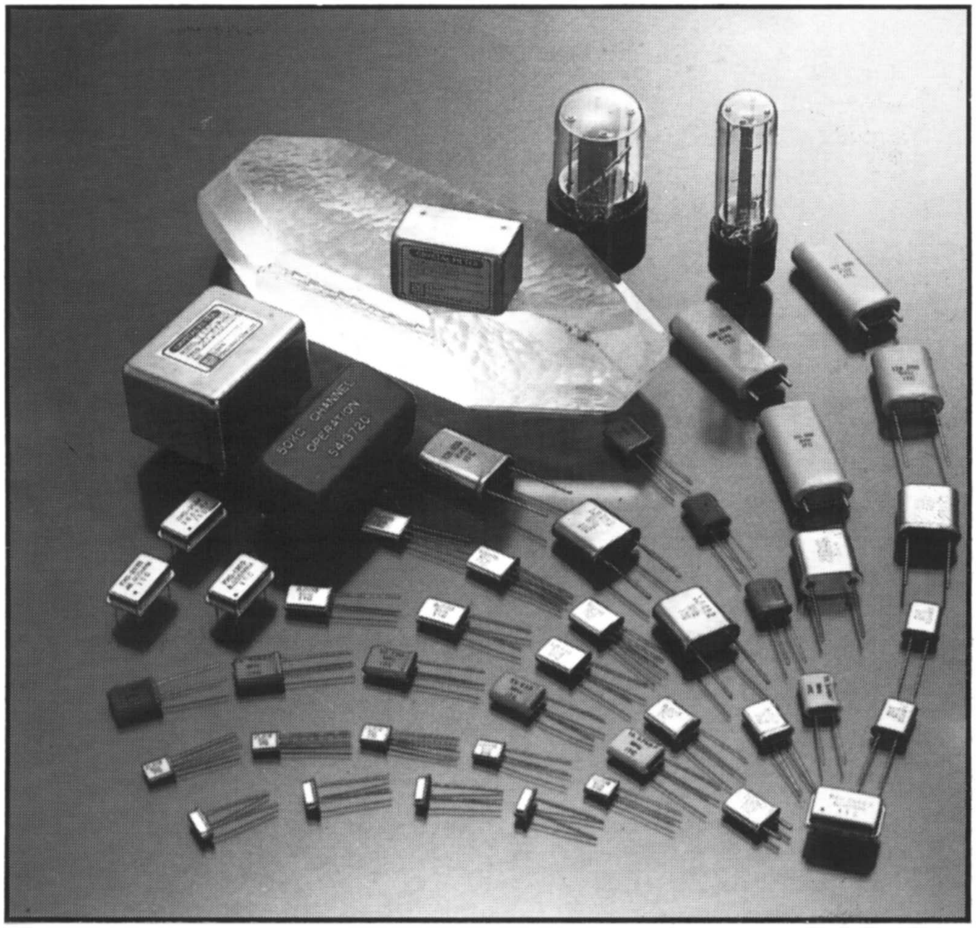
BREL INTERNATIONAL COMPONENTS
1621 UNIVERSITY PARKWAY, SARASOTA, FLORIDA 34243
(813) 355-9791 • FAX: (813) 355-1530 • **TOLL FREE: 1-800-237-4564**

QUARTZ CRYSTALS, CRYSTAL CLOCK OSCILLATORS AND CRYSTAL FILTERS



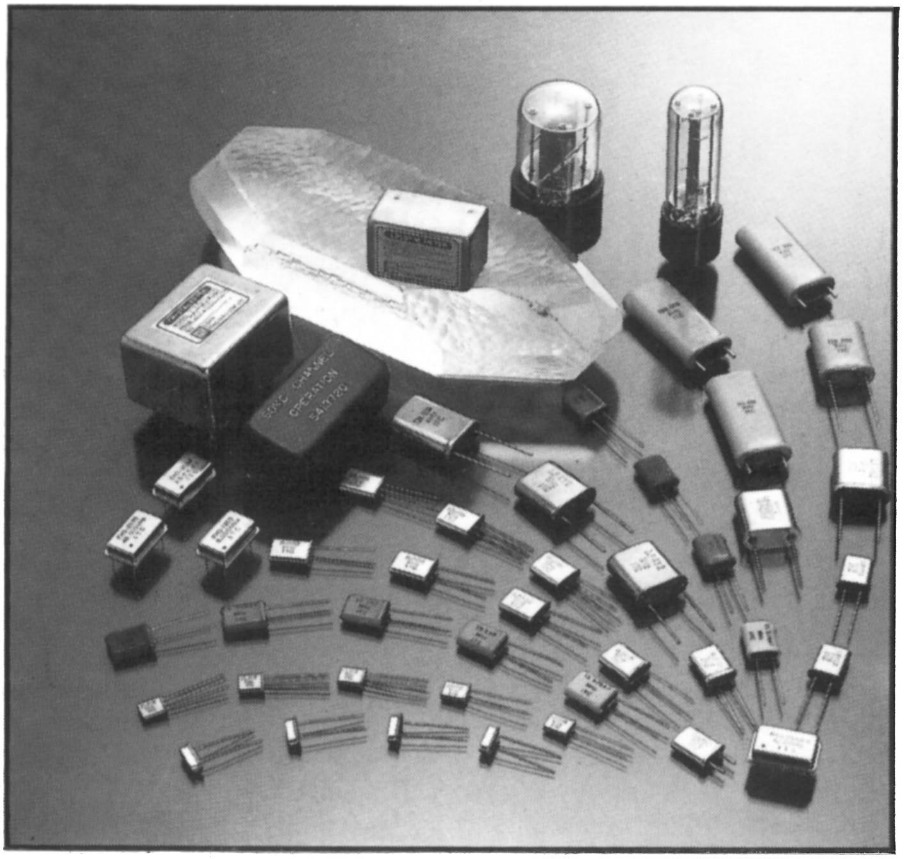
Welcome to BREL—the World of Quartz Crystals!

This brochure will provide you with engineering information and examples of our latest innovations in Quartz Crystals, Filters and Oscillators.

The BREL commitment to high quality and reliability through extensive in-plant testing for accuracy and performance of its products has established a reputation of top quality and competitive prices in both the commercial and military markets.

We are continuing to develop and improve our products to meet your specific applications and welcome the opportunity to discuss your technical requirements.

BREL



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CRYSTAL PARAMETERS

Quartz is a piezoelectric material with a property such that mechanical strain is induced by electrical excitation and electrical charge is also induced by mechanical strain conversely.

Quartz crystals, because of their inherently high Q, provide a remarkable improvement in the stability of crystals.

By slicing the raw quartz at various angles with respect to its axis it is possible to obtain a variety of blanks having different vibrating modes and different temperature characteristics.

RESONANT FREQUENCY

The electrical properties of the quartz crystal unit as a function of frequency can be represented by on equivalent circuit diagram(Fig-1)

The oscillating mass of the quartz cyrstal corresponds to the Motional inductance L_1 while the elasticity of the oscillating body is represented by the Motional capacity C_1.

The values of the Motional capacity C_1 are very small compared with the capacities normally used for oscillating circuits in communications engineering and can be calculated for the 'AT' cut as follows:

$$C_1(PF) = 0.22 \times A(m^2) \times F(H_z)/1670$$

Where A=area of the electrode
F=resonant Frequency

The C_1 value can be changed for a particular resonant frequency by varying the electrode area. The range of variation of the electrode area depends on the diameter of the quartz element.

The static parallel capacity C_0 is the capacity between the vacuum-deposited metal electrodes and quartz material as a dielectric and we have

$$C_0(PF) = 40.4 \times A(m^2) \times F(Hz)/1670 + 0.8(PF)$$

$$L_1(H) = 4.22 \times 10^4 \times (1670)^{31} / \left[F^3(Hz)/ \times A(m^2)\right]$$

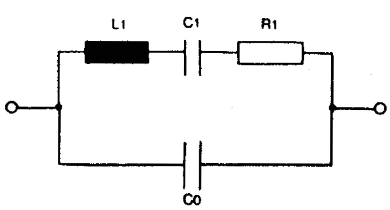

Fig.-2 illustrates the impedance graph for a quartz crystal.

Neglecting losses two resonant frequencies result, namely the series resonant frequency f_s at impedance =0(Fig.-2) and the parallel resonant frequency f_P at impedance=infinity.

$$f_s = \frac{1}{2\pi\sqrt{L_1 C_1}} \qquad f_P = \frac{1}{2\pi\sqrt{L_1 \frac{C_1 \cdot C_0}{C_1 + C_0}}}$$

Parallel and series resonant frequencies are linked by the equation:

$$f_P = f_s\sqrt{1 + \frac{C_1}{C_0}}$$

The relative frequency interval between the two resonant frequencies:

$$\frac{f_P - f_s}{f} = \frac{1}{2} \cdot \frac{C_1}{C_0}$$

i.e. equal to one half of the ratio of motional to static capacity.

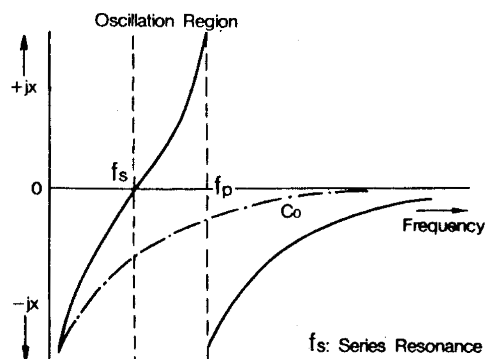

Fig. 2

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TEMPERATURE COEFFICIENT

Temperature coefficient is frequency stability or deviation with temperature change. Temperature coefficient is expressed in parts per millions, change of plus or minus percentage over the operating temperature ranges.

The mode of vibration, the plane of the plate in relation to the axis of the quartz, the dimensions of the plate and the harmonics determine the temperature coefficient.

LOAD CAPACITANCE C_L

The load capacity is the sum of the capacity of the crystal socket or any other parasitic capacitance across the crystal in oscillator.

Load capacitance, C_L is the effective capacitance of the oscillation circuit as viewed from both ends of the crystal units.(shown in Fig.-3)

C_L is the capacitance value comprising the combined capacitance of capacitor, and equivalent capacitance components resulting from the phase lag, Miller's effect, etc, within the semiconductor.

In designing oscillation circuit, proper choice of C_L is very important because the frequency depends on it.

In the electrical equivalent oscillation circuit(Fig.-4), operating frequency, f_0 can be expressed by the following equation.

$$\frac{f_0 - f_s}{f_s} = \frac{1}{2r(1 + C_L/C_0)}$$

Where f_s = series resonance frequency.
$r = C_0/C_1$ (capacitance ratio)

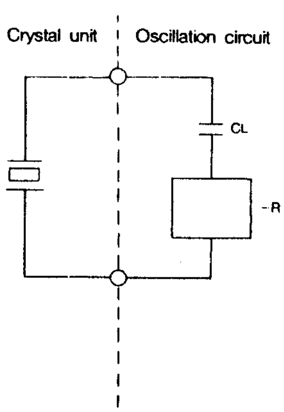

Fig. 3 Equivalent Circuit of a Crystal Oscillator I

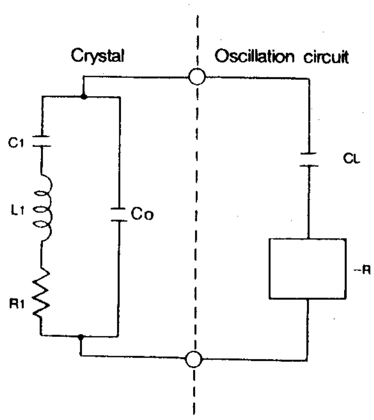

Fig. 4 Equivalent Circuit of a Crystal Oscillator II

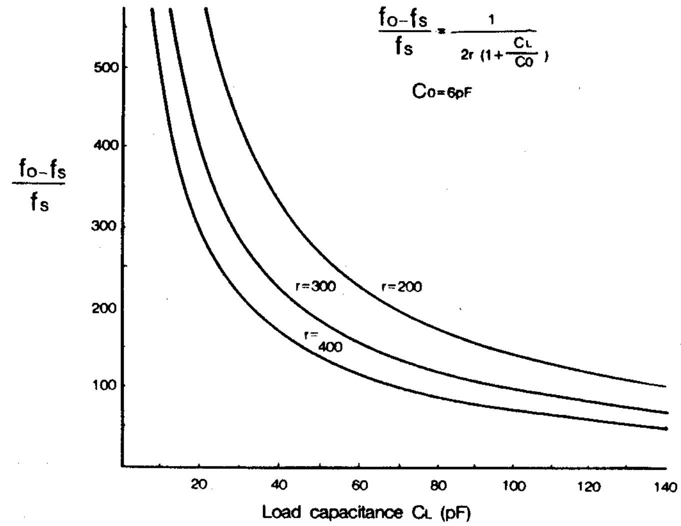

Fig. 5 Load Capacitance Characteristic

Fig.-5 shows an example of the load capacitance characteristic calculated by equation. As can be seen from the figure, the rate of operating frequency change due to change in C_L is high where C_L is small. The rate of operating frequency change due to change in C_L is also high when the capacitance ratio is small.

In most cases the quartz crystal is operated with a load capacity in order to be able to adjust the manufacturing tolerances.

The following applies to the series and parallel connection of C_L:

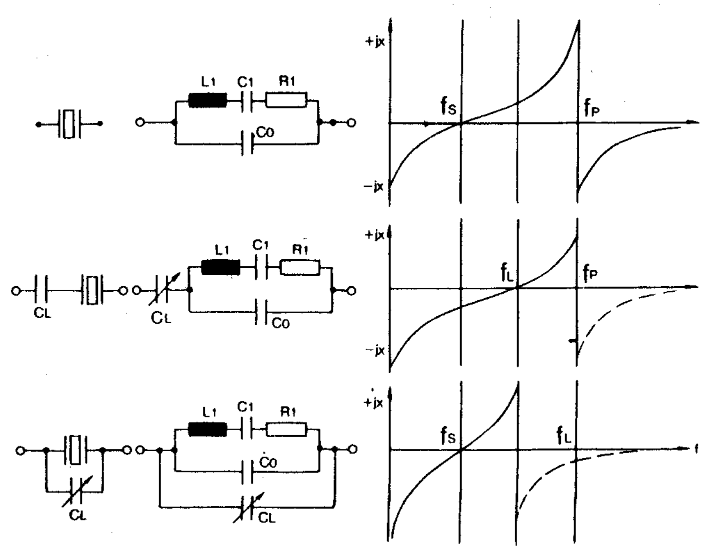

Fig. 6 Influence of the load Capacitance C_L

CRYSTAL PARAMETERS

RESISTANCE AND Q FACTOR

Resistance is the equivalent impedance of the quartz resonator and it determines Q factor of quartz crystal. High crystal Q's are obtained by reducing mechanical and acoustic energy losses which is equivalent to R_1.

The crystal Q is related to the series resonance frequency f_s, the motional inductance L_1, and the equivalent series resistance R_1.

$$Q = \frac{2\pi f_s \cdot L_1}{R_1}$$

A high Q-factor, i.e., low resistance R_1, reduces the influence of external parameters, such as variations in supply voltage, load, temperature, and oscillator components.

SPURIOUS MODES

Spurious modes, which mean unwanted modes, are actually inharmonic modes of vibration of the quartz plate. Since spurious modes are inherent in every crystal resonator, they are suppressed by special design technique.

Typical spurious specifications are 6dB below the desired mode of oscillations but they are more highly suppressed upon customer's request.

DRIVE LEVEL

The drive level normally referenced in milliwatts is the power dissipated in the crystal's equivalent resistance.

Drive level should be the minimum necessary to begin and maintain crystal oscillation, to assure optimum performance and stability.

Excessive drive can result in breakage of the crystal element, excessive frequency drift, and poor aging characteristic.

FREQUENCY TOLERANCE

Frequency tolerance is the amount of frequency deviation(plus or minus) from the desired operating frequency at a specific temperature.

Accuracy requirement for crystal tolerance is expressed in percentage.

AGING

Aging of a quartz crystal is a general term applied to any change in parameters of a crystal unit taking place over a period of time.

In order not to suffer severe aging, the circuit should be designed with drive level kept at absolute minimum.

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LOW FREQUENCY CRYSTALS– 1KHz TO 1MHz

The BREL crystals for the lower frequency ranges 1KHz to 1MHz include units specifically suited for filter and oscillator applications.

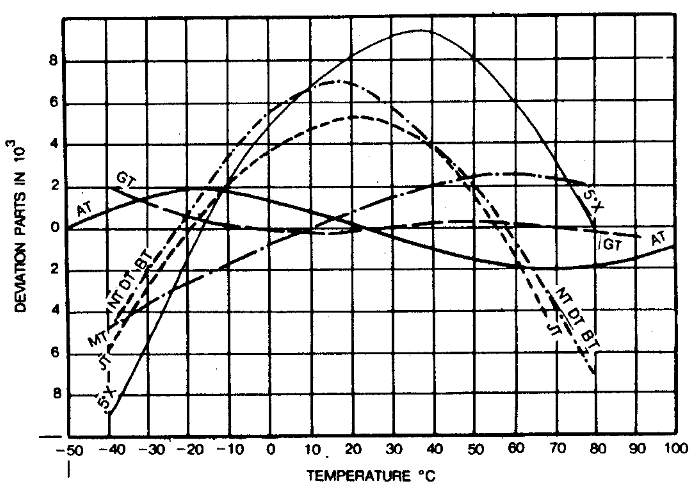
The various holders available for specific frequency ranges are listed, by cuts, in accompanying table. The following illustration shows the basic configurations and lists the most pertinent dimensions, keyed to the dimensional drawing.

SPECIFICATIONS

The Low Frequency range is covered by various crystal cuts and for your convenience, a summary of the frequency temperature characteristics is shown in the following table.

TYPE CUT	FREQUENCY RANGE	APPROXIMATE DEVIATION FROM NOMINAL FREQ. IN PERCENT				
JT	1KHz-12KHz	.015	.025	.03	.035	.005
NT	8KHz-130KHz	.005	.01	.015	.02	.0025
5°X	50KHz-250KHz	.003	.014	.02	.025	.002
MT	80KHz-200KHz	.003	.006	.009	.01	.0015
DT	75KHz-800KHz	.003	.008	.012	.015	.0015
CT	300KHz-900KHz	.006	.01	.018	.02	.001
SL	300KHz-800KHz	.007	.008	.014	.016	.002
TEMPERATURE RANGE-°C		0 +65	−40 +70	−55 +90	−55 +105	+75 ±5

FREQUENCY-TEMPERATURE CURVES



FREQUENCY RANGE	1KHz-12KHz	8KHz-130KHz	50KHz-250KHz	75KHz-800KHz	300KHz-900KHz
CUT	JT	NT	5°X	DT	CT
STANDARD HOLDER	HC-13/U Long	HC-13/U	HC-13/U	HC-6/U	HC-6/U or HC-32/U
COLD WELD HOLDER	N/A	N/A	N/A	HC-36/U	HC-36/U
FREQUENCY TOLERANCE −40 to+70°C	.015%	.01%	.01%	.01%	.01%
FREQUENCY TOLERANCE 0 to+50°C	.008%	.003%	.005%	.003%	.003%
MAXIMUM SERIES RESISTANCE in ohms	75K@3KHz	40K@15KHz to 5K@150KHz	2K@150KHz to 3K@200KHz	1K@190KHz to 2.5K@400KHz	1.8K@500KHz to 7K@1000KHz
ZERO TEMPERATURE COEFFICIENT	25°C	20°C to 75°C	20°C to 75°C	20°C to 75°C	20°C to 75°C
AGING 1'ST MONTH IN PPM/DAY	.1	.2	.2	.2	.2
AGING AFTER 3 MONTHS IN PPM/DAY	.2	.05	.05	.05	.05
MAXIMUM DRIVE LEVEL (mW)	.5	.2	2.0	2.0	2.0
APPLICABLE MIL. SPECIFICATIONS	CR-88A/U	CR-38, CR-50	CR-37	CR-25, CR-26, CR-45, CR-47, CR-63	CR-25, CR-26, CR-46, CR-46, CR-47, CR-63

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AT QUARTZ CRYSTALS – 1 TO 150MHz FOR FUNDAMENTAL & OVERTONE MODES

BREL has been producing hundreds of thousands of crystals for filter and oscillator applications a month. These have covered virtually the complete spectrum of quartz resonators and can be supplied in small lots as well as production quantities.

BREL's well developed technique of mass production enables you to use these AT crystals at lower cost.

CITIZEN BAND CRYSTALS
MARINE BAND CRYSTALS(VHF/FM)
MONITOR BAND CRYSTALS(VHF, UHF)
AMATEUR 2-METER CRYSTALS
MICROPROCESSOR CRYSTALS
MILITARY CRYSTALS

FREQUENCY TOLERANCE: ±.005% @25°C
STABILITY TOLERANCE: ±.01%(−20°C to+70°C)
Co: 7pF MAX

MICROPROCESSOR CRYSTALS

This table lists the standard crystal units commonly used for microprocessor application. Other types are available upon request and our experienced engineering team is also available for consultation on your specific design characteristics.

Frequency (MHz)	Part No.	Holder Type	Calibrated at Series or Parallel (PF)	Maximum Effective Series Resistance (Ohms)	Osc. Mode	Application
1.000	IS100	HC-33/U	13	800	Fund	M6800, S6800, SC/MP, Z80, 1800, 1802, 146805, CDP402, 3870, 6500, 6860
1.8432	IS184	HC-33/U	13	400	Fund	1802, 3850, 3870, 8048, 8748, 8035, 8085, MC144 11, BAUD RATE GENERATOR, 6801, 6802, 6803, 6805, 6809, 1800, 1801
1.8432	IS184-A	HC-18/U	13	800	Fund	〃
2.000	IS200	HC-33/U	20	350	Fund	3852, 3853, 3856, 3870, 6102, 6500, 6800, 6801, 6802, 6809, 6846, 6875, F-8, 6502, COSMAC, MC14 411, 2650A, 650X, 1610, 2650, 3850, 3851, INS8060, INS8900
2.000	IS200-A	HC-18/U	20	800	Fund	〃
2.097152	IS209	HC-33/U	20	300	Fund	MM 5378, MM 5379, 6802, NSC800, 6801, 6803, 68 05, 6809, 8048, 8085, 8748, Auto clocks
2.097152	IS209-A	HC-18/U	20	500	Fund	〃
2.4576	IS245	HC-33/U	32	250	Fund	TMS9980, 9981, 6801, 6802, 6803, 6805, 6809, 80 48, 8085, 34702, BIT RATE GENERATOR, IM 6100,C 2920, IM4702, 4712, 6100
2.4576	IS245-A	HC-18/U	32	300	Fund	〃
3.000	IS300	HC-18/U	32	200	Fund	6501, 6502, 6503, 6504, 6506, 6505, 6507, 6801, 6802, 6803, 6805, 6809, MCS48, IMS9900, SBP0400 A, 8000 Series, 8048, 8748, 8085, 8741
3.2768	IS327	HC-18/U	18	150	Fund	ICM7205, IM6100C, CP1600, NSC800, 6801, 6802, 6803, 6805, 6809, 8048, 8085, 8748
3.579545	IS357	HC-18/U	18	120	Fund	6802, 6808, 6809, 68701, 8748, 6102, PPS-4, PPS-8, MM5369, ICM7206, TV Color BURST, 6801, 6803, 1372, 3870
3.6864	IS368	HC-18/U	Series	120	Fund	8748, 8035-8
3.93216	IS393	HC-18/U	12	120	Fund	clocks
4.000	IS400	HC-18/U	Series	120	Fund	6805, 6808, 6809, 6800, 68701, 68705, 146805, HM 6100, IM6100, EA9002, PACE, Z80A, Z8000, 6801, 6802, 6803

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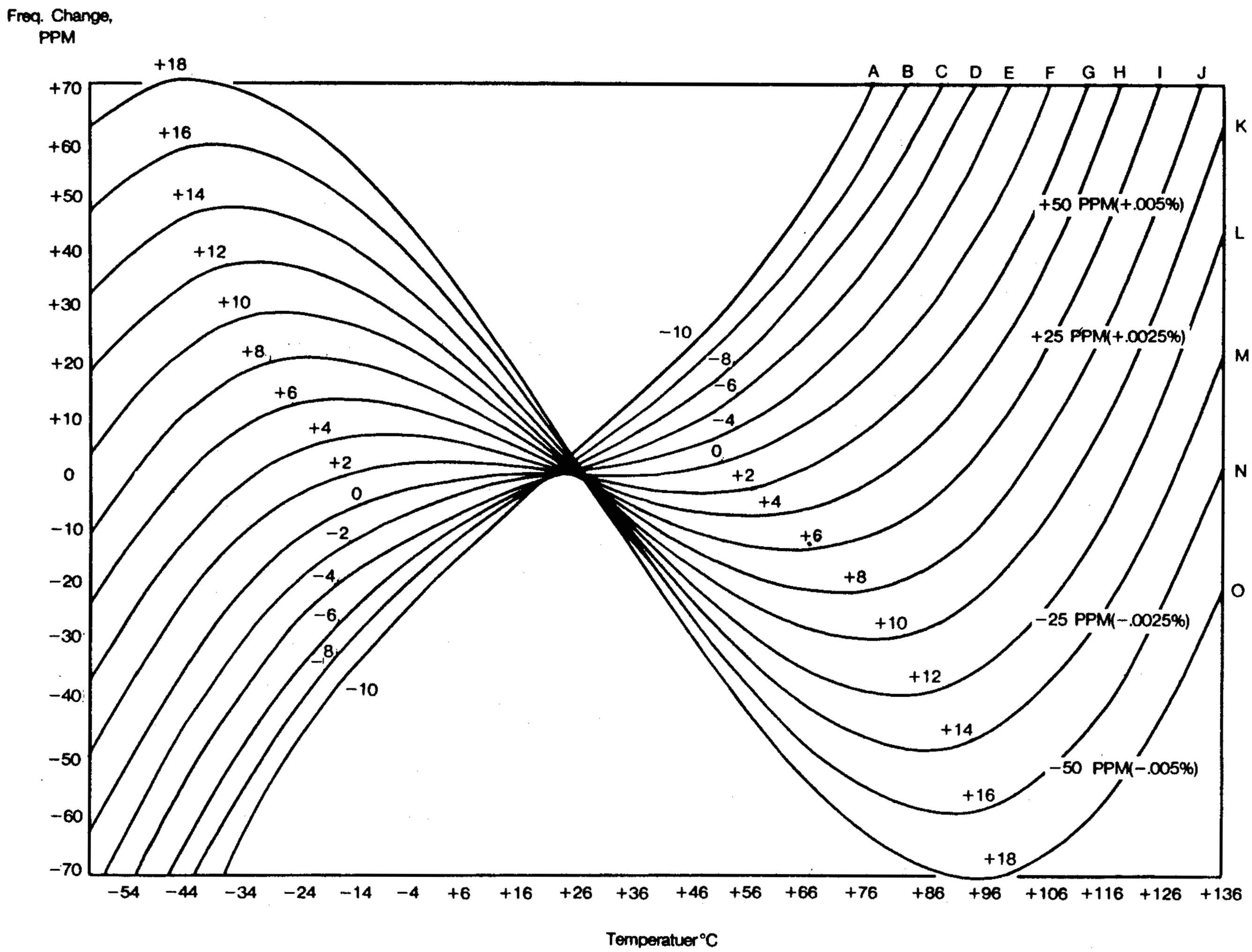
Frequency (MHz)	Part No.	Holder Type	Calibrated at Series or Parallel (PF)	Maximum Effective Series Resistance (Ohms)	Osc. Mode	Application
4.000	IS400-A	HC-18/U	20	120	Fund	4004, 4040, 4048, 4201, 6800, 3870, Z80
4.032	IS403	HC-18/U	22	120	Fund	T199532
4.096	IS409	HC-18/U	16	100	Fund	Several MPU's
4.194304	IS419	HC-18/U	12	100	Fund	ICM7038A, 7040, 7213, 1802
4.433619	IS443	HC-18/U	20	80	Fund	SIG2650, EUROPEAN Color BURST
4.500	IS450	HC-18/U	12	80	Fund	μPD 1700 Series
4.9152	IS491	HC-18/U	Series	80	Fund	Z80A, Z80, COM5026, NSC800, 5046, 8080, 8224, Z8, 4004, 4040, 8048, 8748, 8085
4.9562	IS495	HC-18/U	Series	80	Fund	4004, 4040, 4045, 4048, 4021
5.000	IS500	HC-18/U	20	80	Fund	4040, 8048, 8748, 8085, CP1600 Z80, Z80A, COM5026, NSC80, 5046, 8080, 8224, Z8, 4004
5.0688	IS506	HC-18/U	Series	75	Fund	COM5026, NSC800, 5046, 8080, 8224, Z8, 4004, 4040, 8048, 8748, 8085, COM5016, COM5016T, DUAL BAUD RATE GENERATOR, Z80, Z80A
5.120	IS512	HC-18/U	Series	75	Fund	4040, 4004, 4201
5.185	IS518	HC-18/U	Series	75	Fund	4040, 4004, 4045, 4048, 4201
5.5585	IS555	HC-18/U	Series	75	Fund	"
5.587	IS558	HC-18/U	Series	75	Fund	"
5.7143	IS571	HC-18/U	16	75	Fund	PACE, 6100, 1802
5.760	IS576	HC-18/U	16	75	Fund	μPD 2819 C
6.000	IS600	HC-18/U	Series	50	Fund	6808, 6809, 6800, TMS9995, 6803 CP1600, 8035, 8048, 8049, 8749, MCS48, 8047, 6801, 6802
6.144	IS614	HC-18/U	30	50	Fund	8085A, 8748, CP1600, 8089, MSC-85
6.400	IS640	HC-18/U	20	50	Fund	CDP1802, 1803
6.55360	IS655	HC-18/U	20	50	Fund	ICM7034, 7045, 7207, 7208, 8080, 8224, 8051, 8031
7.000	IS700	HC-18/U	16	50	Fund	Several MPU's
7.200	IS720	HC-18/U	20	50	Fund	Several MPU's
7.3728	IS737	HC-18/U	Series	40	Fund	6875, 8051, 8031, 2920
8.000	IS800	HC-18/U	Series	40	Fund	6808, 6809, 68000, 68701, 1804, 1805, Z8, Z8000, 8086, 8088, 8008, CP1600, IM6100C, TMS9980, 8X300, MC6875, 6801, 6802, 6803
8.867238	IS886	HC-18/U	16	40	Fund	Several MPU's
9.000	IS900	HC-18/U	16	30	Fund	Several MPU's
10.000	IS1000	HC-18/U	Series	25	Fund	8008 TTL MICROLOGIC, CP1600A, AM2901, AM29116, 8086, 8088
10.240	IS1024	HC-18/U	32	25	Fund	Several MPU's
10.738635	IS1073	HC-18/U	Series	25	Fund	TMC9918
11.000	IS1100	HC-18/U	Series	25	Fund	MCS48, 8039, 8049, 8050, 6804, 8040
11.0592	IS1105	HC-18/U	Series	25	Fund	8051
12.000	IS1200	HC-18/U	Series	25	Fund	8031, 8051, 8751, 2920, MSC86, 8284, 9940-12, 8086
12.288	IS1228	HC-18/U	32	25	Fund	Several MPU's
13.5168	IS1351	HC-18/U	Series	25	Fund	8080, 8008, 8224
14.000	IS1400	HC-18/U	32	25	Fund	Several MPU's
14.31818	IS1431	HC-18/U	Series	25	Fund	8080, 8008, 8224, 8350, 8284, 12061
14.7456	IS1474	HC-18/U	32	25	Fund	Several MPU's
15.000	IS1500	HC-18/U	Series	25	Fund	8080, 8008, 8224, 8284, 12061
16.000	IS1600	HC-18/U	Series	25	Fund	8080, 8008, 8224, 8284, 8086, 8202, 12061
17.734475	IS1773	HC-18/U	32	25	Fund	Several MPU's
18.000	IS1800	HC-18/U	Series	25	Fund	8080, 8008, 8224, MSC80, 8350, 12061, 12561
18.432	IS1843	HC-18/U	Series	25	Fund	8080, 8008, 8224, AM9080, μPD8080A, MSC80, 8350, 12061, 12561
19.6608	IS1966	HC-18/U	Series	25	Fund	8080, 8008, 8224, 8350, 12561
20.000	IS2000	HC-18/U	Series	25	Fund	8080, 8008, 8224, MSC80, F9445, AM2900, 8350, 12061, 12561
22.1184	IS2211	HC-18/U	Series	25	Fund.	AM9080, 8080A, TMS8080, μCOM80, 8224, MSC80, 8086, 12061, 12561
24.000	IS2400	HC-18/U	Series	25	Fund	MCS86, 8086, 8224, 8284
24.000	IS2400-A	HC-18/U	Series	40	3'rd	"
27.648	IS2764	HC-18/U	32	40	3'rd	8080A, 8008, 8224
32.000	IS3200	HC-18/U	Series	40	3'rd	8080, 8008, 8224, AM9080, TMS8080, μCOM80
36.000	IS3600	HC-18/U	Series	40	3'rd	8080, 8008, 8224, 8080A, 9070A
48.000	IS4800	HC-18/U	Series	40	3'rd	TMS9900, 9904, SML362

FREQUENCY-TEMPERATURE CURVES – AT CUT CRYSTALS



Several items of foremost interest in specifying quartz crystals are highlighted here; however, there is no substitute, in developing specifications, for direct contact with the company.

The performance of a crystal over the temperature range is completely governed by the angle at which the blank is cut vs. the axis of the quartz. The typical "S" curves shown give the anticipated variation of frequency vs. temperature. It is BREL's responsibility as the manufacturer to select the angle cut which will produce a crystal which will perform within the limits set by the customer's specifications. Obviously, the tight tolerance specifications have to have extreme selection of blanks, resulting in higher price. For crystals from 1 to 150MHz, a frequency tolerance of ±0.005% over a temperature range of −55 to +105°C can be considered normal for BREL manufacturing. Tighter tolerance will influence costing.

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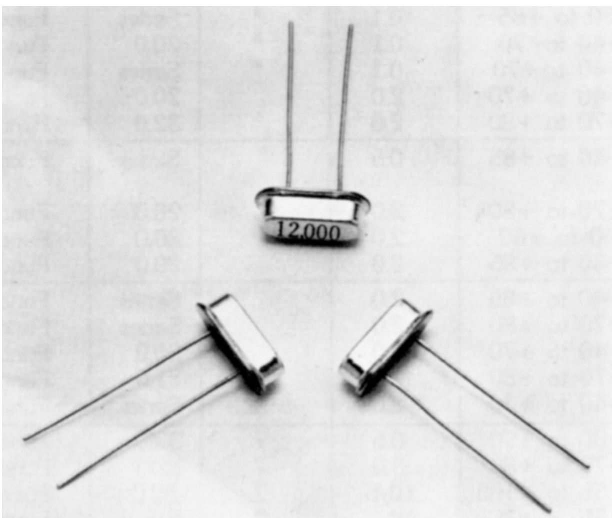
HC49S/RESISTANCE WELD – LOW PROFILE CRYSTAL

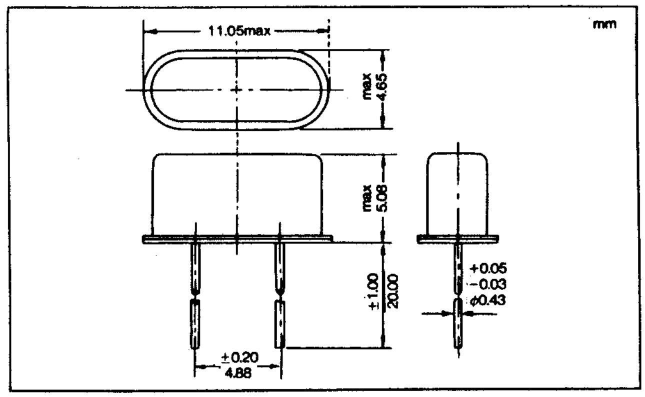
The BREL HC49S in a resistance weld package, features the latest crystal technology in the industry, which utilizes energy trapping principles. This technology is called "AT" Cut strip resonator crystals, and allows for a dramatic reduction in crystal packaging over existing standard designs.

The BREL HC49S has the same pin spacing as the HC18/49U, yet offers a reduction in can height, better shock and vibration characteristics and overall improved reliability. The BREL HC49S also eliminates the need for top leads used for grounding or holding the crystal in PC boards resulting in cost savings and reduction of board space.

Due to the miniaturization of many oscillator and filter components, the crystal size has become the dominant item in area layout requirements. This chart, coupled with the information on crystal can size below, enables the engineer to quickly determine the size crystal can available vs. a specific frequency.



DIMENSIONS



SPECIFICATIONS

Frequency Range	3.579545 MHz–20.000MHz
Frequency Tolerance	±50 ppm @25°C
Frequency Stability	±100 ppm from 0°C to+70°C(ref.25°C)
Operating Temperature Range	−10°C to+70°C(STD)
Aging	5 ppm/Year
Drive level	1mW
ESR	As per listed values

FREQUENCY RANGE/RESISTANCE

Frequency Range	ESR Max
3.579545 MHz– 5.999 MHz	120 ohms
6.000000 MHz– 7.999 MHz	70 ohms
8.000000 MHz– 9.999 MHz	60 ohms
10.000000 MHz–20.000 MHz	50 ohms

All specifications subject to change without notice.

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AT QUARTZ CRYSTALS – 1 TO 150 MHz FOR FUNDAMENTAL & OVERTONE MODES

MILITARY CRYSTALS

ALL BREL MILITARY CRYSTALS meet the Environmental Tests of Table III, MIL-C-3098 Fin the tests of shock, vibration, insulation resistance, leakage, immersion, salt spray, and moisture resistance.

Frequency Range	Crystal Unit Type	Military Holder	Frequency Tolerance (Percent)	Operating Temperature Range °C	Rated Drive Level mW	Crystal Shunt Cap pF Max	Load Cap pF	Mode of Oscil-lator
2.75-16KHz	CR-88A/U	HC-13 Mod	±0.005	0 to +65	0.1	*	Series	Fund.
16-100KHz	CR-38A/U	HC-13/U	±0.012	−40 to+70	0.1	*	20.0	Fund.
16-100KHz	CR-50A/U	HC-13/U	±0.012	−40 to+70	0.1	*	Series	Fund.
90-250KHz	CR-37A/U	HC-13/U	±0.02	−40 to +70	2.0		20.0	Fund.
90-250KHz	CR-42A/U	HC-13/U	±0.003	+70 to +80	2.0		32.0	Fund.
165-360KHz	CR-138/U	HC-6/U	±0.003 ±0.024	−40 to +85	0.5		Series	Fund.
190-500KHz	CR-47A/U	HC-6/U	±0.002	+70 to +80	2.0		20.0	Fund.
200-500KHz	CR-147/U	HC-33/U	±0.01	0 to +60	2.0		20.0	Fund.
200-550KHz	CR-46B/U	HC-6/U	±0.01	−40 to +85	2.0		20.0	Fund.
200-555KHz	CR-25B/U	HC-6/U	±0.01	−40 to +85	2.0		Series	Fund.
200-555KHz	CR-26A/U	HC-6/U	±0.002	+70 to +80	2.0		Series	Fund.
200-555KHz	CR-63B/U	HC-6/U	±0.01	−40 to +70	2.0		20.0	Fund.
200-580KHz	CR-104/U	HC-33/U	±0.002	+70 to +80	2.0		21.5	Fund.
455KHz	CR-45U	HC-6/U	±0.02	−40 to +70	2.0	5±2.5	Series	Fund.
500KHz	CR-57/U	HC-6/U	±0.001	+80 to +90	0.5	7	32.0	Fund.
833.333KHz	CR-142/U	HC-6/U	±0.001	+70 to +80	5.0	7	32.0	Fund.
.8-20MHz	CR-18A/U	HC-6/U	±0.005	−55 to +105	10/5	7	.32.0	Fund.
.8-20MHz	CR-19A/U	HC-6/U	±0.005	−55 to +105	14	7	Series	Fund.
.8-20MHz	CR-27A/U	HC-6/U	±0.002	+70 to +80	5/2.5	7	32.0	Fund.
.8-20MHz	CR-28A/U	HC-6/U	±0.002	−70 to +80	5/2.5	7	Series	Fund.
.8-20MHz	CR-35A/U	HC-6/U	±0.002	+80 to +90	5/2.5	7	Series	Fund.
.8-20MHz	CR-36A/U	HC-6/U	±0.002	+80 to +105	5/2.5	7	32.0	Fund.
.8-20MHz	CR-58A/U	HC-17/U	±0.005	−55 to +105	10/5	7	32.0	Fund.
.8-20MHz	CR-62/U	HC-6/U	±0.001	+70 to +80	5/2.5	7	32.0	Fund.
.8-20MHz	CR-85/U	HC-6/U	±0.002	−40 to +90	10/5	7	Series	Fund.
.8-20MHz	CR-119/U	HC-6/U	±0.005	−55 to +105	10/5	7	30.0	Fund.
.8-20MHz	CR-130/U	HC-6/U	±0.002	−40 to +90	10/5	7	30.0	Fund.
.8-20MHz	CR-131/U	HC-6/U	±0.002	+70 to +80	5/2.5	7	30.0	Fund.
.8-20MHz	CR-132/U	HC-6/U	±0.002	+80 to +90	5/2.5	7	30.0	Fund.
.8-20MHz	CR-157/U	HC-33/U	±0.005	−55 to +105	10/5	7	Series	Fund.
1-10MHz	CR-8A/U	HC-17/U	±0.005	−40 to +70	4.0	7	Series	Fund.
1.75-3.5MHz	CR-100/U	HC-6/U	±0.005	−55 to +90	10.0	7	32.0	Fund.
1.85-3.05MHz	CR-125/U	HC-6/U	±0.005	−55 to +105	10.0	7	32.0	Fund.
2.0-9.25MHz	CR-95/U	HC-11A/U	±0.005	−35 to +75			91.0	Fund.
2.0-9.25MHz	CR-96/U	HC-11A/U	±0.005	−35 to +75	10.0		35.0	Fund.
2.0-10MHz	CR-5A/U	HC-17/U	±0.005	−55 to +90	30.0		25.0	Fund.
2.0-10MHz	CR-6A/U	HC-17/U	±0.005	−40 to +70	30.0		13.0	Fund.
2.12-6.2MHz	CR-89/U	HC-32/U	±0.005	−55 to +90	10.0	7	30.0	Fund.
2.2-20MHz	CR-78A/U	HC-25/U	±0.005	−55 to +105	5.0	7	30.0	Fund.
2.3-3.5MHz	CR-146/U	HC-33/U	±0.002	+70 to +80	0.5	7	32.0	Fund.
2.9-3.8MHz	CR-124/U	HC-18/U	±0.005	−55 to +100	1.0	7	32.0	Fund.
2.9-3.85MHz	CR-114/U	HC-25/U	±0.005	−55 to +105	1.0	7	32.0	Fund.
2.9-20MHz	CR-64/U	HC-18/U	±0.005	−55 to +105	5.0	7	30.0	Fund.
2.9-20MHz	CR-79/U	HC-25/U	±0.005	−55 to +105	5.0	7	Series	Fund.
2.9-25MHz	CR-59A/U	HC-18/U	±0.002	−40 to +90	5.0	7	30.0	Fund.
3-20MHz	CR-66/U	HC-6/U	±0.002	−40 to +90	14	7	30.0	Fund.
3-20MHz	CR-68/U	HC-6/U	±0.002	+70 to +80	5.0	7	32.0	Fund.
3.6-10MHz	CR-1D/U	HC-11A/U	±0.005	−55 to +90	30.0		35.0	Fund.
5-20MHz	CR-60A/U	HC-18/U	±0.005	−55 to +105	5.0	7	Series	Fund.
5-20MHz	CR-112/U	HC-18/U	±0.0025	−55 to +105	5.0	7	Series	Fund.
7-20MHz	CR-101/U	HC-35/U	±0.005	−55 to +105	5.0	7	30.0	Fund.
7-25MHz	CR-118/U	HC-25/U	±0.0015	−55 to +85	5/2.5	7	32.0	Fund.
8-10MHz	CR-97/U	HC-18/U	±0.005	−40 to +85	10.0	7	32.0	Fund.
8-10MHz	CR-136/U	HC-18/U	±0.0025	+10 to +80	10.00	6±5 1.0	32.0	Fund.

All shunt Capacitances are maximum unless otherwise noted. *SPECIAL-See military Specification

Frequency Range	Crystal Unit Type	Military Holder	Frequency Tolerance (Percent)	Operating Temperature Range °C	Rated Drive Level mW	Crystal Shunt Cap pF Max	Load Cap pF	Mode of Oscil-lator
8.5-19.0MHz	CR-137/U	HC-18/U	±0.0025	+20 to +80	2.5	7	32.0	Fund.
9-12MHz	CR-129/U	HC-18/U	±0.0035	−55 to +90	5.0	7	32.0	Fund.
9.5-12.5MHz	CR-91/U	HC-11A/U	±0.005	−55 to +90	25.0	10	55.0	Fund.
0.5-12.5MHz	CR-140/U	HC-6/U	±0.005	−55 to +90	25.0	10	60.0	Fund.
10-11.5MHz	CR-109/U	HC-25/U	±0.002	+80 to +90	2.5	7	32.0	Fund.
10-12MHz	CR-135/U	HC-25/U	±0.002	+80 to +90	2.5	7	32.0	Fund.
10-30MHz	CR-33A/U	HC-6/U	±0.005	−55 ot +105	2.5	12	32.0	3rd
10-61MHz	CR-51A/U	HC-6/U	±0.005	−55 to +105	20.0	7	Series	3rd
10-61MHz	CR-52A/U	HC-6/U	±0.005	−55 to +105	2.0	7	Series	3rd
10-61MHz	CR-65/U	HC-6/U	±0.001	+70 to +80	1.0	7	Series	3rd
10-61MHz	CR-113/U	HC-18/U	±0.001	+70 to +80	1.0	7	Series	3rd
10-61MHz	CR-127/U	HC-6/U	±0.0025	−55 to +90	2.0	7	Series	3rd
10-61MHz	CR-148/U	HC-6/U	±0.005	−55 to +105	2.0	7	Series	3rd
10.5-11.5MHz	CR-106/U	HC-18/U	±0.005	−55 to +105	5.0	7	32.0	Fund.
16-61MHz	CR-76/AU	HC-18/U	±0.002	−40 to +90	2.0	3.5	Series	3rd
16-61MHz	CR-152/U	HC-18/U	±0.002	−40 to +90	2.0	3.5	Series	3rd
17-61MHz	CR-61/U	HC-18/U	±0.002	+80 to +90	1.0	7	Series	3rd
17-61MHz	CR-72/U	HC-25/U Mod	±0.005	−55 to +105	2.0	7	Series	3rd
17-61MHz	CR-84/U	HC-25/U	±0.002	+80 to +90	1.0	7	Series	3rd
17-61MHz	CR-103/U	HC-35/U	±0.0025	−55 to +105	2.0	7	Series	3rd
17-61MHz	CR-128/U	HC-18/U	±0.005	−55 to +105	2.0	7	Series	3rd
17-61MHz	CR-154/U	HC-18/U	±0.002	+80 to +90	1.0	4	Series	3rd
17-62MHz	CR-55A/U	HC-18/U	±0.005	−55 to +105	2.0	7	Series	3rd
17-62MHz	CR-67A/U	HC-18/U	±0.0025	−55 to +1-5	2.0	7	Series	3rd
17-62MHz	CR-77/U	HC-25/U	±0.002	−40 to +90	2.0	7	Series	3rd
17-62MHz	CR-111/U	HC-18/U	±0.005	−55 to +105	2.0	4	Series	3rd
17-65MHz	CR-81/U	HC-25/U	±0.005	−55 to +105	2.0	7	Series	3rd
18-21MHz	CR-134/U	HC-81/U	±0.0025	+10 to +80	5.0	6+.5 −1.0	32.0	Fund.
20-22MHz	CR-139/U	HC-18/U	±0.005	−55 to +105	2.5	12	30.0	Fund.
30-63MHz	CR-117/U	HC-25/U	±0.001	−40 to +65	2.0	7	Series	3rd
35.0004MHz	CR-156/U	HC-43/U	±0.001	+80 to +90	2.0	7	Series	5th
44-69MHz	CR-99A/U	HC-6/U	±0.005	−55 to +105	2.0	7	32.0	3rd
45-125MHz	CR-133/U	HC-25/U	±0.006	−55 to +150	2.0	6.5±1	Series	5th
46-100MHz	CR-149/U	HC-18/U	±0.0025	+10 to +80	2.0	6+.5 −1.0	Series	5th
48-90MHz	CR-141/U	HC-18/U Mod	±0.0025	−30 to +55	3.0	7	Series	5th
48-125MHz	CR-105/U	HC-18/U	±0.001	−40 to +90	2.1	4	Series	5th
50-87MHz	CR-53A/U	HC-6/U	±0.005	−55 to +105	20.0	7	Series	5th
50-100MHz	CR-151/U	HC-18/U	±0.0035	−30 to +70	2.0	6+.5 −1.0	Series	5th
50-125MHz	CR-54A/U	HC-6/U	±0.005	−55 to +105	2.0	7	Series	5th
50-125MHz	CR-56A/U	HC-18/U	±0.005	−55 to +105	2.0	7	Series	5th
50-125MHz	CR-59A/U	HC-18/U	±0.002	+80 to +90	1.0	7	Series	5th
50-125MHz	CR-75/U	HC-6/U	±0.001	+70 to +80	1.0	7	Series	5th
50-125MHz	CR-80/U	HC-18/U	±0.002	−40 to +90	2.0	7	Series	5th
50-125MHz	CR-82/U	HC-25/U	±0.005	−55 to +105	2.0	7	Series	5th
50-125MHz	CR-83/U	HC-25/U	±0.002	−40 to +90	2.0	7	Series	5th
50-125MHz	CR-102/U	HC-35/U	±0.0025	−55 to +105	2.0	7	Series	5th
50-125MHz	CR-107/U	HC-18/U	±0.005	−55 to +105	2.0	6±.5	Series	5th
50-125MHz	CR-116	HC-18/U	±0.0025	−55 to +105	2.0	4.5	Series	5th
50-125MHz	CR-122/U	HC-18/U	±0.001	+80 to +90	1.0	7	Series	5th
50-125MHz	CR-123/U	HC-18/U	±0.001	+80 to +90	2.0	4.5	Series	5th
50-134MHz	CR-98/U	HC-25/U	±0.0015	−30 to +71	2.0	7	Series	5th
56-100MHz	CR-144/U	HC-36/U	±0.00025	+70 to +80	1.0	7	Series	5th
62.5-75MHz	CR-110A/U	HC-18/U	±0.003	−40 to +85	2.0	4	Series	5th
200-220MHz	CR-158/U	HC-35/U	±0.003	+80 ot +90	0.1	4.5	Series	7th

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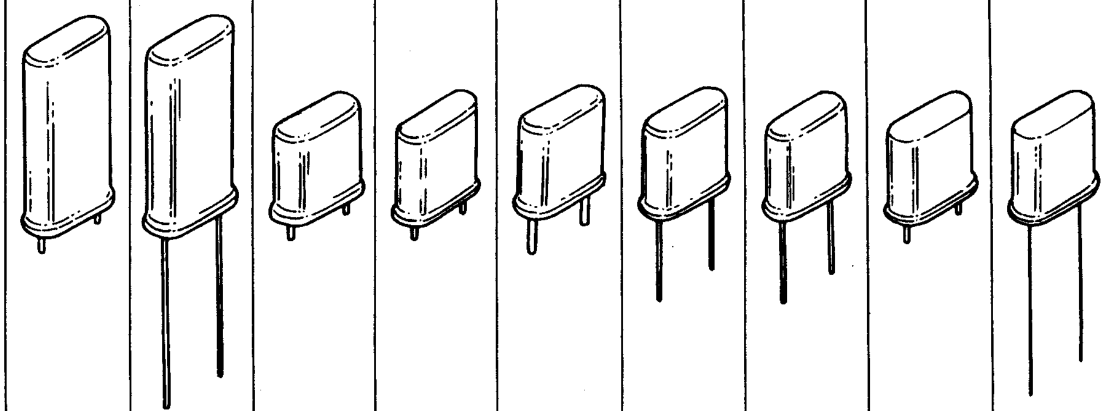
MAJOR CRYSTAL TYPES – FREQUENCY VS. HOLDER

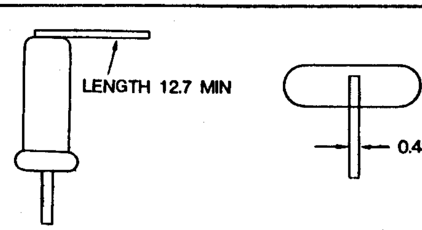


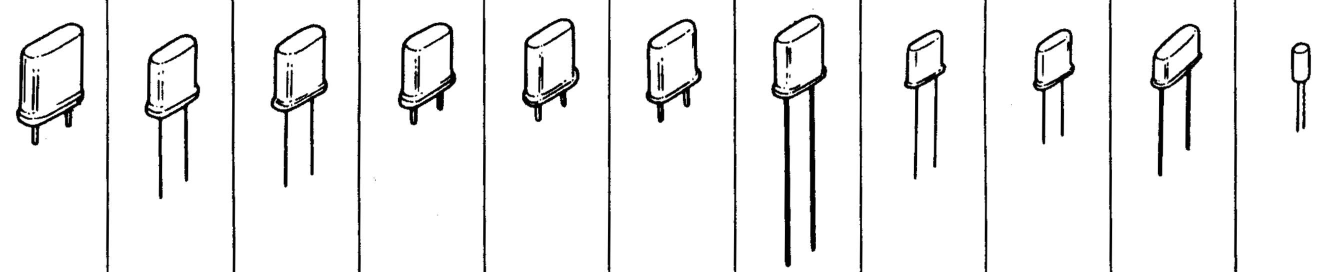
		HC-13/U	HC-34/U	HC-6/U	HC-48/U	HC-17/U	HC-33/U	HC-51/U	HC-36/U	HC-47/U
Frequency Range		14KHz to 50KHz	→	155KHz to 200MHz	→	→	→	→	1.00MHz to 300MHz	→
Holder Type		HC-13/U	HC-34/U	HC-6/U	HC-48/U	HC-17/U	HC-33/U	HC-51/U	HC-36/U	HC-47/U
Solder Seal		✓	✓			✓	✓			
Resist Weld					✓	✓		✓		
Cold Weld										
Nominal Dimensions in mm										
Package	Height	38.76	→	19.68	→	→	→	→	→	→
	Width	19.23	→	→	→	→	→	→	18.67	→
	Thick	8.94	→	→	→	→	→	→	8.51	→
Pin	Length	6.04	38.1	6.04	→	11.09	12.7	→	6.04	38.1
	Diameter	1.27	0.74	1.27	→	2.36	0.74	→	1.27	0.76
	Space*	12.34	→	→	→	→	→	→	→	→

*Center to Center

*Minimum

Special Hold Down/Grounding Pin





1.50MHz to 200MHz	2MHz to 200MHz	→	→	→	2MHz to 300MHz	→	6MHz to 22.12MHz	6MHz to 300MHz	3.5MHz to 20.0MHz	32.768 KHz
HC-32/U	HC-18/U	HC-49/U	HC-25/U	HC-50/U	HC-42/U	HC-43/U	UM-1	UM-2	HC-49/S	TP-38
✓	✓		✓				✓			
		✓		✓				✓	✓	
Nominal Dimensions in mm										
16.26	13.46	→	→	→	→	→	8.00	→	5.08	7.87
14.40	11.05	→	→	→	11.05	→	7:80	9.40	11.05	2.99
6.02	4.64	→	→	→	4.64	→	3.10	3.50	4.65	n/a
6.04	20.00	→	6.04	→	→	38.1	12.07	12.7	20.00	10.41
1.01	0.43	→	1.01	→	→	0.43	0.35	0.40	0.43	0.30
6.98	4.88	→	→	→	→	→	3.75	4.88	4.88	1.09

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CRYSTAL FILTER DEFINITIONS

INTRODUCTION

BREL Frequency Control's primary area of interest lies in crystal controlled units. Filters are designed with Tchebyscheff or Butterworth responses for utilization as combination sets for radar scanning or random vibration system control, upper and lower sideband filters for communication use, one cycle notch filter, etc.

DEFINITIONS

Critical to the understanding of filter behavior is a definition of the vocabulary of the most frequently used terms and familiarity with the typcial filter amplitude frequency response curve, (Figure-1).

a. Center Frequency(F_0) – The arithmetic mean between the high and low cut off frequencies of a filter.
b. Bandwith(BW) – The difference between two cut off frequencies at a specified attenuation level(3dB or 6dB).
c. Attenuation – Reduction of signal in transmission through a filter.(Attenuation is usually expressd in decibels dB).
d. Decibel – Unit that expresses the ratio between two powers, two voltages or two currents

$$(10 \text{ Log}\frac{P_1}{P_2},\ 20 \text{ Log}\frac{V_1}{V_2} \text{ or } 20 \text{ Log}\frac{I_1}{I_2})$$

e. Shape Factor – Ratio of bandwidths at two different levels of attenuation.
f. Ripple – The wavelike response in the passband of a filter(expressed in dB). Unless otherwise specified the maximum ripple will be that excursion from the highest peak to the lowest valley.
g. Insertion Loss – Power loss of the filter in the passband(expressed in dB). Zero dB reference shall be the point of maximum output of the filter unless it is specified otherwise.

$$\text{Insertion Loss} = 10 \text{ Log}\frac{\text{Pin}}{\text{Pout}}$$

h. Source Impedance – (Input termination) – The output impedance of the circuit that drives the filter.
i. Load Impedance – (Output termination) – The impedance that must be connected to the output terminals of the filter in order to achieve the proper response.
j. Spurious Mode – Unwanted responses that occur in the filter due to resonant frequencies of the crystal other than the fundamental frequency.

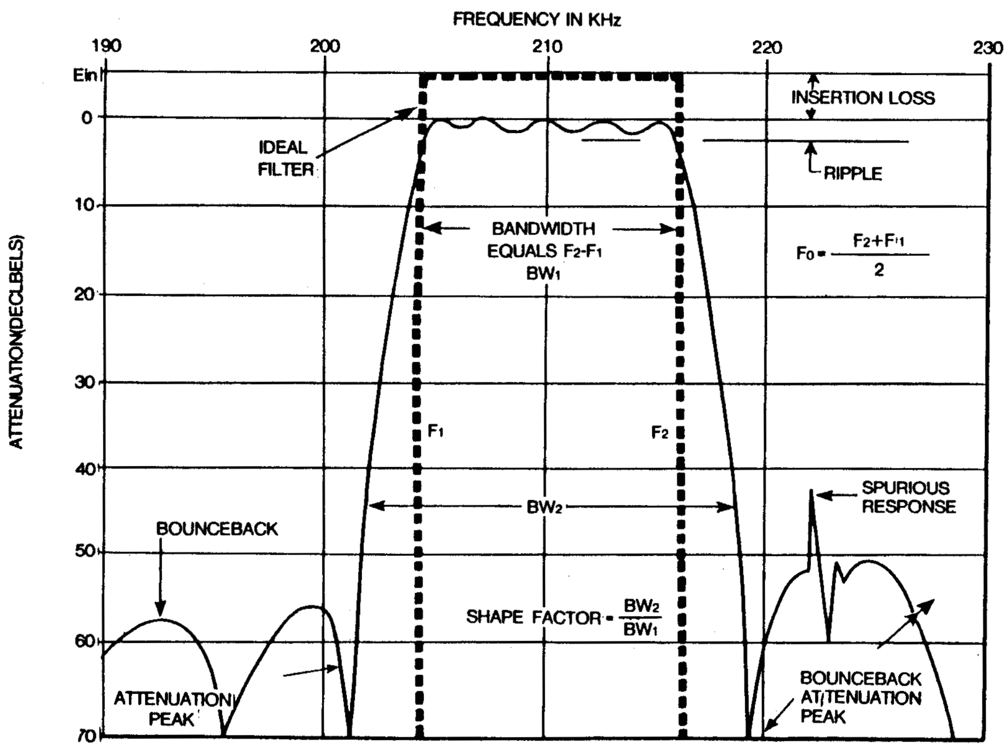

FIGURE 1 TYPICAL FILTER RESPONSE CURVE · BANDPASS FILTER

BREL IS A CUSTOM-FILTER HOUSE MANUFACTURING HIGH RELIABILITY, SPECIAL PURPOSE DISCRETE COMPONENT CRYSTAL FILTERS TO YOUR EXACT SPECIFICATION. SEND US YOUR REQUIREMENTS.

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CRYSTAL FILTERS

Crystal filters from 1KHz are manufactured to customer's requirements or to MIL-specifications at BREL.

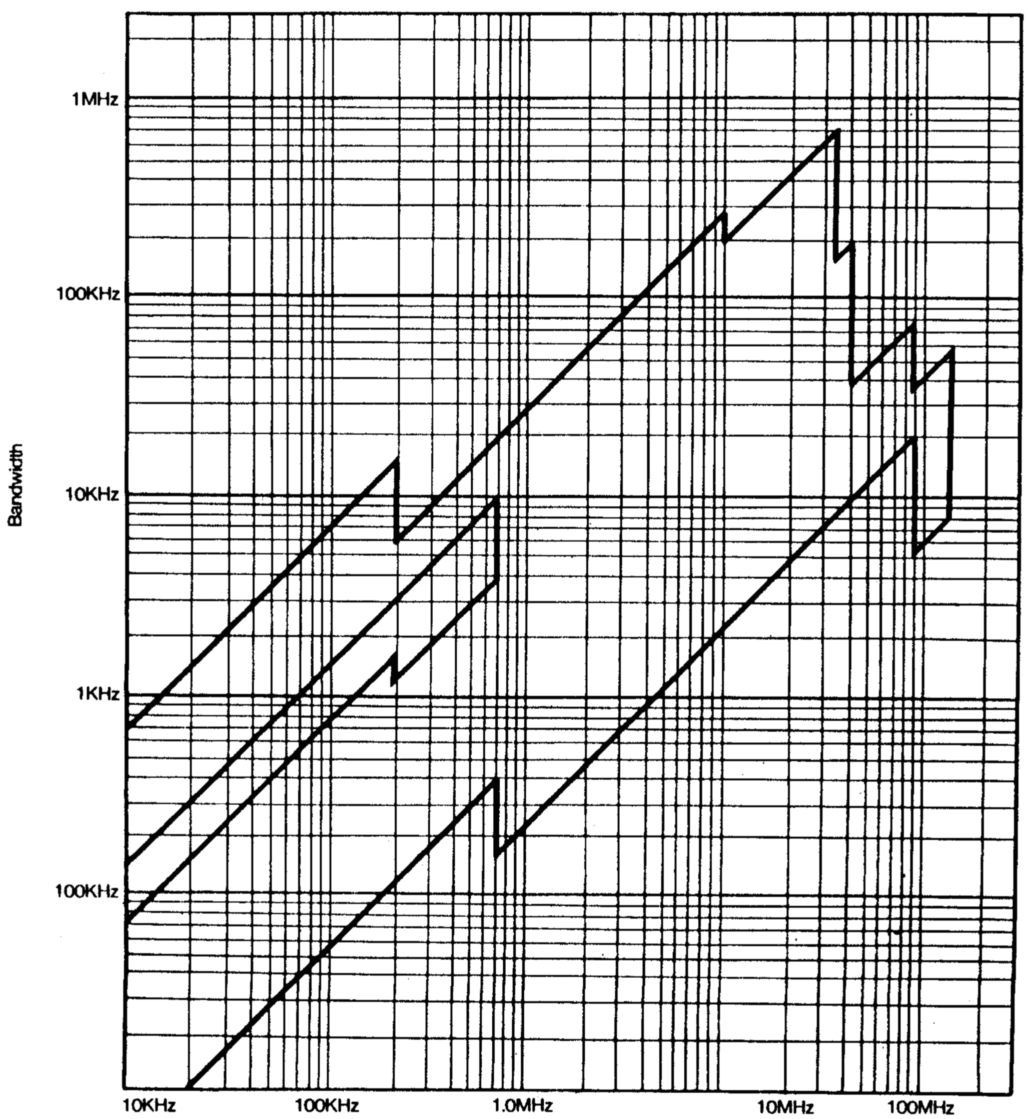
BREL's computer aided design programs and production techniques provide various precision filters with sharp cut-off characteristics, long term stability, wide temperature range, minimum insertion loss, and high stop-band performance.

FM RECEIVERS OF SINGLE AND DOUBLE SUPER-HETERODYNE IN MOBILE AND OTHER EQUIPMENT
SSB SIGNAL GENERATION
EXTRACTION OR REJECTION OF PILOT SIGNAL
TELEPHONE CHANNEL FILTERING
OTHER FREQUENCY CONTROLS

Examples of filters previously produced for specific applications and band-width information are provided in this leaflet.

CENTER FREQUENCY-BANDWIDTH

The center frequency-bandwidth chart shown here can be used in determining center frequency versus bandwidth characteristics.



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CRYSTAL FILTERS – GENERAL USE, FM AND SSB

Model No.	Center Frequency MHz	Passband Width dB KHz	Stopband Width dB KHz	Insertion Loss dB (Max)	Ripple dB (Max)	Case L×W×H (mm)	Operating Temperature (°C)	Terminating Impedance ohm//pF
ISF-2113	60KHz	0.2dB 10Hz	20dB 40dB ±150Hz±600Hz	3	0.2	130×80×20	0–40	75
ISF-2115	100KHz	3dB 30Hz	40dB ±300Hz	6	1.0	90×50×45	0–40	5K//10pF
ISF-2117	104.08 KHz	0.5dB 6Hz	3.5dB ±300Hz	10	1.0	130×80×20	0–40	75
ISF-6114	455KHz	6dB 600Hz	60dB ±800Hz	9	2	64×24×22	−10–+50	5K//50pF
ISF-8113	445KHz	6dB 2.4KHz	66dB ±2.1KHz	6	2	64×24×22	−10–+50	5K//40pF
ISF-8205	1.54MHz	6dB ±150Hz	60dB ±300Hz	4	1	65.8×25.2×58.2	−30–+50	50
ISF-8211	1.75	2dB +1.7535KHz −1.7503KHz	60dB +1.7545KHz −1.7497KHz	6	1.5	95×58×27	−40–+80	200//15pF 190//80pF
ISF-6048	4.287	0.4dB ±0.2	3dB 40dB ±0.4 ±4	3	0.2	50×38×46	+0–+50	75 1000
ISF-6311	5.735	6dB 2.4KHz	26dB 60dB ±1.7 ±2.2	4	2	36×22×21	−20–+50	500
ISF-6031	7.8	6dB ±2.1	18dB 60dB ±2.5 ±4.3	4	2	36×22×20	−20–×50	600 150
ISF-6309	7.8	6dB ±1.2	18dB 60dB ±1.5 ±2.5	4	2	36×22×20	−20–+50	600
ISF-8208	9.0	6dB ±1.2KHz	(60/6) 1.8	3	2	36×22–20	−30–+60	1.2K//30pF
ISF-6304	9.785	6dB ±2.1	18dB 60dB ±2.5 ±4.3	4	2	36×22–20	−2–+50	400//20pF
ISF-6308	10.6935	6dB ±1.2	15dB 50dB ±1.5 ±2.3	3.5	2	36×22×20	−20–+50	600//20pF
ISF-8104	10.7	3dB ±3.75	70dB 90dB ±8.75 ±12.5	4.5	2	36.1×26.7×19.1	−40–+80	470//25pF
ISF-8112	10.7	3dB ±6	75dB 80dB ±12.5 ±15	3.5	2	55×20×22	−20–+60	1K//10pF
ISF-8131	10.7	3dB ±7.5	70dB 90dB ±17.5 ±25	3.5	2	36.1×26.7×19.1	−40–+80	910/25pF
ISF-8107	10.7	3dB ±1.2	25dB 60dB ±1.5 ±2.0	3	2	36×23×23	−20–+50	500
ISF-8127	10.7	3dB ±3.75	70dB 90dB ±8.75 ±12.5	4.5	2	36×23×23	−40–+80	910//25pF
ISF-8132	10.7	3dB ±15	70dB 90dB ±35 ±50	4.5	2	55×20–22	−40–+80	910/25pF
ISF-2112	10.7	3dB ±15	30dB ±36	1.5	2	36×22×20	−40–+80	5K
ISF-8181	11.5	3dB ±1.2	25dB 80dB ±1.5 ±2.0	3	2	36–23–23	−20–+50	500
ISF-6121	11.5	6dB ±16.5	50dB 70dB ±40 ±50	5	0.5	55.5×25.4×19.1	−40–+85	50
ISF-4111	11.5	2dB ±16.5	10dB 36dB ±40 ±200	4	0.5	55.5×19.1×19.1	−40–+85	50
ISF-6307	12.7	3dB +3.0KHz	60dB −4.75KHz	5	2	58.4×19×19	−30–+50	150//70pF 3K//7pF
ISF-8208	25	6dB ±7.5	70dB 80dB ±17.5 ±20	5	2	55×20×22	−30–+60	570
ISF-6403	43.5	6dB ±3.5	60dB ±12	5	2	58×20×17	−2-–+70	900

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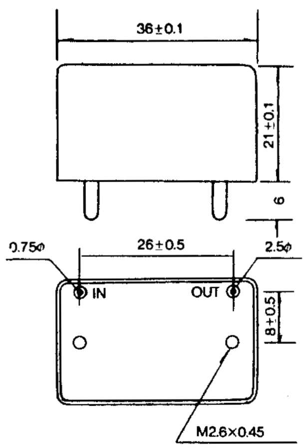
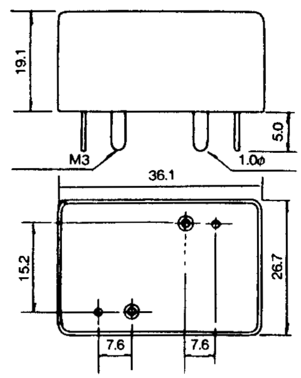
FIG. 1



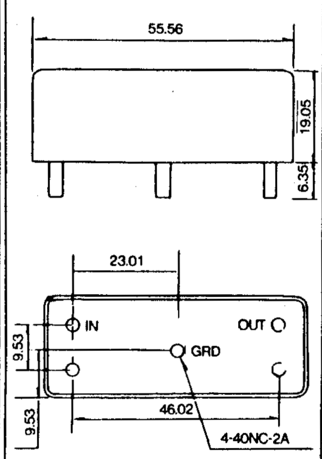
ISF-6311, 6031
6309, 8208
6304, 6306

FIG. 2



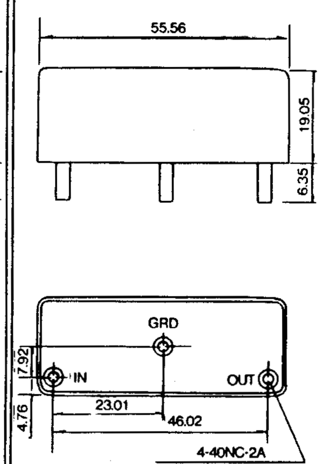
ISF-8104
8131

FIG. 3



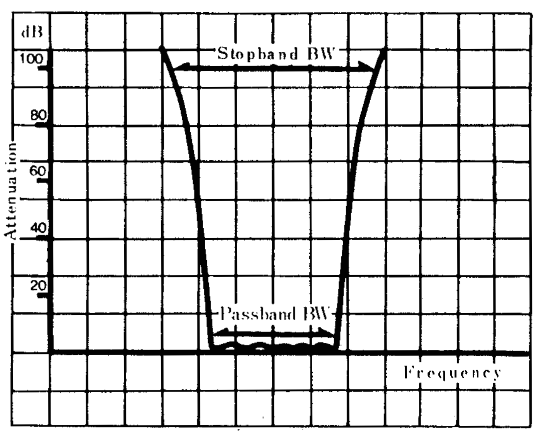
ISF-4111

FIG.4

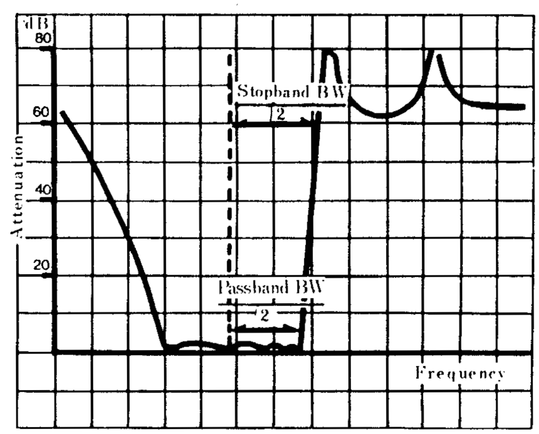


ISF-6121

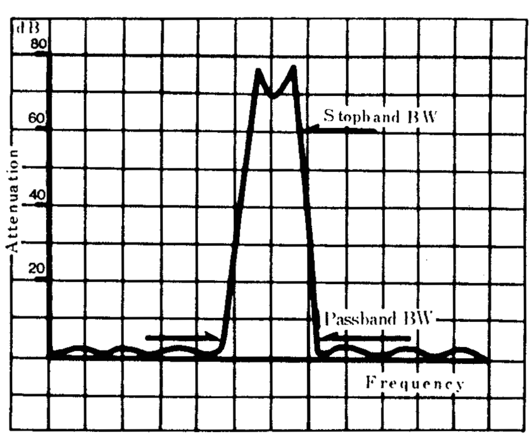
•Bandpass with infinite att. poles



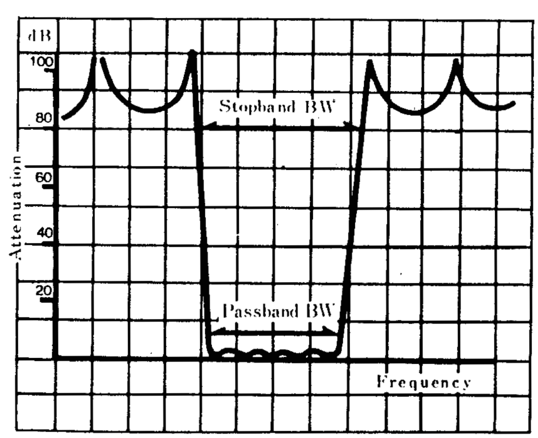
•Asymmetrical Bandpass



•Band stop



•Bandpass with finite att. poles



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MONOLITHIC CRYSTAL FILTERS

1MHz to 160MHz FOR FUNDAMENTAL AND OVERTONE MODE

Monolithic crystal filters, which cover range from 1MHz to 100MHz, are relatively simple 2-pole devices and more complex, multipole units up to 10 pole response.

Monolithic crystal filters have many advantages such as compact size, high temperature stability, and high reliability.

STANDARD BREL MCF

Model No	Center Frequency (MHz)	Channel spacing (KHz)	No of pole	Passbandwidth (Min) dB	Passbandwidth (Min) ±KHz	Stopbandwidth (Max) dB	Stopbandwidth (Max) ±KHz	Insertion Loss dB(Max)	Passband Ripple dB(Max)	Termination Impedance Coupling(Cc) Kohm//PF	case
10M7A	10.695	12.5	2	6	3.5	20	10	2.0	0.5	1.0//10	Fig-1, Fig-2
10M7.5A	10.700	12.5	2	3	3.75	18	18	1.5	0.5	1.2//0	Fig-1, Fig-2
10M7.5B	10.700	12.5	4	3	3.75	40	12.5	2.5	1.0	1.2//0 Cc=10.0PF	Fig-1, Fig-2
10M7.5C	10.700	12.5	6	3	3.75	60	12.5	3.0	2.0	1.2//0	Fig-4
10M12A	10.700	20.0	2	3	6.0	20	25.0	1.5	0.5	3.0//0	Fig-1, Fig-2
10M12B	10.700	20.0	4	3	6.0	40	20.0	2.5	1.0	3.0//0 Cc=5.0PF	Fig-1, Fig-2
10M12C	10.700	20.0	6	3	6.0	60	20.0	3.0	2.0	3.0//0	Fig-4
10M15A	10.700	25.0	2	3	7.5	18	25.0	1.5	0.5	3.0//0	Fig-1, Fig-2
10M15B	10.700	25.0	4	3	7.5	40	25.0	2.5	1.0	3.0//0 Cc=2.0PF	Fig-1, Fig-2
10M15C	10.700	25.0	6	3	7.5	60	22.5	3.0	2.0	3.0//0	Fig-4
10M20A	10.700	35.0	2	3	10.0	18	35.0	2.0	0.5	3.9//0	Fig-1, Fig-2
10M20B	10.700	35.0	4	3	10.0	40	35.0	2.5	1.0	3.9//0 Cc=0.5PF	Fig-1, Fig-2
10M20C	10.700	35.0	6	3	10.0	60	30.0	3.0	2.0	3.9//0	Fig-4
10M30A	10.700	50.0	2	3	15.0	15	50.0	1.5	0.5	5.0//−1.5	Fig-1, Fig-2
1OM30B	10.700	50.0	4	3	15.0	40	50.0	2.5	1.0	5.0//−15 Cc=0PF	Fig-1, Fig-2
10M30C	10.700	50.0	6	3	15.0	60	45.0	3.0	2.0	5.0//1.5	Fig-4, Fig=Fig-3
21M7.5A	21.400	12.5	2	3	3.75	20	18.0	1.5	0.5	1.5//0	Fig-1, Fig-2, Fig-3
21M7.5B	21.400	12.5	4	3	3.75	40	14.0	2.5	1.0	1.5//0 Cc=16PF	Fig-1, Fig-2, Fig-3
21M7.5C	21.400	12.5	6	3	3.75	45	8.75	3.0	2.0	1.5//0	Fig-4, Fig-5
21M12A	21.400	20.0	2	3	6.0	20	25.0	1.5	0.5	1.5//0	Fig-1, Fig-2, Fig-3
21M12B	21.400	20.0	4	3	6.0	40	20.0	2.0	1.0	1.5//0 Cc=13PF	Fig-1, Fig-2, Fig-3
21B12C	21.400	20.0	6	3	6.0	65	20.0	2.5	2.0	1.5//0	Fig-4, Fig-5
21M15A	21.400	25.0	2	3	7.5	18	25.0	1.5	0.5	1.5//0	Fig-1, Fig-2, Fig-3
21M15B	21.400	25.0	4	3	7.5	40	25.0	2.0	1.0	1.5//0 Cc=7PF	Fig-1, Fig-2, Fig-3
21B15C	21.400	25.0	6	3	7.5	65	25.0	2.5	2.0	1.5//0	Fig-4, Fig-5
21M30A	21.400	50.0	2	3	15	15	45.0	1.5	0.5	1.5//0	Fig-1, Fig-2, Fig-3
21M30B	21.400	50.0	4	3	15	40	50.0	2.0	1.0	1.5//0 Cc=2PF	Fig-1, Fig-2, Fig-3
21M30C	21.400	50.0	6	3	15	65	50.0	2.5	2.0	1.5//0	Fig-4, Fig-5
45M15A	45.000	25.0	2	3	7.5	18	28.0	2.0	1.0	4.0//−1.5	Fig-1, Fig-2, Fig-3
45M15B	45.000	25.0	4	3	7.5	40	30.0	3.0	1.0	4.0//−1.5 Cc=−0.5PF	Fig-1, Fig-2, Fig-3
46M15A	46.610	25.0	2	3	7.5	18	30.0	2.5	1.0	4.0//−5.0	Fig-1, Fig-2, Fig-3
46M15B	46.610	25.0	4	3	7.5	40	30.0	3.0	1.0	4.0//−5.0 Cc=−0.5PF	Fig-1, Fig-2, Fig-3
49M15A	49.670	25.0	2	3	7.5	18	30.0	2.5	1.0	4.0//5.0	Fig-1, Fig-2 Fig-3
49M15B	49.670	25.0	4	3	7.5	40	30.0	3.0	1.0	4.0//−5.0	Fig-1, Fig-2, Fig-3
58M17B	58.1125	25.0	4	3	8.5	25	25.0	3.0	1.0	3.0//−1.0 Cc=−1.0PF	Fig-1, Fig-2, Fig-3

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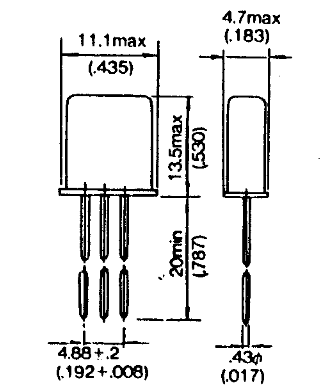
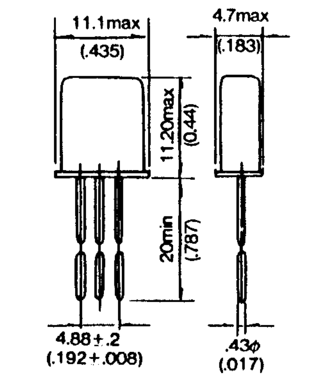
MONOLITHIC CRYSTAL FILTERS



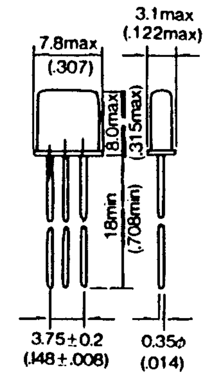
HC-18/U: Solder Seal
HC-49/U: Resistance Weld

Fig-1



HC-18/T: Solder Seal
HC-49/T: Resistance Weld

Fig-2



UM-1
Resistance Weld

Fig-3

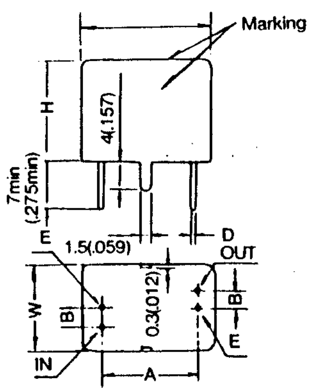


Fig-4 and Fig-5

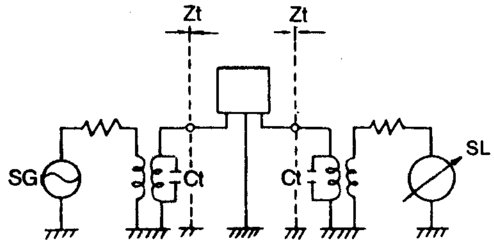
	L	W	H	A	B	Dφ
C-1	11.0	8.5	11.5	7.4	2.0	0.3
C-2	13.4	8.5	11.0	9.8	2.0	0.3
C-3	15	12	15	9.0	2.5	0.43
C-4	18.5	12	15	13.4	2.5	0.43
C-5	23	12	15	17.8	2.5	0.43
C-6	28	12	15	22.2	2.5	0.43

(in mm)

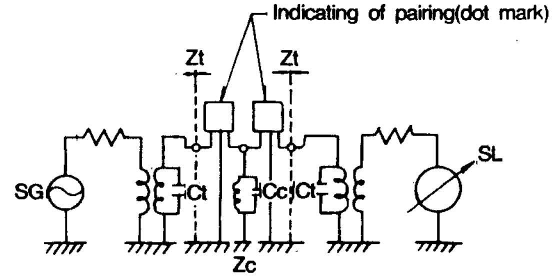
	L	W	H	A	B	Dφ
C-1	.433	.335	.452	.291	.078	.012
C-2	.527	.335	.433	.386	.078	.012
C-3	.590	.472	.590	.354	.098	.017
C-4	.728	.472	.590	.527	.098	.017
C-5	.906	.472	.590	.701	.098	.017
C-6	1.102	.472	.590	.874	.098	.017

(in inch)

TEST CIRCUIT



2 pole M.C.F



4 pole M.C.F

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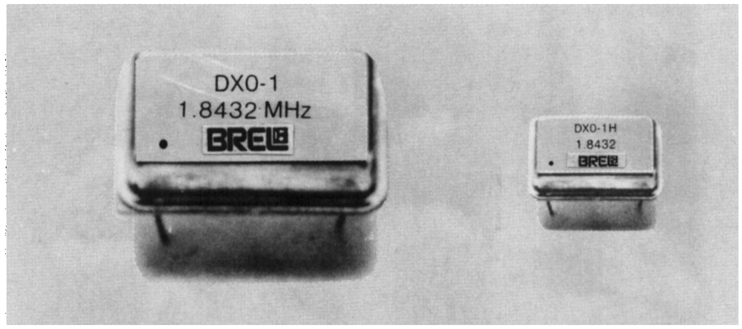
CLOCK OSCILLATOR – TTL & HCMOS

For devices using microprocessor, computer, facsimile, computer controlled devices, etc.

Features

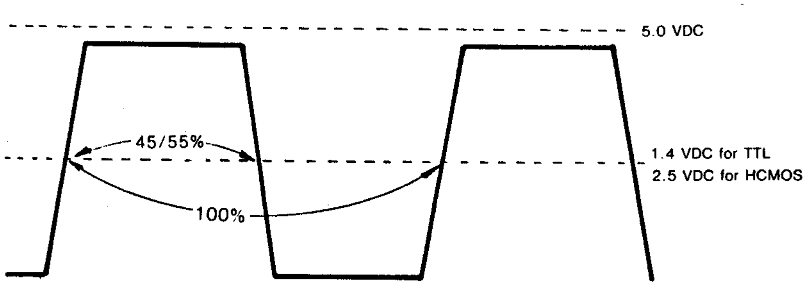
- TTL & CMOS Compatible
- Dual in line package & Half DIP Type



Model	DX0—1	DX0—1H
Frequency Range	500 KHz~3.5 MHz	
Operating Temperature Range	0°C~+70°C	
Storage Temperature Range	−55°C~+105°C	
Supply Voltage	5.0 VDC±5%	
Supply Current	20 mA Max	
Frequency Stability	±100 ppm	
Symmetry at 1.4 VDC / 2.5 VDC	55/45% for TTL 55/45% for HCMOS	
VoH (min)	2.4 VDC for TTL 4.5 VDC for HCMOS	
Vol (max)	0.4 VDC for TTL 0.5 VDC for HCMOS	
Rise & Fall Time 0.4 to 2.4 VDC / 0.5 to 4.5 VDC	15 ns Max for TTL 15 ns Max for HCMOS	
Fan Out	1 to 10 TTL Gate for TTL 50 pF Max for HCMOS	
Size	DIP	Half

* All specifications subject to change without notice.

OUTPUT WAVE FORM



DIMENSIONS

Refer to additional spec.

Test Circuit
Refer to additional spec.

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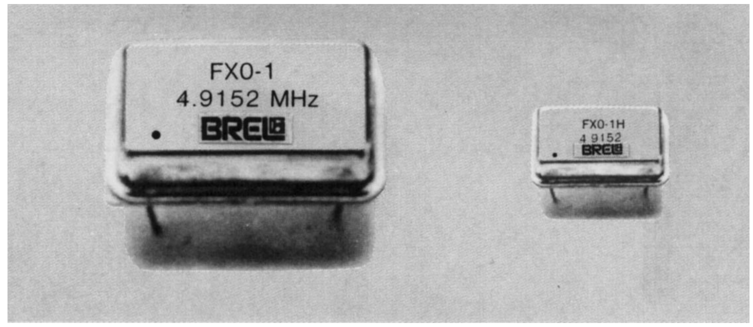
CLOCK OSCILLATOR – TTL

For devices using microprocessor, computer, facsimile, computer controlled devices, etc.

Features

- TTL Compatible
- Fast rise & Full time
- Low profile design

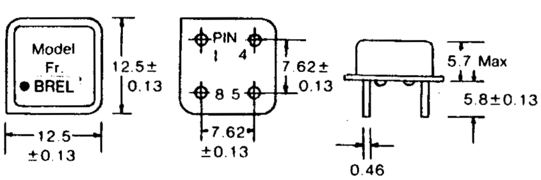


Model	FX0—1		FX0—1H
Frequency Range	3.5 MHz~23.0 MHz	23.0 MHz~60.0 MHz	3.5 MHz~24.0 MHz
Operating Temperature range	0°C~+70°C		
Storage Temperature range	−55°C~+105°C		
Supply Voltage	5 VDC±5%		
Supply Current	25 mA Max	50 mA Max	25 mA Max
Frequency Stability (ppm)	±100 or ±50		
Symmetry at 1.4 VDC	45/55%	40/60%	45/55%
VoH (min)	2.4 VDC		
VoL (max)	0.4 VDC		
Rise & Fall Time 0.4 to 2.4 VDC	10 ns Max	6 na Max	10 ns Max
Fan Out	1 to 10 TTL Gate		
Size	DIP		Half

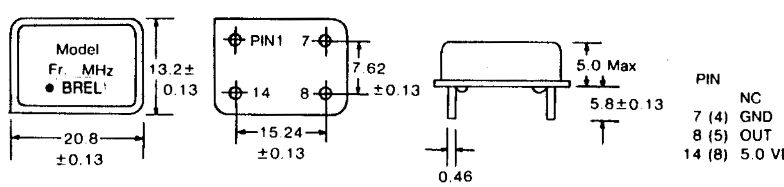
* All specifications subject to change without notice.

DIMENSIONS: in (mm)

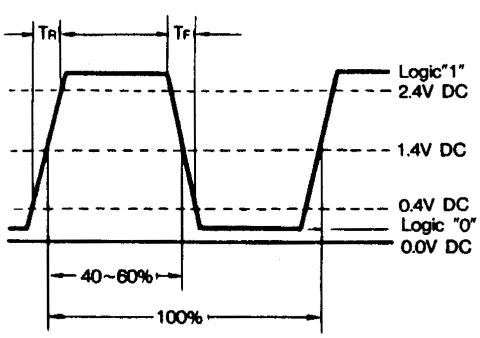
Half Size



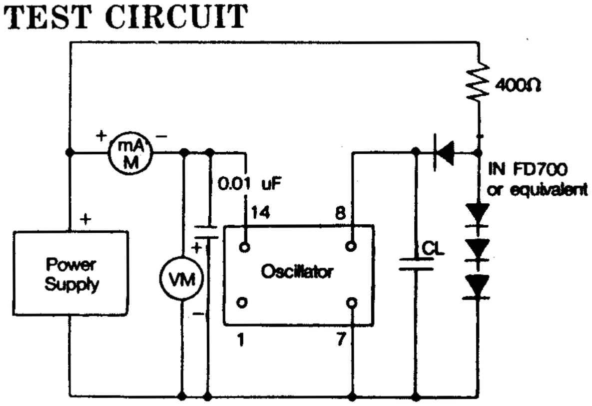
Normal Size



TTL OUTPUT WAVE FORM



TEST CIRCUIT



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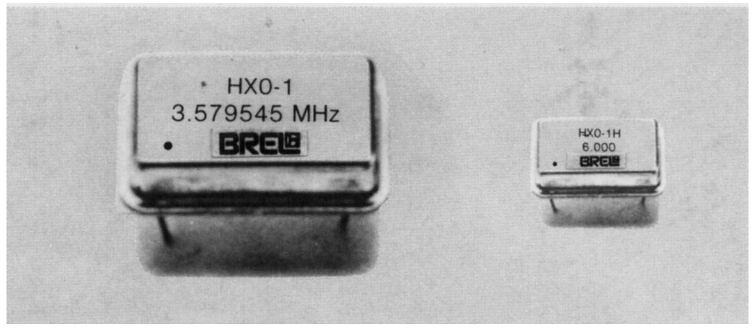
CLOCK OSCILLATOR – CMOS

For office computer, computer controlled devices, microcomputer, etc.

Feature

- CMOS & MOS Compatible
- Fast Rise & Fall Time



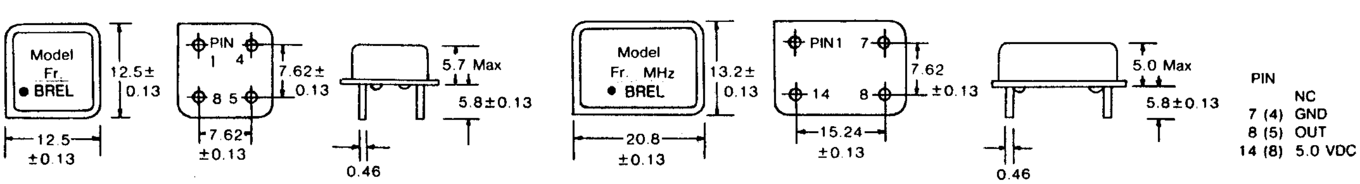
Model	HX0—1		HX0-1H	
Frequency Range	3.5 MHz~23 MHz	23 MHz~42 MHz	3.5 MHz~23 MHz	23 MHz~42 MHz
Operating Temperature range	0°C~+70°C			
Storage Temperature range	−55°C~+105°C			
Supply Voltage	5 VDC±5%			
Supply Current	15 mA Max	25 mA Max	15 mA Max	25 mA Max
Frequency stability (ppm)	±100 or ±50			
Symmetry at 2.5 VDC	40/60%			
VoH (min)	4.5 VDC			
VoL (max)	0.5 VDC			
Rise & Fall time 0.5 to 4.5 VDC	10 ns Max			
Fan Out	50 pF Max			
Size	DIP		Half	

* All specifications subject to change without notice.

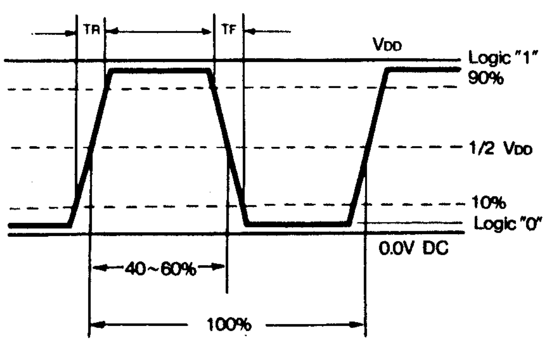
DIMENSIONS: in (mm)

Half Size

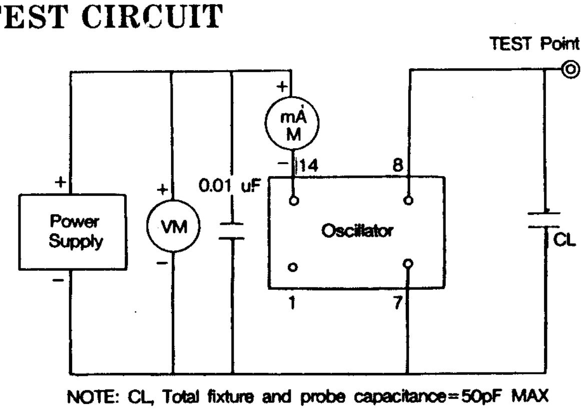
Normal Size



CMOS OUTPUT WAVE FORM



TEST CIRCUIT



NOTE: CL, Total fixture and probe capacitance=50pF MAX

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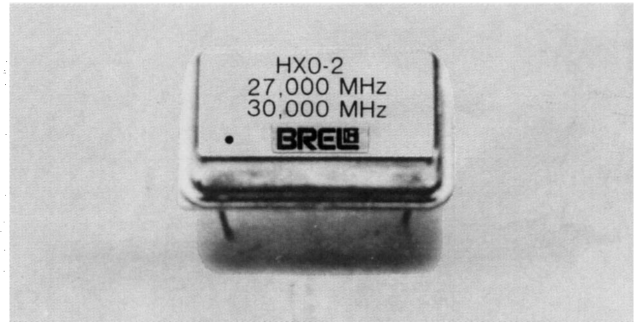
CLOCK OSCILLATOR – DUAL OUTPUT CMOS

For office computer, computer, controlled devices, etc.

Feature

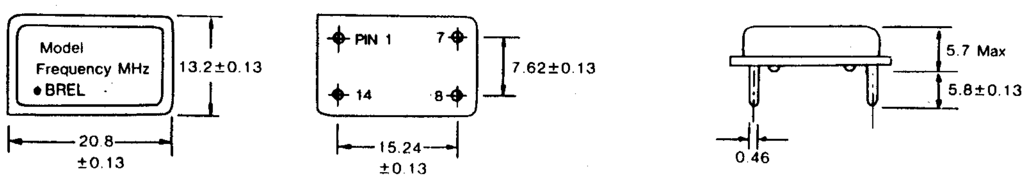
- Dual independent output
- CMOS & MOS Compatible
- Fast Rise & Fall Time



Model	HX0—2
Frequency Range	output 1 23.0 MHz~42.0 MHz output 2 23.0 MHz~42.0 MHz
Operating Temperature Range	-0°C~+70°C
Storage Temperature Range	-55°C~+105°C
Supply Voltage	5 VDC±5%
Supply Current	50 mA Max
Frequency Stability (ppm)	±100 or ±50
Symmetry at 2.5 VDC	40/60%
VoH (min)	4.5 VDC
VoL (max)	0.5 VDC
Rise & Fall Time 0.5 to 4.5 VDC	10 nsec Max
Fan Out	50 pF Max

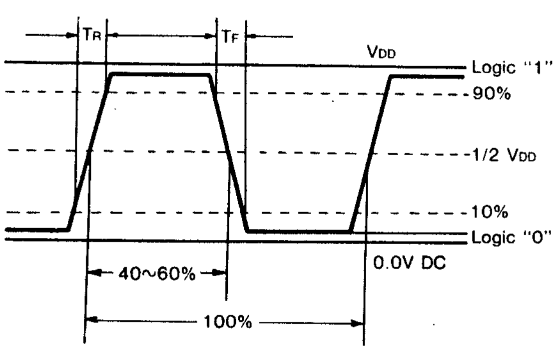
* All specifications subject to change without notice.

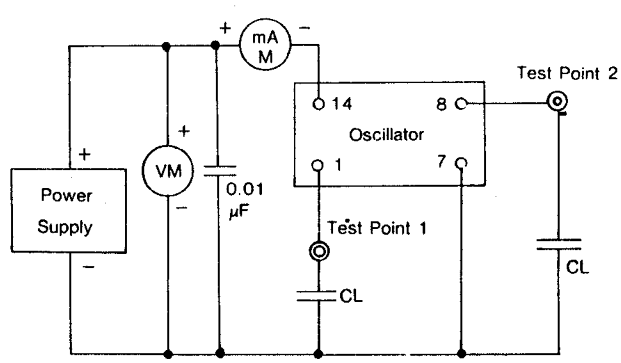
DIMENSIONS: in (mm)



PIN	CONNECTION
1	OUTPUT 1
7	GND. CKT & CASE
8	OUTPUT 2
14	+5Vdc

CMOS OUTPUT WAVE FORM





NOTE: CL, Total fixture and probe capacitance=50pF Max

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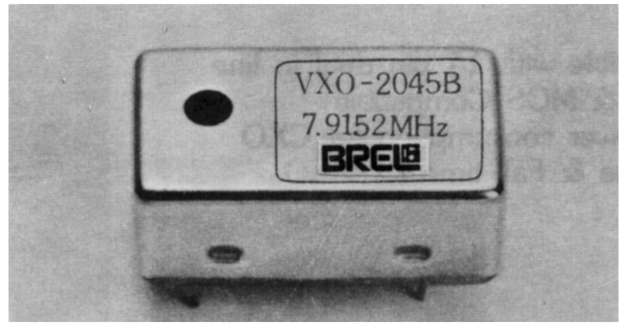
CLOCK OSCILLATOR – VARIABLE FREQUENCY TTL

For facsimile, computer controlled devides, etc

Features

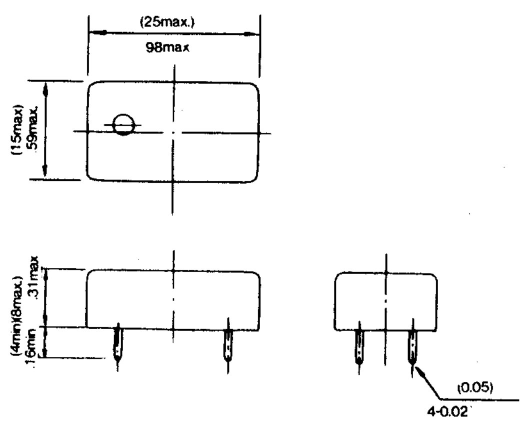
- TTL compatible
- High reliability
- Adjustable Frequency

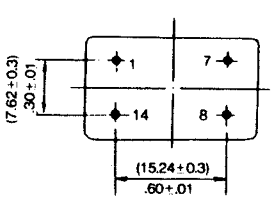


Model	VXO-2045A~C
Frequency range	2.0 MHz~30 MHz
Operating Temperature range	0°C~+50°C
Storage Temperature range	−55°C~+105°C
Supply Voltage	5.0VDC±5%
Supply Current	25 mA Max
Frequency stability	A; ±5ppm B; ±10ppm C; ±20ppm
Symmetry @ 1.4V level	45%~55%
Voh(logic "1")[Min]	2.4V
Vol(logic "0")[Max]	0.4V
Rise & Fall time(0.4 2.4VDC)	20 ns Max
Frequency adjustment	±20 ppm Min by internal trimmer
Fanout	1 to 2 TTL Gate

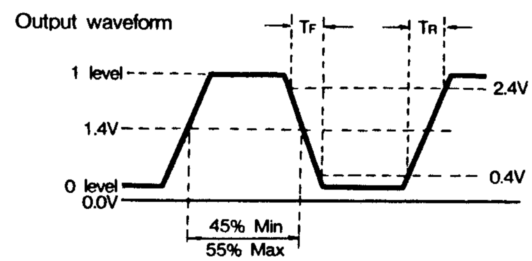
∗All specifications subject to change without notice

DIMENSION: in(mm)

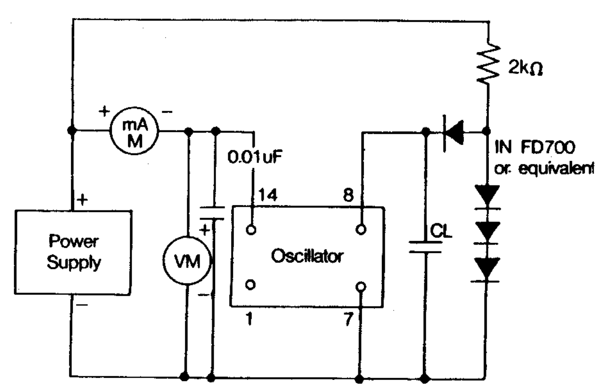




Pin connections
1 NC
7 Common and case
8 Output
14 +Vcc
Size in inc (mm)



TEST CIRCUIT



NOTE: CL, Total fixture and probe capacitance=15pF MAX

BREL INTERNATIONAL COMPONENTS
1621 WEST UNIVERSITY PARKWAY, SARASOTA, FL 34243
SALES: (800) 237-4564 PHONE: (941) 355-9791 FAX: (941) 355-1530

ORDER INFORMATION

FILL IN ONLY THOSE PARAMETERS REQUIRED

Name ______ Title ______
Company ______ Department ______
Address ______
Telex ______ Phone ______
Customer Specification DWG No ______ Date ______

1. CRYSTAL UNIT

☐Communication Equipment ☐Clock ☐Color TV
☐Microprocessor ☐TV Game ☐Others

Frequency ______ Holder ______
Freq. Tol. At. 25°C ______ ppm Drive Level ______ mW
Opet. Temp. Range – °C ~ + ℃ Freq. Tol. AT Oper. Temp. ______ ppm
Equivalent Series Resistance ______ ohm Shunt Capacitance ______ PF
Load Capacitance ______ PF Motional Capacitance ______ PF
Motional Inductance ______ Henry Oscillation Mode ______
Marking ______

2. CRYSTAL FILTER & MONOLITHIC CRYSTAL FILTER

☐Bandpass ☐Band Rejection ☐Single Side Band ☐Others

Center Frequency ______ No of Pole ______
Passbandwidth(Min)± ______ KHz/ ______ dB Stopbandwidth(Max)± ______ KHz/ ______ dB
Insertion Loss(Max) ______ dB Passband Ripple(Max) ______ dB
Attenuation Guaranteed fo± ______ KHz/ ______ dB
Termination Impedance ______ ohm// ______ PF Coupling Capacitance ______ PF
Spurious Response(Min) ______ dB Case ______

3. CLOCK OSCILLATOR

Model No ______ Nominal Frequency ______
Oper. Temp. Range ______ °C~+ ______ °C Frequency stability ______ ppm
Storage. Temp. Range – ______ °C~+ ______ °C Supply Voltage ______ VDC± ______ %
Supply Current(Max) ______ mA Symmetny @ 1.4V Level ______ / ______ %
Voh(Logic "1") [Min] ______ V Vol(Logic "0") [Max] ______ V
Rise & Fall Time(0.4V-2.4 VDC) ______ ns Max Fanout ______ gate