

FOX ELECTRONICS

VOLUME TWENTY

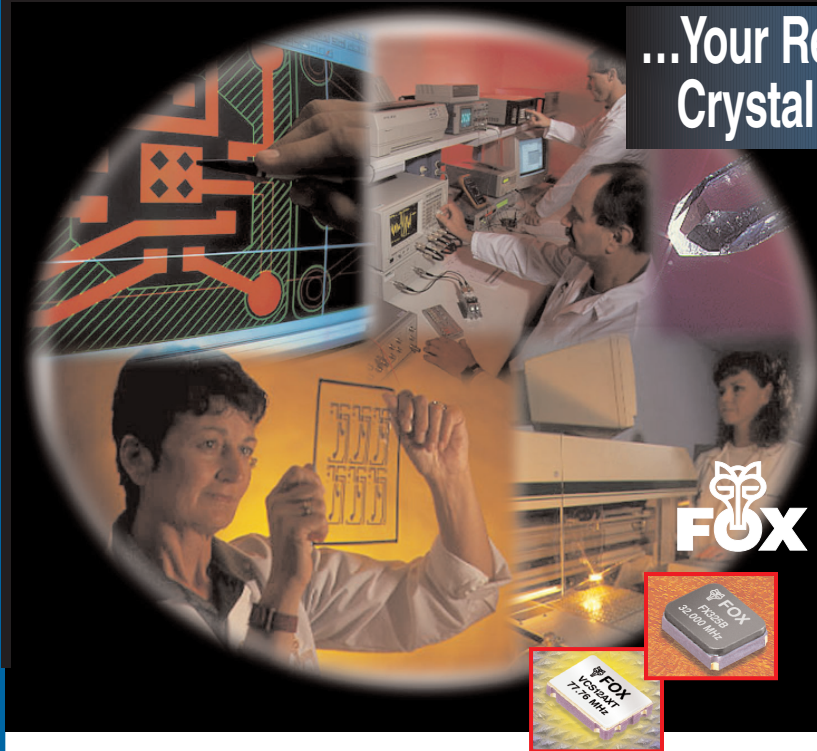
FREQUENCY CONTROL PRODUCTS

- CRYSTALS
- OSCILLATORS
- TCXOs
- VCXOs
- FILTERS



The Fox Customer Technology Center

...Your Resource for Custom Crystal and Oscillator Development



- *Application Specific Crystals, Oscillators, TCXOs, VCXOs and OCXOs*
- *Cost-Effective Development with Rapid Turnaround*
- *Engineered Solutions from Minor Modifications to Full Custom*
- *Dedicated Engineering Support Team for Your Application*
- *Advanced Frequency Control Expertise from the World Leader*

At Fox, we pride ourselves on offering the world's broadest range of standard, stocked, off-the-shelf crystals and oscillators. We also pride ourselves on knowing what the market needs. And we understand that, more and more, your applications may require a frequency control device with characteristics or capabilities that are not met by our standard offerings. That's why we've developed the Fox Customer Technology Center (CTC) ... as a resource for your special needs. Our new CTC is designed specifically to deliver cost-effective, fast-turn solutions to highly application-specific requirements for crystals, oscillators, TCXOs, VCXOs and OCXOs.

From tweaks to full custom

Your custom frequency control need may be for a slight modification to an existing product... a significant variation of a current product... or an entirely new concept never before offered, but just what you need for your unique application. Whatever it takes, the FOX CTC is prepared to tackle it. We'll evaluate your need and provide a candid response on what it will take to meet that need. And, if we simply can't do it, we'll

tell you that, too... and perhaps suggest another solution to the problem. Our application engineers are skilled at creating just the right solutions. If your application warrants it, we'll send a FOX FAE to your site to discuss the situation with you in person.

The Fox CTC has already proven to be a tremendous success: several innovative products have already been developed by the CTC, including a 77 MHz TCXO, which was designed, developed, produced, tested and shipped in a matter of days... rather than the four months quoted by our competitors!!

Engineered solutions for your application

At the heart of the Fox CTC is a powerful, focused engineering capability, representing an integration and expansion of our design engineering and customer support resources, and a significantly expanded Field Application Engineering staff. The CTC specializes in the development of TCXOs, VCXOs and OCXOs over a wide range of frequencies and output structures not previously addressed. The CTC also employs patented

technology for oscillator and RF applications up to 1.4 GHz, opening up new possibilities for highly engineered telecom and fiber optic products.

The CTC is supported by a newly formed Design Central, comprising the Fox's DEN (Design Engineering Network) and the Fox Customer Application Team (CAT). The latter is a dedicated, multi-discipline team consisting of the primary customer service person, technical supervisor, design engineer and marketing person serving that particular customer. On the production side, the CTC has extensive manufacturing tools at its disposal, including an expanded range of thick and thin film, laser, pick and place, wire bonding and wafer handling processes.

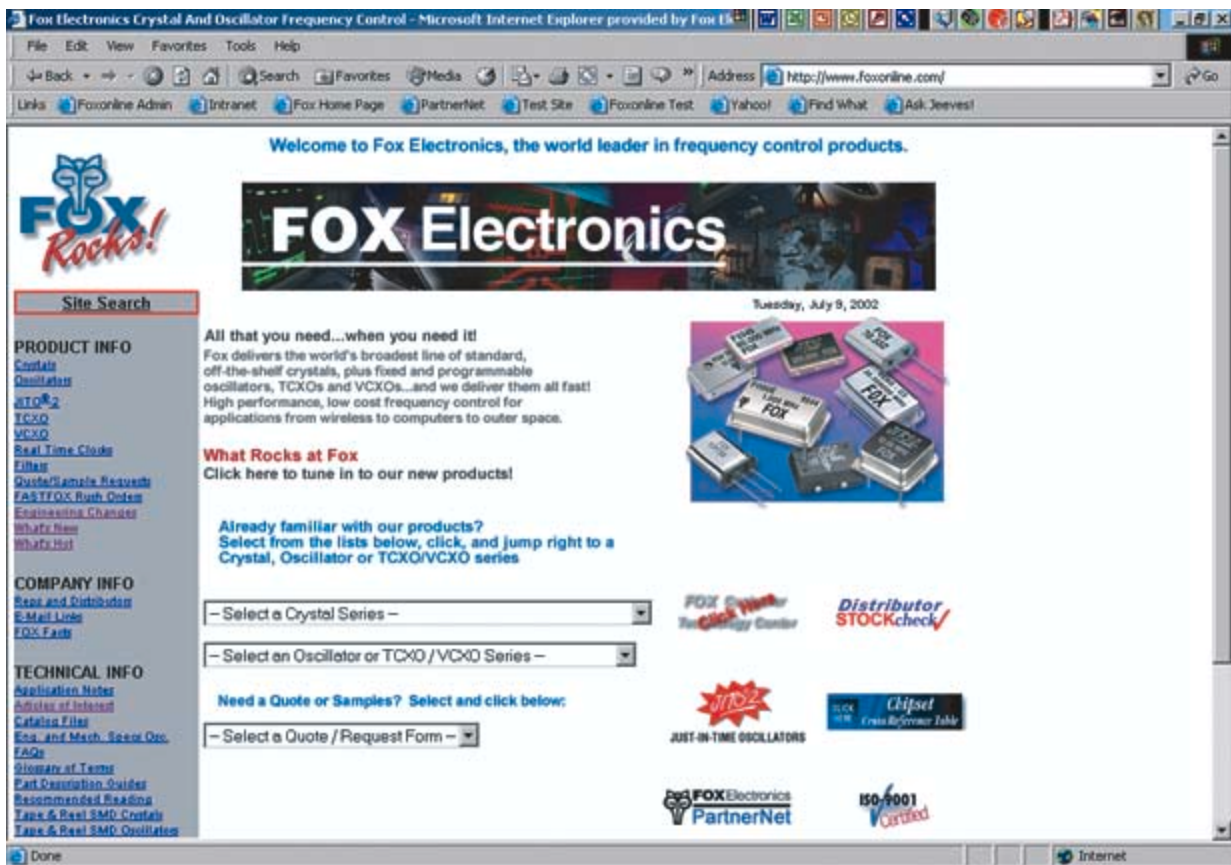
Our CTC is your resource!

No matter how unique your frequency control need may be, chances are high that it can be met at the Fox Customer Technology Center. Call us with your problem... or visit our CTC website at foxonline.com/ctc... and we'll provide the solution!

MISSION STATEMENT

Fox Electronics' mission is to provide a broad line of frequency control products to worldwide electronics markets. Combining the disciplines of engineering, manufacturing, quality assurance, operations, information systems and marketing, Fox strives to provide its customers with superior quality, excellent service, leading edge products and knowledgeable application support.

Regular updates and New Product Announcements are made on our web site. Visit <http://www.foxonline.com>



Fox Electronics has a staff of application specialists ready to help you. Contact our hotline

tech_support@foxonline.com

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DISTRIBUTOR BRIEFING

The Fox Distribution Program includes all of the Fox Part Numbers identified as DISTRIBUTOR STOCKING STANDARDS plus all of our JITO-2 product line. Fox franchised distributors maintain inventory of the STANDARDS to assure a constant supply to customers who design these items into their products. Of course, JITO-2 products are not maintained in inventory as they are 'built to order and schedule' for JIT delivery.

This STANDARDS PROGRAM is formalized in our distributor relationship and in our Contract Manufacturing relationships, providing maximum global flexibility to our OEM customers. Design engineers can be confident that a STANDARD oscillator or crystal will be available for future manufacturing needs. A check with the Fox website will reveal current address and phone number information for all of the authorized distributors in your area. The feature "StockCheck" on Fox's home page (www.foxonline.com) may be used to confirm distributor inventory. Fox global distributors may have regional marketing centers in certain areas of the world, easily located through the distributors' website.

Global Distribution



North American Distribution



European Distribution



Singapore Distribution



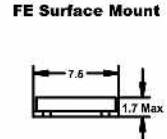
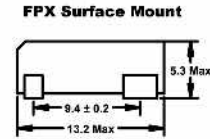
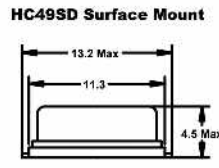
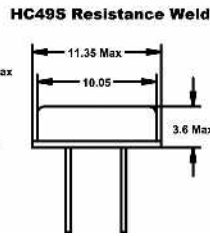
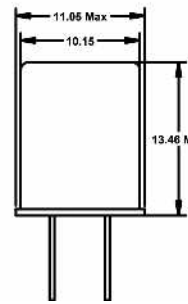
Australian Distribution



STANDARD CRYSTALS

HC49U Resistance Weld

- Inventory Support
- Standard Packages
- Lowest Pricing
- Fox Quality
- Technical Support



• FOX STANDARD SPECIFICATIONS				
PARAMETER	HC49U*	HC49S/49SD	FPX	FE
Frequency Tolerance @ 25°C	±30PPM	±30PPM	±50PPM	±50PPM
Frequency Stability	±50PPM	±50PPM	±100PPM	±50PPM
Operating Temperature Range	-20°C ~ +70°C	-20°C ~ +70°C	-10°C ~ +70°C	-10°C ~ +60°C

*Optional third lead, vinyl sleeves (HC49U only), and mylar spacer. All specifications subject to change without notice.

** Measurements are displayed in Millimeters.

Please Refer To Specification Sheets For Details

FREQ (MHz)	CL	HC49U	ESR W MAX	HC49S	ESR W MAX	HC49SD	ESR W MAX	FPX	ESR W MAX	FE	ESR W MAX
1.843200	13pF	FOX018S	800	---	---	---	---	---	---	---	---
2.000000	20pF	FOX020S	500	---	---	---	---	---	---	---	---
2.097152	20pF	FOX021S	500	---	---	---	---	---	---	---	---
2.457600	32pF	FOX024S	300	---	---	---	---	---	---	---	---
3.579545	18pF	FOX036S	120	FOXS/036S	200	FOXSD/036S	200	FPX036S	200	---	---
3.686400	SERIES	FOX0368S	120	FOXS/0368S	200	---	---	FPX0368S	200	---	---
3.686400	20pF	FOX0368-20	120	FOXS/0368-20	200	FOXSD/0368-20	200	FPX0368-20	200	---	---
4.000000	SERIES	FOX040A	100	FOXS/040A	150	---	---	FPX040A	150	---	---
4.000000	20pF	FOX040	100	FOXS/040	150	FOXSD/040	150	FPX040	150	---	---
4.096000	20pF	FOX0496-20	100	FOXS/0496-20	150	---	---	---	---	---	---
4.194304	12pF	FOX041	100	FOXS/041	150	FOXSD/041	150	---	---	---	---
4.433619	20pF	FOX0443	70	FOXS/0443	150	FOXSD/0443	150	---	---	---	---
4.915200	SERIES	FOX049	55	FOXS/049	150	---	---	FPX049	150	---	---
4.915200	20pF	FOX049-20	55	FOXS/049-20	150	FOXSD/049-20	150	FPX049-20	150	---	---
5.000000	20pF	FOX05A	50	---	---	FOXSD/05A	120	---	---	---	---
6.000000	SERIES	FOX060	40	---	---	---	---	---	---	---	---
6.000000	20pF	FOX060-20	40	---	---	FOXSD/060-20	120	---	---	---	---
6.144000	30pF	FOX061	40	---	---	---	---	---	---	---	---
6.144000	20pF	FOX061-20	40	---	---	---	---	---	---	---	---
7.372800	SERIES	FOX073	40	FOXS/073	80	---	---	FPX073	80	---	---
7.372800	20pF	FOX073-20	40	FOXS/073-20	80	FOXSD/073-20	80	FPX073-20	80	---	---
8.000000	SERIES	FOX080	35	FOXS/080	80	---	---	FPX080	80	---	---
8.000000	20pF	FOX080-20	35	FOXS/080-20	80	FOXSD/080-20	80	FPX080-20	80	---	---
8.192000	SERIES	FOX081	35	---	---	---	---	---	---	---	---
8.192000	20pF	FOX081-20	35	FOXS/081-20	80	FOXSD/081-20	80	FPX081-20	80	---	---
9.216000	SERIES	FOX092	35	---	---	---	---	---	---	---	---
9.830400	SERIES	FOX098	35	FOXS/098	60	---	---	---	---	---	---
9.830400	20pF	FOX098-20	35	FOXS/098-20	60	FOXSD/098-20	60	FPX098-20	60	FE098-20	60
10.000000	SERIES	FOX100	30	FOXS/100	60	---	---	FPX100	60	---	---
10.000000	20pF	FOX100-20	30	FOXS/100-20	60	FOXSD/100-20	60	FPX100-20	60	FE100-20	60
11.000000	SERIES	FOX111	30	---	---	---	---	---	---	---	---
11.000000	20pF	FOX111-20	30	FOXS/111-20	60	FOXSD/111-20	60	FPX111-20	60	---	---
11.059200	20pF	FOX115-20	30	FOXS/115-20	60	FOXSD/115-20	60	FPX115-20	60	FE115-20	60
12.000000	SERIES	FOX120	30	FOXS/120	60	---	---	FPX120	60	---	---
12.000000	20pF	FOX120-20	30	FOXS/120-20	60	FOXSD/120-20	60	FPX120-20	60	---	---
12.288000	20pF	FOX128-20	30	FOXS/128-20	60	FOXSD/128-20	60	FPX128-20	60	---	---
14.318180	20pF	FOX143-20	25	FOXS/143-20	40	FOXSD/143-20	40	FPX143-20	40	FE143-20	60
14.745600	20pF	FOX147-20	25	FOXS/147-20	40	FOXSD/147-20	40	FPX147-20	40	FE147-20	60
15.000000	20pF	---	---	---	---	---	---	---	---	FE150-20	60
16.000000	SERIES	FOX160	25	FOXS/160	40	---	---	FPX160	40	---	---
16.000000	20pF	FOX160-20	25	FOXS/160-20	40	FOXSD/160-20	40	FPX160-20	40	FE160-20	60
18.432000	SERIES	FOX184	20	---	---	---	---	---	---	---	---
18.432000	20pF	FOX184-20	20	FOXS/184-20	40	FOXSD/184-20	40	FPX184-20	40	---	---
19.660800	SERIES	FOX196	20	---	---	---	---	---	---	---	---
19.660800	20pF	FOX196-20	20	FOXS/196-20	40	FOXSD/196-20	40	FPX196-20	40	---	---
20.000000	SERIES	FOX200	20	FOXS/200	30	---	---	FPX200	30	---	---
20.000000	20pF	FOX200-20	20	FOXS/200-20	30	FOXSD/200-20	30	FPX200-20	30	FE200-20	40
22.118400	20pF	FOX221-20	20	FOXS/221-20	30	FOXSD/221-20	30	FPX221-20	30	FE221-20	40
24.000000	20pF	FOX240F-20	20	FOXS/240F-20	30	FOXSD/240F-20	30	FPX240F-20	30	FE240F-20	40
24.576000	20pF	FOX245F-20	20	FOXS/245F-20	30	FOXSD/245F-20	30	FPX245F-20	30	FE245F-20	40
25.000000	20pF	FOX250F-20	20	FOXS/250F-20	30	FOXSD/250F-20	30	FPX250F-20	30	FE250F-20	40
27.000000	20pF	---	---	---	---	FOXSD/270F-20	30	---	---	---	---
32.000000	20pF	FOX320-20 *	40	---	---	FOXSD/320-20 *	100	FPX320-20 *	100	---	---
48.000000	20pF	FOX480-20 *	40	---	---	FOXSD/480-20 *	100	FPX480-20 *	100	---	---
50.000000	20pF	FOX500-20 *	40	---	---	FOXSD/500-20 *	100	FPX500-20 *	100	---	---
56.448000	18pF	---	---	---	---	FOXSD/564-18 *	100	---	---	---	---
60.000000	20pF	FOX600-20 *	40	---	---	FOXSD/600-20 *	100	FPX600-20 *	100	---	---
64.000000	20pF	FOX640-20 *	40	---	---	FOXSD/640-20 *	100	FPX640-20 *	100	---	---

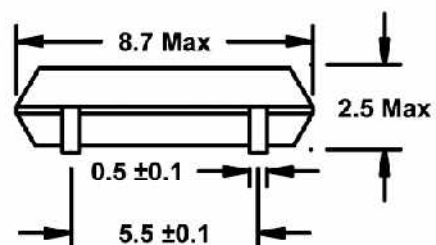
* 3rd Overtone. "F" suffix denotes fundamental Rev. 05/01/02

STANDARD WATCH CRYSTALS

• FOX STANDARD SPECIFICATIONS

PARAMETER	FSR327
Frequency	32.768 kHz
Frequency Tolerance	±20PPM
Frequency Stability	-0.04 PPM/(Δ°C) ²
Operating Temperature Range	-40°C ~ +85°C
Load Capacitance	12.5 pF
Drive Level	1.0 μW

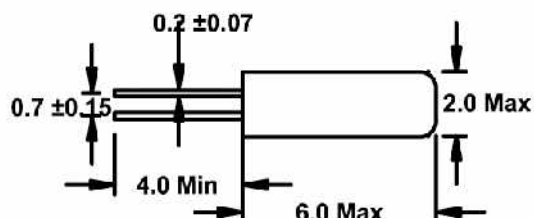
FSR327



• FOX STANDARD SPECIFICATIONS

PARAMETER	NC26
Frequency	32.768 kHz
Frequency Tolerance	±20PPM
Frequency Stability	-0.04 PPM/(Δ°C) ²
Operating Temperature Range	-20°C ~ +60°C
Load Capacitance	12.5 pF
Drive Level	1.0 μW

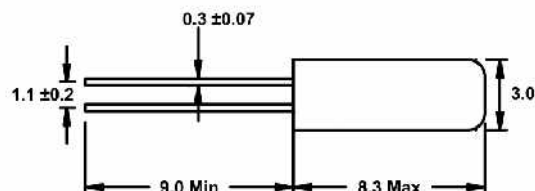
NC26



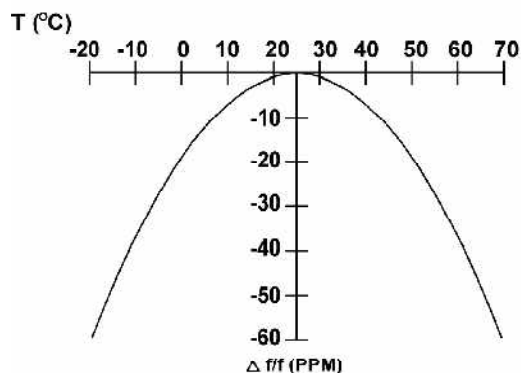
• FOX STANDARD SPECIFICATIONS

PARAMETER	NC38
Frequency	32.768 kHz
Frequency Tolerance	±20PPM
Frequency Stability	-0.04 PPM/(Δ°C) ²
Operating Temperature Range	-20°C ~ +60°C
Load Capacitance	12.5 pF
Drive Level	1.0 μW

NC38



Parabolic Temperature Curve



To determine frequency stability, use parabolic curvature (K).
For example: What is stability at 45°C?

- 1) Change in T (°C) = 45-25 = 20°C
- 2) Change in frequency = -0.04 PPM * (Δ C)²
= -0.04 PPM * (20)²
= -16.0 PPM

STANDARD OSCILLATORS

DISTRIBUTOR STOCKING ITEMS

- Inventory Support
- Standard Packages
- Lowest Pricing
- Fox Quality
- Technical Support



• FOX STANDARD SPECIFICATIONS							
PARAMETER	F1100E	F5C-2E	H5C-2E	KFO90AT	F3345	F4100	F4105/F4106
Voltage	5V	5V	5V	5V	5V	3.3V	3.3V
Frequency Stability	100PPM	±100PPM	±100PPM	±100PPM	±100PPM	±100PPM	±50 / ±25PPM
Operating Temperature Range	0°C ~ +70°C	0°C ~ +70°C	0°C ~ +70°C	-10°C ~ +70°C	-10°C ~ +70°C	-10°C ~ +70°C	-10°C ~ +70°C
Output	TTL	HCMOS	HCMOS	HCMOS	HCMOS	HCMOS	HCMOS

FREQUENCY (MHz)	F1100E	F5C-2E	H5C-2E	F3345	F4100	F4105 / F4106	KFO90AT	JTO-2 JITTER-TIME OSCILLATOR
1.000000	F1100E-010		H5C2E-010					JITO-2
1.843200	F1100E-018			F3345-018	F4100-018		KFO-018	JITO-2
2.000000	F1100E-020						KFO-020	JITO-2
2.457600	F1100E-024							JITO-2
3.686400	F1100E-0368		H5C2E-0368		F4100-0368			JITO-2
4.000000	F1100E-040				F4100-040		KFO-040	JITO-2
6.000000	F1100E-060							JITO-2
7.372800	F1100E-073							JITO-2
8.000000	F1100E-080	F5C2E-080	H5C2E-080	F3345-080			KFO-080	JITO-2
10.000000	F1100E-100	F5C2E-100			F4100-100		KFO-100	JITO-2
11.059200	F1100E-115							JITO-2
12.000000	F1100E-120	F5C2E-120		F3345-120			KFO-120	JITO-2
14.318180	F1100E-143			F3345-143	F4100-143	F4105-143	KFO-143	JITO-2
14.745600	F1100E-147							JITO-2
16.000000	F1100E-160	F5C2E-160	H5C2E-160	F3345-160	F4100-160		KFO-160	JITO-2
18.432000	F1100E-184				F4100-184			JITO-2
20.000000	F1100E-200	F5C2E-200	H5C2E-200	F3345-200	F4100-200	F4105-200	KFO-200	JITO-2
24.000000	F1100E-240	F5C2E-240		F3345-240			KFO-240	JITO-2
25.000000	F1100E-250	F5C2E-250	H5C2E-250	F3345-250	F4100-250	F4105-250		JITO-2
32.000000	F1100E-320	F5C2E-320	H5C2E-320	F3345-320	F4100-320	F4105-320	KFO-320	JITO-2
33.333000					F4100-333			JITO-2
40.000000	F1100E-400	F5C2E-400	H5C2E-400	F3345-400	F4100-400	F4105-400	KFO-400	JITO-2
44.000000						F4106-440		JITO-2
48.000000	F1100E-480				F4100-480		KFO-480	JITO-2
50.000000	F1100E-500		H5C2E-500	F3345-500	F4100-500	F4105-500	KFO-500	JITO-2
60.000000				F3345-600	F4100-600		KFO-600	JITO-2
64.000000	F1100E-640		H5C2E-640	F3345-640			KFO-640	JITO-2
66.666700					F4100-666	F4105-666	KFO-666	JITO-2
80.000000	F1100E-800							JITO-2
100.000000	F1100E-1000					F4105-1000		JITO-2
106.250000					F4100-1062	F4105-1062		JITO-2
125.000000						F4105-1250		JITO-2

Rev. 05/01/02

STANDARD VCXOs & TCXOs

DISTRIBUTOR STOCKING ITEMS

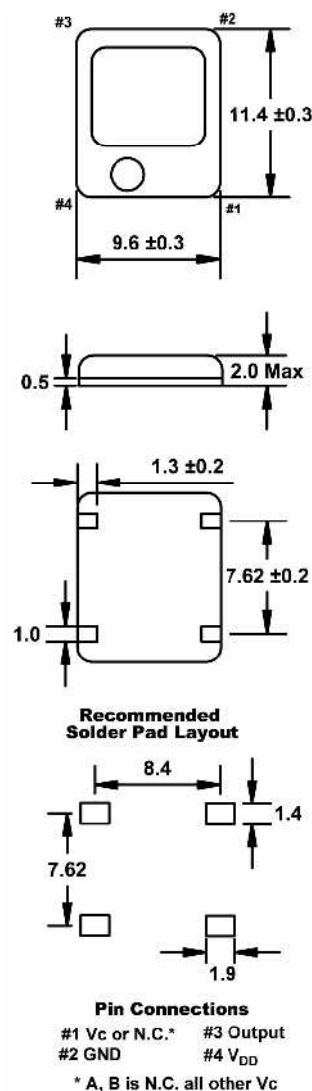
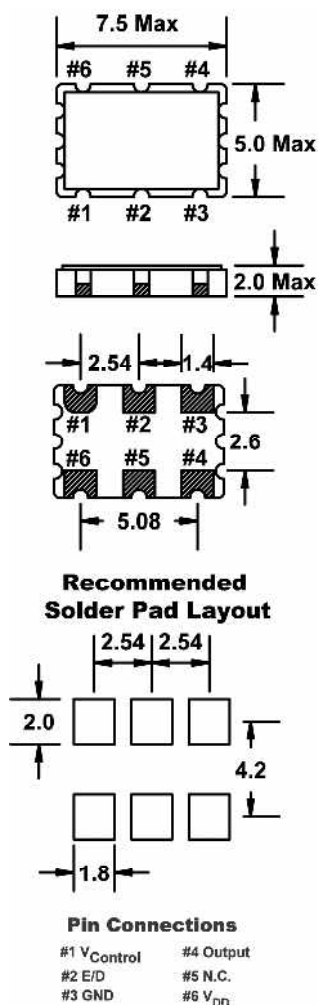
• FOX STANDARD SPECIFICATIONS		
PARAMETER	VCS25AXT	FOX801BE
Supply Voltage	3.3V	3.0V
Frequency Stability	±50PPM	±2.5PPM
Pullability	±100PPM	±3.0PPM
Operating Temperature Range	-10°C ~ +70°C	-30°C ~ +75°C

VCS25AXT ¹ (VCXO)	
Frequency (MHz)	Part Number
4.096000	VCS25AXT-0496
8.192000	VCS25AXT-081
12.288000	VCS25AXT-128
16.384000	VCS25AXT-163
27.000000	VCS25AXT-270
35.328000	VCS25AXT-353
44.736000	VCS25AXT-447

¹ Other voltages, stabilities, and pullabilities available on custom order.
Rev. 05/01/02

FOX801BE ¹ (VCTCXO)	
Frequency (MHz)	Part Number
10.000000	FOX801BE-100
12.800000	FOX801BE-128
14.400000	FOX801BE-144
16.000000	FOX801BE-160
19.200000	FOX801BE-192
20.000000	FOX801BE-200

¹ The voltage control may be disabled by applying 1.50 volts to pin 1.
Trimmerless and non-vc parts available on custom order.



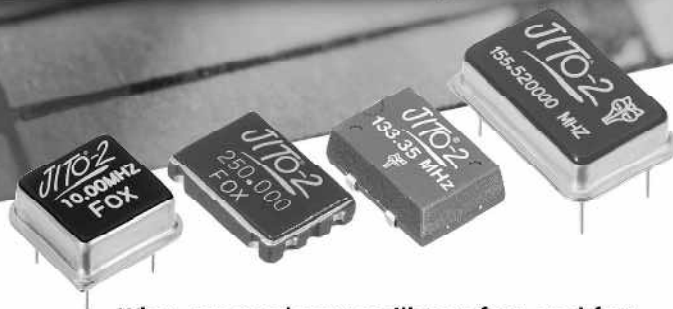
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JUST-IN-TIME OSCILLATORS™

Any frequency up to 250 MHz...
Samples overnite, production
quantities in 10 days or less!



When you need your oscillators fast...real fast...
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- Custom and standard frequencies from 340 kHz to 250 MHz
- Phase jitter comparable to fixed frequency oscillators
- 25-100 PPM stability
- 3.3 or 5 volts; -40° to +85°C; SMD and thru-hole
- Samples/prototypes overnight; production quantities in 10 days or less
- Total ordering/scheduling flexibility for JIT and BTO



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SUPERIOR QUALITY



CRYSTALS AND OSCILLATORS

Let FASTFOX help you with all your "Rush" Requirements 1-888-GET-2-FOX

Delivery: 5 to 30 working days

Quartz Crystals

HC49U

3 ~ 27 MHz fundamental

30 ~ 60 MHz 3rd overtone

HC49SD

3.579 ~ 64MHz

Oscillators

F1100E 4 ~ 25 MHz

F5C-2E 1.000 ~ 50 MHz

H5C-2E 1.000 ~ 50 MHz

JITO-2 0.340 ~ 300 MHz

Quotes: Call 1-888-GET-2-FOX for price and delivery confirmation.



QUARTZ CRYSTAL SELECTION GUIDE

• SURFACE MOUNT CRYSTALS

PRODUCT	FX325B	FX532 Series	FQA	FMB
				
Frequency Range	16.000 ~ 50.000 MHz	12.000 ~ 67.000 MHz	11.0592 ~ 67.000 MHz	10.368 ~ 67.000 MHz
Frequency Tolerance	±50 PPM ~ ±20 PPM	±50 PPM ~ ±10 PPM	±50 PPM ~ ±20 PPM	±50 PPM ~ ±5 PPM
Frequency Stability	±50 PPM ~ ±20 PPM	±50 PPM ~ ±10 PPM	±100 PPM ~ ±20 PPM	±100 PPM ~ ±3 PPM
Temperature Range	-10°C ~ +60°C to -40°C ~ +85°C	-10°C ~ +60°C to -40°C ~ +85°C	-10°C ~ +60°C to -40°C ~ +85°C	-10°C ~ +60°C to -40°C ~ +85°C
Key Features	• 3.2 x 2.5mm • 1.0mm Height Max • Low Cost • Fundamental to 50 MHz • Resin Sealed or Seam Sealed	• 5 x 3.2mm • 1.0mm Height Max • Fundamental to 67 MHz • Low Cost • Resin Sealed or Seam Welded	• 6 x 3.5mm • 1.4mm Height Max • Low Cost - Resin Sealed • Fundamental to 40 MHz	• 6 x 3.5mm • 1.1mm Height Max • Fundamental to 67 MHz • Seam Sealed
Catalog Pages	Page 11	Page 12	Page 13	Page 14

PRODUCT	FE	FD	FC	FPX	HC49SD
	 Stocking Std.			 Stocking Std.	 Stocking Std.
Frequency Range	7.1124 ~ 160.000 MHz	9.8304 ~ 160.000 MHz	3.200 ~ 7.200 MHz	3.579545 ~ 90.000 MHz	3.200 ~ 70.000 MHz
Frequency Tolerance	±50 PPM ~ ±20 PPM	±50 PPM ~ ±5 PPM	±50 PPM ~ ±20 PPM	±50 PPM ~ ±20 PPM	±50 PPM ~ ±10 PPM
Frequency Stability	±50 PPM ~ ±15 PPM	±50 PPM ~ ±3 PPM	±50 PPM ~ ±15 PPM	±100 PPM ~ ±20 PPM	±50 PPM ~ ±5 PPM
Temperature Range	-10°C ~ +60°C to -40°C ~ +85°C	-10°C ~ +60°C to -40°C ~ +85°C	-10°C ~ +60°C to -40°C ~ +85°C	-10°C ~ +60°C to -40°C ~ +85°C	-10°C ~ +60°C to -40°C ~ +85°C
Key Features	• 7.5 x 5mm • 1.4mm Height Max • Low Cost - Resin Sealed • Fundamental to 50 MHz • 2 Additional Footprints (FH, FL)	• 7.5 x 5mm • 1.1mm Height Max • Fundamental to 50 MHz • Seam Sealed	• 11.8 x 5.5mm • 2.5mm Height Max • Low Cost - Resin Sealed	• Low Cost • Plastic Encapsulated	• Low Cost • Fundamental to 50 MHz 
Catalog Pages	Page 15	Page 16	Page 17	Page 18	Page 19

• THRU-HOLE CRYSTALS / WATCH CRYSTALS

PRODUCT	HC49S	HC80U	HC49U	WATCH CRYSTALS
	 Stocking Std.		 Stocking Std.	
Frequency Range	3.200 ~ 70.000 MHz	3.579545 ~ 200.000 MHz	1.8432 ~ 180.000 MHz	32.768 kHz
Frequency Tolerance	±50 PPM ~ ±10 PPM	±30 PPM ~ ±5 PPM	±30 PPM ~ ±5 PPM	±20PPM
Frequency Stability	±50PPM ~ ±5 PPM	±50 PPM ~ ±3 PPM	±50 PPM ~ ±3 PPM	-0.04PPM / (Δ°C) ²
Temperature Range	-10°C ~ +70°C to -40°C ~ +85°C	-20°C ~ +70°C to -40°C ~ +70°C	-20°C ~ +70°C to -40°C ~ +85°C	-20°C ~ +60°C / -40°C ~ +85°C
Key Features	• 3.6mm Profile • Low Cost • Resistance Weld • Fundamental to 50 MHz	• High Frequency Range • Fundamental to 50 MHz	• Low Cost • Fundamental to 40 MHz 	• Miniature Pkgs. • Long Term Stability
Catalog Pages	Page 20	Page 21	Page 22	Pages 23 - 25

FASTFOX is a quick delivery service. Check with Fox Customer Service for available frequencies.

IMPORTANT

When ordering any non-standard crystals, please specify series or parallel resonance. If parallel, the load capacitance (CL) needs to be specified in picofarads ____pF.

CERAMIC SMD CRYSTAL

FX325B

FEATURES

- Low Cost
- Fundamental to 50 MHz
- Tape and Reel (3,000 pcs. STD)

OPTIONS

- Tolerances to < 20 PPM
- Stabilities to < 20 PPM
- Temperatures to -40°C ~ +85°C
- 0.8mm Height Max

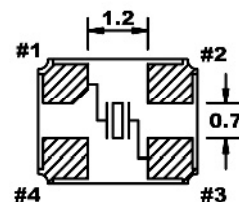
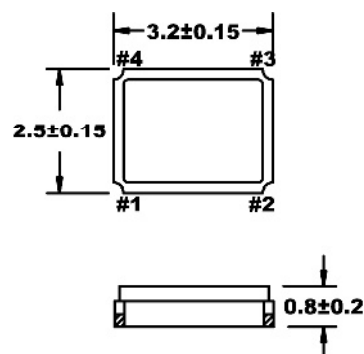


• STANDARD SPECIFICATIONS¹

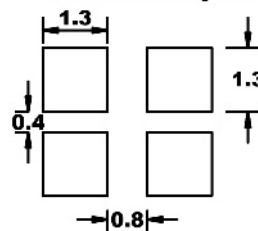
PARAMETERS	MAX (unless otherwise noted)
Frequency Range	16.000 ~ 50.000 MHz
Frequency Tolerance @ 25°C	±50 PPM
Frequency Stability, ref @ 25°C Over Operating Temp Range	±50 PPM
Temperature Range	
Operating (TOPR)	-10°C ~ +60°C
Storage (TSTG)	-40°C ~ +85°C
Equivalent Series Resistance	90 Ω
Shunt Capacitance (Co)	7.0 pF
Load Capacitance (CL)	10 pF ~ Series (Customer Specified)
Drive Level	0.1 mW
Aging per year	±5 PPM

¹ Other tolerances, stabilities & operating temperature ranges available. Consult Fox Customer Service for specific requirements.

All specifications subject to change without notice. Rev. 05/01/02



Recommended Solder Pad Layout



All dimensions are in millimeters.

CERAMIC SMD CRYSTALS

FX532 SERIES

FEATURES

- Low Cost
- Fundamental to 67 MHz
- Resin Sealed or Seam Sealed
- Tape and Reel (2,000 pcs. STD)

OPTIONS

- Tolerances to < 10 PPM
- Stabilities to < 10 PPM
- Temperatures to -40°C ~ +85°C

• STANDARD SPECIFICATIONS¹

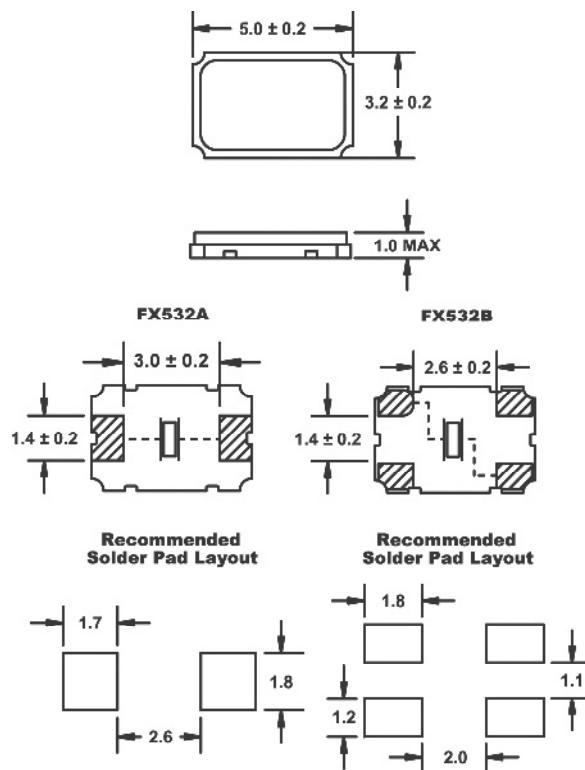
PARAMETERS	MAX (unless otherwise noted)
Frequency Range	12.000 ~ 67.000 MHz
Frequency Tolerance, Ta=25°C 12.000 ~ 40.000 MHz 40.000+ ~ 67.000 MHz	±50PPM See Stability
Frequency Stability 12.000 ~ 40.000 MHz (ref. @ 25°C) 40.000+ ~ 67.000 MHz	±50 PPM ±100 PPM ²
Temperature Range Operating (TOPR) Storage (TSTG)	-10°C ~ +60°C -40°C ~ +85°C
Shunt Capacitance (Co)	7.0 pF
Load Capacitance (CL)	10 pF ~ Series (Customer Specified)
Drive Level	0.1 mW
Aging per year	±5 PPM

¹ Other tolerances, stabilities & operating temperature ranges available. Consult Fox Customer Service for specific requirements.

² Inclusive of tolerance at 25°C

All specifications subject to change without notice. Rev. 05/01/02

Frequency Range (MHz)	Operating Mode	Max ESR W
12.000 ~ 14.000	Fundamental	140
14.000+ ~ 16.000	Fundamental	90
16.000+ ~ 67.000	Fundamental	60



All dimensions are in millimeters.

See page 27 for tape and reel specifications.

CERAMIC RESIN SEALED SMD CRYSTAL

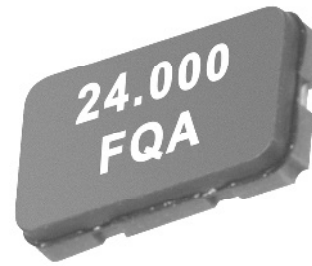
FQA

FEATURES

- Low Cost
- Fundamental to 40 MHz
- Resin Sealed
- Tape and Reel (2,000 pcs. STD)

OPTIONS

- Tolerances to < 20 PPM
- Stabilities to < 20 PPM
- Temperatures to -40°C ~ +85°C



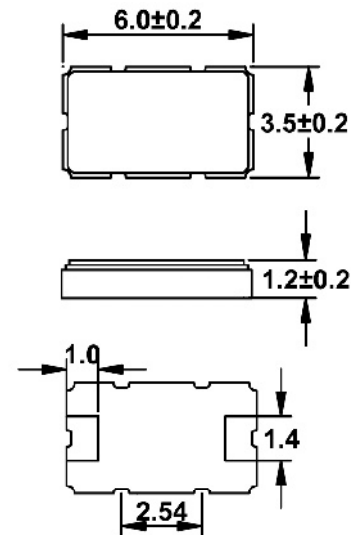
• STANDARD SPECIFICATIONS ¹	
PARAMETERS	MAX (unless otherwise noted)
Frequency Range	11.0592 ~ 67.000 MHz
Frequency Stability Over Operating Temp Range	±100 PPM ²
Temperature Range	
Operating (TOPR)	-10°C ~ +60°C
Storage (TSTG)	-40°C ~ +85°C
Shunt Capacitance (Co)	7.0 pF
Load Capacitance (CL)	10 pF ~ Series (Customer Specified)
Drive Level	0.1 mW
Aging per year	±5 PPM

¹ Other stabilities & operating temperature ranges available. Consult Fox Customer Service for specific requirements.

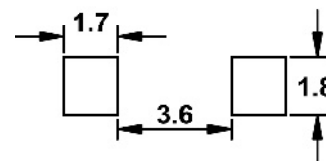
² Inclusive of tolerance at 25°C.

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Frequency Range (MHz)	Operating Mode	Max ESR W
11.0592 ~ 12.000	Fundamental	80
12.000+ ~ 16.000	Fundamental	60
16.000+ ~ 40.000	Fundamental	40
40.000 ~ 67.000	3rd OT	70



Recommended Solder Pad Layout



All dimensions are in millimeters.

See page 27 for tape and reel specifications.

CERAMIC SEAM SEALED SMD CRYSTAL

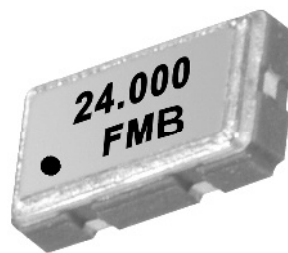
FMB

FEATURES

- Fundamental to 40 MHz
- Seam Sealed
- Tape and Reel (2,000 pcs. STD)

OPTIONS

- Tolerances to < 5 PPM
- Stabilities to < 3 PPM
- Temperatures to -40°C ~ +85°C



• STANDARD SPECIFICATIONS¹

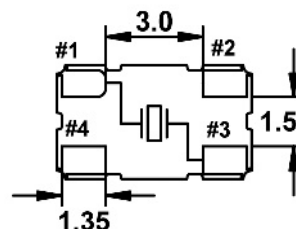
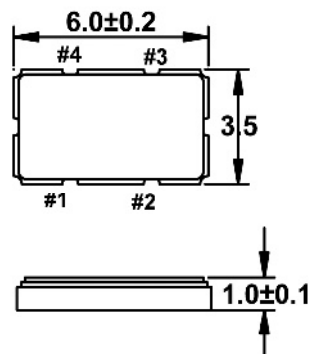
PARAMETERS	MAX (unless otherwise noted)
Frequency Range	10.368 ~ 67.000 MHz
Frequency Stability Over Operating Temp Range	±100 PPM ²
Temperature Range	
Operating (TOPR)	-10°C ~ +60°C
Storage (TSTG)	-40°C ~ +85°C
Shunt Capacitance (Co)	7.0 pF
Load Capacitance (CL)	10 pF ~ Series (Customer Specified)
Drive Level	0.1 mW
Aging per year	±5 PPM

¹ Other tolerances, stabilities & operating temperature ranges available. Consult Fox Customer Service for specific requirements.

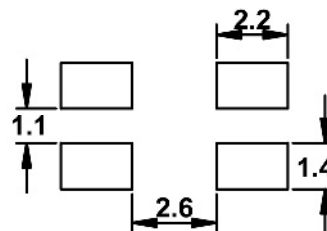
² Inclusive of tolerance at 25°C.

All specifications subject to change without notice. Rev. 05/01/02

Frequency Range (MHz)	Operating Mode	Max ESR W
10.368 ~ 12.000	Fundamental	80
12.000+ ~ 16.000	Fundamental	60
16.000+ ~ 40.000	Fundamental	40
40.000+ ~ 67.000	3rd OT	70



Recommended Solder Pad Layout



All dimensions are in millimeters.

See page 27 for tape and reel specifications.

CERAMIC RESIN SEALED SMD CRYSTAL

FE

FEATURES

- Low Cost
- High Frequency Range
- Fundamental to 50 MHz (BT Cut)
- Resin Sealed
- Tape and Reel (2,000 pcs. STD)

OPTIONS

- Tolerances to < 20 PPM
- Stabilities to < 15 PPM
- Temperatures to -40°C ~ +85°C
- 1.4mm Height Max
- 2 Additional Footprints (FH, FL)



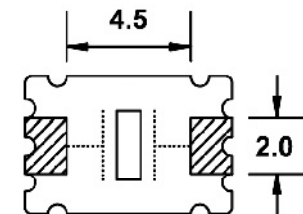
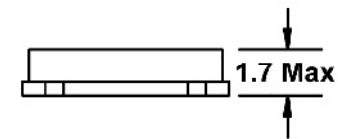
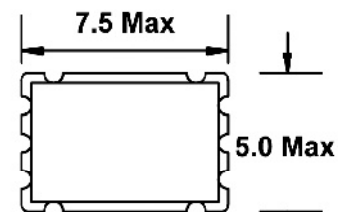
• STANDARD SPECIFICATIONS¹

PARAMETERS	MAX (unless otherwise noted)
Frequency Range	7.1124 ~ 160.000 MHz
Frequency Tolerance @ 25°C	±50 PPM
Frequency Stability, ref @ 25°C Over Operating Temp Range	±50PPM
Temperature Range	
Operating (TOPR)	-10°C ~ +60°C
Storage (TSTG)	-40°C ~ +85°C
Shunt Capacitance (Co)	7.0 pF
Load Capacitance (CL)	10 pF ~ Series (Customer Specified)
Drive Level	0.5 mW
Aging per year	±5 PPM

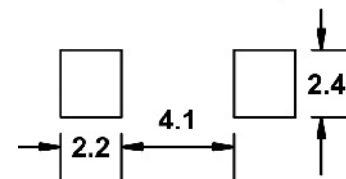
¹ Other stabilities & operating temperature ranges available. Consult Fox Customer Service for specific requirements.

All specifications subject to change without notice. Rev. 05/01/02

Frequency Range (MHz)	Operating Mode	Max ESR W
7.1124 ~ 8.000	Fundamental	80
8.000+ ~ 16.000	Fundamental	60
16.000+ ~ 50.000	Fundamental	40
28.000 ~ 84.000	3rd OT	60
84.000+ ~ 160.000	5th OT	80



Recommended Solder Pad Layout



All dimensions are in millimeters.

See page 27 for tape and reel specifications.

CERAMIC SEAM SEALED SMD CRYSTAL

FD

FEATURES

- High Frequency Range
- Fundamental to 50 MHz (BT Cut)
- Seam Sealed
- Tape and Reel (3,000 pcs. STD)

OPTIONS

- Tolerances to < 5 PPM
- Stabilities to < 3 PPM
- Temperatures to -40°C ~ +85°C

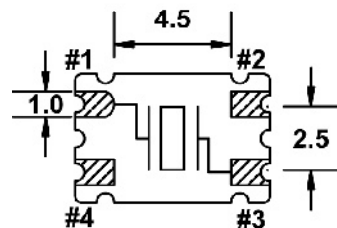
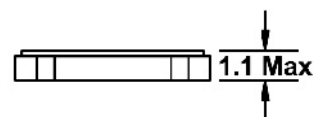
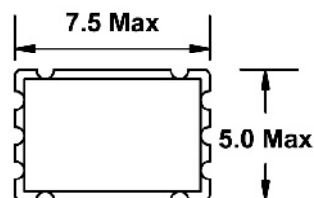


• STANDARD SPECIFICATIONS ¹	
PARAMETERS	MAX (unless otherwise noted)
Frequency Range	9.8304 ~ 160.000 MHz
Frequency Tolerance @ 25°C	±50 PPM
Frequency Stability, ref @ 25°C Over Operating Temp Range	±50 PPM
Temperature Range	
Operating (TOPR)	-10°C ~ +60°C
Storage (TSTG)	-40°C ~ +85°C
Shunt Capacitance (Co)	7.0 pF
Load Capacitance (CL)	10 pF ~ Series (Customer Specified)
Drive Level	0.5 mW
Aging per year	±5 PPM

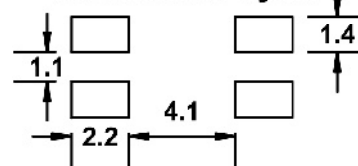
¹ Other tolerances, stabilities & operating temperature ranges available. Consult Fox Customer Service for specific requirements.

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Frequency Range (MHz)	Operating Mode	Max ESR W
9.8304 ~ 16.000	Fundamental	60
16.000+ ~ 50.000	Fundamental	40
28.000 ~ 84.000	3rd OT	60
84.000 ~ 160.000	5th OT	80



Recommended Solder Pad Layout



All dimensions are in millimeters.

See page 27 for tape and reel specifications.

CERAMIC RESIN SEALED SMD CRYSTAL FC

FEATURES

- Low Cost
- Resin Sealed
- Tape and Reel (1,000 pcs. STD)

OPTIONS

- Tolerances to < 20 PPM
- Stabilities to < 15 PPM
- Temperatures to -40°C ~ +85°C

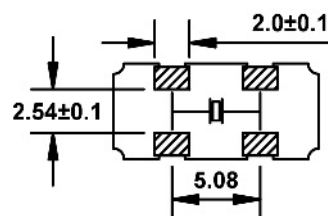
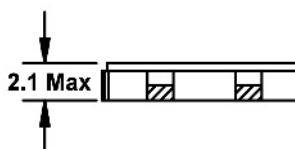
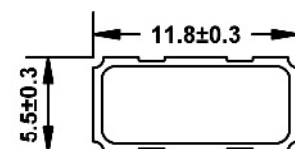


• STANDARD SPECIFICATIONS

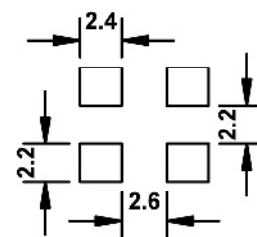
PARAMETERS	MAX (unless otherwise noted)
Frequency Range	3.200 ~ 7.200 MHz
Frequency Tolerance @ 25°C	±50 PPM
Frequency Stability, ref @ 25°C Over Operating Temp Range	±50 PPM
Temperature Range	
Operating (TOPR)	-10°C ~ +60°C
Storage (TSTG)	-40°C ~ +85°C
Shunt Capacitance (Co)	7.0 pF
Load Capacitance (CL)	10 pF ~ Series (Customer Specified)
Drive Level	0.1 mW
Aging per year	±5 PPM

All specifications subject to change without notice. Rev. 05/01/02

Frequency Range (MHz)	Operating Mode	Max ESR W
3.200 ~ 3.499	Fundamental	200
3.499+ ~ 3.999	Fundamental	140
3.999+ ~ 4.399	Fundamental	120
4.399+ ~ 4.899	Fundamental	100
4.899+ ~ 5.999	Fundamental	80
5.999+ ~ 6.999	Fundamental	60
6.999+ ~ 7.200	Fundamental	50



Recommended Solder Pad Layout



All dimensions are in millimeters.

See page 27 for tape and reel specifications.

PLASTIC ENCASED SMD CRYSTAL

FPX

FEATURES

- Low Cost
- Stocking Standard
- Plastic Encapsulated
- Tape and Reel (1,000 pcs. STD)
- Tolerances to < 20 PPM
- Stabilities to < 20 PPM
- Temperatures to -40°C ~ +85°C
- Alternate Metal Can Package (HC49SPX)

OPTIONS

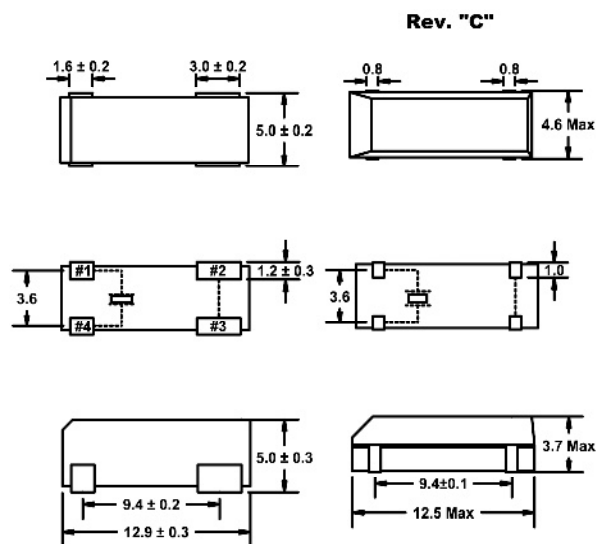
• STANDARD SPECIFICATIONS¹

PARAMETERS	MAX (unless otherwise noted)
Frequency Range	3.579545 ~ 90.000 MHz
Frequency Tolerance @ 25°C	±50 PPM
Frequency Stability, ref @ 25°C Over Operating Temp Range	±100 PPM
Temperature Range	
Operating (TOPR)	-10°C ~ +70°C
Storage (TSTG)	-55°C ~ +125°C
Shunt Capacitance (Co)	7.0 pF
Load Capacitance (CL)	10 pF ~ Series (Customer Specified)
Drive Level	0.1 mW
Aging per year	±5 PPM

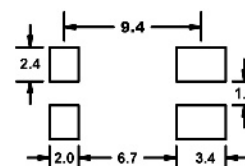
¹ Other tolerances, stabilities & operating temperature ranges available. Consult Fox Customer Service for specific requirements.

All specifications subject to change without notice. Rev. 05/01/02

Frequency Range (MHz)	Operating Mode	Max ESR W
3.579 ~ 4.000	Fundamental	200
4.000+ ~ 5.000	Fundamental	150
5.000+ ~ 6.000	Fundamental	120
6.000+ ~ 7.000	Fundamental	100
7.000+ ~ 9.000	Fundamental	80
9.000+ ~ 13.000	Fundamental	60
13.000+ ~ 20.000	Fundamental	40
20.000+ ~ 30.000	Fundamental	30
30.000+ ~ 90.000	3rd OT	100



Recommended Solder Pad Layout



Note: Solder Pad Layout accommodates both packages

All dimensions are in millimeters.

See page 27 for tape and reel specifications.

RESISTANCE WELD SMD CRYSTAL

HC49SD

FEATURES

- Low Cost
- Stock Standard
- Fundamental to 50 MHz (BT Cut)
- Tape and Reel (1,000 pcs. STD) FPX)
- Tolerances to < 10 PPM
- Stabilities to < 5 PPM
- Temperatures to -40°C ~ -85°C
- 4 Pad HC49SPX (Alternate to
- 3.2mm Height Max (HC49SSD)

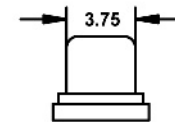
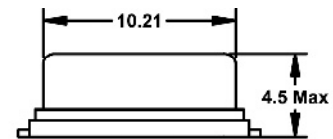
OPTIONS

• STANDARD SPECIFICATIONS¹

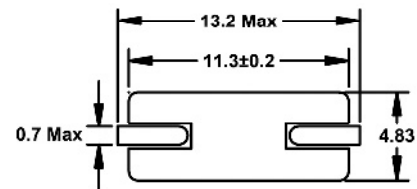
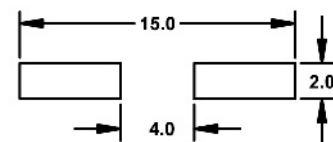
PARAMETERS	MAX (unless otherwise noted)
Frequency Range	3.200 ~ 70.000 MHz
Frequency Tolerance @ 25°C	±50 PPM
Frequency Stability, ref @ 25°C Over Operating Temp Range	±50 PPM
Temperature Range	
Operating (TOPR)	-10°C ~ +70°C
Storage (TSTG)	-40°C ~ +85°C
Shunt Capacitance (Co)	7.0 pF
Load Capacitance (CL)	10 pF ~ Series (Customer Specified)
Drive Level	0.5 mW
Aging @ 25°C; per year	±5 PPM

¹ Other tolerances, stabilities & operating temperature ranges available. Consult Fox Customer Service for specific requirements.

All specifications subject to change without notice. Rev. 05/01/02



Frequency Range (MHz)	Operating Mode	Max ESR W
3.200 ~ 3.500	Fundamental	300
3.500+ ~ 4.000	Fundamental	200
4.000+ ~ 5.000	Fundamental	150
5.000+ ~ 6.000	Fundamental	120
6.000+ ~ 7.000	Fundamental	100
7.000+ ~ 9.000	Fundamental	80
9.000+ ~ 13.000	Fundamental	60
13.000+ ~ 20.000	Fundamental	40
20.000+ ~ 50.000	Fundamental	30
27.000 ~ 70.000	3rd OT	100

Recommended
HC49SD Solder Pad Layout

All dimensions are in millimeters.

See page 27 for tape and reel specifications.

RESISTANCE WELD THRU-HOLE CRYSTAL

HC49S

FEATURES

- Low Cost
- Stocking Standard
- Fundamental to 50 MHz (BT Cut)
- Resistance Weld

OPTIONS

- Tolerances to < 10 PPM
- Stabilities to < 5 PPM
- Temperatures to -40°C ~ +85°C
- 2.5mm Height Max (HC49SS)

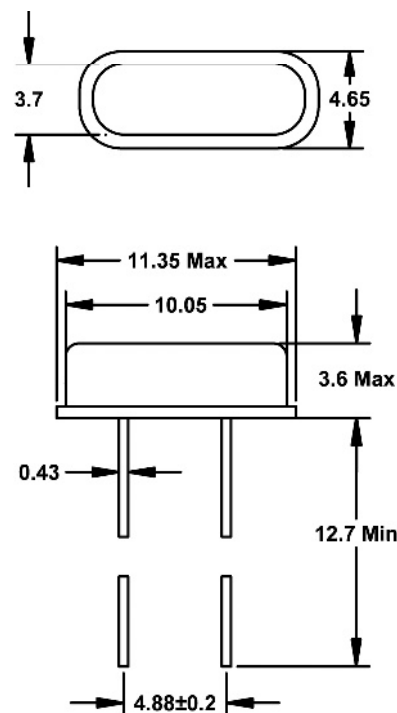


• STANDARD SPECIFICATIONS ¹		
PARAMETERS		MAX (unless otherwise noted)
Frequency Range		3.200 ~ 70.000 MHz
Frequency Tolerance @ 25°C		±50 PPM
Frequency Stability, ref @ 25°C Over Operating Temp Range		±50 PPM
Temperature Range		
Operating (TOPR)		-20°C ~ +70°C
Storage (TSTG)		-40°C ~ +85°C
Shunt Capacitance (Co)		7.0 pF
Load Capacitance (CL)		10 pF ~ Series (Customer Specified)
Drive Level		0.5 mW
Aging per year		±5 PPM

¹ Other tolerances, stabilities & operating temperature ranges available. Consult Fox Customer Service for specific requirements.

All specifications subject to change without notice. Rev. 05/01/02

Frequency Range (MHz)	Operating Mode	Max ESR W
3.200 ~ 3.500	Fundamental	300
3.500+ ~ 4.000	Fundamental	200
4.000+ ~ 5.000	Fundamental	150
5.000+ ~ 6.000	Fundamental	120
6.000+ ~ 7.000	Fundamental	100
7.000+ ~ 9.000	Fundamental	80
9.000+ ~ 13.000	Fundamental	60
13.000+ ~ 20.000	Fundamental	40
20.000+ ~ 50.000	Fundamental	30
27.000 ~ 70.000	3rd OT	100



All dimensions are in millimeters.

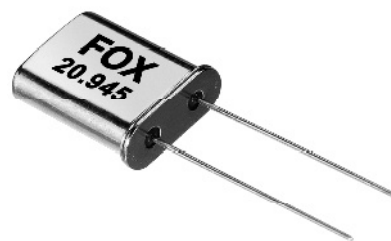
RESISTANCE WELD THRU-HOLE CRYSTAL HC80U

FEATURES

- High Frequency Range
- Fundamental to 50 MHz
- Resistance Weld

OPTIONS

- Tolerances to < 5 PPM
- Stabilities to < 3 PPM
- Temperatures to -40°C ~ -85°C
- SMD Gullwing (HC80UW)



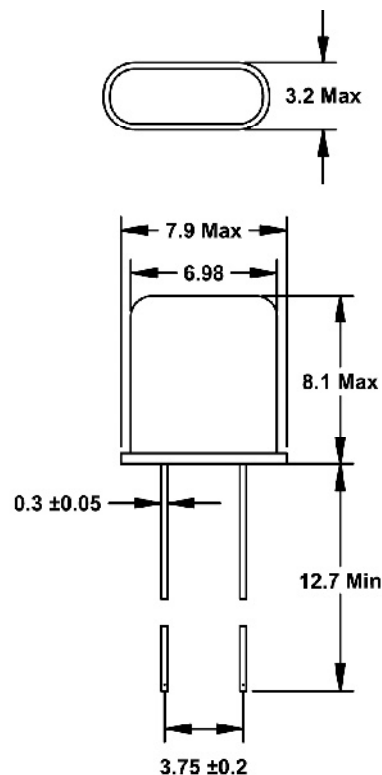
• STANDARD SPECIFICATIONS¹

PARAMETERS	MAX (unless otherwise noted)
Frequency Range	3.579545 ~ 200.000 MHz
Frequency Tolerance @ 25°C	±30 PPM
Frequency Stability, ref @ 25°C Over Operating Temp Range	±50 PPM
Temperature Range	
Operating (TOPR)	-20°C ~ +70°C
Storage (TSTG)	-40°C ~ +85°C
Shunt Capacitance (Co)	7.0 pF
Load Capacitance (CL)	10 pF ~ Series (Customer Specified)
Drive Level	1.0 mW
Aging per year	±3 PPM

¹ Other tolerances, stabilities & operating temperature ranges available. Consult Fox Customer Service for specific requirements.

All specifications subject to change without notice. Rev. 05/01/02

Frequency Range (MHz)	Operating Mode	Max ESR W
3.579545 ~ 4.000	Fundamental	300
4.000+ ~ 5.000	Fundamental	250
5.000+ ~ 6.000	Fundamental	180
6.000+ ~ 7.000	Fundamental	120
7.000+ ~ 8.000	Fundamental	100
8.000+ ~ 10.000	Fundamental	90
10.000+ ~ 11.000	Fundamental	60
11.000+ ~ 50.000	Fundamental	40
25.000 ~ 65.000	3rd OT	60
60.000 ~ 130.000	5th OT	100
130.000+ ~ 200.000	7th OT	150



All dimensions are in millimeters.

RESISTANCE WELD THRU-HOLE CRYSTAL

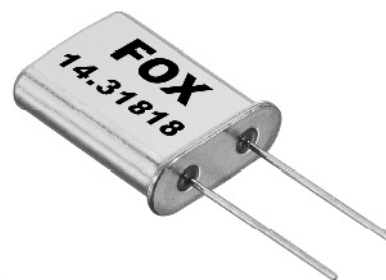
HC49U

FEATURES

- Low Cost
- Stocking Standard
- High Frequency Range
- Fundamental to 40 MHz
- Resistance Weld

OPTIONS

- Tolerances to < 5 PPM
- Stabilities to < 3 PPM
- Temperatures to -40°C ~ -85°C
- Mylar Spacer
- Vinyl Sleeve
- Third Lead
- SMD Gullwing (HC49UW)



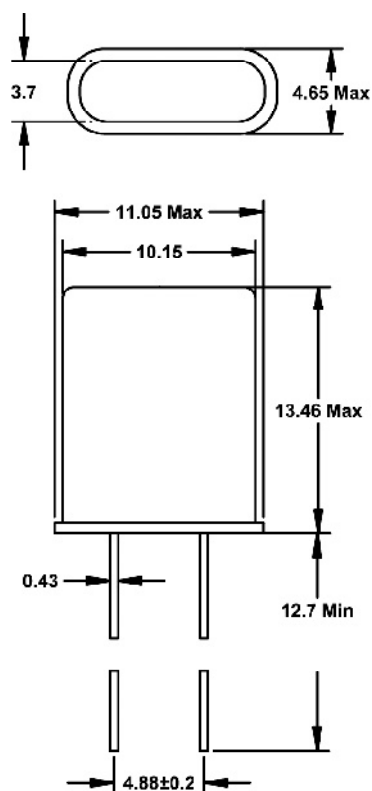
• STANDARD SPECIFICATIONS¹

PARAMETERS	MAX (unless otherwise noted)
Frequency Range	1.8432 ~ 180.000 MHz
Frequency Tolerance @ 25°C	±30 PPM
Frequency Stability, ref @ 25°C Over Operating Temp Range	±50 PPM
Temperature Range	
Operating (TOPR)	-20°C ~ +70°C
Storage (TSTG)	-40°C ~ +85°C
Shunt Capacitance (Co)	7.0 pF
Load Capacitance (CL)	10 pF ~ Series (Customer Specified)
Drive Level	
1.8432 ~ 3.000 MHz	2.0 mW
3.000+ ~ 180.000 MHz	1.0 mW
Aging per year	±5 PPM

¹ Other tolerances, stabilities & operating temperature ranges available. Consult Fox Customer Service for specific requirements.

All specifications subject to change without notice. Rev. 05/01/02

Frequency Range (MHz)	Operating Mode	Max ESR W
1.8432 ~ 2.000	Fundamental	750
2.000+ ~ 2.400	Fundamental	500
2.400+ ~ 3.000	Fundamental	300
3.000+ ~ 3.200	Fundamental	200
3.200+ ~ 3.700	Fundamental	120
3.700+ ~ 4.200	Fundamental	100
4.200+ ~ 4.900	Fundamental	70
4.900+ ~ 5.000	Fundamental	55
5.000+ ~ 6.000	Fundamental	50
6.000+ ~ 8.000	Fundamental	40
8.000+ ~ 10.000	Fundamental	35
10.000+ ~ 12.500	Fundamental	30
12.500+ ~ 16.000	Fundamental	25
16.000+ ~ 40.000	Fundamental	20
23.000+ ~ 75.000	3rd OT	40
60.000 ~ 110.000	5th OT	80
110.000 ~ 180.000	7th OT	120



All dimensions are in millimeters.

SMD TUNING FORK FSX

FEATURES

- Extremely Small Size
- Low Cost
- 1.4mm Height Max
- Tape and Reel (3,000 pcs. STD)

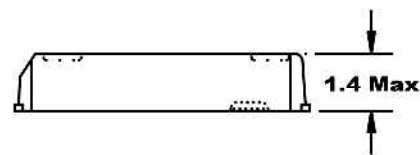
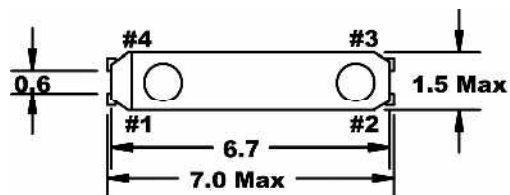


WATCH CRYSTALS

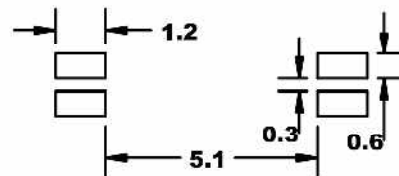
• STANDARD SPECIFICATIONS

PARAMETERS	MAX (unless otherwise noted)
Frequency Range	32.768 kHz
Frequency Tolerance @ 25°C	±20 PPM
Frequency Stability, ref @ 25°C	-0.04 PPM/(Δ°C) ²
Temperature Range	
Operating (TOPR)	-40°C ~ +85°C
Storage (TSTG)	-40°C ~ +85°C
Equivalent Series Resistance	65 kΩ
Load Capacitance (CL)	7 pF, 12.5 pF
Insulation Resistance @ 100VDC	500 MΩ
Drive Level	0.1 μW
Aging	±3 PPM

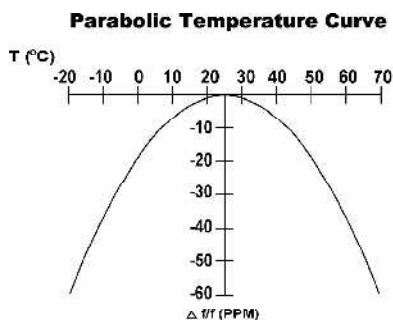
All specifications subject to change without notice. Rev. 05/01/02



Recommended Solder Pad Layout



All dimensions are in millimeters.



To determine frequency stability, use parabolic curvature (K)
For example: What is stability at 45°C?

- 1) Change in T (°C) = 45-25 = 20°C
- 2) Change in frequency = -0.04 PPM * (Δ°C)²
= -0.04 PPM * (20)²
= -16.0 PPM

See page 27 for tape and reel specifications.

FSR327

FEATURES

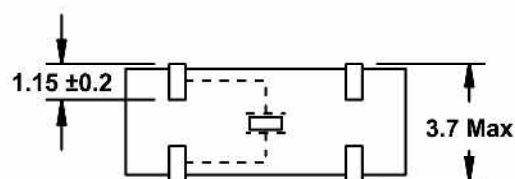
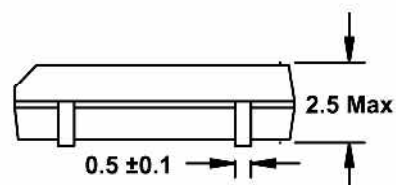
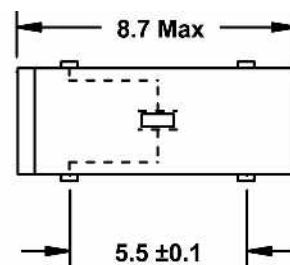
- Miniature Package
- 2.5mm Height
- Long Term Stability
- Tape and Reel (3,000 pcs. STD)



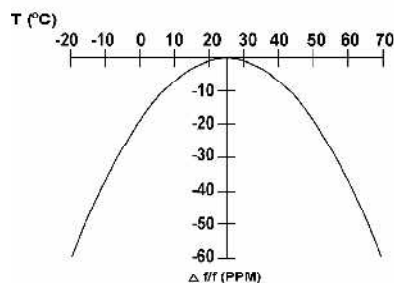
• STANDARD SPECIFICATIONS

PARAMETERS	
Frequency	32.768 kHz
Frequency Tolerance @ 25°C	±20 PPM
Frequency Stability Temperature Coefficient	-0.04 PPM / (Δ°C) ²
Temperature Range	
Turnover (TO)	+20°C ~ +30°C
Operating (TOPR)	-40°C ~ +85°C
Storage (TSTG)	-55°C ~ +125°C
Equivalent Series Resistance (RS)	50 kΩ
Load Capacitance (CL)	12.5 pF (Standard) 6 pF (Optional)
Insulation Resistance @ 100VDC	500 MΩ
Drive Level	1.0 μW
Aging per year	±3 PPM

All specifications subject to change without notice. Rev. 05/01/02



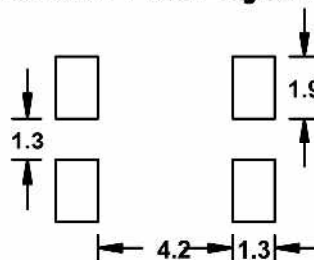
Parabolic Temperature Curve



To determine frequency stability, use parabolic curvature (K)
For example: What is stability at 45°C?

- 1) Change in T (°C) = 45-25 = 20°C
- 2) Change in frequency = $-0.04 \text{ PPM} \cdot (\Delta C)^2$
 $= -0.04 \text{ PPM} \cdot (20)^2$
 $= -16.0 \text{ PPM}$

Recommended Solder Pad Layout



All dimensions are in millimeters.

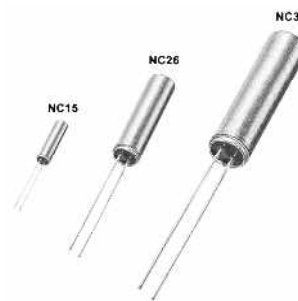
See page 27 for tape and reel specifications.

THRU-HOLE TUNING FORK

NC15/NC26/NC38

FEATURES

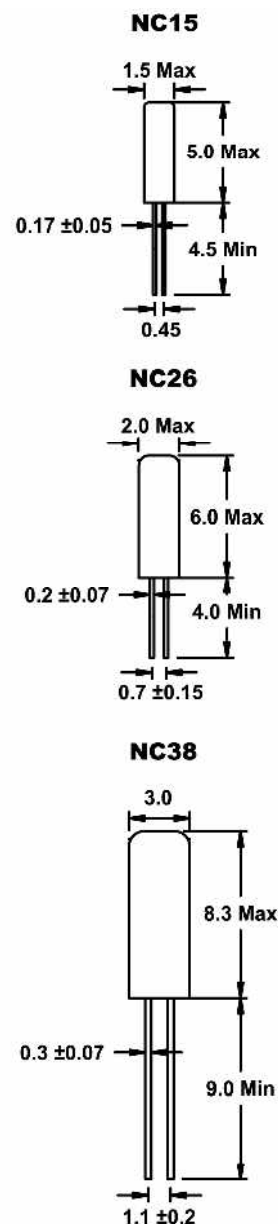
- Miniature Packages
- Low Cost
- Cold Weld Design
- Long Term Stability
- Tight Tolerance



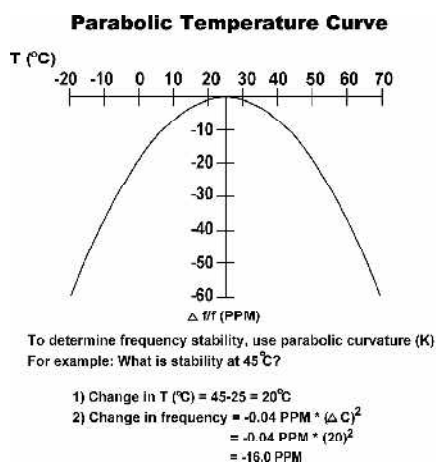
WATCH CRYSTALS

• STANDARD SPECIFICATIONS	
PARAMETERS	MAX (unless otherwise noted)
Frequency	32.768 kHz
Frequency Tolerance @ 25°C	
Frequency Stability Temperature Coefficient	-0.04 PPM / (Δ°C) ²
Temperature Range	
Turnover (TO)	+20°C ~ +30°C
Operating (TOPR)	-20°C ~ +60°C
Storage (TSTG)	-30°C ~ +70°C
Equivalent Series Resistance (RS)	
NC15 / NC26	50 kΩ
NC38	35 kΩ
Load Capacitance (CL)	12.5 pF (Standard) 6 pF (Optional)
Insulation Resistance @ 100VDC	500 MΩ
Drive Level	1.0 μW
Aging per year	±3 PPM

All specifications subject to change without notice. Rev. 05/01/02



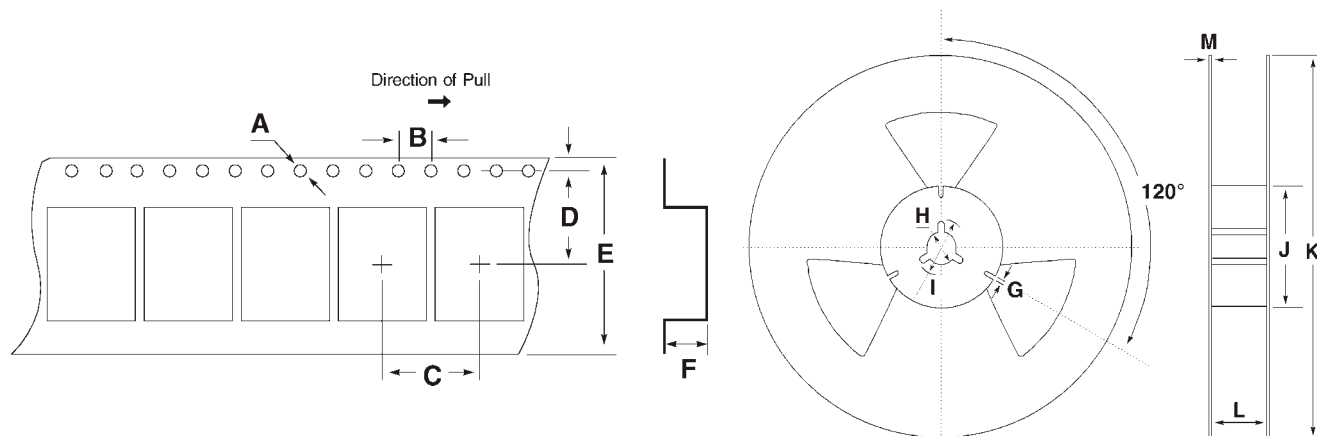
All dimensions are in millimeters.



Fox Electronics Part Description¹ Guide for Crystals

[illegible]

TAPE AND REEL SPECIFICATIONS



• TAPE SPECIFICATIONS (millimeters)

MODEL	A	B	C	D	E	F	STD QTY ¹
FX325B	Ø1.5	4.0	4.0	3.5	8.0	1.3	3,000
FX532 Series	Ø1.5	4.0	8.0	5.5	12.0	1.95	1,000 / 2,000
FQA	Ø1.5	4.0	8.0	5.5	12.0	1.9	2,000
FMB	Ø1.5	4.0	8.0	5.5	12.0	1.9	2,000
FE	Ø1.5	4.0	8.0	7.5	16.0	2.3	2,000
FD	Ø1.5	4.0	8.0	7.5	16.0	1.7	3,000
FC	Ø1.5	4.0	12.0	11.5	24.0	2.9	1,000
FPX	Ø1.5	4.0	12.0	11.5	24.0	5.5	2,000
HC49SD	Ø1.5	4.0	12.0	11.5	24.0	4.8	1,000
FSX	Ø1.5	4.0	8.0	7.5	16.0	1.6	3,000
FSR	Ø1.5	4.0	8.0	7.5	16.0	2.7	3,000

¹ Standard reel quantity.

• REEL SPECIFICATIONS (millimeters)

MODEL	G	H	I	J	K	L	M
FX325B	2.0	Ø13	Ø21	Ø60	Ø180	9.0	1.2
FX532 Series	2.0	Ø13	Ø21	Ø80	Ø178 / Ø250	13.5	2.0
FQA	2.0	Ø13	Ø21	Ø80	Ø250	13.5	2.0
FMB	2.0	Ø13	Ø21	Ø80	Ø250	13.5	2.0
FE	2.0	Ø13	Ø21	Ø80	Ø250	17.5	2.0
FD	2.0	Ø13	Ø21	Ø80	Ø250	17.5	2.0
FC	2.0	Ø13	Ø21	Ø80	Ø250	25.5	2.0
FPX	2.0	Ø13	Ø21	Ø100	Ø250	25.5	2.0
HC49SD	2.0	Ø13	Ø21	Ø80	Ø330	25.5	2.0
FSX	2.0	Ø13	Ø21	Ø50	Ø330	16.4	2.0
FSR	2.0	Ø13	Ø21	Ø50/100	Ø330	16.4	2.0

CLOCK OSCILLATOR SELECTION GUIDE

• JITO®-2 AND SURFACE MOUNT OSCILLATORS

PRODUCT	JITO®-2 	F510L/F540L Series	F530L Series	F4200 Series
	    Full Size 14 PIN DIP Half Size 8 PIN DIP MIN-6 Surface Mount JITO-2P Plastic			
Frequency Range	0.144 ~ 300.000 MHz	1.800 ~ 50.000 MHz	1.544 ~ 155.200 MHz	1.544 ~ 50.000 MHz
Frequency Stability	±100PPM, ±50PPM, ±30PPM, ±25PPM, ±20PPM	±100, ±50, ±25, ±20 PPM	±100, ±50, ±25, ±20 PPM	±100, ±50, ±25, ±20 PPM
Temperature Range	-20°C ~ +70°C and -40°C ~ +85°C	-10°C ~ +70°C -40°C ~ +85°C (Option)	-10°C ~ +70°C -40°C ~ +85°C (Option)	-10°C ~ +70°C -40°C ~ +85°C (Option)
Key Features	• Custom and Standard Frequencies • 3.3 or 5 Volts, HCMOS or PECL • SMD and Thru-Hole packages available • Delivery in 10 days or less!	• 5 x 3.2mm • 1.8V / 2.5V Operation • HCMOS • Low Current Standby Function (10µA MAX)	• 5 x 3.2mm • 3.3V Operation • HCMOS • Low Current Standby Function (10µA MAX)	• 6 x 3.5mm • 3.3V Operation • HCMOS • Low Current Standby Function (10µA MAX)
Catalog Pages	Pages 30-35	Pages 36 & 37	Page 38	Page 39

• SURFACE MOUNT OSCILLATORS

PRODUCT	F4500/F4400 Series	F4100 Series	F3345 Series	F4600 Series
		 Stocking Std.	 Stocking Std.	
Frequency Range	1.800 ~ 70.000 MHz	1.000 ~ 170.000 MHz	1.000 ~ 80.000 MHz	75.000 ~ 170.000 MHz
Frequency Stability	±100, ±50, ±25, ±20 PPM	±100, ±50, ±25, ±20 PPM	±100, ±50, ±25, ±20 PPM	±100, ±50, ±25, ±20 PPM
Temperature Range	-10°C ~ +70°C -40°C ~ +85°C (Option)	-10°C ~ +70°C -40°C ~ +85°C (Option)	-10°C ~ +70°C -40°C ~ +85°C (Option)	-10°C ~ +70°C -40°C ~ +85°C (Option)
Key Features	• 7.5 x 5mm • 1.8V / 2.5V Operation • HCMOS • Low Current Standby Function (10µA MAX)	• 7.5 x 5mm • 3.3V Operation • HCMOS • Low Current Standby Function (10µA MAX)	• 7.5 x 5mm • 5.0V Operation • HCMOS/TTL • Tri-State E/D	• 7.5 x 5mm • 3.3V Operation • LV-PECL • E/D Function
Catalog Pages	Pages 40 & 41	Page 42 & 43	Page 44	Page 45

• SURFACE MOUNT AND THRU-HOLE OSCILLATORS

PRODUCT	FSO Series	KFO Series	F5C-2E / H5C-2E	F5C-2E3 / H5C-2E3	F1100E
		 Stocking Std.	 Stocking Std.		 Stocking Std.
Frequency Range	1.000 ~ 66.6667 MHz	1.500 ~ 67.000 MHz	1.000 ~ 160.000 MHz	1.000 ~ 160.000 MHz	1.000 ~ 100.000 MHz
Frequency Stability	±200, ±100, ±50 PPM	±100, ±50 PPM	±100, ±50, ±25, ±20 PPM	±100, ±50, ±25, ±20 PPM	±100, ±50, ±25, ±20 PPM
Temperature Range	-10°C ~ +70°C -40°C ~ +85°C (±200 PPM Option)	-10°C ~ +70°C -40°C ~ +85°C (Option)	0°C ~ +70°C -40°C ~ +85°C (Option)	0°C ~ +70°C -40°C ~ +85°C (Option)	0°C ~ +70°C -40°C ~ +85°C (Option)
Key Features	• 14 x 9.8mm • 5.0V / 3.3V • HCMOS/TTL • Tri-State E/D	• 12.8 x 9.8mm • 5.0V / 3.3V • HCMOS/TTL • Tri-State E/D	• 14-Pin / 8-Pin DIP • 5.0V • HCMOS/TTL • Tri-State E/D	• 14-Pin / 8-Pin DIP • 3.3V • HCMOS/TTL • Tri-State E/D	• 14-Pin / 8-Pin DIP • 5.0V • TTL
Catalog Pages	Pages 46	Page 47	Page 48	Page 49	Page 50

GENERAL CHARACTERISTICS

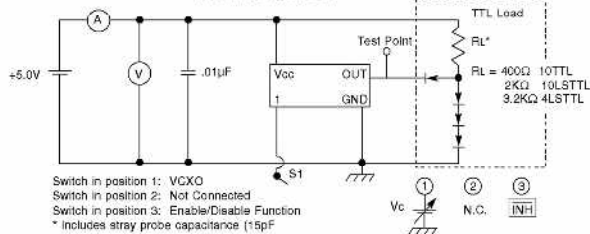
• MECHANICAL SPECIFICATIONS

Gross Leak Test	All units 100% leak tested.
Hermetically Sealed Package	Mass spectrometer leak rate less than 2×10^{-8} Atm. CC/sec. of helium.
Seal Strength (Thru-Hole)	2.27Kg max. force perpendicular to top and bottom.
Bend Test (Pin Material)	Will withstand maximum bend of 90°, referenced to base, for 2 bends. (Iron and Nickel - Nickel coated, solder dipped.)
Solvent Resistance	Isopropyl Alcohol, Trichloroethane Note 1 - Ultrasonic cleaning not to be used. Note 2 - Unit can be cleaned in only one solvent listed.
Marking Ink	Epoxy, heat cured or UV cured (ceramic SMD)
Solderability	The terminals are considered solderable and acceptable for electrical connection if 95% of the cooled solder surface is uniform and free from breaks and pinholes. The other 5% of the cooled solder surface may show only pinholes, voids, or rough spots that are not concentrated in one area.
Maximum Soldering Temp.	270°C for 10 seconds on leads.

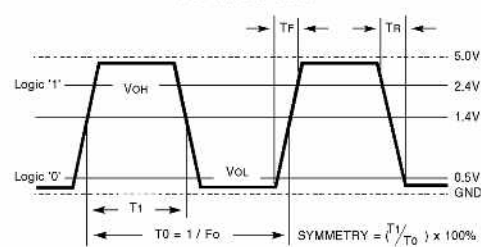
Reliability Tests: Shock, Vibration, Aging (Burn-in), Temperature Cycle.

All specifications subject to change without notice. Rev. 05/03/00

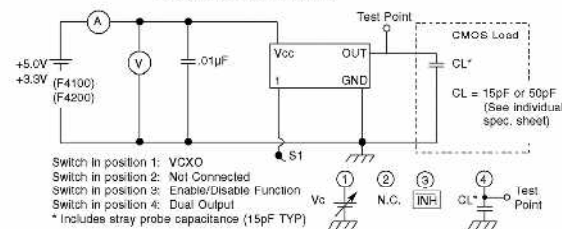
TTL TEST CIRCUIT



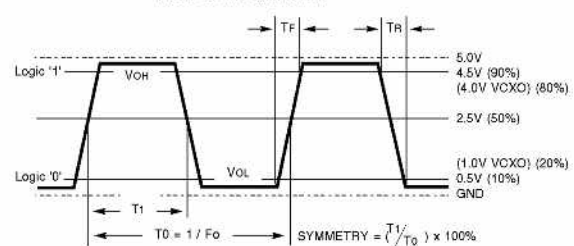
TTL WAVEFORM



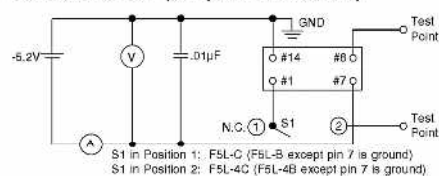
HCMOS TEST CIRCUIT



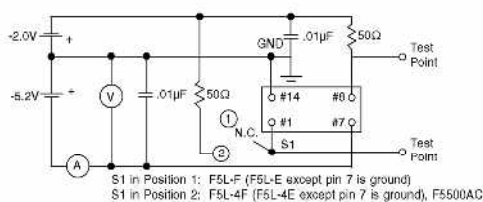
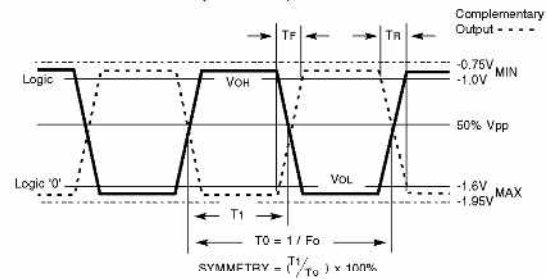
HCMOS WAVEFORM



ECL TEST CIRCUIT (with pull down resistors)



ECL TEST CIRCUIT (without pull down resistors)

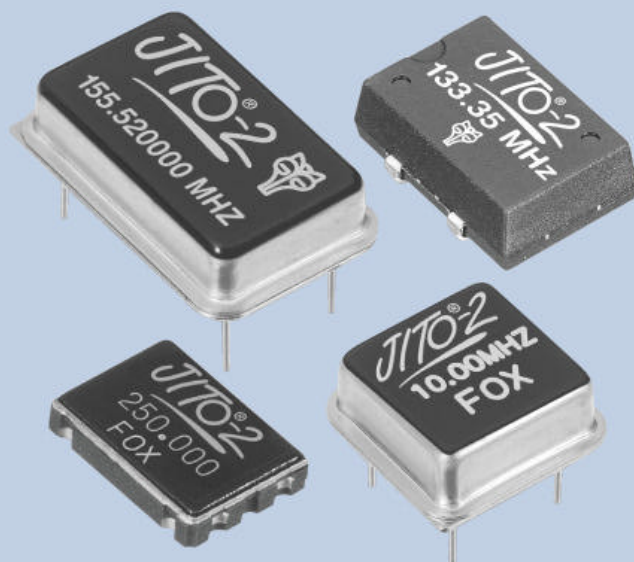
ECL WAVEFORM
(VEE = -5.2V)

*Fox Redefines
Oscillator Delivery.*



J/TO-2[®]

JUST-IN-TIME OSCILLATORS[®]



*Fox's Expanded Line of Custom and Standard
Frequency Oscillators...in Just Days.*

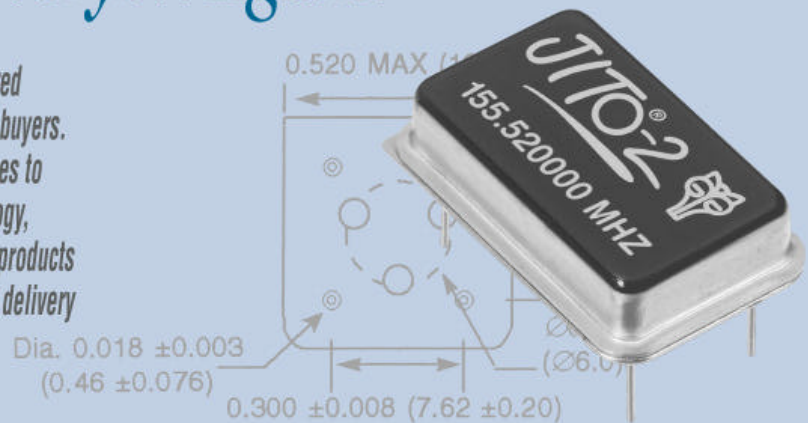
ISO-9001
Certified

FOX Electronics

FOX...

Redefining Oscillator Delivery... Again!

For years, Fox has been ranked as America's preferred oscillator/crystal company...by both engineers and buyers. But we've never rested on our laurels. Fox continues to pioneer advances in crystal and oscillator technology, availability and technical support...from standard products to custom solutions. Now, Fox redefines oscillator delivery and scheduling flexibility.



Meeting Today's Time-to-Market Pressures with JITO®-2 ... Just-In-Time Oscillators®: Custom and Standard Frequency Oscillators in Days!

The new JITO®-2 (Just-In-Time Oscillators®) line represents Fox's latest contribution to helping buyers and engineers alike meet the increasing pressure of bringing new designs and products to market faster and more efficiently. This new line of crystal oscillators cuts the industry standard lead time of 10 weeks down to just 10 business days or less for custom or standard frequency oscillators.

JITO®-2 represents the latest Fox response to urgent marketplace pressures. Engineers need custom frequencies as quickly as possible to test and prove their prototypes. Production people need to know that custom frequency products can be accessed quickly without holding up their line. And buyers have to ensure they can satisfy both engineering and production needs. The JITO®-2 line provides a total solution to those requirements by cutting industry standard lead times by an average of 90%.

Meeting Today's Build-to-Order (BTO) Flexible Scheduling Needs

The ability to provide custom and standard frequency oscillators in days rather than weeks translates to tremendous benefits in terms of production scheduling flexibility. Only Fox's JITO®-2 program provides all this:

- Changes in orders allowed up to ship date
- Flexibility to cancel orders up to 10 days prior to ship date at no cost
- Unlimited upside order flexibility
- Samples and prototypes shipped immediately

These JITO®-2 advantages yield increased user benefits, including:

- No stocking or forecasting required
- JIT scheduling flexibility
- Ideal for build-to-order manufacturing
- No part shortages
- Streamlined inventory handling and control

In every respect, JITO®-2 lets you get to market faster and more efficiently than ever before.

JITO®-2 today...and tomorrow

Fox's current JITO®-2 line is offered in the following ranges:

- Custom and standard frequencies from 340 kHz up to 250 MHz
- 100, 50, 30, 25 and 20 PPM stability
- 3.3 or 5 volts; -20 to +70°C or -40 to +85°C operating range
- Both SMD and thru-hole packaging available
- Fox quality built-in
- Total technical support from the industry leader
- Reduced Phase Jitter - less than that of competitive programmable oscillators

JITO®-2 is Fox's answer to the phenomenal response we received from engineers and buyers to our initial JITO® program. The much-expanded and enhanced line features a wider range of frequencies, stabilities, operating temperatures and packages, plus greater flexibility in specification changing and scheduling. As JITO®-2 expands, we'll post product information on our website; www.foxonline.com. Check it, contact your local Fox representative, or call direct, 888-GET-2-FOX.

JITO®-2 Specifications

ELECTRICAL CHARACTERISTICS (CL = Max Load; HCMOS Option = Single Output)

PARAMETERS	FREQUENCY RANGE	CONDITIONS	MIN	MAX	UNITS
Frequency Range (Fo)			0.340	250.000	MHZ
Frequency Stability	0.340 ~ 250.000	All Conditions ¹	-100 -50 -30 -25 -20	+100 +50 +30 +25 +20 ³	PPM
Temperature Range Operating (TOPR) Storage (TSTG)	0.340 ~ 250.000		-20 -40 -55	+70 +85 +125	°C
Supply Voltage (VDD)	0.340 ~ 250.000		+4.5 +3.0	+5.5 +3.6	V
Input Current**	0.340 ~ 25.000 25.000+ ~ 50.000 50.000+ ~ 150.000 150.000+ ~ 250.000	VDD = 5.0V Max Load (HCMOS)		15 20 33 55	mA
	0.340 ~ 200.000 ⁴	VDD = 5.0V PECL		55	
	0.340 ~ 25.000 25.000+ ~ 50.000 50.000+ ~ 150.000 150.000+ ~ 250.000	VDD = 3.3V Max Load (HCMOS)		8 11 21 30	
	0.340 ~ 200.000 ⁴	VDD = 3.3V PECL		30	
Output Symmetry	0.340 ~ 250.000	50% VDD Level HCMOS	45	55	%
	0.340 ~ 200.000 ⁴	50% Vp-p Level PECL	40	60	
Rise Time	0.340 ~ 250.000	10% ~ 90% VDD Level HCMOS		5	nS
	0.340 ~ 200.000 ⁴	20% ~ 80% Vp-p Level PECL		2	
Fall Time	0.340 ~ 250.000	90% ~ 10% VDD Level HCMOS		5	
	0.340 ~ 200.000 ⁴	80% ~ 20% Vp-p Level PECL		2	
Output Voltage HCMOS (VOL) (VOH)	0.340 ~ 250.000	VDD = 5.0V±10% IOL = 4mA IOH = -4mA		10%VDD 90%VDD	V
PECL (VOL) (VOH)		VDD = 3.3V±10% IOL = 2mA IOH = -2mA		10%VDD 90%VDD	
	0.340 ~ 200.000 ⁴	VDD = 5.0V Per recommended termination	3.0 3.9	3.4 4.3	V
		VDD = 3.3V Per recommended termination	1.2 2.2	1.6 2.6	
Output Current HCMOS (IOL) (IOH)	0.340 ~ 250.000	VDD = 5.0V±10% VOL = 10%VDD VOH = 90% VDD		4 -4	mA
		VDD = 3.3V±10% VOL = 10%VDD VOH = 90%VDD		2 -2	
Output Load	0.340 ~ 100.000 100.000+ ~ 250.000	VDD = 5.0V±10% (HCMOS)		25 10	pF
	0.340 ~ 100.000 100.000+ ~ 250.000	VDD = 3.3V ±10% (HCMOS)		15 10	
Start-up Time (Ts)	0.340 ~ 250.000			10	mS
Enable/Disable Time ² (JITO®-2 D) (JITO®-2 P)	0.340 ~ 250.000			100	nS
Output Skew (JITO®-2 D) (PECL)	0.340 ~ 200.000 ⁴	50% Vp-p		500	pS

¹ Inclusive of 25°C tolerance, operating temperature range, input voltage change, load change, aging, shock and vibration.

² Stand by current (3.3V) = 60µA (MAX) • Stand by enable time = 10mS (MAX)

³ Inclusive of 25°C tolerance, operating temperature range, input voltage change, load change, shock and vibration.

⁴ PECL can be programmed to 250 MHz; output terminations may have to be modified

for desired output levels. See Application Note "JITO-2 PECL Interface Considerations".

NOTE: A0.01µF bypass capacitor should be placed between VDD and GND to minimize power supply line noise.

JITO®-2
JUST-IN-TIME OSCILLATORS®

Covered by U.S. Patents
5,952,890 and 5,960,405
and 6,188,290.

Covered by one or more listed
Foreign Patents: R.S.A. 98/0866
and R.O.C. 120851.

ENABLE/DISABLE FUNCTION

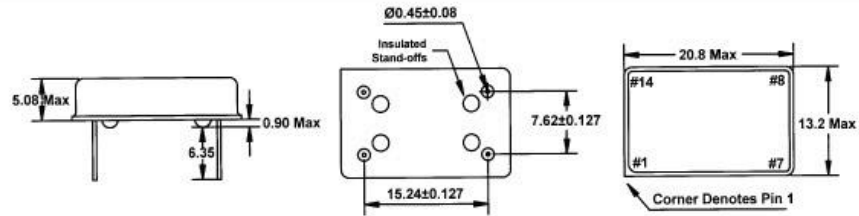
PIN 1	Output
	MIN-6: Pins 4&2 (PECL) JITO®-2 P: Pin 3
OPEN	ACTIVE
'1' Level VIH ≥ 70%VDD	ACTIVE
'0' Level VIL ≤ 30%VDD	High Z

JITO®-2 . Only from Fox Electronics. Because in this business, timing is everything.

FULL SIZE 14 PIN DIP

Pin Connections
#1 N.C. #8 Output
#7 GND #14 VDD

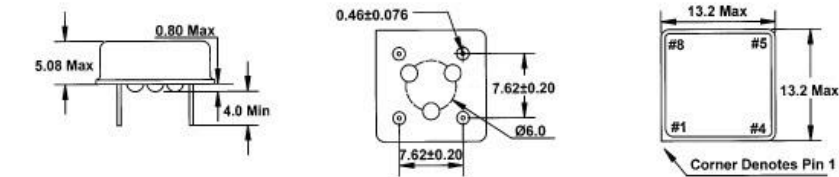
Package
A



HALF SIZE 8 PIN DIP

Pin Connections
#1 N.C. #5 Output
#4 GND #8 VDD

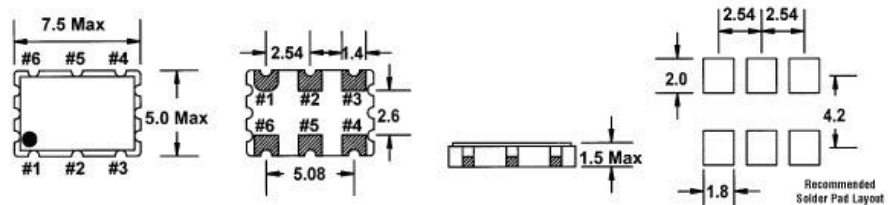
Package
B



MIN-6 SMD

Pin Connections
#1 E/D #6 VDD
#2 N.C. or Out2 #5 N.C.
#3 GND #4 Output

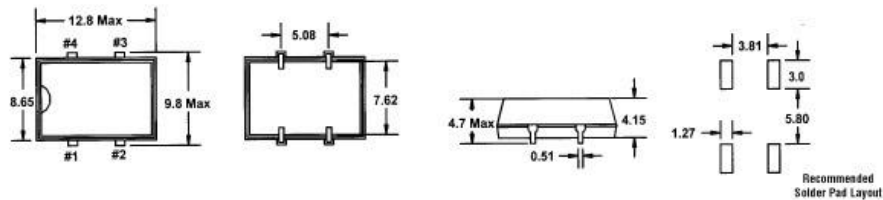
Package
D



JITO®-2P

Pin Connections
#1 E/D #2 GND
#3 Output #4 VDD

Package
P



SMD Packaging – Tape & Reel Specifications (in millimeters)

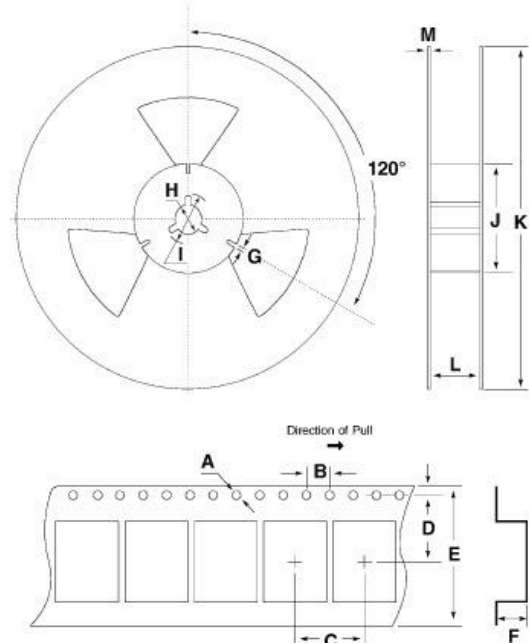
Tape Specifications (millimeters)

Model	A	B	C	D	E	F
JITO®-2D	Ø1.5	4.0	8.0	7.5	16.0	2.15
JITO®-2P	Ø1.5	4.0	12.0	11.5	24.0	5.2
JITO®-2A	Shipped in tubes of 25 only.					
JITO®-2B	Shipped in tubes of 40 only.					

Reel Specifications (millimeters)

Model	G	H	I	J	K	L	M
JITO®-2D	2.0	Ø13	Ø21	Ø80	Ø2.50	17.5	2.0
JITO®-2P	2.0	Ø13	Ø21	Ø80	Ø330	25.5	2.0
JITO®-2A	Shipped in tubes of 25 only.						
JITO®-2B	Shipped in tubes of 40 only.						

JITO®-2D Standard quantity is 2,000. JITO®-2P Standard quantity is 1,000.



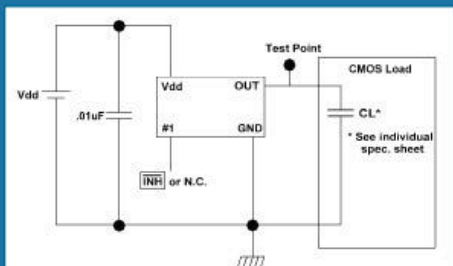
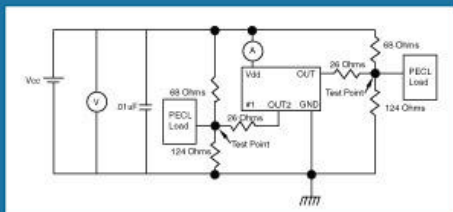
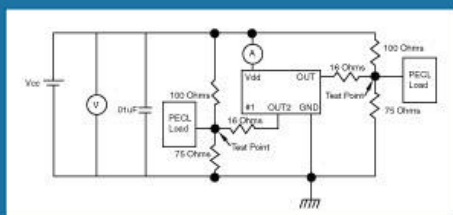
The JITO[®]-2 PECL Advantage

The JITO[®]-2 PECL option is basically a method of getting high-speed differential outputs from the internal CMOS circuitry. Similar to ECL, PECL utilizes positive ECL values. This option places the complement of the f_{out} signal on the f_{out2} output while maintaining a low skew between the signal edges.

Typically these signals have very low voltage swings (around 1Vp-p), thus reducing unwanted radiation. Another big advantage is the complementary pair aids common mode noise rejection. In essence, you can filter out noise, which is common on both lines.

This interface is quickly becoming the standard for new high end disk drives (Fiber Channel) and new high speed networking such as SONET and Ethernet.

JITO[®]-2 3.3V PECL Test Circuit (below),
5.0V PECL Test Circuit (middle), and
HCMOS Test Circuit (bottom).

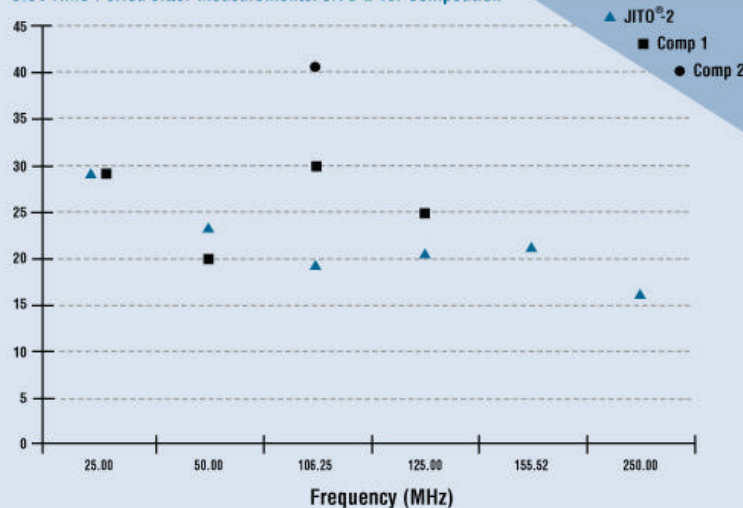


Typical Period Jitter Measurements at Fox Electronics

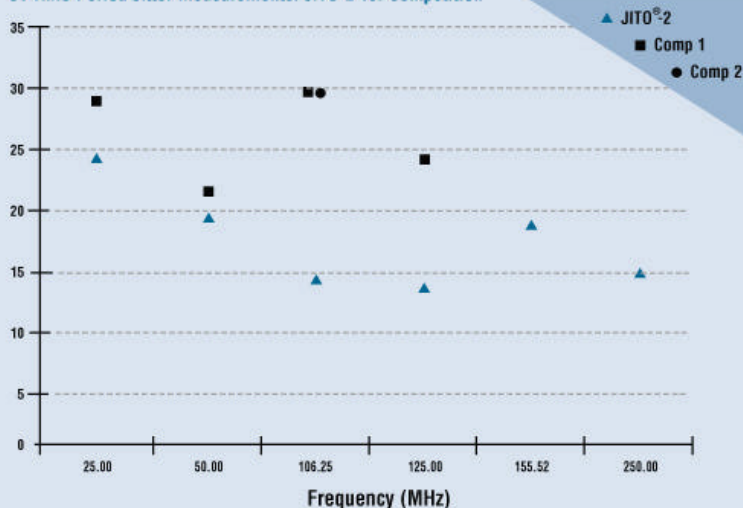
Period jitter is measured as a statistical distribution of the deviation in an oscillator's period widths. Period jitter is measured at Fox Electronics in the following manner:

A 'single-shot' acquisition of several thousand consecutive cycles is taken and each period is measured. A histogram is then constructed of the period widths from which the RMS (one sigma) and p-p (deviation from the smallest measured period to the largest measured period) is determined. For jitter that is gaussian in nature, RMS is considered the most accurate measurement of the period jitter distribution.

3.3V RMS Period Jitter Measurements: JITO-2 vs. Competition



5V RMS Period Jitter Measurements: JITO-2 vs. Competition



Application Precautions: It is recommended that a sample be evaluated in each application before adding JITO[®]-2 or any other oscillator to the AVL. This JITO[®]-2 series of products utilize PLL technology. As a result, overall circuit jitter will often increase if applied to another PLL device. Please contact Fox technical support if you require assistance.

Latch up Statement: The JITO[®] family of oscillators are CMOS devices and are sensitive to latch up conditions characteristic of such devices. Applying power to the enable/disable connection or any other unused connections prior to applying power to the VDD pin can cause latch up. The N/C pins of the JITO[®] family are internally connected; connecting these pins can cause unstable operation and possibly permanent damage.



JITO[®]-2 ORDERING INFORMATION

Use the part description guide below to order the JITO[®]-2 Oscillator you need:

JITO[®]-2 PART DESCRIPTION GUIDE

JITO[®]-2 - B C 3 A M C - 106.250000

Package Style:

A = 14 Pin DIP
B = 8 Pin DIP
D = MIN-6 (5x7.5x1.5mm
6 Pad SMD)
P = Plastic (10x13x5mm)

Type:

C = HCMOS
P = PECL
S = HCMOS/Standby
(D & P Pkg. only)
X = 2nd HCMOS Output/÷2
(D Pkg. only)
Y = 2nd HCMOS Output/÷4
(D Pkg. only)
Z = 2nd HCMOS Output/÷8
(D Pkg. only)

Supply Voltage:

5 = +5.0V
3 = +3.3V

Stability:

A = ±100ppm
B = ±50ppm
C = ±30ppm
D = ±25ppm
E = ±20ppm**

Temperature Range:

F = -20°C to +70°C
M = -40°C to +85°C

Frequency (MHz)

C = Custom
(or leave blank)

If you need assistance in selecting the proper JITO[®]-2 oscillator for your specific application, Fox's skilled technical support team will be glad to assist you. Just call us.

** Only available in F temperature range.

JITO[®]-T: (Thru-Hole, Dual Output PECL, Tri-State) Ask your Customer Service Representative for details.

OTHER FOX FREQUENCY CONTROL PRODUCTS

The JITO[®]-2 series represents just a portion of the broad spectrum of frequency control products and solutions available from Fox, including:

Quartz Crystals: Frequencies from 32.768 kHz to 200 MHz, standard and custom; stabilities to 5 PPM.

Oscillators: Frequencies from 340 kHz to 250 MHz, standard and custom; stabilities from 20 PPM to 100 PPM.

TCXOs/VCXOs: High performance temperature- and voltage-controlled oscillators; frequencies from 1 MHz to 622.080 MHz.

Crystal Filters: Frequencies from 10.7 MHz to 90 MHz.

All Fox frequency control products are 100% tested, offered in a variety of surface mount and thru-hole configurations, and are available directly from Fox or off the shelves of our very well stocked national distribution network.



FOX Electronics

We're On Your Frequency.

5570 Enterprise Parkway
Fort Myers, FL 33905
Tel: **888-GET-2-FOX**
Fax: 941-693-1554

When it comes to frequency control, why trust your products to anyone less than Fox? It always pays to go with the leader. Call, fax or visit us on the web today.

www.foxonline.com

FX-3336-600-SM-FP
Revised November 2001

3.3V HCMOS SMD OSCILLATOR WITH STANDBY

F330 SERIES

FEATURES

- 3.3V Operation
- HCMOS Output
- Standby Function
- Tape and Reel (2,000 pcs. STD)



• MODEL NUMBER SELECTION

Model Number	Frequency Stability ¹	Operating Temperature (°C)	Frequency Range (MHz)
F330	±100PPM	-10 ~ +70	1.800 ~ 50.000
F330R	±100PPM	-40 ~ +85	1.800 ~ 50.000
F335	±50PPM	-10 ~ +70	1.800 ~ 50.000
F335R	±50PPM	-40 ~ +85	1.800 ~ 50.000
F336	±25PPM	-10 ~ +70	1.800 ~ 50.000
F338	±20PPM	-10 ~ +70	1.800 ~ 50.000

• ELECTRICAL CHARACTERISTICS

PARAMETERS	MAX (unless otherwise noted)
Frequency Range (Fo)	1.800 ~ 50.000 MHz
Storage Temperature Range (T _{STG})	-55°C ~ +125°C
Supply Voltage (V _{DD})	3.3V ± 10%
Input Current (I _{DD})	
1.800 ~ 32.000 MHz	20mA
32.000+ ~ 50.000 MHz	25mA
Output Symmetry (50% V _{DD})	
1.000 ~ 50.000 MHz	45% ~ 55%
Rise Time (10% ~ 90% V _{DD}) (T _R)	6nS
Fall Time (90% ~ 10% V _{DD}) (T _F)	6nS
Output Voltage (V _{OL})	10% V _{DD}
(V _{OH})	90% V _{DD} Min
Output Current (I _{OL})	2mA Min
(I _{OH})	-2mA Min
Output Load (HCMOS)	15pF
Standby Current (V _{IL} ≤ 0.99V)	10μA
Start-up Time (T _S)	5mS
Output Disable Time ²	150nS
Output Enable Time ²	5mS

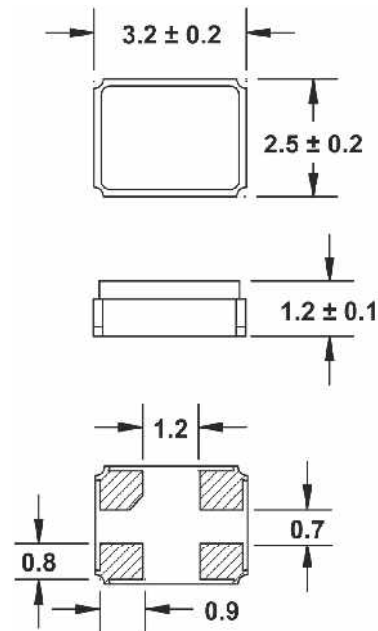
¹ Inclusive of 25°C tolerance, operating temperature range, input voltage change, load change, aging, shock, and vibration.

³ An internal pullup resistor from pin 1 to pin 4 allows active output if pin 1 is left open.

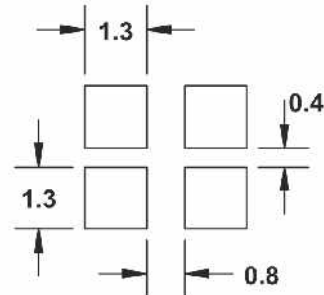
See page 29 for mechanical specifications, test circuits, and output waveform.

Note: A 0.01μF bypass capacitor should be placed between V_{DD} (Pin 4) and GND (Pin 2) to minimize power supply line noise.

All specifications subject to change without notice. Rev. 10/01/02



Recommended Solder Pad Layout



Pin Connections

- #1 E/D** #3 Output
#2 GND #4 V_{DD}

All dimensions are in millimeters.

• ENABLE / DISABLE FUNCTION ²	
INH (Pin 1)	OUTPUT (Pin 3)
OPEN ³	ACTIVE
'1' Level V _{IH} ≥ 2.31 V	ACTIVE
'0' Level V _{IL} ≤ 0.99 V	High Z

See page 53 for tape and reel specifications.

1.8V HCMOS CERAMIC SMD OSCILLATOR WITH STANDBY

F510L SERIES

FEATURES

- 1.8V Operation
- HCMOS Output
- Low Power Consumption
- Standby Function
- Tape and Reel (1,000 or 2,000 pcs. STD)



• MODEL NUMBER SELECTION

Model Number	Frequency Stability ¹	Operating Temperature (°C)	Frequency Range (MHz)
F510L	±100PPM	-10 ~ +70	1.800 ~ 50.000
F510LR	±100PPM	-40 ~ +85	1.800 ~ 50.000
F515L	±50PPM	-10 ~ +70	1.800 ~ 50.000
F515LR	±50PPM	-40 ~ +85	1.800 ~ 50.000
F516L	±25PPM	-10 ~ +70	1.800 ~ 50.000
F516LR	±25PPM	-40 ~ +85	1.800 ~ 50.000
F518L	±20PPM	-10 ~ +70	1.800 ~ 50.000

• ELECTRICAL CHARACTERISTICS

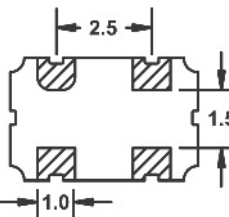
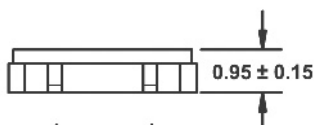
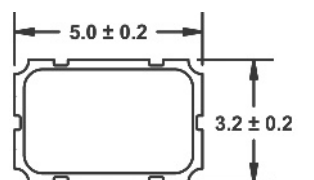
PARAMETERS	MAX (unless otherwise noted)
Frequency Range (Fo)	1.800 ~ 50.000 MHz
Storage Temperature Range (T _{STG})	-55°C ~ +125°C
Supply Voltage (V _{DD})	1.8V ± 5%
Input Current (I _{DD})	
1.800 ~ 32.100 MHz	7mA
32.100+ ~ 50.000 MHz	15mA
Output Symmetry (50% V _{DD})	40% ~ 60%
Rise Time (20% ~ 80% V _{DD}) (T _R)	
1.800 ~ 32.100 MHz	5nS
32.100+ ~ 50.000 MHz	3.5nS
Fall Time (80% ~ 20% V _{DD}) (T _F)	
1.800 ~ 32.100 MHz	5nS
32.100+ ~ 50.000 MHz	3.5nS
Output Voltage (V _{OL})	20% V _{DD}
(V _{OH})	80% V _{DD} Min
Output Current (I _{OL})	2mA Min
(I _{OH})	2mA Min
Output Load (HCMOS)	15pF
Standby Current	10μA
Start-up Time (T _s)	10mS
Output Disable Time ²	300nS
Output Enable Time ²	10mS

¹ Inclusive of 25°C tolerance, operating temperature range, input voltage change, load change, aging,

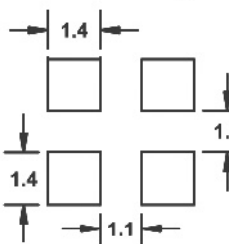
shock, and vibration.

See page 29 for mechanical specifications, test circuits, and output waveform.

All specifications subject to change without notice. Rev. 05/01/02



Recommended Solder Pad Layout



Pin Connections

- #1 E/D** #3 Output
#2 GND #4 V_{DD}

All dimensions are in millimeters.

• ENABLE / DISABLE FUNCTION²

INH (Pin 1)	OUTPUT (Pin 3)
OPEN	ACTIVE
'1' Level V _{IH} ≥ 0.7 V	ACTIVE
'0' Level V _{IL} ≤ 0.3 V	High Z

See page 53 for tape and reel specifications.

2.5V HCMOS CERAMIC SMD OSCILLATOR WITH STANDBY

F540L SERIES

FEATURES

- 2.5V Operation
- HCMOS Output
- Low Power Consumption
- Standby Function
- Tape and Reel (1,000 or 2,000 pcs. STD)



• MODEL NUMBER SELECTION

Model Number	Frequency Stability ¹	Operating Temperature (°C)	Frequency Range (MHz)
F540L	±100PPM	-10 ~ +70	1.800 ~ 50.000
F540LR	±100PPM	-40 ~ +85	1.800 ~ 50.000
F545L	±50PPM	-10 ~ +70	1.800 ~ 50.000
F545LR	±50PPM	-40 ~ +85	1.800 ~ 50.000
F546L	±25PPM	-10 ~ +70	1.800 ~ 50.000
F546LR	±25PPM	-40 ~ +85	1.800 ~ 50.000
F548L	±20PPM	-10 ~ +70	1.800 ~ 50.000

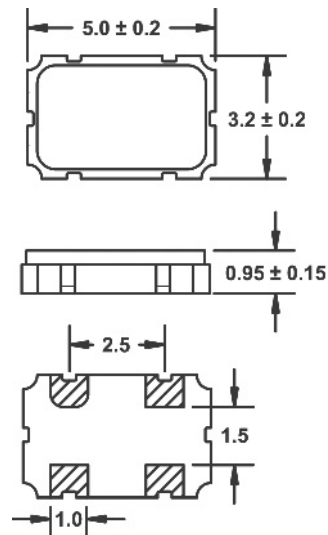
• ELECTRICAL CHARACTERISTICS

PARAMETERS	MAX (unless otherwise noted)
Frequency Range (Fo)	1.800 ~ 50.000 MHz
Storage Temperature Range (T _{STG})	-55°C ~ +125°C
Supply Voltage (V _{DD})	2.5V ± 5%
Input Current (I _{DD})	
1.800 ~ 32.100 MHz	10mA
32.100+ ~ 50.000 MHz	12mA
Output Symmetry (50% V _{DD})	45% ~ 55%
Rise Time (10% ~ 90% V _{DD}) (T _R)	5nS
Fall Time (90% ~ 10% V _{DD}) (T _F)	5nS
Output Voltage (V _{OL})	10% V _{DD}
(V _{OH})	90% V _{DD} Min
Output Current (I _{OL})	4mA Min
(I _{OH})	4mA Min
Output Load (HCMOS)	15pF
Standby Current	10μA
Start-up Time (T _S)	10mS
Output Disable Time ²	150nS
Output Enable Time ²	10mS

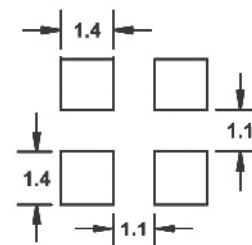
¹ Inclusive of 25°C tolerance, operating temperature range, input voltage change, load change, aging, shock, and vibration.

See page 29 for mechanical specifications, test circuits, and output waveform.

All specifications subject to change without notice. Rev. 05/01/02



Recommended Solder Pad Layout



Pin Connections

#1 E/D** #3 Output
#2 GND #4 V DD

All dimensions are in millimeters.

• ENABLE / DISABLE FUNCTION ²

INH (Pin 1)	OUTPUT (Pin 3)
OPEN	ACTIVE
'1' Level V _{IH} ≥ 0.7 V	ACTIVE
'0' Level V _{IL} ≤ 0.3 V	High Z

See page 53 for tape and reel specifications.

3.3V HCMOS CERAMIC SMD OSCILLATOR WITH STANDBY

F530L SERIES

FEATURES

- 3.3V Operation
- HCMOS Output
- Standby Function
- Tape and Reel (1,000 or 2,000 pcs. STD)

OPTIONS

- 5.0V (F550L) Version Available



• MODEL NUMBER SELECTION

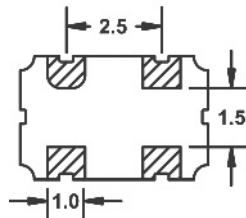
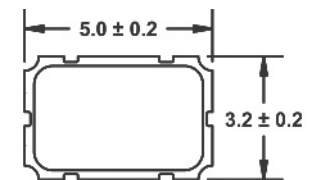
Model Number	Frequency Stability ¹	Operating Temperature (°C)	Frequency Range (MHz)
F530L	±100PPM	-10 ~ +70	1.544 ~ 155.520
F530LR	±100PPM	-40 ~ +85	1.544 ~ 155.520
F535L	±50PPM	-10 ~ +70	1.544 ~ 155.520
F535LR	±50PPM	-40 ~ +85	1.544 ~ 155.520
F536L	±25PPM	-10 ~ +70	1.544 ~ 155.520
F536LR	±25PPM	-40 ~ +85	1.544 ~ 50.000
F538L	±20PPM	-10 ~ +70	1.544 ~ 50.000

• ELECTRICAL CHARACTERISTICS

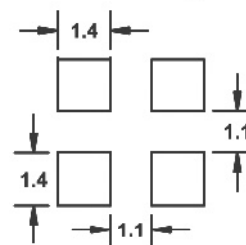
PARAMETERS	MAX (unless otherwise noted)
Frequency Range (Fo)	1.544 ~ 155.520 MHz
Storage Temperature Range (T _{STG})	-40°C ~ +85°C
Supply Voltage (V _{DD})	3.3V ± 10%
Input Current (I _{DD})	20mA
Output Symmetry (50% V _{DD})	40% ~ 60%
Rise Time (10% ~ 90% V _{DD}) (T _R)	7nS
Fall Time (90% ~ 10% V _{DD}) (T _F)	7nS
Output Voltage (V _{OL})	10% V _{DD}
(V _{OH})	90% V _{DD} Min
Output Current (I _{OL})	2mA Min
(I _{OH})	-2mA Min
Output Load HCMOS	15pF
Standby Current	10μA
Start-up Time (T _s)	10mS
Output Disable Time ²	150nS
Output Enable Time ²	10mS

¹ Inclusive of 25°C tolerance, operating temperature range, input voltage change, load change, aging, shock, and vibration.

See page 29 for mechanical specifications, test circuits, and output waveform.
All specifications subject to change without notice. Rev. 05/01/02



Recommended Solder Pad Layout



Pin Connections

- #1 E/D**
- #2 GND
- #3 Output
- #4 V_{DD}

All dimensions are in millimeters.

• ENABLE / DISABLE FUNCTION²

INH (Pin 1)	OUTPUT (Pin 3)
OPEN	ACTIVE
'1' Level V _{IH} ≥ 2.31 V	ACTIVE
'0' Level V _{IL} ≤ 0.99 V	High Z

See page 53 for tape and reel specifications.

3.3V HCMOS CERAMIC SMD OSCILLATOR WITH STANDBY

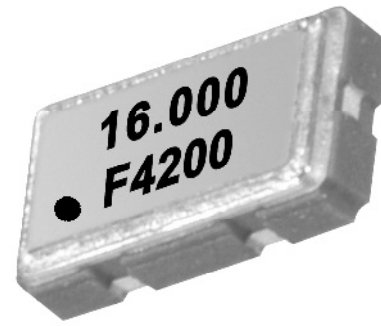
F4200 SERIES

FEATURES

- 3.3V Operation
- HCMOS Output
- Standby Function
- Tape and Reel (2,000 pcs. STD)

OPTIONS

- 5.0V (F3400) Version Available



OSCILLATORS

• MODEL NUMBER SELECTION

Model Number	Frequency Stability ¹	Operating Temperature (°C)	Frequency Range (MHz)
F4200	±100PPM	-10 ~ +70	1.544 ~ 50.000
F4200R	±100PPM	-40 ~ +85	1.544 ~ 50.000
F4205	±50PPM	-10 ~ +70	1.544 ~ 50.000
F4205R	±50PPM	-40 ~ +85	1.544 ~ 50.000
F4206	±25PPM	-10 ~ +70	1.544 ~ 50.000
F4206R	±25PPM	-40 ~ +85	1.544 ~ 50.000
F4208	±20PPM	-10 ~ +70	1.544 ~ 50.000

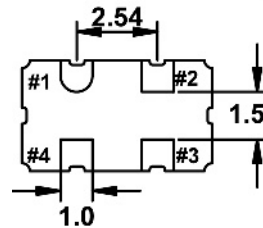
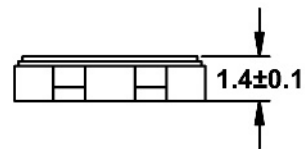
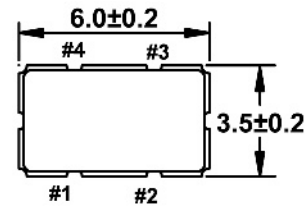
• ELECTRICAL CHARACTERISTICS

PARAMETERS	MAX (unless otherwise noted)
Frequency Range (Fo)	1.544 ~ 50.000 MHz
Storage Temperature Range (T _{STG})	-40°C ~ +85°C
Supply Voltage (V _{DD})	3.3V ± 10%
Input Current (I _{DD})	20mA
Output Symmetry (50% V _{DD})	40% ~ 60%
Rise Time (10% ~ 90% V _{DD}) (T _R)	6nS
Fall Time (90% ~ 10% V _{DD}) (T _F)	6nS
Output Voltage (V _{OL})	10% V _{DD}
(V _{OH})	90% V _{DD} Min
Output Current (I _{OL})	2mA Min
(I _{OH})	-2mA Min
Output Load (HCMOS)	15pF
Standby Current	10μA
Start-up Time (T _S)	10mS
Output Disable Time ²	150nS
Output Enable Time ²	10nS

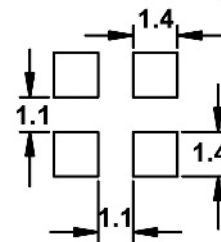
¹ Inclusive of 25°C tolerance, operating temperature range, input voltage change, load change, aging, shock, and vibration.

³ An internal pullup resistor from pin 1 to pin 4 allows active output if pin 1 is left open. See page 29 for mechanical specifications, test circuits, and output waveform.

All specifications subject to change without notice. Rev. 05/01/02



Recommended Solder Pad Layout



Pin Connections

#1 E/D** #3 Output
#2 GND #4 V_{DD}

All dimensions are in millimeters.

• ENABLE / DISABLE FUNCTION ²	
INH (Pin 1)	OUTPUT (Pin 3)
OPEN ³	ACTIVE
'1' Level V _{IH} ≥ 2.31 V	ACTIVE
'0' Level V _{IL} ≤ 0.99 V	High Z

See page 53 for tape and reel specifications.

F4500 SERIES

FEATURES

- 1.8V Operation
- HCMOS Output
- Low Power Consumption
- Standby Function
- Tape and Reel (2,000 pcs. STD)



• MODEL NUMBER SELECTION

Model Number	Frequency Stability ¹	Operating Temperature (°C)	Frequency Range (MHz)
F4500	±100PPM	-10 ~ +70	1.800 ~ 70.000
F4500R	±100PPM	-40 ~ +85	1.800 ~ 70.000
F4505	±50PPM	-10 ~ +70	1.800 ~ 70.000
F4505R	±50PPM	-40 ~ +85	1.800 ~ 70.000
F4506	±25PPM	-10 ~ +70	1.800 ~ 70.000
F4506R	±25PPM	-40 ~ +85	1.800 ~ 70.000
F4508	±20PPM	-10 ~ +70	1.800 ~ 70.000

• ELECTRICAL CHARACTERISTICS

PARAMETERS	MAX (unless otherwise noted)
Frequency Range (F _o)	1.800 ~ 70.000 MHz
Storage Temperature Range (T _{STG})	-55°C ~ +125°C
Supply Voltage (V _{DD})	1.8V ± 5%
Input Current (I _{DD})	
1.000 ~ 32.100 MHz	7mA
32.100+ ~ 70.000 MHz	15mA
Output Symmetry (50% V _{DD})	40% ~ 60%
Rise Time (20% ~ 80% V _{DD}) (T _R)	
1.800 ~ 32.100 MHz	5nS
32.100+ ~ 70.000 MHz	3.5nS
Fall Time (80% ~ 20% V _{DD}) (T _F)	
1.800 ~ 32.100 MHz	5nS
32.100+ ~ 70.000 MHz	3.5nS
Output Voltage (V _{OL})	20% V _{DD}
(V _{OH})	80% V _{DD} Min
Output Current (I _{OL})	2mA Min
(I _{OH})	2mA Min
Output Load (HCMOS)	15pF
Standby Current	10μA
Start-up Time (T _s)	10mS
Output Disable Time ²	300nS
Output Enable Time ²	10mS

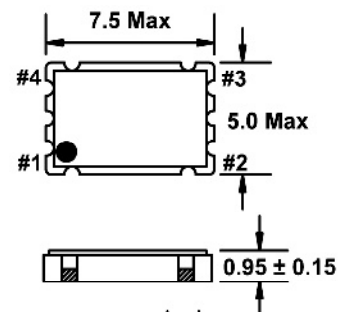
¹ Inclusive of 25°C tolerance, operating temperature range, input voltage change, load change, aging, shock, and vibration.

³ An internal pullup resistor from pin 1 to pin 4 allows active output if pin 1 is left open.

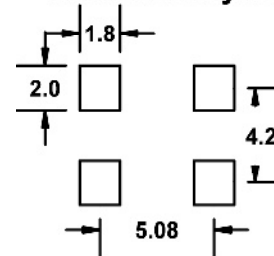
See page 29 for mechanical specifications, test circuits, and output waveform.

Note: A 0.01μF bypass capacitor should be placed between VDD (Pin 4) and GND (Pin 2) to minimize power supply line noise.

All specifications subject to change without notice. Rev. 05/01/02



Recommended Solder Pad Layout



Pin Connections

#1 E/D #3 Output
#2 GND #4 V_{DD}

All dimensions are in millimeters.

• ENABLE / DISABLE FUNCTION ²

INH (Pin 1)	OUTPUT (Pin 3)
OPEN ³	ACTIVE
'1' Level V _{IH} ≥ 0.7 V	ACTIVE
'0' Level V _{IL} ≤ 0.3 V	High Z

See page 53 for tape and reel specifications.

2.5V HCMOS SMD OSCILLATOR WITH STANDBY

F4400 SERIES

FEATURES

- 2.5V Operation
- HCMOS Output
- Low Power Consumption
- Standby Function
- Tape and Reel (2,000 pcs. STD)



• MODEL NUMBER SELECTION

Model Number	Frequency Stability ¹	Operating Temperature (°C)	Frequency Range (MHz)
F4400	±100PPM	-10 ~ +70	1.800 ~ 50.000
F4400R	±100PPM	-40 ~ +85	1.800 ~ 50.000
F4405	±50PPM	-10 ~ +70	1.800 ~ 50.000
F4405R	±50PPM	-40 ~ +85	1.800 ~ 50.000
F4406	±25PPM	-10 ~ +70	1.800 ~ 50.000
F4406R	±25PPM	-40 ~ +85	1.800 ~ 50.000
F4408	±20PPM	-10 ~ +70	1.800 ~ 50.000

• ELECTRICAL CHARACTERISTICS

PARAMETERS	MAX (unless otherwise noted)
Frequency Range (Fo)	1.800 ~ 50.000 MHz
Storage Temperature Range (T _{STG})	-55°C ~ +125°C
Supply Voltage (V _{DD})	2.5V ± 5%
Input Current (I _{DD})	
1.800 ~ 32.100 MHz	10mA
32.100+ ~ 50.000 MHz	12mA
Output Symmetry (50% V _{DD})	45% ~ 55%
Rise Time (10% ~ 90% V _{DD}) (T _R)	5nS
Fall Time (90% ~ 10% V _{DD}) (T _F)	5nS
Output Voltage (V _{OL})	10% V _{DD}
(V _{OH})	90% V _{DD} Min
Output Current (I _{OL})	4mA Min
(I _{OH})	4mA Min
Output Load (HCMOS)	15pF
Standby Current	10μA
Start-up Time (T _S)	10mS
Output Disable Time ²	150nS
Output Enable Time ²	10mS

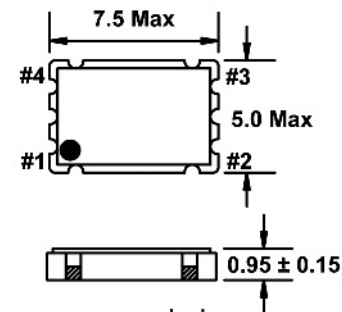
¹ Inclusive of 25°C tolerance, operating temperature range, input voltage change, load change, aging, shock, and vibration.

³ Pin #1: In case of open connection, oscillator is not functioning.

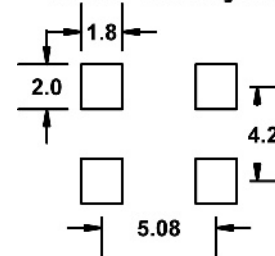
See page 29 for mechanical specifications, test circuits, and output waveform.

Note: A 0.01μF bypass capacitor should be placed between VDD (Pin 4) and GND (Pin 2) to minimize power supply line noise.

All specifications subject to change without notice. Rev. 05/01/02



Recommended Solder Pad Layout



Pin Connections

#1 E/D #3 Output
#2 GND #4 V_{DD}

All dimensions are in millimeters.

• ENABLE / DISABLE FUNCTION ²

INH (Pin 1)	OUTPUT (Pin 3)
OPEN ³	
'1' Level V _{IH} ≥ 0.7 V	ACTIVE
'0' Level V _{IL} ≤ 0.3 V	High Z

See page 53 for tape and reel specifications.

2.85V HCMOS SMD OSCILLATOR WITH STANDBY

F4300 SERIES

FEATURES

- 2.85V Operation
- HCMOS Output
- Standby Function
- Tape and Reel (2,000 pcs. STD)



• MODEL NUMBER SELECTION

Model Number	Frequency Stability	Operating Temperature (°C)	Frequency Range (MHz)
F4300	±100PPM	-10 ~ +70	1.544 ~ 80.000
F4305	±50PPM	-10 ~ +70	1.544 ~ 80.000
F4306	±25PPM	-10 ~ +70	1.544 ~ 80.000
F4308	±20PPM	-10 ~ +70	1.544 ~ 80.000

• ELECTRICAL CHARACTERISTICS

PARAMETERS	MAX (unless otherwise noted)
Frequency Range (F _o)	1.544 ~ 80.000 MHz
Temperature Range (T _{STG})	-55°C ~ +125°C
Supply Voltage (V _{DD})	2.85V ± 5%
Input Current (I _{DD})	
1.544 ~ 32.000 MHz	15mA
32.000+ ~ 50.000 MHz	20mA
50.000+ ~ 67.000 MHz	25mA
67.000+ ~ 80.000 MHz	30mA
Output Symmetry (50% V _{DD})	45% ~ 55%
Rise Time (10% ~ 90% V _{DD}) (T _R)	
1.544 ~ 50.000 MHz	6nS
50.000 ~ 80.000 MHz	4nS
Fall Time (90% ~ 10% V _{DD}) (T _F)	
1.544 ~ 50.000 MHz	6nS
50.000 ~ 80.000 MHz	4nS
Output Voltage (I _{OL} = 2mA) (V _{OL})	10% V _{DD}
(I _{OH} = 2mA) (V _{OH})	90% V _{DD} Min
Output Current (V _{OL} = 10% V _{DD}) (I _{OL})	2mA
(V _{OH} = 90% V _{DD}) (I _{OH})	-2mA
Output Load (HCMOS)	15pF
Standby Current (V _{IL} ≤ 30% V _{DD})	10μA
Start-up Time (T _S)	10mS
Output Disable Time ²	150nS
Output Enable Time ²	10mS

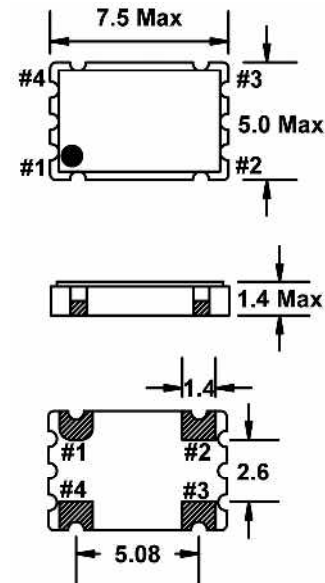
¹ Inclusive of 25°C tolerance, operating temperature range, input voltage change, load change, aging, shock, and vibration.

² An internal pullup resistor from pin 1 to pin 4 allows active output if pin 1 is left open.

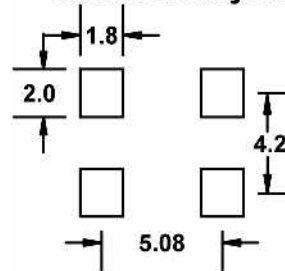
See page 29 for mechanical specifications, test circuits, and output waveform.

Note: A 0.01μF bypass capacitor should be placed between V_{DD} (Pin 4) and GND (Pin 2) to minimize power supply line noise.

All specifications subject to change without notice. Rev. 11/11/02



Recommended Solder Pad Layout



Pin Connections

#1 E/D #3 Output
#2 GND #4 V_{DD}

All dimensions are in millimeters.

• ENABLE / DISABLE FUNCTION ²

INH (Pin 1)	OUTPUT (Pin 3)
OPEN ²	ACTIVE
'1' Level V _{IH} ≥ 70% V _{DD}	ACTIVE
'0' Level V _{IL} ≤ 30% V _{DD}	High Z

See page 53 for tape and reel specifications.

3.3V HCMOS SMD OSCILLATOR WITH STANDBY

F4100 SERIES

FEATURES

- 3.3V Operation
- HCMOS Output
- Standby Function
- Tape and Reel (2,000 pcs. STD)

OPTIONS

- 1.05mm Height Max



• MODEL NUMBER SELECTION

Model Number	Frequency Stability ¹	Operating Temperature (°C)	Frequency Range (MHz)
F4100	±100PPM	-10 ~ +70	1.000 ~ 170.000
F4100R	±100PPM	-40 ~ +85	1.000 ~ 170.000
F4105	±50PPM	-10 ~ +70	1.000 ~ 170.000
F4105R	±50PPM	-40 ~ +85	1.000 ~ 170.000
F4106	±25PPM	-10 ~ +70	1.000 ~ 125.000
F4106R	±25PPM	-40 ~ +85	1.000 ~ 100.000
F4108	±20PPM	-10 ~ +70	1.000 ~ 80.000

• ELECTRICAL CHARACTERISTICS

PARAMETERS	MAX (unless otherwise noted)
Frequency Range (F _o)	1.000 ~ 170.000 MHz
Storage Temperature Range (T _{STG})	-55°C ~ +125°C
Supply Voltage (V _{DD})	3.3V ± 10%
Input Current (I _{DD})	
1.000 ~ 32.000 MHz	15mA
32.000+ ~ 50.000 MHz	20mA
50.000+ ~ 67.000 MHz	25mA
67.000+ ~ 170.000 MHz	40mA
Output Symmetry (50% V _{DD})	
1.000 ~ 50.000 MHz	45% ~ 55%
50.000+ ~ 170.000 MHz	40% ~ 60%
Rise Time (10% ~ 90% V _{DD}) (T _R)	6nS
Fall Time (90% ~ 10% V _{DD}) (T _F)	6nS
Output Voltage (V _{OL})	10% V _{DD}
(V _{OH})	90% V _{DD} Min
Output Current (I _{OL})	2mA Min
(I _{OH})	-2mA Min
Output Load (HCMOS)	15pF
Standby Current (V _{IL} ≤ 0.99V)	10μA
Start-up Time (T _s)	10mS
Output Disable Time ²	150nS
Output Enable Time ²	10mS

¹ Inclusive of 25°C tolerance, operating temperature range, input voltage change, load change, aging,

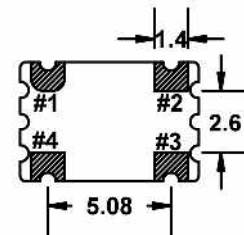
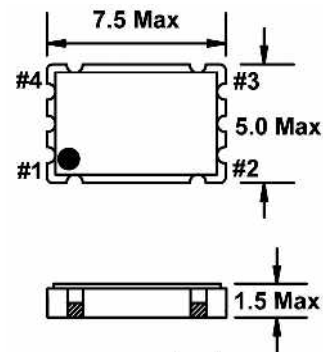
shock, and vibration.

³ An internal pullup resistor from pin 1 to pin 4 allows active output if pin 1 is left open.

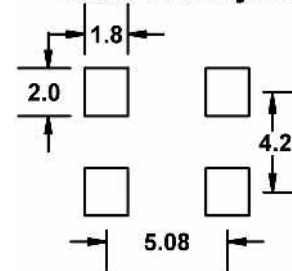
See page 29 for mechanical specifications, test circuits, and output waveform.

Note: A 0.01μF bypass capacitor should be placed between VDD (Pin 4) and GND (Pin 2) to minimize power supply line noise.

All specifications subject to change without notice. Rev. 05/01/02



Recommended Solder Pad Layout



Pin Connections

#1 E/D #3 Output
#2 GND #4 V_{DD}

All dimensions are in millimeters.

• ENABLE / DISABLE FUNCTION ²

INH (Pin 1)	OUTPUT (Pin 3)
OPEN ³	ACTIVE
'1' Level V _{IH} ≥ 2.31 V	ACTIVE
'0' Level V _{IL} ≤ 0.99 V	High Z

See page 53 for tape and reel specifications.

3.3V TIGHT STABILITY HCMOS SMD OSCILLATOR WITH STANDBY

F4100 SERIES

FEATURES

- Tight Stability
- 3.3V Operation
- HCMOS Output
- Standby Function
- Tape and Reel (2,000 pcs. STD)



• MODEL NUMBER SELECTION

Model Number	Frequency Stability ¹	Operating Temperature(°C)	Frequency Range (MHz)
F4108R	±20PPM	-40 ~ +85	1.800 ~ 50.000
F4107	±15PPM	-10 ~ +70	1.800 ~ 50.000
F4107R	±15PPM	-40 ~ +85	1.800 ~ 50.000
F4109	±10PPM	-10 ~ +70	1.800 ~ 50.000

• ELECTRICAL CHARACTERISTICS

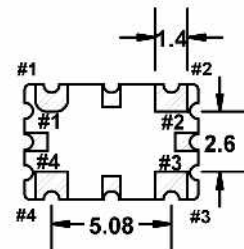
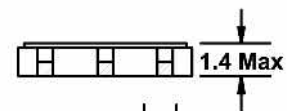
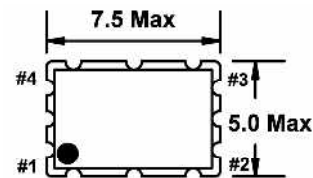
PARAMETERS	MAX (unless otherwise noted)
Frequency Range (Fo)	1.800 ~ 50.000 MHz
Storage Temperature Range (T _{STG})	-55°C ~ +125°C
Supply Voltage (V _{DD})	3.3V ± 5%
Input Current (I _{DD})	22 mA
Output Symmetry (50% V _{DD})	45% ~ 55%
Rise Time (10% ~ 90% V _{DD}) (T _R)	5nS
Fall Time (90% ~ 10% V _{DD}) (T _F)	5nS
Output Voltage (V _{OL})	10% V _{DD}
(V _{OH})	90% V _{DD} Min
Output Current (I _{OL})	8mA Min
(I _{OH})	4mA Min
Output Load (HCMOS)	15pF
Standby Current	50μA
Start-up Time (T _S)	5mS
Output Disable Time ²	150nS
Output Enable Time ²	5mS

¹ Inclusive of 25°C tolerance, operating temperature range, input voltage change, load change, aging, shock, and vibration.

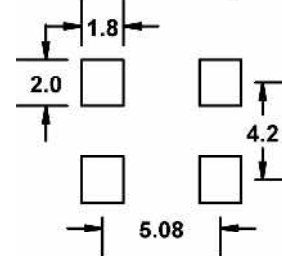
³ An internal pullup resistor from pin 1 to pin 4 allows active output if pin 1 is left open. See page 29 for mechanical specifications, test circuits, and output waveform.

Note: A 0.01μF bypass capacitor should be placed between VDD (Pin 4) and GND (Pin 2) to minimize power supply line noise.

All specifications subject to change without notice. Rev. 05/01/02



Recommended Solder Pad Layout



Pin Connections

#1 E/D #3 Output
#2 GND #4 V_{DD}

All dimensions are in millimeters.

• ENABLE / DISABLE FUNCTION ²

INH (Pin 1)	OUTPUT (Pin 3)
OPEN ³	ACTIVE
'1' Level V _{IH} ≥ 2.31 V	ACTIVE
'0' Level V _{IL} ≤ 0.99 V	High Z

See page 53 for tape and reel specifications.

5.0V HCMOS SMD OSCILLATOR

F3345 SERIES

FEATURES

- 5.0V Operation
- HCMOS/TTL Output
- Tri-State Enable/Disable
- Tape and Reel (2,000 pcs. STD)

OPTIONS

- 1.05mm Height Max
- Standby Function (F4101)



• MODEL NUMBER SELECTION

Model Number	Frequency Stability ¹	Operating Temperature (°C)	Frequency Range (MHz)
F3345	±100PPM	-10 ~ +70	1.000 ~ 80.000
F3345R	±100PPM	-40 ~ +85	1.000 ~ 80.000
F3340	±50PPM	-10 ~ +70	1.000 ~ 80.000
F3340R	±50PPM	-40 ~ +85	1.000 ~ 80.000
F3346	±25PPM	-10 ~ +70	1.000 ~ 80.000
F3346R	±25PPM	-40 ~ +85	1.000 ~ 80.000
F3348	±20PPM	-10 ~ +70	1.000 ~ 80.000

• ELECTRICAL CHARACTERISTICS

PARAMETERS	MAX (unless otherwise noted)
Frequency Range (F _o)	1.000 ~ 80.000 MHz
Storage Temperature Range (T _{STG})	-55°C ~ +125°C
Supply Voltage (V _{DD})	5.0V ± 10%
Input Current (I _{DD})	
1.000 ~ 25.000 MHz	25mA
25.000+ ~ 50.000 MHz	40mA
50.000+ ~ 67.000 MHz	60mA
67.000+ ~ 80.000 MHz	73mA
Output Symmetry (50% V _{DD})	45% ~ 55%
Rise Time (10% ~ 90% V _{DD}) (T _R)	5nS
Fall Time (90% ~ 10% V _{DD}) (T _F)	5nS
Output Voltage (V _{OL})	10% V _{DD}
(V _{OH})	90% V _{DD} Min
Output Current (I _{OL})	16mA Min
(I _{OH})	-16mA Min
Output Load	
TTL	10TTL
HCMOS	50pF
Start-up Time (T _s)	10mS
Enable/Disable Time ²	100nS

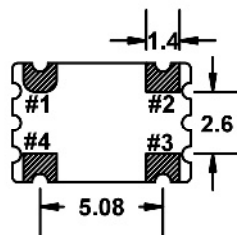
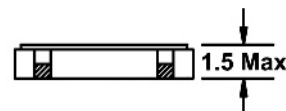
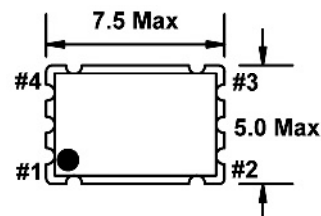
¹ Inclusive of 25°C tolerance, operating temperature range, input voltage change, load change, aging, shock, and vibration.

³ An internal pullup resistor from pin 1 to pin 4 allows active output if pin 1 is left open.

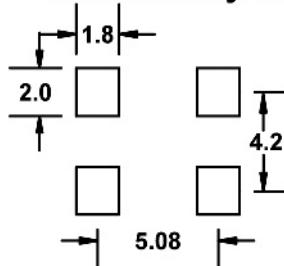
See page 29 for mechanical specifications, test circuits, and output waveform.

Note: A 0.01μF bypass capacitor should be placed between V_{DD} (Pin 4) and GND (Pin 2) to minimize power supply line noise.

All specifications subject to change without notice. Rev. 05/01/02



Recommended Solder Pad Layout



Pin Connections

#1 E/D #3 Output
#2 GND #4 V_{DD}

All dimensions are in millimeters.

• ENABLE / DISABLE FUNCTION²

INH (Pin 1)	OUTPUT (Pin 3)
OPEN ³	ACTIVE
'1' Level V _{IH} ≥ 2.2 V	ACTIVE
'0' Level V _{IL} ≤ 0.8 V	High Z

See page 53 for tape and reel specifications.

3.3V LV-PECL OSCILLATOR WITH STANDBY

F4600 SERIES

FEATURES

- 3.3V Operation
- LV-PECL Output
- Complementary Outputs
- Standby Function
- Tape and Reel (2,000 pcs. STD)



OSCILLATORS

• MODEL NUMBER SELECTION

Model Number	Frequency Stability ¹	Operating Temperature (°C)	Frequency Range (MHz)
F4600	±100PPM	-10 ~ +70	75.000 ~ 170.000
F4600R	±100PPM	-40 ~ +85	75.000 ~ 170.000
F4605	±50PPM	-10 ~ +70	75.000 ~ 170.000
F4605R	±50PPM	-40 ~ +85	75.000 ~ 170.000
F4606	±25PPM	-10 ~ +70	75.000 ~ 170.000
F4606R	±25PPM	-40 ~ +85	75.000 ~ 170.000
F4608	±20PPM	-10 ~ +70	75.000 ~ 170.000

• ELECTRICAL CHARACTERISTICS

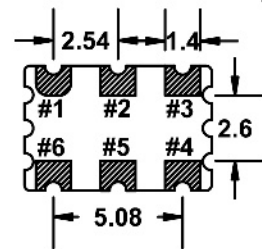
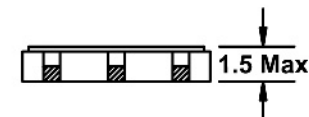
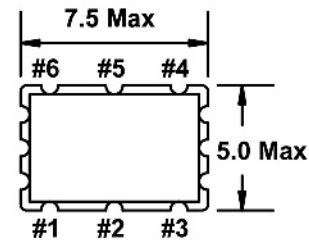
PARAMETERS	MAX (unless otherwise noted)
Frequency Range (Fo)	75.000 ~ 170.000 MHz
Storage Temperature Range (T _{STG})	-55°C ~ +125°C
Supply Voltage (V _{DD})	3.3V ± 5%
Input Current (I _{DD})	60mA
Output Symmetry (50% V _{p-p} Level)	40% ~ 60%
Rise Time (20% ~ 80% V _{p-p}) (T _R)	1nS
Fall Time (80% ~ 20% V _{p-p}) (T _F)	1nS
Output Voltage (V _{OL})	1.7V
(V _{OH})	2.2V Min
Output Load	5 Gates
Standby Current	10μA
Start-up Time (T _S)	10mS
Output Disable Time ²	100nS
Output Enable Time ²	10mS

¹ Inclusive of 25°C tolerance, operating temperature range, input voltage change, load change, aging, shock, and vibration.

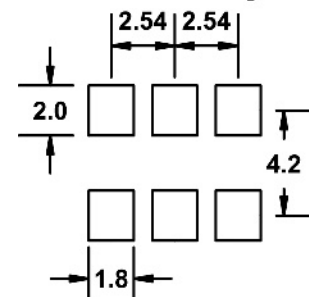
See page 29 for mechanical specifications, test circuits, and output waveform.

Note: A 0.01μF bypass capacitor should be placed between VDD (Pin 6) and GND (Pin 3) to minimize power supply line noise.

All specifications subject to change without notice. Rev. 05/01/02



Recommended Solder Pad Layout



Pin Connections

#1 E/D	#4 Output 1
#2 NC	#5 Output 2
#3 GND	#6 V _{DD}

All dimensions are in millimeters.

• ENABLE / DISABLE FUNCTION ²

INH (Pin 1)	OUTPUT (Pin 4)	OUTPUT (Pin 5)
OPEN	ACTIVE	ACTIVE
'1' Level V _{IH} ≥ 0.7 V	ACTIVE	ACTIVE
'0' Level V _{IL} ≤ 0.3 V	High Z	High Z

See page 53 for tape and reel specifications.

5.0V/3.3V PLASTIC HCMOS SMD CLOCK OSCILLATOR

FSO SERIES

FEATURES

- 5.0V / 3.3V Operation
- HCMOS/TTL Output
- Tri-State Enable/Disable
- Extended Temperature Range
- Tape and Reel (1,000 pcs. STD)



• MODEL NUMBER SELECTION

Model Number	V _{DD} (V)	Frequency Stability ¹	Operating Temperature (°C)	Frequency Range (MHz)
FSO-2 ⁴	5.0 ± 0.5	±100PPM	-20 ~ +70	1.000 ~ 66.6667
FSO-2R		±100PPM	-40 ~ +85	1.000 ~ 66.6667
FSO-25		±50PPM	-20 ~ +70	1.000 ~ 66.6667
FSO-3 ⁴	3.3 ± 0.3	±100PPM	-20 ~ +70	1.000 ~ 66.6667
FSO-3R		±100PPM	-40 ~ +85	1.000 ~ 66.6667
FSO-35		±50PPM	-20 ~ +70	1.000 ~ 66.6667

• ELECTRICAL CHARACTERISTICS

PARAMETERS	FSO-2 Series	FSO-3 Series
	MAX (unless otherwise noted)	
Frequency Range (F _o)	1.000 ~ 66.6667 MHz	
Input Current (I _{DD})		
1.000 ~ 30.000 MHz	23mA	9mA
30.000+ ~ 66.6667 MHz	35mA	20mA
Output Symmetry (50% V _{DD})	40% ~ 60%	
Rise Time (20% ~ 80% V _{DD}) (T _R)		
1.000 ~ 30.000 MHz	8nS	6nS
30.000+ ~ 66.6667 MHz	7nS	6nS
Fall Time (80% ~ 20% V _{DD}) (T _F)		
1.000 ~ 30.000 MHz	8nS	6nS
30.000+ ~ 66.6667 MHz	7nS	6nS
Output Voltage (V _{OL})	0.4V	0.4V
(V _{OH})	4.6V Min	2.9V Min
Output Current (I _{OL})	16mA Min	4mA Min
(I _{OH})	-16mA Min	-4mA Min
Output Load (TTL) (HCMOS)	10TTL 50pF	--- 30pF
Start-up Time (T _s)		
1.000 ~ 30.000 MHz	4mS	
30.000+ ~ 66.6667 MHz	10mS	
Enable/Disable Time ²	100nS	

¹ Inclusive of 25°C tolerance, operating temperature range, input voltage change, and load change.

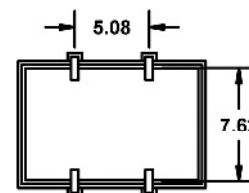
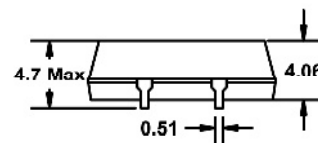
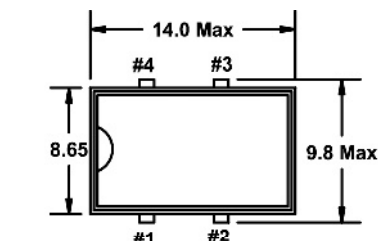
³ An internal pullup resistor from pin 1 to pin 4 allows active output if pin 1 is left open.

⁴ The FSO-2 and FSO-3 models will also operate over -40°C ~ +85°C, but with a relax stability of ±200 PPM.

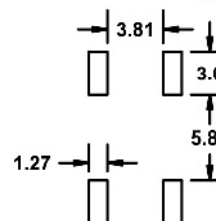
See page 29 for mechanical specifications, test circuits, and output waveform.

Note: A 0.01μF bypass capacitor should be placed between VDD (Pin 4) and GND (Pin 2) to minimize power supply line noise.

All specifications subject to change without notice. Rev. 05/01/02



Recommended Solder Pad Layout



Pin Connections

#1 E/D** #3 Output
#2 GND #4 V_{DD}

All dimensions are in millimeters.

• ENABLE / DISABLE FUNCTION²

INH (Pin 1)	OUTPUT (Pin 3)
OPEN ³	ACTIVE
'1' Level V _{IH} ≥ 2.4 V	ACTIVE
'0' Level V _{IL} ≤ 0.6 V	High Z

See page 53 for tape and reel specifications.

5.0V PLASTIC HCMOS/TTL SMD OSCILLATOR

KFO SERIES

FEATURES

- 5.0V Operation
- HCMOS/TTL Output
- Tri-State Enable/Disable
- Tape and Reel (1,000 pcs. STD)

OPTIONS

- 3.3V Operation (KFO30AT)



• MODEL NUMBER SELECTION

Model Number	Frequency Stability ¹	Operating Temperature (°C)	Frequency Range (MHz)
KFO90AT	±100PPM	-10 ~ +70	1.500 ~ 67.000
KFO90FT	±100PPM	-40 ~ +85	1.500 ~ 67.000
KFO95AT	±50PPM	-10 ~ +70	1.500 ~ 67.000

• ELECTRICAL CHARACTERISTICS

PARAMETERS	MAX (unless otherwise noted)
Frequency Range (F _o)	1.500 ~ 67.000 MHz
Storage Temperature Range (T _{STG})	-55°C ~ +125°C
Supply Voltage (V _{DD})	5.0V ± 10%
Input Current (I _{DD})	
1.500 ~ 32.000 MHz	27mA
32.000+ ~ 50.000 MHz	45mA
50.000+ ~ 67.000 MHz	60mA
Output Symmetry (50% V _{DD})	
1.500 ~ 50.000 MHz	45% ~ 55%
50.000+ ~ 67.000 MHz	40% ~ 60%
Rise Time (10% ~ 90% V _{DD}) (T _R)	7nS
Fall Time (90% ~ 10% V _{DD}) (T _F)	7nS
Output Voltage (V _{OL})	10% V _{DD}
(V _{OH})	90% V _{DD} Min
Output Current (I _{OL})	16mA Min
(I _{OH})	-16mA Min
Output Load	
TTL	10TTL
HCMOS	50pF
Start-up Time (T _s)	10mS
Enable/Disable Time ²	100nS

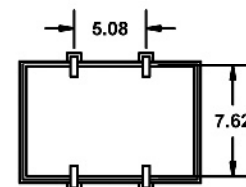
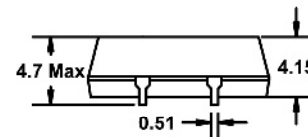
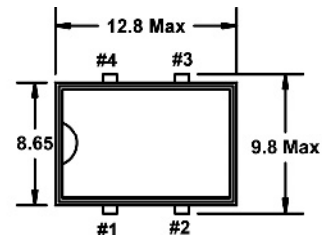
¹ Inclusive of 25°C tolerance, operating temperature range, input voltage change, load change, aging, shock, and vibration.

³ An internal pullup resistor from pin 1 to pin 4 allows active output if pin 1 is left open.

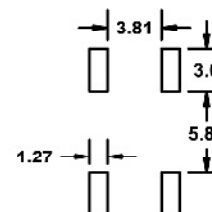
See page 29 for mechanical specifications, test circuits, and output waveform.

Note: A 0.01μF bypass capacitor should be placed between VDD (Pin 4) and GND (Pin 2) to minimize power supply line noise.

All specifications subject to change without notice. Rev. 05/01/02



Recommended Solder Pad Layout



Pin Connections

#1 E/D**	#3 Output
#2 GND	#4 V _{DD}

All dimensions are in millimeters.

• ENABLE / DISABLE FUNCTION²

INH (Pin 1)	OUTPUT (Pin 3)
OPEN ³	ACTIVE
'1' Level V _{IH} ≥ 2.2 V	ACTIVE
'0' Level V _{IL} ≤ 0.8 V	High Z

See page 53 for tape and reel specifications.

3.3V TRI-STATE ENABLE/DISABLE OSCILLATORS

F5C-2E3 / H5C-2E3

FEATURES

- 3.3V Operation
- HCMOS Output
- Tri-State Enable/Disable
- 14-Pin DIP / 8-Pin DIP



• MODEL NUMBER SELECTION

Model Number	Frequency Stability ¹	Operating Temperature (°C)	Frequency Range (MHz)
F5C-2E3 / H5C-2E3	±100PPM	0 ~ +70	1.000 ~ 160.000
F5C-2E3R / H5C-2E3R	±100PPM	-40 ~ +85	1.000 ~ 160.000
F6C-2E3 / H6C-2E3	±50PPM	0 ~ +70	1.000 ~ 160.000
F6C-2E3R / H6C-2E3R	±50PPM	-40 ~ +85	1.000 ~ 160.000
F7C-2E3 / H7C-2E3	±25PPM	0 ~ +70	1.000 ~ 160.000
F7C-2E3R / H7C-2E3R	±25PPM	-40 ~ +85	1.000 ~ 160.000
F8C-2E3 / H8C-2E3	±20PPM	0 ~ +70	1.000 ~ 160.000

• ELECTRICAL CHARACTERISTICS

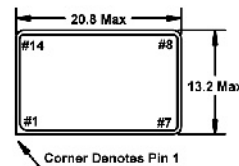
PARAMETERS	MAX (unless otherwise noted)
Frequency Range (F _o)	1.000 ~ 160.000 MHz
Storage Temperature Range (T _{STG})	-55°C ~ +125°C
Supply Voltage (V _{DD})	3.3V ± 10%
Input Current (I _{DD})	
1.000 ~ 40.000 MHz	20mA
40.000+ ~ 160.000 MHz	40mA
Output Symmetry (50% V _{DD})	40% ~ 60%
Rise Time (10% ~ 90% V _{DD}) (T _R)	10 nS
Fall Time (90% ~ 10% V _{DD}) (T _F)	10 nS
Output Voltage (V _{OL})	10% V _{DD}
(V _{OH})	90% V _{DD} Min
Output Current (I _{OL})	8mA Min
(I _{OH})	-8mA Min
Output Load (HCMOS)	15pF
Start-up Time (T _s)	10mS
Output Enable/Disable Time ²	100nS

¹ Inclusive of 25°C tolerance, operating temperature range, input voltage change, load change, aging, shock, and vibration.

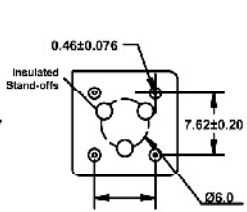
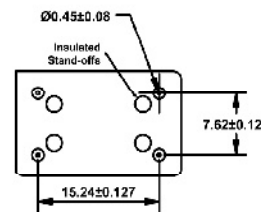
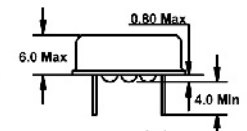
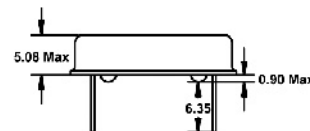
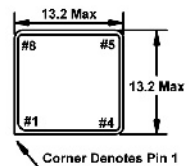
² An internal pullup resistor from pin 1 to pin 14 allows active output if pin 1 is left open. See page 29 for mechanical specifications, test circuits, and output waveform.

All specifications subject to change without notice. Rev. 05/01/02

F5C-2E3



H5C-2E3



Pin Connections

#1 E/D** #8 Output
#7 GND (Case) #14 Vdd

Pin Connections

#1 E/D** #5 Output
#4 GND (Case) #8 Vdd

All dimensions are in millimeters.

• ENABLE / DISABLE FUNCTION ²

INH (Pin 1)	OUTPUT (Pin 8)
OPEN ³	ACTIVE
'1' Level V _{IH} ≥ 2.2 V	ACTIVE
'0' Level V _{IL} ≤ 0.8 V	High Z

5.0V HCMOS TRI-STATE ENABLE/DISABLE OSCILLATORS

F5C-2E / H5C-2E

FEATURES

- 5.0V Operationg
- HCMOS/TTL Output
- Tri-State Enable/Disable
- 14-Pin DIP / 8-Pin DIP



OSCILLATORS

• MODEL NUMBER SELECTION

Model Number	Frequency Stability ¹	Operating Temperature (°C)	Frequency Range (MHz)
F5C-2E / H5C-2E	±100PPM	0 ~ +70	1.000 ~ 160.000
F5C-2ER / H5C-2ER	±100PPM	-40 ~ +85	1.000 ~ 160.000
F6C-2E / H6C-2E	±50PPM	0 ~ +70	1.000 ~ 160.000
F6C-2ER / H6C-2ER	±50PPM	-40 ~ +85	1.000 ~ 160.000
F7C-2E / H7C-2E	±25PPM	0 ~ +70	1.000 ~ 160.000
F7C-2ER / H7C-2ER	±25PPM	-40 ~ +85	1.000 ~ 125.000
F8C-2E / H8C-2E	±20PPM	0 ~ +70	1.000 ~ 125.000

• ELECTRICAL CHARACTERISTICS

PARAMETERS	MAX (unless otherwise noted)
Frequency Range (Fo)	1.000 ~ 160.000 MHz
Storage Temperature Range (T _{STG})	-55°C ~ +125°C
Supply Voltage (V _{DD})	5.0V ± 10%
Input Current (I _{DD})	
1.000 ~ 40.000 MHz	40mA
40.000+ ~ 125.000 MHz	60mA
125.000+ ~ 160.000 MHz	100mA
Output Symmetry (50% V _{DD})	
1.000 ~ 50.000 MHz	45% ~ 55%
50.000+ ~ 160.000 MHz	40% ~ 60%
Rise Time (10% ~ 90% V _{DD}) (T _R)	
1.000 ~ 125.000 MHz	10 nS
125.000+ ~ 160.000 MHz	6 nS
Fall Time (90% ~ 10% V _{DD}) (T _F)	
1.000 ~ 125.000 MHz	10 nS
125.000+ ~ 160.000 MHz	6 nS
Output Voltage (V _{OL})	10% V _{DD}
(V _{OH})	90% V _{DD} Min
Output Current (I _{OL})	16mA Min
(I _{OH})	-16mA Min
Output Load	
TTL	10TTL
HCMOS	50pF
Start-up Time (T _s)	10mS
Output Enable/Disable Time ²	100nS

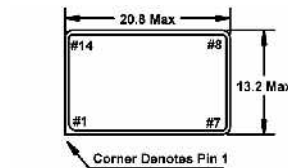
¹ Inclusive of 25°C tolerance, operating temperature range, input voltage change, load change, aging, shock, and vibration.

³ An internal pullup resistor from pin 1 to pin 14 allows active output if pin 1 is left open.

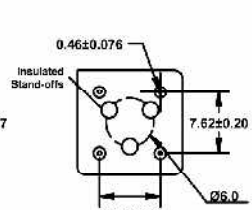
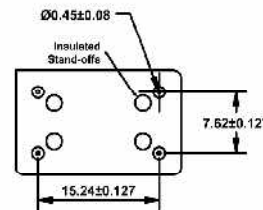
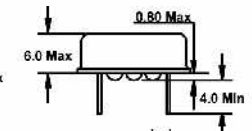
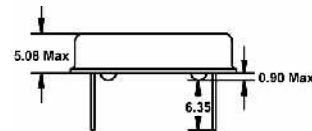
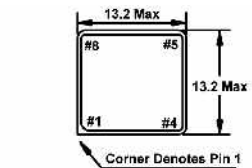
See page 29 for mechanical specifications, test circuits, and output waveform.

All specifications subject to change without notice. Rev. 05/01/02

F5C-2E



H5C-2E



Pin Connections
 #1 E/D⁺⁺ #8 Output
 #7 GND (Case) #14 V_{DD}

Pin Connections
 #1 E/D⁺⁺ #5 Output
 #4 GND (Case) #8 V_{DD}

All dimensions are in millimeters.

• ENABLE / DISABLE FUNCTION ²

INH (Pin 1)	OUTPUT (Pin 8)
OPEN ³	ACTIVE
'1' Level V _{IH} ≥ 2.2 V	ACTIVE
'0' Level V _{IL} ≤ 0.8 V	High Z

5.0V TTL CLOCK OSCILLATOR

F1100E

FEATURES

- 5.0V Operation
- TTL Output
- 14-Pin DIP



• MODEL NUMBER SELECTION

Model Number	Frequency Stability ¹	Operating Temperature (°C)	Frequency Range (MHz)
F1100E	±100PPM (STD)	0 ~ +70	1.000 ~ 100.000
F1100ER	±100PPM	-40 ~ +85	1.000 ~ 100.000
F1145E	±50PPM	0 ~ +70	1.000 ~ 100.000
F1145ER	±50PPM	-40 ~ +85	1.000 ~ 100.000
F1144E	±25PPM	0 ~ +70	1.000 ~ 100.000
F1144ER	±25PPM	-40 ~ +85	1.000 ~ 100.000

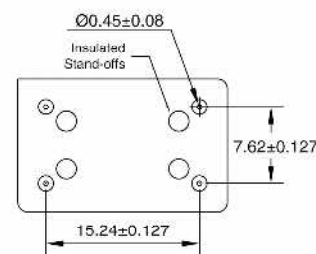
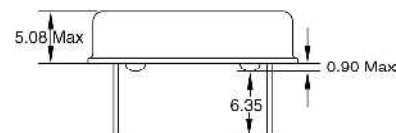
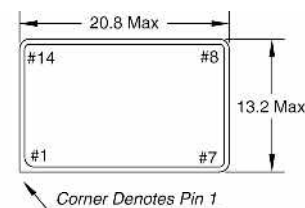
• ELECTRICAL CHARACTERISTICS

PARAMETERS	MAX (unless otherwise noted)
Frequency Range (F ₀)	1.000 ~ 100.000 MHz
Storage Temperature Range (T _{STG})	-55°C ~ +125°C
Supply Voltage (V _{DD})	5.0V ± 10%
Input Current (I _{DD})	
1.000 ~ 8.000 MHz	15mA
8.000+ ~ 24.000 MHz	30mA
24.000+ ~ 70.000 MHz	70mA
70.000+ ~ 100.000 MHz	80mA
Output Symmetry (1.4V Level)	
1.000 ~ 8.000 MHz	45% ~ 55%
8.000+ ~ 100.000 MHz	40% ~ 60%
Rise Time (0.5V ~ 2.4V) (T _R)	
1.000 ~ 25.000 MHz	10 nS
25.000+ ~ 70.000 MHz	5 nS
70.000+ ~ 100.000 MHz	4 nS
Fall Time (2.4V ~ 0.5V) (T _F)	
1.000 ~ 25.000 MHz	10 nS
25.000+ ~ 70.000 MHz	5 nS
70.000+ ~ 100.000 MHz	4 nS
Output Voltage	
1.000 ~ 25.000 MHz (V _{OL})	0.4V
25.000+ ~ 100.000 MHz	0.5V
1.000 ~ 100.000 MHz (V _{OH})	2.4V Min
Output Current (I _{OL})	20mA Min
(I _{OH})	-1.0mA Min
Output Load	10TTL
Start-up Time (T _S)	
1.000 ~ 3.500 MHz	20mS
3.500+ ~ 4.000 MHz	35mS
4.000+ ~ 6.000 MHz	30mS
6.000+ ~ 20.000 MHz	20mS
20.000+ ~ 100.000 MHz	15mS

¹ Inclusive of 25°C tolerance, operating temperature range, input voltage change, load change, aging, shock, and vibration.

See [page 29](#) for mechanical specifications, test circuits, and output waveform.

All specifications subject to change without notice. Rev. 05/01/02



Pin Connections

#1 N.C. #8 Output
#7 GND (Case) #14 +5Vdc

All dimensions are in millimeters.

14-PIN DIP PECL OSCILLATOR

F5L-4G

FEATURES

- 5.0V Operation
- PECL Output
- 10 KH Logic Output
- Complementary Output

OPTIONS

- Single-Ended Output
- Pullup/Down Internal Resistors
- Various Pin Connections
- -5.2V ECL Output



• MODEL NUMBER SELECTION

Model Number	Frequency Stability ¹	Operating Temperature (°C)	Frequency Range (MHz)
F5L-4G	±100PPM	-10 ~ +70	30.000 ~ 200.000
F5L-4GR	±100PPM	-40 ~ +85	30.000 ~ 200.000
F6L-4G	±50PPM	-10 ~ +70	30.000 ~ 200.000
F6L-4GR	±50PPM	-40 ~ +85	30.000 ~ 200.000
F7L-4G	±25PPM	-10 ~ +70	30.000 ~ 200.000
F7L-4GR	±25PPM	-40 ~ +85	30.000 ~ 200.000
F8L-4G	±20PPM	-10 ~ +70	30.000 ~ 200.000

• ELECTRICAL CHARACTERISTICS

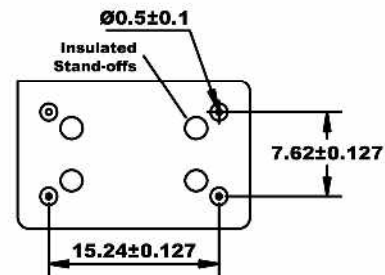
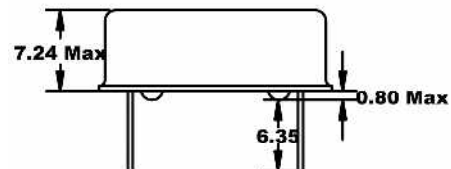
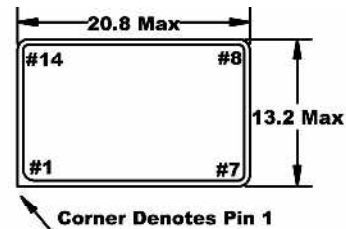
PARAMETERS	MAX (unless otherwise noted)
Frequency Range (Fo)	30.000 ~ 200.000 MHz
Temperature Range	
Operating (TOPR)	-10°C ~ +70°C
Storage (TSTG)	-55°C ~ +125°C
Supply Voltage (VEE)	5.0V ± 10%
Input Current (IDD)	
30.000 ~ 170.000 MHz	50mA
170.000+ ~ 200.000 MHz	60mA
Output Symmetry (50% Vp-p Level)	40% ~ 60%
Rise Time (20% ~ 80%Vp-p) (TR)	
30.000 ~ 170.000 MHz	2.0nS
170.000+ ~ 200.000 MHz	1.5nS
Fall Time (80% ~ 20%Vp-p) (TF)	
30.000 ~ 170.000 MHz	2.0nS
170.000+ ~ 200.000 MHz	1.5nS
Output Voltage (VOL)	+3.05V ~ +3.42V
(VOH)	+4.00V ~ +4.45V
Output Load (PECL Load)	5 Gates
Overlap Time (50% Vp-p (Complementary Only))	0.5nS
Start-up Time (Ts)	10mS

¹ Inclusive of 25°C tolerance, operating temperature range, input voltage change, load change, aging,

shock, and vibration.

See page 29 for mechanical specifications, test circuits, and output waveform.

All specifications subject to change without notice. Rev. 05/01/02



All dimensions are in millimeters.

Fox Electronics Part Description¹ Guide for Oscillators



(#####.#####)

1
Make Selection from
Product Family
in Fox Catalog or
Foxonline.com
For Example: F5C-2E

2
Frequency MHz
Customer Fills In

3
Stability²
Pick from
Section A

4
**Operating
Temp²**

5
**SMD
Packaging**

6
**Fox
Use**

7/8
**Value
Added**

9
Custom

Section A

Operating Temp. Range

SMD Packaging

Value Added

Custom

Fox Production SMD
Reel Quantities

F3345 Series 2K
F3355 Series 2K
F3365 Series 2K
F3400/3410 Series 2K
F4100 Series 2K
F4101 Series 2K
F4200 Series 2K
F5500 (ECL) 1K
KFO90AT/80AT/50AT 1K
FSO-2 Series 1K

A = 0° to +50°C
B = -10° to +50°C
C = 0° to +70°C
D = -10° to +60°C
E = -10° to +70°C
F = -20° to +70°C
Z = -25° to +75°C
G = -30° to +70°C
H = -30° to +75°C
J = -30° to +80°C
K = -30° to +85°C
L = -35° to +80°C
V = -35° to +85°C
M = -40° to +85°C

0 = Tape/Reel*
250 = 250
500 = 500
1000 = 1000
Tape Only = Tape Only

C = Custom
Place attach drawing
and/or additional
electrical specs for
our engineering
department.

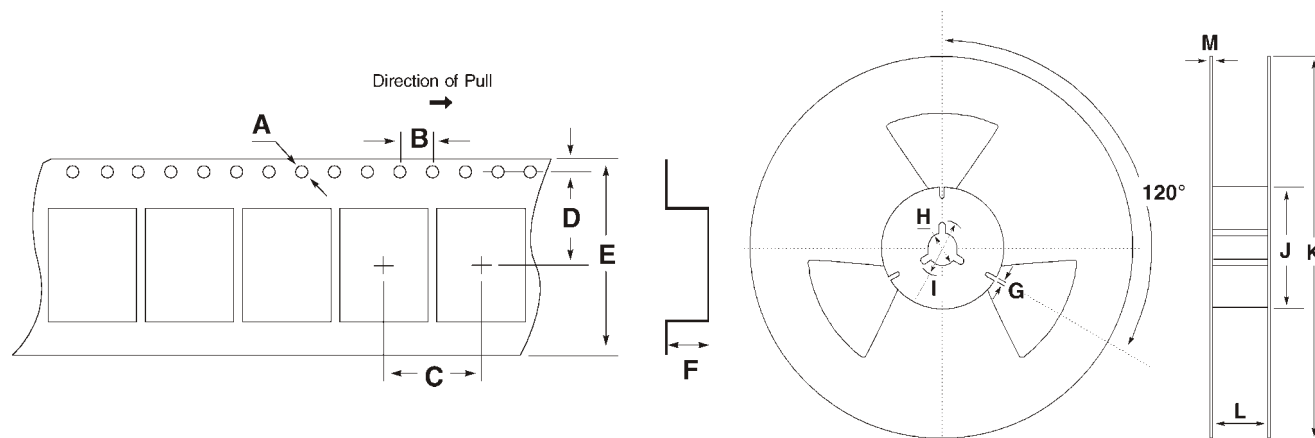
Notes:

¹ Fox unique part numbers for non-standards are randomly generated based on the elements of the part description in a format: **### - Frequency - Random #** (099-22.1184-39789 is Fox unique part number).

² **All combinations are not possible.**

* 0 = Tape/Reel assumes that no quantity per reel was specified; therefore, the Fox Production SMD Reel Quantities list applies. For any other quantities specified a broken reel charge will apply.

TAPE AND REEL SPECIFICATIONS



• TAPE SPECIFICATIONS (millimeters)							
MODEL	A	B	C	D	E	F	STD QTY ¹
F510L Series	Ø1.5	4.0	8.0	7.5	16.0	2.5	1,000 / 2,000
F540L Series	Ø1.5	4.0	8.0	7.5	16.0	2.5	1,000 / 2,000
F530L Series	Ø1.5	4.0	8.0	7.5	16.0	2.5	1,000 / 2,000
F4200 Series	Ø1.5	4.0	8.0	5.5	12.0	1.9	2,000
F4500 Series	Ø1.5	4.0	8.0	5.5	12.0	1.9	2,000
F4400 Series	Ø1.5	4.0	8.0	5.5	12.0	1.9	2,000
F4100 Series	Ø1.5	4.0	8.0	5.5	12.0	1.9	2,000
F3345 Series	Ø1.5	4.0	8.0	5.5	12.0	1.9	2,000
F4600 Series	Ø1.5	4.0	8.0	5.5	12.0	1.9	2,000
FSO Series	Ø1.5	4.0	12.0	11.5	24.0	5.0	1,000
KFO Series	Ø1.5	4.0	12.0	11.5	24.0	5.2	1,000

¹ Standard reel quantity.

• REEL SPECIFICATIONS (millimeters)							
MODEL	G	H	I	J	K	L	M
F510L Series	2.0	Ø13	Ø21	Ø80	Ø178 / Ø250	13.5	2.0
F540L Series	2.0	Ø13	Ø21	Ø80	Ø178 / Ø250	13.5	2.0
F530L Series	2.0	Ø13	Ø21	Ø80	Ø178 / Ø250	13.5	2.0
F4200 Series	2.0	Ø13	Ø21	Ø80	Ø255	13.5	2.0
F4500 Series	2.0	Ø13	Ø21	Ø80	Ø255	17.5	2.0
F4400 Series	2.0	Ø13	Ø21	Ø80	Ø255	17.5	2.0
F4100 Series	2.0	Ø13	Ø21	Ø80	Ø255	17.5	2.0
F3345 Series	2.0	Ø13	Ø21	Ø80	Ø255	17.5	2.0
F4600 Series	2.0	Ø13	Ø21	Ø80	Ø255	17.5	2.0
FSO Series	2.0	Ø13	Ø21	Ø80	Ø330	25.5	2.0
KFO Series	2.0	Ø13	Ø21	Ø80	Ø330	25.5	2.0

TCXOs, VCXOs AND OCXOs

SELECTION GUIDE

• SURFACE MOUNT AND THRU-HOLE VCXOs

PRODUCT	VCSAXT Series	VCXO-D	VCXO-C
	 Stocking Std.		
Frequency Range	1.000 ~ 77.760 MHz	1.000 ~ 40.500 MHz	1.000 ~ 40.000 MHz
Frequency Stability	±25 PPM	±2.5 PPM	±2.5 PPM
Pullability	±100 PPM, ±50 PPM		
Temperature Range	-10°C ~ +70°C -40°C ~ +85°C (Option)	-10°C ~ +70°C -40°C ~ +85°C (Option)	-10°C ~ +70°C -40°C ~ +85°C (Option)
Key Features	• 7.5 x 5mm • 3.3V Operation • HCMOS Output • Enable/Disable	• 14-Pin DIP • 3.3V Operation • HCMOS Output • Low Power Consumption	• 14-Pin DIP • 5.0V Operation • HCMOS/TTL Output • Rugged Resistance Weld
Catalog Pages	Page 56	Page 57	Page 58

• SURFACE MOUNT TCXOs

PRODUCT	FOX914 Series	FOX307H	FOX312BE	FOX801 Series
				 Stocking Std.
Frequency Range	12.600 ~ 26.000 MHz	10.000 ~ 26.000 MHz	12.600 ~ 26.000 MHz	10.000 ~ 22.000 MHz
Frequency Stability	±2.5 PPM	±2.5 PPM	±2.5 PPM	±2.5 PPM
Temperature Range	-20°C ~ +75°C	-20°C ~ +75°C	-20°C ~ +75°C	-30°C ~ +75°C
Key Features	• 5 x 3.2mm • 1.5mm Height Max • 3.0V Operation • Clipped Sine Output • VCTCXO	• 7 x 5mm • 1.9mm Height Max • 3.0V Operation • Clipped Sine Output • VCTCXO	• 7 x 5mm • 2.0mm Height Max • 3.0V Operation • Clipped Sine Output • VCTCXO	• 11.4 x 9.6mm • 2.0mm Height Max • 3.0 / 5.0V Operation • Clipped Sine Output • TCXO or VCTCXO
Catalog Pages	Page 59	Page 60	Page 61	Page 63

• THRU-HOLE TCXOs and OCXOs

PRODUCT	FOX781B	FOX782	FTS501AH
			
Frequency Range	8.000 ~ 20.000 MHz	8.000 ~ 20.000 MHz	10.000 ~ 40.000 MHz
Frequency Stability	±2.5 PPM	±2.5 PPM	±250 PPB
Temperature Range	-20°C ~ +75°C	-20°C ~ +75°C	0°C ~ +70°C
Key Features	• 14-Pin DIP • 5.0V Operation • Clipped Sine Output • TCXO or VCTCXO • Up to 45 MHz Available	• 14-Pin DIP • 5.0V Operation • HCMOS Output • TCXO or VCTCXO • Up to 45 MHz Available	• 14-Pin DIP • 5.0V Operation • HCMOS/TTL Output • Meets Stratum III
Catalog Pages	Page 64	Page 65	Page 66-67

3.3V LOW PROFILE SMD VCXO

VCS25AXT

FEATURES

- 3.3V Operation
- Stocking Standard
- HCMOS Output
- Enable/Disable
- Tape and Reel (2,000 pcs. STD)



• DISTRIBUTOR STOCKING ITEMS

Model Number	Frequency (MHz)
VCS25AXT-0496	4.096
VCS25AXT-081	8.192
VCS25AXT-128	12.288
VCS25AXT-163	16.384
VCS25AXT-270	27.000
VCS25AXT-353	35.328
VCS25AXT-447	44.736

• ELECTRICAL CHARACTERISTICS

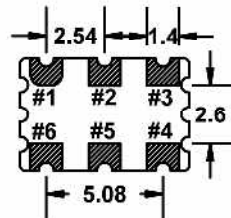
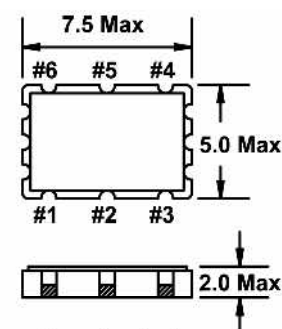
PARAMETERS	MAX (unless otherwise noted)
Frequency Range (Fo)	1.000 ~ 77.760 ¹ MHz
Temperature Range	
Operating (T _{OPR})	-10°C ~ +70°C ³
Storage (T _{STG})	-40°C ~ +85°C
Frequency Stability	±50PPM ³
Pullability	±100PPM ³
Supply Voltage (V _{DD})	3.3V ± 10%
Control Voltage (V _C)	1.65V ± 1.5V
Input Current (I _{DD})	
1.000 ~ 30.000 MHz	15mA
30.000+ ~ 45.000 MHz	25mA
45.000+ ~ 77.760 MHz	50mA
Output Symmetry (50% V _{DD})	40% ~ 60%
Rise Time (10% ~ 90% V _{DD}) (T _R)	5nS
Fall Time (90% ~ 10% V _{DD}) (T _F)	5nS
Output Voltage (V _{OL})	10% V _{DD}
(V _{OH})	90% V _{DD} Min
Output Current (I _{OL})	4.0mA Min
(I _{OH})	-1.0mA Min
Output Load (HCMOS)	15pF
Start-up Time (T _s)	10mS
Enable/Disable Time ²	150nS
Frequency Linearity	±10%
Modulation Bandwidth	20 kHz

¹ Custom specifications from 45.000 to 77.760 MHz available on an individual inquiry basis.

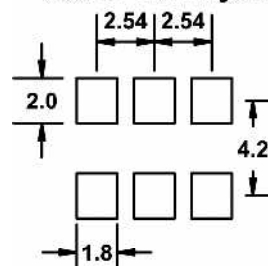
³ Other temperature ranges, stabilities, and pullabilities available. See Page 56.

Note: A 0.01μF bypass capacitor should be placed between V_{DD} (Pin 6) and GND (Pin 3) to minimize power supply line noise.

All specifications subject to change without notice. Rev. 05/01/02



Recommended Solder Pad Layout



Pin Connections

#1 V _{Control}	#4 Output
#2 E/D	#5 N.C.
#3 GND	#6 V _{DD}

All dimensions are in millimeters.

VCXOs & TCXOs

• ENABLE / DISABLE FUNCTION ²

Pin 2	OUTPUT (Pin 4)
OPEN	ACTIVE
'1' Level V _{IH} ≥ 2.7 V	ACTIVE
'0' Level V _{IL} ≤ 0.3 V	High Z

See page 69 for tape and reel specifications.

VCSAXT SERIES

FEATURES

- 3.3V Operation
- HCMOS Output
- Enable/Disable
- Tape and Reel (2,000 pcs. STD)

OPTIONS

- Many Stability/Pullability Options
- -40°C ~ +85°C Option ('R' Version)



• MODEL NUMBER SELECTION

Model Number	Frequency Stability ¹	Frequency Pullability	Operating Temperature(°C)	Frequency Range (MHz)
VCS12AXT	±25PPM	±50PPM	-10 ~ +70	1.000 ~ 77.760
VCS12AXTR ³	±25PPM	±50PPM	-40 ~ +85	1.000 ~ 77.760
VCS15AXT	±50PPM	±50PPM	-10 ~ +70	1.000 ~ 77.760
VCS15AXTR	±50PPM	±50PPM	-40 ~ +85	1.000 ~ 77.760
VCS22AXT	±25PPM	±100PPM	-10 ~ +70	1.000 ~ 77.760
VCS22AXTR ³	±25PPM	±100PPM	-40 ~ +85	1.000 ~ 77.760
VCS25AXT	±50PPM	±100PPM	-10 ~ +70	1.000 ~ 77.760
VCS25AXTR	±50PPM	±100PPM	-40 ~ +85	1.000 ~ 77.760
VCS20AXT	±100PPM	±100PPM	-10 ~ +70	1.000 ~ 77.760
VCS20AXTR	±100PPM	±100PPM	-40 ~ +85	1.000 ~ 77.760

• ELECTRICAL CHARACTERISTICS

PARAMETERS	MAX (unless otherwise noted)
Frequency Range (Fo)	1.000 ~ 77.760 ⁴ MHz
Storage Temperature Range (T _{STG})	-40°C ~ +85°C
Supply Voltage (V _{DD})	3.3V ± 10%
Control Voltage (V _c)	1.65V ± 1.5V
Input Current (I _{DD})	
1.000 ~ 30.000 MHz	15mA
30.000+ ~ 45.000 MHz	25mA
45.000+ ~ 77.760 MHz	50mA
Output Symmetry (50% V _{DD})	40% ~ 60%
Rise Time (10% ~ 90% V _{DD}) (T _R)	5nS
Fall Time (90% ~ 10% V _{DD}) (T _F)	5nS
Output Voltage (V _{OL})	10% V _{DD}
(V _{OH})	90% V _{DD} Min
Output Current (I _{OL})	4.0mA Min
(I _{OH})	-1.0mA Min
Output Load (HCMOS)	15pF
Start-up Time (T _s)	10mS
Enable/Disable Time ²	150nS
Frequency Linearity	±10%
Modulation Bandwidth	20 kHz

¹ Inclusive of 25°C tolerance, operating temperature range, input voltage change, load change, aging,

shock, vibration, and V_c = 1.65V.

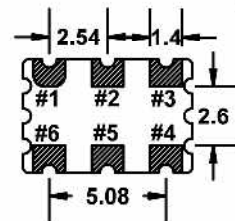
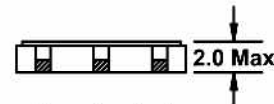
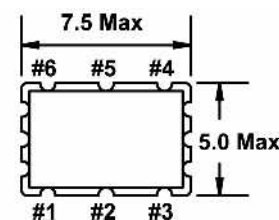
³ Available on an individual inquiry basis.

⁴ Custom specifications from 45.000 to 77.760 MHz available on an individual inquiry basis.

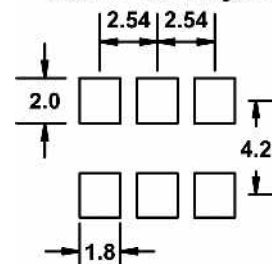
Note: A 0.01μF bypass capacitor should be placed between V_{DD} (Pin 6) and GND (Pin 3) to minimize power supply line noise.

Note: An alternate pin connection with E/D on pin #5 is available.

All specifications subject to change without notice. Rev. 05/01/02



Recommended Solder Pad Layout



Pin Connections

#1 V _{Control}	#4 Output
#2 E/D	#5 N.C.
#3 GND	#6 V _{DD}

All dimensions are in millimeters.

• ENABLE / DISABLE FUNCTION ²

Pin 2	OUTPUT (Pin 4)
OPEN	ACTIVE
'1' Level V _{IH} ≥ 2.7 V	ACTIVE
'0' Level V _{IL} ≤ 0.3 V	High Z

See page 69 for tape and reel specifications.

3.3V THRU-HOLE VOLTAGE CONTROLLED CRYSTAL OSCILLATOR

VCXO-D

FEATURES

- 3.3V Operation
- HCMOS Output
- Low Power Consumption
- Rugged Resistance Weld

OPTIONS

- Many Stability/Pullability Options
- -40°C ~ +85°C Option ('R' Version)



• MODEL NUMBER SELECTION

Model Number	Frequency Stability ¹	Frequency Pullability	Operating Temperature (°C)	Frequency Range (MHz)
VCXO-D3	±50PPM	±100PPM	-10 ~ +70	1.000 ~ 40.500
VCXO-D3R	±50PPM	±100PPM	-40 ~ +85	1.000 ~ 40.500
VCXO-D4	±25PPM	±100PPM	-10 ~ +70	1.000 ~ 40.500
VCXO-D4R	±25PPM	±100PPM	-40 ~ +85	1.000 ~ 40.500
VCXO-D7	±25PPM	±50PPM	-10 ~ +70	1.000 ~ 40.500
VCXO-D7R	±25PPM	±50PPM	-40 ~ +85	1.000 ~ 40.500
VCXO-D8	±100PPM	±100PPM	-10 ~ +70	1.000 ~ 40.500
VCXO-D8R	±100PPM	±100PPM	-40 ~ +85	1.000 ~ 40.500

• ELECTRICAL CHARACTERISTICS

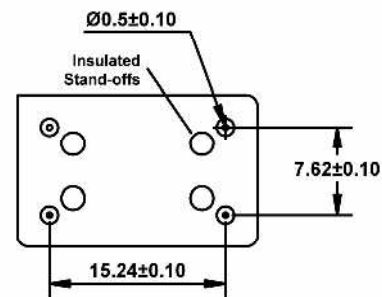
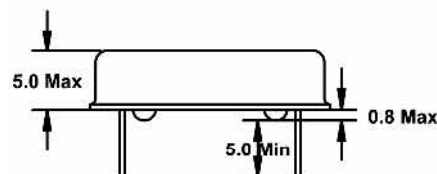
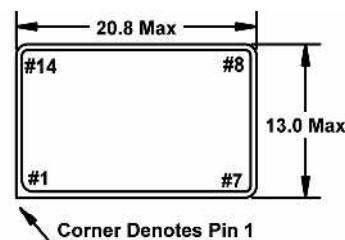
PARAMETERS	MAX (unless otherwise noted)
Frequency Range (Fo)	1.000 ~ 40.500 ³ MHz
Storage Temperature Range (T _{STG})	-55°C ~ +125°C
Supply Voltage (V _{DD})	3.3V ± 5%
Control Voltage (V _C)	1.65V ± 1.65V
Input Current (I _{DD})	
1.000 ~ 24.000 MHz	10mA
24.000+ ~ 35.000 MHz	15mA
35.000+ ~ 40.500 MHz	25mA
Output Symmetry (50% V _{DD})	40% ~ 60%
Rise Time (10% ~ 90% V _{DD}) (T _R)	10nS
Fall Time (90% ~ 10% V _{DD}) (T _F)	10nS
Output Voltage (V _{OL})	10% V _{DD}
(V _{OH})	90% V _{DD} Min
Output Current (I _{OL})	4.0mA Min
(I _{OH})	-1.0mA Min
Output Load (HCMOS)	15pF
Start-up Time (T _s)	10mS
Frequency Linearity	±10%

¹ Inclusive of 25°C tolerance, operating temperature range, input voltage change, load change, aging,

shock, vibration, and V_C = 1.65V.

³ Higher frequencies available on an individual inquiry basis.

All specifications subject to change without notice. Rev. 05/01/02



Pin Connections

#1 V_C #8 Output
#7 GND #14 +3.3V_{DC}

All dimensions are in millimeters.

VCXOs & TCXOs

5.0V THRU-HOLE VOLTAGE CONTROLLED CRYSTAL OSCILLATOR

VCXO-C

FEATURES

- 5.0V Operation
- HCMOS/TTL Output
- Rugged Resistance Weld

OPTIONS

- Many Stability/Pullability Options
- -40°C ~ +85°C Option ('R' Version)



• MODEL NUMBER SELECTION

Model Number	Frequency Stability ¹	Frequency Pullability	Operating Temperature(°C)	Frequency Range (MHz)
VCXO-C2	±50PPM	±200PPM	-10 ~ +70	1.000 ~ 40.000
VCXO-C2R	±50PPM	±200PPM	-40 ~ +85	1.000 ~ 40.000
VCXO-C3	±50PPM	±100PPM	-10 ~ +70	1.000 ~ 40.000
VCXO-C3R	±50PPM	±100PPM	-40 ~ +85	1.000 ~ 40.000
VCXO-C4	±25PPM	±100PPM	-10 ~ +70	1.000 ~ 40.000
VCXO-C4R	±25PPM	±100PPM	-40 ~ +85	1.000 ~ 40.000
VCXO-C7	±25PPM	±50PPM	-10 ~ +70	1.000 ~ 40.000
VCXO-C7R	±25PPM	±50PPM	-40 ~ +85	1.000 ~ 40.000
VCXO-C8	±100PPM	±100PPM	-10 ~ +70	1.000 ~ 40.000
VCXO-C8R	±100PPM	±100PPM	-40 ~ +85	1.000 ~ 40.000

• ELECTRICAL CHARACTERISTICS

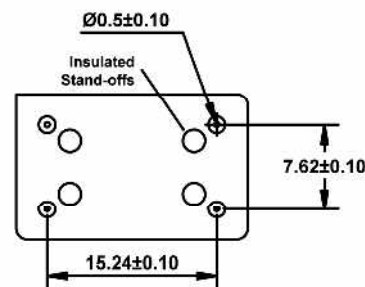
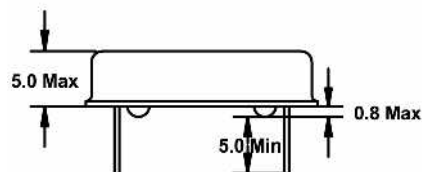
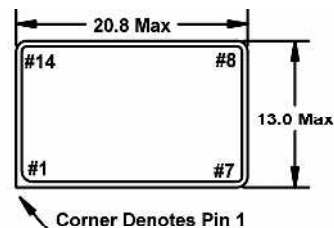
PARAMETERS	MAX (unless otherwise noted)
Frequency Range (Fo)	1.000 ~ 40.000 ³ MHz
Storage Temperature Range (T _{STG})	-40°C ~ +85°C
Supply Voltage (V _{DD})	5.0V ± 5%
Control Voltage (V _C)	2.5V ± 2V
Input Current (I _{DD})	
1.000 ~ 24.000 MHz	15mA
24.000+ ~ 30.000 MHz	20mA
30.000+ ~ 40.000 MHz	30mA
Output Symmetry (50% V _{DD})	40% ~ 60%
Rise Time (10% ~ 90% V _{DD}) (T _R)	10nS
Fall Time (90% ~ 10% V _{DD}) (T _F)	10nS
Output Voltage (V _{OL})	10% V _{DD}
(V _{OH})	90% V _{DD} Min
Output Current (I _{OL})	3.2mA Min
(I _{OH})	-0.1mA Min
Output Load	
TTL	8 LSTTL
HCMOS	15pF
Start-up Time (T _S)	10mS
Phase Noise	
Fo + 1 kHz	-125 dBc/Hz
Fo + 10 kHz	-130 dBc/Hz
Stability vs. Voltage (V _{DD} = 5.0V ± 5%)	±1.0PPM
Linearity	±10%
Modulation	10kHz

¹ Inclusive of 25°C tolerance, operating temperature range, input voltage change, load change, aging.

shock, vibration, and V_C = 2.5V.

³ Higher frequencies available on an individual inquiry basis.

All specifications subject to change without notice. Rev. 05/01/02



Pin Connections

#1 V_C #8 Output
#7 GND #14 +5V_{DC}

All dimensions are in millimeters.

FOX914 SERIES

FEATURES

- 3.0V Operation
- 1.5mm Height Max
- Clipped Sine Output
- Low Cost
- Tape and Reel (2,000 pcs. STD)

OPTIONS

- Voltage Control (FOX914E)
- Lower Voltages



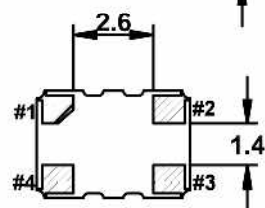
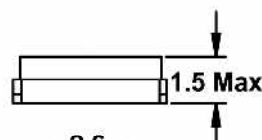
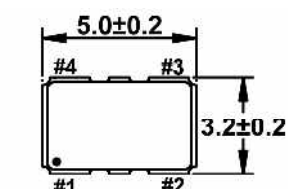
• DEVELOPED FREQUENCIES ¹	
12.600 MHz	19.200 MHz
12.800 MHz	19.440 MHz
13.000 MHz	19.680 MHz
13.824 MHz	19.800 MHz
14.400 MHz	20.000 MHz
14.850 MHz	26.000 MHz
16.800 MHz	

• ELECTRICAL CHARACTERISTICS	
PARAMETERS	MAX (unless otherwise noted)
Frequency Range (Fo)	12.600 ~ 26.000 MHz
Temperature Range	
Operating (T _{OPR})	-20°C ~ +75°C
Storage (T _{STG})	-40°C ~ +85°C
Supply Voltage (V _{DD})	3.0V ± 5%
Input Current (I _{DD})	2.0mA
Initial Frequency Tolerance (@ 25°C ± 2°C) (V _c = 1.5V) ²	±0.5PPM
Frequency Stability	
Over Temperature Range	±2.5PPM
Over Supply Voltage Change (3.0V ± 5%)	±0.2PPM
Over Load Change (10Ω ± 10% // 10pF ± 10%)	±0.2PPM
Output Waveform (Clipped Sine)	
Peak-to-Peak Level (V _{p-p})	0.8V Min
Output Load	10kΩ // 10pF
Aging per year	±1.0PPM
Pullability ² (V _c = 1.5 ± 1.0V)	±5.0 ~ ±15.0 PPM

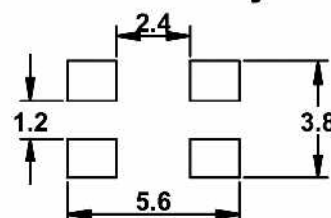
¹ Undeveloped frequencies available on an inquiry basis.

² For proper operation, a control voltage (V_c) must be applied to pin 1 on VCTCXOs.

All specifications subject to change without notice. Rev. 05/01/02



Recommended Solder Pad Layout



Pin Connections

FOX914B		FOX914E	
#1 GND	#3 Output	#1 V _c	#3 Output
#2 GND	#4 V _{DD}	#2 GND	#4 V _{DD}

All dimensions are in millimeters.

FOX307H

FEATURES

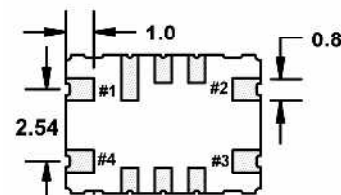
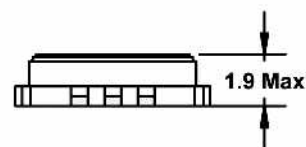
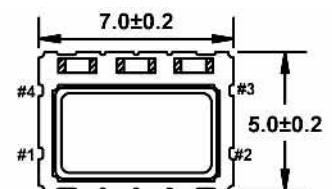
- 3.0V Operation
- 1.9mm Height Max
- Clipped Sine Output
- Tape and Reel (2,000 pcs. STD)



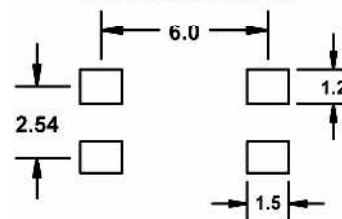
• ELECTRICAL CHARACTERISTICS

PARAMETERS	MAX (unless otherwise noted)
Frequency Range (Fo)	10.000 ~ 26.000 MHz
Temperature Range	
Operating (T _{OPR})	-20°C ~ +75°C
Storage (T _{STG})	-40°C ~ +85°C
Supply Voltage (V _{DD})	3.0V ± 5%
Input Current (I _{DD})	2.0mA
Frequency Stability	
Over Temperature Range	±2.5PPM
Over Supply Voltage Change (3.0V ± 5%)	±0.3PPM
Over Load Change (10 Ω // 10pF)	±0.3PPM
Voltage Control ¹ (1.5V ± 1.0V)	±5.0 ~ ±15.0PPM
Output Waveform (Clipped Sine)	
Peak-to-Peak Level (V _{p-p})	0.8V Min
Output Load	10k Ω // 10pF
Aging per year	±1.0PPM

¹ For proper operation, a control voltage (V_c) must be applied to pin 1.
All specifications subject to change without notice. Rev. 05/01/02



Recommended Solderpad Layout



Pin Connections

- #1 V_{cont}
- #2 GND
- #3 Output
- #4 V_{DD}

All dimensions are in millimeters.

FOX312BE

FEATURES

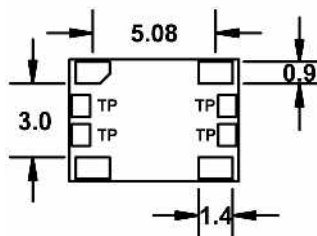
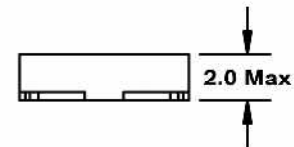
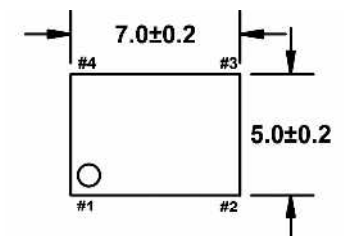
- 3.0V Operation
- 2.0mm Height Max
- Clipped Sine Output
- Tape and Reel (1,000 pcs. STD)



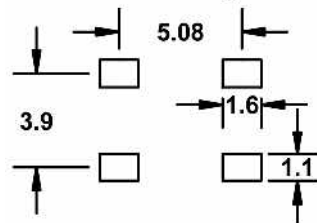
• ELECTRICAL CHARACTERISTICS	
PARAMETERS	MAX (unless otherwise noted)
Frequency Range (Fo)	12.600 ~ 26.000 MHz
Temperature Range	
Operating (T _{OPR})	-20°C ~ +75°C
Storage (T _{STG})	-40°C ~ +85°C
Supply Voltage (V _{DD})	3.0V ± 5%
Input Current (I _{DD})	2.0mA
Frequency Stability	
Over Temperature Range	±2.5PPM
Over Supply Voltage Change (3.0V ± 5%)	±0.1PPM
Over Load Change (10KΩ±10% // 10pF±10%)	±0.3PPM
Initial Frequency Tolerance @ 25°C V _c = 1.5V ¹	±0.5PPM
Output Waveform (Clipped Sine)	
Peak-to-Peak Level (V _{p-p})	0.8V Min
Output Load	10KΩ // 10pF
Pullability ¹ (1.5V ± 1.0V)	±5.0 ~ ±15.0PPM
Aging per year	±1.0PPM

¹ For proper operation, a control voltage (V_c) must be applied to pin 1.

All specifications subject to change without notice. Rev. 05/01/02



Recommended Solder Pad Layout



Pin Connections

#1 VC #3 OUTPUT
#2 GND #4 V_{DD}

All dimensions are in millimeters.

3.0V LOW PROFILE VCTCXO

FOX801BE

FEATURES

- 3.0V Operation
- 2.0mm Height Max
- Clipped Sine Output
- Low Cost
- Stocking Standard
- Tape and Reel (2,000 pcs. STD)



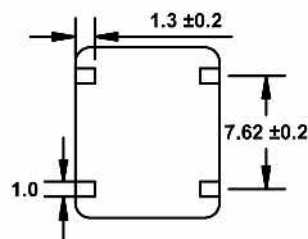
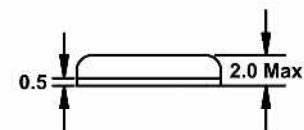
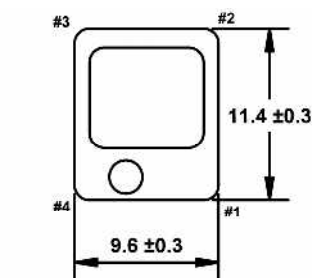
• DISTRIBUTOR STOCKING ITEMS

Model Number	Frequency (MHz)
FOX801BE-100	10.000
FOX801BE-128	12.800
FOX801BE-144	14.400
FOX801BE-160	16.000
FOX801BE-192	19.200

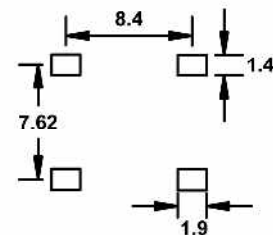
• ELECTRICAL CHARACTERISTICS

PARAMETERS	MAX (unless otherwise noted)
Frequency Range (Fo)	10.000 ~ 22.000 MHz
Temperature Range	
Operating (T _{OPR})	-30°C ~ +75°C
Storage (T _{STG})	-35°C ~ +85°C
Frequency Tolerance (@25°C) V _C = 1.5V ¹	±0.5PPM
Supply Voltage (V _{DD})	3.0V ± 5%
Input Current (I _{DD})	2.0mA
Frequency Stability	
Over Temperature Range	±2.5PPM
Over Supply Voltage Change (3.0V ± 5%)	±0.3PPM
Over Load Change (10Ω ± 10% // 10pF ± 10%)	±0.3PPM
	±3.0PPM Min
Voltage Control ¹ (1.5V ± 1.0V)	
Output Waveform (Clipped Sine)	
Peak-to-Peak Level (V _{p-p})	0.8V Min
10.000 ~ 14.400	0.7V Min
14.400+ ~ 22.000	10KΩ // 10pF
Output Load	±3.0PPM
Frequency Adjustment (Internal Trimmer)	±0.8PPM

¹ For proper operation, a control voltage (V_C) must be applied to pin 1 on VCTCXOs.
All specifications subject to change without notice. Rev. 05/01/02



Recommended Solder Pad Layout



Pin Connections

#1 V_C #3 Output
#2 GND #4 V_{DD}

All dimensions are in millimeters.

3.0V/5.0V LOW PROFILE TCXO

FOX801 SERIES

FEATURES

- 2.0mm Height Max
- Low Cost
- Clipped Sine Output
- Tape and Reel (2,000 pcs. STD)

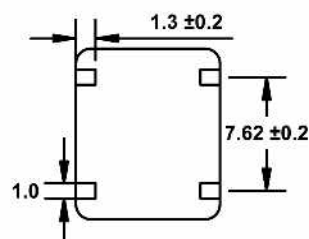
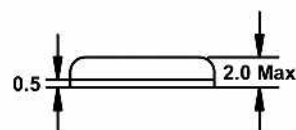
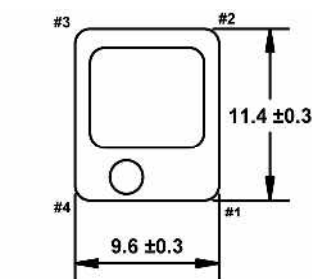
OPTIONS

- 'A' Version - 5.0V
- 'B' Version - 3.3V
- VCTCXO - AE/BE Version
- VCTCXO - AH/BH Version (trimmerless)

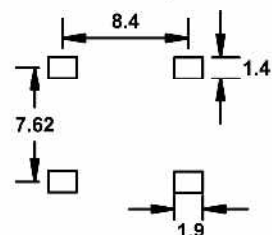


• ELECTRICAL CHARACTERISTICS	
PARAMETERS	MAX (unless otherwise noted)
Frequency Range (Fo)	10.000 ~ 22.000 MHz
Temperature Range	
Operating (TOPR)	-30°C ~ +75°C
Storage (TSTG)	-35°C ~ +80°C
Initial Frequency Tolerance (@25°C)	
Vc = 2.5V (A Series) ¹ FOX801A/B/AE/BE	±0.5PPM
Vc = 1.5V (B Series) ¹ FOX801AH/BH	±2.0PPM
Supply Voltage (VDD)	
A Version	5.0V ± 5%
B Version	3.0V ± 5%
Input Current (IDD)	2.0mA
Frequency Stability	
Over Temperature Range	±2.5PPM
Over Supply Voltage Change (VDD ± 5%)	±0.3PPM
Over Load Change (10Ω ± 10% // 10pF ± 10%)	±0.3PPM
Output Waveform (Clipped Sine)	
Peak-to-Peak Level (Vp-p)	1.0V Min
A Version: 10.000 ~ 22.000 MHz	0.8V Min
B Version: 10.000 ~ 14.400 MHz	0.7V Min
B Version: 14.400+ ~ 22.000 MHz	10KΩ // 10pF
Output Load	
Frequency Adjustment (Internal Trimmer)	±3.0PPM
FOX801A/B/AE/BE	Trimmerless
FOX801AH/BH	
Voltage Control Option (VCTCXO) ¹	None
A Version (Vc=2.5±2.0V) FOX801A/B	±5.0PPM Min
B Version (Vc=1.5±1.0V) FOX801AE/BE	±8.0PPM Min
FOX801AH/BH	
Aging per year	±0.8PPM

¹ For 10.000 or 22.000, a control voltage (Vc) must be applied to pin 1 on VCTCXOs.
All specifications subject to change without notice. Rev. 05/01/02



Recommended Solder Pad Layout



Pin Connections

- #1 Vc or N.C.*
- #2 GND
- #3 Output
- #4 VDD

* A, B is N.C. all other Vc

All dimensions are in millimeters.

FOX781B

FEATURES

- 5.0V Operation
- Clipped Sine Output
- Adjustable Frequency
- 14-Pin DIP

OPTIONS

- VCTCXO - FOX781C
- Higher Frequencies



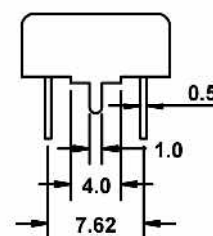
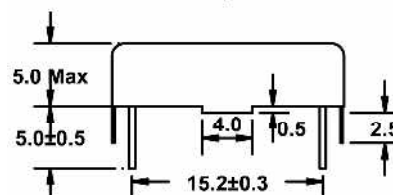
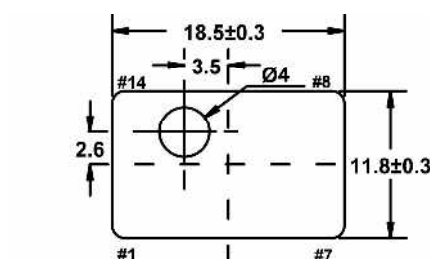
• ELECTRICAL CHARACTERISTICS

PARAMETERS	MAX (unless otherwise noted)
Frequency Range (Fo)	8.000 ~ 20.000 ¹ MHz
Initial Frequency Tolerance @ 25°C	±1.0PPM
Frequency Stability	
Over Temperature Range	±2.5PPM
Over Supply Voltage Change (5.0V ± 5%)	±0.2PPM
Over Load Change (10KΩ ± 10% // 10pF	±0.2PPM
10%)	
Temperature Range	
Operating (T _{OPR})	-20°C ~ +75°C
Storage (T _{STG})	-40°C ~ +80°C
Supply Voltage (V _{DD})	5.0V ± 5%
Output Waveform (Clipped Sine)	1.0V Min
Peak-to-Peak Level (V _{p-p})	2.0mA
Input Current (I _{DD})	10KΩ // 10pF
Output Load	
Aging @ 25°C; per year	±1.0PPM
8.000 ~ 19.999999 MHz	±2.0PPM
20.000000 MHz	±3.0PPM Min

¹ Frequency Adjustment (Internal 5.000000) available on an individual inquiry basis.

³ VCTCXO version (FOX781C) available on an individual inquiry basis to custom customer specifications.

All specifications subject to change without notice. Rev. 05/01/02



Pin Connections

TCXO	VCTCXO
#1 VC	#1 VC
#7 GND	#7 GND
#8 OUTPUT	#8 OUTPUT
#14 V _{DD}	#14 V _{DD}

All dimensions are in millimeters.

5.0V THRU-HOLE TCXO/VCTCXO

FOX782

FEATURES

- 5.0V Operation
- HCMOS Output
- Adjustable Frequency
- 14-Pin DIP

OPTIONS

- VCTCXO - FOX782C
- Higher Frequencies
- 3.3V (FOX782A)



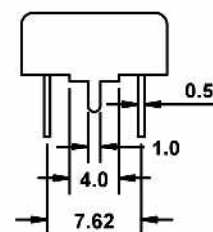
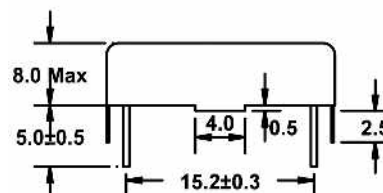
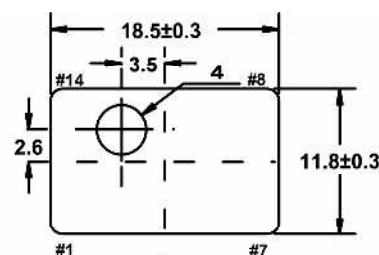
• ELECTRICAL CHARACTERISTICS

PARAMETERS	MAX (unless otherwise noted)
Frequency Range (Fo)	8.000 ~ 20.000 MHz
Initial Frequency Tolerance @ 25°C	±1.0PPM
Frequency Stability	
Over Temperature Range	±2.5PPM
Over Supply Voltage Change (5.0V ± 5%)	±0.2PPM
Temperature Range	
Operating (T _{OPR})	-20°C ~ +75°C
Storage (T _{STG})	-40°C ~ +80°C
Supply Voltage (V _{DD})	5.0V ± 5%
Input Current (I _{DD})	
8.000 ~ 20.000 MHz	15mA
Output Symmetry (50% V _{DD})	40% ~ 60%
Rise Time (10% ~ 90% V _{DD}) (T _R)	5nS
Fall Time (90% ~ 10% V _{DD}) (T _F)	5nS
Output Voltage (V _{OL})	10% V _{DD}
(V _{OH})	90% V _{DD} Min
Output Current (I _{OL})	4.0mA Min
(I _{OH})	-1.0mA Min
Output Load (HCMOS)	15pF
Start-up Time (T _s)	10mS

¹ Frequencies from 20.000+ MHz to 45.000 MHz available on an individual inquiry basis.

³ VCTCXO version (FOX782C) available on an individual inquiry basis to custom customer specifications.

All specifications subject to change without notice. Rev. 05/01/02



Pin Connections

TCXO	VCTCXO
#7 GND	#1 VC
#8 OUTPUT	#7 GND
#14 V _{DD}	#8 OUTPUT
	#14 V _{DD}

All dimensions are in millimeters.

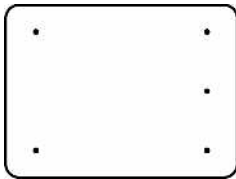
OVEN CONTROLLED CRYSTAL OSCILLATORS (OCXO)

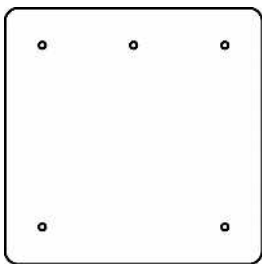
GENERAL DESIGN SPECIFICATIONS

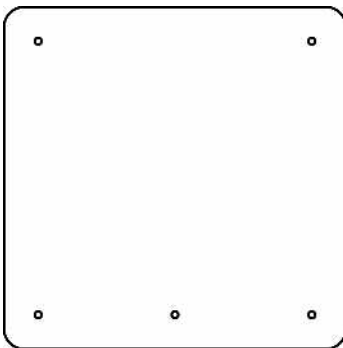
PRELIMINARY

As Fox ventures into the OCXO product offerings, we have established a General Specification Matrix of products we currently have in development. In addition to the matrix, we can develop new OCXOs based on customer needs. To discuss your OCXO requirements, contact the Fox Customer Technology Center (CTC) referenced on the inside covers of this catalog.

• 14-PIN DIP	
	
Frequency Range	10.000 ~ 125.000 MHz
Stability	$\pm 250 \sim \pm 750$ PPB
Temperature Range	0°C ~ +70°C, -40°C ~ +75°C
Supply Voltages	3.3V, 5.0V
Output Type	HCMOS, Sine Wave

• EURO PACKAGE	
	
Frequency Range	5.000 ~ 125.000 MHz
Stability	$\pm 4 \sim \pm 120$ PPB
Temperature Range	0°C ~ +50°C, -40°C ~ +75°C
Supply Voltages	5.0V, 12.0V
Output Type	HCMOS, Sine Wave

• 38.1 x 38.1mm PACKAGE	
	
Frequency Range	5.000 ~ 125.000 MHz
Stability	$\pm 4 \sim \pm 120$ PPB
Temperature Range	0°C ~ +50°C, -40°C ~ +75°C
Supply Voltages	5.0V, 12.0V
Output Type	HCMOS, Sine Wave

• 50.8 x 50.8mm PACKAGE	
	
Frequency Range	5.000 ~ 125.000 MHz
Stability	$\pm 4 \sim \pm 120$ PPB
Temperature Range	0°C ~ +50°C, -40°C ~ +75°C
Supply Voltages	5.0V, 12.0V
Output Type	HCMOS, Sine Wave

- * Current Capabilities not yet in production.
- * All specifications to be confirmed at prototype.

Rev. 05/01/02

STRATUM III 14-PIN DIP OVEN CONTROLLED CRYSTAL OSCILLATOR

FTS501AH

FEATURES

- Meets Stratum III
- 5.0V Operation
- HCMOS Output
- 14-Pin DIP

OPTIONS

- 3.3V Available

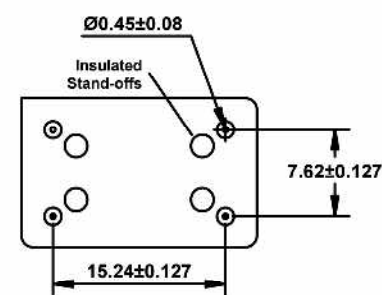
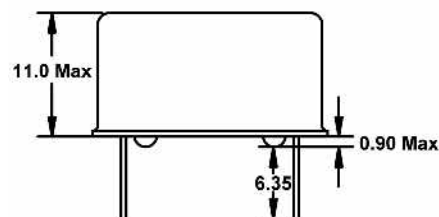
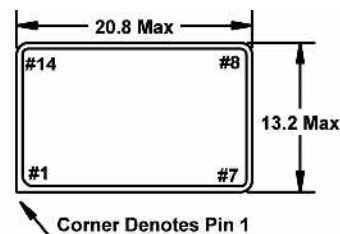


• ELECTRICAL CHARACTERISTICS

PARAMETERS	MAX (unless otherwise noted)
Frequency Range (Fo)	10.000 ~ 40.000 MHz
Temperature Range	
Operating (T _{OPR})	0°C ~ +70°C
Storage (T _{STG})	-40°C ~ +85°C
Supply Voltage	5V ±0.2V ¹
Output Type	HCMOS
Pullability	4 PPM Min
Control Voltage	0.5V ~ 5.0V
Frequency Stabilities	±4.6 PPM
	All effects for 10 years
Frequency vs. Temperature	±250 PPB
Frequency vs. Voltage	±100 PPB
Holdover Aging (24 hours)	±20 PPB
Holdover Stability	±370 PPB
Load Stability	±10 PPB
Long Term Aging 1st Year	±0.75 PPM
Aging 10 Years	±4.2 PPM
Warm-up to within ±4.6 PPM	2 Minutes
Warm-up Power	< 1.5 Watts
Operating Power (Typical)	1.0W ~ 0°C, 0.6W @ +25°C
Phase Noise	-115 dBc/Hz @ 100 Hz -140 dBc/Hz @ 10 kHz

¹ 3.3V available upon request

All specifications subject to change without notice. Rev. 05/01/02



Pin Connections

#1 V_c #8 Output
#7 GND #14 V_{DD}

All dimensions are in millimeters.

OCXOS



Radio Frequency Crystal Oscillators



The **RFXO Family** of Oscillators was developed by Fox Electronics Inc. for SONET/SDH/ATM/WAN applications. By combining a proprietary ASIC architecture with our advanced quartz technologies, these RFXOs are able to generate very clean output frequencies. This exclusive combination of radio frequency control technologies enables these RFXOs to deliver the optimum cost-to-performance ratio in the industry for RF applications. See us at [Electronica 2002](#).



[RFXV300
Spec Sheet](#)



[RFX300
Spec Sheet](#)

RFXO Features:

- Available as a standard Oscillator (XO) or Voltage controlled Crystal Oscillator (VCXO)
- Frequencies from 600MHz to 1.25GHz
- Industry standard SMT package (7.5x5x1.5mm Max)
- LV-PECL complementary outputs
- 3.3v and 2.5v versions
- Output Enable/Disable function
- Low jitter and phase Noise
- Tight stabilities and extended temperature ranges available

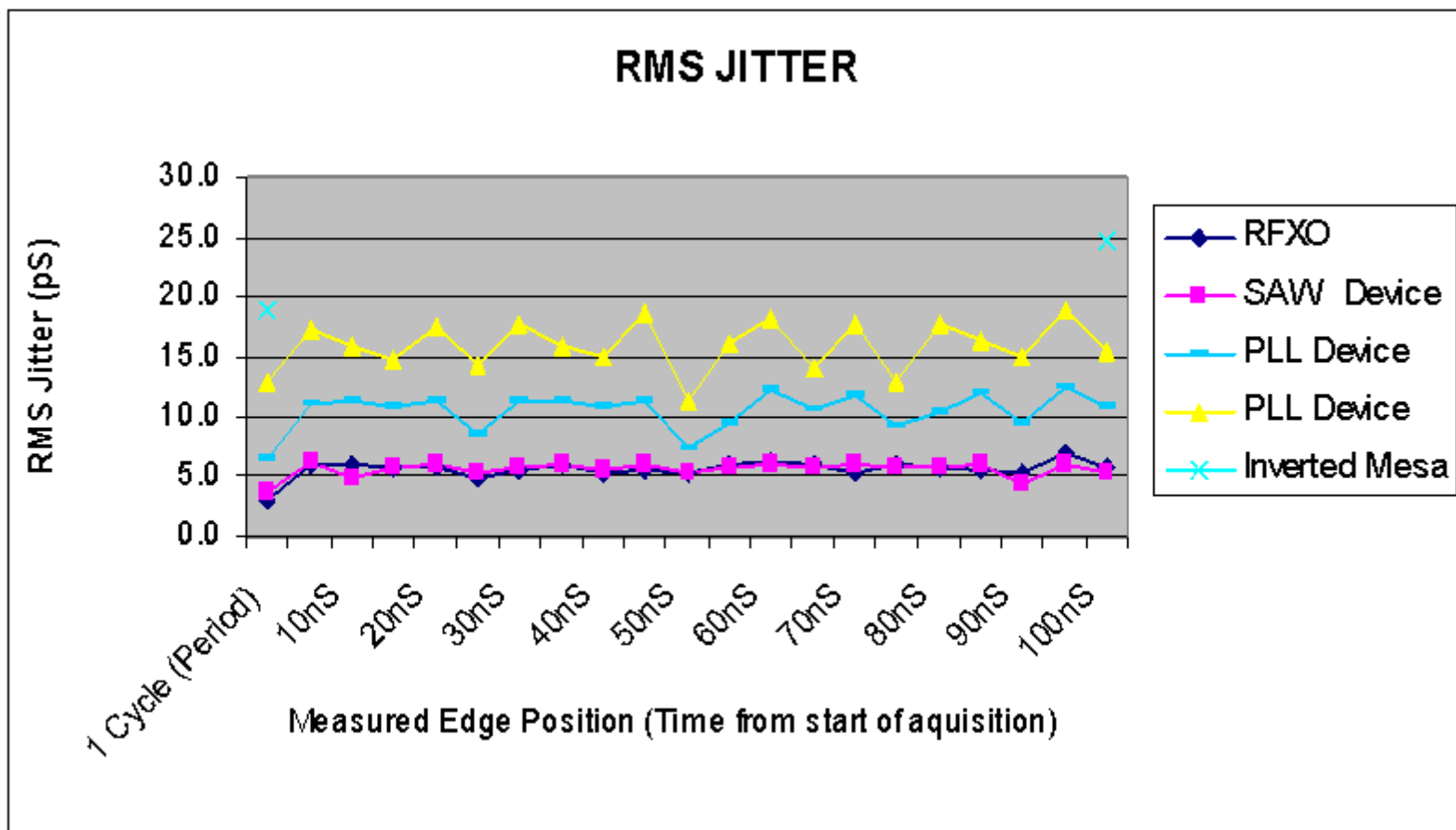
[RFXO Series, includes both PDFs](#)

RFXO Applications:

- PLL circuits for clock smoothing or frequency translation
- SONET/SDH, ATM, WAN, OC-12 up through OC-768 including FEC rates, Gb Ethernet and Fiber Channel
- Timing reference for Optical and Data Communications systems

RFXO Description:

The RFXO family of Oscillators is an ASIC-driven crystal-based line of frequency control products. These RFXOs are available as standard Crystal Oscillators (XOs) or Voltage Controlled Crystal Oscillators (VCXOs) with frequencies from 600MHz to 1.25GHz. The RFXO family of products generates an output at the frequency of operation (f_o) with low jitter and phase noise in the frequency domain. Low clock jitter is essential to achieve a low bit error rate in optical data communications and also allows for full use of the allotted bandwidth. This makes the RFXO ideally suited for the next generation of low jitter clocks and data streams for SONET/SDH applications.



Electronica 2002

New Munich Trade Fair Center

Munich, Germany

November 12 ~15 November 2002



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RFX300



FEATURES

- 3.3V Operation
- High Performance
- Complementary Output

Applications include SONET / SDH / ATM / WAN



PRELIMINARY

• MODEL NUMBER SELECTION

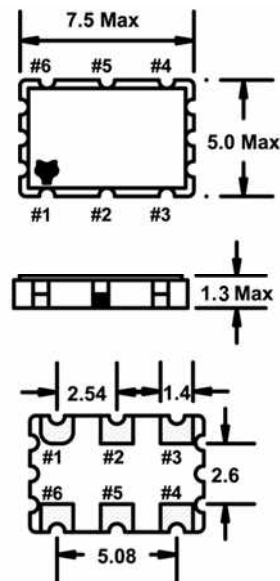
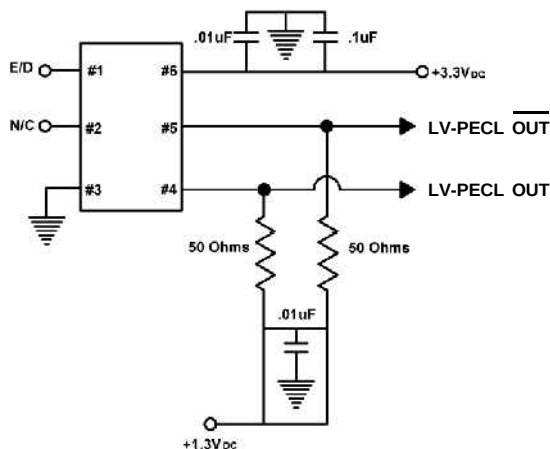
Model Number	Frequency Stability	Operating Temperature (°C)
RFX300	±100PPM	-20 ~ +70
RFX300R	±100PPM	-40 ~ +85
RFX305	±50PPM	-20 ~ +70
RFX305R	±50PPM	-40 ~ +85
RFX306	±25PPM	-20 ~ +70
RFX306R	±25PPM	-40 ~ +85
RFX308	±20PPM	-20 ~ +70

• ELECTRICAL CHARACTERISTICS

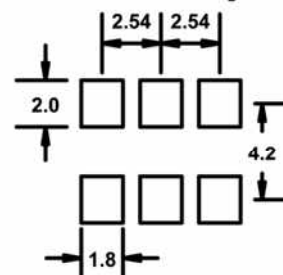
PARAMETERS		
Available Frequencies		622 ~ 700 MHz, 1.244 ~ 1.25GHz
Storage Temperature Range		-55°C ~ +125°C
Supply Voltage (V _{DD})		3.3V ± 10%
Supply Current	3.3V Version	60mA
Rise Time	(20% ~ 80% V _{p-p})	0.5nS
Fall Time	(80% ~ 20% V _{p-p})	0.5nS
Symmetry	(50% V _{p-p})	45/55
Output Voltage	3.3V Version(V _{OL})	1.305V ~ 1.65 V
	(V _{OH})	2.155 ~ 2.405 V
Start-up Time (T _s)		10mS
PECL Skew (50% V _{p-p})		125pS
Jitter	Integrated 12kHz to 20MHz	<0.5pS
	RMS	3 pS
	Cycle-to-Cycle	30 pS

Inclusive of 25°C tolerance, operating temperature range, input voltage change, load change, aging, shock, and vibration.

RFX300 Series Recommended Circuit



Recommended Solder Pad Layout



Pin Connections

# 1 V c	# 4 Output 1
# 2 E/D	# 5 Output 2
# 3 GND	# 6 VDD

All dimensions are in millimeters.

RFV300



FEATURES

- 3.3V Operation
- High Performance
- Complementary Output

Applications include SONET / SDH / ATM / WAN



PRELIMINARY

• MODEL NUMBER SELECTION

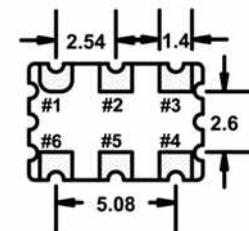
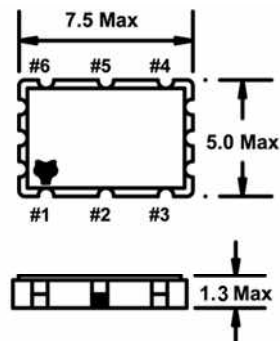
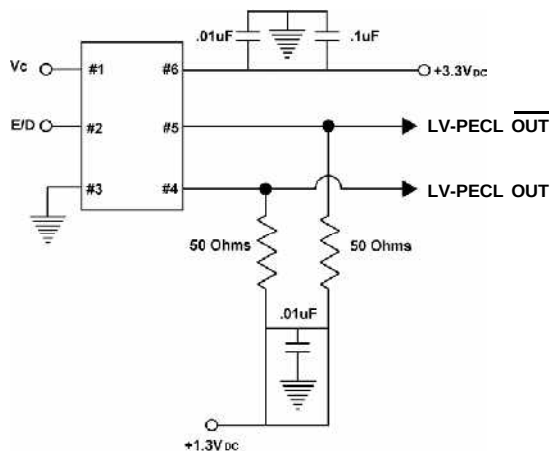
Model Number	Frequency Stability	Frequency Pullability	Operating Temperature (°C)
RFV350	±50PPM	±100PPM	-20 ~ +70
RFV350R	±50PPM	±100PPM	-40 ~ +85
RFV325	±25PPM	±50PPM	-20 ~ +70
RFV325R	±25PPM	±50PPM	-40 ~ +85
RFV330	±20PPM	±50PPM	-20 ~ +70

• ELECTRICAL CHARACTERISTICS

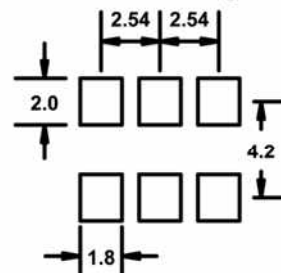
PARAMETERS		
Available Frequencies		622 ~ 700 MHz, 1.244 ~ 1.25GHz
Storage Temperature Range		-55°C ~ +125°C
Supply Voltage (V _{DD})		3.3V ± 10%
Supply Current	3.3V Version	60mA
Rise Time	(20% ~ 80% V _{p-p})	0.5nS
Fall Time	(80% ~ 20% V _{p-p})	0.5nS
Symmetry	(50% V _{p-p})	45/55
Output Voltage	3.3V Version(V _{OL})	1.305V ~ 1.65 V
	(V _{OH})	2.155 ~ 2.405 V
Start-up Time (T _s)		10mS
Linearity		± 10%
Modulation Bandwidth		>10kHz
PECL Skew (50% V _{p-p})		125pS
Jitter		
Integrated 12kHz to 20MHz RMS		<0.5pS
Cycle-to-Cycle		3 pS
		30 pS

Inclusive of 25°C tolerance, operating temperature range, input voltage change, load change, aging, shock, and vibration.

RFV300 Series Recommended Circuit



Recommended Solder Pad Layout



Pin Connections

# 1 V c	# 4 Output 1
# 2 E/D	# 5 Output 2
# 3 GND	# 6 VDD

All dimensions are in millimeters.

Fox Electronics Part Description¹ Guide for TCXOs/VCXOs

1

Make Selection from Product Family in Fox Catalog or Foxonline.com
For Example: Fox801B

2

Frequency MHz
Customer Fills In

3

Stability²
Pick from Section A

4

Operating Temp²

5/6

Fox Use

7

SMD Packaging

8

Fox Use

9/10

Value Added

11

Custom

Fox Production SMD Reel Quantities

759/739 Series	1K
F5000/F5100 Series	1K
FOX801 Series	2K
FOX305B Series	1K
FOX312BE Series	1K
VCS Series	2K

Section A

A ± 100ppm
B ± 50 ppm
C ± 30ppm
D ± 25ppm
E ± 20ppm
F ± 15ppm
G ± 12ppm
H ± 10ppm
J ± 7.5ppm
K ± 7ppm
L ± 5ppm
M ± 4ppm
N ± 3ppm
P ± 2.5ppm
R ± 2ppm
S ± 1.5ppm
T ± 1ppm
U ± 0.5ppm

Operating Temp. Range

A = 0° to +50°C
B = -10° to +50°C
C = 0° to +70°C
D = -10° to +60°C
E = -10° to +70°C
F = -20° to +70°C
Z = -25° to +75°C
G = -30° to +70°C
H = -30° to +75°C
J = -30° to +80°C
K = -30° to +85°C
L = -35° to +80°C
V = -35° to +85°C
M = -40° to +85°C

SMD Packaging

0 = Tape/Reel*
250 = 250
500 = 500
1000 = 1000
Tape Only = Tape Only

Value Added

M = Special Marking
N = Cut Base
S = Bulk
Z = SMD tape

Custom

C = Custom
Place attach drawing and/or additional electrical specs for our engineering department.

Notes:

¹ Fox unique part numbers for non-standards are randomly generated based on the elements of the part description in a format: ### - Frequency - Random # (099-22.1184-39789 is Fox unique part number).

² All combinations are not possible.

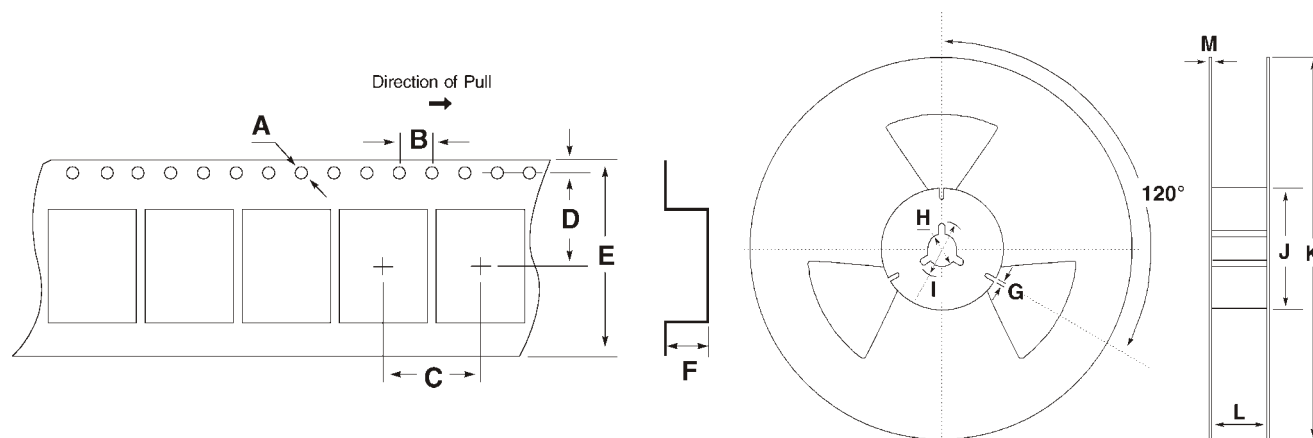
* 0 = Tape/Reel assumes that no quantity per reel was specified; therefore, the Fox Production SMD Reel Quantities list applies. For any other quantities specified a broken reel charge will apply.

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FOX Electronics 5570 Enterprise Parkway Fort Myers, Florida 33905 USA +001(239)693-0099 FAX +001(239)693-1554 <http://www.foxonline.com>

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TAPE AND REEL SPECIFICATIONS



• TAPE SPECIFICATIONS (millimeters)

MODEL	A	B	C	D	E	F	STD QTY ¹
VCSAXT Series	Ø1.5	4.0	8.0	5.5	12.0	1.9	2,000
FOX914 Series	Ø1.5	4.0	8.0	5.5	12.0	1.7	2,000
FOX307H	Ø1.5	4.0	8.0	7.5	16.0	2.5	2,000
FOX312BE	Ø1.5	4.0	8.0	7.5	16.0	2.2	1,000
FOX801 Series	Ø1.5	4.0	12.0	11.5	24.0	2.7	2,000

¹ Standard reel quantity.

• REEL SPECIFICATIONS (millimeters)

MODEL	G	H	I	J	K	L	M
VCSAXT Series	2.0	Ø13	Ø21	Ø80	Ø255	17.5	2.0
FOX914 Series	2.0	Ø13	Ø21	Ø100	Ø254	13.5	2.0
FOX307H	2.0	Ø13	Ø25	Ø80	Ø255	17.5	2.0
FOX312BE	2.0	Ø13	Ø21	Ø100	Ø330	16.4	2.0
FOX801 Series	2.0	Ø13	Ø21	Ø80	Ø330	25.5	1.6

MONOLITHIC CRYSTAL FILTERS

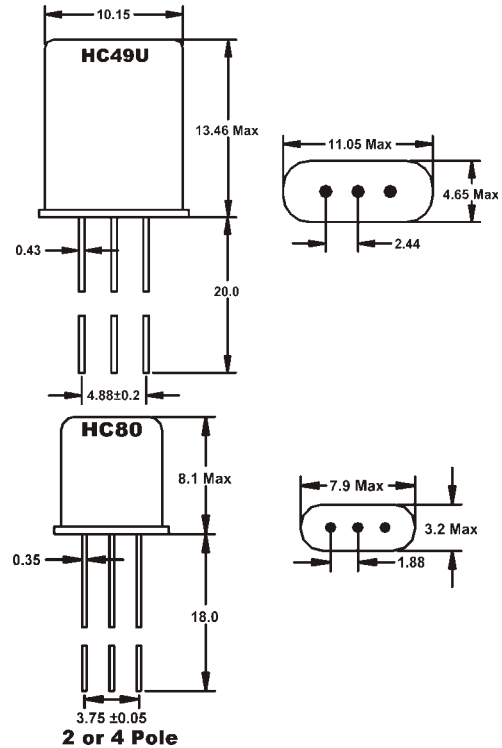
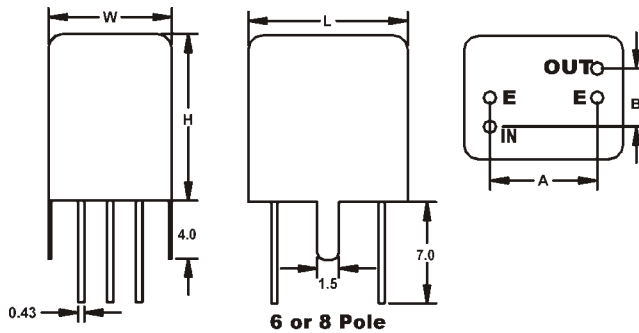
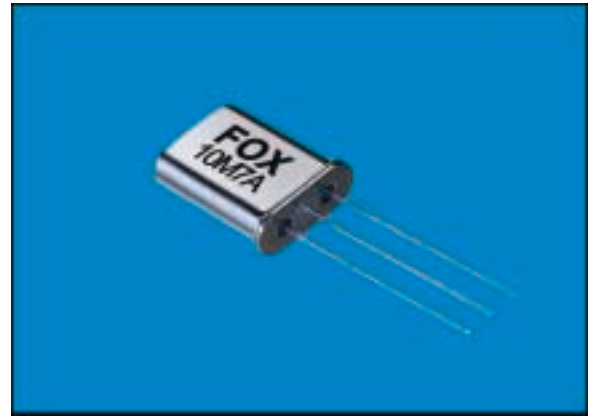
Fox filters offer excellent features such as sharp cut off characteristics, low loss and high stability over a wide temperature range which are superior to LC Filters and Ceramic Filters.

The basic building block for all custom built Fox filters is the two-pole monolithic filter available in standard package as shown. Two-pole monolithic filters are cascaded to produce four, six and eight pole filter responses with the addition of coupling capacitors between two-pole sections. Standard Fox filters are available with center frequencies from 10.7 MHz to 90 MHz, and from two to eight poles.

For custom made filters, please specify the following:

- Holder Size
- Insertion Loss
- Ripple
- Nominal Frequency
- Attenuation
- Terminating Impedance
- Pass Bandwidth
- Spurious Response
- Operating Temp. Range

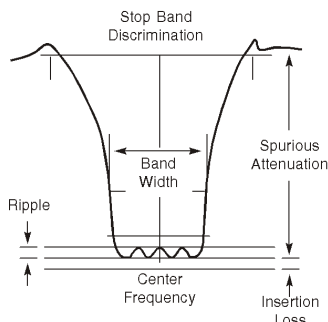
Note: 45F Series 45.000 MHz fundamental is a special filter designed for mobile radio and cellular phone applications.



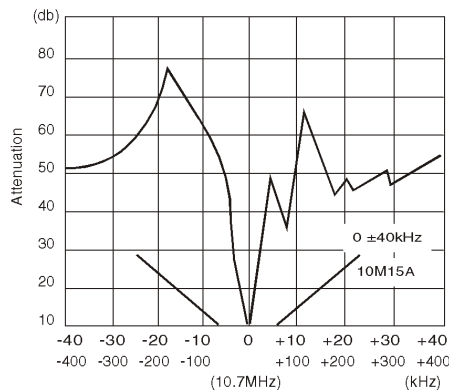
• MULTI-POLE PACKAGE DIMENSIONS

CASE TYPE	L		W		H		A		B	
C	0.590	(15.0)	0.472	(12.0)	0.591	(15.0)	0.354	(9.0)	0.197	(5.0)
D	0.728	(18.5)	0.472	(12.0)	0.591	(15.0)	0.531	(13.5)	0.197	(5.0)
CN	0.433	(11.0)	0.335	(8.5)	0.453	(11.5)	0.291	(7.4)	0.157	(4.0)

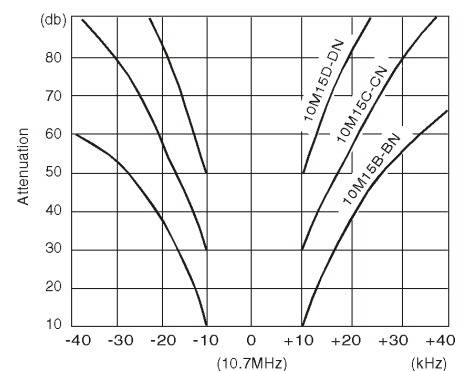
FILTER PARAMETERS



10.7MHz TWO POLE CHARACTERISTICS



MULTI-POLE CHARACTERISTICS



• STANDARD MONOLITHIC CRYSTAL FILTERS

Type	Frequency MHz	Pole	Case	Pass Band dB kHz	Stop Band dB kHz	Stop Band dB kHz	Ripple Max dB	Loss Max dB	Attenuation Guaranteed to $\pm$ kHz	Terminating Impedance ohms/pF
10M7A	10.700	2	49U	3 $\pm$ 3.75	20 $\pm$ 18		0.5	1.5	35 +300 ~ +1000 40 -200 ~ -1000	1.8K//6.0
10M7B	10.700	4	49Ux2	3 $\pm$ 3.75	40 $\pm$ 14		1.0	2.5	50 +300 ~ +1000 70 -200 ~ -1000	1.8K//5.0 Cc = 11pF
10M7C	10.700	6	C	3 $\pm$ 3.75	45 $\pm$ 8.75	65 $\pm$ 12.5	2.0	3.5	65 $\pm$ 12.5 ~ $\pm$ 300	1.8K//5.0
10M7D	10.700	8	D	3 $\pm$ 3.75	65 $\pm$ 8.75	90 $\pm$ 12.5	2.0	4.0	90 $\pm$ 12.5 ~ $\pm$ 300	1.8K//5.0
10M12A	10.700	2	49U	3 $\pm$ 6.0	20 $\pm$ 25		0.5	1.5	35 +300 ~ +1000 40 -200 ~ -1000	3.3K//1.5
10M12B	10.700	4	49Ux2	3 $\pm$ 6.0	40 $\pm$ 20		1.0	2.5	50 +300 ~ +1000 70 -200 ~ -1000	3.3K//1.5 Cc = 6pF
10M12C	10.700	6	C	3 $\pm$ 6.0	50 $\pm$ 14	65 $\pm$ 20	2.0	3.0	65 $\pm$ 20 ~ $\pm$ 300	3.3K//2.0
10M12D	10.700	8	D	6 $\pm$ 6.0	65 $\pm$ 14	90 $\pm$ 20	2.0	3.5	90 $\pm$ 20 ~ $\pm$ 300	3.3K//2.0
10M15A	10.700	2	49U	3 $\pm$ 7.5	18 $\pm$ 25		0.5	1.5	35 +300 ~ +1000 40 -200 ~ -1000	3.0K//2.0
10M15B	10.700	4	49Ux2	3 $\pm$ 7.5	40 $\pm$ 25		1.0	2.5	50 +300 ~ +1000 70 -200 ~ -1000	3.0K//2.0 Cc = 5pF
10M15C	10.700	6	C	3 $\pm$ 7.5	50 $\pm$ 17.5	65 $\pm$ 25	2.0	3.0	65 $\pm$ 25 ~ $\pm$ 300	3.3K//1.5
10M15D	10.700	8	D	6 $\pm$ 7.5	65 $\pm$ 17.5	90 $\pm$ 25	2.0	3.5	90 $\pm$ 25 ~ $\pm$ 300	3.3K//1.5
10M20A	10.700	2	49U	3 $\pm$ 10.0	18 $\pm$ 34		0.5	1.5	35 +300 ~ +1000 40 -200 ~ -1000	3.9K//1.0
10M20B	10.700	4	49Ux2	3 $\pm$ 10.0	40 $\pm$ 34		1.0	2.5	50 +300 ~ +1000 70 -200 ~ -1000	3.9K//1.0 Cc = 3pF
16M15A	16.900	2	49U	3 $\pm$ 7.5	18 $\pm$ 25		0.5	1.5	35 +300 ~ +1000 40 -200 ~ -1000	1.8K//2.0
16M15B	16.900	4	49Ux2	3 $\pm$ 7.5	40 $\pm$ 25		1.0	2.5	50 +300 ~ +1000 70 -200 ~ -1000	1.8K//1.5 Cc = 7.5pF
16M15C	16.900	6	C	3 $\pm$ 7.5	45 $\pm$ 17.5	65 $\pm$ 25	2.0	3.0	65 $\pm$ 25 ~ $\pm$ 300	1.8K//1.5
16M15D	16.900	8	D	3 $\pm$ 7.5	65 $\pm$ 17.5	90 $\pm$ 25	2.0	3.5	90 $\pm$ 25 ~ $\pm$ 300	1.8K//1.5
21M7A	21.400	2	HC80	3 $\pm$ 3.75	20 $\pm$ 18		0.5	1.5	35 +350 ~ +1000 50 -200 ~ -1000	850//6.0
21M7B	21.400	4	HC80x2	3 $\pm$ 3.75	40 $\pm$ 14		1.0	2.5	65 +350 ~ +1000 80 -200 ~ -1000	850//5.0 Cc = 16pF
21M7C	21.400	6	CN	3 $\pm$ 3.75	45 $\pm$ 8.75	65 $\pm$ 12.5	2.0	3.0	65 $\pm$ 12.5 ~ $\pm$ 300	850//5.0
21M7D	21.400	8	CN	3 $\pm$ 3.75	65 $\pm$ 9.0	90 $\pm$ 12.5	2.0	4.0	90 $\pm$ 12.5 ~ $\pm$ 300	850//5.0
21M12A	21.400	2	HC80	3 $\pm$ 6.0	20 $\pm$ 25		0.5	1.5	35 +350 ~ +1000 50 -200 ~ -1000	1.2K//3.0
21M12B	21.400	4	HC80x2	3 $\pm$ 6.0	40 $\pm$ 20		1.0	2.5	65 +350 ~ +1000 80 -200 ~ -1000	1.2K//2.5 Cc = 10.5pF
21M12C	21.400	6	CN	3 $\pm$ 6.0	45 $\pm$ 14	65 $\pm$ 20	2.0	2.5	65 $\pm$ 20 ~ $\pm$ 300	1.2K//2.5
21M12D	21.400	8	CN	3 $\pm$ 6.0	65 $\pm$ 14	90 $\pm$ 20	2.0	3.0	90 $\pm$ 20 ~ $\pm$ 300	1.2K//2.5
21M15A	21.400	2	HC80	3 $\pm$ 7.5	18 $\pm$ 25		0.5	1.5	35 +350 ~ +1000 50 -200 ~ -1000	1.5K//2.0
21M15B	21.400	4	HC80x2	3 $\pm$ 7.5	40 $\pm$ 25		1.0	2.5	65 +350 ~ +1000 80 -200 ~ -1000	1.5K//2.0 Cc = 8pF
21M15C	21.400	6	CN	3 $\pm$ 7.5	45 $\pm$ 17.5	65 $\pm$ 25	2.0	2.5	65 $\pm$ 25 ~ $\pm$ 300	1.5K//2.0
21M15D	21.400	8	CN	3 $\pm$ 7.5	65 $\pm$ 17.5	90 $\pm$ 25	2.0	3.0	90 $\pm$ 25 ~ $\pm$ 300	1.5K//2.0
21M20A	21.400	2	HC80	3 $\pm$ 10.0	18 $\pm$ 34		0.5	2.0	35 +350 ~ +1000 50 -200 ~ -1000	1.8K//1.5
21M20B	21.400	4	HC80x2	3 $\pm$ 10.0	40 $\pm$ 34		1.0	2.5	65 +350 ~ +1000 80 -200 ~ -1000	1.8K//1.5 Cc = 5pF
21M30A	21.400	2	HC80	3 $\pm$ 15.0	15 $\pm$ 45		0.5	1.5	35 +350 ~ +1000 50 -300 ~ -1000	3.0K//0.5
21M30B	21.400	4	HC80x2	3 $\pm$ 15.0	40 $\pm$ 50		1.0	2.5	65 +350 ~ +1000 80 -300 ~ -1000	3.0K//0.5 Cc = 3pF
45F15A	45.000	2	HC80	3 $\pm$ 7.5	15 $\pm$ 25		1.0	2.0	35 +500 ~ +1000 40 -200 ~ -1000	650//4.5
45F15B	45.000	4	HC80x2	3 $\pm$ 7.5	30 $\pm$ 25		1.0	3.0	70 +500 ~ +1000 -200 ~ -1000	650//1.5 Cc = 9pF
45F20A	45.000	2	HC80	3 $\pm$ 10.0	15 $\pm$ 34		1.0	2.0	35 +500 ~ +1000 40 -200 ~ -1000	700//2.5
45F20B	45.000	4	HC80x2	3 $\pm$ 10.0	40 $\pm$ 48		1.0	3.0	70 +500 ~ +1000 -200 ~ -1000	700//1.5 Cc = 6.5pF
45F30A	45.000	2	HC80	3 $\pm$ 15.0	15 $\pm$ 50		1.0	2.0	35 +500 ~ +1000 -300 ~ -1000	800//1.5
45F30B	45.000	4	HC80x2	3 $\pm$ 15.0	40 $\pm$ 60		1.0	3.0	70 +500 ~ +1000 -300 ~ -1000	800//1.0 Cc = 5pF
45M15A	45.000	2	HC80	3 $\pm$ 7.5	18 $\pm$ 28		1.0	2.0	35 +500 ~ +1000 -200 ~ -1000	4K//1.0
45M15B	45.000	4	HC80x2	3 $\pm$ 7.5	40 $\pm$ 30		1.0	3.0	70 +500 ~ +1000 -200 ~ -1000	4K//1.0 Cc = -1pF
45M20A	45.000	2	HC80	3 $\pm$ 10.0	15 $\pm$ 30		1.0	2.0	35 +500 ~ +1000 -200 ~ -1000	5K//1.0
45M20B	45.000	4	HC80x2	3 $\pm$ 10.0	35 $\pm$ 40		1.0	3.0	70 +500 ~ +1000 -200 ~ -1000	5K//1.0 Cc = -1.5pF
70M15A	70.000	2	HC80	3 $\pm$ 7.5	15 $\pm$ 30		1.0	2.0	35 +500 ~ +1000 -200 ~ -1000	2.0K//1.0
70M15B	70.000	4	HC80x2	3 $\pm$ 7.5	25 $\pm$ 25		1.0	3.0	70 +500 ~ +1000 -200 ~ -1000	2.0K//1.0 Cc = -1pF
70M20A	70.000	2	HC80	3 $\pm$ 10.0	15 $\pm$ 40		1.0	2.0	35 +500 ~ +1000 -200 ~ -1000	2.5K//1.0
70M20B	70.000	4	HC80x2	3 $\pm$ 10.0	35 $\pm$ 40		1.0	3.0	70 +500 ~ +1000 -200 ~ -1000	2.5K//1.0 Cc = -1pF

All specifications subject to change without notice. Rev. 05/01/02

Note: Operating Temperature -20°C to +70°C

Fox Electronics Part Description¹ Guide for Filters

The diagram illustrates the layout of a 16M15C tape, showing the sequence of markings and their meanings. The tape is represented as a horizontal strip with various markings and labels.

1 Make Selection from Product Family in Fox Catalog or Foxonline.com
For Example: 16M15C

2 Frequency MHz
Customer Fills In
(#####.#####)

3 Operating Temp²

Operating Temp. Range

- A = 0° to +50°C
- B = -10° to +50°C
- C = 0° to +70°C
- D = -10° to +60°C
- E = -10° to +70°C
- F = -20° to +70°C
- Z = -25° to +75°C
- G = -30° to +70°C
- H = -30° to +75°C
- J = -30° to +80°C
- K = -30° to +85°C
- L = -35° to +80°C
- V = -35° to +85°C
- M = -40° to +85°C

4 SMD Packaging

SMD Packaging

- 0 = Tape/Reel*
- 250 = 250
- 500 = 500
- 1000 = 1000
- Tape Only = Tape Only

5 Fox Use

6/7 Value Added

Value Added

- M = Special Marking
- N = Cut Base
- S = Bulk
- Z = SMD tape

8 Custom

Custom
C = Custom

If standard Fox Part is not applicable, attach full specifications/drawings.

Notes:

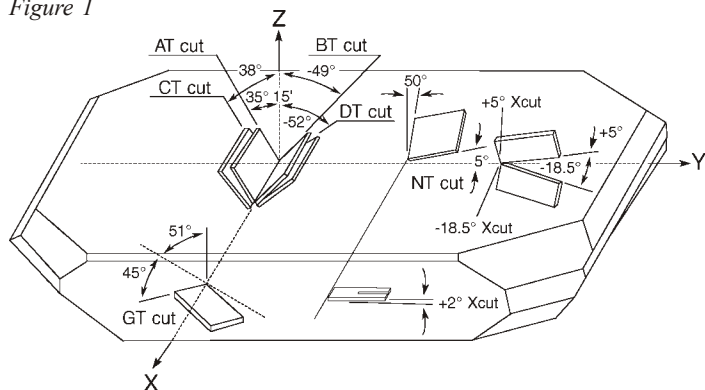
[†] Fox unique part numbers for non-standards are randomly generated based on the elements of the part description in a format: ### - Frequency - Random # (099-22.1184-39789 is Fox unique part number).

* 0 = Tape/Reel assumes that no quantity per reel was specified; therefore, the Fox Production SMD part number(s) will be used.

QUARTZ CRYSTAL THEORY OF OPERATION

Quartz crystal units serve as the controlling element of oscillator circuits by conversion of mechanical vibrations to electrical current at a specific frequency. This is accomplished by means of the "Piezoelectric" effect. Piezoelectricity is electricity created by pressure. In a piezoelectric material, the application of mechanical pressure along an axis will result in the creation of an electrical charge along an axis at right angles to the first. In some materials, the obverse piezoelectric effect is found, which means that the imposition of an electric field on the ends of an axis will result in a mechanical deflection along an axis at right angles to the first. Quartz is uniquely suited, in terms of mechanical, electrical and chemical properties, for the manufacture of frequency control devices. Quartz crystal units which oscillate within certain frequency and temperature ranges have been developed over the years. *Figure 1* shows the location of specific elements within a quartz stone.

Figure 1

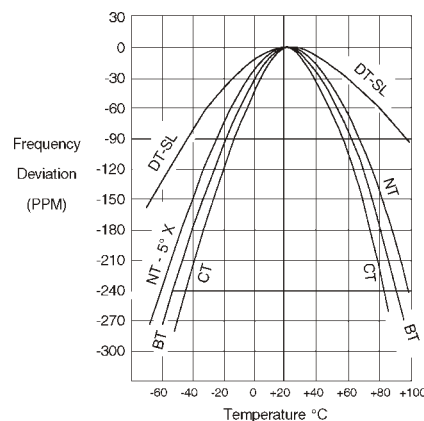


The elements as shown above vibrate in various modes, the most important of which are the extensional, flexural and shear. The mode of vibration determines the maximum frequency, stability vs. temperature, and resistance of a given element. The various modes of vibration are shown in *Figure 2*, while a comparison of the various frequency stabilities vs temperature are shown in *Figure 3*.

Figure 2

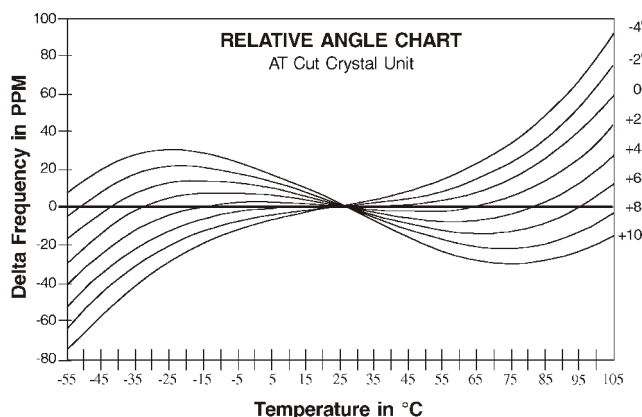
Thickness	Extensional
Fundamental	
3rd Overtone	
5th Overtone	
Face Shear	Length-Width Flexure

Figure 3



Of the various elements, the "AT" cut has become the most popular as it is available at relatively high frequencies, exhibits excellent frequency vs temperature stability and is widely available at reasonable cost. The frequency vs. temperature capabilities of the "AT" cut crystal unit are illustrated in *Figure 4*.

Figure 4



Fundamental vs. Overtone

This is of concern primarily when specifying the "AT" cut crystal unit. These units increase in frequency as the thickness of the resonator plate is diminished. At some point, typically around 30MHz, the plate becomes too thin for efficient processing. As the "AT" will resonate at odd integer multiples of the fundamental frequency, it is necessary to specify the desired order of overtone when ordering higher frequency crystals.

Drive Level

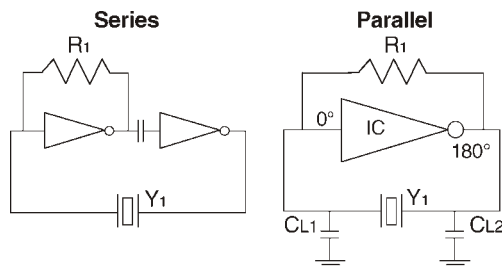
Drive level is the amount of power dissipated by the crystal. Drive level is usually specified in terms of micro or milliwatts, with a typical value being 100 microwatts.

QUARTZ CRYSTAL DESIGN NOTES

Series vs. Parallel

"Series" resonant crystals are intended for use in circuits which contain no reactive components in the oscillator feedback loop. "Parallel" resonant crystals are intended for use in circuits which contain reactive components (usually capacitors) in the oscillator feedback loop. Such circuits depend on the combination of the reactive components and the crystal to accomplish the phase shift necessary to start and maintain oscillation at the specified frequency. Basic depictions of two such circuits are shown below.

Figure 5



Load Capacitance

This refers to capacitance external to the crystal, contained within the feedback loop of the oscillator circuit. If the application requires a "parallel" resonant crystal, the value of load capacitance must be specified. If the application requires a "series" resonant crystal, load capacitance is not a factor and need not be specified. Load capacitance is the amount of capacitance measured or computed across the crystal terminals on the PCB.

Frequency Tolerance

Frequency tolerance refers to the allowable deviation from nominal, in parts per million (PPM), at a specific temperature, usually $+25^\circ\text{C}$.

Frequency Stability

Frequency stability refers to the allowable deviation, in parts per million (PPM), over a specified temperature range. Deviation is referenced to the measured frequency at $+25^\circ\text{C}$.

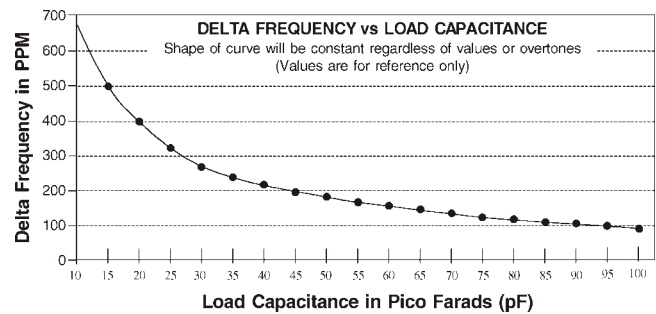
Aging

Aging refers to the cumulative change in frequency experienced by a crystal unit over time. Factors affecting aging are excessive drive level, various thermal effects, wire fatigue and frictional wear. Circuit design incorporating low operating ambients and minimum drive level will reduce the aging rate.

Pullability

Pullability refers to the change in frequency of a crystal unit, either from the natural resonant frequency (F_r) to a load resonant frequency (F_L), or from one load resonant frequency to another. See Figure 6. The amount of pullability exhibited by a given crystal unit at a given value of load capacitance is a function of the shunt capacitance (C_0) and the motional capacitance (C_1) of the crystal unit.

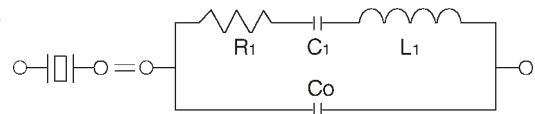
Figure 6



Equivalent Circuit

The equivalent circuit, shown in Figure 7, is an electrical depiction of the quartz crystal unit when operating at a frequency of natural resonance. The C_0 , or shunt capacitance, represents the capacitance of the crystal electrodes plus the capacitance of the holder and leads. R_1 , C_1 , and L_1 compose the "motional arm" of the crystal and are referred to as the motional parameters. The motional inductance (L_1), represents the vibrating mass of the crystal unit. The motional capacitance (C_1), represents the elasticity of the quartz and the resistance (R_1), represents bulk losses occurring within the quartz.

Figure 7

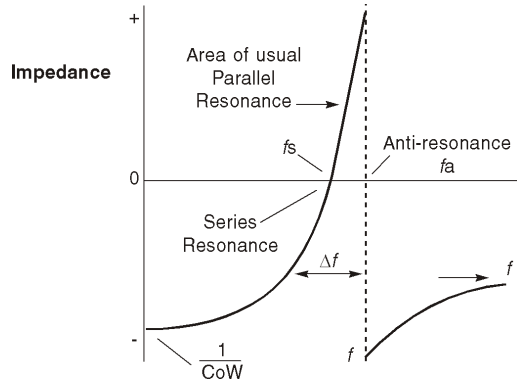


Impedance/Reactance Curve

A crystal has two frequencies of zero phase, as illustrated in Figure 8. The first, or lower of the two, is the Series Resonant Frequency, denoted as (f_s). At this point, the crystal appears resistive in the circuit, impedance is at a minimum and current flow is maximum. As the frequency is increased beyond the point of series resonance, the crystal appears inductive in the circuit. When the reactances of the motional inductance and shunt capacitance cancel, the crystal is at the Frequency of Anti-resonance, denoted as (f_a). At this point, impedance is maximized and current flow is minimized.

QUARTZ CRYSTAL DESIGN NOTES

Figure 8



Quality Factor (Q)

The "Q" value of a crystal unit is a measure of the units relative quality, or efficiency of oscillation. The maximum attainable stability of a crystal unit is dependent on the "Q" value. In Figure 8 above, the separation between the series and parallel frequencies is called the bandwidth. The smaller the bandwidth, the higher the "Q" value, and the steeper the slope of the reactance. Changes in the reactance of external circuit components have less effect (less "pullability") on a high "Q" crystal, therefore such a part is more stable.

Calculation of Load Capacitance

If the circuit configuration is as shown in Figure 5 for the parallel version, the load capacitance may be calculated by means of the following equation:

$$C_L = \frac{C_{L1} * C_{L2}}{C_{L1} + C_{L2}} + C_{stray}$$

Cstray includes the pin to pin input and output capacitance of the microprocessor chip at the *Crystal 1* and *Crystal 2* pins, plus any parasitic capacitances. As a rule of thumb, Cstray may be assumed to equal 5.0 pF. Therefore, if $C_{L1} = C_{L2} = 50\text{pF}$, $C_L = 30\text{pF}$.

Trim Sensitivity

Trim sensitivity is a measure of the incremental fractional frequency change for an incremental change in the value of the load capacitance. Trim sensitivity (S) is expressed in terms of PPM/pF and is calculated by the following equation:

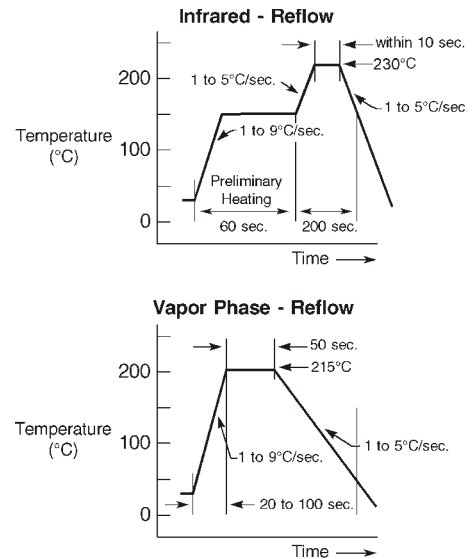
$$S = \frac{C_1 * 1000000}{2 * C_t^2}$$

Where (C_t) is the sum of C_o and C_L .

Solder Reflow of Surface Mount Devices

Mounting of SMD units is typically accomplished by means of solder reflow, in Figure 9 either by infrared heat or by vapor phase. The following graphs depict the recommended times and temperatures for each of the two methods:

Figure 9



Note: These are recommended temperature profiles.

Useful Crystal Equations

$$C_t = C_o + C_L$$

$$f_s = \text{Series Resonant Frequency} = \frac{1}{2\pi \sqrt{C_1 * L_1}}$$

$$f_a = \text{Anti Resonant Frequency} = \frac{1}{2\pi \sqrt{\frac{C_o * C_1}{C_o + C_1} * L_1}}$$

$$f_L = \text{Load Resonant Frequency} = \frac{1}{2\pi \sqrt{\frac{C_t * C_1}{C_t + C_1} * L_1}}$$

$$C_1 = \text{Motional Capacitance} = \frac{2 * C_t * \Delta F}{f_s}$$

$$L_1 = \text{Motional Inductance} = \frac{1}{4\pi^2 * f_s^2 * C_1}$$

$$\frac{\Delta F}{F} = \text{Change in Frequency} = \frac{f_s * C_1}{2 * C_t}$$

$$R_1 = \text{Series Resonant Resistance} = \frac{2\pi f_s L_1}{Q}$$

$$R_a = \text{Anti Resonant Resistance} = R_1 \left(1 + \frac{C_o}{C_1}\right)^2$$

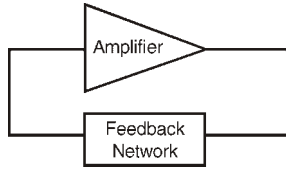
$$Q = \text{Quality Factor} = \frac{2\pi f_s L_1}{R_1}$$

OSCILLATOR

THEORY OF OPERATION

Crystal controlled oscillators may be considered as consisting of an amplifier and a feedback network that selects a part of the amplifier output and returns it to the amplifier input. A generalized depiction of such a circuit is shown below.

Figure 1.0



In order for an oscillator circuit to operate, two (2) conditions must be met:

- (A) The loop power gain must be equal to unity.
- (B) The loop phase shift must be equal to $0, 2\pi, 4\pi$, etc. radians.

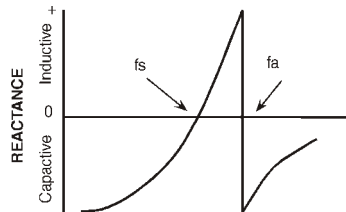
The power fed back to the input of the amplifier must be adequate to supply the oscillator output, the amplifier input, and to overcome circuit losses.

The exact frequency at which an oscillator will operate is dependent on the loop phase angle shifts within the oscillator circuit. Any net change in phase angle will result in a change in the output frequency. As the usual goal of an oscillator is to provide a frequency that is essentially independent of variables, some means of minimizing the net phase shift must be employed. Perhaps the best, and certainly the most common means of minimizing the net phase shift is to use a quartz crystal unit in the feedback loop.

The impedance of a quartz crystal changes so dramatically with changes in the applied frequency that all other circuit components can be considered as being of essentially constant reactance. Therefore, when a crystal unit is used in the feedback loop of an oscillator, the frequency of the crystal unit will adjust itself so that the crystal unit presents a reactance which satisfies the loop phase requirements.

A depiction of the reactance vs. frequency of a quartz crystal unit is shown below.

Figure 2.0



As is apparent from Figure 2.0, a quartz crystal unit has two frequencies of zero phase. The first, or lower of the two, is the series resonant frequency, usually abbreviated as F_s . The second, or higher of the two frequencies of zero phase is the parallel, or anti-resonant frequency, usually abbreviated as F_a . Both the series and parallel resonant frequencies appear resistive in an oscillator circuit. At the series resonant point, the resistance is minimal and the current flow is maximal.

At the parallel point, the resistance is maximal and the current flow is minimal. Therefore, the parallel resonant frequency, F_a , should never be used as the controlling frequency of an oscillator circuit.

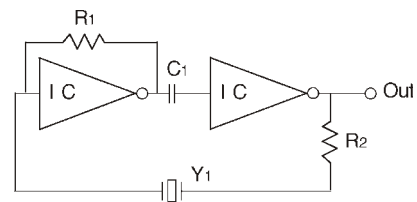
A quartz crystal unit can be made to oscillate at any point along the line between the series and parallel resonant points by the inclusion of reactive components (usually capacitors) in the feedback loop of the oscillator circuit. In such a case, the frequency of oscillation will be higher than the series resonant frequency but lower than the parallel resonant frequency. Because of the fact that the frequency resulting from the addition of capacitance is higher than the series resonant frequency, it is usually called the parallel frequency, though it is lower than the true parallel frequency.

Just as there are two frequencies of zero phase associated with a quartz crystal unit, there are two primary oscillator circuits. These circuits are generally described by the type of crystal unit to be used, namely "series" or "parallel."

SERIES CIRCUIT:

A series resonant oscillator circuit uses a crystal which is designed to operate at its natural series resonant frequency. In such a circuit, there will be no capacitors in the feedback loop. Series resonant oscillator circuits are used primarily because of their minimal component count. These circuits may, however, provide feedback paths other than through the crystal unit. Therefore, in the event of crystal failure, such a circuit may continue to oscillate at some arbitrary frequency. A depiction of a basic series resonant oscillator circuit is given below.

Figure 3.0



As is apparent from Figure 3.0, a series resonant oscillator circuit provides no means of adjusting the output frequency, should adjustment be required. In the above circuit, resistor R_1 is used to bias the inverter and to cause it to operate in its linear region. This resistor also provides negative feedback to the inverter. Capacitor C_1 is a coupling capacitor, used to block DC voltage. Resistor R_2 is used to bias the crystal unit. This resistor strongly influences the drive current seen by the crystal unit, therefore care must be taken that too small a value is not chosen. Crystal unit Y_1 is a series resonant crystal unit, specified to operate at the desired frequency and with the desired frequency tolerance and stability.

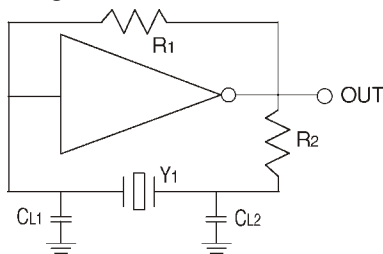
OSCILLATOR

THEORY OF OPERATION

PARALLEL CIRCUIT:

A parallel resonant oscillator circuit uses a crystal unit which is designed to operate with a specified value of load capacitance. This will result in a crystal frequency which is higher than the series resonant frequency but lower than the true parallel resonant frequency. These circuits do not provide paths other than through the crystal unit to complete the feedback loop. In the event of crystal unit failure, the circuit will not continue to oscillate. A basic depiction of a parallel resonant circuit is given below.

Figure 4.0



This circuit uses a single inverter, with two capacitors in the feedback loop. These capacitors comprise the “load capacitance” and together with the crystal unit, establish the frequency at which the oscillator will operate. As the value of the load capacitance is changed, so is the output frequency of the oscillator. Therefore, this circuit does provide a convenient means of adjusting the output frequency, should adjustment be required.

The resistors R1 and R2 serve the same functions as detailed for the series resonant circuit shown in Figure 3.0. The two load capacitors, CL1 and CL2, serve to establish the frequency at which the crystal unit and therefore the oscillator will operate. Crystal unit Y1 is a parallel resonant crystal unit, specified to operate with a specified value of load capacitance, at the desired frequency and with the desired frequency tolerance and stability.

LOAD CAPACITANCE:

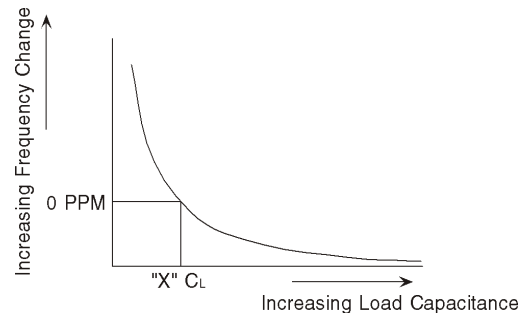
Reference has been made to a “specified value of load capacitance.” Load capacitance may be defined as “that value of capacitance, either measured or calculated, present in the oscillator circuit, across the connection points of the crystal.” In the case of a series resonant circuit, there is no capacitance present between the connecting points of the crystal unit and therefore, load capacitance need not be specified for a series resonant crystal unit. In the case of a parallel resonant oscillator circuit, capacitance is present. As a direct measurement of this capacitance is impractical, it is usually necessary to calculate the value. The calculation of the value of the load capacitance is done with the following equation:

$$CL = \frac{CL1 * CL2}{CL1 + CL2} + CS \quad (1)$$

Where CL1 and CL2 are the load capacitors and CS is the circuit stray capacitance, usually 3.0 to 5.0 pF.

It must be noted that changes in the value of the load capacitance will result in changes in the output frequency of the oscillator. Therefore, if precise frequency control is required, then a precise specification of load capacitance is required. To illustrate, assume that a crystal unit is specified to operate at a frequency of 20.000 MHz with a load capacitance of 20.0 pF. Assume that the crystal unit is then placed in a circuit which presents a value of 30.0 pF. The frequency of the crystal unit will then be lower than the specified value. Conversely, should the circuit in question present a value of 10.0 pF, the frequency will be higher than the specified value. The relationship between frequency and load capacitance is shown below.

Figure 5.0



DRIVE LEVEL:

The “drive level” is the power dissipated by the crystal unit while operating. The power is a function of the applied current, and is usually expressed in terms of Milliwatts or Microwatts. Crystal units are specified as having certain maximum values of drive level, which change as functions of the frequency and mode of operation. It is well to consult with the crystal unit vendor as to the maximum value of drive level allowed for a particular crystal unit. Exceeding the maximum drive level for a given crystal unit may result in unstable operation, increased aging rates, and in some cases, catastrophic damage. The drive level may be calculated by the following equation:

$$POWER = (I_{rms}^2 * R) \quad (2)$$

Where *I* is the *rms* current through the crystal unit and *R* is the maximum resistance value of the specific crystal unit in question. Equation (2) is simply “Ohms law” for power.

Measurement of the actual drive level in an operating oscillator circuit may be accomplished by temporarily inserting a resistor in series with the crystal unit. The resistor must be of the same ohmic value as the crystal unit. The voltage drop across the resistor may then be read and the current and power dissipation calculated. The resistor must then be removed. As an alternative means of measuring the drive level, a current probe may be used at the output lead of the crystal unit, if space permits.

OSCILLATOR

THEORY OF OPERATION

FREQUENCY VS OVERTONE MODE:

The frequency of a quartz crystal unit is limited by the physical dimensions of the vibrating quartz element. In some cases, the limiting dimension(s) are the length and width. In the case of the most popular crystal unit, the “AT” cut crystal unit, the limiting dimension is the thickness of the vibrating quartz element. As the thickness is diminished, the frequency is increased. At some point, usually around 30.000 MHz, the thickness of the quartz plate becomes too thin for processing.

Should it be desired to develop an oscillator at a frequency higher than the limiting frequency, advantage must be taken of the fact that quartz crystal units will oscillate at odd integer multiples of their “fundamental” frequency. We may define the “fundamental” frequency as “that frequency which naturally occurs at a given set of mechanical dimensions.” Therefore, if a crystal unit has a fundamental frequency of 10.0 MHz, it can also be made to oscillate at 3, 5, 7, etc. times the fundamental. That is, the unit will oscillate at 30.0, 50.0, 70.0, etc. MHz. These multiples of the fundamental frequency are called “overtones” and are identified by the integer of multiplication, as in the “third overtone”, the “fifth overtone”, etc. When use at an overtone frequency is required, the crystal unit must be specified to operate at the desired frequency and on the desired overtone. One should never attempt to order a fundamental mode crystal unit and then operate it at an overtone frequency. This is so due to the fact that the crystal manufacturing processes differ for fundamental and overtone crystal units.

In many cases, the characteristics of the integrated circuit used in a particular oscillator design dictate that the fundamental frequency of the crystal unit be suppressed in order to ensure operation at the desired frequency and on the desired overtone. In such cases, it is usually necessary to modify the oscillator circuit. One method of modification is to add a “tank” circuit, consisting of an inductor and a capacitor. These modifications are shown in *Figure 6.0* and *Figure 7.0*

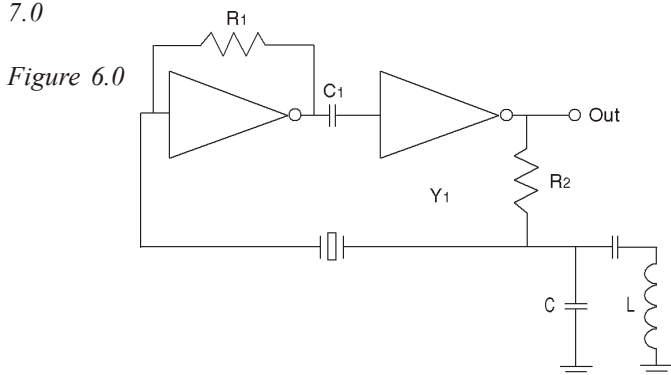
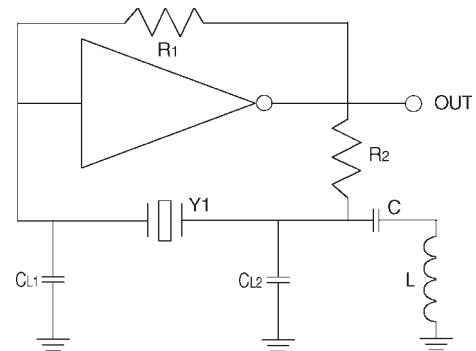


Figure 6.0 depicts the modification of a series resonant circuit while *Figure 7.0* depicts the modification of a parallel resonant circuit.

Figure 7.0



In both cases, the tank circuit is tuned to resonate at some frequency between the fundamental and the desired frequency. This results in the unwanted frequency being shunted to ground, leaving only the desired frequency being present at the output of the oscillator.

DESIGN CONSIDERATIONS:

For good operation of an oscillator circuit, certain design considerations should be followed. In all cases, it is recommended that parallel traces be avoided in order to reduce circuit stray capacitance. All traces should be kept as short as possible and components should be isolated in order to prevent coupling. Ground planes should be used to isolate signals.

NEGATIVE RESISTANCE:

For optimum performance, an oscillator circuit must be designed in such a way as to enhance “negative resistance,” which is sometimes called the “oscillation allowance.” Evaluation of the amount of negative resistance in a given circuit is accomplished by temporarily installing a variable resistor in series with the crystal unit. The resistor should be set initially at its lowest setting, preferably close to zero ohms. The oscillator is then started and the output monitored on an oscilloscope. The variable resistor is then adjusted so that resistance is increased while the output is continuously monitored. At some value of resistance, oscillation will be stopped. At this point, the variable resistor is measured to determine the ohmic value at which oscillation ceased. To this value, the maximum resistance of the crystal unit, as specified by the vendor, must be added. The total ohmic resistance is deemed to be the “negative resistance” or the “oscillation allowance.” For good, reliable circuit operation, it is recommended that the negative resistance be a minimum of five times the specified maximum resistance value of the crystal unit.

Values of negative resistance exceeding five times the maximum resistance of the crystal unit are better yet. As negative resistance tends to decrease at elevated temperatures, it is recommended that the test be performed at the highest temperature of the operating range.

FREQUENTLY ASKED QUESTIONS TECHNICAL INFO

Check our Web Site: <http://www.foxonline.com> often for updates on the FAQ and other technical issues

1. *What is the difference between series resonant and parallel resonant crystals?*

All quartz crystal resonators have a series resonant frequency (f_s , frequency of lowest impedance). At this frequency, the crystal appears resistive in the circuit. Crystals can be “pulled” from this series frequency by adding reactance (capacitance) in series with the crystal. When operated in combination with an external load capacitance (C_L) the crystal oscillates in a frequency range slightly above its series resonant frequency. This is the parallel (load resonant) frequency.

When ordering a parallel crystal, always specify the nominal parallel resonant frequency and the amount of load capacitance in picofarads (pF). Alternatively, a standard value of C_L (such as 20pF) can be ordered; the capacitor values are then calculated to match the crystal C_L . Note that a series type will oscillate in a parallel oscillator, and vice versa. The observable difference is a frequency offset of less than + 1000 PPM (0.1%) from the nominal frequency.

2. *The load capacitance (C_L) of my parallel resonant crystal is rated at 20pF. How do I calculate the value of the load capacitors used in my parallel resonant oscillator circuit?*

Use this formula to approximate the value of capacitors needed:

$$C_L = ((C_1 \times C_2) / (C_1 + C_2)) + C_{\text{stray}}$$

C_{stray} is the stray capacitance in the circuit, typically 2-5pF. If the oscillation frequency is high, the capacitor values should be increased to lower the frequency. If the frequency is low, the capacitor values should be decreased, thus raising the oscillation frequency. It is desirable to keep C_1 and C_2 of equal value for optimum symmetry. When $C_L=20\text{pF}$, C_1 and C_2 will be approximately 27-33pF each, depending on the amount of stray capacitance.

3. *Can I get crystals rated for -40° C to +85° C?*

Yes, this industrial temperature range (-40° C to +85° C) is optional on most crystals. Depending on the crystal package, temperature ranges of up to -55° C to +105° C may be available. Contact Fox’s engineering department to discuss your specific requirements.

4. *What happens if I operate a crystal outside of its specified temp range?*

We do not recommend that you operate a crystal outside of its specified temp range. The most notable change will be a greater frequency drift due to the increased temperature extremes. Another and more serious problem that can occur is activity dips. Activity dips can cause the oscillator to stop oscillating at a specific temperature.

5. *What happens if I operate a crystal over its maximum drive level spec?*

Exceeding the maximum drive level (power dissipation) of a crystal can lead to an increased rate of aging, Drive Level Dependency (DLD) problems, increased intensity of activity dips that can stop oscillation and, at very high drive levels, breakage of the crystal blank.

6. *What is an activity dip?*

An activity dip is defined as an abrupt increase in Effective Series Resistance (ESR) with an associated shift in resonant frequency over a narrow range of a few degrees Celsius. Activity dips can cause an oscillator to stop oscillating at a specific temperature, then restart as the temperature continues to change. This is because the oscillator has insufficient loop gain to maintain oscillation. The amount and intensity of activity dips are proportional to the drive level. As the drive level increases, so does the intensity of the activity dips.

7. *I have an existing design that uses a HC49U. What should I consider if I change to the smaller HC49S crystal, or an SMD crystal?*

Drive Level – HC49U crystals are typically rated 1.0mW max, while the HC49S and most SMD crystals are rated at only 0.5mW or 0.1mW maximum. See question 5 for more information on exceeding the maximum drive level of a crystal.

Pullability – some applications require tuning the frequency of the oscillator, either by mechanically or electrically changing the value of load capacitance. The HC49S and surface mount crystals have less pullability than the HC49U. It is important to verify whether the HC49S or the surface mount crystal will have sufficient pull range for the application.

ESR – The Equivalent Series Resistance (ESR) is generally higher with the HC49S and surface mount crystals, and can cause a problem if the oscillator circuit does not have sufficient loop gain.

FREQUENTLY ASKED QUESTIONS

TECHNICAL INFO

Check our Web Site: <http://www.foxonline.com> often for updates on the FAQ and other technical issues

8. Why don't HC49S and surface mount crystals pull as much as HC49U crystals?

The HC49U crystal utilizes a circular AT-cut crystal blank. Due to their small size, most surface mount crystals use a rectangular AT-strip cut crystal blank. ("Strip" refers to the rectangular shape of the blank.) While both are AT-cut blanks, several differences exist due to their different geometries. In general, given the same frequency and overtone, an AT-strip cut will have a lower Shunt Capacitance (C_0) and Motional Capacitance (C_1) than the AT-cut. Because pullability is a function of the capacitance ratio C_0/C_1 , AT-strip crystals have less pullability.

9. What is the difference between AT- and BT-cuts?

Both AT and BT indicate singularly rotated "Y"-axis cuts through the quartz crystal. The BT is cut at an angle approximately opposite that of the AT.

BT-cut blanks are thicker than AT-cuts at the same frequency; therefore, higher fundamental mode frequencies are possible with the BT before the blank becomes too thin to process. BT-cuts have a parabolic frequency vs. temperature response while AT-cuts have a cubic response. Thus, over a given temperature range, the BT will exhibit a greater frequency shift than the AT. In addition, BT-cuts tend to have a lower capacitance ratio (C_0/C_1) and, as a result, less pullability.

10. What are the differences between AT-cuts and AT-strip cuts?

The differences are in size, shape and some performance characteristics. AT-cut crystal blanks are circular, and AT-strip cut crystal blanks are rectangular. Both types are AT-cuts, but several differences in performance characteristics exist because of the different geometries of the blanks. In general, given the same frequency and overtone, the AT-strip will have a lower value of Shunt Capacitance (C_0) and Motional Capacitance (C_1). It will also have a higher value of Effective Series Resistance (ESR) and Motional Inductance (L_1). Because pullability is a function of C_0 and C_1 , AT-strip cut crystals have less pullability than circular AT-cut crystals.

11. Why is there more than one holder designator for the same package?

There are three ways to seal a crystal package: solder seal, cold weld and resistance weld. Most manufacturers use the resistance weld method because it is superior to the other two methods. Since not all customer prints have been changed to include the resistance weld crystals, a cross reference is provided below.

Resistance weld	Cold weld	Solder seal
HC49U	HC43U	HC18U
HC80U	HC47U	HC33U
HC50U	HC45U	HC25U
	HC42U	HC6U

12. What information is necessary to order a crystal?

The minimum information needed is the Holder or Package, Frequency, and Correlation (series resonant, or load capacitance if parallel resonant). All other specifications will be per our standard specifications for the indicated holder. All specifications that differ from our standard specifications must also be supplied when ordered.

13. Should I focus my design on a series or parallel crystal?

For most applications, the parallel crystal is a good choice, in that the parallel design is more widely standardized and is more likely to be a stock item for future purchases.

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