COAXIAL RESONATORS

EXXELIA

COAXIAL RESONATORS

Thanks to its high know-how in ceramic material manufacturing, **EXXELIA** has developed its own coaxial resonator product line. These products are the poles of filter, oscillator and duplexer functions for Telecom, Military & Space, Industrial and Wireless applications

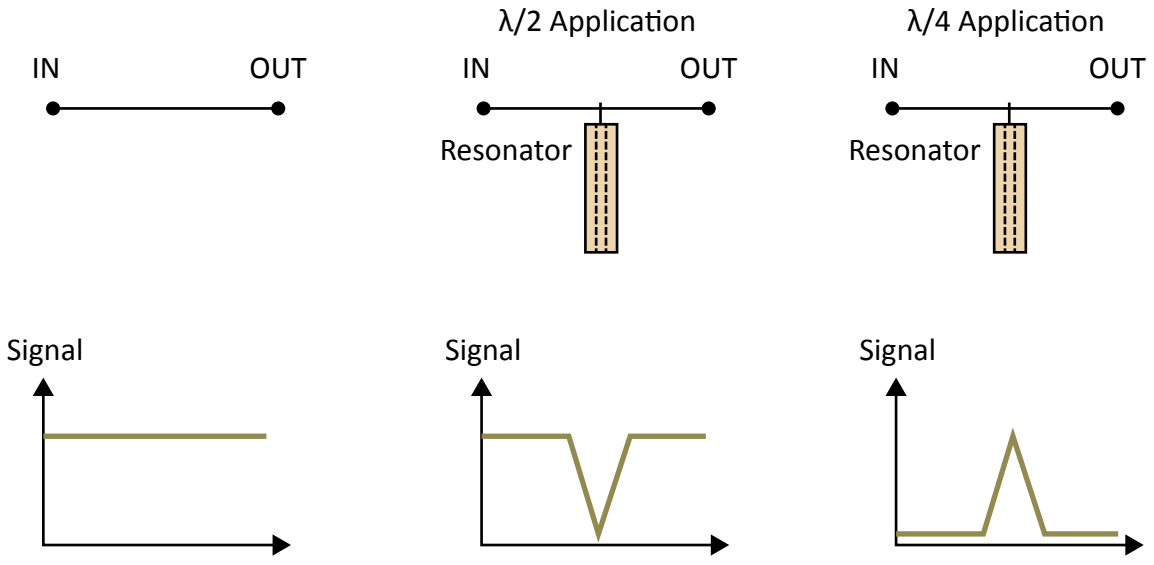
Coaxial resonators are designed to use the size-reducing effect of high dielectric constant materials in microwave functions such as VCOs (Voltage Controlled Oscillators), CROs (Coaxial Resonator Oscillators) and filters. Their use allows designers to get more compact devices.

I. BASIC PROPERTIES

Resonance effect origins

The most commonly used mode in many applications is the TEM (Transverse Electro-Magnetic) mode. Such mode has neither electric nor magnetic field in the direction of propagation. They are contained primarily within the metalized ceramic.

Let's consider a line in which a signal is sent through "IN" and received in "OUT". When a coaxial resonator is connected, this one allows or blocks (whether it is λ/2 or λ/4 configurations) microwave energy corresponding to its resonant frequency (see Figure 1).



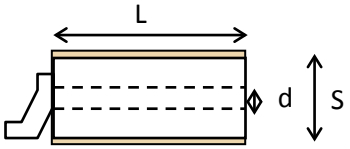
COAXIAL RESONATORS

Resonant frequency: f

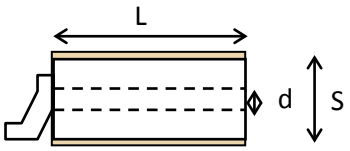
The frequency is governed by the length of the coaxial resonator. This length is usually close to a quarter or half wavelength of the required frequency. Resonators are then defined as either quarter or half wavelength type.

Quarter wavelength resonators have only one end metalized to "short-circuit" the center conductor to the external diameter conductor, whereas both ends are non-metalized on half wavelength types. Frequency is given by:

- λ/2 applications : $f = \frac{300}{2L\sqrt{e_r}}$



- λ/4 applications : $f = \frac{300}{4L\sqrt{e_r}}$



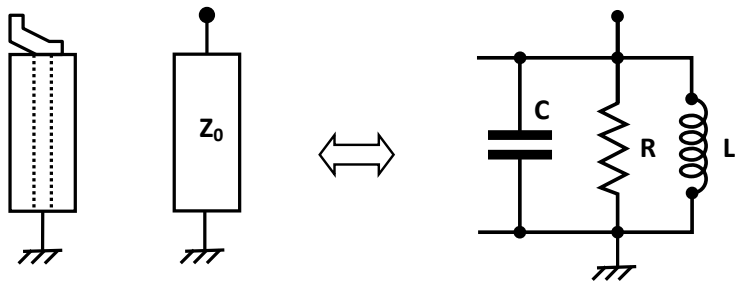
Where f is the resonant frequency (GHz), l the resonator length (mm) and εr the dielectric constant.

Useful simplified formulas are given in below table to determine the resonator length.

	λ/4 application	λ/2 application
εr = 21	$l = \frac{16.37}{f}$	$l = \frac{32.73}{f}$
εr = 38.5	$l = \frac{12.09}{f}$	$l = \frac{24.17}{f}$
εr = 45	$l = \frac{11.18}{f}$	$l = \frac{22.36}{f}$
εr = 55	$l = \frac{10.11}{f}$	$l = \frac{20.23}{f}$
εr = 90	$l = \frac{7.91}{f}$	$l = \frac{15.81}{f}$

Impedance: Z_0

The coaxial resonator impedance is directly linked to the section, the inner hole diameter and the dielectric constant of the material. An equivalent circuit is given by a common RLC circuit.



COAXIAL RESONATORS

For a λ/4 coaxial resonator, having a nominal frequency ƒ (MHz), a section S (mm), an inner hole diameter d (mm) and a dielectric constant εr, the lumped elements are given by:

$$l = \frac{2Z_0}{\pi^2 f} \qquad C = \frac{1}{8Z_0 f} \qquad R = \frac{4Z_0 Q}{\pi}$$

with

$$\begin{cases} Z_0 = \dfrac{60}{\sqrt{\varepsilon_r}} . Ln\left(1.079.\dfrac{S}{d}\right) \\ Q = 60.\dfrac{S\sqrt{f}}{25.4} \end{cases}$$

Quality factor: Q

What is essentially required by designers is the lowest bandwidth at 3dB giving a more selective frequency. This performance is directly given by the Q factor which is essentially determined by the Metallization. A thick film silver coating is then realized for excellent Q. Let's note that a low loss dielectric material does not influence at the first order the Q factor.

$$Q = 60.\frac{S\sqrt{f}}{25.4}$$

II. USER GUIDE

How to order "Commercial Models"

CRS	06	T	Q	1500	F	S	1	E	RoHS
Type Coaxial resonator	**Size** See table	**Material** V (ε_r 21) T (ε_r 38.5) K (ε_r 45) W (ε_r 55) N (ε_r 90)	**Application** Q : λ/4 H : λ/2	**Frequency (MHz)** See range in table	**Frequency tolerance** F = ±1% D = ±0.5% 5 = ±5 MHz 1 = ±1 MHz	**Metallization** S : Silver	**Connection** 0 : none 1 : one 2 : wire 4 : ribbon	**Tape & Reel** E : T&R Blank : none	**RoHs compliant**

How to order "Flight Models"

CRS	06	T	Q	1500	F	S	1	TRFxxx	RoHS
Type Coaxial resonator	**Size** See table	**Material** V (ε_r 21) T (ε_r 38.5) K (ε_r 45) W (ε_r 55) N (ε_r 90)	**Application** Q : λ/4 H : λ/2	**Frequency (MHz)** See range in table	**Frequency tolerance** F = ±1% D = ±0.5% 5 = ±5 MHz 1 = ±1 MHz	**Metallization** S : Silver	**Connection** 0 : none	**Hi-Rel**	**RoHs compliant**

Note: flight models are delivered with tab separately

Materials and applications

Our portfolio is designed to offer the highest degree of freedom to electronic engineers. Several dielectric constants are available (21/38.5/45/55/90) allowing the best trade-off between impedance, Q factor and resonant frequency.

Operating temperature range: -40°C / +85°C

COAXIAL RESONATORS

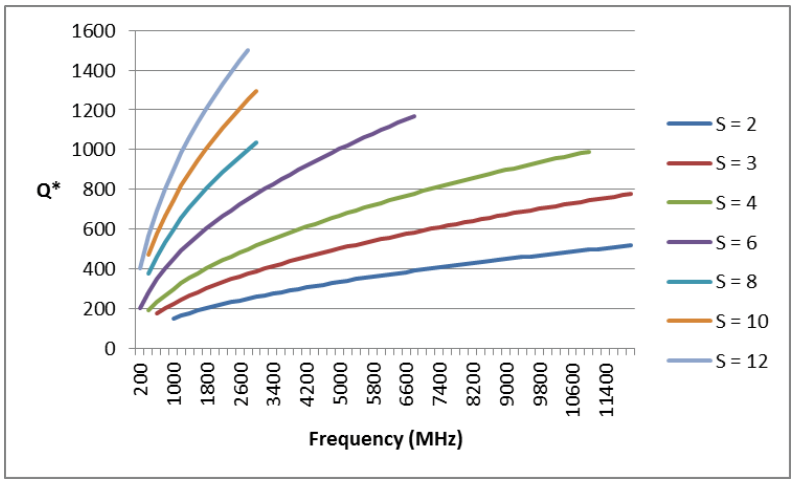
Frequency range and general characteristics

Dielectric constant	Temperature coefficient (ppm/°C)	Section		Frequency range (MHz) λ/4	Frequency range (MHz) λ/2	Q min
		(mm)	(inches)			
21	0 ± 15	2	(0.079)	2135-6000	4305-12000	200,0
		3	(0.118)	1335-6000	2730-12000	300,0
		4	(0.157)	870-5520	1735-11000	400,0
		6	(0.236)	650-3310	1365-6625	550,0
		8	(0.315)	915-3000	1890-3000	700,0
		10	(0.394)	915-3000	1890-3000	800,0
		12	(0.472)	670-2500	1365-3000	850,0
38.5	0 ± 15	2	(0.079)	1575-6000	3100-12000	200,0
		3	(0.118)	1005-4560	2050-9130	300,0
		4	(0.157)	660-4140	1315-8280	350,0
		6	(0.236)	490-2430	1000-4965	400,0
		8	(0.315)	690-3000	1420-3000	680,0
		10	(0.394)	690-3000	1420-3000	760,0
		12	(0.472)	505-2500	1050-2500	800,0
45	0 ± 15	2	(0.079)	1500-5500	3000-11000	180,0
		3	(0.118)	870-4000	1740-8000	280,0
		4	(0.157)	750-3500	1500-7000	300,0
		6	(0.236)	500-2200	1000-4400	350,0
		8	(0.315)	600-2500	1200-5000	550,0
		10	(0.394)	600-2500	1200-5000	650,0
		12	(0.472)	600-2500	1200-5000	750,0
55	0 ± 15	2	(0.079)	1400-5000	2800-10000	160,0
		3	(0.118)	800-3700	1600-7400	250,0
		4	(0.157)	700-3300	1400-6600	280,0
		6	(0.236)	450-2000	900-4000	350,0
		8	(0.315)	500-2400	1000-4800	500,0
		10	(0.394)	500-2400	1000-4800	620,0
		12	(0.472)	520-2000	1040-4000	700,0
90	0 ± 15	2	(0.079)	1040-3970	2100-7940	160,0
		3	(0.118)	650-2940	1315-5880	230,0
		4	(0.157)	410-2650	840-5300	250,0
		6	(0.236)	305-1590	630-3180	350,0
		8	(0.315)	410-1800	840-3000	460,0
		10	(0.394)	445-1800	895-3000	580,0
		12	(0.472)	330-1500	685-2500	640,0

Other frequencies on request

COAXIAL RESONATORS

Q factor



* Typical values

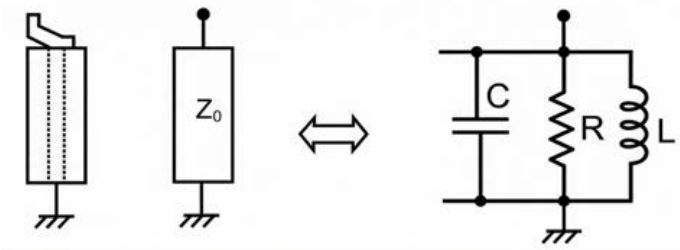
Dimensions and impedance

Section		Inner hole diameter		Impedance (Ω)					EXXELIA Reference
(± 0.2 mm)	(± 0.008")	(± 0.1 mm)	(± 0.004")	εr = 21	εr = 38.5	εr = 45	εr = 55	εr = 90	
2	(0.079)	0.65	(0.026)	15.7	11.6	10.7	9.7	7.6	CRS02
		0.80	(0.031)	13.0	9.6	8.9	8.0	6.3	CRS22
3	(0.118)	0.95	(0.037)	16.1	11.9	11.0	9.9	7.6	CRS03
4	(0.157)	1.20	(0.047)	16.8	12.4	11.4	10.4	8.1	CRS14
		1.50	(0.059)	13.8	10.2	9.5	8.6	6.7	CRS04
		2.00	(0.079)	10.1	7.4	6.9	6.2	4.9	CRS24
6	(0.236)	2.00	(0.079)	15.4	11.4	10.5	9.5	7.4	CRS06
		2.20	(0.087)	14.1	10.4	9.7	8.7	6.8	CRS16
		2.40	(0.094)	13.0	9.6	8.9	8.0	6.3	CRS26
		2.50 *	(0.098)*	12.5	9.2	8.5	7.7	6.0	CRS36
8	(0.315)	2.80	(0.110)	14.7	10.9	10.1	9.1	7.1	CRS08
10	(0.394)	3.50 *	(0.138)*	14.7	10.9	10.1	9.1	7.1	CRS10
12	(0.472)	3.50	(0.138)	17.1	12.6	11.7	10.6	8.3	CRS12
		4.00 *	(0.157)*	15.4	11.4	10.5	9.5	7.4	CRS412

* Connection not available

Connection dimensions

Section	2	3	4	6	8	10	12
L1 (± 0.1 mm)	0.65	0.70	0.80	1.20	1.50	N/A	2.00
L1 (± 0.004")	(0.026)	(0.028)	(0.031)	(0.047)	(0.059)	N/A	(0.079)
L2 (± 0.2 mm)	1.00	1.30	1.30	1.80	1.80	N/A	2.50
L2 (± 0.008")	(0.039)	(0.051)	(0.051)	(0.071)	(0.071)	N/A	(0.098)
e (± 0.1 mm)	0.40	0.50	0.60	0.80	0.80	N/A	1.00
e (± 0.004")	(0.016)	(0.020)	(0.024)	(0.031)	(0.031)	N/A	(0.039)



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