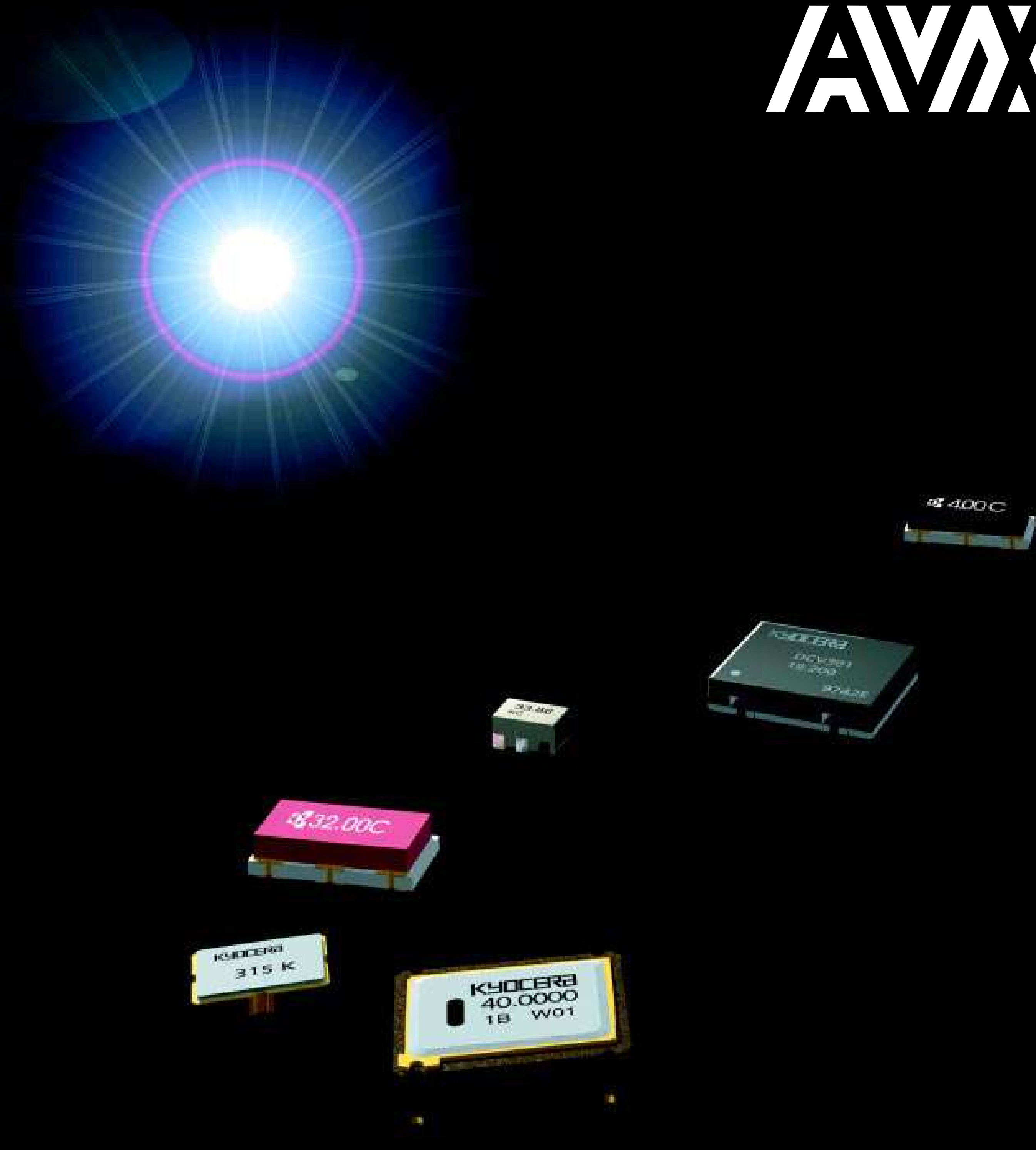


KYOCERA
Timing Devices
Resonators Crystals Oscillators

Table of Contents

CERAMIC RESONATORS

SURFACE ACOUSTIC WAVE RESONATORS

QUARTZ CRYSTALS

CLOCK OSCILLATORS

Timing Device Product Offering

QUARTZ CRYSTALS, RESONATORS and CLOCK OSCILLATORS

Product Name		Type	Oscillating Frequency (1KHz, 10KHz, 100KHz, 1MHz, 10MHz, 100MHz, 1GHz, 10GHz)	Applications
Quartz Crystal		Leaded	12.0M – 22.0M	Telecommunication
Quartz Crystal		SMD	12.0M – 22.0M	Telecommunication
Ceramic Resonator	KHz Band	Leaded	190k ~ 680k 795k ~ 815k 960k ~ 1050k	Micro Processor
Ceramic Resonator	KHz Band	SMD	380k ~ 430k 440k ~ 525k 600k ~ 655k 795k ~ 815k 960k ~ 1050k	Micro Processor
Ceramic Resonator	MHz Band	Leaded	1.92M – 40.0M	Micro Processor
Ceramic Resonator	MHz Band	SMD	2.0M – 60.0M	Micro Processor
Saw Resonator		Leaded	46M – 479M	RF Modulator Keyless Entry
Saw Resonator		SMD	300M – 479M	RF Modulator Keyless Entry
Clock Oscillator		Leaded	500k – 72M	Micro Processor
Clock Oscillator		SMD	8.0M – 68M	Micro Processor
Clock Oscillator	KT 11,12,14 Series	SMD	12.0M – 20.0M	Telecommunication

VOLTAGE CONTROLLED OSCILLATORS

Frequency: 500MHz, 1GHz, 1.5GHz, 2GHz

Series: VK Series, EK Series, YK Series, RK Series

Application Availability

Application	System	VK Series	EK Series	YK Series	RK Series
Cordless Phone	JPN	●			
Cordless Phone	CTI CTI+	●			
Cordless Phone	CTI CTI+		●		
Cordless Phone	PHS				●
Cordless Phone	DECT				●
Cordless Phone	CT2+				●
Low Power Transmitter	Transceiver LAN Remote Controller Control	●			
Low Power Transmitter	Wireless Microphone		●		
Cellular Phone	AMPS		●		
Cellular Phone	TACS		●		
Cellular Phone	NMT		●		
Cellular Phone	NTT		●		
Cellular Phone	PDC	●	●	●	
Cellular Phone	GSM			●	●
Cellular Phone	GSM		●		
Cellular Phone	US digital		●		
Cellular Phone	PCN			●	●
Satellite	GPS		●		
Satellite	GPS				●

kHz BAND CERAMIC RESONATORS

Part Series	Frequency Range	Type	Lead Configuration
KBR-Y	380 to 1050 kHz	SMT	Gull Wing Surface Mount
KBR-B	190 to 680 kHz	Std Q_m	Standard, Single-in-line, Formed Leads
KBR-BK	380 to 655 kHz	Std Q_m	Standard, Single-in-line
KBR-F	795 to 1050 kHz	High Q_m	Standard, Single-in-line
Specials	Per application	—	—

MHz BAND CERAMIC RESONATORS

Part Series	Frequency Range*	Type
PBRC-A	2.00 to 8.00 MHz	SMT without Capacitor
PBRC-B/D	2.00 to 36.00 MHz	SMT with Built-in Capacitor
SSR-B	16.00 to 60.00 MHz	Ultraminiature SMT with Built-in Capacitor
KBR-MS	2.00 to 3.57 MHz	Standard
KBR-MSA	3.58 to 8.00 MHz	Water resistant
KBR-MSB	3.58 to 6.00 MHz	“No-Clean” Process only
KBR-M	6.01 to 13.00 MHz	Standard
KBR-MY	13.01 to 16.00 MHz	CMOS
KBR-MSA	16.00 to 36.00 MHz	High Frequency Standard
KBR-MKS	3.58 to 8.00 MHz	Built-in Capacitor –Low Profile
KBR-MKC	3.58 to 8.00 MHz	Built-in Capacitor -“No-Clean” Process only
KBR-MKD	3.58 to 8.00 MHz, 16.00 to 36 MHz	Built-in Capacitor-Water resistant

*For additional frequencies consult factory.

GENERAL DESCRIPTION

AVX/Kyocera produces a broad range of high quality ceramic resonators covering both the kilohertz and megahertz frequency ranges. The high quality and extensive coverage of this product line allows optimum design of almost any oscillating circuit.

Ceramic resonators stand between quartz crystal oscillators and LC/RC oscillators in regard to accuracy but are considerably smaller, require no adjustments, have improved start-up times, and are low in cost.

Their oscillation is dependent upon mechanical resonance associated with their piezoelectric crystalline structure. These materials (usually barium titanate or lead-zirconium titanate, PZT) have large dipole movement which causes the distortion or growth of the crystal by an applied electric field. The resonance frequency depends on the vibration mode as shown in Figure 1.

A basic feedback circuit is shown in Figure 2. It consists of an amplifier with a 180° phase shift and attenuator. A negative polar output (volt) is obtained with an amplitude equal to the gain of the amplifier times the input voltage ($G \times V_{IN}$). After the signal goes through the feedback network with an attenuation ratio of ß, a negative polar wave equal to $ß \times (G \times V_{IN})$ is fed back to the input. If this feedback is greater than the initial input voltage (V_{IN}), oscillation will occur. This satisfies the two conditions necessary for oscillation:

1. $G \times ß > 1$
2. Phase cycle around the loop is an integral multiple of 360°.

Table I
Oscillators and Resonator Frequency Application

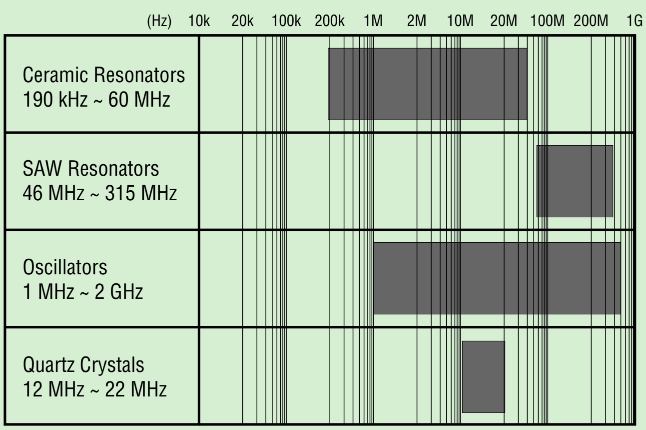


Table II
Timing Devices

Type	Symbol	Frequency Tolerance	Typical Frequency Stability	Relative Size	Cost
LC		±2%	±500ppm/°C	Largest	Low
RC		±1%	±100ppm/°C	Smallest	Low
Ceramic Resonator		±0.5%	±50ppm/°C	Next to Smallest	Low
Quartz Crystal		±0.002%	±1ppm/°C	Next to Largest	High

Figure 1: Vibration Modes vs Frequency

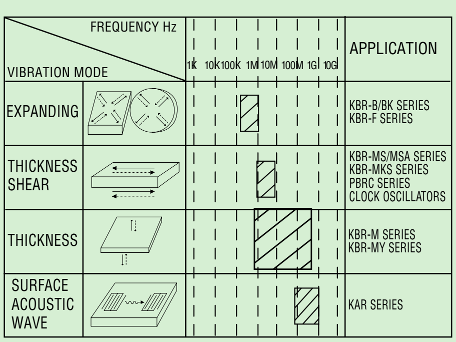


Figure 2: Basic Feedback Circuit

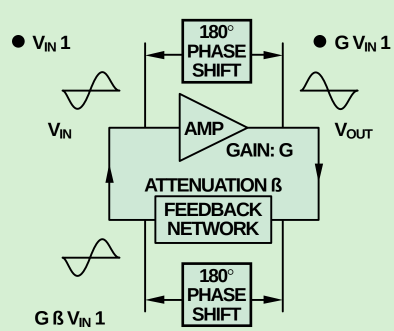
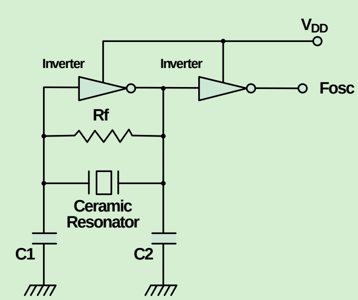


Figure 3: Oscillator Circuit



EXAMPLE

Inverter:	MC14069UBP
Vcc:	5 V.D.C.
Rf:	1M ohms
C1, C2:	100 pF (455 kHz Resonator)
	33 pF (4.00 MHz Resonator)

GENERAL DESCRIPTION continued

The mechanical vibration of a ceramic resonator can be represented by an equivalent electrical circuit consisting of L, C, and R's (Figure 4). The impedance and phase curves of a ceramic resonator are shown in Figure 5.

Between the resonant frequency (f_r) and the anti-resonant frequency (f_a), the ceramic resonator acts like an inductor with performance identical to a coil and a resistor (Figure 4-B). At other frequencies, it has capacitive characteristics (Figure 4-A).

The equivalent circuit parameters can be determined from the resonant and anti-resonant frequencies. These equations are shown in Table III with the equivalent circuit parameters of typical AVX/Kyocera resonators shown in Table IV.

Ceramic resonators have much lower Q_m and higher equivalent capacitances than crystal oscillators. Oscillation circuits of various I.C.'s can be either low (inverter) or high (Schmidt) gain.

Figure 4:
Electrical Equivalent Circuit

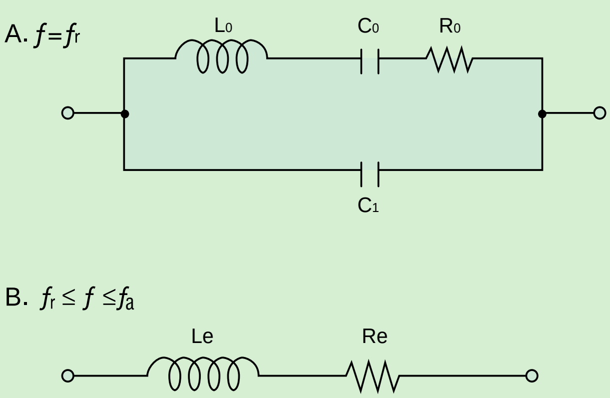


Figure 5:
Impedance and Phase Charts

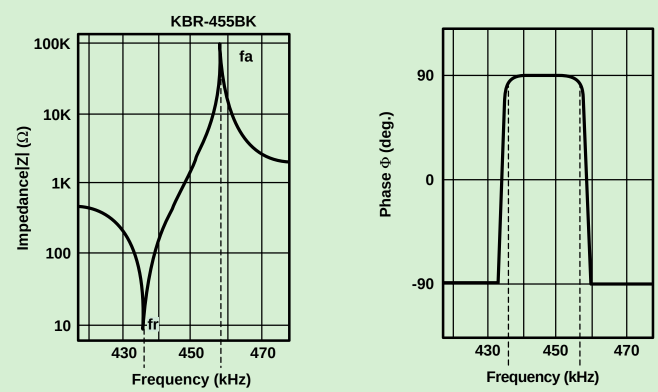


Table III: Equivalent Circuit Equations

$$f_r = \frac{1}{2\pi\sqrt{L_0C_0}}$$

$$f_a = \frac{1}{2\pi\sqrt{L_0C_0C_1/(C_0+C_1)}}$$

$$f_a = f_r\sqrt{1+\left(\frac{C_0}{C_1}\right)}$$

$$Q_m = \frac{1}{2\pi f_r R_0 C_0}$$

$$L_0 = \frac{1}{4\pi^2 f_r^2 C\left[1-\left(\frac{f_r}{f_a}\right)^2\right]}$$

$$C_0 = C\left[1-\left(\frac{f_r}{f_a}\right)^2\right]$$

where $C=C_0+C_1$

$$Q_m = \frac{1}{2\pi f_r R_0 C\left[1-\left(\frac{f_r}{f_a}\right)^2\right]}$$

Table IV: Typical Parameters of the Equivalent Circuit

	KBR-4.00MSA/MSB	KBR-455(BK)
R_0	8Ω	6Ω
L_0	318µH	3.2mH
C_0	5.4pF	43pF
C_1	42pF	360pF
Q_M	970	1600

APPLICATION AND TEST CIRCUITS

In some circuits, a feedback resistor (R_f, Figure 1) is required to allow oscillation to start when the power is initially applied. Its value is generally 1 MΩ in ceramic resonator circuits.

Special attention should be paid to the design of oscillator circuits, because they have a significant impact on the performance of the system. To determine proper circuit parameters, careful consideration must be given to each component's characteristics under normal and marginal working conditions. Recommended component values for various IC's and microprocessors are given in theAppendix "Application Circuits for Ceramic Resonators." These values should be checked in the actual operating circuit to confirm their performance over changing conditions of input voltage and temperature.

Figure 1:
CMOS Clock Generator 480kHz

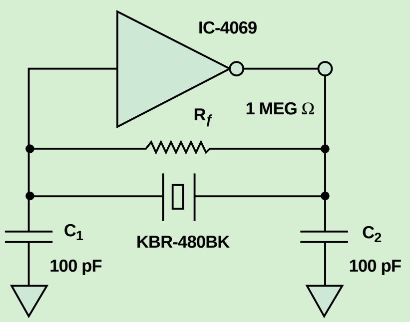


Figure 2:
Low Power Schottky

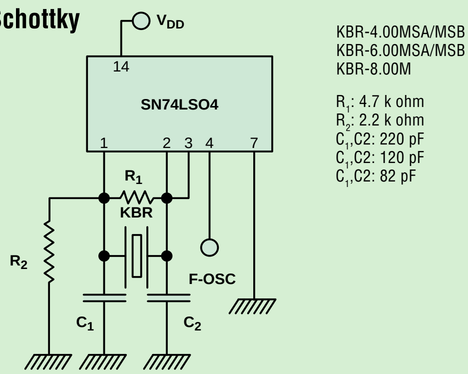


Figure 3:
4 Bit Microprocessor Clock

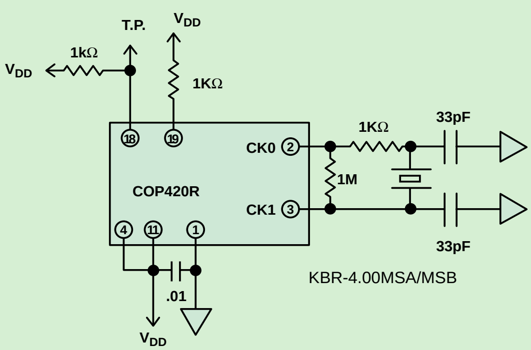


Figure 4:
Test Circuit Spurious Response

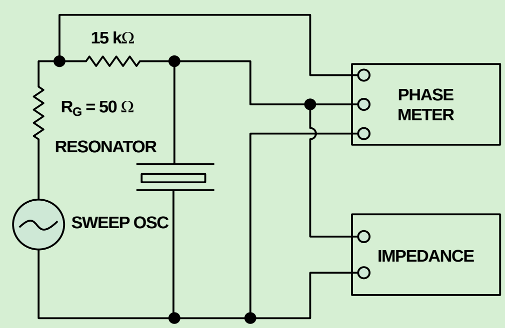
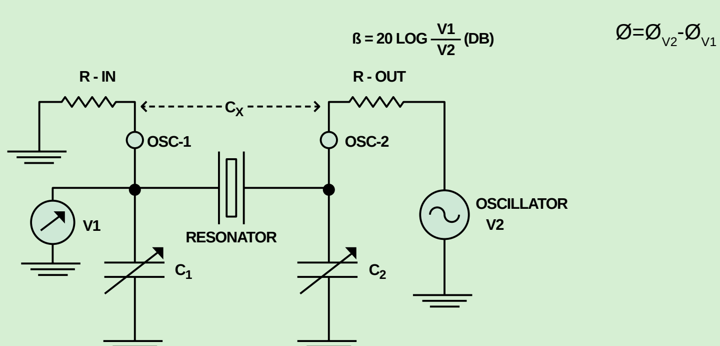


Figure 5:
Simulation Circuit



APPLICATION AND TEST CIRCUITS continued

The design of an oscillation circuit requires an accurate choice of circuit components to ensure oscillation within the specific voltage range of the IC (Figure 6). Semiconductor manufacturers' data books categorize V_H and V_L for both input and output requirements. The next stage of a design can be driven from either the IC input or output. Special attention should be paid to V_{IH} and V_{IL} or V_{OH} and V_{OL} depending upon where the next stage comes from the IC.

Oscillation frequency and amplitude depend upon the values of the external load capacitors (C_1, C_2). These effects are illustrated in Figures 7, 8 and 9. When the feedback ratio and the input oscillation amplitude are decreased too far, the circuit becomes vulnerable to external noise and might oscillate spuriously with the external noise.

There are some cases when a high gain IC or one with a wide non-linear range will give abnormal oscillation from sub-vibration of the resonator. This can be prevented by adding a damping resistor to decrease the feedback ratio or by increasing the load capacitance values. The spurious characteristics of typical AVX/Kyocera kHz and MHz resonators are shown in Figures 10 and 11.

Figure 6:
Oscillation Level

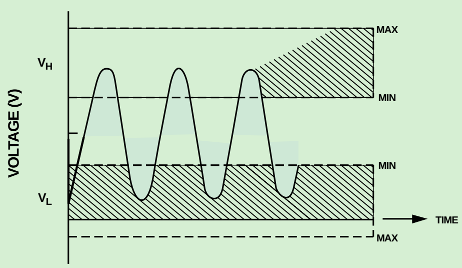


Figure 7:
Load Capacitor Effects

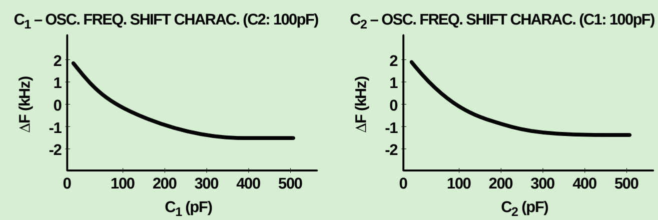


Figure 8:
C_2 Held Constant OSC Voltage Characteristics

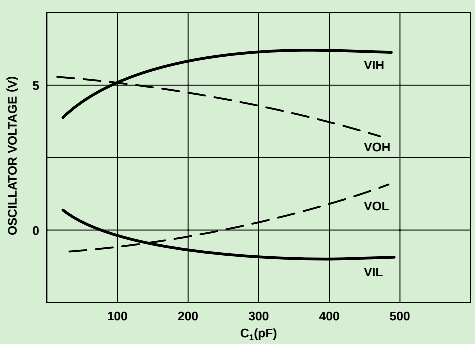


Figure 9:
C_1 Held Constant OSC Voltage Characteristics

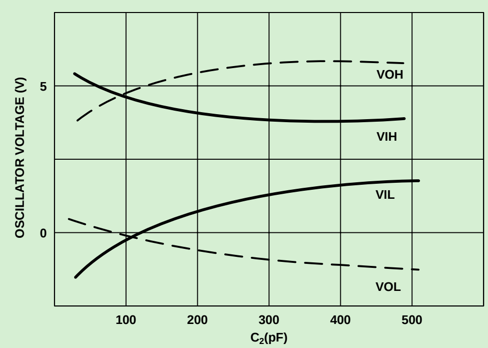


Figure 10:
kHz Spurious Response

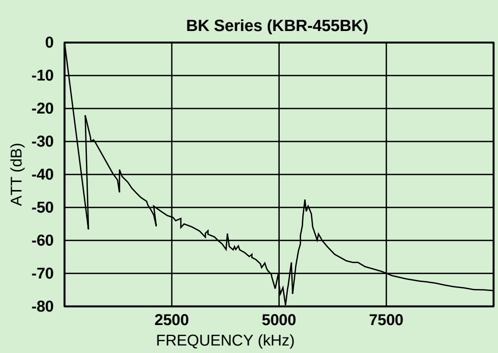
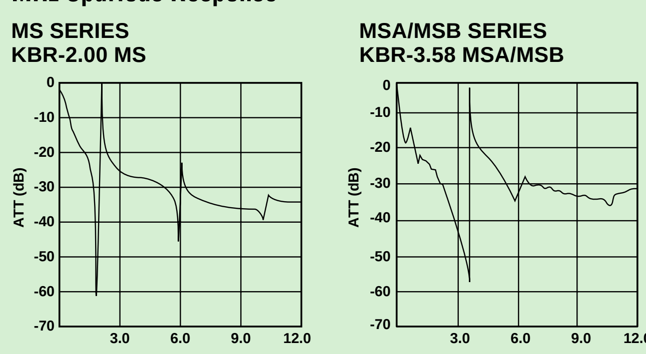


Figure 11:
MHz Spurious Response



Capacitor Built-In Type Chip

MHz Band Ceramic Resonators - SSR-B Series

FEATURES

1) World's smallest (2.1x3.2x1.5 mm)
2) High density mounting possible
3) Wide frequency range in same case size
4) 2000 pieces per reel
5) Sold in increments of 2000 pieces

HOW TO ORDER

SSR 33.86 B R

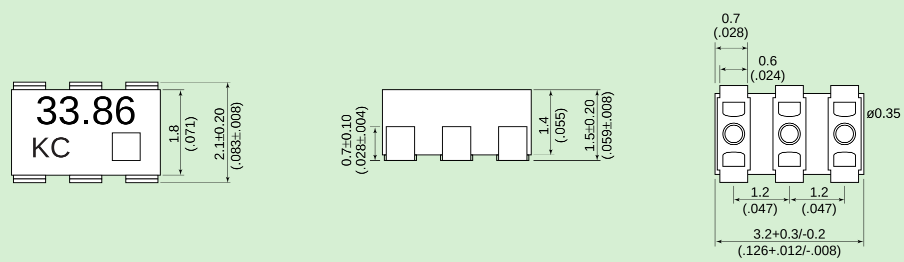
① ② ③ ④

① Type: (Super Small Resonator)
② Oscillating frequency
③ Resonator type: B = With capacitor
④ Packaging: R = Tape and reel

SPECIFICATIONS

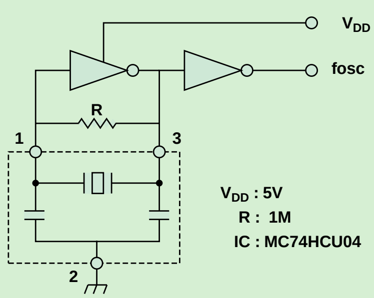
Frequency Range	Frequency Tolerance	Resonant Impedance	Temperature Stability (-20~80°C)	IC	Popular Frequencies
16~60MHz	±0.5%	100 max.	±0.3%	MC74HCU04 (MOTOROLA)	16, 25, 27, 29, 33.86, 40

DIMENSIONS

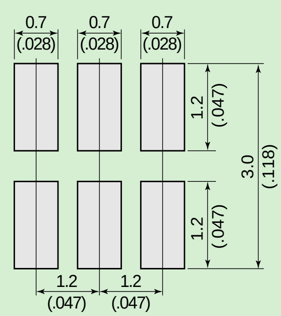


Units: mm (inches)

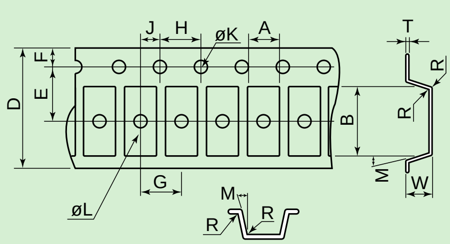
TEST CIRCUIT



RECOMMENDED LAND PATTERN



PACKAGING: TAPE and REEL



Symbol	A	B	D	E	F	G	H
Dimension	2.4	3.6	8.0	3.5	1.75	4.0	4.0
Symbol	J	K	L	M	R	W	T
Dimension	2.0	1.5	1.1	5° max.	0.3 max.	1.8	8.0

Unit: mm (inches)