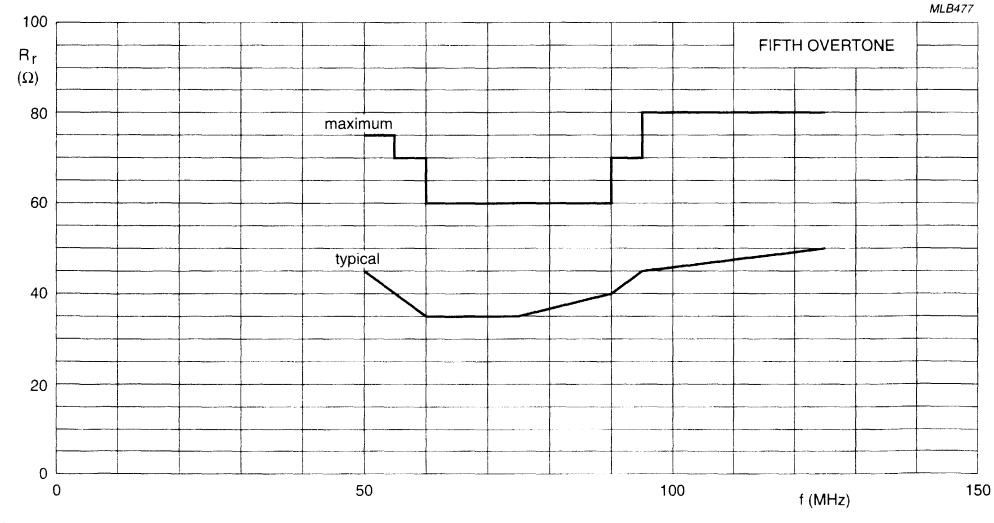
HC-49/U in the third overtone.
Typical values at 25 °C.
Other values available by extrapolation with C_0 values.

Fig.19 Motional capacitance C_1 as a function of resonance frequency.



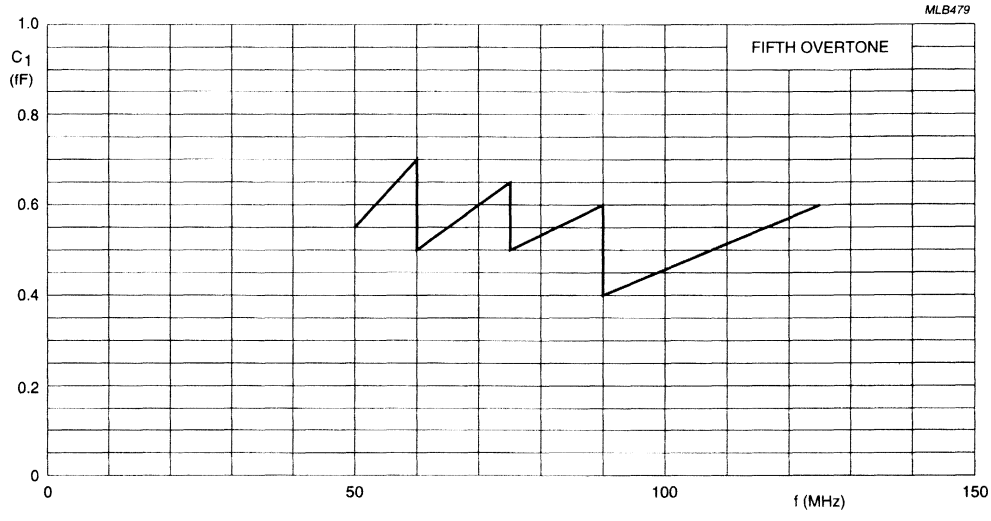
HC-49/U in the third overtone.
Typical values at 25 °C.
Other values available by extrapolation with C_1 values.

Fig.20 Parallel capacitance C_0 as a function of resonance frequency.



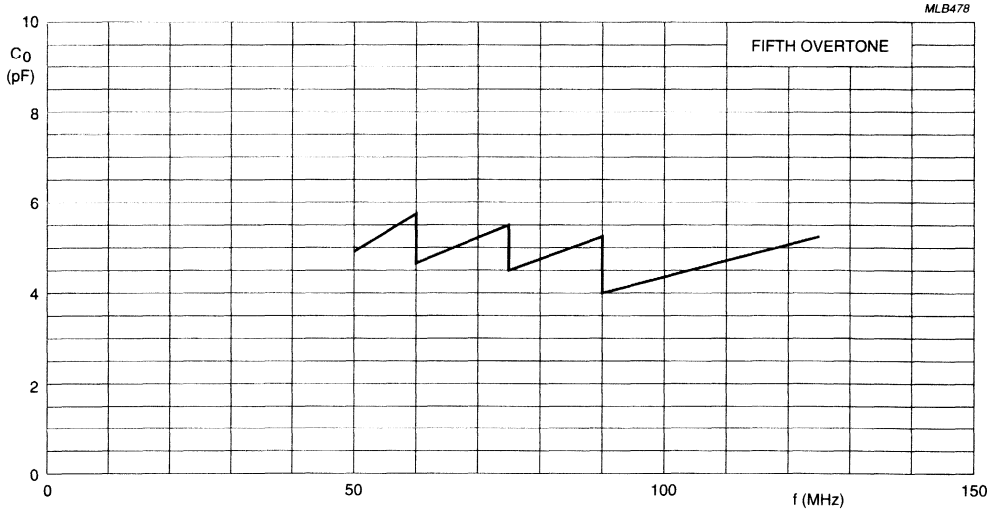
HC-49/U in the fifth overtone.
Values at 25 °C.
Other values available by extrapolation with C_0 and C_1 values.

Fig.21 Resonance resistance R_r as a function of resonance frequency.



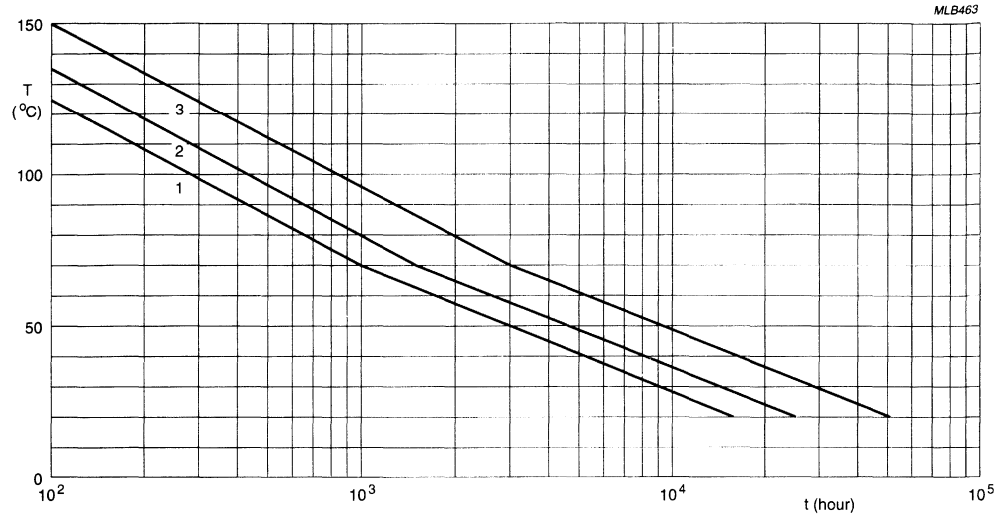
HC-49/U in the fifth overtone.
Typical values at 25 °C.
Other values available by extrapolation with C_0 values.

Fig.22 Motional capacitance C_1 as a function of resonance frequency.



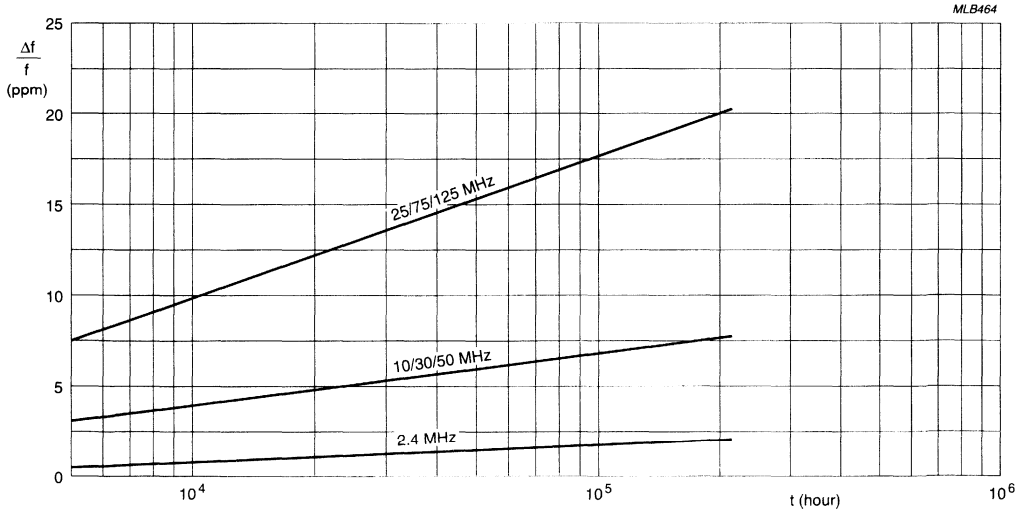
HC-49/U in the fifth overtone.
Typical values at 25 °C.
Other values available by extrapolation with C_1 values.

Fig.23 Parallel capacitance C_0 as a function of resonance frequency.



Curve 1 = 1000 hours at 70 °C.
Curve 2 = 720 hours at 85 °C.
Curve 3 = 240 hours at 130 °C.

Fig.24 Time/temperature relation at which ageing is approximately equivalent.



Fundamental, third and fifth overtones.
Necessary pre-ageing can be calculated using Fig.24.

Fig.25 Typical frequency ageing as a function of time at 25 °C, **without pre-ageing of crystals.**

TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with IEC publication 68-2, *"Recommended basic climatic and mechanical robustness testing procedure for electronic components"* and IEC publication 1178-1, *"Generic specification for quartz crystal units"*.

Table 5 Test procedures and requirements; note 1

IEC 68-2 METHOD	TEST	PROCEDURE	REQUIREMENTS
Ba	ageing	1000 hours at 70 °C	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Db	accelerated damp heat	+25 to +55 °C; 6 cycles at RH >95%	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Ea	shock	100 g; half sinewave; 6 directions; 1 blow/direction	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Eb	bump	4000 bumps of 40 g	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Ed	free fall	3 times on hard wood; for height of fall (h) see Table 6	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Fc	vibration	frequency 10 to 500 to 10 Hz; acceleration 10 g; 3 directions; 30 minutes/direction	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Na	temperature cycling test	−40 to +85 °C; 10 cycles; 0.1 hour/cycle	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Q	sealing (method 1)	16 hours; 700 kPa He	$<1 \times 10^{-8}$ ncc/s He
Ta	solderability	235 ±5 °C; 2 ±0.5 s; flux 600 (activated); optional steam pre-heat 8 hours. This reflects at least 36 months of storage at room conditions	≥90%, except for 1 mm from body; no visible damage, no leaks
Tb	resistance to soldering heat	350 ±5 °C; 3.5 ±0.5 s	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Ub	bending of leads	1 × 90°; 5 N	no visible damage, no leaks

IEC 68-2 METHOD	TEST	PROCEDURE	REQUIREMENTS
Other applicable tests			
Xa	resistance to solvents (note 2): Bio-Act EC7®; Neutropon P3® and Saxin P3®; Meta Clean 820®; Lonco 446®; Isopropanol cleaning solvent	in accordance with *"IEC 68-2-45"*, *"IEC 653"* (immersion time 5 minutes) and *"MIL 202 E215"*. At ambient temperature and ultrasonic frequency (40 kHz)	no degradation of marking

Notes

1. Test table including MIL-specs (*"MIL-Std 883"* and *"MIL-Std 202"*) can be provided upon request.
2. Bio-Act is a registered trademark of Petroform.
   Neutropon P3 and Saxin P3 are registered trademarks of Henkel.
   Meta Clean 820 is a registered trademark of Mavom.
   Lonco 447 is a registered trademark of London Chemical Co.

Table 6 Height of fall

h (mm)	FREQUENCY RANGE[1] (MHz)		
	FUNDAMENTAL MODE	THIRD OVERTONE	FIFTH OVERTONE
750	2.4 to 16.0	20.0 to 48.0	50.0 to 80.0
500	16.1 to 27.0	48.1 to 75.0	80.1 to 125.0

Note

1. Standard values. Actual designs can be made to obtain higher or lower values.

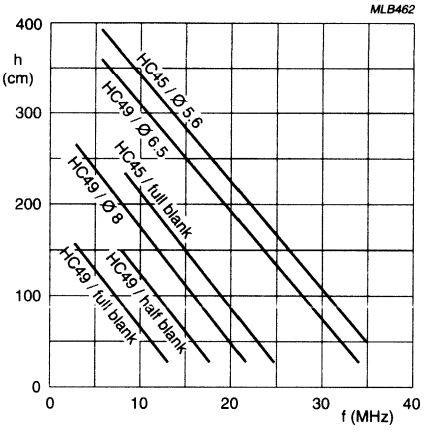


Fig.26 Typical height of fall values (3× on hard wood) for various quartz blank and holder combinations. 'Full' and 'half' blanks refer to rectangular quartz designs; '∅' designates circular quartz designs and the appropriate diameter.

Quartz crystals - professional applications HC-45/U

9922 521 6/7.... series

FEATURES

- Small dimensions
- Outstanding electrical performance
- High mechanical and electrical stability
- Low ageing.

APPLICATIONS

- Microprocessors
- Traffic control
- Weather balloons
- Medical systems
- Military applications
- Communication systems
- Agrarian applications
- Machine control
- Environmental applications.

DESCRIPTION

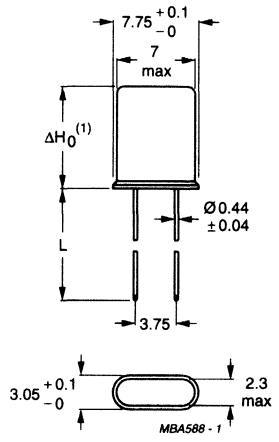
The unit consists of a silver-plated AT-cut quartz plate, encapsulated in a nitrogen-filled metal holder. The holder is hermetically sealed by resistance-welding and provided with connecting leads.

QUICK REFERENCE DATA

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT
f_{nom}	nominal frequency:				
	fundamental mode	6.0	–	30.0	MHz
	third overtone	24.0	–	90.0	MHz
	fifth overtone	60.0	–	150.0	MHz
	seventh overtone	125.0	–	200.0	MHz
T_{oper}	operating temperature	−40	–	+105	°C
T_{op}	operable temperature	−55	–	+155	°C
$\Delta f/f_{nom}$	adjustment tolerance	±5	±30	–	ppm
$\Delta f/f_{25}$	frequency stability over temperature range: −20 to +70 °C with respect to T_{amb} = 25 °C:				
	class 0	–	±10	–	ppm
	class 1	–	±15	–	ppm
	class 2	–	±20	–	ppm
C_1	motional capacitance tolerance	±5	±10	–	%
C_0	parallel capacitance tolerance	±5	±10	–	%
$\Delta f/f$	ageing over 10 years at 25 °C	±3	–	±5	ppm

MECHANICAL DATA

Package outlines



Dimensions in mm.

(1) For ΔH_0 see Table 1.

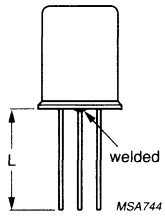
Fig.1 Style 1: HC-45/U in box.

Table 1 Product height and lead length; notes 1 and 2

MAXIMUM HEIGHT ΔH_0 (mm)	MAXIMUM LEAD LENGTH L (mm)	FREQUENCY RANGE (MHz)	
		FUNDAMENTAL MODE	THIRD OVERTONE
6.4	20.0	8.0 to 24.0	32.0 to 70.0
8.0	20.0	6.0 to 25.0	24.0 to 80.0
8.8	20.0	all frequencies	

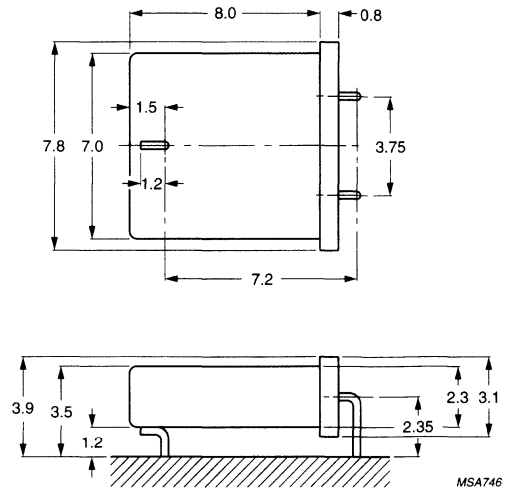
Notes

1. Lead length tolerances L for Style 1:
   a) Lead length (H_2) > 3 mm: ±0.5 mm
   b) Lead length (H_2) ≤ 3 mm: ±0.2 mm.
2. Lead diameters 0.44 ±0.04 mm or 0.35 ±0.05 mm optional.



L: min. 12.7 mm; max. 13.0 mm.

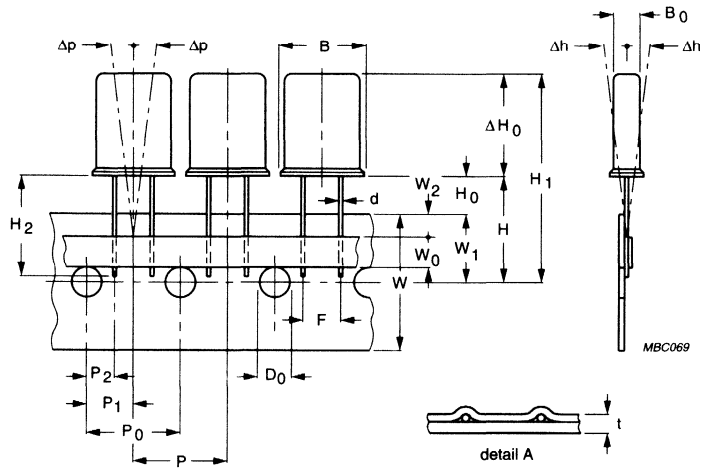
Fig.2 Style 4: HC-45/U in box.



Dimensions in mm.

Fig.3 Style 5: HC-45/U in box.

Taping data



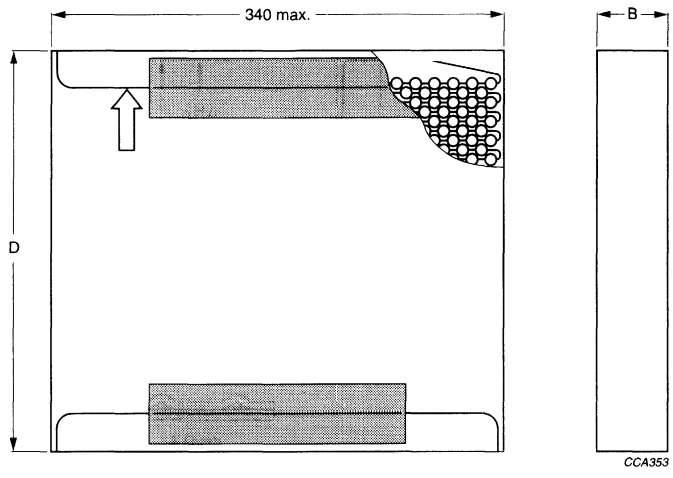
For dimensions see Table 2.

Fig.4 Style 2: HC-45/U on tape.

Table 2 Taping dimensions (without the insulation plate) in accordance with *"IEC 286-2"*; see Fig.4

SYMBOL	PARAMETER	VALUE	TOLERANCE	UNIT
B_0	body thickness	3.1	+0.05	mm
B	body width	7.8	+0.05	mm
Δh	component alignment vertical to tape plane	0	±2.0	mm
Δp	component alignment in tape plane	0	±1.3	mm
d	lead wire diameter, option	0.44/0.35	±0.04/±0.05	mm
F	lead-to-lead distance	3.75	–	mm
P	pitch of components	12.7	±1.0	mm
P_0	feed-hole pitch	12.7	±0.3	mm
P_2	feed-hole centre to lead	4.45	±0.7	mm
P_1	feed-hole centre to component centre	6.35	±0.3	mm
D_0	feed-hole diameter	4.0	±0.2	mm
H	distance of component from tape centre	18.0	+2/0	mm
H_0	minimum component base to tape top	9.0	–	mm
H_2	lead length	20.	±0.5	mm
W	carrier tape width	18.0	+1/–0.5	mm
W_0	maximum hold-down tape width, option	7.0/13.0	–	mm
W_1	feed-hole position	9.0	+0.75/–0.5	mm
W_2	maximum hold-down tape position	3.0	–	mm
t	maximum total tape thickness	0.9	–	mm

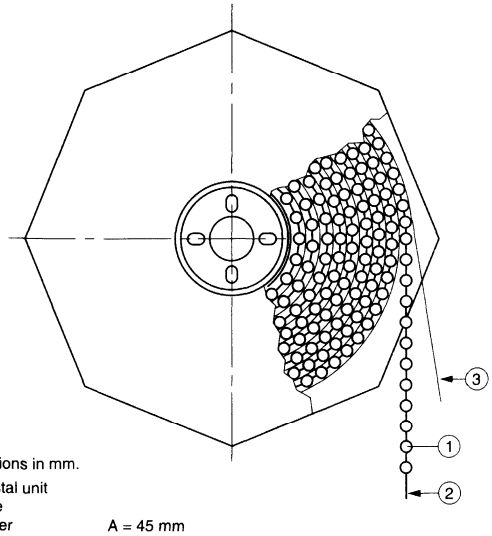
Ammopack and reel data

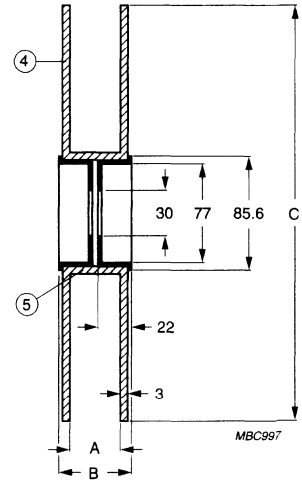


Dimensions in mm.
B = 46 mm max.
D = 185 mm max.

Style 3a is with insulation plate; see Fig.7.

Fig.5 Style 2a, and 3a units on tape in ammopack.





Dimensions in mm.
1 = crystal unit
2 = tape
3 = paper
4 = flange
5 = cylinder

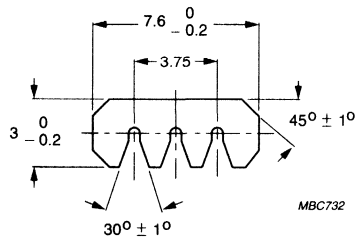
A = 45 mm
B = 55 mm max.
C = 355 mm max.

Style 3b is with insulation plate; see Fig.7.

Fig.6 Style 2b and 3b units on tape on reel.

Insulation plate

Style 3 units are equipped with an insulation plate (see Fig.7) at the unit base. The insulation plate is made of PEEK (polyetherketone) in 0.25 mm thickness and resistant to soldering heat tests.



Dimensions in mm.

Fig.7 Insulation plate outline for Style 3.

PACKAGING AND QUANTITIES

Table 3 HC-45/U holder

STYLE	PACKAGING	QUANTITY	DIMENSIONS OF BOX (mm)		
			LENGTH	WIDTH	HEIGHT
1	in box	maximum 1000 units per box	200	125	45
	in blister	24 units per blister, 8 blisters per box	315	155	67
	on tray in box	100 units per tray, 1 tray in box	380	92	33
		10 trays per box	380	92	168
2a and 3a	on tape in ammopack	1000 units per pack, in box	340	185	46
2b and 3b	on tape on reel	1000 units per reel, in box	283	283	60
4 and 5	in blister	24 units per blister	380	92	168
	in box	1000 units per box			
	on tray in box	100 units per tray; 1 or 10 trays per box			

STANDARD MARKING[1]

- Line 1: PHILIPS
- Line 2: frequency in kHz (fundamental mode) or in MHz (overtone)
- LIne 3: last five digits of catalogue number followed by the manufacturing date code (last four digits of week code in accordance with UN-D1120).

MASS AND LEADS

Typical mass: 0.4 g.

The leads are finished with either Sn99Cu1, Sn60Pb40 or a gold finish on a nickel underplate.

The first 1 mm from the body is not guaranteed for soldering.

(1) Special marking on product and/or package is available on request.

Quartz crystals - professional applications HC-45/U

9922 521 6/7.... series

ELECTRICAL DATA

Valid at T_{amb} = 25 ±2 °C and a nominal drive level of 100 μW into 25 Ω unless otherwise specified. Measuring system: π-network in accordance with *"IEC 444"* recommendations.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
f_{nom}	nominal frequency	fundamental	6.0	–	30.0	MHz
		third overtone	24.0	–	90.0	MHz
		fifth overtone	60.0	–	150.0	MHz
		seventh overtone	125.0	–	200.0	MHz
$\Delta f/f_{nom}$	adjustment tolerance		±5	±30	–	ppm
		6.4 mm height	±20	±30	–	ppm
R_r	resonance resistance	see note 1	see Figs 8, 10 and 10			Ω
C_L	load capacitance	fundamental mode; note 2	5	20	∞	pF
		overtones; note 2	5	∞	–	pF
T_{oper}	operating temperature		–40	–	+105	°C
T_{op}	operable temperature		–55	–	+155	°C
$\Delta f/f_{25}$	frequency stability over temperature range	T_{amb} = 25 °C	see Table 4			ppm
R_r (T)	resonance resistance over temperature range	see note 1	available from R_r upwards			Ω
C_1	motional capacitance		see Figs 9, 11 and 13			fF
	tolerance		±5	±10	–	%
C_0	parallel capacitance		see Figs 9, 11 and 13			pF
	tolerance		±5	±10	–	%
S	pulling sensitivity		$S = -0.5C_1 / (C_0 + C_L)^2$			ppm/pF
R_n	resonance resistance of unwanted response (spurious)	fundamental mode; f_{nom} ±20%	2 R_r (T)	–	–	Ω
			+6	–	–	dB
		overtones; f_{nom} ±200 kHz	2 R_r (T)	–	–	Ω
			+6	–	–	dB
R_{did}	drive level dependency, being the resonance resistance in the drive level range	drive level range 10^{-16} W to 10^{-4} W; note 1	see note 2			Ω
R_{ins}	insulation resistance	DC test voltage = 100 V	500	–	–	MΩ
$\Delta f/f_{nom}$	frequency hysteresis or discontinuity		–	–	1	ppm
$\Delta f/f$	ageing	10 years at T_{amb} = 25 °C; see Figs 14 and 15	±3	–	±5	ppm

Notes

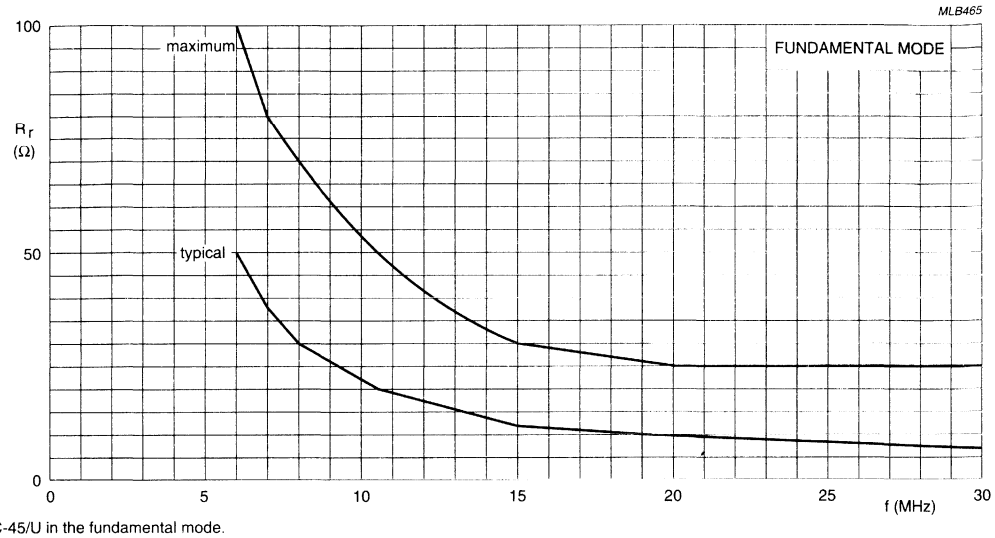
1. All resistance values are measured in series resonance, other values available on request.
2. Values available on request.

Table 4 Frequency stability with temperature variation (available maximum values)

TEMPERATURE RANGE[1] (°C)	FREQUENCY STABILITY (ppm)		
	CLASS 0	CLASS 1	CLASS 2
+20/+30	±1.0	±1.5	±2.0
0/+50	±5.0	±7.5	±10.0
−10/+60	±7.5	±10.0	±15.0
−20/+70	±10.0	±15.0	±20.0
−30/+80	±12.5	±20.0	±25.0
−40/+90	±17.5	±25.0	±30.0
−55/+105	±25.0	±30.0	±40.0
−40/+130	–	±50.0	±80.0

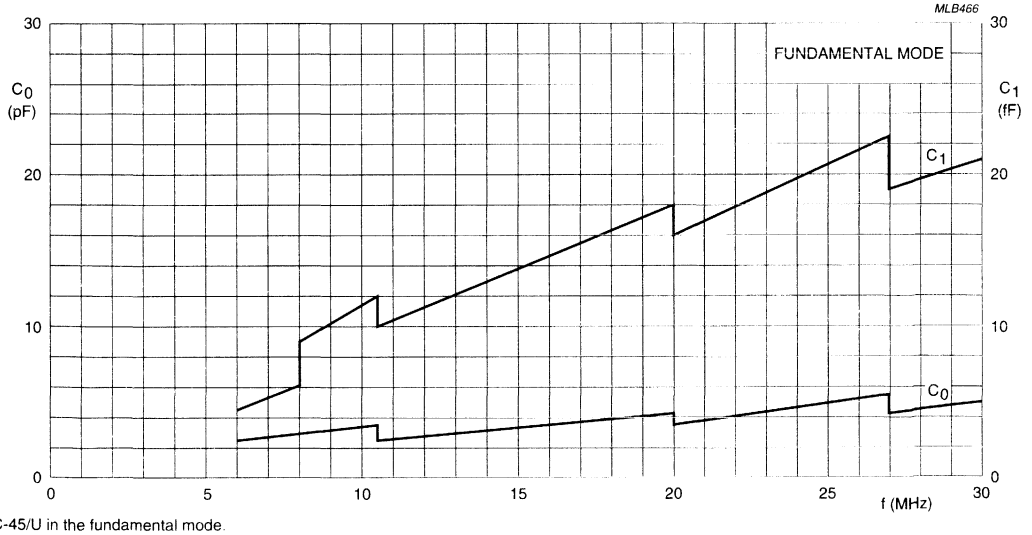
Note

1. To obtain the same stability at frequencies below 8.0 MHz, the upper temperature limit is 10 °C lower.



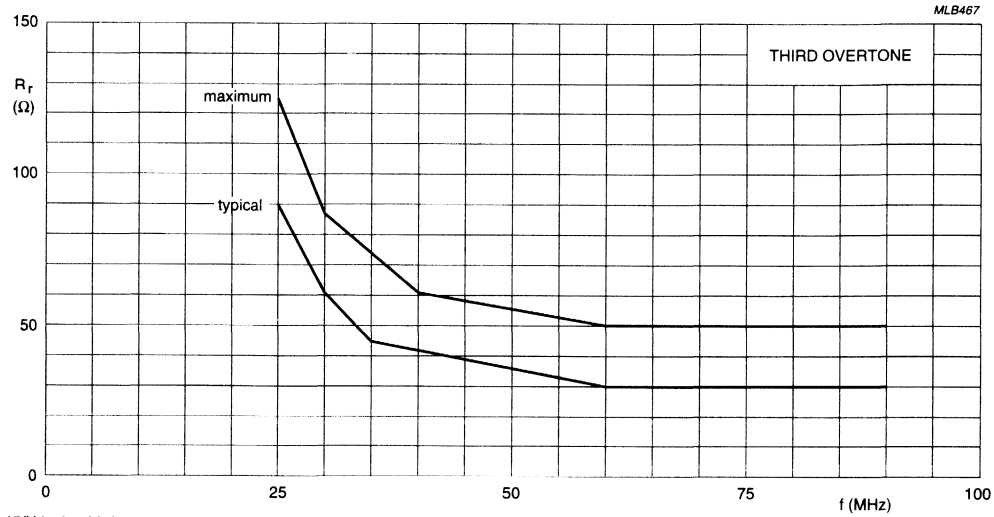
HC-45/U in the fundamental mode.
Values at 25 °C.
Other values available by extrapolation with C_0 and C_1 values.

Fig.8 Resonance resistance R_r as a function of resonance frequency, for HC-45/U crystals in 8 mm product height (involving large quartz blanks).



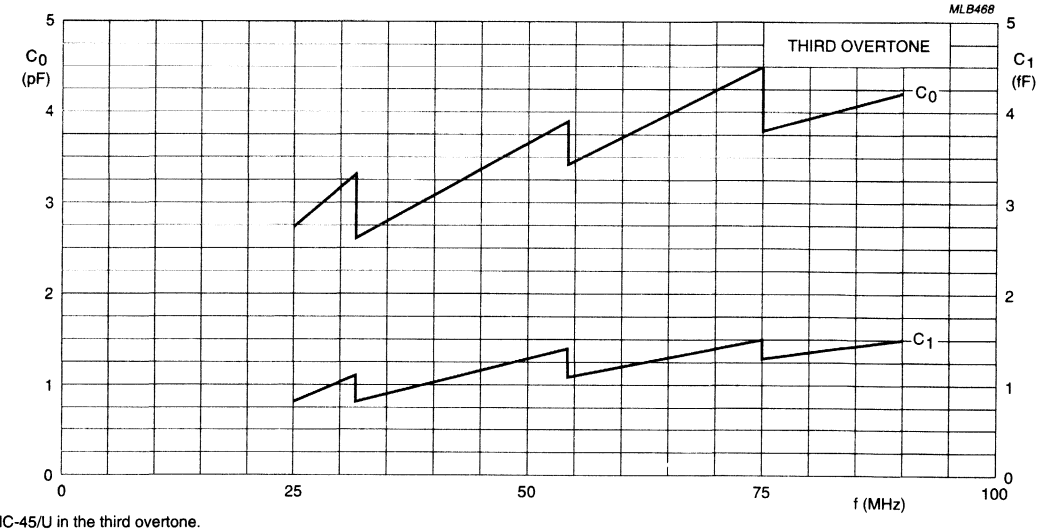
HC-45/U in the fundamental mode.
Typical values at 25 °C.
Other values available by extrapolation of the curve segments.

Fig.9 Motional capacitance C_1 and parallel capacitance C_0 as a function of resonance frequency, for HC-45/U crystals in 8 mm product height (involving large quartz blanks).



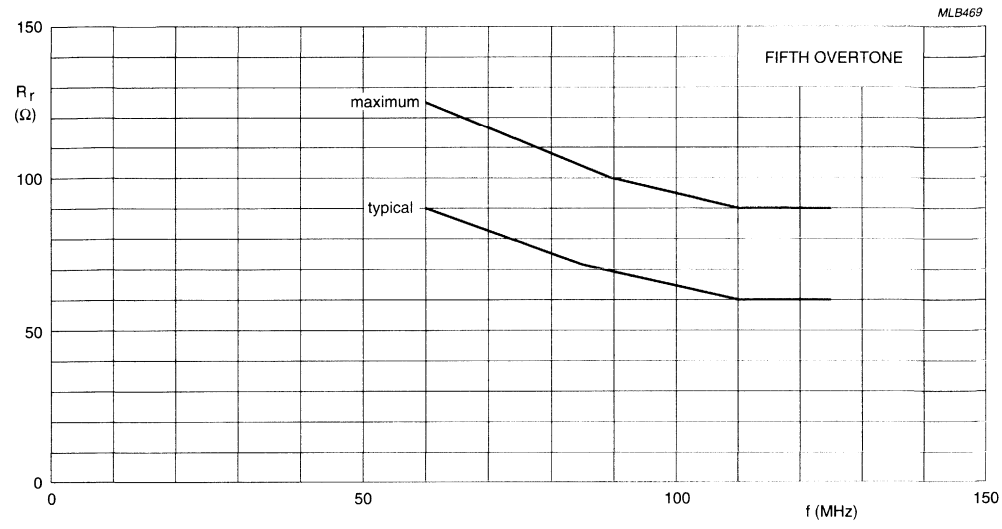
HC-45/U in the third overtone.
Values at 25 °C.
Other values available by extrapolation with C_0 and C_1 values.

Fig.10 Resonance resistance R_r as a function of resonance frequency, for HC-45/U crystals in 8 mm product height (involving large quartz blanks).



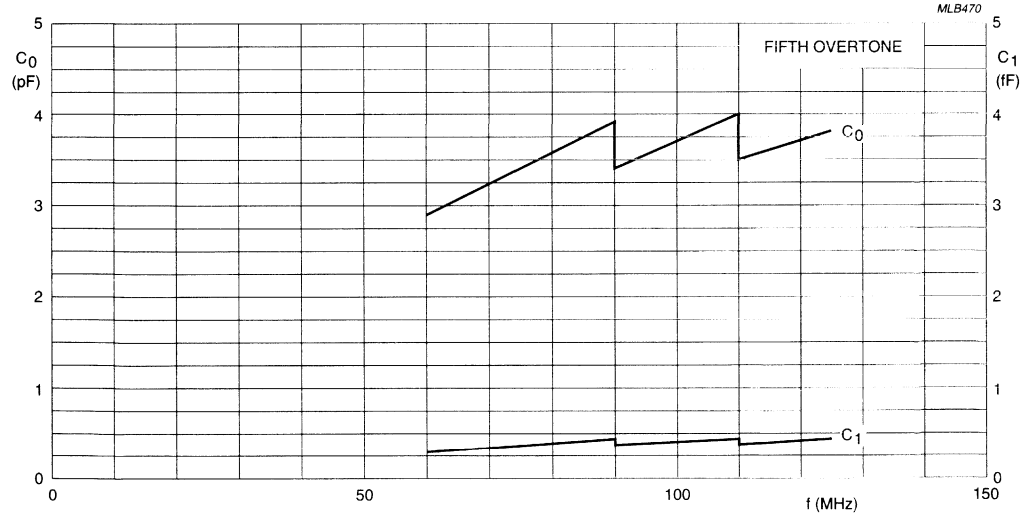
HC-45/U in the third overtone.
Typical values at 25 °C.
Other values available by extrapolation with C_0 and C_1 values.

Fig.11 Motional capacitance C_1 and parallel capacitance C_0 as a function of resonance frequency, for HC-45/U crystals in 8 mm product height (involving large quartz blanks).



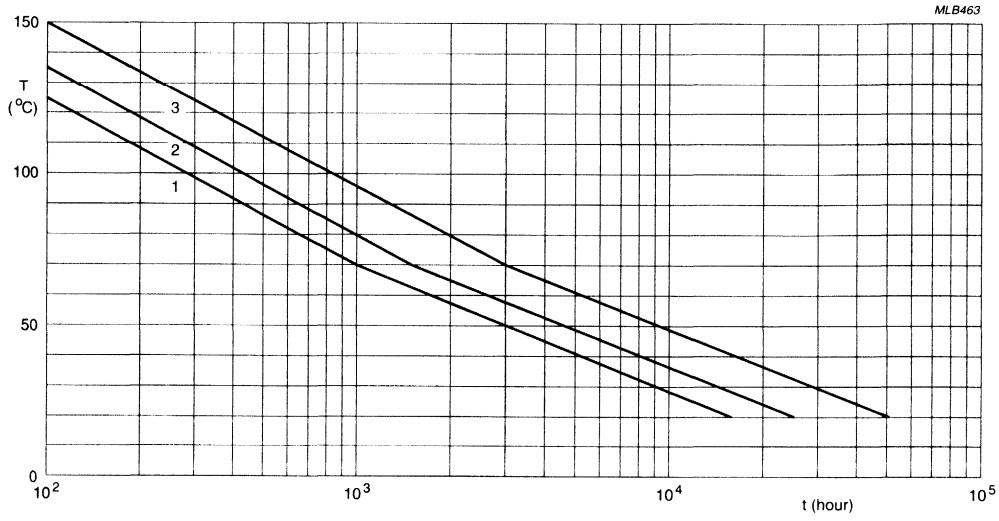
HC-45/U in the fifth overtone.
Values at 25 °C.

Fig.12 Resonance resistance R_r as a function of resonance frequency, for HC-45/U crystals in 8 mm product height (involving large quartz blanks).



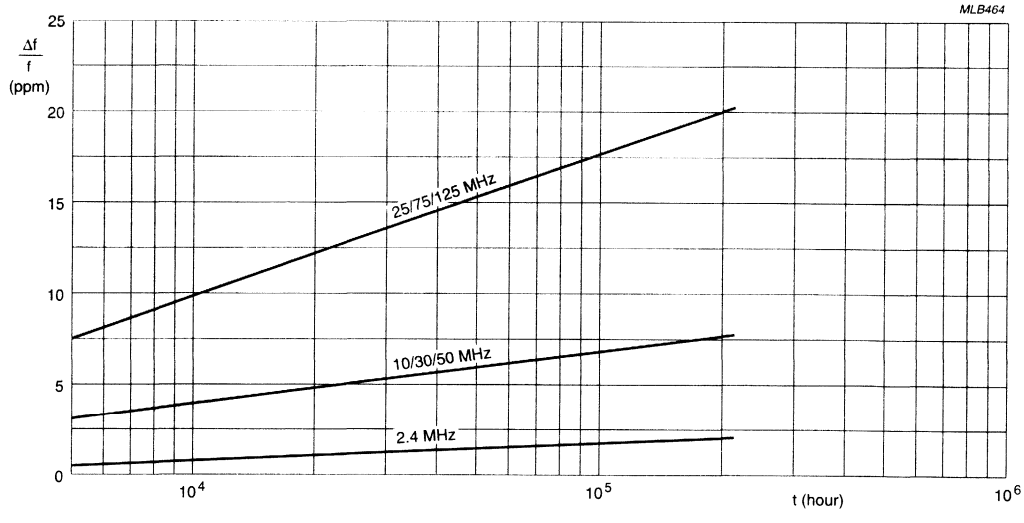
HC-45/U in the fifth overtone.
Typical values at 25 °C.

Fig.13 Motional capacitance C_1 and parallel capacitance C_0 as a function of resonance frequency, for HC-45/U crystals in 8 mm product height (involving large quartz blanks).



Curve 1 = 1000 hours at 70 °C.
Curve 2 = 720 hours at 85 °C.
Curve 3 = 240 hours at 130 °C.

Fig.14 Time/temperature relation at which ageing is approximately equivalent.



Fundamental, third and fifth overtones.
Necessary pre-ageing can be calculated using Fig.14.

Fig.15 Typical frequency ageing as a function of time at 25 °C, **without pre-ageing of crystals.**

TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with IEC publication 68-2, *"Recommended basic climatic and mechanical robustness testing procedure for electronic components"* and IEC publication 1178-1, *"Generic specification for quartz crystal units"*.

Table 5 Test procedures and requirements; note 1

IEC 68-2 METHOD	TEST	PROCEDURE	REQUIREMENTS
Ba	ageing	1000 hours at 70 °C	$\Delta f/f \leq \pm 5$ ppm
Db	accelerated damp heat	+25 to +55 °C; 6 cycles at RH >95%	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Ea	shock; note 2	100 g; half sinewave; 6 directions; 1 blow/direction	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Eb	bump; note 2	4000 bumps of 40 g	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Ed	free fall; note 2	3 times on hard wood; for height of fall (h) see Table 6	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Fc	vibration	frequency 10 to 500 to 10 Hz; acceleration 10 g; 3 directions; 30 minutes/direction	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Na	temperature cycling test	−40 to +85 °C; 10 cycles; 0.1 hour/cycle	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Q	sealing (method 1)	16 hours; 700 kPa He	$<1 \times 10^{-8}$ ncc/s He
Ta	solderability	235 ±5 °C; 2 ±0.5 s; flux 600 (activated)	≥90%, except for 1 mm from body; no visible damage, no leaks
Tb	resistance to soldering heat	350 ±5 °C; 3.5 ±0.5 s	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Ub	bending of terminations	1 × 90°; 5 N	no visible damage, no leaks

IEC 68-2 METHOD	TEST	PROCEDURE	REQUIREMENTS
Other applicable tests			
Xa	resistance to solvents; note 3: Bio-Act EC7®; Neutropon P3® and Saxin P3® ; Meta Clean 820®; Lonco 446®; Isopropanol cleaning solvent; Dowanol DPM® (glass crystals only)	in accordance with *"IEC 68-2-45"*, *"IEC 653"* (immersion time 5 minutes) and *"MIL 202 E215"*. At ambient temperature and ultrasonic frequency (40 kHz)	no degradation of marking

Notes

1. Test table including MIL-specs (*"MIL-Std 883"* and *"MIL-Std 202"*) can be provided upon request.
2. Mechanical tests to be performed on units clamped to a printed-circuit board for the total unit height.
3. Bio-Act is a registered trademark of Petroform.
   Neutropon P3 and Saxin P3 are registered trademarks of Henkel.
   Meta Clean 820 is a registered trademark of Mavom.
   Lonco 447 is a registered trademark of London Chemical Co.
   Dowanol DPM is a registered trademark of Dow Chemical.

Table 6 Height of fall

h (mm)	PRODUCT HEIGHT (mm)	FREQUENCY RANGE[1] (MHz)		
		FUNDAMENTAL MODE	THIRD OVERTONE	FIFTH OVERTONE
750	6.4	8.0 to 12.0	24.0 to 36.0	–
750	8.0 and 8.8	6.0 to 16.0	24.0 to 48.0	60.0 to 80.0
500	6.4	12.1 to 20.0	36.1 to 60.0	–
500	8.0 and 8.8	16.1 to 30.0	48.1 to 90.0	80.0 to 150.0
250	6.4	20.1 to 24.0	60.1 to 75.0	–

Note

1. Standard values. Actual designs can be made to obtain higher or lower values.

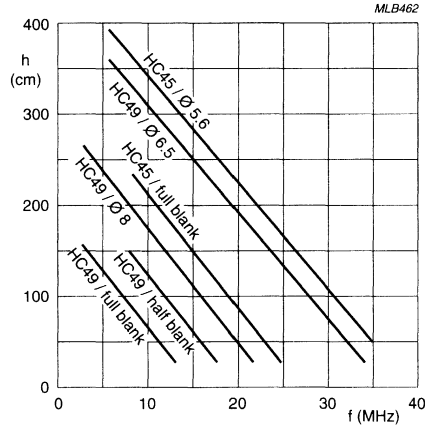


Fig.16 Typical height of fall values (3× on hard wood) for various quartz blank and holder combinations. 'Full' and 'half' blanks refer to rectangular quartz designs; '∅' designates circular quartz designs and the appropriate diameter.

Quartz crystals - HFX tubular 9922 524 0.... series

FEATURES

- Very high frequencies in fundamental mode
- Stringent process control for highly reliable operation
- Photolithographic processing in an automated facility
- Small package, cold-weld seal
- AT-cut.

APPLICATIONS

- Telecommunications
- Wireless RF applications
- Video, graphics
- VCXO's
- Low jitter, high frequency oscillators
- Ultra low power oscillators and transmitters
- Micro-miniature modules.

DESCRIPTION

Crystals in the HFX Series are rugged, very high frequency miniature AT-cut resonators housed in cold-welded tubular packages. Tab-Mesa Technology (TmT™) is used to achieve fundamental resonators to 250 MHz.

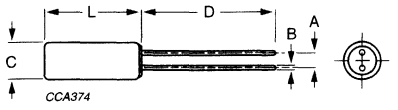
QUICK REFERENCE DATA

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT
f_{nom}	nominal frequency: fundamental mode	30.0	–	250.0	MHz
T_{oper}	operating temperature	–20	–	+70	°C
T_{op}	operable temperature	–40	–	+85	°C
$\Delta f/f_{nom}$	adjustment tolerance	±25	±50	+100	ppm
$\Delta f/f_{25}$	frequency stability over temperature range: –20 to +70 °C with respect to T_{amb} = 25 °C	±10	±25	±50	ppm
$\Delta f/f$	ageing over 10 years at 25 °C	–	±15	–	ppm

Quartz crystals - HFX tubular 9922 524 0.... series

MECHANICAL DATA

Package outline



Dimensions in mm.
For dimensions see Table 1.

Fig.1 Style 1: HFX in box.

Table 1 Product dimensions; see Fig.1

A (mm)	B (mm)	C_{max} (mm)	L_{max} (mm)	D_{max} (mm)
0.7 ±0.1	0.2 ±0.05	2.1	5.2	5.9

PACKAGING AND QUANTITIES

Table 2 HFX tubular

STYLE	PACKAGING	QUANTITY	DIMENSIONS OF BOX (mm)		
			LENGTH	WIDTH	HEIGHT
1	in box	100 to 1000 units per box	200	125	70

STANDARD MARKING[1]

The products are not marked. The packaging is marked with the following 3 lines:

- Line 1: PHILIPS
- Line 2: frequency in kHz (fundamental mode) or in MHz (overtone)
- Line 3: last five digits of catalogue number followed by the manufacturing date code (last four digits of week code in accordance with UN-D1120).

MASS AND LEADS

Typical mass: 0.2 g.

The leads have a solder-tin finish on a nickel underplate.

The first 1 mm from the body is not guaranteed for soldering.

(1) Special marking on product and/or package is available on request.

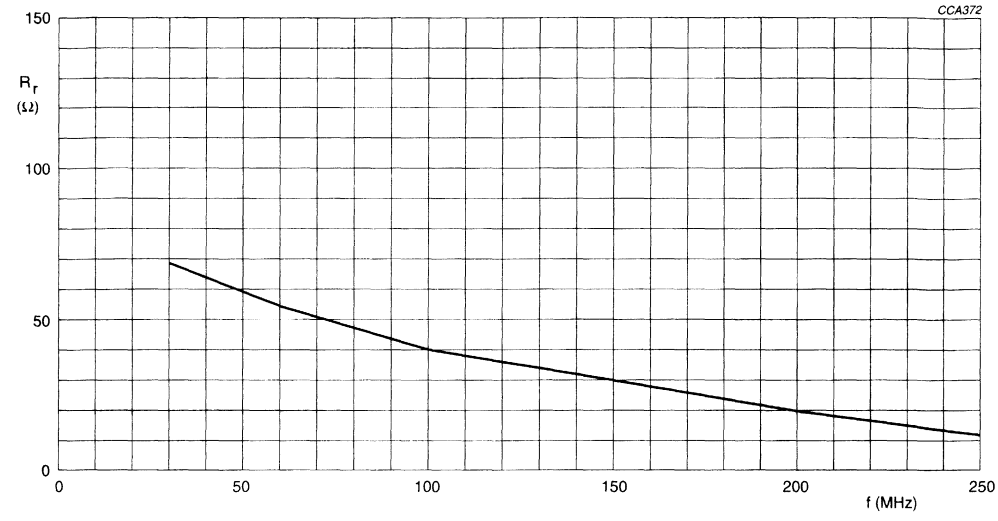
ELECTRICAL DATA

Valid at T_{amb} = 25 ±2 °C and a nominal drive level of 25 µW into 25 Ω unless otherwise specified. Maximum drive level is 500 µW. Measuring system: π-network in accordance with *"IEC 444"* recommendations.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
f_{nom}	nominal frequency	fundamental	30.0	–	250.0	MHz
$\Delta f/f_{nom}$	adjustment tolerance		±25	±50	±100	ppm
R_r	resonance resistance	see note 1	see Fig. 2			Ω
C_L	load capacitance	see note 2	4	20	∞	pF
T_{oper}	operating temperature		–20	–	+70	°C
T_{op}	operable temperature		–40	–	+85	°C
$\Delta f/f_{25}$	frequency stability over temperature range with respect to T_{amb} = 25 °C	see note 3	±10	±25	±50	ppm
R_r (T)	resonance resistance over temperature range	see note 1	available from R_r upwards; see Fig. 2			Ω
C_1	motional capacitance		see Fig 3			fF
C_0	parallel capacitance		see Fig 4			pF
$\Delta f/f$	ageing	10 years at T_{amb} = 25 °C	–	±15	–	ppm

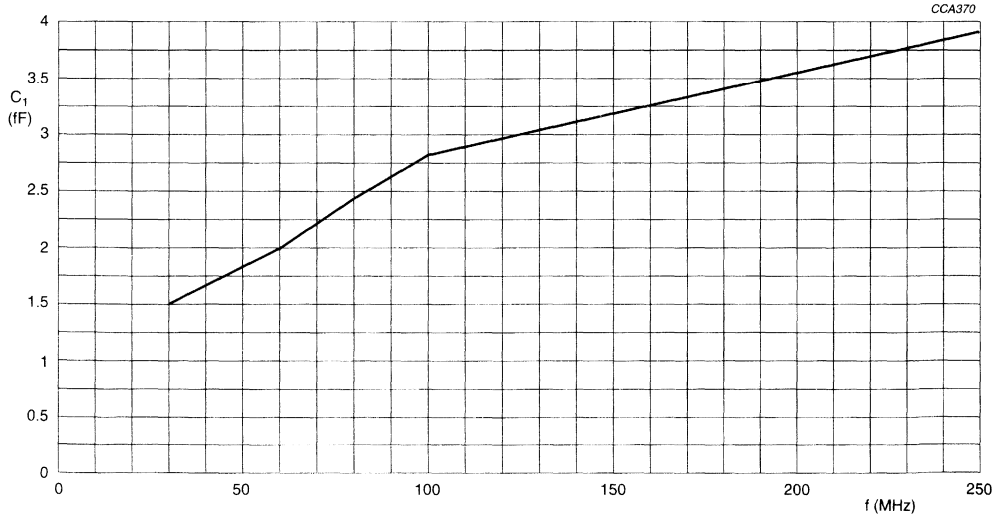
Notes

1. All resistance values are measured in series resonance. Load resonance measurement available on request.
2. Values available on request.
3. Frequency measurement in temperature range is performed in series resonance. Measurement of load resonance frequency can be performed on request.



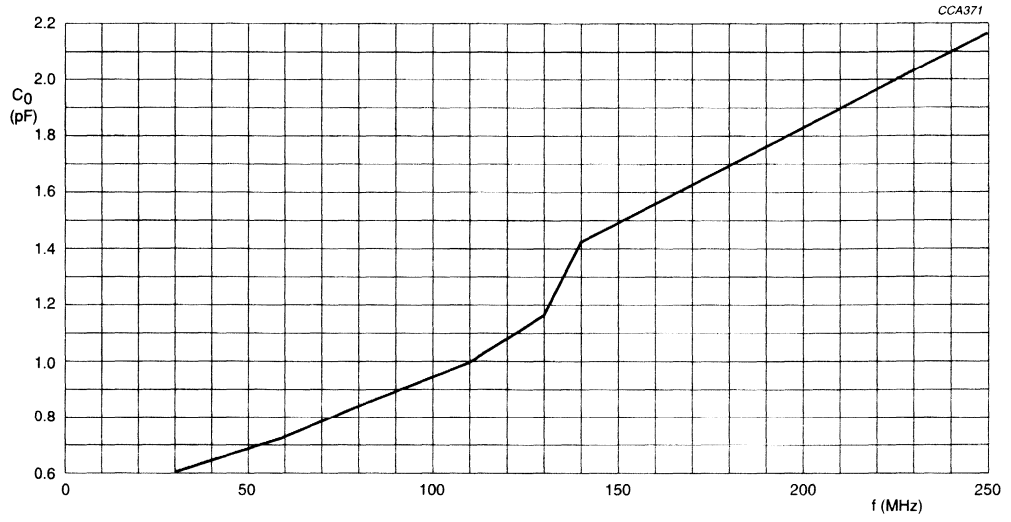
Values shown represent crystals that are designed primarily for clocking applications.
Crystals with higher C_1 values for use in VCXO applications are available on request.

Fig.2 Typical effective series resistance as a function of frequency.



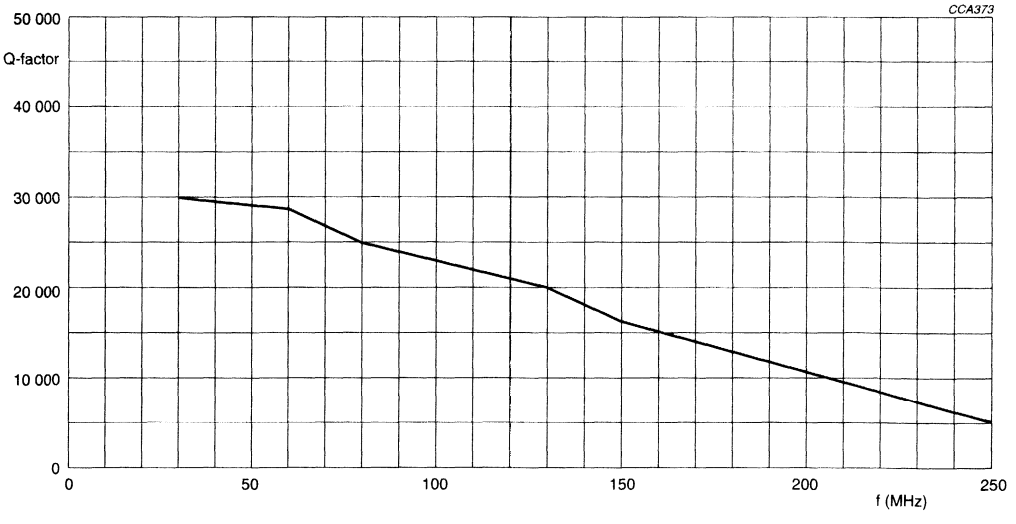
Values shown represent crystals that are designed primarily for clocking applications.
Crystals with higher C_1 values for use in VCXO applications are available on request.

Fig.3 Typical motional capacitance C_1 as a function of frequency.



Values shown represent crystals that are designed primarily for clocking applications.
Crystals with higher C_1 values for use in VCXO applications are available on request.

Fig.4 Typical parallel capacitance C_0 as a function of frequency.



Values shown represent crystals that are designed primarily for clocking applications.
Crystals with higher C_1 values for use in VCXO applications are available on request.

Fig.5 Typical Q-factor as a function of frequency.

TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with *"MIL-Standards 202 and 883"*.

Table 3 Test procedures and requirements

MIL STANDARD	TEST	PROCEDURE	REQUIREMENTS
Mechanical tests			
883	shock	method 1014	condition C
883	vibration	method 2007	condition A
202	terminal strength	method 211	conditions A and C
202	solvent resistance	method 215	
883	solderability	method 2003	
202	resistance to soldering heat	method 210	condition B
Environmental tests			
883	gross leak	method 1014	condition C
883	fine leak	method 1014 ($<5 \times 10^{-8}$ ATM cc/s)	condition A2
883	thermal shock	method 1011	condition A
883	moisture resistance	method 1004	

Quartz crystals - professional applications HC-26/U and HC-29/U

9922 526 0/3.... series

FEATURES

- Outstanding electrical performance
- Very high level of reliability
- Low resistance values
- High pullability values
- Extremely low ageing characteristics.

APPLICATIONS

- Transmitters
- Measurement equipment
- Medical applications
- Military applications
- Telephone switchboards
- Oven-controlled oscillators.

DESCRIPTION

The unit consists of a silver-plated AT-cut quartz plate, encapsulated in a high-vacuum all-glass holder. The holder is hermetically sealed and provided with connecting leads (HC-26/U) or pins (HC-29/U).

QUICK REFERENCE DATA

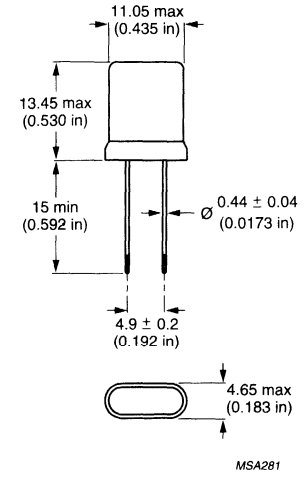
SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT
f_{nom}	nominal frequency:				
	fundamental mode	4.5	–	25.0	MHz
	third overtone	20.0	–	75.0	MHz
	fifth overtone	50.0	–	125.0	MHz
T_{oper}	operating temperature	−55	–	+105	°C
T_{op}	operable temperature	−55	–	+155	°C
$\Delta f/f_{nom}$	adjustment tolerance	±5	±20	–	ppm
$\Delta f/f_{25}$	frequency stability over temperature range: −55 to +105 °C with respect to T_{amb} = 25 °C	–	±25	–	ppm
C_1	motional capacitance tolerance	±5	±10	–	%
C_0	parallel capacitance tolerance	±5	±10	–	%
$\Delta f/f$	ageing over 10 years at 25 °C	±0.1	–	±2.0	ppm

Quartz crystals - professional applications HC-26/U and HC-29/U

9922 526 0/3.... series

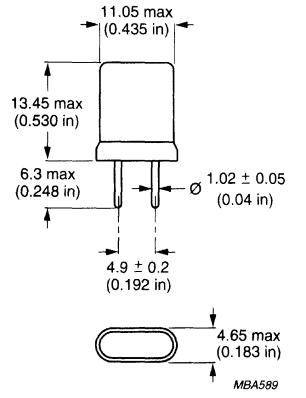
MECHANICAL DATA

Package outlines



Dimensions in mm.

Fig.1 Style 1: HC-26/U in box.



Dimensions in mm.

Fig.2 Style 1: HC-29/U in box.

PACKAGING AND QUANTITIES

Table 1 HC-26/U and HC-29/U

STYLE	PACKAGING	QUANTITY	DIMENSIONS OF BOX (mm)		
			LENGTH	WIDTH	HEIGHT
1 and 2	in blister	24 units per blister, 8 blisters per box	315	155	67

STANDARD MARKING[1]

- Line 1: PHILIPS
- Line 2: frequency in kHz (fundamental mode) or in MHz (overtone)
- LIne 3: last five digits of catalogue number followed by the manufacturing date code (last four digits of week code in accordance with UN-D1120).

MASS

Typical mass: 0.8 g.

(1) Special marking on product and/or package is available on request.

ELECTRICAL DATA

Valid at T_{amb} = 25 ± 2 °C and a nominal drive level of 100 μW into 25 Ω unless otherwise specified. Measuring system: π-network in accordance with *"IEC 444"* recommendations.

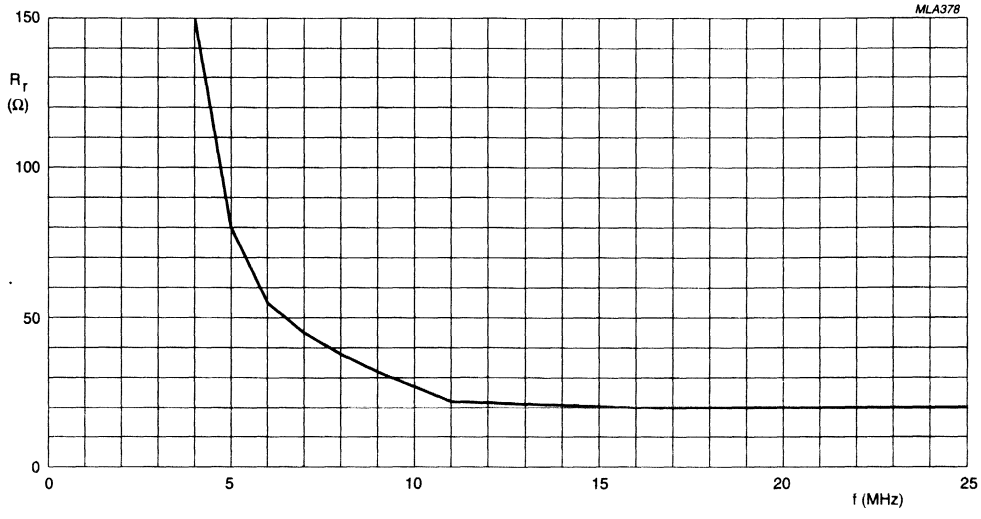
SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
f_{nom}	nominal frequency	fundamental	4.5	–	25.0	MHz
		third overtone	20.0	–	75.0	MHz
		fifth overtone	50.0	–	125.0	MHz
$\Delta f/f_{nom}$	adjustment tolerance	see note 1	±5	±20	–	ppm
R_r	resonance resistance	see note 2	see Fig.3 and Table 3			Ω
C_L	load capacitance	fundamental mode; note 3	5	20	∞	pF
		overtones; note 3	5	∞	–	pF
T_{oper}	operating temperature		−55	–	+105	°C
T_{op}	operable temperature		−55	–	+155	°C
$\Delta f/f_{25}$	frequency stability over temperature range	T_{amb} = 25 °C; note 4	see Table 2			ppm
R_r (T)	resonance resistance over temperature range	see note 2	available from R_r upwards			Ω
C_1	motional capacitance		see Fig.4 and Table 4			fF
	tolerance		±5	±10	–	%
C_0	parallel capacitance		see Fig.4 and Table 4			pF
	tolerance		±5	±10	–	%
S	pulling sensitivity		$S = -C_1 / 2(C_0 + C_L)^2$			ppm/pF
R_n	resonance resistance of unwanted response (spurious)	fundamental mode; f_{nom} ±20%	2 R_r (T)	–	–	Ω
			+6	–	–	dB
		overtones; f_{nom} ±200 kHz	2 R_r (T)	–	–	Ω
			+6	–	–	dB
R_{did}	drive level dependency, being the resonance resistance in the drive level range	drive level range 10^{-16} W to 10^{-4} W; note 2	see note 3			Ω
R_{ins}	insulation resistance	DC test voltage = 100 V	500	–	–	MΩ
	frequency hysteresis or discontinuity		–	–	1	ppm
Δf/f	ageing	10 years at T_{amb} = 25 °C	±0.1	–	±2.0	ppm

Notes

1. For ovenized crystals usually the upper turning point temperature is specified e.g. T_{ref} = 80 ±5 °C. The crystals are adjusted to meet adjustment tolerance at the specified reference temperature.
2. All resistance values are measured in series resonance. Load resonance measurement is available on request.
3. Values available on request.
4. Frequency measurement in temperature range is performed in series resonance if not requested otherwise.

Table 2 Frequency stability in different temperature ranges with respect to 25 °C; other temperature ranges and tolerances on request

TEMPERATURE RANGE (°C)	FREQUENCY STABILITY (ppm)				
	CLASS 0	CLASS 1	CLASS 2	CLASS 3	CLASS 3
Frequency range from 4.5 to 6.0 MHz					
0/+50	–	–	±7.0	±9.0	±12.0
–10/+60	–	–	±10.0	±13.0	±16.0
–20/+70	–	–	±14.0	±18.0	±22.0
–40/+90	–	–	±25.0	±30.0	±35.0
–55/+105	–	–	±35.0	±40.0	±50.0
Frequency range from 6.0 to 12.0 MHz					
0/+50	–	±3.5	±5.0	±7.5	±10.0
–10/+60	–	±6.0	±7.5	±10.0	±15.0
–20/+70	–	±8.0	±12.0	±15.0	±20.0
–40/+90	–	±16.0	±20.0	±25.0	±30.0
–55/+105	–	±25.0	±30.0	±35.0	±40.0
Frequency range ≥12.0 MHz					
+20/+30	±1.0	±1.0	±1.0	±1.5	±2.0
0/+50	±2.5	±4.0	±5.0	±7.5	±10.0
–10/+60	±4.0	±6.0	±7.5	±10.0	±15.0
–20/+70	±6.0	±8.0	±10.0	±15.0	±20.0
–40/+90	±12.5	±15.0	±20.0	±25.0	±30.0
–55/+105	±20.0	±25.0	±30.0	±35.0	±40.0

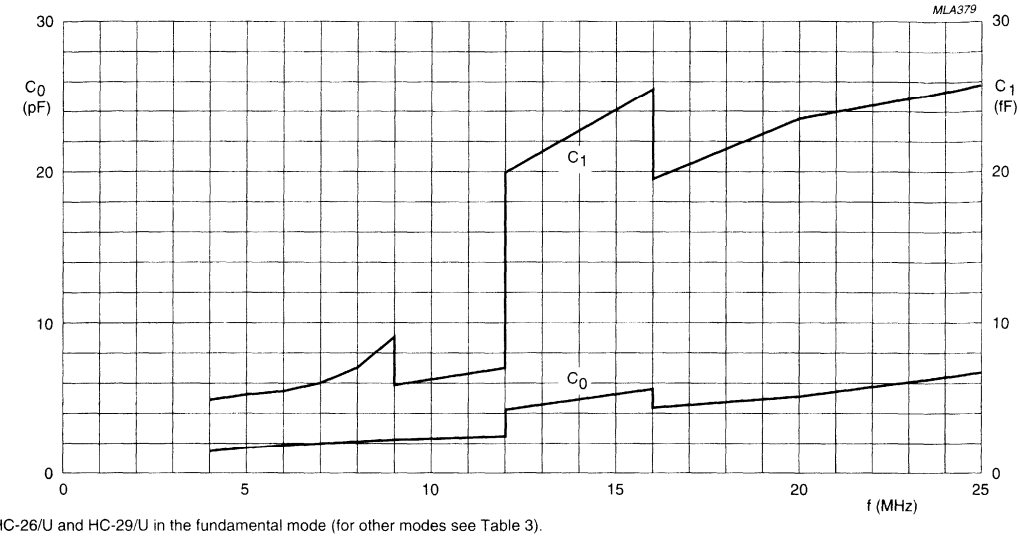


HC-26/U and HC-29/U in the fundamental mode (other modes in Table 4).
Other values are obtained if C_0 and C_1 values different from Fig.4 are specified.

Fig.3 Resonance resistance R_r as a function of resonance frequency.

Table 3 Resonance resistance for HC-26/U and HC-29/U in overtones

MODE	FREQUENCY (MHz)	R_r (Ω)
3	20.0 to 30.0	50
3	30.1 to 75.0	30
5	50.0 to 90.0	50
5	90.1 to 125.0	70



HC-26/U and HC-29/U in the fundamental mode (for other modes see Table 3).
Typical values at 25 °C.
Other values available on request.

Fig.4 Motional capacitance C_1 and parallel capacitance C_0 as a function of resonance frequency.

Table 4 Capacitances for HC-26/U and HC-29/U in overtones

MODE	FREQUENCY (MHz)	C_1 (fF)	C_0 MAX. (pF)
3	20.0 to 75.0	1.5	7
5	75.1 to 125.0	0.5	7

TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with IEC publication 68-2, *"Recommended basic climatic and mechanical robustness testing procedure for electronic components"* and IEC publication 1178-1, *"Generic specification for quartz crystal units"*.

Table 5 Test procedures and requirements

IEC 68-2 METHOD	TEST	PROCEDURE	REQUIREMENTS
Ba	ageing	2000 hours at 85 °C	$\Delta f/f$ −0.5/+1.0 ppm $\Delta f/f$ typical 0.5 ppm
Db	accelerated damp heat	+25 to +55 °C; 6 cycles at RH >95%	$\Delta f/f \leq \pm 1$ ppm ΔR_r ±1 Ω or ±20% whichever is the greater $R_{ins} \geq 10^8$ Ω at 50 VDC
Ea	shock; note 1	100 g; half sinewave; 6 directions; 1 blow/direction	$\Delta f/f \leq \pm 1$ ppm ΔR_r ±1 Ω or ±20% whichever is the greater
Fc	vibration; note 1	frequency 10 to 500 to 10 Hz; acceleration 20 g; 3 directions; 30 minutes/direction	$\Delta f/f \leq \pm 1$ ppm ΔR_r ±1 Ω or ±20% whichever is the greater
Na	temperature cycling test	−40 to +85 °C; 10 cycles; 2 hour/cycle	$\Delta f/f \leq \pm 1$ ppm ΔR_r ±1 Ω or ±20% whichever is the greater
Ta	solderability; note 2	235 ±5 °C; 2 ±0.5 s; flux 600 (activated); optional steam pre-heat 8 hours. This reflects at least 36 months of storage at room conditions	≥90%, except for 1 mm from body; no visible damage, no leaks
Tb	resistance to soldering heat; note 2	350 ±5 °C; 3.5 ±0.5 s	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±1 Ω or ±20% whichever is the greater
Ub	bending of terminations; note 2	1 × 90°; 5 N	no visible damage, no leaks

IEC 68-2 METHOD	TEST	PROCEDURE	REQUIREMENTS
Other applicable tests			
Xa	resistance to solvents; note 3: Bio-Act EC7®; Neutropon P3® and Saxin P3®; Meta Clean 820®; Lonco 446®; Isopropanol cleaning solvent; Dowanol DPM® (glass crystals only)	in accordance with *"IEC 68-2-45"*, *"IEC 653"* (immersion time 5 minutes) and *"MIL 202 E215"*. At ambient temperature and ultrasonic frequency (40 kHz)	no degradation of marking

Notes

1. Mechanical tests to be performed on units clamped to a printed-circuit board for the total unit height.
2. Not valid for type HC-29/U.
3. Bio-Act is a registered trademark of Petroform.
   Neutropon P3 and Saxin P3 are registered trademarks of Henkel.
   Meta Clean 820 is a registered trademark of Mavom.
   Lonco 447 is a registered trademark of London Chemical Co.
   Dowanol DPM is a registered trademark of Dow Chemical.

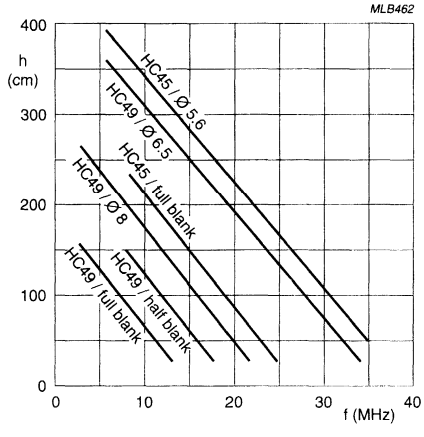


Fig.5 Typical height of fall values (3× on hard wood) for various quartz blank and holder combinations. 'Full' and 'half' blanks refer to rectangular quartz designs; '∅' designates circular quartz designs and the appropriate diameter.

Quartz crystals - professional applications HC-27/U

9922 527 0/2.... series

FEATURES

- Outstanding electrical performance
- Very high level of reliability
- Low resistance values
- High pullability values
- Extreme low ageing characteristics.

APPLICATIONS

- Transmitters
- Measurement equipment
- Medical applications
- Military applications
- Telephone switchboards
- Oven-controlled oscillators
- Low-frequency applications
- Aerospace
- Frequency counters.

DESCRIPTION

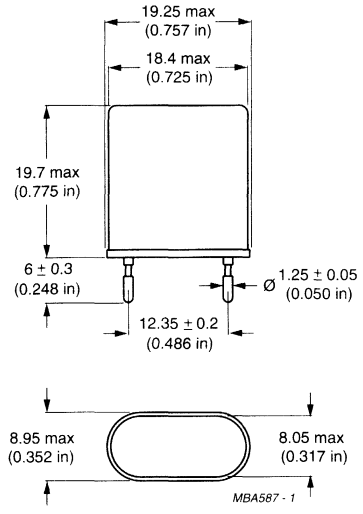
The unit consists of a silver-plated AT-cut quartz plate, encapsulated in a high-vacuum all-glass holder. The holder is hermetically sealed and provided with pins.

QUICK REFERENCE DATA

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT
f_{nom}	nominal frequency				
	fundamental mode	1.8	–	25.0	MHz
	third overtone	10.0	–	75.0	MHz
	fifth overtone	50.0	–	125.0	MHz
T_{oper}	operating temperature	−55	–	+105	°C
T_{op}	operable temperature	−55	–	+155	°C
$\Delta f/f_{nom}$	adjustment tolerance	±5	±10	–	ppm
$\Delta f/f_{25}$	frequency stability over temperature range: −20 to +70 °C with respect to T_{amb} = 25 °C	–	±25	–	ppm
C_1	motional capacitance tolerance	±5	±10	–	%
C_0	parallel capacitance tolerance	±5	±10	–	%
$\Delta f/f$	ageing over 10 years at 25 °C	±0.1	–	±2.0	ppm

MECHANICAL DATA

Package outlines



Dimensions in mm.
IEC type DB is identical except for the height which is 26 mm max.

Fig.1 Style 1: HC-27/U.

PACKAGING AND QUANTITIES

Table 1 HC-27/U

STYLE	PACKAGING	QUANTITY	DIMENSIONS OF BOX (mm)		
			LENGTH	WIDTH	HEIGHT
1	in blister	4 units per tray, 32 blisters per box	315	155	67

STANDARD MARKING(1)

- Line 1: PHILIPS
- Line 2: frequency in kHz (fundamental mode) or in MHz (overtone)
- LIne 3: last five digits of catalogue number followed by the manufacturing date code (last four digits of week code in accordance with UN-D1120).

MASS

Typical mass: 2.5 g.

(1) Special marking on product and/or package is available on request.

Quartz crystals - professional applications HC-27/U

9922 527 0/2.... series

ELECTRICAL DATA

Valid at T_{amb} = 25 ±2 °C and a nominal drive level of 100 μW into 25 Ω unless otherwise specified. Measuring system: π-network in accordance with *"IEC 444"* recommendations.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
f_{nom}	nominal frequency	fundamental	1.8	–	25.0	MHz
		third overtone	10.0	–	75.0	MHz
		fifth overtone	50.0	–	125.0	MHz
$\Delta f/f_{nom}$	adjustment tolerance	note 1	±5	±10	–	ppm
R_r	resonance resistance	fundamental mode; note 2	see Fig.2			Ω
		third overtone; note 2	–	≤40	–	Ω
		fifth overtone; note 2	–	≤50	–	Ω
C_L	load capacitance	fundamental mode; note 3	5	20	∞	pF
		overtones; note 3	5	∞	–	pF
T_{oper}	operating temperature		−55	–	+105	°C
T_{op}	operable temperature		−55	–	+155	°C
$\Delta f/f_{25}$	frequency stability over temperature range	T_{amb} = 25 °C; note 4	see Table 2			ppm
R_r (T)	resonance resistance over temperature range	see note 2	available from R_r upwards			Ω
C_1	motional capacitance	fundamental mode	see Fig.3			fF
		third overtone	–	1.5	–	fF
		fifth overtone	–	0.5	–	fF
	tolerance		±5	±10	–	%
C_0	parallel capacitance	fundamental mode	see Fig.3			pF
		third overtone	–	–	7	pF
		fifth overtone	–	–	7	pF
	tolerance		±5	±10	–	%
S	pulling sensitivity		$S = -0.5\ C_1 / (C_0 + C_L)^2$			ppm/pF
R_n	resonance resistance of unwanted response (spurious)	fundamental mode; f_{nom} ±20%	2 R_r (T)	–	–	Ω
			+6	–	–	dB
		overtones; f_{nom} ±200 kHz	2 R_r (T)	–	–	Ω
			+6	–	–	dB
R_{did}	drive level dependency, being the resonance resistance in the drive level range	drive level range 10^{-16} W to 10^{-4} W; note 2	see note 3			Ω

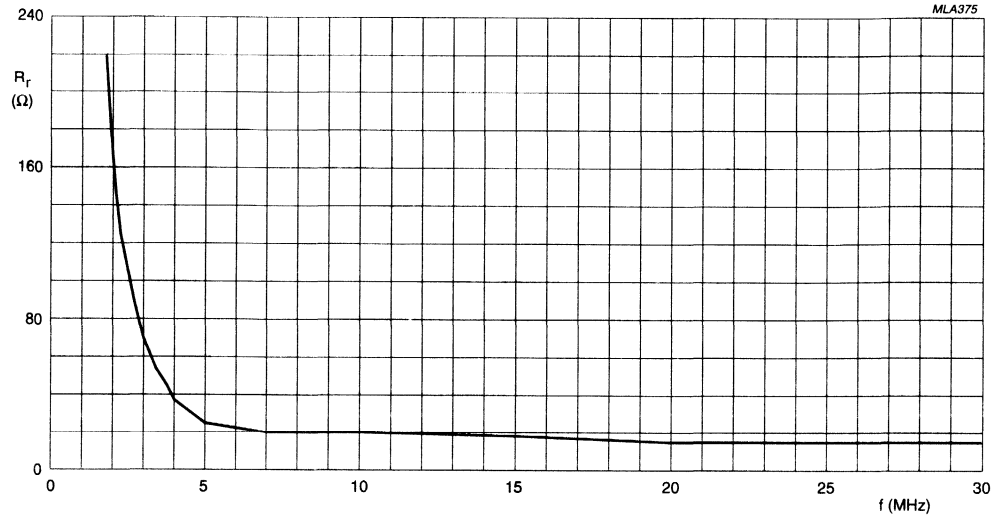
SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
R_{ins}	insulation resistance	DC test voltage = 100 V	500	–	–	MΩ
	frequency hysteresis or discontinuity		–	–	1	ppm
Δf/f	ageing	10 years at T_{amb} = 25 °C	±0.1	–	±2.0	ppm

Notes

1. For ovenized crystals usually the upper turning point temperature is specified e.g. T_{ref} = 80 ±5 °C. The crystals are adjusted to meet adjustment tolerance at the specified reference temperature.
2. All resistance values are measured in series resonance. Load resonance measurement is available on request.
3. Values available on request.
4. Frequency measurement in temperature range is performed in series resonance if not requested otherwise.

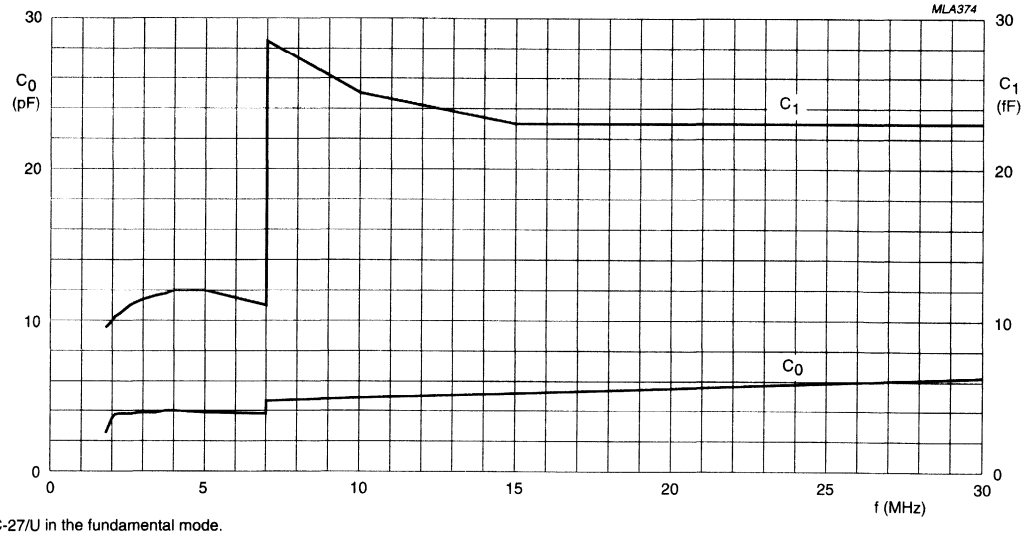
Table 2 Frequency stability in different temperature ranges with respect to 25 °C; other temperature ranges and tolerances on request

FREQUENCY RANGE (MHz)	TEMPERATURE RANGE (°C)	FREQUENCY STABILITY (ppm)		
		CLASS 0	CLASS 1	CLASS 2
Fundamental mode				
1.8 to 2.3	–5/+45	–	±10.0	±13.0
	–10/+50	–	±12.0	±16.0
	–15/+70	–	±17.0	±22.0
	–55/+105	–	±42.0	±50.0
2.3 to 7.0	–5/+45	±6.0	±9.0	±12.0
	–10/+50	±8.0	±11.0	±15.0
	–15/+70	±12.0	±15.0	±20.0
	–55/+105	±32.5	±40.0	±50.0
7.0 to 25.0	–5/+45	±5.0	±7.5	±12.0
	–10/+60	±7.5	±10.0	±15.0
	–20/+70	±10.0	±15.0	±20.0
	–40/+90	±20.0	±25.0	±30.0
	–55/+105	±30.0	±35.0	±40.0
1.8 to 25.0	T_{ref} ±5.0	±1.0	±1.5	±2.5
Third and fifth overtone				
10.0 to 125.0	–5/+50	±5.0	±7.5	±10.0
	–10/+60	±7.5	±10.0	±15.0
	–20/+70	±10.0	±13.0	±20.0
	–55/+105	±25.0	±30.0	±40.0
	T_{ref} ±5.0	±1.0	±1.5	±2.5



HC-27/U in the fundamental mode.
Typical values at 25 °C.
Other values available by extrapolation with C_0 and C_1 values.

Fig.2 Resonance resistance R_r as a function of resonance frequency.



HC-27/U in the fundamental mode.
Maximum values in the temperature range.
Other values available by extrapolation with C_0 and C_1 values.

Fig.3 Motional capacitance C_1 and parallel capacitance C_0 as a function of resonance frequency.

TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with IEC publication 68-2, *"Recommended basic climatic and mechanical robustness testing procedure for electronic components"* and IEC publication 1178-1.

Table 3 Test procedures and requirements

IEC 68-2 METHOD	TEST	PROCEDURE	REQUIREMENTS
Ba	ageing	2000 hours at 85 °C	$\Delta f/f$ −0.5/+1.0 ppm $\Delta f/f$ typical 0.5 ppm
Db	accelerated damp heat	+25 to +55 °C; 6 cycles at RH >95%	$\Delta f/f \leq \pm 1$ ppm ΔR_r ±1 Ω or ±20% whichever is the greater
Ea	shock; note 1	100 g; half sinewave; 6 directions; 1 blow/direction	$\Delta f/f \leq \pm 1$ ppm ΔR_r ±1 Ω or ±20% whichever is the greater
Fc	vibration; note 1	frequency 10 to 500 to 10 Hz; acceleration 20 g; 3 directions; 30 minutes/direction	$\Delta f/f \leq \pm 1$ ppm ΔR_r ±1 Ω or ±20% whichever is the greater
Na	temperature cycling test	−40 to +85 °C; 10 cycles; 0.1 hour/cycle	$\Delta f/f \leq \pm 1$ ppm ΔR_r ±1 Ω or ±20% whichever is the greater
Other applicable tests			
Xa	resistance to solvents; note 2: Bio-Act EC7®; Neutropon P3® and Saxin P3®; Meta Clean 820®; Lonco 446®; Isopropanol cleaning solvent; Dowanol DPM® (glass crystals only)	in accordance with *"IEC 68-2-45"*, *"IEC 653"* (immersion time 5 minutes) and *"MIL 202 E215"*. At ambient temperature and ultrasonic frequency (40 kHz)	no degradation of marking

Notes

1. Mechanical tests to be performed on units clamped to a printed-circuit board for the total unit height.
2. Bio-Act is a registered trademark of Petroform.
   Neutropon P3 and Saxin P3 are registered trademarks of Henkel.
   Meta Clean 820 is a registered trademark of Mavom.
   Lonco 447 is a registered trademark of London Chemical Co.
   Dowanol DPM is a registered trademark of Dow Chemical.

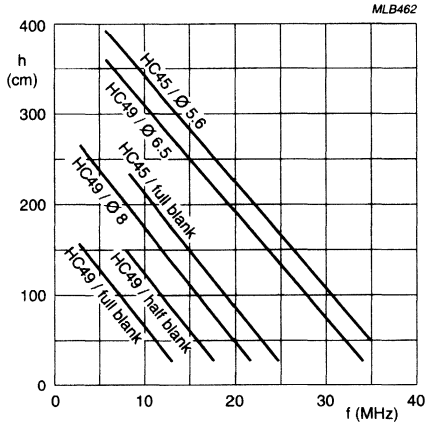


Fig.4 Typical height of fall values (3× on hard wood) for various quartz blank and holder combinations. 'Full' and 'half' blanks refer to rectangular quartz designs; '∅' designates circular quartz designs and the appropriate diameter.

Quartz crystals - professional applications HC-33/U and HC-36/U

9922 529 900.. series

FEATURES

- Outstanding electrical performance
- High mechanical and electrical stability
- High pullability values
- Low resistance values at low frequencies.

APPLICATIONS

- Low frequency applications
- Transmitters.

DESCRIPTION

The unit consists of a metal-plated AT-cut quartz plate, encapsulated in a nitrogen-filled metal holder. The holder is hermetically sealed by resistance welding and provided with two connecting leads (HC-33/U). Products are also available with connecting pins (HC-36/U).

QUICK REFERENCE DATA

SYMBOL	PARAMETER[1]	MIN.	TYP.	MAX.	UNIT
f_{nom}	nominal frequency:				
	fundamental mode	1.8	–	25.0	MHz
	third overtone	10.0	–	75.0	MHz
	fifth overtone	50.0	–	125.0	MHz
T_{oper}	operating temperature	−55	–	+105	°C
T_{op}	operable temperature	−55	–	+125	°C
$\Delta f/f_{nom}$	adjustment tolerance	±5	±10	–	ppm
$\Delta f/f_{25}$	frequency stability over temperature range from −20 to +70 °C with respect to T_{amb} = 25 ±2 °C:				
	class 0	–	±10	–	ppm
	class 1	–	±15	–	ppm
	class 2	–	±20	–	ppm
C_1	motional capacitance tolerance	±5	±10	–	%
C_0	parallel capacitance tolerance	±5	±10	–	%
$\Delta f/f$	ageing over 10 years at 25 °C	±3.0	–	±5.0	ppm

Note

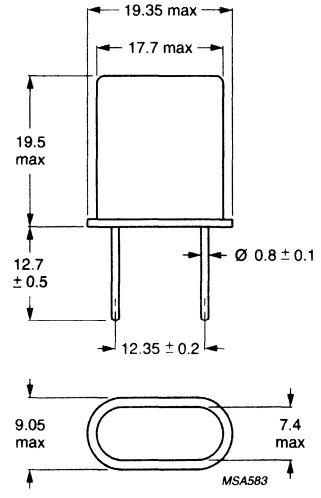
1. Crystals with 7^{th} and 9^{th} overtone are available on request.

Quartz crystals - professional applications HC-33/U and HC-36/U

9922 529 900.. series

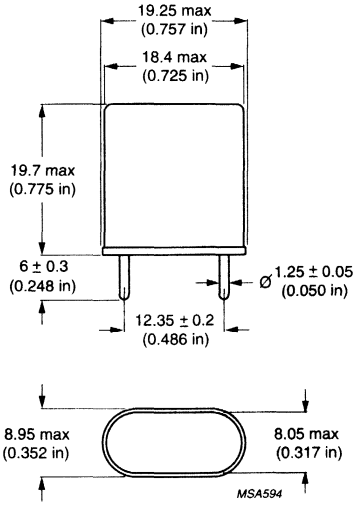
MECHANICAL DATA

Package outlines



Dimensions in mm.

Fig.1 HC-33/U, resistance welded.



Dimensions in mm.

Fig.2 HC-36/U, resistance welded.

PACKAGING AND QUANTITIES

Table 1 HC-33/U and HC-36/U

STYLE	PACKAGING	QUANTITY	DIMENSIONS OF BOX (mm)		
			LENGTH	WIDTH	HEIGHT
1	in blister in box	16 units per blister, 8 blisters per box	315	155	67

STANDARD MARKING[1]

- Line 1: PHILIPS
- Line 2: frequency in kHz (fundamental mode) or in MHz (overtone)
- Line 3: last five digits of catalogue number followed by the manufacturing date code (last four digits of week code in accordance with UN-D1120).

MASS

Typical mass:

fundamental: 4 g.

(1) Special marking on product and/or package is available on request.

Quartz crystals - professional applications HC-33/U and HC-36/U

9922 529 900.. series

ELECTRICAL DATA

Valid at T_{amb} = 25 ± 2 °C and a nominal drive level of 100 µW into 25 Ω unless otherwise specified. Measuring system: π-network in accordance with *"IEC 444"* recommendations.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
f_{nom}	nominal frequency	fundamental	1.8	–	25.0	MHz
		third overtone	10.0	–	75.0	MHz
		fifth overtone	50.0	–	125.0	MHz
$\Delta f/f_{nom}$	adjustment tolerance	see note **1**	±5	±10	–	ppm
R_r	resonance resistance	see note 2	see Fig.3 and Table 3			Ω
C_L	load capacitance	fundamental mode; note 3	5	20	∞	pF
		overtones; note 3	5	∞	–	pF
T_{oper}	operating temperature		–55	–	+105	°C
T_{op}	operable temperature		–55	–	+125	°C
$\Delta f/f_{25}$	frequency stability over temperature range	T_{amb} = 25 °C; note 4	see Table 2			ppm
R_r (T)	resonance resistance over temperature range	see note 2	available from R_r upwards			Ω
C_1	motional capacitance	fundamental	see Fig.4			fF
		third overtone	–	1.5	–	fF
		fifth overtone	–	0.5	–	fF
	tolerance		±5	±10	–	%
C_0	parallel capacitance	fundamental	see Fig.4			pF
		third and fifth overtones	–	–	7	pF
	tolerance		±5	±10	–	%
S	pulling sensitivity		$S = -0.5\ C_1 / (C_0 + C_L)^2$			ppm/pF
R_n	resonance resistance of unwanted response (spurious)	fundamental mode; f_{nom} ±20%	2 R_r (T)	–	–	Ω
			+6	–	–	dB
		overtones; f_{nom} ±200 kHz	2 R_r (T)	–	–	Ω
			+6	–	–	dB
R_{did}	drive level dependency, being the resonance resistance in the drive level range	drive level range 10^{-16} W to 10^{-4} W; note 2	see note 3			Ω
R_{ins}	insulation resistance	DC test voltage = 100 V	500	–	–	MΩ
$\Delta f/f_{nom}$	frequency hysteresis or discontinuity		–	–	1	ppm
$\Delta f/f$	ageing	10 years at T_{amb} = 25 °C	±3.0	–	±5.0	ppm

Notes

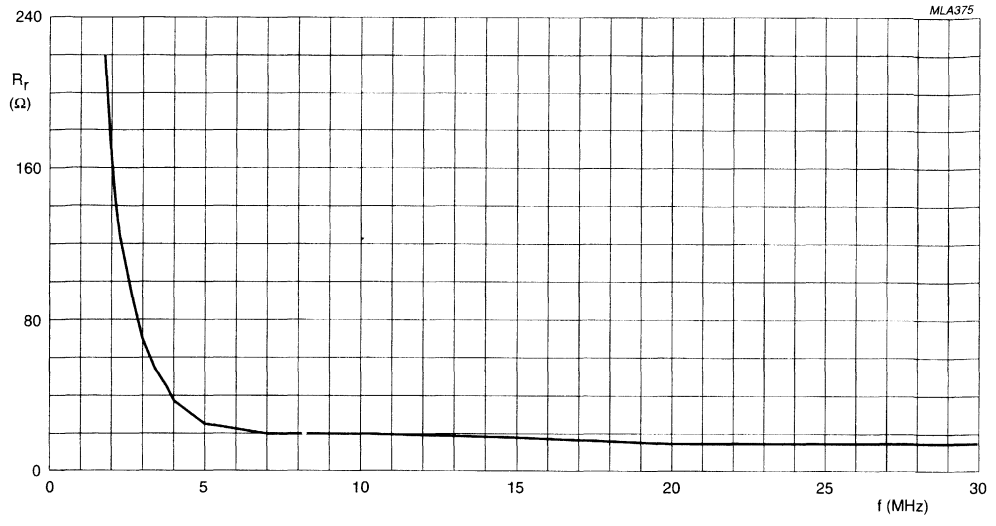
1. For ovenized crystals usually the upper turning point temperature is specified e.g. T_{ref} = 80 ±5 °C. The crystals are adjusted to meet adjustment tolerance at the specified reference temperature.
2. All resistance values are measured in series resonance. Load resonance measurement is available on request.
3. Values available on request.
4. Frequency measurement in temperature range is performed in series resonance if not requested otherwise.

Table 2 Frequency stability in different temperature ranges with respect to +25 °C; other temperature ranges and tolerances on request

FREQUENCY RANGE (MHz)	TEMPERATURE RANGE (°C)	FREQUENCY STABILITY (ppm)		
		CLASS 0	CLASS 1	CLASS 2
Fundamental mode				
1.8 to 25.0	−5/+45	±5	±7.5	±10
	−10/+50	±7.5	±10	±15
	−15/+70	±10	±15	±20
1.8 to 2.3	−55/+105	±30	±13	±20
2.3 to 7.0	−55/+105	±32.5	±35	+40
7.0 to 25.0	−55/+105	+25	+30	+40
1.8 to 25.0	T_{nom} ±5	–	±2.5	−5
Third and fifth overtones				
	−5/+50	±5	±7.5	±10
	−10/+60	±7.5	±10	±15
	−20/+70	±10	±13	±20
	−55/+105	±25	±30	±40
	T_{nom} ±5	–	±2.5	±5

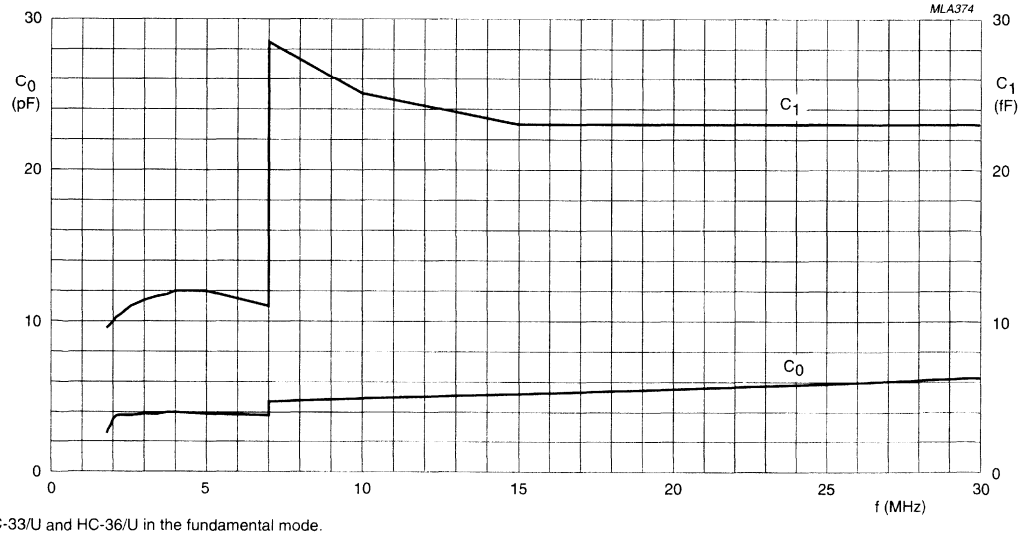
Table 3 Resonance resistance (R_r)

FREQUENCY (MHz)	MAXIMUM R_r (Ω)
Fundamental mode	
1.8 to 1.999	300
2.0 to 2.249	250
2.26 to 3.749	150
3.75 to 4.999	100
5.0 to 6.999	50
7.0 to 9.999	30
10.0 to 25.0	25
Third overtone	
10.0 to 15.0	60
15.0 to 75.0	40
Fifth overtone	
50.0 to 90.0	60
90.0 to 125.0	80



HC-33/U and HC-36/U in the fundamental mode.
Typical values at 25 °C.
Other values available by extrapolation with C_0 and C_1 values.

Fig.3 Resonance resistance R_r as a function of resonance frequency.



HC-33/U and HC-36/U in the fundamental mode.
Maximum values in the temperature range.
Other values available by extrapolation with C_0 and C_1 values.

Fig.4 Motional capacitance C_1 and parallel capacitance C_0 as a function of resonance frequency.

TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with IEC publication 68-2, *"Recommended basic climatic and mechanical robustness testing procedure for electronic components"*. Ageing test is in accordance with IEC publication 679-1.

Table 4 Test procedures and requirements

IEC 68-2 METHOD	TEST	PROCEDURE	REQUIREMENTS
Ba	ageing; note 1	1000 hours at 70 °C	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Db	accelerated damp heat	+25 to +55 °C; 6 cycles at RH >95%	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Ea	shock	100 g; half sinewave; 6 directions; 1 blow/direction	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Fc	vibration	frequency 10 to 500 to 10 Hz; acceleration; 3 directions; 30 minutes/direction	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Na	temperature cycling test	−40 to +85 °C; 10 cycles; 2 hour/cycle	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Q	sealing (method 1)	16 hours; 700 kPa He	$< 1 \times 10^{-8}$ ncc/s He
Ta	solderability; note 2	235 ±5 °C; 2 ±0.5 s; flux 600 (activated); optional steam pre-heat 8 hours. This reflects at least 36 months of storage at room conditions	≥90%, except for 1 mm from body; no visible damage, no leaks
Tb	resistance to soldering heat; note 2	350 ±5 °C; 3.5 ±0.5 s	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±20% whichever is the greater
Ub	bending of terminations; note 2	1 × 90°; 5 N	no visible damage, no leaks

IEC 68-2 METHOD	TEST	PROCEDURE	REQUIREMENTS
Other applicable tests			
Xa	resistance to solvents; note 3: Bio-Act EC7®; Neutropon P3® and Saxin P3®; Meta Clean 820®; Lonco 446®; Isopropanol cleaning solvent; Dowanol DPM® (glass crystals only)	in accordance with *"IEC 68-2-45"*, *"IEC 653"* (immersion time 5 minutes) and *"MIL 202 E215"*. At ambient temperature and ultrasonic frequency (40 kHz)	no degradation of marking

Notes

1. Overtone: $\Delta f/f \leq 10$ ppm.
2. Not valid for HC-36/U.
3. Bio-Act is a registered trademark of Petroform.
   Neutropon P3 and Saxin P3 are registered trademarks of Henkel.
   Meta Clean 820 is a registered trademark of Mavom.
   Lonco 447 is a registered trademark of London Chemical Co.
   Dowanol DPM is a registered trademark of Dow Chemical.

TEMPERATURE SENSORS

Quartz temperature sensor HC-49/U

9922 529 801.. series

FEATURES

- No A/D conversion
- Excellent linearity
- High stability, low ageing
- Wide temperature range
- High noise immunity
- Easy calibration
- Quantity production at low cost.

APPLICATIONS

- In industrial temperature measurement and control
- Car electronics
- Flow meters
- Weather balloons
- Medical systems
- Energy saving projects, for example:
  - heat monitors
  - solar panels.

DESCRIPTION

The sensor consists of a metal-plated special TC-cut piezoelectric quartz plate, mounted in a hermetically sealed resistance-welded metal holder, which has two or three leads and is filled with a dry inert gas.

The quartz plate oscillates in a fundamental thickness-shear mode and the resonance frequency is an almost linear function of the temperature.

QUICK REFERENCE DATA

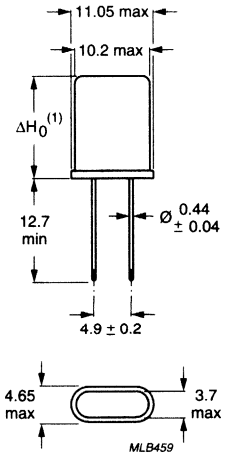
SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT
f_{nom}	nominal frequency	4.0	–	25.0	MHz
T_{oper}	operating temperature	–55	–	+125	°C
T_{op}	operable temperature	–55	–	+155	°C
TC	temperature coefficient	–40	–	+80	ppm/K
LIN	linearity	–	±2.5	–	%
$\Delta f/f_{nom}$	adjustment tolerance	–	±150	–	ppm
τ_{th}	thermal time constant	–	10	–	s

Quartz temperature sensor HC-49/U

9922 529 801.. series

MECHANICAL DATA

Package outlines



Dimensions in mm.

This type is also available as a surface mounting device.

(1) For ΔH_0 see Table 1.

Fig.1 Style 1: HC-49/U in box.

Table 1 Product height; notes 1 and 2

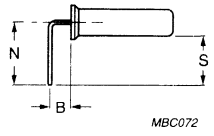
MAXIMUM HEIGHT ΔH_0 (mm)	FREQUENCY RANGE (MHz)
9.6	8.0 to 25.0
11.0	8.0 to 25.0
13.4	4.0 to 25.0

Notes

1. Available lead length: up to 13 mm.
2. Lead length tolerance (for Style 1):
   a) Lead length (H_2) > 3 mm: ±0.5 mm
   b) Lead length (H_2) ≤ 3 mm: ±0.2 mm.

Quartz temperature sensor HC-49/U

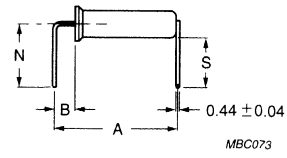
9922 529 801.. series



Dimensions in mm.

STYLE 4	N	B	S
a	7.0 ±0.6	2.5 ±0.6	5.2 ±0.6
b	8.0 ±0.6	2.0 ±0.6	6.2 ±0.6
c	9.7 ±0.6	3.0 ±0.6	7.9 ±0.6

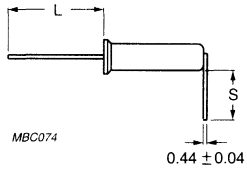
Fig.2 Style 4: HC-49/U on tray in box.



The third lead is symmetric, ±0.5 mm with respect to the other leads .Dimensions in mm.

STYLE 5	N	B	A	S
a	5.7 ±1.0	1.5	15.2 ±0.2	3.9 ±1.0
b	5.9 ±1.0	4.1	17.8 ±0.2	4.1 ±1.0
c	10.2 ±1.0	3.3	16.5 ±0.2	8.4 ±1.0
d	5.7 ±1.0	1.9	15.6 ±0.2	3.9 ±1.0

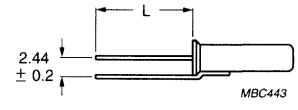
Fig.3 Style 5: HC-49/U on tray in box.



The third lead is symmetric, ±0.5 mm with respect to the other leads .Dimensions in mm.

STYLE 6	L	S
a	13.2 ±0.5	4.5 ±1.0
b	13.2 ±0.5	10.0 ±1.0
c	5.0 ±0.5	19.5 ±1.0
d	13.2 ±0.5	19.5 ±1.0

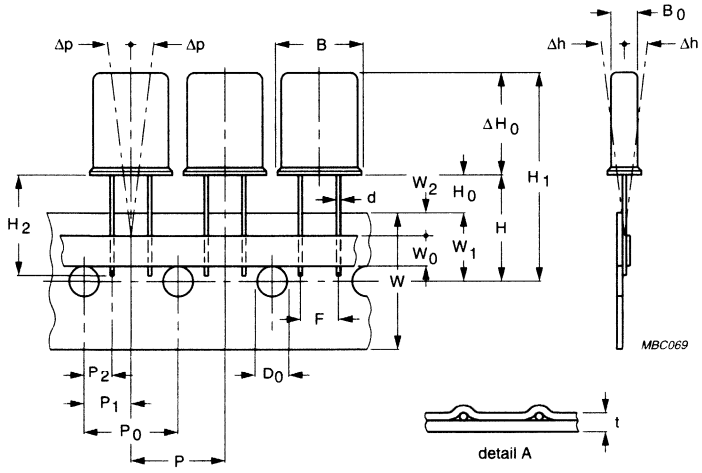
Fig.4 Style 6: HC-49/U on tray in box.



L: min. 12.7 mm; max. 13.0 mm.
The third lead is symmetric, ±0.5 mm with respect to the other leads.
Dimensions in mm.

Fig.5 Style 7: HC-49/U on tray in box.

Taping data



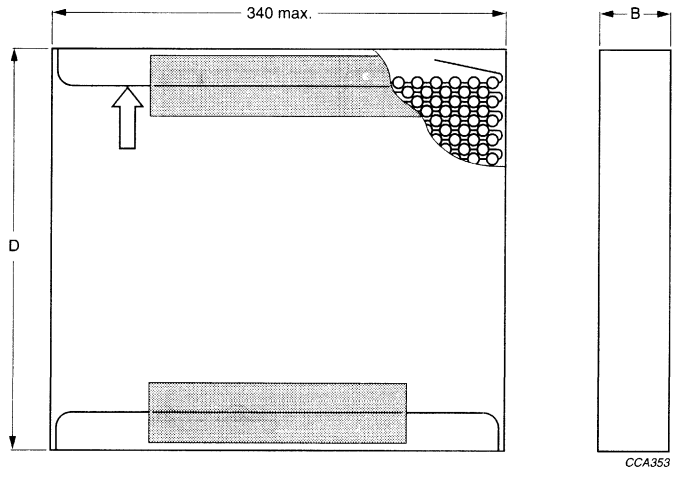
For dimensions see Table 2.

Fig.6 Style 2a and 2b: HC-49/U on tape.

Table 2 Taping dimensions (without the insulation plate) in accordance with *"IEC 286-2"*; see Fig.6

SYMBOL	PARAMETER	VALUE	TOLERANCE	UNIT
B_0	body thickness	4.43	±0.05	mm
B	body width	10.75	±0.1	mm
Δh	component alignment vertical to tape plane	–	±2.0	mm
Δp	component alignment in tape plane	–	±1.3	mm
d	lead wire diameter	0.44	±0.04	mm
F	lead-to-lead	4.9	–	mm
P	pitch of components	12.7	±1.0	mm
P_0	feed-hole pitch	12.7	±0.3	mm
P_2	feed-hole centre to lead	3.9	±0.7	mm
P_1	feed-hole centre to component centre	6.35	±0.3	mm
D_0	feed-hole diameter	4.0	±0.2	mm
H	distance of component from tape centre	16.0	+2/0	mm
H_0	minimum component base to tape top	7.0	–	mm
H_2	lead length	13.2	±0.5	mm
W	carrier tape width	18.0	+1/–0.5	mm
W_0	maximum hold-down tape width	7.0	–	mm
W_1	feed-hole position	9.0	+0.75/–0.5	mm
W_2	maximum hold-down tape position	3.0	–	mm
t	maximum total tape thickness	0.9	–	mm

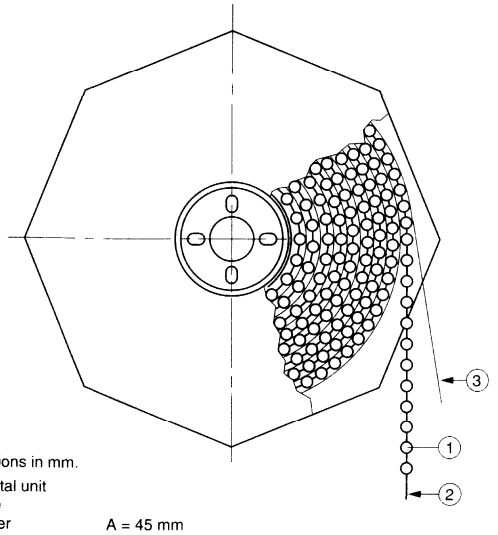
Ammopack and reel data

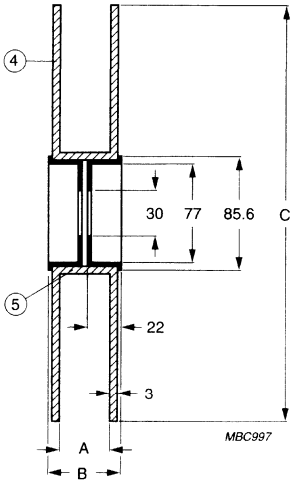


Dimensions in mm.
B = 46 mm max.
D = 185 mm max.

Style 3a is with insulation plate; see Fig.9.

Fig.7 Style 2a and 3a and units on tape in ammopack.





Dimensions in mm.
1 = crystal unit
2 = tape
3 = paper
4 = flange
5 = cylinder

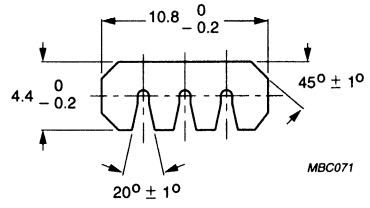
A = 45 mm
B = 55 mm max.
C = 355 mm max.

Style 3b is with insulation plate; see Fig.9.

Fig.8 Style 2b and 3b units on tape on reel.

Insulation plate

Style 3 units are equipped with an insulation plate (see Fig.9) at the unit base. The insulation plate is made of PEEK (polyetherketone) in 0.25 mm thickness and resistant to soldering heat tests.



Dimensions in mm.

Fig.9 Insulation plate outline for Style 3.

PACKAGING AND QUANTITIES

Table 3 HC-49/U holder

STYLE	PACKAGING	QUANTITY	DIMENSIONS OF BOX (mm)		
			LENGTH	WIDTH	HEIGHT
1	in box	maximum 1000 units per box	200	125	70
	in blister	24 units per blister			
	on tray in box	100 units per tray, 1 or 10 trays per box			
2a and 3a	on tape in ammopack	1000 units per pack, in box	340	185	46
2b and 3b	on tape on reel	1000 units per reel, in box	361	367	61
4, 5, 6 and 7	on tray in box	100 units per tray; 10 trays per box	380	90	168
5c	on tray in box	50 units per tray; 10 trays per box, minimum 2 boxes			

STANDARD MARKING(1)

- Line 1: PHILIPS
- Line 2: frequency in kHz (fundamental mode)
- LIne 3: last five digits of catalogue number followed by the manufacturing date code (last four digits of week code in accordance with UN-D1120).

MASS AND LEADS

Typical mass: 1.2 g.

The leads are finished with Sn99Cu1, on a nickel underplate.

The first 1 mm from the body is not guaranteed for soldering.

(1) Special marking on product and/or package is available on request.

Quartz temperature sensor HC-49/U

9922 529 801.. series

ELECTRICAL DATA

Valid at an ambient temperature T_{amb} = 25 ±2 °C and a nominal drive level of 100 μW into 25 Ω unless otherwise specified. Measuring system: π-network in accordance with *"IEC 444"* recommendations.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
f_{nom}	nominal frequency	fundamental	4.0	–	25.0	MHz
T_{oper}	operating temperature		–55	–	+125	°C
T_{op}	operable temperature		–55	–	+155	°C
TC	temperature coefficient	note 1	–40	–	+80	ppm/K
LIN	linearity		–	±2.5	–	%
$\Delta f/f_{nom}$	adjustment tolerance		–	±150	–	ppm
τ_{th}	thermal time constant		–	10	–	s

Note

1. A specific value should be chosen within the given range.

SPECIFIC PRODUCT DATA

CATALOGUE NUMBER	f_{nom} (kHz)	TC (ppm/K)	C_L (pF)	$\Delta f/f_{nom}$ (ppm)	C_1 (fF)	C_0 (pF)	DRIVE LEVEL (μW)	OPERATING TEMP. RANGE (°C)	PACKAGE OUTLINE STYLE
9922 520 60001	16000	–27.5 ±1%	–	±150	12.8	4.8	100	–10 to +40	1
9922 520 60002	6000	–27.5 ±1%	–	±150	13.6	5.4	100	–10 to +40	1

TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with IEC publication 68-2, *"Recommended basic climatic and mechanical robustness testing procedure for electronic components"* and IEC publication 1178-1, *"Generic specification for quartz crystal units"*.

Table 4 Test procedures and requirements; note 1

IEC 68-2 METHOD	TEST	PROCEDURE	REQUIREMENTS
Ba	ageing	1000 hours at 70 °C	$\Delta f/f \leq \pm 10$ ppm
Db	accelerated damp heat	+25 to +55 °C; 6 cycles at RH >95%	$\Delta f/f \leq \pm 10$ ppm ΔR_r ±5 Ω or ±50% whichever is the greater
Ea	shock	100 g; half sinewave; 6 directions; 1 blow/direction	$\Delta f/f \leq \pm 10$ ppm ΔR_r ±5 Ω or ±50% whichever is the greater
Eb	bump	4000 bumps of 40 g	$\Delta f/f \leq \pm 10$ ppm ΔR_r ±5 Ω or ±50% whichever is the greater
Ed	free fall	3 times on hard wood; for height of fall (h) see Table 5	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±50% whichever is the greater
Fc	vibration	frequency 10 to 500 to 10 Hz; acceleration 10 g; 3 directions; 30 minutes/direction	$\Delta f/f \leq \pm 10$ ppm ΔR_r ±5 Ω or ±50% whichever is the greater
Na	temperature cycling test	−40 to +85 °C; 10 cycles; 0.1 hour/cycle	$\Delta f/f \leq \pm 10$ ppm ΔR_r ±5 Ω or ±50% whichever is the greater
Q	sealing (method 1)	16 hours; 700 kPa He	$< 1 \times 10^{-8}$ ncc/s He
Ta	solderability	235 ±5 °C; 2 ±0.5 s; flux 600 (activated); optional steam pre-heat 8 hours. This reflects at least 36 months of storage at room conditions	≥90%, except for 1 mm from body; no visible damage, no leaks
Tb	resistance to soldering heat	350 ±5 °C; 3.5 ±0.5 s	$\Delta f/f \leq \pm 10$ ppm ΔR_r ±5 Ω or ±50% whichever is the greater
Ub	bending of terminations	1 × 90°; 5 N	no visible damage, no leaks

IEC 68-2 METHOD	TEST	PROCEDURE	REQUIREMENTS
Other applicable tests			
Xa	resistance to solvents; note 2: Bio-Act EC7®; Neutropon P3® and Saxin P3®; Meta Clean 820®; Lonco 446®; Isopropanol cleaning solvent; Dowanol DPM® (glass crystals only)	in accordance with *"IEC 68-2-45"*, *"IEC 653"* (immersion time 5 minutes) and *"MIL 202 E215"*. At ambient temperature and ultrasonic frequency (40 kHz)	no degradation of marking

Notes

1. Test table including MIL-specs (*"MIL-Std 883"* and *"MIL-Std 202"*) can be provided upon request.
2. Bio-Act is a registered trademark of Petroform.
   Neutropon P3 and Saxin P3 are registered trademarks of Henkel.
   Meta Clean 820 is a registered trademark of Mavom.
   Lonco 447 is a registered trademark of London Chemical Co.
   Dowanol DPM is a registered trademark of Dow Chemical.

Table 5 Height of fall

h (mm)	FREQUENCY RANGE (MHz)
750	4.00 to 7.50
500	7.51 to 10.00
250	10.10 to 25.00

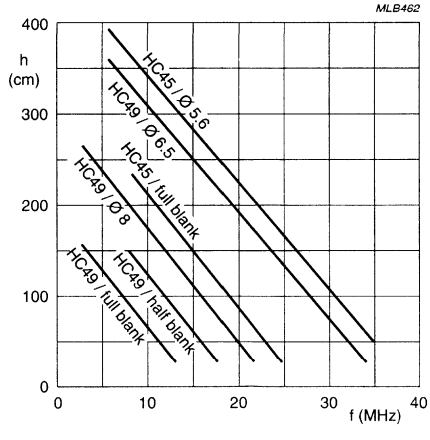


Fig.10 Typical height of fall values (3× on hard wood) for various quartz blank and holder combinations. 'Full' and 'half' blanks refer to rectangular quartz designs; '∅' designates circular quartz designs and the appropriate diameter.

Quartz temperature sensor HC-45/U

9922 529 802.. series

FEATURES

- No A/D conversion
- Excellent linearity
- High stability, low ageing
- Wide temperature range
- High noise immunity
- Easy calibration
- Quantity production at low cost
- Small dimensions.

APPLICATIONS

- In industrial temperature measurement and control
- Car electronics
- Flow meters
- Weather balloons
- Medical systems
- Energy saving projects, for example:
  - heat monitors
  - solar panels.

DESCRIPTION

The sensor consists of a metal-plated special TC-cut piezoelectric quartz plate, mounted in a hermetically sealed resistance-welded metal holder, which has two or three leads and is filled with dry nitrogen gas.

The quartz plate oscillates in a fundamental thickness-shear mode and the resonance frequency is an almost linear function of the temperature.

QUICK REFERENCE DATA

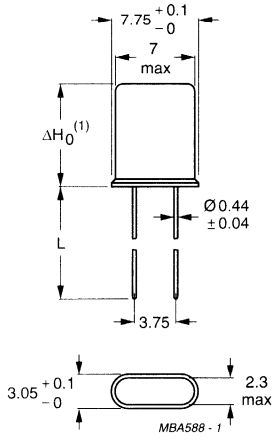
SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT
f_{nom}	nominal frequency	8.0	–	25.0	MHz
T_{oper}	operating temperature	–55	–	+150	°C
TC	temperature coefficient	–40	–	+80	ppm/K
LIN	linearity	–	±2.5	–	%
$\Delta f/f_{nom}$	adjustment tolerance	–	±150	–	ppm
τ_{th}	thermal time constant	–	5	–	s

Quartz temperature sensor HC-45/U

9922 529 802.. series

MECHANICAL DATA

Package outline



Dimensions in mm.
This type is also available as a surface mounting device.
(1) For ΔH_0 see Table 1.

Fig.1 Style 1: HC-45/U in box.

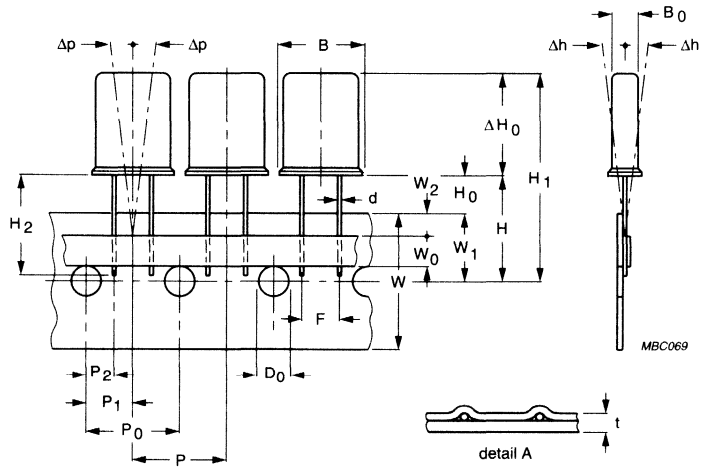
Table 1 Product height; notes 1 and 2

MAXIMUM HEIGHT ΔH_0 (mm)	FREQUENCY RANGE (MHz)
8.8	8.0 to 25.0

Notes

1. Available lead length: up to 20.0 mm.
2. Lead length tolerance (for Style 1):
   a) Lead length (H_2) > 3 mm: ±0.5 mm
   b) Lead length (H_2) ≤ 3 mm: ±0.2 mm.

Taping data



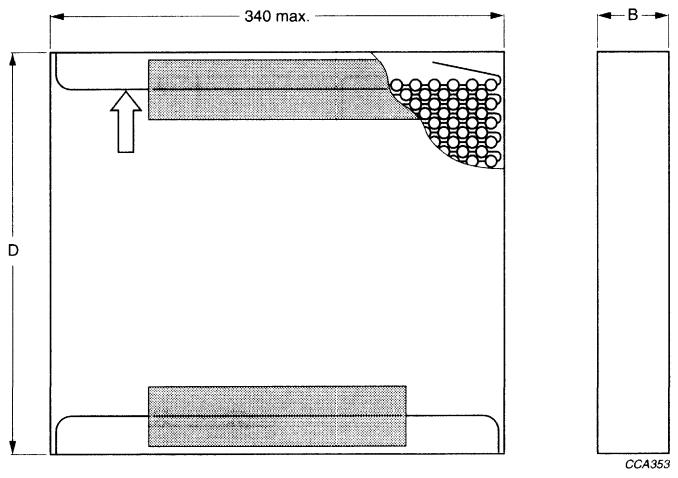
For dimensions see Table 2.

Fig.2 Style 2a and 2b: HC-45/U on tape.

Table 2 Taping dimensions (without the insulation plate) in accordance with *"IEC 286-2"*; see Fig.2

SYMBOL	PARAMETER	VALUE	TOLERANCE	UNIT
B_0	body thickness	3.1	±0.05	mm
B	body width	7.8	±0.05	mm
Δh	component alignment vertical to tape plane	–	±2.0	mm
Δp	component alignment in tape plane	–	±1.3	mm
d	lead wire diameter	0.44	±0.04	mm
F	lead-to-lead	3.75	–	mm
P	pitch of components	12.7	±1.0	mm
P_0	feed-hole pitch	12.7	±0.3	mm
P_2	feed-hole centre to lead	4.5	±0.7	mm
P_1	feed-hole centre to component centre	6.35	±0.3	mm
D_0	feed-hole diameter	4.0	±0.2	mm
H	distance of component from tape centre	18.0	+2/0	mm
H_0	minimum component base to tape top	9.0	–	mm
H_2	lead length	20.0	±0.5	mm
W	carrier tape width	18.0	+1/–0.5	mm
W_0	maximum hold-down tape width	7.0	–	mm
W_1	feed-hole position	9.0	+0.75/–0.5	mm
W_2	maximum hold-down tape position	3.0	–	mm
t	maximum total tape thickness	0.9	–	mm

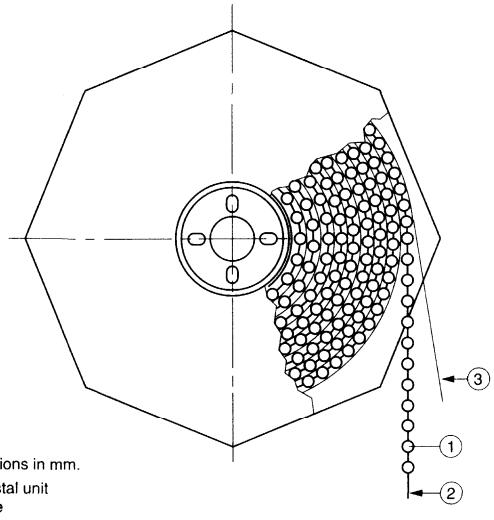
Ammopack and reel data

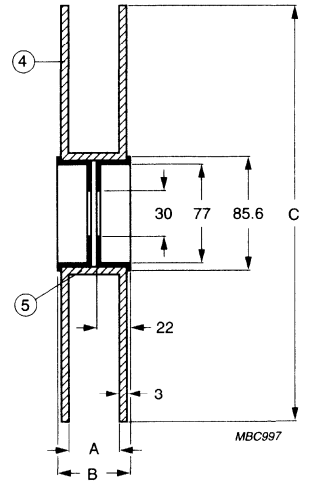


Dimensions in mm.
B = 46 mm max.
D = 185 mm max.

Style 3a is with insulation plate; see Fig.5.

Fig.3 Style 2a and 3a and units on tape in ammopack.





Dimensions in mm.

1 = crystal unit
2 = tape
3 = paper
4 = flange
5 = cylinder

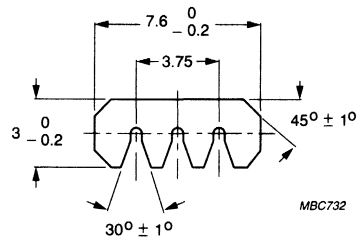
A = 45 mm
B = 55 mm max.
C = 355 mm max.

Style 3b is with insulation plate; see Fig.5.

Fig.4 Style 2b and 3b units on tape on reel.

Insulation plate

Style 3 units are equipped with an insulation plate (see Fig.5) at the unit base. The insulation plate is made of PEEK (polyetherketone) in 0.25 mm thickness and resistant to soldering heat tests.



Dimensions in mm.

Fig.5 Insulation plate outline for Style 3.

PACKAGING AND QUANTITIES

Table 3 HC-45/U holder

STYLE	PACKAGING	QUANTITY	DIMENSIONS OF BOX (mm)		
			LENGTH	WIDTH	HEIGHT
1	in box	maximum 1000 units per box	200	125	45
2a and 3a	on tape in ammopack	1000 units per pack, in box	340	185	46
2b and 3b	on tape on reel	1000 units per reel, in box	283	283	60

STANDARD MARKING(1)

- Line 1: PHILIPS
- Line 2: frequency in kHz (fundamental mode)
- LIne 3: last five digits of catalogue number followed by the manufacturing date code (last four digits of week code in accordance with UN-D1120).

MASS AND LEADS

Typical mass: 0.4 g.

The leads are finished with Sn60Pb40 or Sn99Cu1 on a nickel underplate.

The first 1 mm from the body is not guaranteed for soldering.

(1) Special marking on product and/or package is available on request.

Quartz temperature sensor HC-45/U

9922 529 802.. series

ELECTRICAL DATA

Valid at an ambient temperature T_{amb} = 25 ±2 °C and a nominal drive level of 100 μW into 25 Ω unless otherwise specified. Measuring system: π-network in accordance with *"IEC 444"* recommendations.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
f_{nom}	nominal frequency	fundamental	8.0	–	25.0	MHz
T_{oper}	operating temperature		–55	–	+150	°C
TC	temperature coefficient	see note 1	–40	–	+80	ppm/K
LIN	linearity		–	±2.5	–	%
$\Delta f/f_{nom}$	adjustment tolerance		–	±150	–	ppm
τ_{th}	thermal time constant		–	5	–	s

Note

1. A specific value should be chosen within the given range.

TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with IEC publication 68-2, *"Recommended basic climatic and mechanical robustness testing procedure for electronic components"* and IEC publication 1178-1, *"Generic specification for quartz crystal units".*

Table 4 Test procedures and requirements; note 1

IEC 68-2 METHOD	TEST	PROCEDURE	REQUIREMENTS
Ba	ageing	1000 hours at 70 °C	$\Delta f/f \leq \pm 10$ ppm
Db	accelerated damp heat	+25 to +55 °C; 6 cycles at RH >95%	$\Delta f/f \leq \pm 10$ ppm ΔR_r ±5 Ω or ±50% whichever is the greater
Ea	shock	100 g; half sinewave; 6 directions; 1 blow/direction	$\Delta f/f \leq \pm 10$ ppm ΔR_r ±5 Ω or ±50% whichever is the greater
Eb	bump	4000 bumps of 40 g	$\Delta f/f \leq \pm 10$ ppm ΔR_r ±5 Ω or ±50% whichever is the greater
Ed	free fall	3 times on hard wood; for height of fall (h) see Table 5	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±5 Ω or ±50% whichever is the greater
Fc	vibration	frequency 10 to 500 to 10 Hz; acceleration 10 g; 3 directions; 30 minutes/direction	$\Delta f/f \leq \pm 10$ ppm ΔR_r ±5 Ω or ±50% whichever is the greater
Na	temperature cycling test	−40 to +85 °C; 10 cycles; 0.1 hour/cycle	$\Delta f/f \leq \pm 10$ ppm ΔR_r ±5 Ω or ±50% whichever is the greater
Q	sealing (method 1)	16 hours; 700 kPa He	$<1 \times 10^{-8}$ ncc/s He
Ta	solderability	235 ±5 °C; 2 ±0.5 s; flux 600 (activated); optional steam pre-heat 8 hours. This reflects at least 36 months of storage at room conditions	≥90%, except for 1 mm from body; no visible damage, no leaks
Tb	resistance to soldering heat	350 ±5 °C; 3.5 ±0.5 s	$\Delta f/f \leq \pm 10$ ppm ΔR_r ±5 Ω or ±50% whichever is the greater
Ub	bending of terminations	1 × 90°; 5 N	no visible damage, no leaks

IEC 68-2 METHOD	TEST	PROCEDURE	REQUIREMENTS
Other applicable tests			
Xa	resistance to solvents; note 2: Bio-Act EC7®; Neutropon P3® and Saxin P3®; Meta Clean 820®; Lonco 446®; Isopropanol cleaning solvent; Dowanol DPM® (glass crystals only)	in accordance with *"IEC 68-2-45"*, *"IEC 653"* (immersion time 5 minutes) and *"MIL 202 E215"*. At ambient temperature and ultrasonic frequency (40 kHz)	no degradation of marking

Notes

1. Test table including MIL-specs (*"MIL-Std 883"* and *"MIL-Std 202"*) can be provided upon request.
2. Bio-Act is a registered trademark of Petroform.
   Neutropon P3 and Saxin P3 are registered trademarks of Henkel.
   Meta Clean 820 is a registered trademark of Mavom.
   Lonco 447 is a registered trademark of London Chemical Co.
   Dowanol DPM is a registered trademark of Dow Chemical.

Table 5 Height of fall

h (mm)	FREQUENCY RANGE (MHz)
750	8.0 to 16.0
500	16.1 to 25.0

Quartz temperature sensors HC-26/U and HC-29/U

9922 526 2.... series

FEATURES

- No A/D conversion
- Excellent linearity
- High stability, very low ageing
- Wide temperature range
- High noise immunity
- Easy calibration.

APPLICATIONS

- In industrial temperature measurement and control
- Car electronics
- Flow meters
- Weather balloons
- Medical systems
- Energy saving projects, for example:
  - heat monitors
  - solar panels.

DESCRIPTION

The sensor consists of a metal-plated special TC-cut piezoelectric quartz plate, encapsulated in a high-vacuum all-glass holder. The holder is hermetically sealed and provided with connecting leads (HC-26/U) or pins (HC-29/U).

The quartz plate oscillates in a fundamental thickness-shear mode and the resonance frequency is an almost linear function of the temperature.

QUICK REFERENCE DATA

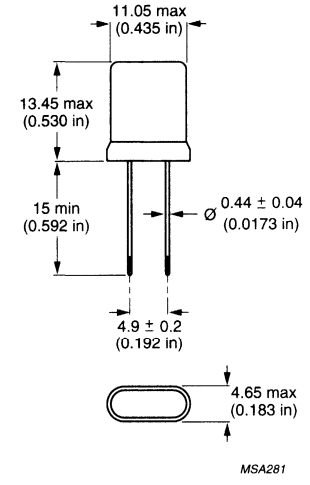
SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT
f_{nom}	nominal frequency	4.0	–	25.0	MHz
T_{oper}	operating temperature	−100	–	+300	°C
T_{op}	operable temperature	−100	–	+300	°C
TC	temperature coefficient	−50	–	+85	ppm/K
LIN	linearity	–	±1.5	–	%
$\Delta f/f_{nom}$	adjustment tolerance	–	±100	–	ppm
τ_{th}	thermal time constant	10	–	30	s

Quartz temperature sensors HC-26/U and HC-29/U

9922 526 2.... series

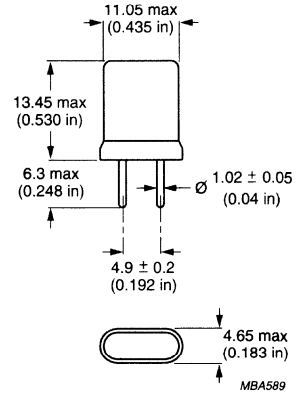
MECHANICAL DATA

Package outlines



Dimensions in mm.

Fig.1 Style 1: HC-26/U in box.



Dimensions in mm.

Fig.2 Style 2: HC-29/U in box.

PACKAGING AND QUANTITIES

Table 1 HC-26/U and HC-29/U

STYLE	PACKAGING	QUANTITY	DIMENSIONS OF BOX (mm)		
			LENGTH	WIDTH	HEIGHT
1 and 2	in blister	24 units per tray, 8 blisters per box	315	155	67

STANDARD MARKING(1)

- Line 1: PHILIPS
- Line 2: frequency in kHz (fundamental mode)
- Line 3: last five digits of catalogue number followed by the manufacturing date code (last four digits of week code in accordance with UN-D1120).

MASS

Typical mass: 0.8 g.

(1) Special marking on product and/or package is available on request.

ELECTRICAL DATA

Valid at T_{amb} = 25 ±2 °C and a nominal drive level of 100 μW into 25 Ω unless otherwise specified. Measuring system: π-network in accordance with *"IEC 444"* recommendations.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
f_{nom}	nominal frequency	fundamental	4.0	–	25.0	MHz
T_{oper}	operating temperature		−100	–	+300	°C
T_{op}	operable temperature		−100	–	+300	°C
TC	temperature coefficient	see note 1	−50	–	+85	ppm/K
LIN	linearity		–	±1.5	–	%
$\Delta f/f_{nom}$	adjustment tolerance		–	±100	–	ppm
τ_{th}	thermal time constant		10	–	30	s

Note

1. A specific value should be chosen within the given range.

TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with IEC publication 68-2, *"Recommended basic climatic and mechanical robustness testing procedure for electronic components"* and IEC publication 1178-1, *"Generic specification for quartz crystal units"*.

Table 2 Test procedures and requirements

IEC 68-2 METHOD	TEST	PROCEDURE	REQUIREMENTS
Ba	ageing	1000 hours at 85 °C	$\Delta f/f \leq \pm 6$ ppm $\Delta f/f$ typical ±2 ppm
Db	accelerated damp heat	+25 to +55 °C; 6 cycles at RH >95%	$\Delta f/f \leq \pm 6$ ppm ΔR_r ±5 Ω or ±30% whichever is the greater
Ea	shock; note 1	100 g; half sinewave; 6 directions; 1 blow/direction	$\Delta f/f \leq \pm 6$ ppm ΔR_r ±1 Ω or ±30% whichever is the greater
Fc	vibration; note 1	frequency 10 to 500 to 10 Hz; acceleration; 3 directions; 30 minutes/direction	$\Delta f/f \leq \pm 6$ ppm ΔR_r ±1 Ω or ±30% whichever is the greater
Na	temperature cycling test	−40 to +85 °C; 10 cycles; 0.1 hour/cycle	$\Delta f/f \leq \pm 6$ ppm ΔR_r ±1 Ω or ±30% whichever is the greater
Ta	solderability; note 2	235 ±5 °C; 2 ±0.5 s; flux 600 (activated); optional steam pre-heat 8 hours. This reflects at least 36 months of storage at room conditions	≥90%, except for 1 mm from body; no visible damage, no leaks
Tb	resistance to soldering heat; note 2	350 ±5 °C; 3.5 ±0.5 s	$\Delta f/f \leq \pm 5$ ppm ΔR_r ±1 Ω or ±30% whichever is the greater
Ub	bending of terminations; note 2	1 × 90°; 5 N	no visible damage, no leaks

IEC 68-2 METHOD	TEST	PROCEDURE	REQUIREMENTS
Other applicable tests			
Xa	resistance to solvents; note 3: Bio-Act EC7®; Neutropon P3® and Saxin P3®; Meta Clean 820®; Lonco 446®; Isopropanol cleaning solvent; Dowanol DPM® (glass crystals only)	in accordance with *"IEC 68-2-45"*, *"IEC 653"* (immersion time 5 minutes) and *"MIL 202 E215"*. At ambient temperature and ultrasonic frequency (40 kHz)	no degradation of marking

Notes

1. Mechanical tests to be performed on units clamped to a printed-circuit board for the total unit height.
2. Not valid for type HC-29/U.
3. Bio-Act is a registered trademark of Petroform.
   Neutropon P3 and Saxin P3 are registered trademarks of Henkel.
   Meta Clean 820 is a registered trademark of Mavom.
   Lonco 447 is a registered trademark of London Chemical Co.
   Dowanol DPM is a registered trademark of Dow Chemical.

THICKNESS SENSOR

Quartz thickness sensor elements 9922 529 800.. series

FEATURES

- Good linearity
- Low resonance resistance
- Low temperature coefficient of frequency
- Packed in an easy-to-use dispenser of 10 elements.

APPLICATIONS

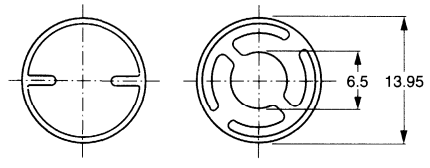
- These sensors can be used in vacuum deposition systems for accurate monitoring of the amount of deposited material.

DESCRIPTION

The sensor consists of a metal-plated special TC-cut piezoelectric quartz blank without encapsulation. Operating in a thickness-shear mode, this sensor acts as a very sensitive microbalance and the design is such that it will fit into many commercially available quartz thickness monitors.

Electrode material is silver (other materials on request).

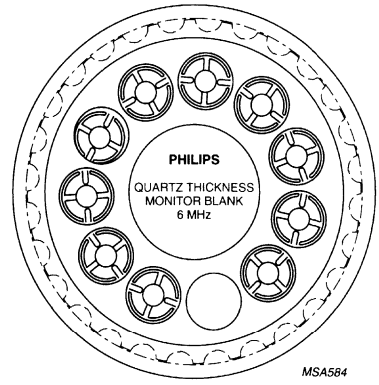
MECHANICAL DATA



Dimensions in mm.

Fig.1 Quartz thickness sensor outline.

PACKAGING



One product has been drawn out of centre to indicate that it can move in the packaging.

Fig.2 Packaging outline.

ORDERING INFORMATION

Specification of quartz thickness sensor elements.

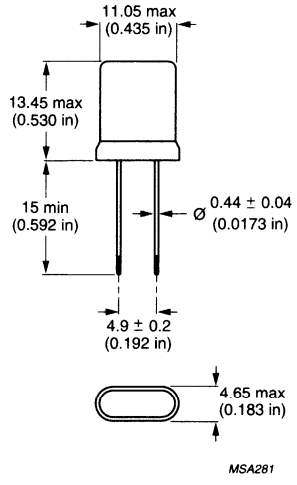
RESONANCE FREQUENCY (kHz)	MAXIMUM RESONANCE RESISTANCE (Ω)	CATALOGUE NUMBER
5000 ±10	50	9922 529 80001
6000 ±10	50	9922 529 80002

QUICK REFERENCE DATA

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT
f_{nom}	nominal frequency: fundamental mode	4000	–	9500	kHz
TC	typical temperature coefficient over +25 to +75 °C	–	±0.0025	–	%
m	mass	–	0.1	–	g

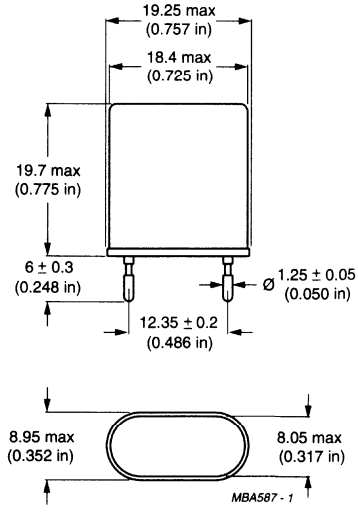
OVERVIEW OF HOLDER TYPES

MECHANICAL DATA



Dimensions in mm.

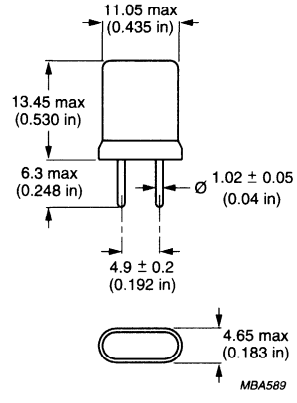
Fig.1 Style 1: HC-26/U.



Dimensions in mm.

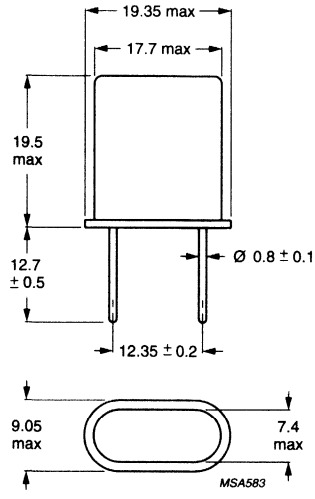
IEC type DB is identical except for the height which is: 26 mm max.

Fig.2 HC-27/U.



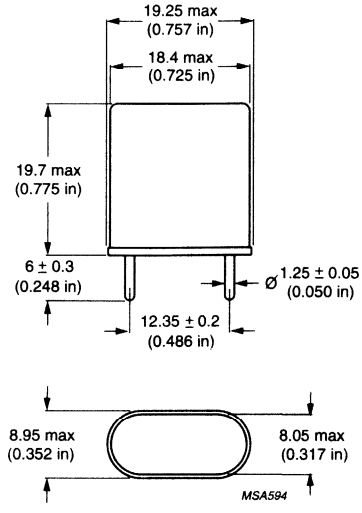
Dimensions in mm.

Fig.3 Style 2: HC-29/U.



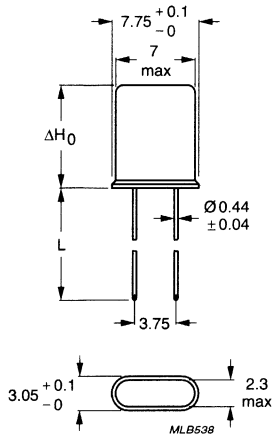
Dimensions in mm.

Fig.4 HC-33/U resistance welded.



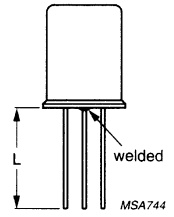
Dimensions in mm.

Fig.5 HC-36/U resistance welded.



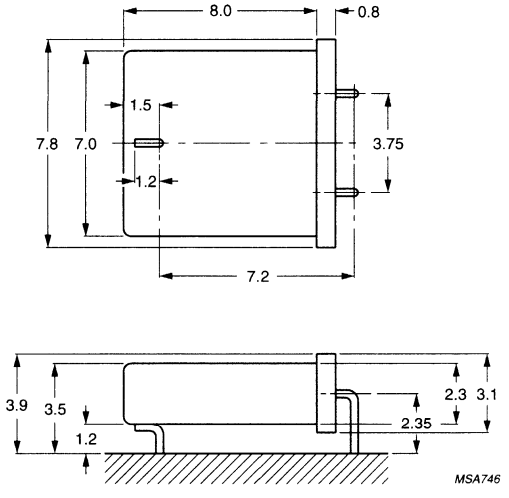
Dimensions in mm.

Fig.6 Style 1: HC-45/U in box.



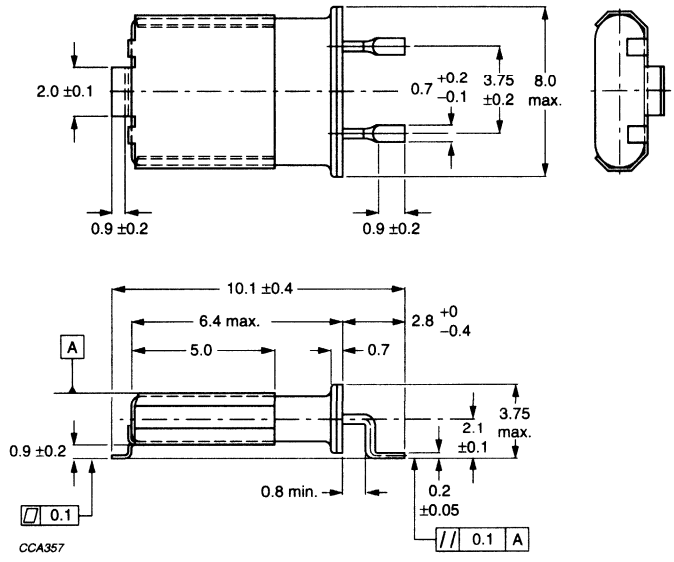
L: min. 12.7 mm; max. 13.0 mm.

Fig.7 Style 4: HC-45/U in box.



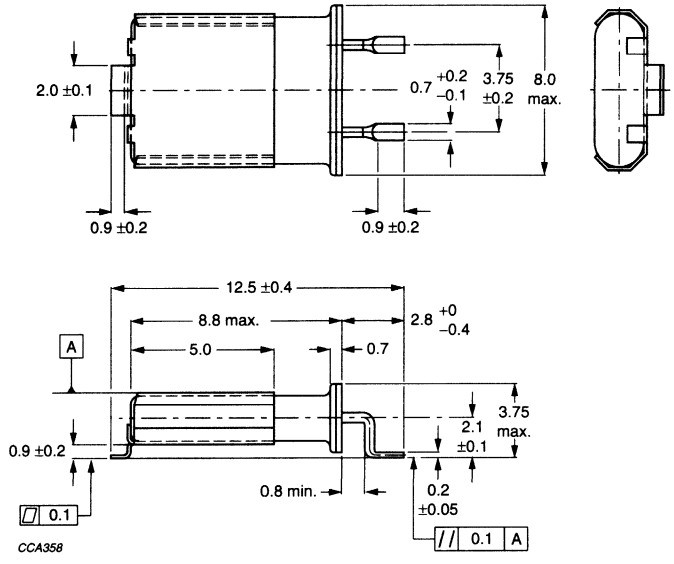
Dimensions in mm.

Fig.8 Style 5: HC-45/U in box.



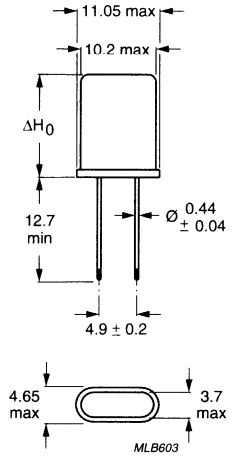
Dimensions in mm.

Fig.9 Style 1: HC-45/U10-SMD/Clip I.



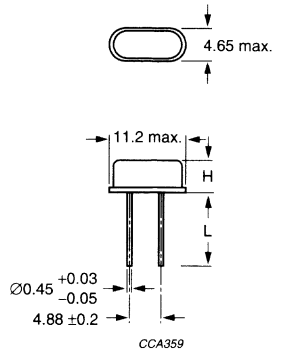
Dimensions in mm.

Fig.10 Style 2: HC-45/U12-SMD/Clip I.



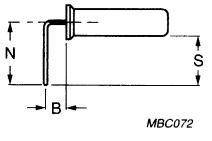
Dimensions in mm.

Fig.11 Style 1: HC-49/U in box.



Dimensions in mm.

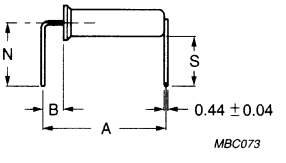
Fig.12 Style 1: HC-49/L in box.



Dimensions in mm.

STYLE 4	N	B	S
a	7.0 ±0.6	2.5 ±0.6	5.2 ±0.6
b	8.0 ±0.6	2.0 ±0.6	6.2 ±0.6
c	9.7 ±0.6	3.0 ±0.6	7.9 ±0.6

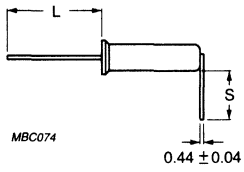
Fig.13 Style 4: HC-49/U on tray in box.



The third lead is symmetric, ±0.5 mm with respect to the other leads.
Dimensions in mm.

STYLE 5	N	B	A	S
a	5.7 ±1.0	1.5	15.2 ±0.2	3.9 ±1.0
b	5.9 ±1.0	4.1	17.8 ±0.2	4.1 ±1.0
c	10.2 ±1.0	3.3	16.5 ±0.2	8.4 ±1.0
d	5.7 ±1.0	1.9	15.6 ±0.2	3.9 ±1.0

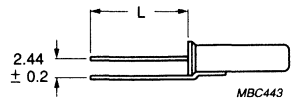
Fig.14 Style 5: HC-49/U on tray in box.



The third lead is symmetric, ±0.5 mm with respect to the other leads.
Dimensions in mm.

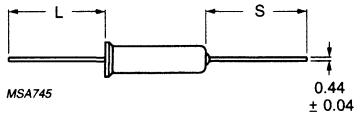
STYLE 6	L	S
a	13.2 ±0.5	4.5 ±1.0
b	13.2 ±0.5	10.0 ±1.0
c	5.0 ±0.5	19.5 ±1.0
d	13.2 ±0.5	19.5 ±1.0

Fig.15 Style 6: HC-49/U on tray in box.



L: min. 12.7 mm; max. 13.0 mm.
The third lead is symmetric, ±0.5 mm with respect to the other leads.
Dimensions in mm.

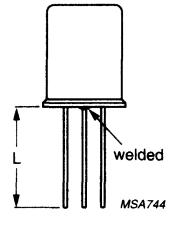
Fig.16 Style 7: HC-49/U on tray in box.



The third lead is symmetric, ±0.5 mm with respect to the other leads.
Dimensions in mm.

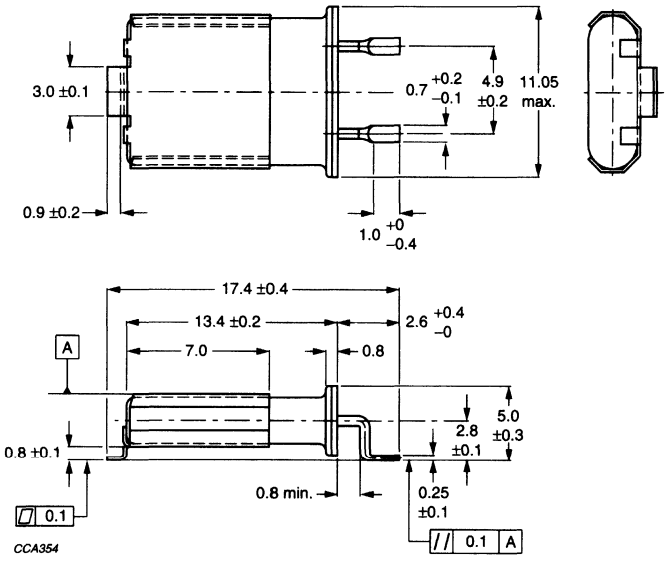
STYLE 8	L	S
a	13.2 ±0.5	16.0 ±1.0
b	5.0 ±0.5	16.0 ±1.0

Fig.17 Style 8: HC-49/U on tray in box.



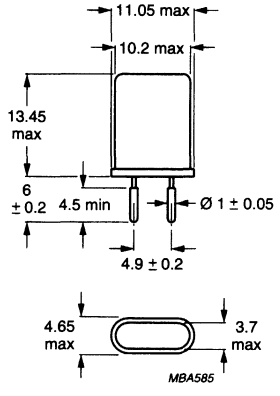
L: min. 12.7 mm; max. 13.0 mm.
The third lead is symmetric, ±0.5 mm with respect to the other leads.

Fig.18 Style 9: HC-49/U on tray in box.



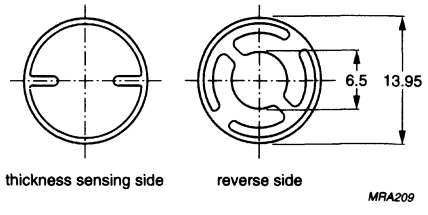
Dimensions in mm.

Fig.19 Style 1: HC-49/U17-SMD/Clip I.



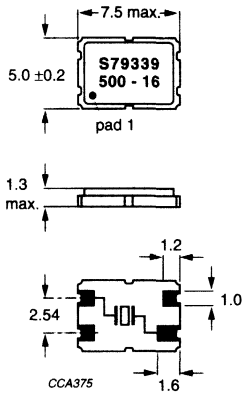
Dimensions in mm.

Fig.20 Style 10: HC-50/U in box.



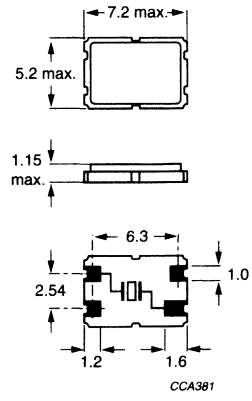
Dimensions in mm.

Fig.21 Quartz thickness sensor outline.



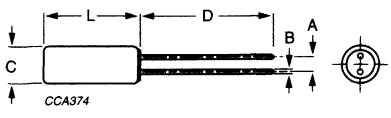
Dimensions in mm.

Fig.22 Style 1: Ceramic SMD (NKS-7).



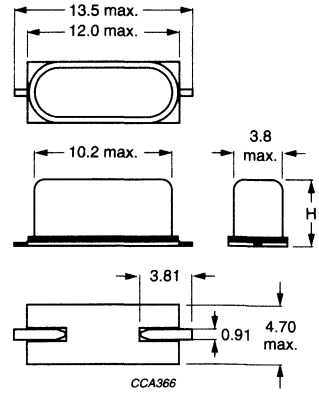
Dimensions in mm.

Fig.23 Style 1: HFX ceramic SMD.



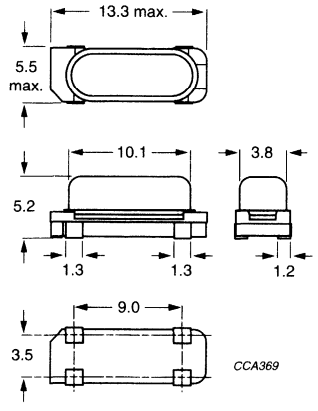
Dimensions in mm.

Fig.24 Style 1: HFX tubular.



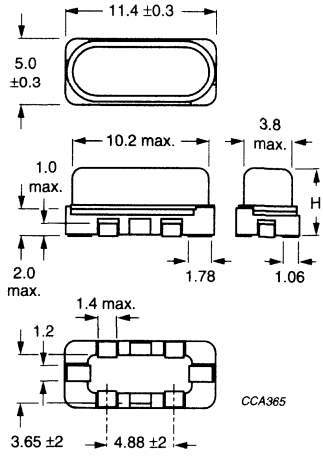
Dimensions in mm.

Fig.25 Style 1: HC-49/SMD.



Dimensions in mm.

Fig.26 Style 2: HC-49/SMD.



Dimensions in mm.

Fig.27 Style 3: HC-49/SMD.

CROSS REFERENCE OF HOLDER TYPES

Corresponding IEC, DIN and MIL type numbers.

HOLDER TYPE	IEC 122-3	DIN 45110	MIL 3098	OTHERS[1]
HC-6/U	AA	K1A	HC-6/U	–
HC-26/U	CY	R2A	HC-26/U	–
HC-27/U	DA	Q1A	HC-27/U	–
HC-27/U, extended	DB	Q1B	HC-28/U	–
HC-29/U	CZ	R1A	HC-29/U	–
HC-33/U	DZ	K6B	HC-51/U	–
HC-45/U	EB; EK	N4B	HC-52/U	UM-1
HC-49/U9	–	–	–	–
HC-49/U11	EH	M4B	HC-49/U	HC-43/U
HC-49/U13	DP	M4C	HC-49/U	HC-18U
HC-50/U13	DQ	M3C	HC-42/U	–
RW-36	DN	K3A	HC-48/U	HC-36/U
RW-10	DS	K4A	–	–

Note

1. Corresponding numbers may have different sealing techniques.

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Data handbook system

DATA HANDBOOK SYSTEM

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IC03	Semiconductors for Wired Telecom Systems
IC04	HE4000B Logic Family CMOS
IC05	Advanced Low-power Schottky (ALS) Logic
IC06	High-speed CMOS Logic Family
IC11	General-purpose/Linear ICs
IC12	I^2C Peripherals
IC13	Programmable Logic Devices (PLD)
IC14	8048-based 8-bit Microcontrollers
IC15	FAST TTL Logic Series
IC16	CMOS ICs for Clocks and Watches
IC17	Semiconductors for Wireless Communications
IC18	Semiconductors for In-Car Electronics
IC19	ICs for Data Communications
IC20	80C51-based 8-bit Microcontrollers
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