CRYSTAL FILTERS - Section Contents

SPECIFYING CRYSTAL FILTERS

A typical Crystal Filter specification reads like this:

45.0MHz ±7.5kHz ±15kHz 3 2 90 3k 20 UM1

- Centre Frequency, f_0
- Passband
- Stopband (dB)
- Insertion Loss (dB)
- Ripple
- Guaranteed Attenuation
- Terminating Impedances
- Operating Temperature Range
- Holder

Definitions

The following terms and definitions will aid you in specifying a filter for your application. **Please refer to p134 for a guide to ordering your filter.**

Centre Frequency (f_0)

- The arithmetic mean of the passband limits or the defined nominal frequency

Passband (BW1)

- The range of frequencies attenuated less than a specified value, typically 3dB or 6dB.

Stopband (BW2)

- The range of frequencies attenuated greater than a specified minimum level of attenuation, typically 40dB or 60dB.

Insertion Loss

- The loss at centre frequency or at the maximum transmission level normally expressed in dB as a result of inserting the filter into the circuit

Ripple

- The amplitude difference in dB between the maximum passband peak and the minimum passband valley. Both peak and valley are defined by a surrounding change in slope, i.e. The sign of the amplitude response.

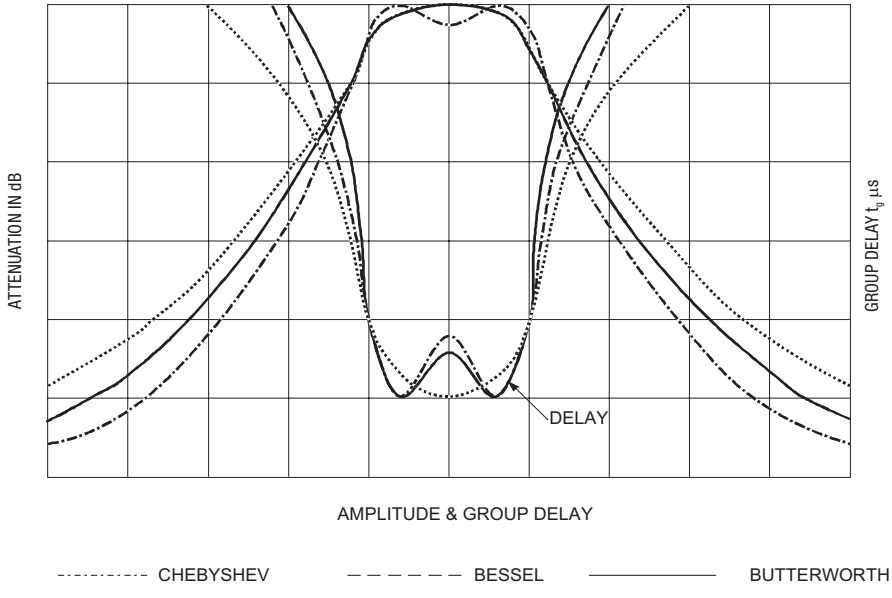
Guaranteed Attenuation

- A minimum attenuation in dB by which a specified frequency band either side of F_0 must be guaranteed.

Source & Load Impedance

- Source Impedance: The impedance driving the filter.

Attenuation and Group Delay Graph



- Load Impedance: The impedance of the circuit terminating the filter.

Shape Factor

- Ratio of bandwidths, normally stopband and passband of filter.

Spurious Attenuation

- The specified minimum level of attenuation received by all non-harmonic related resonances of each crystal resonator within the filter network.

Maximum Drive Level

- For continuous operation normally specified in dBm.

Linear Phase Characteristics

- The term phase shift is defined as 'phase shift of output voltage with respect to input voltage as a function of frequency'. There are two ways to specify this:-
  By directly defining the slope per segment of bandwidth
  $N_2 \leq$ Ndegrees/kHz $\leq N_1$
  or by the phase shift derivative with respect to frequency, i.e. Group Delay
  $$Tg = \frac{\varphi_2 - \varphi_1}{360 \times (f_2 - f_1)}$$
  where Tg = Group delay in seconds
  and φ_1 & φ_2 are phase shift at frequency f_1 & f_2 (measured in degrees and Hertz)

- The phase slope is proportional to the number of poles and inversly proportional to bandwidth. The 2nd order characteristic is dependant upon filter design i.e. Butterworth, Chebychev, Bessel, however for a given number of poles phase distortion will increase with selectivity.

- Phase linearity is a different parameter and is sensitive to ambiant conditions such as temperature, vibration & termination impedances.

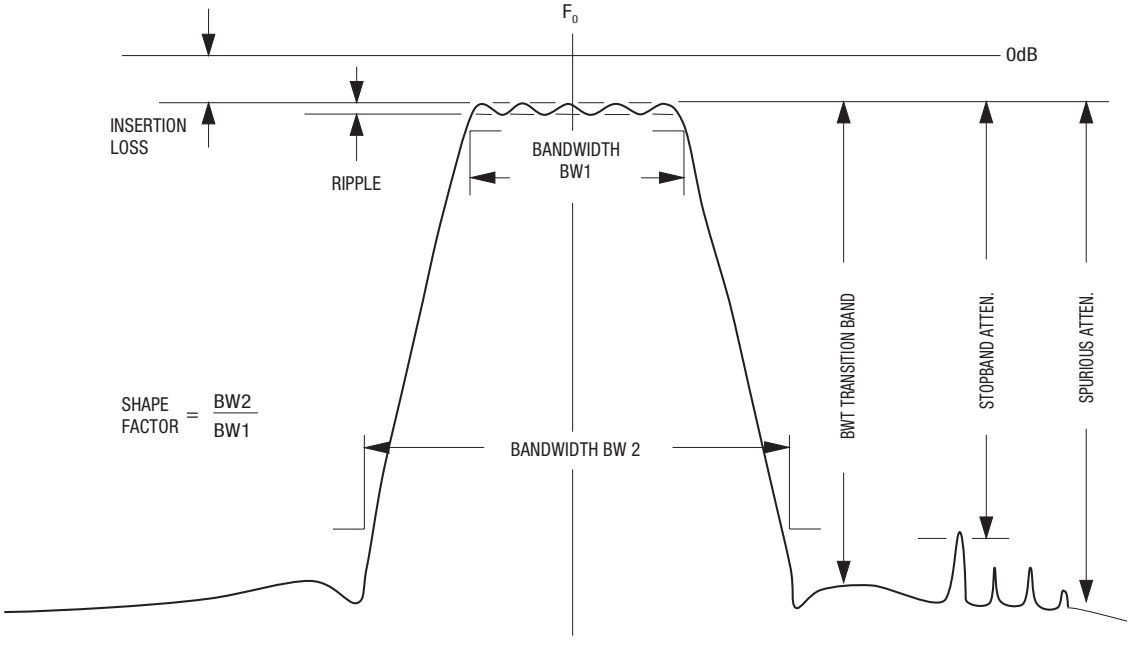
Inband Intermodulation Distortion

- The attenuation, in dB, of 3rd and higher order signal products, inband, relative to the power level of two signals placed within the passband.

Out of Band Intermodulation Distortion

- The attenuation, in dB, of 3rd and higher order signal products, inband, relative to the power level of two signals placed in the stopband, or one tone in the transition region and the other in the stopband.

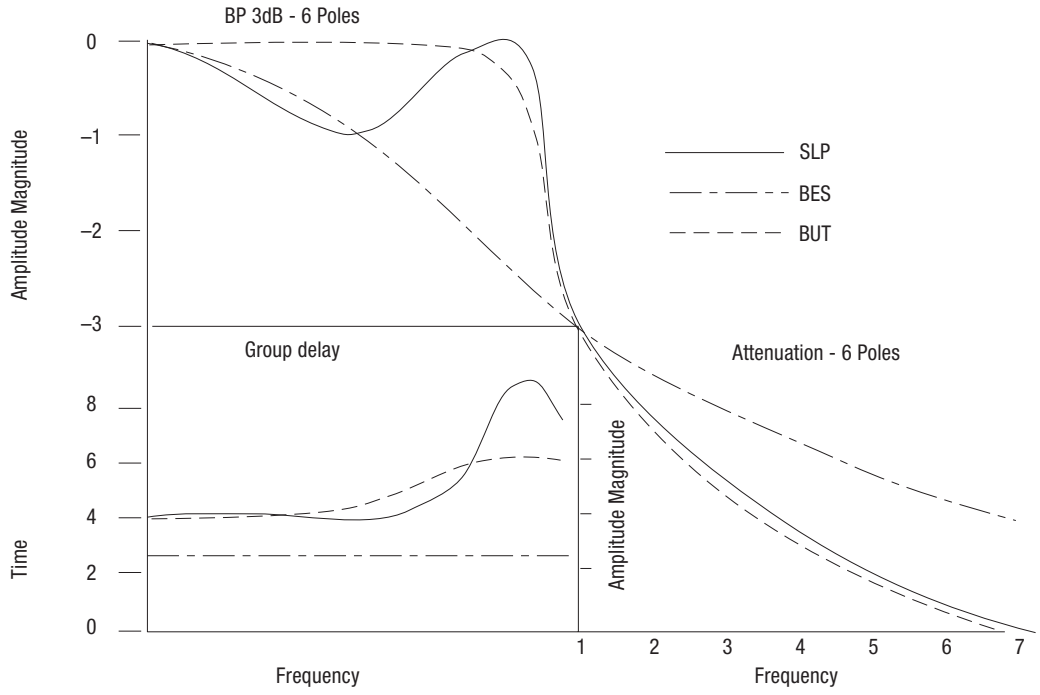
Filter Characteristics



Theoretical Characteristics

No. of poles	Type of filter	Magnitude shape factors for 10% phase linearity (theoretical values)				
		BA/BP	BU/BP	ONDUL. BU dB	BA/BU*	Notes
4	CHEB. 5	4	0.20	0.5	20	BP: pass band 3 dB
	CHEB. 1	4.5	0.40	0.1	11.2	
	S.L.P.	4.15	0.68	1.5	6.1	BU: 10% phase
	BUTTER	5.6	0.45	0	12.5	linearity band
	GAUSS6	7.1	1.75	14	7.1	
	BESSEL	8.5	1.18	5	8.5	BA: stop band 60 dB
6	CHEB. 5	2.1	0.15	0.5	13.8	*BA/BU (if BU <BP)
	CHEB. 1	2.3	0.50	0.1	4.6	
	S.L.P.	2.75	0.70	1.5	3.9	BA/BP (if BU >BP)
	BUTTER	3.15	0.50	0	6.3	
	GAUSS6	3.4	0.90	2.5	3.7	
	BESSEL	5.45	1.70	9.5	5.4	

No. of poles	Type of filter	Bandwidth relative group delay variation (%) (theoretical values)				
		0.3 × BP	0.6 × BP	0.9 × BP	1 × BP	Value of T at Fo T in seconds/BP in Hz
4	CHEB. 5	19.4	22.6	142	150	0.95/BP
	CHEB. 1	6.5	22.6	97	97	0.95/BP
	S.L.P.	5.3	6.4	112	125	1.03/BP
	BUTTER	4.7	23.2	51	51	0.83/BP
	GAUSS6	3	3	4.5	4.5	0.71/BP
	BESSEL	0	0	0	0	0.66/BP
6	CHEB. 5	18	30	120	232	1.53/BP
	CHEB. 1	6	24	116	160	1.54BP
	S.L.P.	2.2	2.2	116	210	1.44/BP
	BUTTER	3.1	18.8	66	67	1.24/BP
	GAUSS6	4	4	9.5	12	4.14/BP
	BESSEL	0	0	0	0	0.85/BP



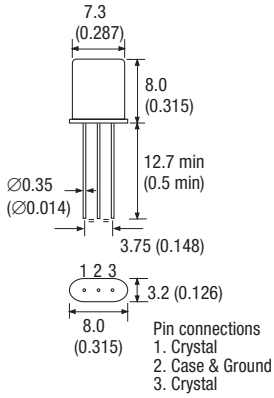
STANDARD CRYSTAL FILTERS

MONOLITHIC CRYSTAL FILTERS

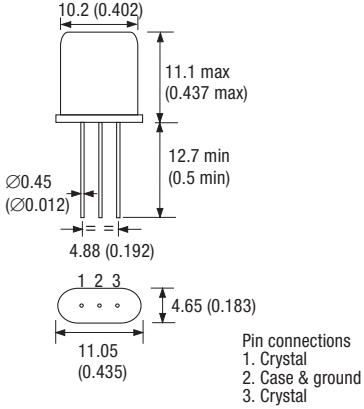
Model	Centre Frequency	Passband Width @ –3dB	Vibration Mode	Attenuation Bandwidth		Poles	Ripple (max.)	Ins. Loss (ax)	Terminating Impedance (Ω//pF)	Holder
IQXF-10M08A	10.7MHz	±3.75kHz	Fundamental	±12.5kHz	–18dB	2	1.0dB	2.0dB	1.5k//5	HC49/T
IQXF-10M15A	10.7MHz	±7.5kHz	Fundamental	±25.0kHz	–18dB	2	1.0dB	2.0dB	3k//2	HC49/T
IQXF-10M30A	10.7MHz	±15.0kHz	Fundamental	±50.0kHz	–18dB	2	0.5dB	2.0dB	5k//0	HC49/T
IQXF-21M07AU	21.4MHz	±3.75kHz	Fundamental	±18.0kHz	–20dB	2	0.5dB	1.5dB	850//6	UM1
IQXF-21M07BU	21.4MHz	±3.75kHz	Fundamental	±14.0kHz	–40dB	4	1.0dB	2.5dB	850//5	UM1 x 2
IQXF-21M15AU	21.4MHz	±7.5kHz	Fundamental	±25.0kHz	–18dB	2	0.5dB	1.5dB	1.5k//2	UM1
IQXF-21M15BU	21.4MHz	±7.5kHz	Fundamental	±25.0kHz	–40dB	4	1.0dB	2.5dB	1.5k//2	UM1 x 2
IQXF-21M30AU	21.4MHz	±15.0kHz	Fundamental	±45.0kHz	–15dB	2	0.5dB	1.5dB	3.0k/0.5	UM1
IQXF-21M30BU	21.4MHz	±15.0kHz	Fundamental	±50.0kHz	–40dB	4	1.0dB	2.5dB	3.0k//–0.5	UM1 x 2
IQXF-21M30C	21.4MHz	±15.0kHz	Fundamental	±50.0kHz	–65dB	6	2.0dB	2.5dB	2.2k//0.5	MF-61
IQXF-21M30D	21.4MHz	±15.0kHz	Fundamental	±50.0kHz	–80dB	8	2.0dB	2.0dB	2.2k//0.5	MF-61
IQXF-45K07AU	45.0MHz	±3.75kHz	Fundamental	±12.5kHz	–10dB	2	1.0dB	2.5dB	300//10	UM1
IQXF-45K07BU	45.0MHz	±3.75kHz	Fundamental	±12.5kHz	–30dB	4	1.0dB	4.0dB	300//8	UM1 x 2
IQXF-45K15AU	45.0MHz	±7.5kHz	Fundamental	±25.0kHz	–15dB	2	1.0dB	2.0dB	650//4.5	UM1
IQXF-45K15BU	45.0MHz	±7.5kHz	Fundamental	±25.0kHz	–30dB	4	1.0dB	3.0dB	600//1.5	UM1 x 2
IQXF-45K30AU	45.0MHz	±15.0kHz	Fundamental	±50.0kHz	–15dB	2	1.0dB	2.0dB	800//1.5	UM1
IQXF-45K30BU	45.0MHz	±15.0kHz	Fundamental	±60.0kHz	–40dB	4	1.0dB	3.0dB	800//1.0	UM1 x 2
IQXF-45M07AU	45.0MHz	±3.75kHz	3rd Overtone	±12.5kHz	–10dB	2	1.0dB	2.5dB	2.5k//–0.5	UM1
IQXF-45M07BU	45.0MHz	±3.75kHz	3rd Overtone	±12.5kHz	–30dB	4	1.0dB	4.0dB	2.5k//–0.5	UM1 x 2
IQXF-45M15AU	45.0MHz	±7.5kHz	3rd Overtone	±25.0kHz	–18dB	2	1.0dB	3.0dB	3k//0	UM1
IQXF-45M15BU	45.0MHz	±7.5kHz	3rd Overtone	±30.0kHz	–40dB	4	1.0dB	3.0dB	4k//–1.0	UM1 x 2
IQXF-45M20AU	45.0MHz	±10.0kHz	3rd Overtone	±30.0kHz	–15dB	2	1.0dB	2.0dB	5k//–1.0	UM1
IQXF-45M20BU	45.0MHz	±10.0kHz	3rd Overtone	±40.0kHz	–35dB	4	1.0dB	3.0dB	5k//–1.0	UM1 x 2
IQXF-45M30AU	45.0MHz	±15.0kHz	3rd Overtone	±50.0kHz	–15dB	2	1.0dB	2.0dB	8k//–1.0	UM1
IQXF-45M30BU	45.0MHz	±15.0kHz	3rd Overtone	±50.0kHz	–30dB	4	1.0dB	3.0dB	8k//–1.0	UM1 x 2
IQXF-91M15AU	90.0MHz	±7.5kHz	3rd Overtone	±30.0kHz	–15dB	2	1.0dB	2.0dB	1.4k//0	UM1
IQXF-91M15BU	90.0MHz	±7.5kHz	3rd Overtone	±25.0kHz	–25dB	4	1.0dB	3.5dB	1.4k//0	UM1 x 2
IQXF-91M20AU	90.0MHz	±10.0kHz	3rd Overtone	±40.0kHz	–15dB	2	1.0dB	2.0dB	1.5k//–1.0	UM1
IQXF-91M20BU	90.0MHz	±10.0kHz	3rd Overtone	±40.0kHz	–35dB	4	1.0dB	3.0dB	1.5k//–1.0	UM1 x 2
IQXF-91M30AU	90.0MHz	±15.0kHz	3rd Overtone	±50.0kHz	–15dB	2	1.0dB	2.0dB	4k//–1.0	UM1
IQXF-91M30BU	90.0MHz	±15.0kHz	3rd Overtone	±50.0kHz	–25dB	4	1.0dB	3.0dB	4k//–1.0	UM1 x 2

Please Note: Operating Temperature Range (for all filters shown above) is –20 to 70ºC
Please contact the Application Support Department for the value of the coupling capacitor

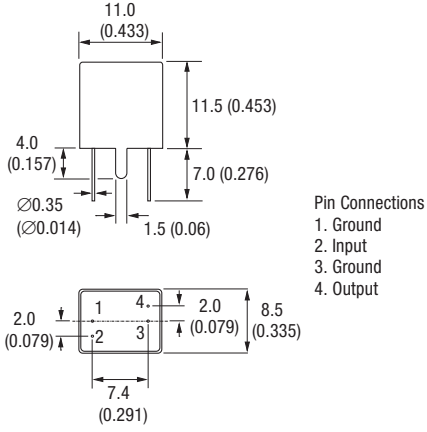
Outline in mm (inches) - UM1



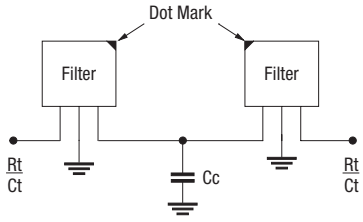
Outline in mm (inches) - HC49/T



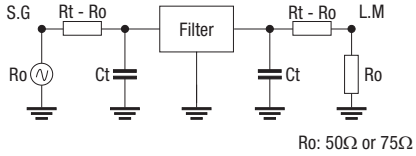
Outline in mm (inches) - MF61



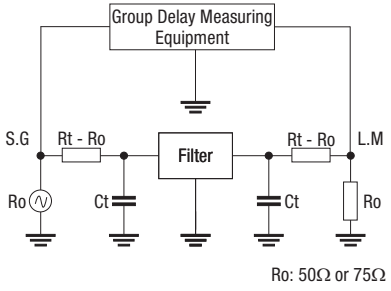
Test Circuits



Coupling Capacitance



Attenuation Measurement



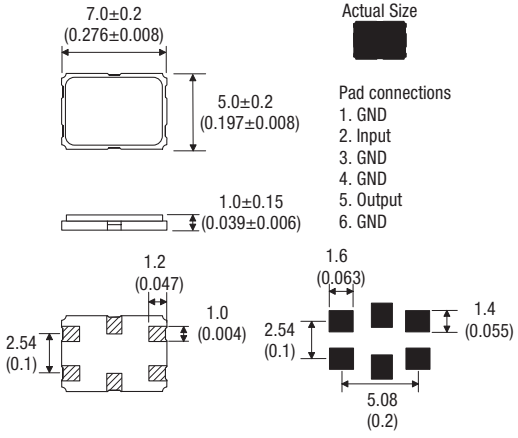
Group Delay Measurement

Surface Mount Monolithic Crystal Filters in a Ceramic Package

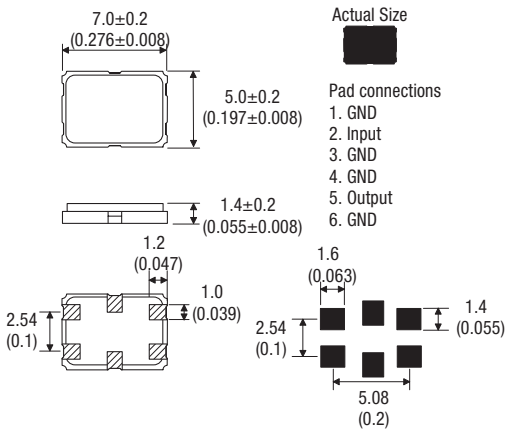
Model	Nominal Frequency	Passband Width @ –3dB	Attenuation Bandwidth		Ripple	Loss	Spurious	Guaranteed Attenuation	Terminating Impedance			Pole
									R	C1	C2	
CFPF-12	21.400MHz	±7.5kHz	18dB	±25.0kHz	1.0dB	2.0dB	10.0dB	70.0dB	1.5kΩ	2.5pF	—	2
CFPF-12	21.700MHz	±3.75kHz	18dB	±12.5kHz	1.0dB	2.0dB	18.0dB	70.0dB	850Ω	8.0pF	—	2
CFPF-12	21.700MHz	±7.5kHz	18	±25.0kHz	1.0dB	2.0dB	10.0dB	70.0dB	1.5kΩ	2.5pF	—	2
CFPF-13	45.000MHz	±7.5kHz	13	±25.0kHz	1.0dB	2.0dB	10.0dB	70.0dB	560Ω	6.0pF	—	2
CFPF-13	45.000MHz	±15.0kHz	15	±60.0kHz	1.0dB	3.0dB	3.0dB	70.0dB	1.2kΩ	0.0pF	—	2
CFPF-14	45.000MHz	±7.5kHz	25	±22.0kHz	1.0dB	3.0dB	40.0dB	80.0dB	800Ω	1.7pF	8.0pF	4
CFPF-14	45.000MHz	±10.0kHz	25	±25.0kHz	1.0dB	3.0dB	40.0dB	80.0dB	800Ω	1.7pF	7.0pF	4
CFPF-14	45.000MHz	±15.0kHz	35	±50.0kHz	1.0dB	3.0dB	40.0dB	80.0dB	800Ω	1.7pF	6.0pF	4
CFPF-13	73.350MHz	±10.0kHz*	15	±50.0kHz	1.5dB	5.0dB	15.0dB	70.0dB	600Ω	2.5pF	—	2
CFPF-13	90.000MHz	±4.0kHz	8	±12.5kHz	0.5dB	5.0dB	20.0dB	70.0dB	200Ω	8.0pF	—	2

*Please note: Passband Width is @ –1dB

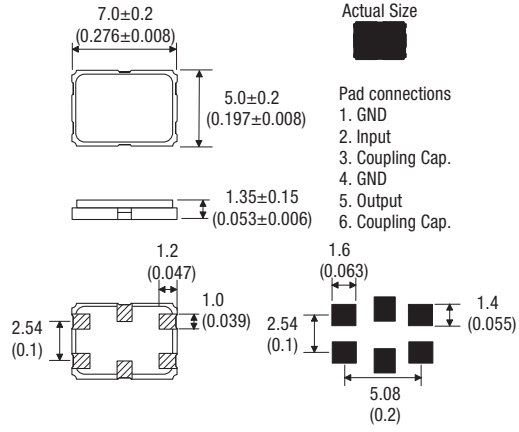
Outline in mm (inches) - CFPF-12 (scale 2:1)



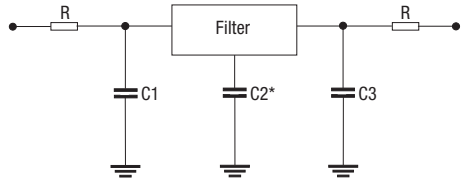
Outline in mm (inches) - CFPF-13 (scale 2:1)



Outline in mm (inches) - CFPF-14 (scale 2:1)



Test Circuit



*C2 is in circuit for CFPF-14 only

CRYSTAL FILTERS

Custom filter order form

Customer Filter Requirements Fax Form - Please copy form, fill out using BLOCK CAPITALS and fax to C-MAC on +44 (0)1460 72578					
x = Minimum Specification Information Required for Filter pricing					
Nominal Frequency (F_O)		x			MHz
Passband (Min)		x	dB	$F_o \pm$	kHz
Stopband (Max)		x	dB	$F_o \pm$	kHz
Insertion Loss		x			dB
Ripple (Peak to valley)		x	dB	$F_o \pm$	kHz
Guaranteed attenuation	dB		From F_o-	to F_o-	kHz
	dB		From F_o+	to F_o+	kHz
Terminating impedances	Source	x	Ω	pF	±pF
	Load	x	Ω	pF	±pF
Operating Temperature Range		x			°C
Holder style		x			
Spurious attenuation	dB		From F_o-	to F_o-	kHz
	dB		From F_o+	to F_o+	kHz
Input levels	Test level				dBm
	Max continous level				dBm
	Max level before damage				dBm
Group delay requirements			$F_o \pm$ (kHz)	µS	max
Intermodulation requirements	Test tone frequencies		f_1	f_2	MHz
	Test tone power level				dBm
	Third order IM product				dBm min
V.S.W.R. requirements			$F_o \pm$ (kHz)	dBm min	
Environmental Specification specification	Vibration (operational)				
	Vibration (non-operational)				
	Shock (non-operational)				
Additional Notes					
Name					
Job Title					
Company Name					
Address					
Postcode					
Telephone			E-mail		
Fax			http://		