



International Crystal
Manufacturing
CRYSTAL
OSCILLATOR
AND
FILTER
PRODUCTS

QUARTZ CRYSTALS

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ORDER FORM



ICM CUSTOMER NUMBER	PO NUMBER
CUSTOMER NAME (PRINT)	
STREET ADDRESS (PRINT)	
CITY	STATE ZIP
PHONE (AREA CODE FIRST)	FAX
<input type="checkbox"/> THIS IS MY HOME ADDRESS	<input type="checkbox"/> THIS IS MY BUSINESS ADDRESS

CHARGE CARD NUMBER	EXP. DATE
NAME ON CARD (PRINT)	
REMARKS	
SIGNATURE	

ALL ORDERS MUST BE SIGNED
NOTE: ALL OK RESIDENTS MUST ADD APPLICABLE SALES TAX TO ORDER TOTAL.

ITEM NO.	QUANTITY	ICM CATALOG NUMBER	CHANNEL FREQUENCY (MHz)	CRYSTAL FREQUENCY (MHz)	PRICE EA.	EXTENSION
_____	_____	_____	_____	_____		
_____	_____	_____	_____	_____		
_____	_____	_____	_____	_____		
_____	_____	_____	_____	_____		
					TAX IF APPLICABLE	

IMPORTANT! IF THIS ORDER IS TO BE SENT BY FAX, PLEASE USE BLACK INK. **TOTAL**

TERMS AND CONDITIONS OF SALE

A. ICM does not assume responsibility in collecting applicable state use taxes other than Oklahoma and those states with which Oklahoma has a reciprocal agreement. It is assumed that customers will declare and pay said use taxes to their respective state.

B. All sales are cash with order except where previous arrangements have been made for an approved open account.

C. All ICM crystals are custom made to order and are not stock items, therefore cannot be returned for credit and/or refund.

D. ICM crystals are guaranteed against defective materials and workmanship for a year when used in the oscillator circuit and/or equipment for which they were designed, except where harsh treatment or user negligence is the cause of failure.



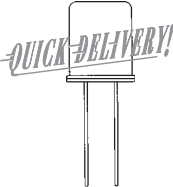
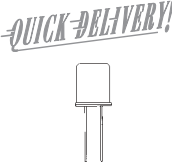
E. A claim for damage in transportation, erroneous count or incorrect product must be made within ten (10) days of receipt of order. Any claim made after this date will not be recognized.

F. Acknowledgments are mailed or faxed for each order, upon receipt please review and advise ICM of any error immediately so corrections can be made.


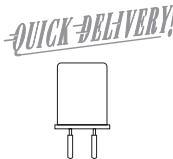
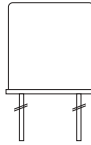
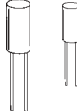


QUARTZ CRYSTAL SELECTION GUIDE

THRU-HOLE CRYSTALS

PRODUCT	T38	HC49US	HC49U	HC45U
				
Frequency Range	3.579545 ~ 70 MHz	3.200 ~ 70 MHz	1.800 ~ 200 MHz	3.579545 ~ 200 MHz
Frequency Tolerance	±50PPM	±30 PPM	±30 PPM	±30 PPM
Frequency Stability	±50PPM	±50 PPM	±50 PPM	±50 PPM
Temperature Range	-10°C ~ +70°C	0°C ~ +70°C	-20°C ~ +70°C	-10°C ~ +60°C
Key Features	<ul style="list-style-type: none"> ✓ Miniature Package ✓ Very Small Footprint ✓ Cost Effective ✓ High Shock Resistance ✓ "AT" Strip 	<ul style="list-style-type: none"> ✓ 3.6mm Profile ✓ Industry Standard ✓ Cost Effective ✓ "AT" Strip 	<ul style="list-style-type: none"> ✓ Low Cost ✓ Industry Standard ✓ Wide Freq. Range ✓ Tighter Tolerances 	<ul style="list-style-type: none"> ✓ Miniature Pkg. ✓ Wide Freq. Range ✓ Tighter Tolerances ✓ Small Footprint ✓ Excellent Aging
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Check with ICM Customer Service for available frequencies.

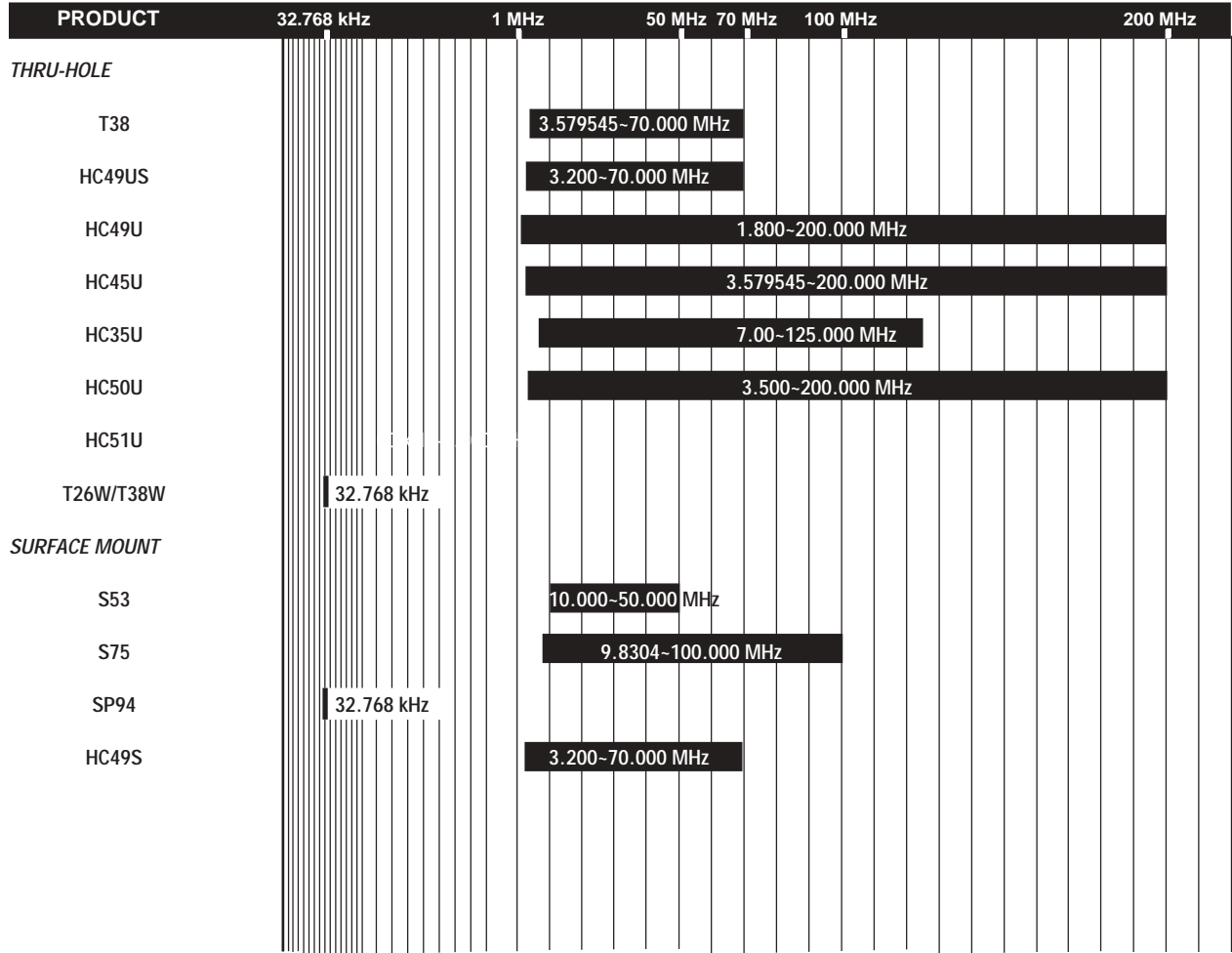
PRODUCT	HC35/U	HC50/U	HC51/U	T26W/T38W
				
Frequency Range	7.000 ~ 125 MHz	3.500 ~ 200 MHz	100 kHz ~ 4.800 MHz	32.768 kHz
Frequency Tolerance	±30PPM	±30PPM	±50PPM	±20 PPM
Frequency Stability	±50PPM	±50PPM	±100PPM	±0.04 PPM / (Δ°C) ²
Temperature Range	-10°C ~ +60°C	-20°C ~ +70°C	-10°C ~ +60°C	-10°C ~ +60°C
Key Features	<ul style="list-style-type: none"> ✓ Miniature Package ✓ Very Small Footprint ✓ Tighter Tolerances ✓ Low Phase Noise ✓ Extended Temperature Range 	<ul style="list-style-type: none"> ✓ Low Cost ✓ Industry Standard ✓ Third Lead ✓ Wide Freq. Range ✓ Extended Temp. Range 	<ul style="list-style-type: none"> ✓ Low Frequency ✓ Excellent Reliability ✓ Third Lead Option 	<ul style="list-style-type: none"> ✓ Tuning Fork ✓ Miniature Pkgs. ✓ Low Cost ✓ Cold Weld Design ✓ Long Term Stability ✓ Tight Tolerance
CATALOG PAGES	PAGE 14	PAGE 15	PAGE 16	PAGE 17

Check with ICM Customer Service for available frequencies.





QUARTZ CRYSTAL SELECTION GUIDE - continued


FREQUENCY RANGE BY PRODUCT




QUARTZ CRYSTAL SELECTION GUIDE

SURFACE MOUNT CRYSTALS

PRODUCT	S53	S75	
			
Frequency Range	10.000 ~ 50.000 MHz	9.8304 ~ 100 MHz	
Frequency Tolerance	±100 PPM	±50 PPM	
Frequency Stability	±50 PPM	±50 PPM	
Temperature Range	-20°C ~ +70°C	-10°C ~ +60°C	
Key Features	<ul style="list-style-type: none"> ✓ 1.0mm Profile ✓ Wide Freq. Range ✓ Tight Stability Option ✓ "AT" Cut 	<ul style="list-style-type: none"> ✓ 1.1mm Profile ✓ Wide Freq. Range ✓ Tight Stability Option ✓ "AT" Cut 	
CATALOG PAGES Page 18		Page 19	

PRODUCT	SP94	
	<p>BOTTOM VIEW</p> 	
Frequency Range	32.768 kHz	
Frequency Tolerance	±20 PPM	
Frequency Stability	-0.04 PPM / (Δ°C) ²	
Temperature Range	-40°C ~ +85°C	
Key Features	<ul style="list-style-type: none"> ✓ SMD Watch Crystal ✓ Miniature Package ✓ Long Term Stability ✓ 2 Pin Connection <p>Options</p> <ul style="list-style-type: none"> ✓ 2.5mm Profile 	
CATALOG PAGES PAGE 20		

All specifications subject to change without notice.

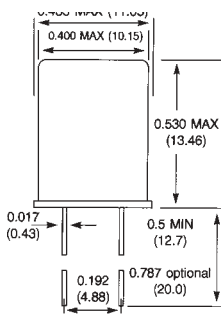
PRODUCT	HC49S	
	<p>BOTTOM VIEW</p> 	
Frequency Range	3.200~70 MHz	
Frequency Tolerance	±30 PPM	
Frequency Stability	±50 PPM	
Temperature Range	0°C ~ +70°C	
Key Features	<ul style="list-style-type: none"> ✓ Cost Effective ✓ "AT" Strip ✓ 4.5 mm Profile 	
CATALOG PAGES PAGE 11		

All specifications subject to change without notice.

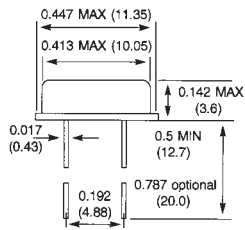


STANDARD MICROPROCESSOR CRYSTALS

HC49U Resistance Weld



HC49US Resistance Weld



SPECIFICATIONS

PARAMETER	HC49U*	HC49US
Frequency Tolerance @ 25°C	±30 PPM	±30 PPM
Frequency Stability over Operating Temperature	±50 PPM	±50 PPM
Operating Temp. Range	-20°C to +70°C	0°C to +70°C

*Optional third lead vinyl sleeves (HC49U only), and mylar spacer
 All specifications subject to change without notice.
 Inch dimensions shall govern
 All dimensions are in inches & parenthetically in millimeters.

FREQUENCY (MHz)	CL	HC49U Part No.	ESR Ω MAX	HC49US Part No.	ESR Ω MAX
1.000 **	SERIES	M49010S	3000		
1.8432	13PF	M49018-13	800		
2.000	20PF	M49020-20	500		
2.097152	20PF	M49021-20	500		
2.4576	32PF	M49024-32	300		
3.579545	18PF	M49036-18	120	M49US036S	200
3.6864	SERIES	M490368S	120	M49US0368S	200
3.6864	20PF	M490368-20	120	M49US0368-20	200
4.000	SERIES	M49040S	100	M49US040S	150
4.000	20PF	M49040-20	100	M49US040-20	150
4.096	20PF	M490496-20	100	M49US0496-20	150
4.194304	12PF	M49041-12	100	M49US041-12	150
4.433619	20PF	M490443-20	70	M49US0443-20	150
4.9152	SERIES	M49049S	55	M49US049S	150
4.9152	20PF	M49049-20	55	M49US049-20	150
5.000	20PF	M4905-20	50		
5.0688	SERIES	M49050S	50		
6.000	SERIES	M49060S	40		
6.000	20PF	M49060-20	40		
6.144	30PF	M49061-30	40		
6.144	20PF	M49061-20	40		
7.3728	SERIES	M49073S	40	M49US073S	80
7.3728	20PF	M49073-20	40	M49US073-20	80
8.000	SERIES	M49080S	35	M49US080S	80
8.000	20PF	M49080-20	35	M49US080-20	80
8.192	SERIES	M49081S	35		
8.192	20PF	M49081-20	35	M49US081-20	80
9.216	SERIES	M49092S	35		
9.8304	SERIES	M49098S	35	M49US098S	60
9.8304	20PF	M49098-20	35	M49US098-20	60
10.000	SERIES	M49100S	30	M49US100S	60
10.000	20PF	M49100-20	30	M49US100-20	60
11.000	SERIES	M4911S	30		
11.000	20PF	M4911-20	30		
11.0592	SERIES	M49115S	30	M49US115S	60
11.0592	20PF	M49115-20	30	M49US115-20	60
12.000	SERIES	M49120S	30	M49US120S	60
12.000	20PF	M49120-20	30	M49US120-20	60
12.288	SERIES	M49128S	30	M49US128S	60
12.288	20PF	M49128-20	30	M49US128-20	60
14.31818	SERIES	M49143S	25	M49US143S	40
14.31818	20PF	M49143-20	25	M49US143-20	40
14.7456	SERIES	M49147S	25	M49US147S	40
14.7456	20PF	M49147-20	25	M49US147-20	40
16.000	SERIES	M49160S	25	M49US160S	40
16.000	20PF	M49160-20	25	M49US160-20	40
18.432	SERIES	M49184S	20		
18.432	2 0PF	M49184-20	20	M49US184-20	40
19.6608	SERIES	M49196S	20		
19.6608	20PF	M49196-20	20	M49US196-20	40
20.000	SERIES	M49200S	20	M49US200S	30
20.000	20PF	M49200-20	20	M49US200-20	30
22.1184	SERIES	M49221S	20	M49US221S	30
22.1184	20PF	M49221-20	20		
24.000	SERIES	M49240S	20	M49US240S	30
24.000	20PF	M49240-20	20	M49US240S-20	30
32.000	SERIES	M49320S***	40		
32.000	20PF	M49320-20***	40		

** Frequency Tolerance = ±1000 PPM, Frequency Stability over -10°C to 60°C = ±1000 PPM (SL Cut)

***3rd Overtone



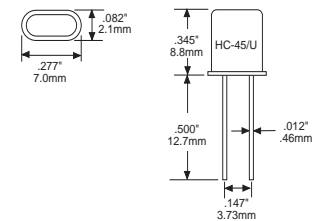
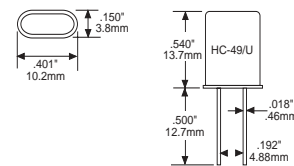
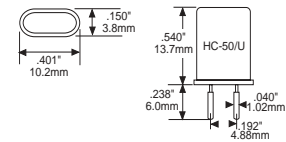
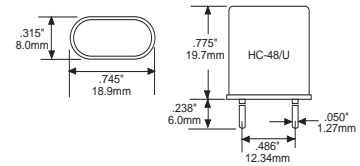
BUILD A CRYSTAL

SAMPLE PART NUMBER:

E	X	4	9	D	G	0	0
---	---	---	---	---	---	---	---

HOLDER STYLE		GRADE		FREQUENCY RANGE		LOAD	
CODE	DESCRIPTION	CODE	DESCRIPTION	CODE	DESCRIPTION	CODE	DESCRIPTION
48	HC-48/U	H	GOOD	F	4.00-9.999 MHz Fundamental	00	Series Resonant
49	HC-49/U	D	BETTER	G	10.000-19.999 MHz Fundamental		
50	HC-50/U	A	BEST	H	20.000-24.999 MHz Fundamental	10 to 99	Load Capacitance
45	HC-45/U			L	20.000-59.999 MHz 3rd Overtone		In pF
				M	60.000-74.999 MHz 3rd Overtone		

Specifications:	Calibration Tolerance at 25°C and Specified Load	Temperature Tolerance Relative to 25°C from -30°C to +60°C
GOOD	± 50 PPM	± 50 PPM
BETTER	± 20 PPM	± 20 PPM
BEST	± 10 PPM	± 10 PPM



EQUIVALENT RESISTANCE BY FREQUENCY AND HOLDER

Standard Holder Style	Freq. Range in MHz	Mode of Operation	Resistance in OHMS*
HC-48/U	4.000 - 4.999	FUNDAMENTAL	150
HC-48/U	5.000 - 24.999	FUNDAMENTAL	30
HC-49/U, HC-50/U	4.000 - 5.749	FUNDAMENTAL	80
HC-49/U, HC-50/U	5.750 - 24.999	FUNDAMENTAL	30
HC-45/U	7.500 - 24.999	FUNDAMENTAL	30
HC-48/U	20.000 - 74.999	3RD OVERTONE	40
HC-49/U, HC-50/U	20.000 - 74.999	3RD OVERTONE	40
HC-45/U	20.000 - 74.999	3RD OVERTONE	50

* UNLESS OTHERWISE STATED, OUR STANDARD DRIVE LEVEL IS 1MW

SHUNT CAPACITANCE (CO) IS 7pF MAXIMUM.

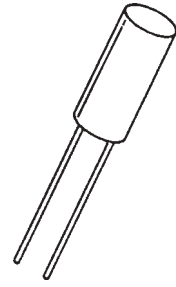


MICRO MINIATURE "AT STRIP" CRYSTAL

T38

FEATURES

- ✓ Very Small Footprint
- ✓ Miniature Package
- ✓ Cost Effective
- ✓ Rugged Cold Weld Design
- ✓ High Shock Resistance

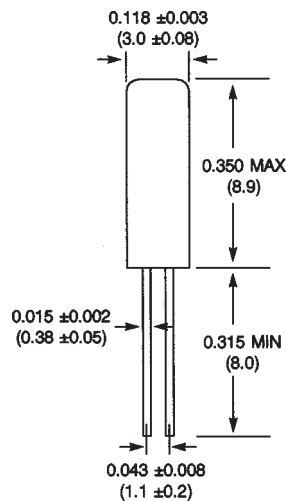


T38 STANDARD SPECIFICATIONS*

PARAMETERS	CONDITIONS	MIN.	MAX.	UNITS
Frequency Range		3.579545	70.000	MHz
Frequency Tolerance	Ta = 25°C	-50	+50	PPM
Frequency Stability, ref @ 25°C	Ta = -10°C ~ +70°C	-50	+50	PPM
Temperature Range				°C
Operating (TOPR)		-10	+70	
Storage (TSTG)		-40	+90	
Shunt Capacitance (Co)			7.0	pF
Load Capacitance (CL)	Customer Specified	10.0	Series	pF
Drive Level	3.579545 ~ 70.000 MHz		0.1	mW
Aging	Ta = 25°C; per year	-5.0	+5.0	PPM

FREQUENCY RANGE (MHz)	OPERATIONAL MODE	MAX ESR Ω	FREQUENCY RANGE (MHz)	OPERATIONAL MODE	MAX ESR Ω
3.579 ~ 4.000	Fundamental	200	9.000 ~ 13.000	Fundamental	60
4.000 ~ 5.000	Fundamental	150	13.000 ~ 20.000	Fundamental	40
5.000 ~ 6.000	Fundamental	120	20.000 ~ 30.000	Fundamental	30
6.000 ~ 7.000	Fundamental	100	30.000 ~ 70.000	3rd OT	100
7.000 ~ 9.000	Fundamental	80			

* Other tolerances, stabilities & operating temperature ranges available. Call us for specific requirements.
All specifications subject to change without notice.

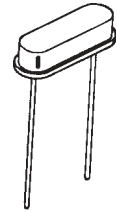


Inch dimensions shall govern.
All dimensions are in inches & parenthetically in millimeters.



RESISTANCE WELD LOW PROFILE CRYSTALS

HC49US/S



FEATURES

- ✓ Low Profile
- ✓ Industry Standard
- ✓ Cost Effective
- ✓ "AT Strip"

OPTIONS

- ✓ Surface Mount HC49S
- ✓ Mylar Spacer (Leaded)
- ✓ Tape and Reel (1,000 pcs. STD)

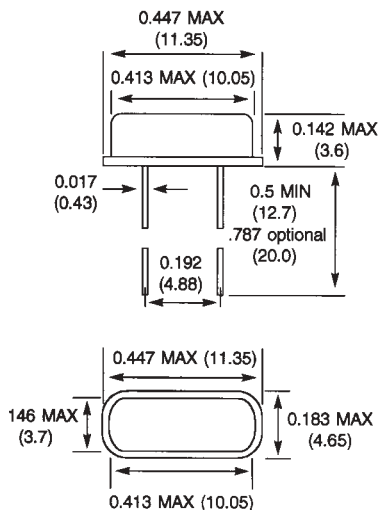
HC49US/S STANDARD SPECIFICATIONS*

PARAMETERS	CONDITIONS	MIN.	MAX.	UNITS
Frequency Range		3.200	70.000	MHz
Frequency Tolerance	Ta = 25°C	-30	+30	PPM
Frequency Stability, ref @ 25°C	Ta = 0°C ~ +70°C	-50	+50	PPM
Temperature Range				°C
Operating (TOPR)		0	+70	
Storage (TSTG)		-30	+85	
Shunt Capacitance (Co)			7.0	pF
Load Capacitance (CL)	Customer Specified	10.0	Series	pF
Drive Level	3.200 ~ 70.000 MHz		0.5	mW
Aging	Ta = 25°C; per year	-5.0	+5.0	PPM

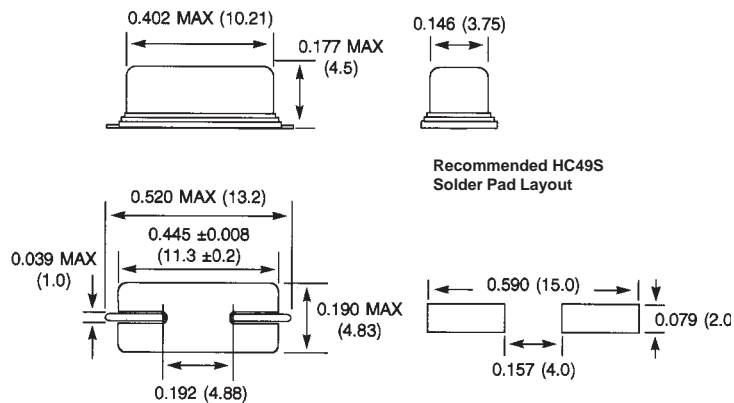
FREQUENCY RANGE (MHz)	OPERATIONAL MODE	MAX ESR Ω	FREQUENCY RANGE (MHz)	OPERATIONAL MODE	MAX ESR Ω
3.200 ~ 3.500	Fundamental	300	7.000 ~ 9.000	Fundamental	80
3.500 ~ 4.000	Fundamental	200	9.000 ~ 13.000	Fundamental	60
4.000 ~ 5.000	Fundamental	150	13.000 ~ 20.000	Fundamental	40
5.000 ~ 6.000	Fundamental	120	20.000 ~ 30.000	Fundamental	30
6.000 ~ 7.000	Fundamental	100	27.000 ~ 70.000	3rd OT	100

* Other tolerances, stabilities & operating temperature ranges available. Call us for specific requirements.
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HC49US



HC49S



Recommended HC49S Solder Pad Layout

Inch dimensions shall govern.
All dimensions are in inches & parenthetically in millimeters.



RESISTANCE WELD CRYSTAL

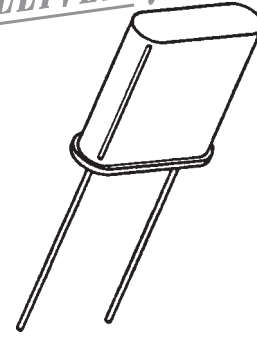
HC49U

FEATURES

- ✓ Industry Standard
- ✓ Low Cost
- ✓ Wide Frequency Range
- ✓ "AT" Cut Crystal
- ✓ Excellent Aging

OPTIONS

- ✓ Tighter Tolerances
- ✓ Extended Temperature Ranges
- ✓ Mylar Spacer
- ✓ Tape and Reel
- ✓ Vinyl Sleeve
- ✓ Third Lead

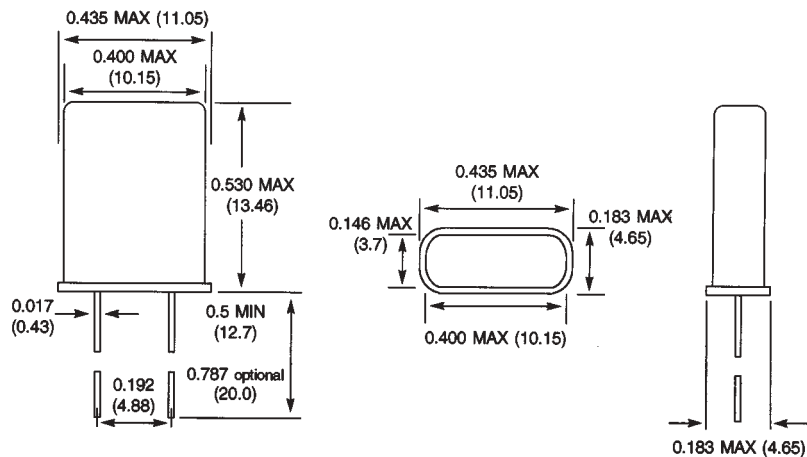
QUICK DELIVERY!

HC49U STANDARD SPECIFICATIONS*

PARAMETERS	CONDITIONS	MIN.	MAX.	UNITS
Frequency Range		1.800	200.000	MHz
Frequency Tolerance	Ta = 25°C	-30	+30	PPM
Frequency Stability, ref @ 25°C	Ta = -20°C ~ +70°C	-50	+50	PPM
Temperature Range				
Operating (TOPR)		-20	+70	°C
Storage (TSTG)		-30	+85	
Shunt Capacitance (Co)			7.0	pF
Load Capacitance (CL)	Customer Specified	10.0	Series	pF
Drive Level	1.800 ~ 3.000 MHz 3.000 ~ 200.000 MHz		2.0 1.0	mW
Aging	Ta = 25°C; per year	-5.0	+5.0	PPM

FREQUENCY RANGE (MHz)	OPERATIONAL MODE	MAX ESR Ω	FREQUENCY RANGE (MHz)	OPERATIONAL MODE	MAX ESR Ω
1.800 ~ 2.000	Fundamental	750	8.000 ~ 10.000	Fundamental	35
2.000 ~ 2.400	Fundamental	500	10.000 ~ 12.500	Fundamental	30
2.400 ~ 3.000	Fundamental	300	12.500 ~ 16.000	Fundamental	25
3.000 ~ 3.200	Fundamental	200	16.000 ~ 25.000	Fundamental	20
3.200 ~ 3.700	Fundamental	120	16.000 ~ 23.000	3rd OT	60
3.700 ~ 4.200	Fundamental	100	23.000 ~ 65.000	3rd OT	40
4.200 ~ 4.900	Fundamental	70	60.000 ~ 110.000	5th OT	80
4.900 ~ 5.000	Fundamental	55	110.000 ~ 200.000	7th OT	120
5.000 ~ 6.000	Fundamental	50			
6.000 ~ 8.000	Fundamental	40			

* Other tolerances, stabilities & operating temperature ranges available. Call us for specific requirements.
All specifications subject to change without notice.



Inch dimensions shall govern.
All dimensions are in inches & parenthetically in millimeters.



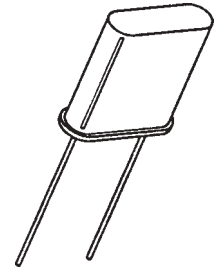
RESISTANCE WELD MINIATURE CRYSTAL

HC45U

FEATURES

- ✓ Low Profile
- ✓ Miniature Package
- ✓ Wide Frequency Range
- ✓ Small Footprint
- ✓ Excellent Aging

QUICK DELIVERY!

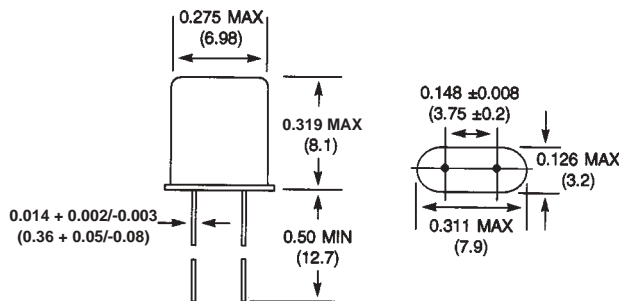


HC45U STANDARD SPECIFICATIONS*

PARAMETERS	CONDITIONS	MIN.	MAX.	UNITS
Frequency Range		3.579545	200.000	MHz
Frequency Tolerance	Ta = 25°C	-30	+30	PPM
Frequency Stability, ref @ 25°C	Ta=-10°C~+60°C	-50	+50	PPM
Temperature Range				°C
Operating (TOPR)		-10	+60	
Storage (TSTG)		-40	+85	
Shunt Capacitance (Co)			7.0	pF
Load Capacitance (CL)	Customer Specified	10.0	Series	pF
Drive Level	3.579 ~ 200.000 MHz		1.0	mW
Aging	Ta = 25°C; per year	-3.0	+3.0	PPM

FREQUENCY RANGE (MHz)	OPERATIONAL MODE	MAX ESR Ω	FREQUENCY RANGE (MHz)	OPERATIONAL MODE	MAX ESR Ω
3.579 ~ 4.000	Fundamental	300	10.000 ~ 11.000	Fundamental	60
4.000 ~ 5.000	Fundamental	250	11.000 ~ 27.000	Fundamental	40
5.000 ~ 6.000	Fundamental	180	25.000 ~ 65.000	3rd OT	60
6.000 ~ 7.000	Fundamental	120	60.000 ~ 130.000	5th OT	100
7.000 ~ 8.000	Fundamental	100	130.000 ~ 200.000	7th OT	150
8.000 ~ 10.000	Fundamental	90			

* Other tolerances, stabilities & operating temperature ranges available. Call us for specific requirements. All specifications subject to change without notice.



Inch dimensions shall govern.
All dimensions are in inches & parenthetically in millimeters.



RESISTANCE WELD MINIATURE CRYSTAL

HC35U

FEATURES

- ✓ High Stability
- ✓ Low Phase Noise
- ✓ Superior Shock & Vibration
- ✓ Tighter Tolerances
- ✓ Smaller Mass for Faster Warm-up in Oven Use
- ✓ Extended Temperature Range

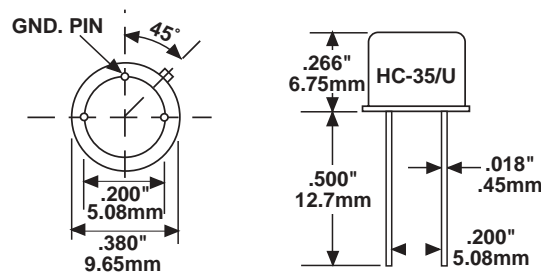
QUICK DELIVERY!

HC35U STANDARD SPECIFICATIONS*

PARAMETERS	CONDITIONS	MIN.	MAX.	UNITS
Frequency Range		7.00	125.000	MHz
Frequency Tolerance	Ta = 25°C	-30	+30	PPM
Frequency Stability, ref @ 25°C	Ta = -20°C ~ +70°C	-50	+50	PPM
Temperature Range				°C
Operating (TOPR)		-10	+60	
Storage (TSTG)		-30	+85	
Shunt Capacitance (Co)			7.0	pF
Load Capacitance (CL)	Customer Specified	10.0	Series	pF
Drive Level	7.00 ~ 125.000 MHz		1.0	mW
Aging	Ta = 25°C; per year	-5.0	+5.0	PPM

FREQUENCY RANGE (MHz)	OPERATIONAL MODE	MAX ESR Ω
7.000 ~ 10.999	Fundamental	30
11.000 ~ 20.000	Fundamental	25
21.000 ~ 61.000	3rd Overtone	40
50.000 ~ 125.000	5th Overtone	60

* Other tolerances, stabilities & operating temperature ranges available. Call us for specific requirements.
All specifications subject to change without notice.



RESISTANCE WELD MINIATURE CRYSTAL

HC50U

FEATURES

- ✓ Industry Standard
- ✓ Low Cost
- ✓ Wide Frequency Range
- ✓ "AT" Cut Crystal
- ✓ Excellent Aging
- ✓ Plug in Pins

OPTIONS

- ✓ Tighter Tolerances
- ✓ Extended Temperature Ranges
- ✓ Mylar Spacer
- ✓ Tape and Reel
- ✓ Vinyl Sleeve
- ✓ Third Lead



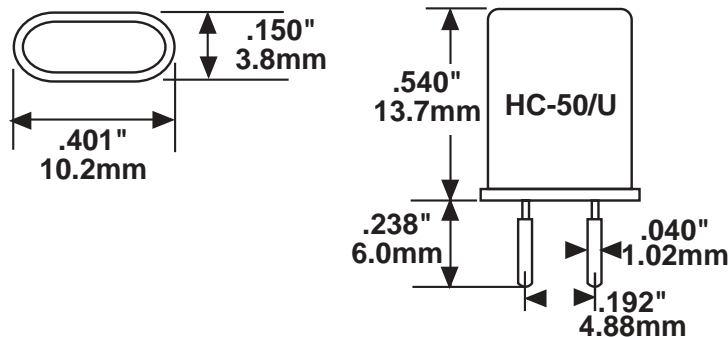
QUICK DELIVERY!

HC50U STANDARD SPECIFICATIONS*

PARAMETERS	CONDITIONS	MIN.	MAX.	UNITS
Frequency Range		3.500	200.000	MHz
Frequency Tolerance	Ta = 25°C	-30	+30	PPM
Frequency Stability, ref @ 25°C	Ta = -20°C ~ +70°C	-50	+50	PPM
Temperature Range				
Operating (TOPR)		-20	+70	°C
Storage (TSTG)		-30	+85	
Shunt Capacitance (Co)			7.0	pF
Load Capacitance (CL)	Customer Specified	10.0	Series	pF
Drive Level	3.500 ~ 200.000 MHz		1.0	mW
Aging	Ta = 25°C; per year	-5.0	+5.0	PPM

FREQUENCY RANGE (MHz)	OPERATIONAL MODE	MAX ESR Ω	FREQUENCY RANGE (MHz)	OPERATIONAL MODE	MAX ESR Ω
3.500 ~ 3.700	Fundamental	120	8.000 ~ 10.000	Fundamental	35
3.700 ~ 4.200	Fundamental	100	10.000 ~ 12.500	Fundamental	30
4.200 ~ 4.900	Fundamental	70	12.500 ~ 16.000	Fundamental	25
4.900 ~ 5.000	Fundamental	55	16.000 ~ 25.000	Fundamental	20
5.000 ~ 6.000	Fundamental	50	16.000 ~ 23.000	3rd OT	60
6.000 ~ 8.000	Fundamental	40	23.000 ~ 65.000	3rd OT	40
			60.000 ~ 110.000	5th OT	80
			110.000 ~ 200.000	7th OT	120

* Other tolerances, stabilities & operating temperature ranges available. Call us for specific requirements.
All specifications subject to change without notice.

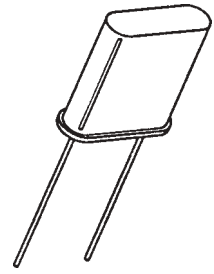


LOW FREQUENCY CRYSTAL

HC51U

FEATURES

- ✓ Excellent Reliability
- ✓ Low Frequency
- ✓ Third Lead Option



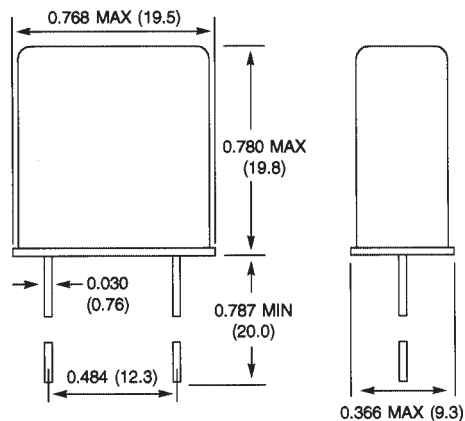
HC51U STANDARD SPECIFICATIONS*

PARAMETERS	CONDITIONS	MIN.	MAX.	UNITS
Frequency Range		100 kHz**	4.800	MHz
Frequency Tolerance	Ta = 25°C	-50	+50	PPM
Frequency Stability, ref @ 25°C	Ta = -10°C ~ +60°C	-100	+100	PPM
Temperature Range				°C
Operating (TOPR)		-10	+60	
Storage (TSTG)		-30	+85	
Shunt Capacitance (Co)			7.0	pF
Load Capacitance (CL)	Customer Specified	10.0	Series	pF
Drive Level	100 kHz ~ 4.800 MHz		2.0	mW
Aging	Ta = 25°C; per year	-7.0	+7.0	PPM

FREQUENCY RANGE (MHz)	OPERATIONAL MODE	MAX ESR Ω	FREQUENCY RANGE (MHz)	OPERATIONAL MODE	MAX ESR Ω
0.100 ~ 0.160	Fundamental	5000	2.000 ~ 2.400	Fundamental	300
0.160 ~ 0.500	Fundamental	3000	2.400 ~ 3.000	Fundamental	250
0.500 ~ 0.800	Fundamental	3000	3.000 ~ 3.200	Fundamental	150
0.800 ~ 1.000	Fundamental	2000	3.200 ~ 4.000	Fundamental	120
1.000 ~ 1.250	Fundamental	800	4.000 ~ 4.400	Fundamental	80
1.250 ~ 1.800	Fundamental	500	4.400 ~ 4.800	Fundamental	70
1.800 ~ 2.000	Fundamental	400			

* Other tolerances, stabilities & operating temperature ranges available. Call us for specific requirements.
All specifications subject to change without notice.

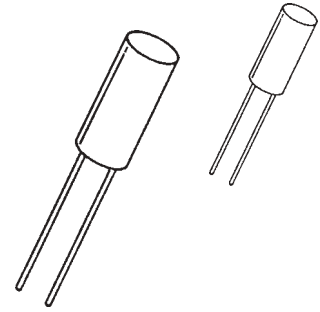
** Call ICM for specifications below 1 MHz



TUNING FORK WATCH CRYSTAL T26W/T38W

FEATURES

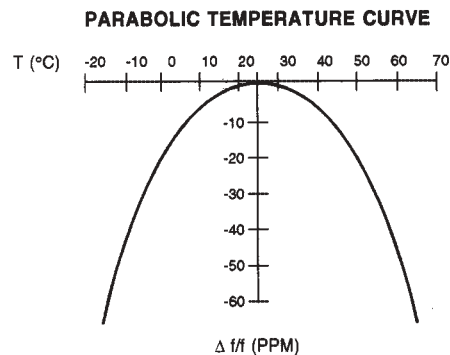
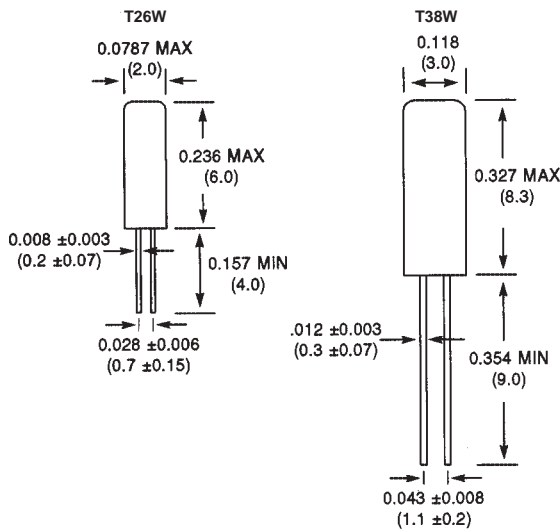
- ✓ Low Cost
- ✓ Miniature Packages
- ✓ Tight Tolerance
- ✓ Cold Weld Design
- ✓ Long Term Stability



T26W/T38W STANDARD SPECIFICATIONS*

PARAMETERS	CONDITIONS	T26W		T38W		UNITS
		MIN.	MAX.	MIN.	MAX.	
Frequency	32.768 kHz					
Frequency Tolerance	Ta = 25°C, CL=12.5pF	-20	+20	-20	+20	PPM
Frequency Stability	(K) Temperature Coefficient		-0.04		-0.04	PPM / (Δ°C) ²
Temperature Range						°C
Turnover (To)		+20	+30	+20	+30	
Operating (TOPR)		-10	+60	-10	+60	
Storage (TSTG)		-20	+70	-20	+70	
Equivalent Series Resistance (ESR)			50		35	kΩ
Insulation Resistance	100 VDC	500		500		MΩ
Drive Level			1.0		1.0	μW
Aging	Ta = 25°C; per year	-3.0	+3.0	-3.0	+3.0	PPM

All specifications subject to change without notice.



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

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

Inch dimensions shall govern.
All dimensions are in inches & parenthetically in millimeters.



MICRO MINIATURE CERAMIC SMD CRYSTAL

S53

FEATURES

- ✓ Tight Stability Option
- ✓ Tight Tolerance Option
- ✓ Low Profile
- ✓ Wide Frequency Range
- ✓ "AT" Cut Crystal Blank
- ✓ Tape and Reel (3,000 pcs. STD)

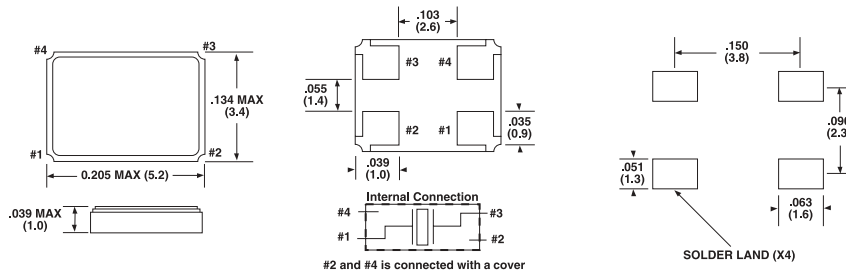


S53 STANDARD SPECIFICATIONS*

PARAMETERS	CONDITIONS	MIN.	MAX.	UNITS
Frequency Range		10.000	50.000	MHz
Frequency Tolerance	Ta = 25°C	- 50	+ 50	PPM
Frequency Stability, ref @ 25°C	Ta = -20°C ~ +70°C	- 100	+ 100	PPM
Temperature Range				°C
Operating (TOPR)		-20	+70	
Storage (TSTG)		-40	+90	
Shunt Capacitance (CO)			5.0	pF
Load Capacitance (CL)	Customer Specified	10.0	Series	pF(18pF Standard)
Drive Level	10.000 ~ 50.000 MHz		10.0	μW
Aging	Ta = 25°C: per year	-5.0	+5.0	PPM

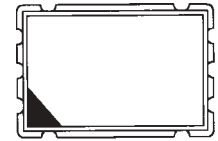
FREQUENCY RANGE (MHz)	OPERATIONAL MODE	MAX ESR Ω	FREQUENCY RANGE (MHz)	OPERATIONAL MODE	MAX ESR Ω
10,000 ~ 15,999	Fundamental	60	16,000 ~ 50,000	Fundamental	50

* Other tolerances, stabilities & operating temperature ranges available. Call us for specific requirements.
All specifications subject to change without notice.



MICRO MINIATURE CERAMIC SMD CRYSTAL

S75



FEATURES

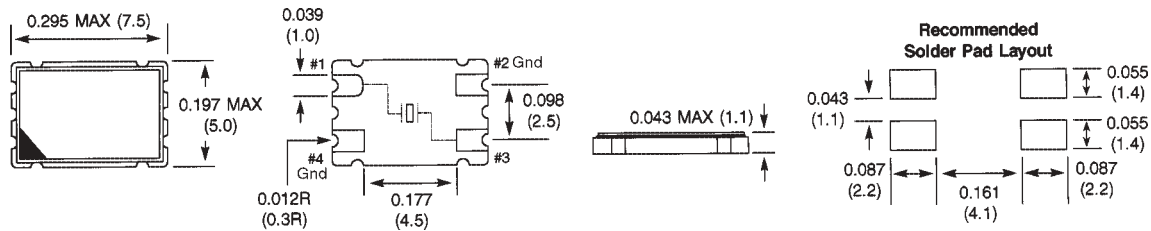
- ✓ Tight Stability Option
- ✓ Tight Tolerance Option
- ✓ Low Profile
- ✓ Wide Frequency Range
- ✓ "AT" Cut Crystal Blank
- ✓ Tape and Reel (3,000 pcs. STD)

S75 STANDARD SPECIFICATIONS*

PARAMETERS	CONDITIONS	MIN.	MAX.	UNITS
Frequency Range		9.8304	100.000	MHz
Frequency Tolerance	Ta = 25°C	- 50	+ 50	PPM
Frequency Stability, ref @ 25°C	Ta = -10°C ~ +60°C	- 50	+ 50	PPM
Temperature Range				°C
Operating (TOPR)		-10	+60	
Storage (TSTG)		-30	+85	
Shunt Capacitance (CO)			7.0	pF
Load Capacitance (CL)	Customer Specified	10.0	Series	pF
Drive Level	9.8304 ~ 100.000 MHz		0.5	mW
Aging	Ta = 25°C; per year	-5.0	+5.0	PPM

FREQUENCY RANGE (MHz)	OPERATIONAL MODE	MAX ESR Ω	FREQUENCY RANGE (MHz)	OPERATIONAL MODE	MAX ESR Ω
9.8304 ~ 16.000	Fundamental	60	28.000 ~ 84.000	3rd OT	60
16.000 ~ 32.000	Fundamental	40	84.000 ~ 100.000	5th OT	80

* Other tolerances, stabilities & operating temperature ranges available. Call us for specific requirements. All specifications subject to change without notice.



Inch dimensions shall govern.
All dimensions are in inches & parenthetically in millimeters.



MINIATURE SMD TUNING FORK WATCH CRYSTAL

SP94

FEATURES

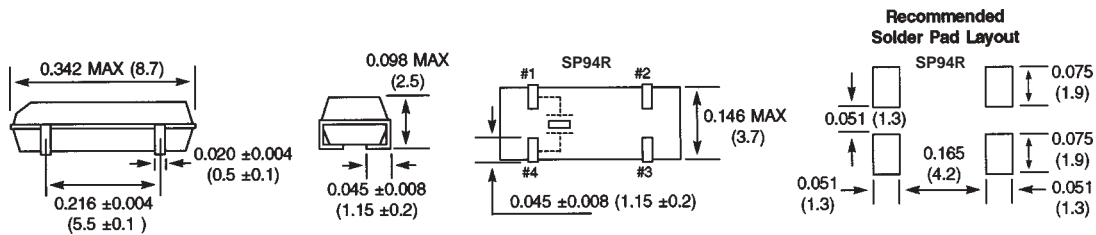
- ✓ Long Term Stability
- ✓ 2.5mm Height
- ✓ Miniature Package
- ✓ Two Pin Connection Types
- ✓ Tape and Reel (3,000 pcs. STD)



SP94 STANDARD SPECIFICATIONS

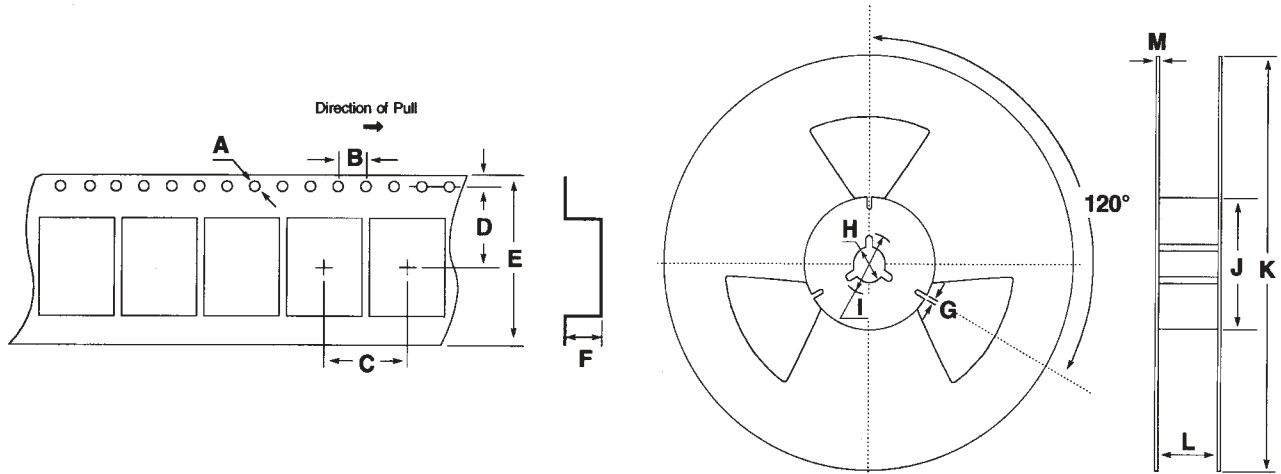
PARAMETERS	CONDITIONS	MIN.	MAX.	UNITS
Frequency	32.768 kHz			
Frequency Tolerance	Ta = 25°C, CL=12.5 pF	-20	+20	PPM
Frequency Stability	Temperature Coefficient		-0.04	PPM / (Δ°C) ²
Temperature Range				°C
Turnover (To)		+20	+30	
Operating (TOPR)		-40	+85	
Storage (TSTG)		-55	+125	
Equivalent Series Resistance (RS)			60.0	kΩ
Insulation Resistance		100		MΩ
Drive Level			1.0	μW
Aging	Ta = 25°C; per year	-3.0	+3.0	PPM

All specifications subject to change without notice.



Inch dimensions shall govern.
All dimensions are in inches &
parenthetically in millimeters.

SURFACE MOUNT CRYSTALS TAPE AND REEL SPECIFICATIONS



TAPE SPECIFICATIONS (Millimeters)

MODEL	A	B	C	D	E	F	STD. QTY*
S75	Ø1.5	4.0	8.0	7.5	16.0	1.7	3,000
SP94	Ø1.5	4.0	8.0	7.5	16.0	2.7	3,000
HC49S	Ø1.5	4.0	12.0	11.5	24.0	4.8	1,000

REEL SPECIFICATIONS (Millimeters)

MODEL	G	H	I	J	K	L	M
S75	2.0	Ø13	Ø21	Ø80	Ø250	17.5	2.0
SP94	2.0	Ø13	Ø21	Ø50	Ø330	16.4	2.0
HC49S	2.0	Ø13	Ø21	Ø80	Ø330	25.5	2.0

* Standard reel quantity.

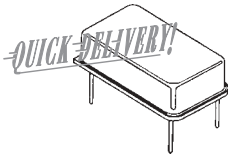
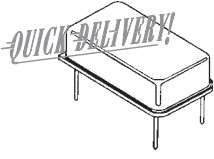

All tape and reel specifications are specified in millimeters.

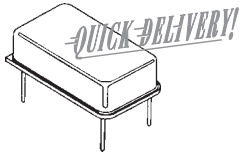
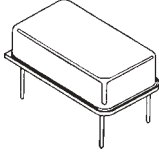
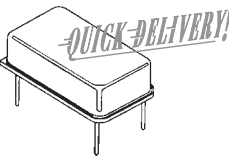
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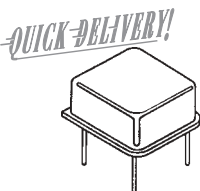
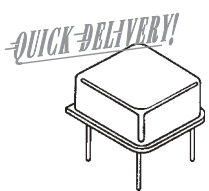


CLOCK OSCILLATOR SELECTION GUIDE

THRU-HOLE OSCILLATORS

PRODUCT	IT1100FSS	IT1100FRT	IT1100FRT3S
			
Frequency Range	0.032-160.000 MHz	1.800-80.000 MHz	1.800-80.000 MHz
Frequency Stability	±100 PPM	±100 PPM	±100 PPM
Temperature Range	0°C ~ +70°C	-10°C ~ +70°C	-10°C ~ +70°C
Key Features	<ul style="list-style-type: none"> ✓ Industry Standard ✓ Low Cost ✓ Drives Full 10 TTL Load ✓ Wide Frequency Range ✓ Rugged Resistance Weld 	<ul style="list-style-type: none"> ✓ 45/55 Symmetry up to 50 MHz ✓ Fast Rise/Fall Times ✓ -40°C to 85°C Option ✓ Low Current Consumption 	<ul style="list-style-type: none"> ✓ High Frequency TTL ✓ Fast Rise/Fall Times ✓ 45/55 Symmetry (1.8 ~ 80 MHz) ✓ Tri-state Enable/Disable
CATALOG PAGES	PAGE 25	PAGE 26	PAGE 27

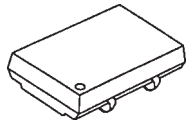

PRODUCT	IT1100FSS3S	IE1100FRS	IC1100FRSV2
			
Frequency Range	0.032-160.000 MHz	30.000-200.000 MHz	.032-160.000 MHz
Frequency Stability	±100 PPM	±100 PPM	±100 PPM
Temperature Range	0°C ~ +70°C	-10°C ~ +70°C	0°C ~ +70°C
Key Features	<ul style="list-style-type: none"> ✓ HCMOS/TTL ✓ Wide Frequency Range ✓ Tri-state Enable/Disable 	<ul style="list-style-type: none"> ✓ High Frequency ECL ✓ 10kh Logic Output ✓ Low Noise 	<ul style="list-style-type: none"> ✓ Low Power Consumption ✓ Tight Stabilities ✓ Rugged Resistance Weld ✓ Pullability
CATALOG PAGES	PAGE 28	PAGE 29	PAGE 32

PRODUCT	IT1100HRT3S	IT1100HSS3S
		
Frequency Range	1.8000- 80.000 MHz	0.032-100.000 MHz
Frequency Stability	±100 PPM	±100 PPM
Temperature Range	-10°C ~ +70°C	0°C ~ +70°C
Key Features	<ul style="list-style-type: none"> ✓ 8 Pin Dip ✓ 15pF HCMOS Load ✓ 10TTL Fanout ✓ Tri-state Enable/Disable ✓ Fast Rise Fall Times 	<ul style="list-style-type: none"> ✓ 8 Pin Dip ✓ 15pF HCMOS Load ✓ 10TTL Fanout ✓ Low Cost ✓ Tri-state Enable/Disable
CATALOG PAGES	PAGE 30	PAGE 31



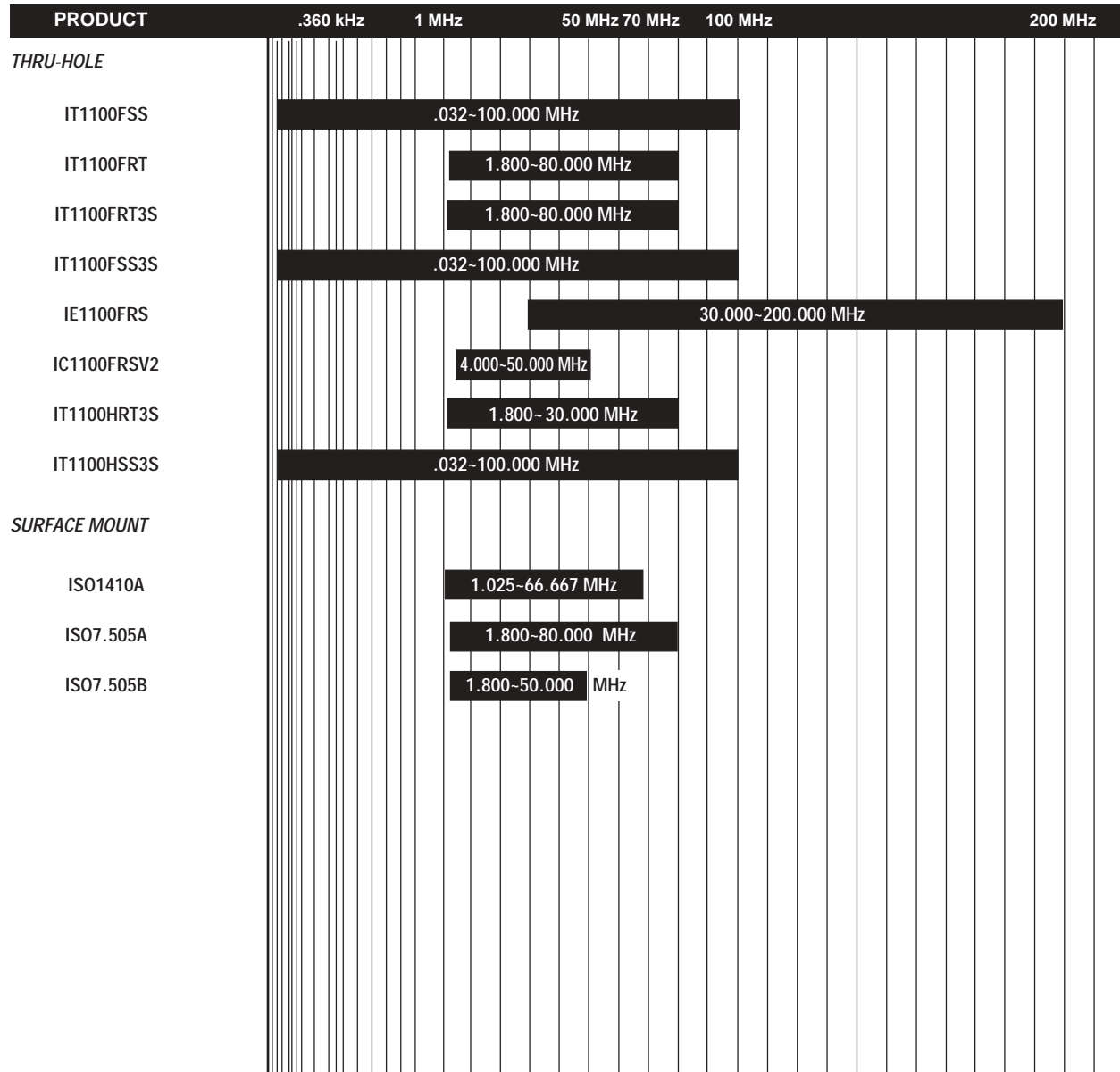
CLOCK OSCILLATOR SELECTION GUIDE

SURFACE MOUNT OSCILLATORS

PRODUCT	ISO1410	ISO7.505A/B
		
Freq. Range	1.025-66.667 MHz	SO7.505A 1.800-80.000 MHz ISO7.505B 1.800-50.000 MHz
Freq. Stability	±100 PPM -10 ~ +70°C ±200 PPM -40 ~ +85°C	±100 PPM
Temp. Range	-10°C ~ +70°C	-10°C ~ +70°C -40°C ~ +85°C Option
Key Features	<ul style="list-style-type: none"> ✓ Extended Temp. Range ✓ Solderable ~ 260°C for 10 sec. ✓ Tape and Reel 	<ul style="list-style-type: none"> ✓ Miniature Package ✓ Tri-State Enable/Disable ✓ Available -40° ~ +85°C ✓ 3000 G Shock Resistance ✓ Tape and Reel

CATALOG PAGES **PAGE 31** **PAGE 33**

FREQUENCY RANGE BY PRODUCT



TTL/HCMOS CLOCK OSCILLATOR

IT1100FSS

FEATURES

- ✓ Low Cost
- ✓ Industry Standard
- ✓ Wide Frequency Range
- ✓ Rugged Resistance Weld
- ✓ Drives Full 10 TTL Load
- ✓ Optional +3.3 VDC Supply

PART NUMBER SELECTION

Frequency Stability	Part Number
±100 PPM (STD)	IT1100FSS
±50PPM	IT1150FSS
±25PPM	IT1125FSS



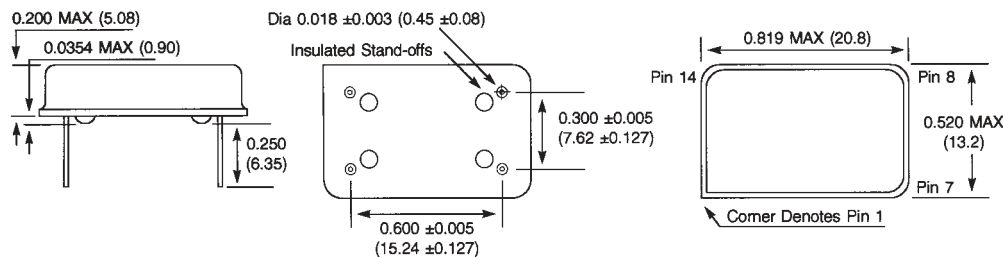
QUICK DELIVERY!

ELECTRICAL CHARACTERISTICS (Ta = 25°C, VDD = 5.0 V, RL = 400Ω, CL = 15pF)

PARAMETERS	FREQUENCY RANGE	CONDITIONS	MIN.	MAX.	UNITS
Frequency Range (Fo)			0.032	160.000	MHz
Frequency Stability	0.032 ~ 160.000	All Conditions*	-100	+100	PPM
Temperature Range	0.032 ~ 160.000				
Operating (TOPR)			0	+70	°C
Storage (TSTG)			-55	+125	
Supply Voltage (VDD)	0.032 ~ 160.000		+4.5	+5.5	V
Input Current (IDD)	0.032 ~ 160.000			45	mA
Output Symmetry	0.032 ~ 160.000		40	60	%
Rise Time (TR)	0.032 ~ 160.000			6	nS
Fall Time (TF)	0.032 ~ 160.000			6	
Output Voltage (VOL)	0.032 ~ 160.000			0.5	V
(VOH)				4.5	
Output Load	0.032 ~ 160.000	TTL Load		10	TTL
		HCMOS Load		15	pF

* Inclusive of 25°C tolerance, operating temperature range, input voltage change, load change, aging, shock, and vibration. See page 35 for environmental/mechanical specifications, test circuits, and output waveform.

All specifications subject to change without notice.



Pin Connections
 #1 N.C. #8 Output
 #7 GND (Case) #14 +5VDC

Inch dimensions shall govern.
 All dimensions are in inches & parenthetically in millimeters.



TTL/HCMOS CLOCK OSCILLATOR

IT1100FRT

FEATURES

- ✓ Fast Rise/Fall Times
- ✓ 45/55% Symmetry up to 50 MHz
- ✓ Low Current Consumption
- ✓ Optional +3.3 VDC Supply

PART NUMBER SELECTION

Frequency Stability	Part Number
±100 PPM (STD -10°C-70°C)	IT1100FRT
±50 PPM	IT1150FRT
±25 PPM	IT1125FRT

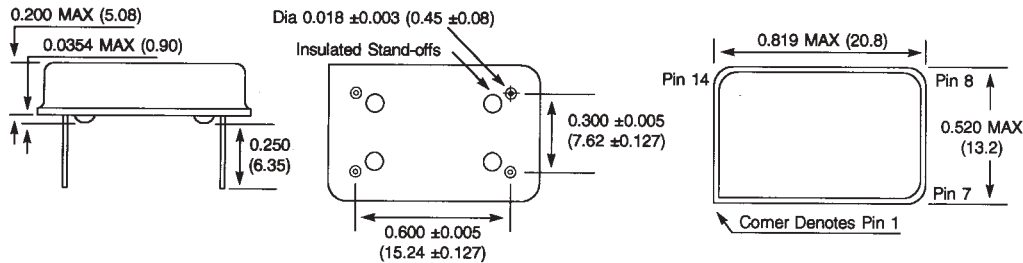


QUICK DELIVERY!

ELECTRICAL CHARACTERISTICS (Ta = 25°C, VDD = 5.0 V, RL = noted below, CL = 15pF)

PARAMETERS	FREQUENCY RANGE	CONDITIONS	MIN.	MAX.	UNITS
Frequency Range (Fo)			1.800	80.000	MHz
Frequency Stability	1.800 - 80.000	All Conditions*	-100	+100	PPM
Temperature Range Operating (TOPR) Storage (TSTG)	1.800 - 80.000		-10 -55	+70 +125	°C
Supply Voltage (VDD)	1.800 - 80.000		+4.5	+5.5	V
Input Current (IDD)	1.800 - 80.000			45	mA
Output Symmetry	1.800 - 80.000	1.4 V Level	45	55	%
Rise Time (TR)	1.800 - 80.000	0.5 V to 4.5 V		6	nS
Fall Time (TF)		4.5 V to 0.5 V		6	
Output Voltage (VOL)	1.800 - 80.000			0.5	V
(VOH)				4.5	
Output Load	1.800 - 80.000	TTL Load HCMOS Load		10 15	TTL pF

* Inclusive of 25°C tolerance, operating temperature range, input voltage change, load change, aging, shock, and vibration
See page 35 for environmental/mechanical specifications, test circuits, and output waveform.
All specifications subject to change without notice.



Pin Connections
#1 N.C. #8 Output
#7 GND (Case) #14 +5 VDC

Inch dimensions shall govern.
All dimensions are in inches & parenthetically in millimeters.



TTL/HCMOS TRI-STATE HIGH FREQUENCY CLOCK OSCILLATOR IT1100FRT3S

FEATURES

- ✓ Fast Rise/Fall Times
- ✓ High Frequency TTL
- ✓ Tri-state Enable/Disable
- ✓ 45/55 Symmetry(1.8 ~ 80 MHz)
- ✓ Optional +3.3 VDC Supply

PART NUMBER SELECTION

Frequency Stability	Part Number
±100 PPM	IT1100FRT3S
±50 PPM	IT1150FRT3S
±25PPM (to 50 MHz)	IT1125FRT3S



QUICK DELIVERY!

OSCILLATORS

ELECTRICAL CHARACTERISTICS (Ta = 25°C, VDD = 5.0 V, RL = 400Ω)

PARAMETERS	FREQUENCY RANGE	CONDITIONS	MIN.	MAX.	UNITS
Frequency Range (FO)			1.800	80.000	MHz
Frequency Stability	1.800 ~ 80.000	All Conditions*	-100	+100	PPM
Temperature	1.800 ~ 80.000				
Operating (TOPR)			-10	+70	°C
Storage (TSTG)			-55	+125	
Supply Voltage (VDD)	1.800 ~ 80.000		+4.5	+5.5	V
Input Current (IDD)	1.800 ~ 80.000			45	mA
Output Symmetry	1.800 ~ 80.000	1.4 V Level	45	55	%
Rise Time (TR)	1.800 ~ 80.000	0.5 V to 4.5 V		6	nS
Fall Time (TF)		4.5 V to 0.5 V		6	
Output Voltage (VOL) (VOH)	1.800 ~ 80.000			0.5 4.5	V
Output Load	1.800 ~ 80.000	TTL Load HCMOS Load		10 15	TTL pF

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

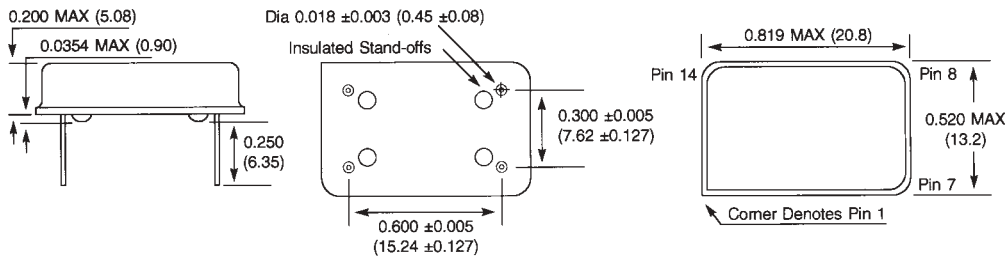
***An internal pullup resistor from pin 1 to pin 14 allows active output if pin 1 is left open.

See page 35 for environmental/mechanical specifications, test circuits, and output waveform.

All specifications subject to change without notice.

ENABLE / DISABLE FUNCTION**

INH (Pin 1)	OUTPUT (Pin 8)
OPEN ***	ACTIVE
'1' Level VIH ≥ 2.2 V	ACTIVE
'0' Level VIL ≥ 0.8 V	High Z



Pin Connections
 #1 E/D ** #8 Output
 #7 GND (Case) #14 +5VDC

Inch dimensions shall govern.
 All dimensions are in inches &
 parenthetically in millimeters.



TTL/HCMOS TRI-STATE OSCILLATOR

IT1100FSS3S

FEATURES

- ✓ HCMOS/TTL
- ✓ Wide Frequency Range
- ✓ Tri-state Enable/Disable
- ✓ Industry Standard Footprint
- ✓ Grounded metal cover reduces EMI
- ✓ Internal Bypass Capacitors - no external components required
- ✓ Optional +3.3 VDC Supply

PART NUMBER SELECTION

Frequency Stability	Part Number
±100 PPM	IT1100FSS3S
±50 PPM	IT1150FSS3S
±25PPM	IT1125FSS3S



QUICK DELIVERY!

ELECTRICAL CHARACTERISTICS (Ta = 25°C, VDD = 5.0 V, CL = Max load)

PARAMETERS	FREQUENCY RANGE	CONDITIONS	MIN.	MAX.	UNITS
Frequency Range (Fo)			0.032	160.000	MHz
Frequency Stability	0.032 ~ 160.000	All Conditions	-100	+100	PPM
Temperature Range					
Operating (TOPR)	0.032 ~ 160.000		0	+70	°C
Storage (TSTG)			-55	+125	
Supply Voltage (VDD)	0.032 ~ 160.000		+4.5	+5.5	V
Input Current (IDD)	0.032 ~ 160.000			45	mA
Output Symmetry	0.032 ~ 160.000	2.5V	40	60	%
Rise Time (TR)	0.032 ~ 160.000	0.5V ~ 4.5V		6	nS
Fall Time (TF)	0.032 ~ 160.000	4.5V ~ 0.5V		6	
Output Voltage (VOL)	0.032 ~ 160.000			0.5	V
(VOH)				4.5	
Output Load	0.032 ~ 160.000	TTL Load		10	TTL
		HCMOS Load		15	pF

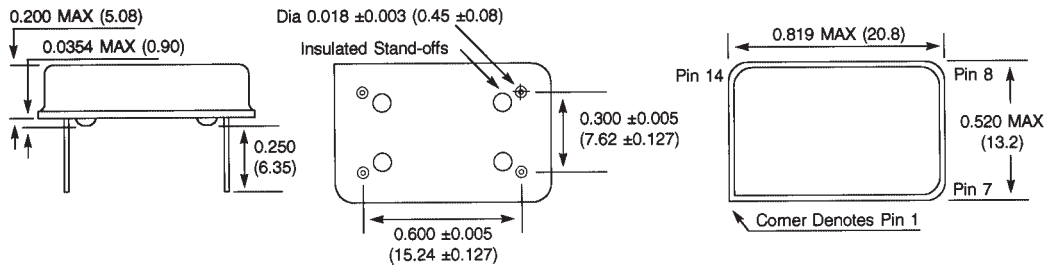
***An internal pullup resistor from pin 1 to pin 14 allows active output if pin 1 is floating.

See page 35 or environmental/mechanical specifications, test circuits, and output waveform.

All specifications subject to change without notice.

ENABLE / DISABLE FUNCTION**

INH (Pin 1)	OUTPUT (Pin 8)
N.C. ***	ACTIVE
VIH ≤ 2.0 V	ACTIVE
VIL ≥ 0.8 V	High Z



Pin Connections
#1 E/D or N.C.** #8 Output
#7 GND (Case) #14 VDD

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Inch dimensions shall govern.

All dimensions are in inches & parenthetically in millimeters.



14 PIN DIP ECL OSCILLATOR IE1100FRS



FEATURES

- ✓ 10 KH Logic Output
- ✓ High Frequency Range
- ✓ Low Noise

OPTIONS

- ✓ Various Pin Connections
- ✓ Complementary Output
- ✓ ±50PPM (IE1150FRS Series)
- ±25PPM (IE1125FRS Series)

ELECTRICAL CHARACTERISTICS (Ta = -10~70°C, VEE = 5.2 V ±5%** , VTT = 2.0 V** RT=50Ω**)

PARAMETERS	FREQUENCY RANGE	CONDITIONS	MIN.	MAX.	UNITS
Frequency Range (Fo)			30.000	200.000	MHz
Frequency Stability	30.000 ~ 200.000	All Conditions*	-100	+100	PPM
Temperature Range Operating (TOPR) Storage (TSTG)			-10 -55	+70 +125	°C
Supply Voltage (VEE)			-5.46	-4.94	V**
Input Current (IDD)	30.000 ~ 170.000 170.000 ~ 200.000	NOE, NOF, COE, COF NOE, NOF, COE, COF		40 50 50 60	mA
Output Symmetry	30.000 ~ 200.000	50% Vp-p Level	40	60	%
Rise Time (TR)	30.000 ~ 170.000 170.000 ~ 200.000	20% Vp-p ~ 80% Vp-p Level		2.0 1.5	nS
Fall Time (TF)	30.000 ~ 170.000 170.000 ~ 200.000	80% Vp-p ~ 20% Vp-p Level		2.0 1.5	nS
Output Voltage (VOL)	30.000 ~ 200.000	'0' Logic Level NOE, NOF, COE, COF	-1.95 +3.05	-1.60 +3.42	V
(VOH)	30.000 ~ 200.000	'1' Logic Level NOE, NOF, COE, COF	-1.00 +4.00	-0.75 +4.45	V
Output Load	30.000 ~ 200.000	ECL Load		5	Gates
Overlap Time	30.000 ~ 200.000	50% Vp-p (Complementary only)		0.5	nS
Start-up Time (Ts)	30.000 ~ 200.000			10	mS

PART NUMBER SELECTION / PIN CONNECTIONS

Single Output					Pull Up/Down		Complementary Output				Pull Up/Down	
Part#	Pin 1	Pin 7	Pin 8	Pin 14	Resistor	Part#	Pin 1	Pin 7	Pin 8	Pin 14	Resistor	
IE1100FRSNOA	NC	GND	OUTPUT	-5.2V	Down [a]	IE1100FRSCO A	OUTPUT 1	GND	OUTPUT 2	-5.2V	Down [a]	
IE1100FRSNOB	NC	GND	OUTPUT	-5.2V	None	IE1100FRSCOB	OUTPUT 1	GND	OUTPUT 2	-5.2V	None	
IE1100FRSNOC	NC	-5.2V	OUTPUT	GND	Down [a]	IE1100FRSCOC	OUTPUT 1	-5.2V	OUTPUT 2	GND	Down [a]	
IE1100FRSNOD	NC	-5.2V	OUTPUT	GND	None	IE1100FRSCOD	OUTPUT 1	-5.2V	OUTPUT 2	GND	None	
IE1100FRSNOE	NC	GND	OUTPUT	+5.0V	Up [a]	IE1100FRSCOE	OUTPUT 1	GND	OUTPUT 2	+5.0V	Up [a]	
IE1100FRSNOF	NC	GND	OUTPUT	+5.0V	None	IE1100FRSCOF	OUTPUT 1	GND	OUTPUT 2	+5.0V	None	

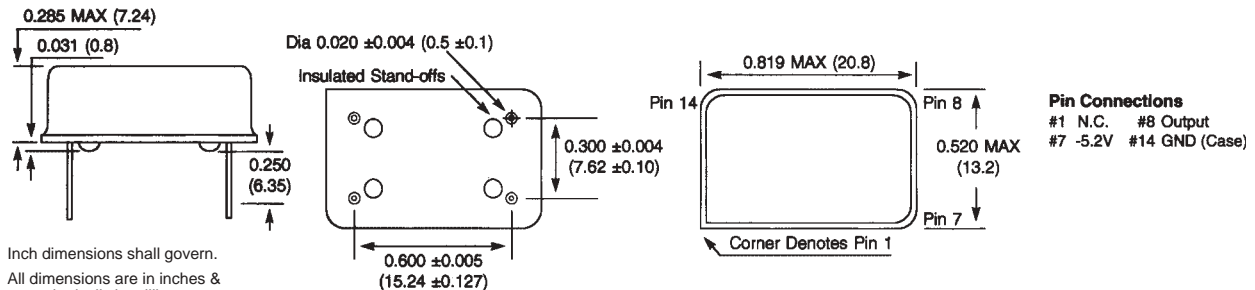
* Inclusive of 25°C tolerance, operating temperature range, input voltage change, load change, aging, shock, and vibration.

[a] up to 1 70MHZ

** IE1100FRSNOF, IE1100FRSNOE VCC = 5.0 V ±0.25 V. Consult factory for test circuitry

See page 35 for environmental/mechanical specifications, test circuits, and output waveform.

All specifications subject to change without notice.



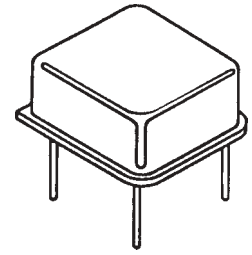
HALF SIZE TTL/HCMOS TRI-STATE ENABLE/DISABLE OSCILLATOR IT1100HRT3S

FEATURES

- ✓ 10 TTL Fanout
- ✓ 8 Pin Dip
- ✓ 15 pF HCMOS Load
- ✓ Tri-state Enable/Disable
- ✓ Fast Rise/Fall Times
- ✓ 45/55 Symmetry (To 80 MHz)
- ✓ Optional +3.3 VDC Supply

PART NUMBER SELECTION

Frequency Stability	Part Number
±100 PPM	IT1100HRT3S
±50 PPM	IT1150HRT3S
±25PPM (up to 50 MHz)	IT1125HRT3S



QUICK DELIVERY!

ELECTRICAL CHARACTERISTICS (Ta = 25°C, VDD = 5.0 V, CL = 15pF)

PARAMETERS	FREQUENCY RANGE	CONDITIONS	MIN.	MAX.	UNITS
Frequency Range (Fo)			1.800	80.000	MHz
Frequency Stability	1.800 ~ 80.000	All Conditions *	-100	+100	PPM
Temperature Range Operating (TOPR) Storage (TSTG)	1.800 ~ 80.000		-10 -55	+70 +125	°C
Supply Voltage (VDD)	1.800 ~ 80.000		+4.5	+5.5	V
Input Current (IDD)	1.800 ~ 80.000			45	mA
Output Symmetry	1.800 ~ 80.000	1.4V Level	45	55	%
Rise Time (TR) Fall Time (TF)	1.800 ~ 80.000	0.5V ~ 4.5V 4.5V ~ 0.5V		6	nS
Output Voltage (VOL) (VOH)	1.800 ~ 80.000			0.5 4.5	V
Output Load	1.800 ~ 80.000	TTL HCMOS		10 15	TTL pF

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

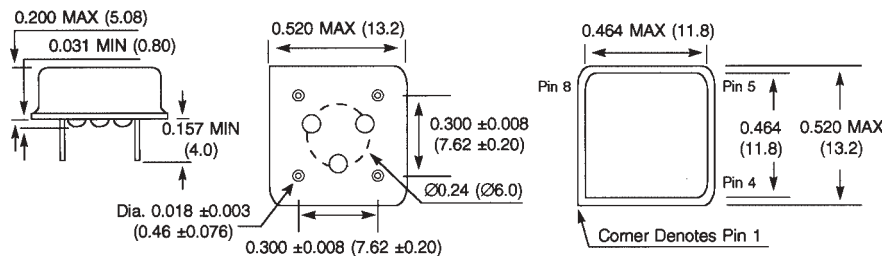
**An internal pullup resistor from pin 1 to pin 8 allows active output if pin 1 is left open.

See page 35 for environmental/mechanical specifications, test circuits, and output waveform.

All specifications subject to change without notice.

ENABLE / DISABLE FUNCTION**

ENABLE / DISABLE FUNCTION**	OUTPUT (Pin 5)
INH (Pin 1)	OUTPUT (Pin 5)
OPEN ***	ACTIVE
'1' Level VIH ≤ 2.2 V	ACTIVE
'0' Level VIL ≥ 0.8 V	High Z



Pin Connections

- #1 E/D**
- #4 GND (Case)
- #5 Output
- #8 +5Vdc

Inch dimensions shall govern.

All dimensions are in inches & parenthetically in millimeters.



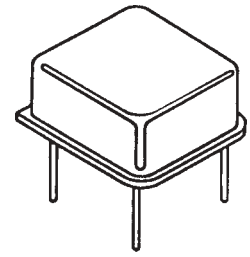
HALF SIZE TTL/HCMOS TRI-STATE ENABLE/DISABLE OSCILLATOR IT1100HSS3S

FEATURES

- ✓ 15pF HCMOS Load
- ✓ Low Cost
- ✓ 10TTL Loads
- ✓ 8 Pin Dip
- ✓ Tri-state Enable/Disable
- ✓ Optional +3.3 VDC Supply

PART NUMBER SELECTION

Frequency Stability	Part Number
±100 PPM	IT1100HSS3S
±50 PPM	IT1150HSS3S
±25PPM	IT1125HSS3S



QUICK DELIVERY!

ELECTRICAL CHARACTERISTICS (Ta = 25°C, VDD = 5.0 V, CL = 15pF)

PARAMETERS	FREQUENCY RANGE	CONDITIONS	MIN.	MAX.	UNITS
Frequency Range (Fo)			0.032	100.000	MHz
Frequency Stability	0.032 ~ 100.000	All Conditions*	-100	+100	PPM
Temperature Range					
Operating (TOPR)			0	+70	°C
Storage (TSTG)			-55	+125	
Supply Voltage (VDD)			+4.5	+5.5	V
Input Current (IDD)	0.032 ~ 100.000			45	mA
Output Symmetry	0.032 ~ 100.000	2.5V	40	60	%
Rise Time (TR)	0.032 ~ 100.000	0.5V ~ 4.5V		6	nS
Fall Time (TF)	0.032 ~ 100.000	4.5V ~ 0.5V		6	
Output Voltage (VOL) (VOH)	0.032 ~ 100.000			0.5 4.5	V
Output Load	0.032 ~ 100.000	TTL HCMOS		10 15	TTL pF

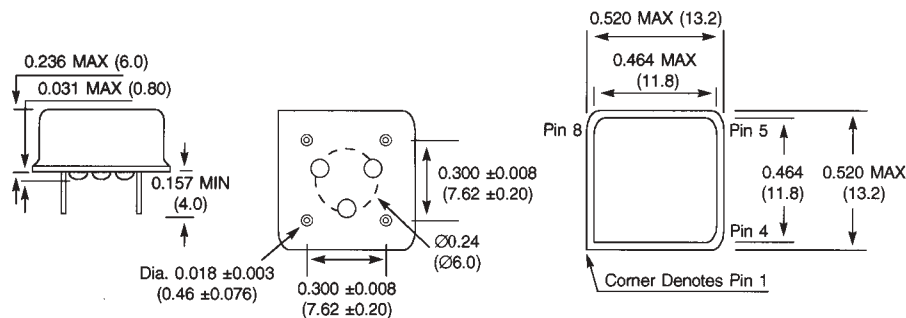
* Inclusive of 25°C tolerance, operating temperature range, input voltage change, load change, aging, shock, and vibration.

***An internal pullup resistor from pin 1 to pin 8 allows active output if pin 1 is left open.

See page 35 for environmental/mechanical specifications, test circuits, and output waveform.
All specifications subject to change without notice.

ENABLE / DISABLE FUNCTION**

INH (Pin 1)	OUTPUT (Pin 5)
OPEN ***	ACTIVE
'1' Level VIH ≥ 2.2 V	ACTIVE
'0' Level VIL ≤ 0.8 V	High Z



Inch dimensions shall govern.
All dimensions are in inches & parenthetically in millimeters.



VOLTAGE CONTROLLED CRYSTAL OSCILLATOR

IC1100FRSV2

FEATURES

- ✓ Low Power Consumption
- ✓ Tight Stabilities
- ✓ Rugged Resistance Weld
- ✓ HCMOS/TTL Output
- ✓ Pullability

PART NUMBER SELECTION

Parts *	Stability (MAX) *	Pullability (MIN) Vc = 2.5 ±2V
IC1100FRSV2	±100 PPM	±150
IC1150FRSV2	±50 PPM	±150
IC1150FRSV1	±50 PPM	±100
IC1125FRSV1	±25 PPM	±100
IC1120FRSV5	±20 PPM	±50



QUICK DELIVERY!

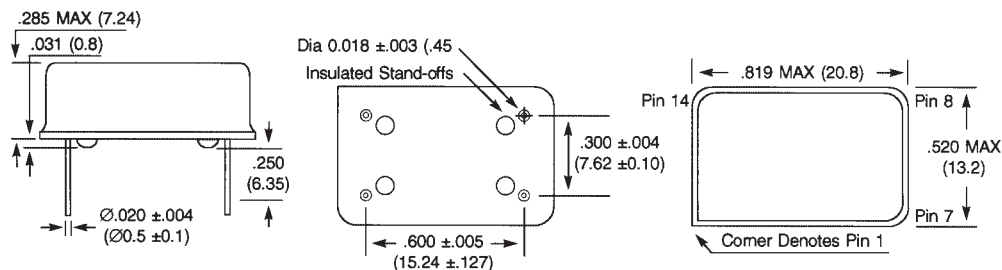
ELECTRICAL CHARACTERISTICS (Ta = 25°C, VDD = 5.0 V, CL = 15pF)

PARAMETERS	FREQUENCY RANGE	CONDITIONS	MIN.	MAX.	UNITS
Frequency Range (Fo)			4.000	160.000	MHz
Temperature Range					
Operating (TOPR)	4.000 ~ 160.000		-10	+70	°C
Storage (TSTG)			-30	+85	
Supply Voltage (VDD)	4.000 ~ 160.000		+4.75	+5.25	V
Control Voltage (Vc)	4.000 ~ 160.000		+0.5	+4.5	V
Input Current (IDD)	4.000 ~ 160.000			25	mA
Output Symmetry	4.000 ~ 160.000	2.5V	40	60	%
Rise Time (TR)	4.000 ~ 160.000	1.0V ~ 4.0V		10	nS
Fall Time (TF)	4.000 ~ 160.000	4.0V ~ 1.0V		10	
Output Voltage (VOL)	4.000 ~ 160.000	IOl = 3.2 mA		0.5	V
(VOH)		IOH = -1 mA	4.5		
Output Load	4.000 ~ 160.000	TTL Load		10	TTL
	4.000 ~ 160.000	HCMOS Load		15	pF
Start-up Time (TS)	4.000 ~ 160.000			10	mS
Frequency Stability vs Voltage	4.000 ~ 160.000	VDD = 5.0V ±10%	-3.0	+3.0	PPM
Modulation Bandwidth	4.000 ~ 160.000			20	kHz

* Inclusive of 25°C tolerance, operating temperature range, input voltage change, load change, aging, shock, vibration, and Vc = 2.5V.

See page 35 for environmental/mechanical specifications, test circuits, and output waveform.

All specifications subject to change without notice.

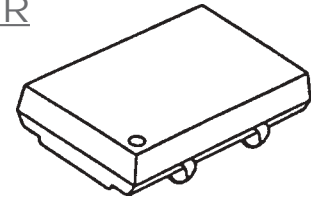


Inch dimensions shall govern.
 All dimensions are in inches & parenthetically in millimeters.



SURFACE MOUNT HCMOS CLOCK OSCILLATOR

ISO1410



FEATURES

- ✓ Extended Temperature Range
- ✓ Tape and Reel (1,000 pcs. STD)
- ✓ Solderable @ 260° for 10 sec.

ELECTRICAL CHARACTERISTICS (Ta = 25°C, VDD = 5.0 V, CL = 15pF)

PARAMETERS	CONDITIONS	ISO1410A		ISO1410B		ISO1410C		UNITS
		MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
Frequency Range		1.025	26.000	26.000	66.667	26.000	66.667	MHz
Frequency Stability *	-10°C ~ +70°C -40°C ~ +85°C	-100 -200	+100 +200	-100 -200	+100 +200	-100 -	+100 -	PPM
Temperature Range								
Operating (TOPR)		-10	+70	-10	+70	-10	+70	°C
Storage (TSTG)		-55	+125	-55	+125	-55	+125	
Supply Voltage (VDD)		+4.5	+5.5	+4.5	+5.5	+4.5	+5.5	V
Input Current (IDD)	No Load Output Disabled (IZ)		23 12		35 28		35 20	mA
Output Symmetry	2.5V 1.4V	40 45	60 55	- 45	- 55	40 -	60 -	%
Rise Time (TR)	1.0V ~ 4.0V 0.4V ~ 2.4V		8 8		5 5		7 7	nS
Fall Time (TF)	4.0V ~ 1.0V 2.4V ~ 0.4V		8 8		5 5		7 7	
Output Voltage (VOL) (VOH)	IOL = MAX IOH = MAX	4.6	0.4	2.4	0.4	4.6	0.4	V
Output Current (IOL) (IOH)	VOL = MAX VOH = MIN		16 -0.4		8 -0.4		4.0 -4.0	mA
Output Load	HCMOS TTL		50 10		5		50	pF TTL
Start-up Time (TS)			4		10		10	mS
Output Enable/Disable Time			100		100		100	nS

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

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

See page 35 for environmental/mechanical specifications, test circuits, and output waveform.

Note: ±50 PPM frequency stability at -10 to +70°C also available.

Note: A 0.01 µF bypass capacitor should be placed between VDD (Pin 4) and GND (Pin 2)

to minimize power supply line noise.

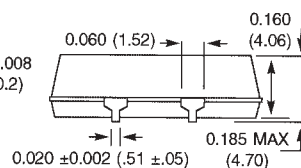
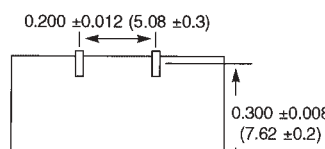
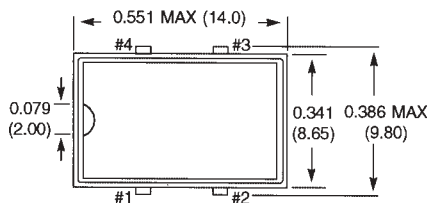
All specifications subject to change without notice.

ENABLE / DISABLE FUNCTION**

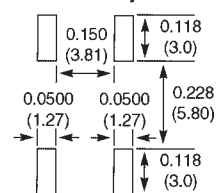
INH (Pin 1)	OUTPUT (Pin 5)
OPEN ***	ACTIVE
'1' Level VIH ≥ 2.0 V (ISO1410A/C)	ACTIVE
'1' Level VIH ≥ 3.5 V (ISO1410B)	ACTIVE
'0' Level VIL ≤ 0.8 V (ISO1410A/C)	High Z
'0' Level VIL ≤ 1.5 V (ISO1410B)	High Z

Pin Connections

- #1 E/D**
- #2 GND
- #3 Output
- #4 +5Voc



Recommended Solder Pad Layout



MINIATURE SMD HCMOS OSCILLATOR

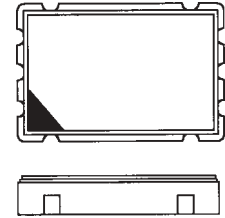
ISO7.505

FEATURES

- ✓ Miniature Package
- ✓ Available -40°C ~ +85°C
- ✓ 3000 G Shock Resistance
- ✓ Tri-State Enable/Disable
- ✓ Tape and Reel (2,000 pcs. STD)

PART NUMBER SELECTION

Frequency Stability	Part Number	
±100 PPM -10°C to +70°C	ISO7.505A	ISO7.505B
±100 PPM -40°C to +85°C	ISO7.505AE	ISO7.505BE
±50 PPM (up to 50 MHz)	ISO7.505A50	ISO7.505B50
±25 PPM (up to 50 MHz)	ISO7.505A25	ISO7.505B25



ELECTRICAL CHARACTERISTICS (Ta = 25°C, VDD = 5.0 V, CL = Max load)

PARAMETERS	FREQUENCY RANGE	CONDITIONS	ISO7.505A		ISO7.505B		UNITS
			MIN.	MAX.	MIN.	MAX.	
Frequency Range (Fo)			1.800	80.000	1.800	50.000	MHz
Frequency Stability		All Conditions*	-100	+100	-100	+100	PPM
Temperature Range Operating (TOPR) Storage (TSTG)			-10 -55	+70 +125	-10 -55	+70 +125	°C
Supply Voltage (VDD)			+4.5	+5.5	+4.5	+5.5	V
Input Current (IDD)	1.800 ~ 25.000 25.000 ~ 50.000 50.000 ~ 67.000 67.000 ~ 80.000			25 45 60 73		20 35 -	mA
Output Symmetry	1.800 ~ 80.000	2.5V	45	55	45	55	%
Rise Time (TR) Fall Time (TF)	1.800 ~ 80.000	0.5V to 4.5V 4.5V to 0.5V		7 7		10 10	nS
Output Voltage (VOL) (VOH)	1.800 ~ 80.000	IOL = 16 mA / IOL = 4 mA IOH = -16 mA / IOH = -4 mA	4.5	0.5	4.5	0.5	V
Output Current (IOL) (IOH)	1.800 ~ 80.000	VOL = 0.5V VOH = 4.5V		16 -16		4 -4	mA
Output Load	1.800 ~ 80.000	TTL HCMOS		10 50		10 LS 15	TTL pF
Start-up Time(Ts)	1.800 ~ 80.000			10		10	mS
Enable/Disable Time	1.800 ~ 80.000			100		100	nS

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

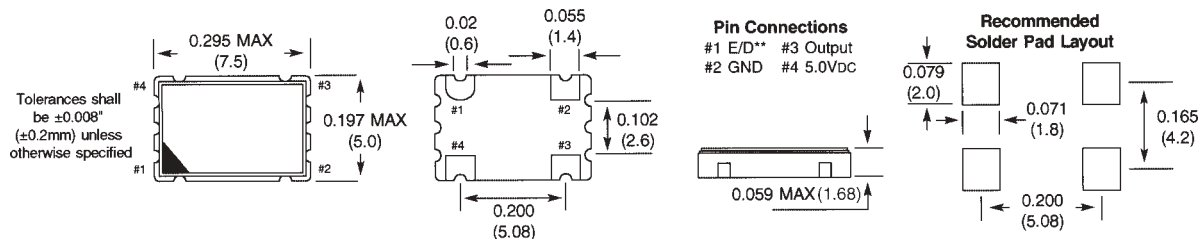
*** An internal pullup resistor from pin 1 to pin 4 allows active output if pin 1 is left open.

Note: A 0.01, µF bypass capacitor should be placed between VDD (Pin 4) and GND (Pin 2) to minimize power supply line noise. See page 35 for environmental/mechanical specifications, test circuits, and output waveform.

All specifications subject to change without notice.

ENABLE / DISABLE FUNCTION**

INH (Pin 1)	OUTPUT (Pin 3)
OPEN ***	ACTIVE
'1' Level VIH ≤ 2.2 V	ACTIVE
'0' Level VIL ≥ 0.8 V	High Z



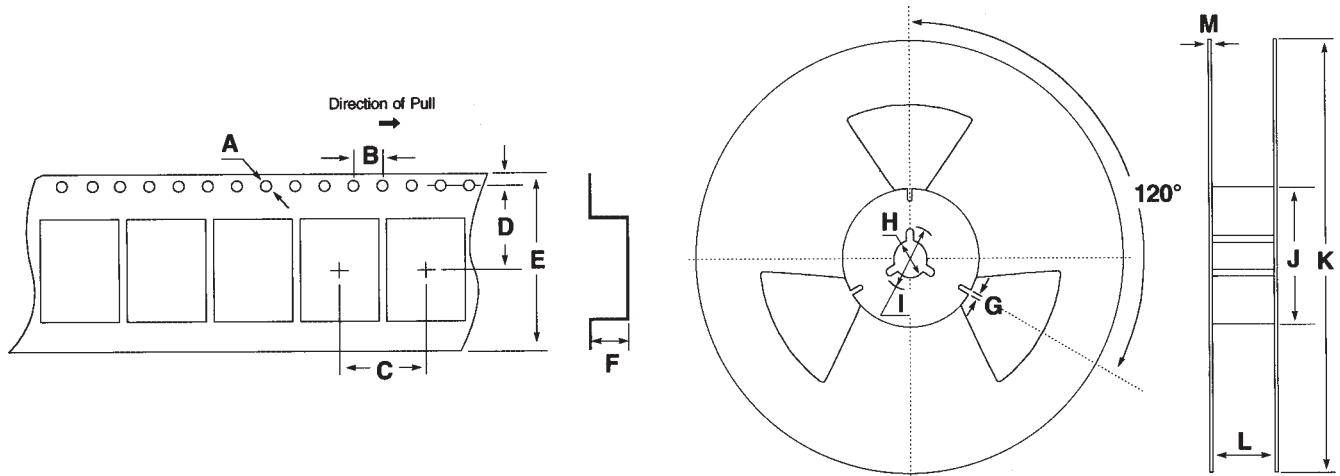
Inch dimensions shall govern.

All dimensions are in inches & parenthetically in millimeters.

See page 40 for tape and reel specifications.



SURFACE MOUNT OSCILLATORS TAPE AND REEL SPECIFICATIONS



MODEL	A	B	C	D	E	F	STD QTY *
ISO1410	Ø1.5	4.0	12.0	11.5	24.0	4.8	1,000
ISO7.505	Ø1.5	4.0	8.0	7.5	16.0	2.15	2,000
ISTCX01110	Ø1.5	4.0	16.0	11.5	24.0	4.4	1,000

MODEL	G	H	I	J	K	L	M
ISO1410	2.0	Ø13	Ø21	Ø80	Ø330	25.5	2.0
ISO7.505	2.0	Ø13	Ø21	Ø80	Ø250	17.5	2.0
ISTCX01110	3.0	Ø13	Ø21	Ø80	Ø330	24.4	3.0

* Standard reel quantity.

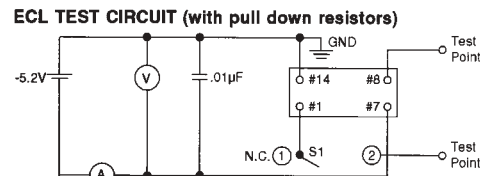
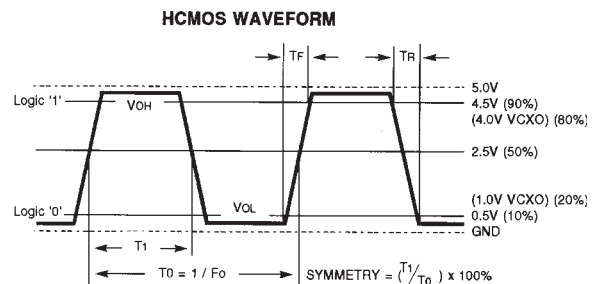
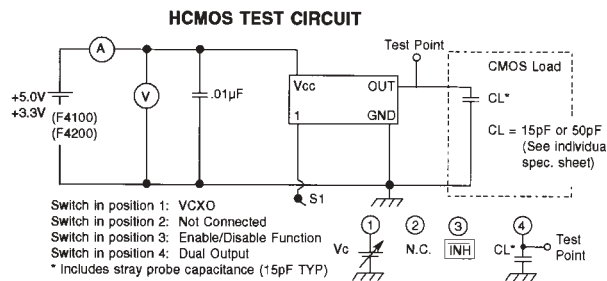
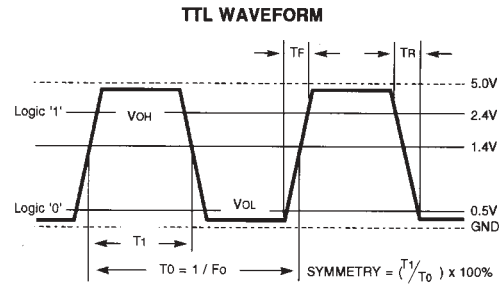
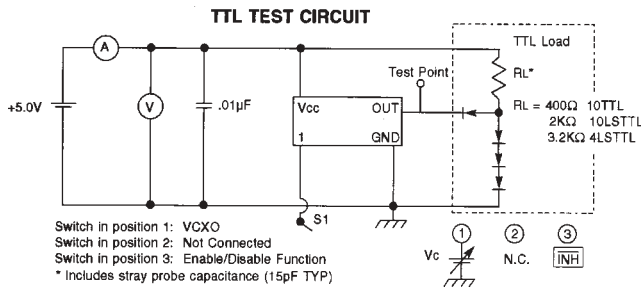
Inch dimensions shall govern.
All dimensions are in inches & parenthetically in millimeters.



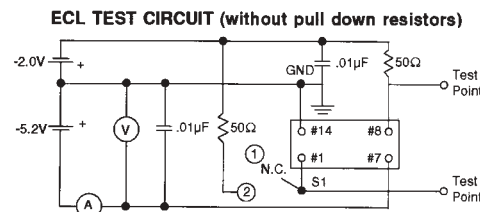
CLOCK OSCILLATOR GENERAL CHARACTERISTICS

ENVIRONMENTAL/MECHANICAL SPECIFICATIONS

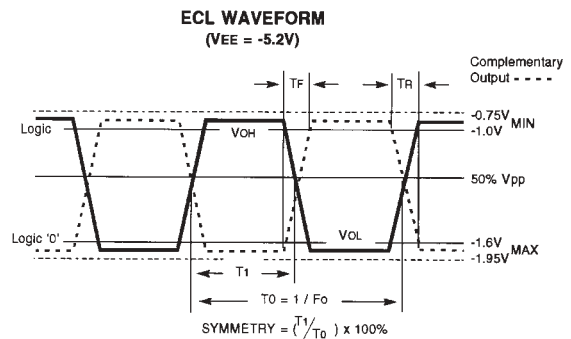
Gross Leak Test	All units 100% leak tested in Fluorinert FC-43.
Hermetically Sealed Package	Mass spectrometer leak rate less than 2×10^{-8} Atm. CC/sec. of helium.
Seal Strength	2.27 Kg max. force perpendicular to top and bottom.
Bend Test (Pin Material)	Will withstand maximum bend of 90°, referenced 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
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.
Shock Test	1000 G's, 0.35 ms, 1/2 sine wave, 3 shocks each plane
Vibration Test	10-55 Hz, 0.060" D. A., 55-2000 Hz, 20 G's, duration time 6 hours
Temperature Cycle	20 cycles from -55°C to +125°C, 1 hour per cycle, 25°C ref



S1 in Position 1: IE1100FRSNOC (IE1100FRSNOA except pin 7 is ground)
S1 in Position 2: IE1100FRSCOC (IE1100FRSCOA except pin 7 is ground)

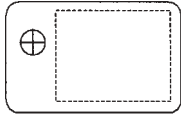


S1 in Position 1: IE1100FRSNOD (IE1100FRSNOB except pin 7 is ground)
S1 in Position 2: IE1100FRSCOD (IE1100FRSCOB except pin 7 is ground)

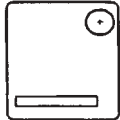
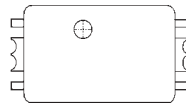


TEMPERATURE COMPENSATED CRYSTAL OSCILLATORS SELECTION GUIDE

THRU HOLE TCXOs

PRODUCT	ITCXO1912/IVCTCXO1912	
		
Frequency Range	9.600 ~ 20.000 MHz	
Frequency Stability	± 2.0 PPM -20°C ~ +70°C ± 2.5 PPM -30°C ~ +70°C	
Key Features	<ul style="list-style-type: none"> ✓ Tight Stability over Wide Temp. Range ✓ Adjustable Frequency ✓ Superior Quality 	
CATALOG PAGES		
	PAGE 38	

SURFACE MOUNT TCXOs

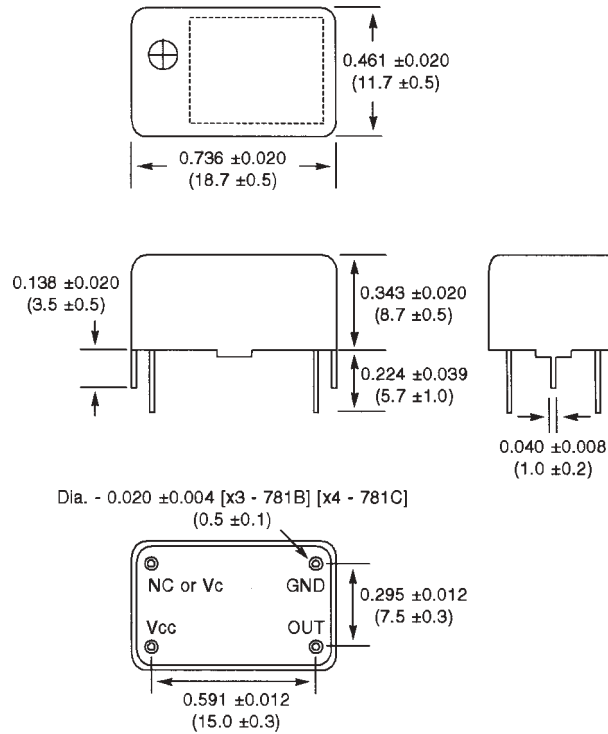
PRODUCT	ISTCXO1110	ISTCXO2112
		
Frequency Range	9.600 ~ 20.000 MHz	9.600 ~ 20.000 MHz
Frequency Stability	± 2.5 PPM -30°C ~ 75°C	± 2.5 PPM -30°C ~ 75°C
Key Features	<ul style="list-style-type: none"> ✓ SMD TCXO ✓ Low Profile ✓ Wide Temp. Range ✓ Opt. Voltage Control ✓ Opt. 3.0 V Supply Voltage 	<ul style="list-style-type: none"> ✓ SMD TCXO ✓ Wide Temp. Range ✓ Standard Footprint ✓ Opt. Voltage Control
CATALOG PAGES		
	PAGE 39	PAGE 40

FREQUENCY RANGE BY PRODUCT

PRODUCT	1 MHz	9MHz	20 MHz
<i>THRU HOLE</i>			
ITCXO1912/IVCTCXO1912			9.600 ~ 20.000MHz
<i>SURFACE MOUNT</i>			
ISTCXO1110			9.600 ~ 20.000MHz
ISTCXO2112			9.600 ~ 20.000MHz

TCXO THRU HOLE

ITCXO1912/IVCTCXO1912

Fully Supported
For New Designs

ELECTRICAL CHARACTERISTICS

PARAMETERS	CONDITIONS	MIN.	MAX.	UNITS
Frequency Range		9.600	20.000	MHz
Frequency Tolerance	Ta = 25°C	-0.5	+0.5	PPM
Frequency Stability	-20°C ~ +70°C -30°C ~ +75°C	-2.0 -2.5	+2.0 +2.5	PPM
Temperature Range (TOPR) (TSTG)	Operating Storage	-35 -55	+85 +125	°C
Supply Voltage (VDD)		4.7	5.3	V
Input Current (IDD)			2	mA
Output Waveform	(Clipped SineWave) Vp-p	1.0		V
Output Load			20 5	kΩ pF
Aging	Per Year @ 25°C	-1.0	+1.0	PPM
Frequency Stability vs Voltage Change	VDD = 5.0V±0.3V	-0.2	+0.2	PPM
Pullability (VCTCXO1912) Frequency Adjust Range	Vc = 2.5V ±2.0V Int. Trimmer	±4.0 (IVCTCXO1912) ±3.0		PPM PPM

Specifications available upon request.

* IVCTCXO1912- Voltage Control option.

All specifications subject to change without notice.

Inch dimensions shall govern.

All dimensions are in inches & parenthetically in millimeters.



TCXO SMD TEMPERATURE COMPENSATED CRYSTAL OSCILLATORS

ISTCXO1110/ISVCTCXO1110

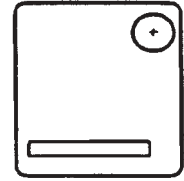
TCXO

FEATURES

- ✓ Tight Stability
- ✓ Miniature Size
- ✓ Wide Temperature Range
- ✓ 3V Supply Voltage - L Version

APPLICATIONS

- ✓ Communications Equipment
- ✓ Cellular Phones
- ✓ Cordless Phones
- ✓ Portable Instrumentation
- ✓ Aerospace



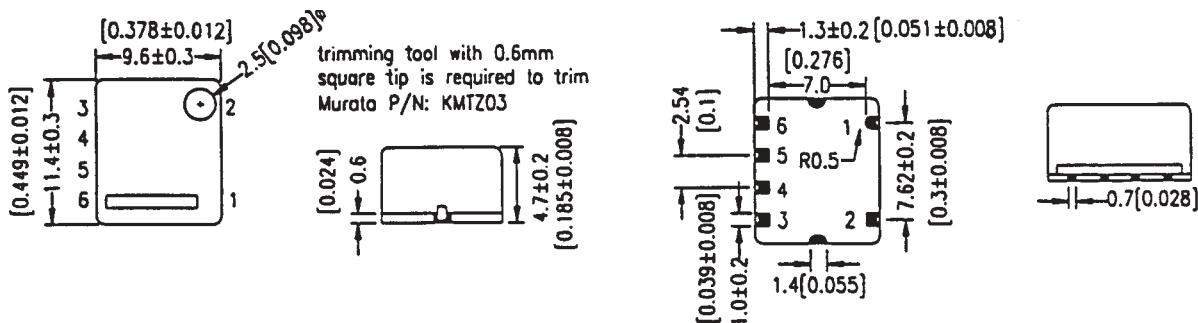
ELECTRICAL CHARACTERISTICS (Ta = 25°C, VDD = +5.0 V, CL = Max load)

PARAMETERS	MIN.	MAX.	UNITS
Frequency Range* (Fo) (9.60, 12.00, 12.80, 15.36, 19.20 STD)	9.600	20.000	MHz
Frequency Stability			
Over Temperature Range	-2.5	+2.5	PPM
Over Supply Voltage Change (VDD ±5%)	-0.3	+0.3	
Over Load Change 10 kΩ ±10%, 15 pF ±10%	-0.3	+0.3	
Temperature Range			
Operating Temperature (TOPR)	-30	+75	°C
Storage Temperature (TSTG)	-35	+80	
Supply Voltage (VDD)	+4.75	+5.25	V
Output Waveform (Clipped Sine)			
Peak-to-Peak Level (Vp-p)	1.0		V
Input Current (IDD)		2.0	mA
Output Load		10 15	kΩ pF
Frequency Adjustment (Internal Trimmer)	±3.0		PPM
Aging (per year at 25°C)	-1.0	+1.0	PPM
Voltage Control Option VCTCXO - Version (2.5 V ±2.0 V)	±4.0		PPM

* Other frequencies available. Consult ICM for your requirements.
All specifications subject to change without notice.

PIN CONNECTIONS

ISTCXO1110	
#1 GND	#4 GND
#2 GND	#5 N.C. or Vc
#3 OUTPUT	#6 VDD



Inch dimensions shall govern.

All dimensions are in inches & parenthetically in millimeters.

See page 36 for tape and reel specifications.



TCXO SMD TEMPERATURE COMPENSATED CRYSTAL OSCILLATORS

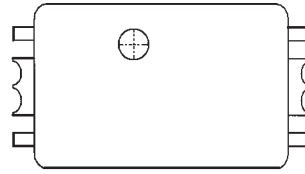
ISTCXO2112

FEATURES

- ✓ Miniature Size
- ✓ Surface Mount
- ✓ Wide Temperature Range
- ✓ Tight Stability
- ✓ Optional Voltage Control

APPLICATIONS

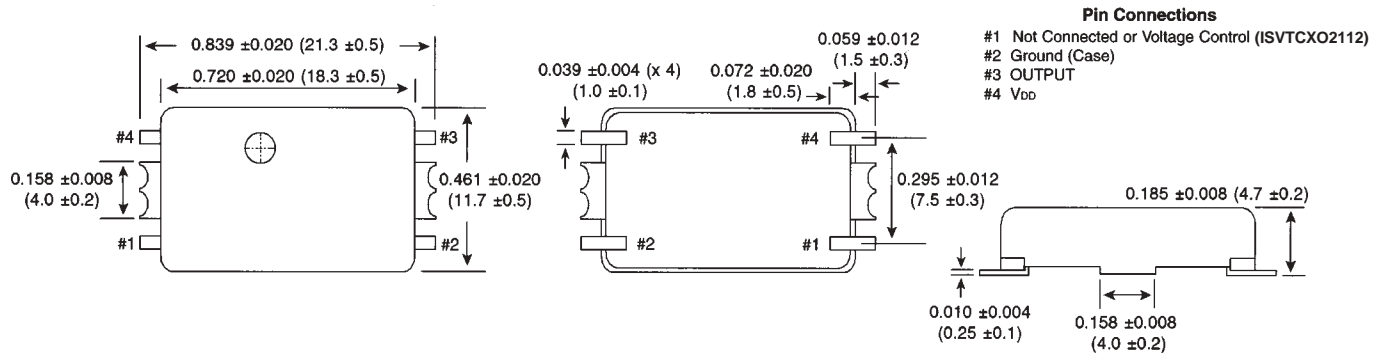
- ✓ Communications Equipment
- ✓ Cellular Phones
- ✓ Cordless Phones
- ✓ Aerospace
- ✓ Portable Instrumentation



ELECTRICAL CHARACTERISTICS (Ta = 25°C, VCC = +5.0 V, CL = 10 kΩ//10 pF)

PARAMETERS		MIN.	MAX.	UNITS
Frequency Range	(Fo)	9.600	20.000	MHz
Frequency Stability				PPM
Over -30°C to +75°C		-2.5	+2.5	
Over Supply Voltage Change (5.0 V ±0.3 V)		-0.3	+0.3	
Temperature Range				°C
Operating	(TOPR)	-30	+75	
Storage	(TSTG)	-35	+80	
Supply Voltage	(VDD)	+4.75	+5.25	V
Output Waveform	(Clipped Sine)			
Peak-to-Peak Level	(Vp-p)	1.0		V
Input Current	(IDD)		2.0	mA
Output Load			10	kΩ
			10	pF
Frequency Adjustment	(Internal Trimmer)	±3.0		PPM
Aging	(per year at 25°C)	-1.0	+1.0	PPM
Voltage Control Option	VCTCXO - (pin 1: 2.5 V ±2.0 V)	±5.0		PPM

All specifications subject to change without notice.



Inch dimensions shall govern.

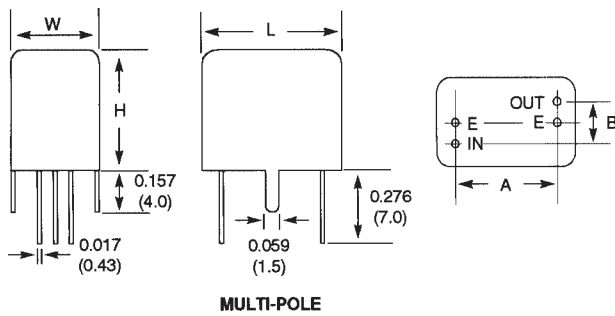
All dimensions are in inches & parenthetically in millimeters.



MONOLITHIC CRYSTAL FILTERS

ICM 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 ICM 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 ICM filters are available with center frequencies from 10.7 MHz to 90 MHz, and from two to eight poles.

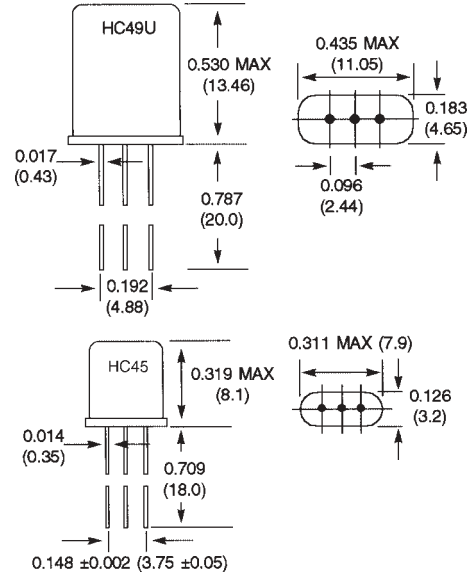


MULTI-POLE

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

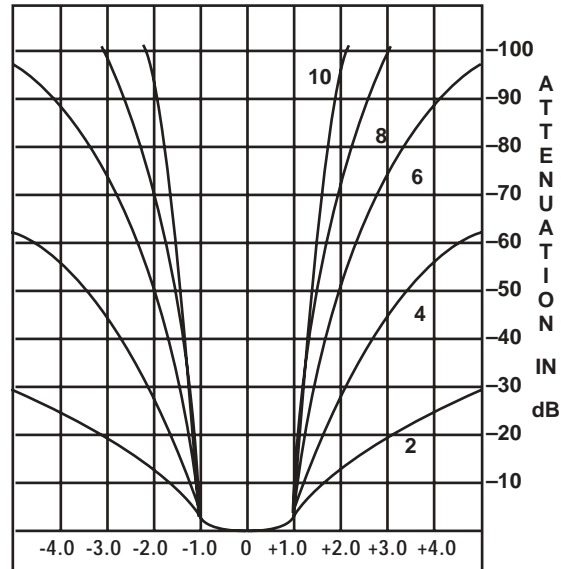
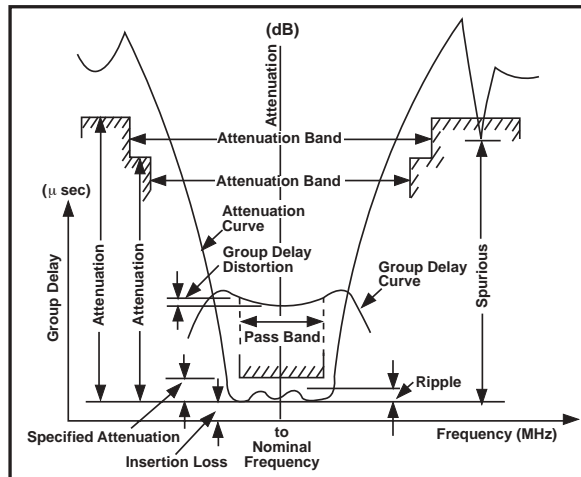
Note: 45F Series 45.000 MHz fundamental is a special filter designed for mobile radio and cellular phone applications.



TWO-POLE

MULTI-POLE PACKAGE DIMENSIONS

CASE TYPE	L	W	H	A	B
SF101	0.590 (15.0)	0.472 (12.0)	0.591 (15.0)	0.354 (9.0)	0.197 (5.0)
SF102	0.728 (18.5)	0.472 (12.0)	0.591 (15.0)	0.531 (13.5)	0.197 (5.0)
SF103	0.433 (11.0)	0.335 (8.5)	0.453 (11.5)	0.291 (7.4)	0.148 (3.75)
SF104	0.527 (13.4)	0.335 (8.5)	0.453 (11.5)	0.386 (9.8)	0.148 (3.75)



SHAPE FACTOR VS NUMBER OF POLES



CRYSTAL FILTERS

Monolithic Crystal Filters (MCF)

10.7MHz

Model No.	Nominal Frequency (MHz)	Pole	Pass Band		Attenuation Band		Ripple Max. (dB)	Loss Max. (dB)	Attenuation Guaranteed		Terminating Impedance (ohm/pF)	Operating Temperature (C)	Package Style
			(dB)	(kHz)	(dB)	(kHz)			(dB)	(Fo±kHz)			
✓ 12.5 kHz Channel Spacing													
10M7A	10.700	2	3	±3.75	20	±18.0	0.5	1.5	35/40	+300~+1000 -200~-1000	1.8K//6.0	-20~+70	HC-49/U
10M7B	10.700	4	3	±3.75	40	±14.0	1.0	2.5	50/70	+300~+1000 -200~-1000	1.8K//5.0	-20~+70	HC-49/Ux2
10M7C	10.700	6	3	±3.75	65	±12.5	2.0	3.5	65	±12.5~±300	1.8K//5.0	-20~+70	SF 101
10M7D	10.700	8	3	±3.75	90	±12.5	2.0	4.0	90	±12.5~±300	1.8K//5.0	-20~+70	SF 102

✓ 20 kHz Channel Spacing

10M12A	10.700	2	3	±6.0	20	±25.0	0.5	1.5	35/40	+300~+1000 -200~-1000	3.3K//1.5	-20~+70	HC-49/U
10M12B	10.700	4	3	±6.0	40	±20.0	1.0	2.5	50/70	+300~+1000 -200~-1000	3.3K//1.5	-20~+70	HC49/UX2
10M12C	10.700	6	3	±6.0	65	±20.0	2.0	3.0	65	±20.0~±300	3.3K//2.0	-20~+70	SF 101
10M12D	10.700	8	6	±6.0	90	±20.0	2.0	3.5	90	±20.0~±300	3.3K//2.0	-20~+70	SF 102

✓ 25 kHz Channel Spacing

10M15A	10.700	2	3	±7.5	18	+25.0	0.5	1.5	35/40	+300~+1000 -200~-1000	3.0K//2.0	-20~+70	HC-49/U
10M15B	10.700	4	3	±7.5	40	+25.0	1.0	2.5	50/70	+300~+1000 -200~-1000	3.0K//2.0	-20~+70	HC-49/Ux2
10M15C	10.700	6	3	±7.5	65	±25.0	2.0	3.0	65	±25.0~±300	3.3K//1.5	-20~+70	SF 101
10M15D	10.700	8	6	±7.5	90	+25.0	2.0	3.5	90	±25.0~±300	3.3K//1.5	-20~+70	SF 102

✓ 50 kHz Channel Spacing

10M30A	10.700	2	3	±15.0	15	±50.0	0.5	1.5	30/35	+300~+1000 -200~-1000	5.0K//0	-20~+70	HC-49/U
10M30B	10.700	4	3	±15.0	30	±40.0	1.0	2.5	65/80	+300~+1000 -200~-1000	5.0K//-1.0	-20~+70	HC-49/Ux2
10M30C	10.700	6	3	±15.0	60	±45.0	2.0	2.5	60	±45.0~±300	5.0K//-1.0	-20~+70	SF 101
10M30D	10.700	8	6	±15.0	80	±40.0	2.0	3.0	80	±40.0~±300	5.0K//-1.0	-20~+70	SF 102

21.4 MHz

Model No.	Nominal Frequency (MHz)	Pole	Pass Band		Attenuation Band		Ripple Max. (dB)	Loss Max. (dB)	Attenuation Guaranteed		Terminal Impedance (ohm/pF)	Operating Temperature (C)	Package Style
			(dB)	(kHz)	(dB)	(kHz)			(dB)	(Fo±kHz)			

✓ 12.5 kHz Channel Spacing

21M7A	21.400	2	3	±3.75	20	±18.0	0.5	1.5	35/50	+350~+1000 -200~-1000	850//6.0	-20~+70	HC-45
21M7B	21.400	4	3	±3.75	40	±14.0	1.0	2.5	65/80	+350~+1000 -200~-1000	850//5.0	-20~+70	HC-45x2
21M7C	21.400	6	3	±3.75	65	±12.5	2.0	3.0	65	±12.5~±300	850//5.0	-20~+70	SF 103
21M7D	21.400	8	3	±3.75	90	±12.5	2.0	4.0	90	±12.5~±300	850//5.0	-20~+70	SF 104

✓ 20 kHz Channel Spacing

21M12A	21.400	2	3	±6.0	20	±25.0	0.5	1.5	35/50	+350~+1000 -200~-1000	1.2K//3.0	-20~+70	HC-45
21M12B	21.400	4	3	±6.0	40	±20.0	1.0	2.5	65/80	+350~+1000 -200~-1000	1.2K//2.5	-20~+70	HC-45x2
21M12C	21.400	6	3	±6.0	65	±20.0	2.0	3.5	65	±20.0~±300	1.2K//2.5	-20~+70	SF 103
21M12D	21.400	8	3	±6.0	90	±20.0	2.0	3.0	90	±20.0~±300	1.2K//2.5	-20~+70	SF104

✓ 25 kHz Channel Spacing

21M15A	21.400	2	3	±7.5	18	+25.0	0.5	1.5	35/50	+350~+1000 -200~-1000	1.5K//2.0	-20~+70	HC-45
21M15B	21.400	4	3	±7.5	40	+25.0	1.0	2.5	65/80	+350~+1000 -200~-1000	1.5K//2.0	-20~+70	HC-45x2
21M15C	21.400	6	3	±7.5	65	±25.0	2.0	2.5	65	±25.0~±300	1.5K//2.0	-20~+70	SF 103
21M15D	21.400	8	3	±7.5	90	+25.0	2.0	3.5	90	±25.0~±300	1.5K//2.0	-20~+70	SF 104

✓ 50 kHz Channel Spacing

21M30A	21.400	2	3	±15.0	15	±45.0	0.5	1.5	35/40	+350~+1000 -300~-1000	3.0K//0.5	-20~+70	HC 45
21M30B	21.400	4	3	±15.0	40	±50.0	1.0	2.5	65/80	+350~+1000 -300~-1000	3.0K//-0.5	-20~+70	HC-45x2
21M30C	21.400	6	3	±15.0	65	±50.0	2.0	2.5	65	±50.0~±300	2.2K//0.5	-20~+70	SF 103
21M30D	21.400	8	3	±15.0	80	±50.0	2.0	3.0	80	±50.0~±300	2.2K//0.5	-20~+70	SF 104



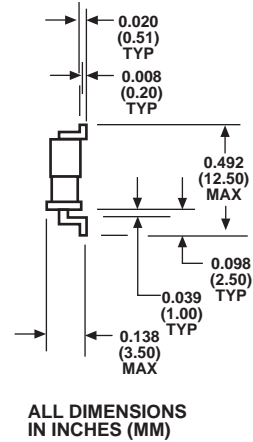
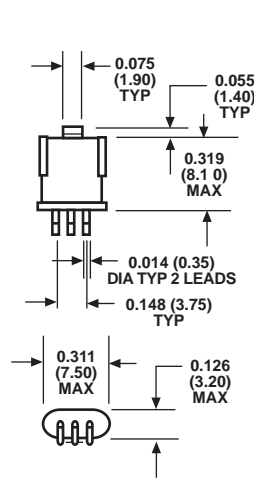
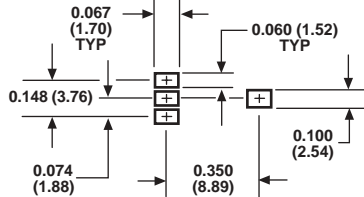
HIGH FREQUENCY SERIES

Model No.	Nominal Frequency (MHz)	Pole	Pass Band		Attenuation Band		Ripple Max. (dB)	Loss Max. (dB)	Attenuation Guaranteed		Terminating Impedance (ohm//pF)	Operating Temperature (C)	Package Style
			(dB)	(kHz)	(dB)	(kHz)			(dB)	(Fo \pm kHz)			
✓ Fundamental Tone													
45MF7A	45.000	2	3	± 3.75	10	± 12.5	1.0	2.5	65	± 910	300//10.0	-20~+70	HC-45
45MF7B	45.000	4	3	± 3.75	30	± 12.5	1.0	4.0	90	± 910	300// 8.0	-20~+70	HC-45x2
45MF15A	45.000	2	3	± 7.5	15	± 25.0	1.0	2.0	35 40	$\frac{+500-+1000}{-200-1000}$	650// 4.5	-20~+70	HC-45
45MF15B	45.000	4	3	± 7.5	30	± 25.0	1.0	3.0	70	$\frac{+500-+1000}{-200-1000}$	650// 1.5	-20~+70	HC-45x2
45MF20A	45.000	2	3	± 10.0	15	± 34.0	1.0	2.0	35 40	$\frac{+500-+1000}{-200-1000}$	700// 2.5	-20~+70	HC-45
45MF20B	45.000	4	3	± 10.0	40	± 48.0	1.0	3.0	70	$\frac{+500-+1000}{-200-1000}$	700// 1.5	-20~+70	HC-45x2
45MF30A	45.000	2	3	± 15.0	15	± 50.0	1.0	2.0	35	$\frac{+500-+1000}{-300-1000}$	800// 1.5	-20~+70	HC-45
45MF30B	45.000	4	3	± 15.0	40	± 60.0	1.0	3.0	70	$\frac{+500-+1000}{-300-1000}$	800// 1.0	-20~+70	HC-45x2
✓ 3rd Overtone													
45M7A	45.000	2	3	± 3.75	10	± 12.5	1.0	2.5	35	± 910	2.5K// -0.5	-20~+70	HC-45
45M7B	45.000	4	3	± 3.75	30	± 12.5	1.0	4.0	75	± 910	2.5K// -0.5	-20~+70	HC-45x2
45M15A	45.000	2	3	± 7.5	18	± 28.0	1.0	2.0	35	$\frac{+500-+1000}{-200-1000}$	4K// -1.0	-20~+70	HC-45
45M15B	45.000	4	3	± 7.5	40	± 30.0	1.0	3.0	70	$\frac{+500-+1000}{-200-1000}$	4K// -1.0	-20~+70	HC-45x2
45M20A	45.000	2	3	± 10.0	15	± 30.0	1.0	2.0	35	$\frac{+500-+1000}{-200-1000}$	5K// -1.0	-20~+70	HC-45
45M20B	45.000	4	3	± 10.0	35	± 40.0	1.0	3.0	70	$\frac{+500-+1000}{-200-1000}$	5K// -1.0	-20~+70	HC-45x2
45M30A	45.000	2	3	± 15.0	15	± 50.0	1.0	2.0	30	$\frac{+500-+1000}{-300-1000}$	8K// -1.0	-20~+70	HC-45
45M30B	45.000	4	3	± 15.0	30	± 50.0	1.0	3.0	70	$\frac{+500-+1000}{-300-1000}$	8K// -1.0	-20~+70	HC-45x2
70M15A	70.000	2	3	± 7.5	15	± 30.0	1.0	2.0	35	$\frac{+500-+1000}{-200-1000}$	2.0K// -1.0	-20~+70	HC-45
70M15B	70.000	4	3	± 7.5	25	± 25.0	1.0	3.0	70	$\frac{+500-+1000}{-200-1000}$	2.0K// -1.0	-20~+70	HC-45x2
70M20A	70.000	2	3	± 10.0	15	± 40.0	1.0	2.0	35	$\frac{+500-+1000}{-200-1000}$	2.5K// -1.0	-20~+70	HC-45
70M20B	70.000	4	3	± 10.0	35	± 40.0	1.0	3.0	70	$\frac{+500-+1000}{-200-1000}$	2.5K// -1.0	-20~+70	HC-45x2
90M15A	90.000	2	3	± 7.5	15	± 30.0	1.0	2.0	35	$\frac{+500-+1000}{-200-1000}$	1.4K// 0	-35~+70	HC-45
90M15B	90.000	4	3	± 7.5	25	± 25.0	1.0	3.5	70	$\frac{+500-+1000}{-200-1000}$	1.4K// 0	-35~+70	HC-45x2
90M20A	90.000	2	3	± 10.0	15	± 40.0	1.0	2.0	35	$\frac{+500-+1000}{-200-1000}$	1.5K// -1.0	-35~+70	HC-45
90M20B	90.000	4	3	± 10.0	35	± 40.0	1.0	3.0	70	$\frac{+500-+1000}{-200-1000}$	1.5K// -1.0	-35~+70	HC-45x2
90M30A	90.000	2	3	± 15.0	15	± 50.0	1.0	2.0	35	$\frac{+500-+1000}{-300-1000}$	4K// -1.0	-35~+70	HC-45
90M30B	90.000	4	3	± 15.0	25	± 50.0	1.0	3.0	70	$\frac{+500-+1000}{-300-1000}$	4K// -1.0	-35~+70	HC-45x2

SURFACE MOUNT PACKAGES

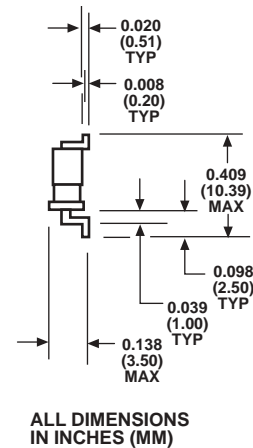
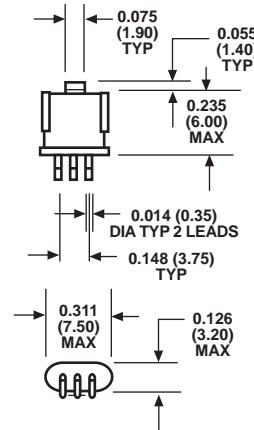
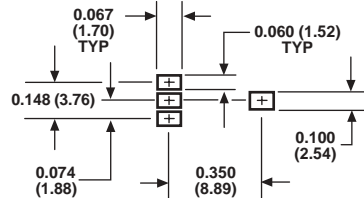
UM-1 Surface Mount Option

SUGGESTED SOLDER PAD LAYOUT



UM-5 Surface Mount Option

SUGGESTED SOLDER PAD LAYOUT



CRYSTAL DATA

Typical Crystal Design

Before beginning a design or purchase of a crystal there are system parameters which must be considered. Below are questions which need to be determined by your system. These parameters will determine the crystal specifications.

1. On what crystal frequency do you wish to operate?
2. How much can the frequency be off at room temperature (+25C)?
3. What is the temperature range over which the crystal will operate?
4. How much can the crystal change frequency over the temperature range?
5. Is the crystal to be operated at Series or Parallel resonant?
6. If operated at parallel. What is the parallel capacitance in picofarads (pF)?
7. Is pullability important?
8. What holder type or can size do you require?

The Quartz Crystal

The quartz crystal may be represented by the L, C, R circuit (Below).

CO is the capacitance formed by the crystal electrodes plus any holder capacitance. The LI, CI, RI branch is called the "motional arm". The motional capacitance, CI, controls the "pullability" of the crystal. The shift of a crystal can be calculated by the following formula...

$$\text{PPm fr Series} = \frac{C1}{2 * (C0+CL)}$$

Knowing two different loads on the crystal, we can look at the differences between each shift from series to calculate total trim range.

Example: given a 0.020 pF CI and a CO of 4.26 pF the shift from series of a 20 pF load is 412.2 ppm and the shift of a 27 pF load is 319.9 ppm. This gives us a tune range of 92.3 ppm between 20 pF and 27 pF loads.

CI and RI can be specified on any crystal. Typical values of RI are 10 to 25 ohms on the fundamental mode and higher on overtones. Typical motional capacitance values are between 0.016 pF and 0.034 pF for a fundamental crystal. Motional capacitance is divided by the overtone squared. Static capacitance (CO) is about 213 times CI on the fundamental mode.

Frequency

The quartz crystal can be made on frequencies between 70 kHz and 200 MHz. The quartz crystal is designed to operate on its fundamental frequency or one of its overtones. The overtones are related to the fundamental frequency and

occur at odd harmonic intervals. (1, 3, 5, 7, etc.) This becomes important between the 15 MHz to 30 MHz Range. Crystals in that frequency range can be made as either a fundamental or 3rd overtone. Fundamental mode crystals at these frequencies become very expensive as the quartz blank is extremely thin and difficult to handle, and therefore causing a higher rate of breakage in processing. If you specify an overtone mode instead of the fundamental, the cost savings may be significant.

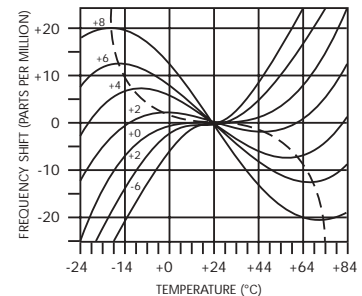
Calibration

Crystals are the key components in an oscillator circuit and they are affected by ambient conditions, particularly the temperature.

The most common calibration specification is ± 10 ppm or $\pm 0.001\%$ at +25°C and your specific load, it is also the least expensive.

Temperature Calibration

The chart to the right shows the change in frequency with respect to temperature. The various curves are dependent on the angle at which the quartz is cut from the original crystal. The angle of cut is controlled by x-ray diffraction techniques. The curves in this chart show that as the tolerance becomes tighter. The operation temperature range is reduced.

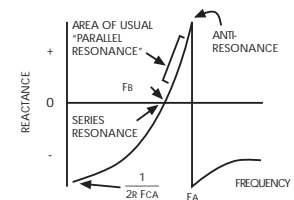


Crystal Load Series Resonance

When a crystal is operating at series resonance (fs), it looks resistive in the circuit. Thus, its impedance at fs is near zero. In a well designed series resonant circuit, correlation is not a problem and load capacitance does not have to be specified.

Parallel Resonance (antiresonance)

The crystal's impedance values will have the effect of pulling the frequency of the crystal. If the crystal is to be used at parallel resonance, the load capacity (in picofarads) should always be specified. Load capacity is the dynamic capacity of the total circuit measured or computed across the crystal terminals. It is selected to operate the crystal at a stable point on fs-fa reactance curve (10pf to close to fs). For more information on computing the load capacity of a circuit see our Oscillator Data sheet.



CRYSTAL OSCILLATOR DATA

Typical Crystal Oscillator Design

An oscillator is an amplifier with a feedback loop from output to input. Barkhausen criteria states that for oscillation to occur the product of the gains around a loop must be equal to or greater than unity and that the sum of the phase shifts around the loop must be a multiple of 360°.

Before beginning a design or purchase of an oscillator there are system parameters which the oscillator will need to conform to. Below are questions which need to be determined by your system. These parameters will determine the type of oscillator you will require (TCXO, TCVCXO, VCXO, Clock, Ovenized).

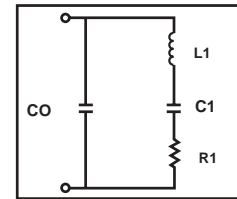
- 1) What frequency do you wish to operate on?
- 2) How much can the frequency vary in your system?
- 3) What is the temperature range the oscillator will operate in?
- 4) What power is available to operate the oscillator?
 - a) What is the voltage level and its tolerance?
 - b) How much current can the oscillator consume?
- 5) How large can this oscillator be physically?
- 6) What output wave shape is required in your system?
(TTL, CMOS, ECL, Sine Wave)
 - a) Sinewave level and harmonic levels required
- 7) What type of load will the output of the oscillator experience?
(ex. 50 ohms)
- 8) How closely does the oscillator need to be set to frequency?
- 9) Do you need a trimmer to compensate for aging or crystal differences?
- 10) How much can the oscillator shift frequency over time?
- 11) Does your system require control of the frequency by a voltage?
 - a) What is the direction of frequency vs. voltage?
 - b) Is the control AC or DC (modulation or PLL)?
 - c) What is the voltage control range?
 - d) What is the minimum and maximum frequency change required
 - e) Do you need the frequency change vs. the voltage change to be linear?

The Quartz Crystal

The quartz crystal may be represented by the L,C,R circuit (Upper Right).

CO is the capacitance formed by the crystal electrodes plus any holder capacitance. The LI, CI,

RI branch is called the "motional arm". The motional capacitance, CI, controls the "pullability" of the crystal. The shift of a crystal can be calculated by the following formula....



$$\text{PPm fr Series} = \frac{C1}{2 * (C0 + C1)}$$

Knowing two different loads on the crystal, we can look at the differences between each shift from series to calculate the total trim range.

C1 and R1 can be specified on any crystal. Typical values of R1 are 10 to 25 ohms on the fundamental mode and higher on overtones. Typical motional capacitance values are between 0.018 pf and 0.024 pf for a fundamental crystal. Motional capacitance is divided by the overtone squared. Static capacitance (CO) is about 213 times C1 on the fundamental mode.

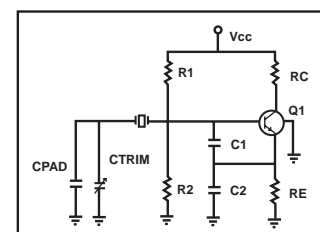
L1 can be calculated knowing the series frequency of the crystal.

Example: given a 0.020 pf C1 and a C0 of 4.26pf the shift from series of a 20pf load is 412.2 ppm and the shift of a 27pf load is 319.9 ppm. This gives us a tune range of 92.3ppm between 20 pf and 27 pf loads.

Fundamental Oscillators

MODIFIED COLPITTS OSCILLATOR

The oscillating loop C1, C2 in parallel with RE, Ctrim in parallel with Cpad and the crystal can be isolated from load effects in the colpitts oscillator by keeping RC≪RE. The output waveform at the collector is highly distorted due to the self limiting of the oscillator drawing pulses of collector current. The trimmer in this design has only a second order effect on loop gain. The loop gain in this circuit is controlled by the gain of the transistor and the reactance and ratio of C1 and C2. To begin with the reactance of C2 should be -j75 ohms and the reactance of C1 should be slightly larger.

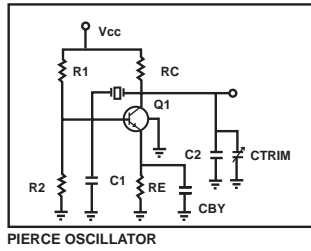


MODIFIED COLPITTS OSCILLATOR

$$\text{Crystal load capacity} = \frac{1}{\frac{1}{C1} + \frac{1}{C2} + \frac{1}{(Cpad + Ctrim)}}$$

PIERCE OSCILLATOR

The oscillating loop C1 in parallel with R2, Ctrim in parallel with C2 & Rc and the crystal is directly tied to the load causing poor load stability. The trimmer is across one of the feedback capacitors and directly effects loop gain. The output waveform at the collector is relatively sinusoidal.



PIERCE OSCILLATOR

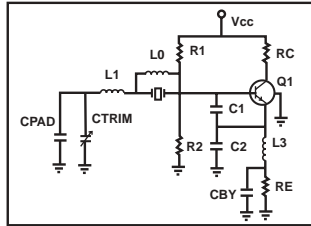
$$\text{Crystal load capacity} = \frac{1}{\frac{1}{C1} + \frac{1}{(Cpad + Ctrim)}}$$

Overtone Oscillators

C1 (C2 + Ctrim)

OVERTONE COLPITTS OSCILLATOR

The design considerations are the same as the modified colpitts oscillator. Tune C2 and L3 to the frequency directly between the desired overtone and the overtone just below. Choose values of C2 and L3 such that X_{C2} in parallel with $X_{L3} = -j75$ ohms. The static capacitance of the crystal can be canceled by placing an inductor across the crystal, from the crystal to ground or from the crystal to the emitter of the transistor. This will increase the drive on the crystal. Cby is used to increase the Q of the trap.



OVERTONE COLPITTS

$$\text{Load} = \frac{1}{W * (X_{Cpad+Ctrim} + X_{L1} + X_{C1} + \frac{1}{\frac{1}{X_{L3}} + \frac{1}{X_{C2}}})}$$

$$W = 2\pi F$$

OVERTONE PIERCE

L1//C2 form a trap in the same manner as C2//L3 in the colpitts oscillator. Choose L1 and C2 in the manner outlined in the "Overtone Colpitts" design. As in the colpitts design an inductor can be added to tone out the effect of the crystal's static capacitance (C0).

$$\text{Load} = \frac{1}{W * (X_{C1} + \frac{1}{\frac{1}{X_{Cpad+Ctrim}} + \frac{1}{X_{L1}}})}$$

Nth Overtone Oscillators

GROUNDING BASE CONFIGURATIONS

These oscillators may be tuned initially by placing an AC short across the crystal and tuning Ctrim. These are basically amplifiers with a tapped capacitor resonant circuit in the collector. The tapped capacitor should match the impedances of the input and output. In the "Grounded Base Butler" Oscillator the loop gain may be increased by shunting Re.

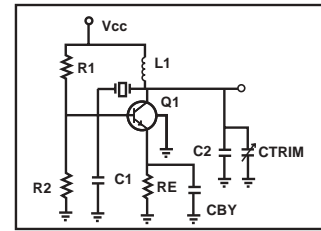
Crystal Load Capacity = Series

TWO TRANSISTOR BUTLER

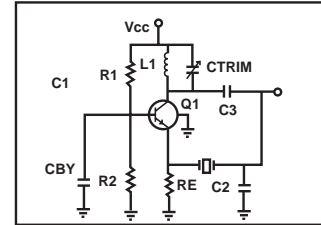
The butler oscillator has the ability of high frequency good load stability and output amplitude gain.

This circuit is commonly used in wide pull VCXOs and TCVCXOs.

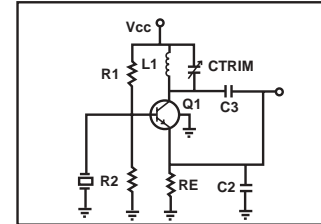
Crystal Load Capacity = Series



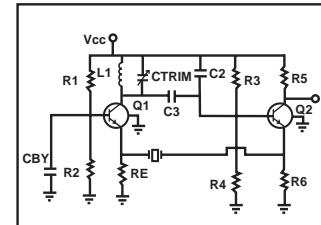
OVERTONE PIERCE



GROUNDING BASE BUTLER OSCILLATOR

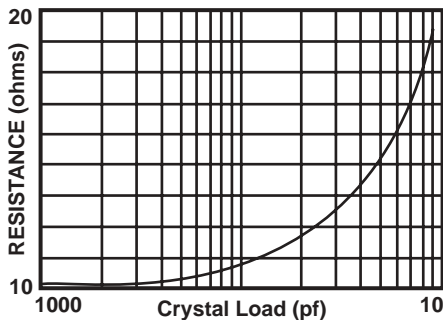


GROUNDING BASE OSCILLATOR



TWO TRANSISTOR BUTLER OSCILLATOR

NOTE: Crystal loads should be kept between series and 10 pf. The lighter the load the higher the apparent series resistance. Tolerances at lighter loads cause more variations in crystal calibration tolerance.



NOTES

