

Softrock Lite II 02_Local Oscillator

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Local Oscillator Introduction

Theory of Operation

The Local Oscillator stage implements a basic Colpitts Crystal Oscillator with a buffer stage to increase the signal level. The oscillator produces a signal that is at the crystal's specified fundamental frequency.

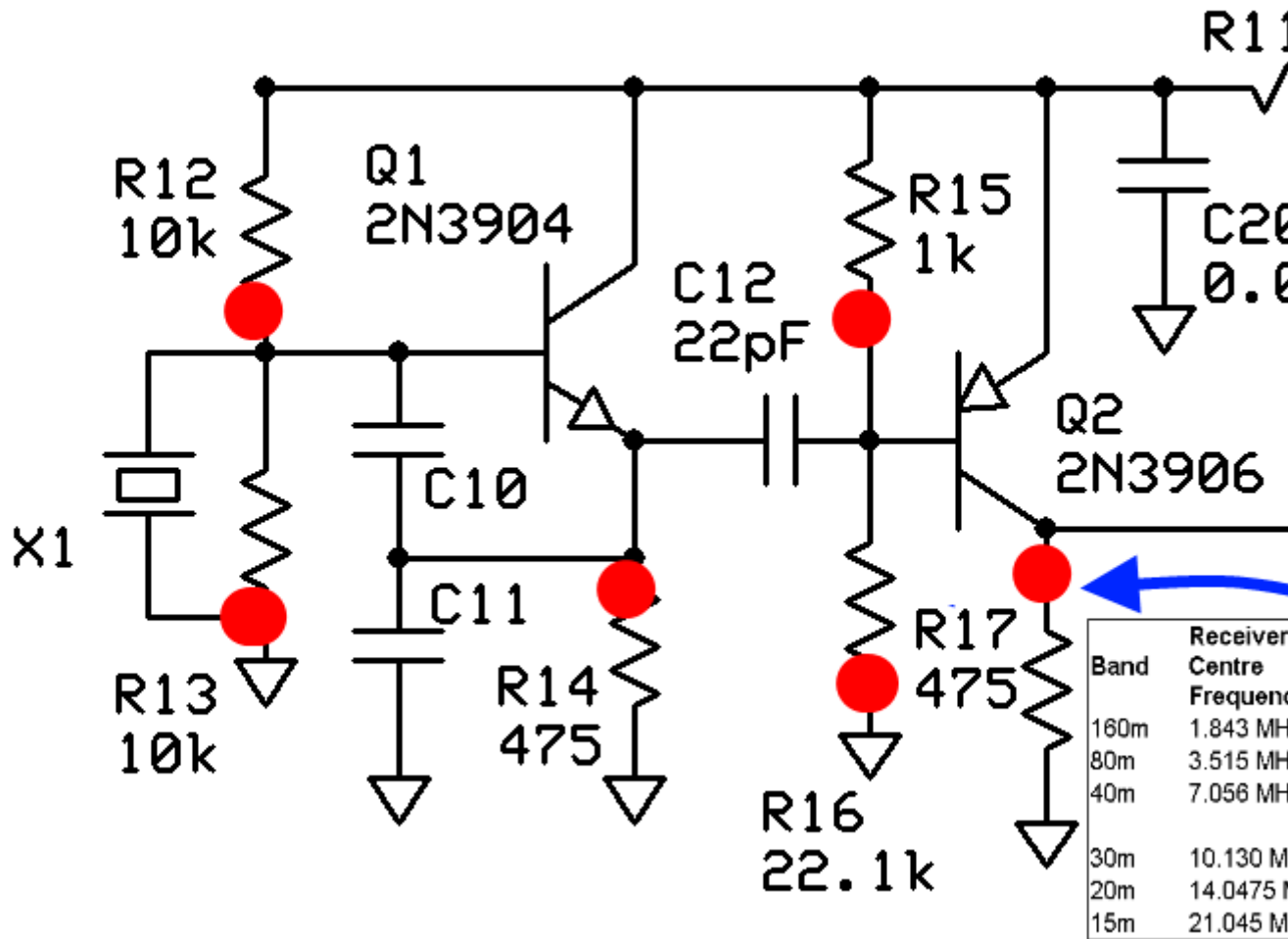
See the table in the lower right-hand corner of the schematic below for the frequencies produced by this stage, for the appropriate band/kit.

In reality, for each frequency the crystal circuit will oscillate at a slightly lower frequency (~ - 1 kHz), due to the capacitive divider (C10/C11) pulling the crystal down somewhat. The effect is more pronounced for the higher bands.

Local Oscillator Schematic

(Resistor testpoints (hairpin, top, or left-hand lead), as physically installed on the board, are marked in the schematic with red dots)

(Click for Full Schematic)


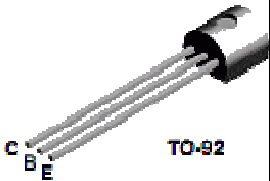
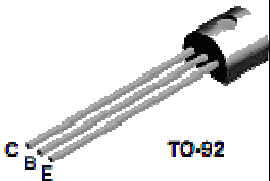









(above schematic has clickable areas that can be used for navigation)

Local Oscillator Bill of Materials

Detailed Bill of Materials

Check	Designation	Component	Marking	Category	Orientation	Notes	Circuit
<input type="checkbox"/>	C10	band-specific		misc			Local Oscillator
<input type="checkbox"/>	C11	band-specific		misc		Not used at all for 40m & 15m	Local Oscillator

						versions	
<input type="checkbox"/>	C12	22 pF 5%	22J	Ceramic			Local Oscillator
<input type="checkbox"/>	C20	0.01 uF		SMT 1206			Local Oscillator
<input type="checkbox"/>	Q1	2N3904 NPN Transistor	2N3904 	TO-92			Local Oscillator
<input type="checkbox"/>	Q2	2N3906 PNP transistor	2N3906 	TO-92			Local Oscillator
<input type="checkbox"/>	R11	10 ohm 1/4W 1%	br-blk-blk-gld-br 	1/4W	W-E		Local Oscillator
<input type="checkbox"/>	R12	10 k 1/4W 1%	br-blk-blk-r-br 	1/4W	E-W		Local Oscillator
<input type="checkbox"/>	R13	10 k 1/4W 1%	br-blk-blk-r-br 	1/4W	E-W		Local Oscillator
<input type="checkbox"/>	R14	475 1/4W 1%	y-v-grn-bl-br 	1/4W	E-W		Local Oscillator
<input type="checkbox"/>	R15	1 k 1/4W 1%	br-blk-blk-br-br 	1/4W	N-S		Local Oscillator
<input type="checkbox"/>	R16	22.1k 1/4W 1%	r-r-brn-r-br 	1/4W	N-S		Local Oscillator
<input type="checkbox"/>	R17	475 1/4W 1%	y-v-grn-bl-br 	1/4W	E-W		Local Oscillator
<input type="checkbox"/>	X1	band-specific		misc			Local Oscillator

Band Specific Items for 160m Band

Check	Designation	Component	Marking	Category	Orientation	Notes	Circuit
<input type="checkbox"/>	C10	330 pF 5%	331	Ceramic			Local Oscillator
<input type="checkbox"/>	C11	180 pF 5%	181	Ceramic		Not used at all for 40m & 15m versions	Local Oscillator
<input type="checkbox"/>	X1	7.3728 MHz		Xtal			Local Oscillator

Band Specific Items for 80m Band

Check	Designation	Component	Marking	Category	Orientation	Notes	Circuit
<input type="checkbox"/>	C10	180 pF 5%	181	Ceramic			Local Oscillator
<input type="checkbox"/>	C11	100 pF 5%	101	Ceramic		Not used at all for 40m & 15m versions	Local Oscillator
<input type="checkbox"/>	X1	14.06 MHz		Xtal			Local Oscillator

Band Specific Items for 40m Band

Check	Designation	Component	Marking	Category	Orientation	Notes	Circuit
<input type="checkbox"/>	C10	100 pF 5%	101	Ceramic			Local Oscillator
<input type="checkbox"/>	C11	unused capacitor		unused		Not used at all for 40m & 15m versions	Local Oscillator
<input type="checkbox"/>	X1	28.224 MHz Crystal	28.224 or 28.2C69	Xtal			Local Oscillator

Band Specific Items for 30m Band

Check	Designation	Component	Marking	Category	Orientation	Notes	Circuit
<input type="checkbox"/>	C10	180 pF 5%	181	Ceramic			Local Oscillator
<input type="checkbox"/>	C11	100 pF 5%	101	Ceramic		Not used at all for 40m & 15m versions	Local Oscillator
<input type="checkbox"/>	X1	13.5 MHz		Xtal			Local Oscillator

Band Specific Items for 20m Band

Check	Designation	Component	Marking	Category	Orientation	Notes	Circuit
<input type="checkbox"/>	C10	180 pF 5%	181	Ceramic			Local Oscillator
<input type="checkbox"/>	C11	100 pF 5%	101	Ceramic		Not used at all for 40m & 15m versions	Local Oscillator
<input type="checkbox"/>	X1	18.73 MHz	18.730 1108	Xtal			Local Oscillator

Band Specific Items for 15m Band

Check	Designation	Component	Marking	Category	Orientation	Notes	Circuit
<input type="checkbox"/>	C10	100 pF 5%	101	Ceramic			Local Oscillator
<input type="checkbox"/>	C11	unused capacitor		unused		Not used at all for 40m & 15m versions	Local Oscillator
<input type="checkbox"/>	X1	28.06 MHz		Xtal			Local Oscillator

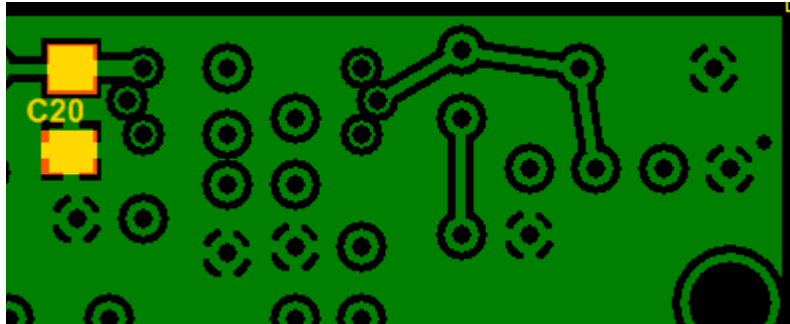
Local Oscillator Summary Build Notes

- Install SMT cap
- Install Crystal

- Install Ceramic Capacitors
- Install transistors
- Install Resistors
- [Test the Stage](#)

Local Oscillator Detailed Build Notes

Bottom of the Board

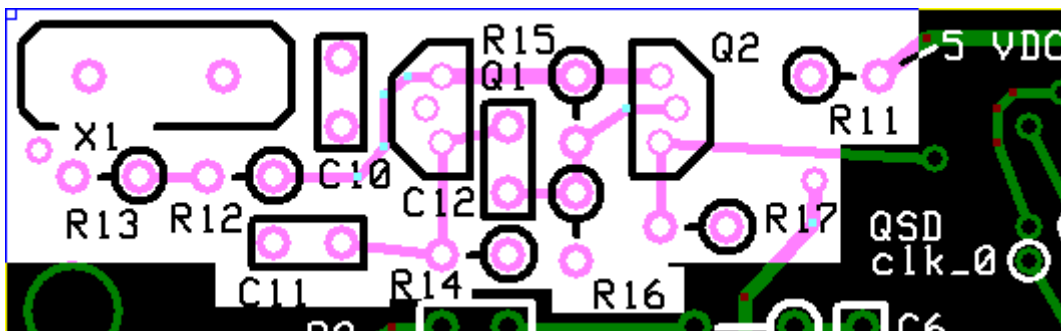


Install SMT cap

See [hints on installing SMT Caps.](#)

Check	Designation	Component	Marking	Category	Orientation	Notes
<input type="checkbox"/>	C20	0.01 uF		SMT 1206		

Top of the Board



Install Crystal

See [Band-specific Components chart](#) for value.

Mount the HC49 crystal mounting in the upper left corner of the board, mounting it vertically to the board. A small plated-through hole in the lower left corner of the crystal mounting position provides a place for a grounding wire to be soldered to the metal crystal case. The grounding wire also provides additional mechanical support for the crystal.

Make sure the crystal is mounted slightly above the board. You can use a piece of cardboard or wire insulation between the bottom of the crystal and the board to get the desired standoff distance while mounting X1.

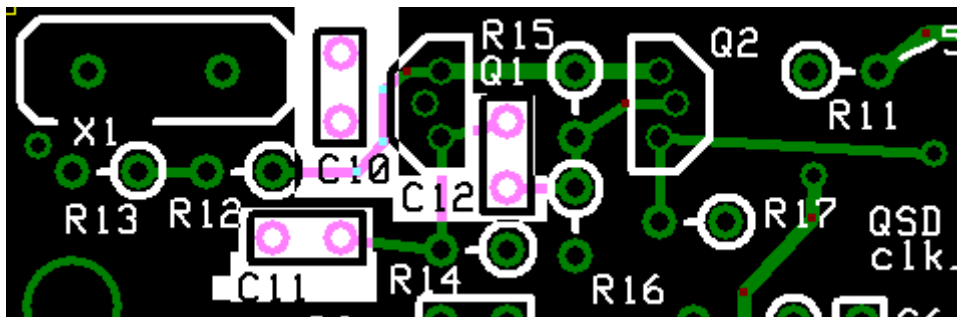


Check	Designation	Component	Marking	Category	Orientation	Notes
<input type="checkbox"/>	X1	band-specific		misc		

Install Ceramic Capacitors

See [Band-specific Capacitors chart](#) for value.

See [hints on identifying and installing Ceramic Capacitors](#).



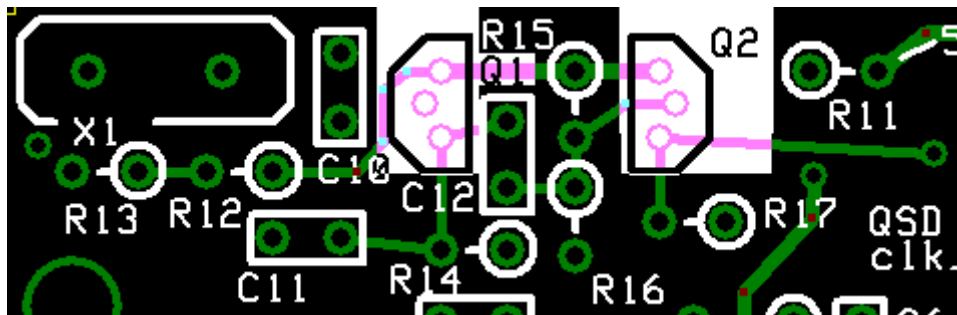
Check	Designation	Component	Marking	Category	Orientation	Notes
<input type="checkbox"/>	C12	22 pF 5%	22J	Ceramic		
<input type="checkbox"/>	C10	band-specific		misc		
<input type="checkbox"/>	C11	band-specific		misc		Not used at all for 40m &

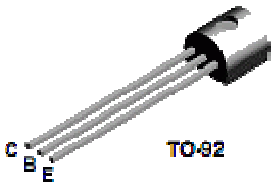
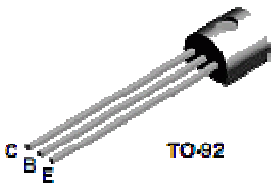
						15m versions
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Install transistors

Mount the two transistors being careful to orient them according to the pattern in the silkscreen.

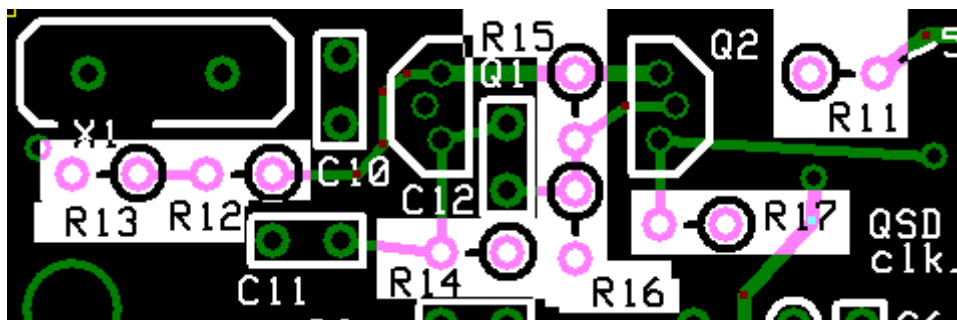
Take care not to get 2N3904 and 2N3906 mixed up. Carefully check the last digit.










Check	Designation	Component	Marking	Category	Orientation	Notes
<input type="checkbox"/>	Q1	2N3904 NPN Transistor	2N3904 	TO-92		
<input type="checkbox"/>	Q2	2N3906 PNP transistor	2N3906 	TO-92		

Install Resistors

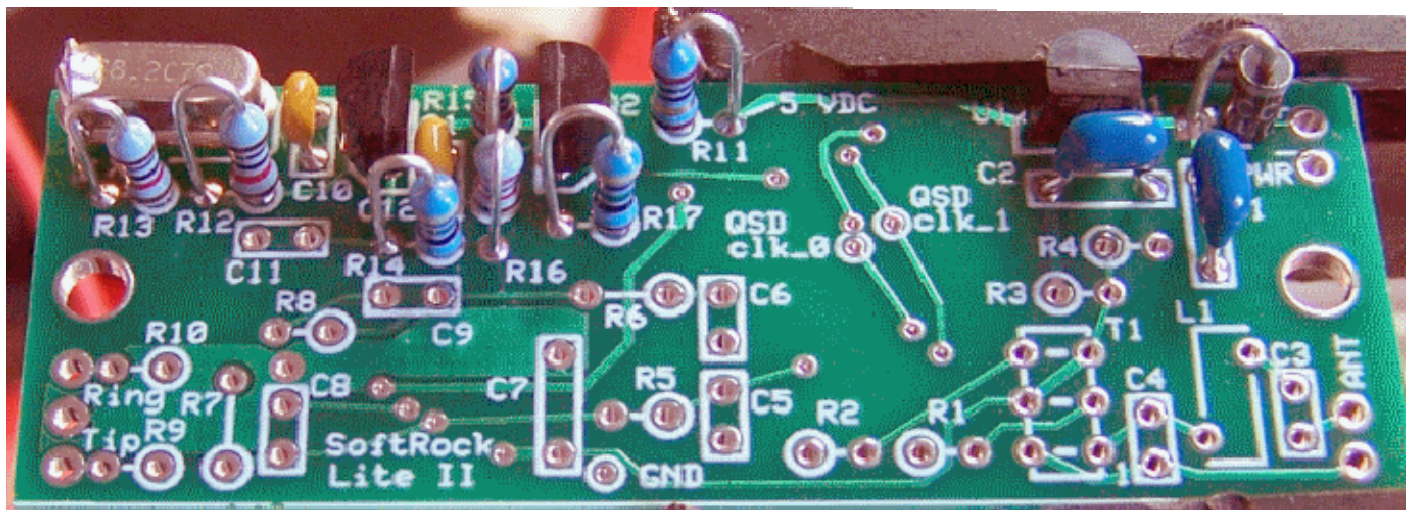
See [hints on installing and orienting resistors](#)



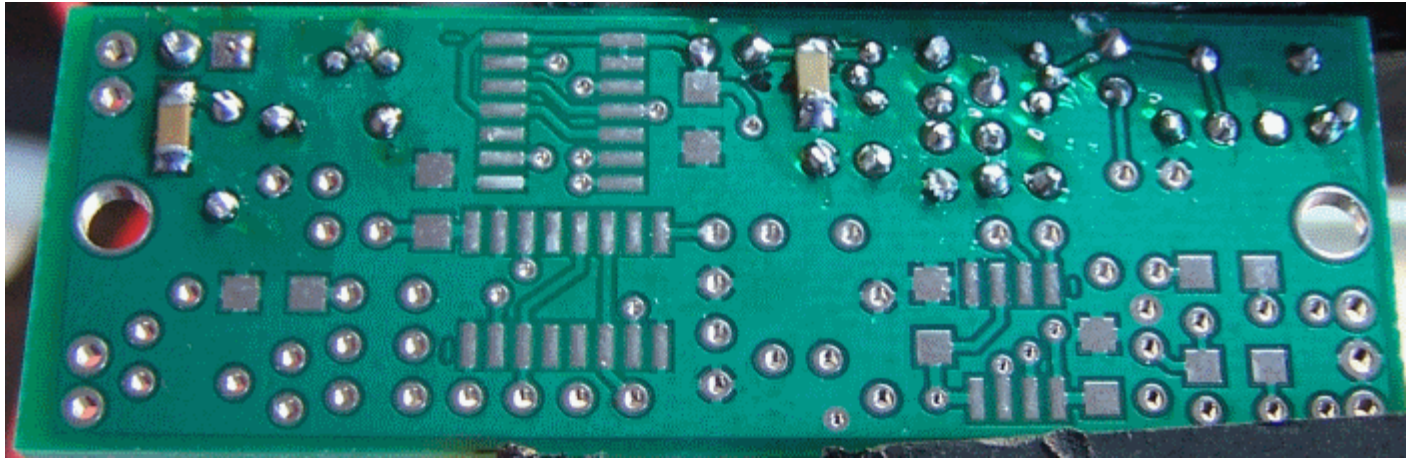
Check	Designation	Component	Marking	Category	Orientation	Notes
<input type="checkbox"/>	R17	475 1/4W 1%	y-v-grn- bl-br 	1/4W	E-W	
<input type="checkbox"/>	R16	22.1k 1/4W 1%	r-r-brn-r- br 	1/4W	N-S	
<input type="checkbox"/>	R15	1 k 1/4W 1%	br-blk- blk-br-br 	1/4W	N-S	
<input type="checkbox"/>	R14	475 1/4W 1%	y-v-grn- bl-br 	1/4W	E-W	
<input type="checkbox"/>	R13	10 k 1/4W 1%	br-blk- blk-r-br 	1/4W	E-W	
<input type="checkbox"/>	R12	10 k 1/4W 1%	br-blk- blk-r-br 	1/4W	E-W	
<input type="checkbox"/>	R11	10 ohm 1/4W 1%	br-blk- blk-gld- br 	1/4W	W-E	

Local Oscillator Completed Stage

Top of the Board



Bottom of the Board



Local Oscillator Testing

Visual Check

Test Setup

Using very good lighting and magnification, carefully inspect the solder joints to identify bridges, cold joints, or poor contacts.

Current Draw

Test Setup

- connect a 1k ohm resistor in series with the positive power lead
- apply 12 Vdc and measure the current draw with the limiting resistor in place
- remove the current limiting resistor
- apply 12 Vdc and measure the current draw without the limiting resistor (measurements courtesy of Leonard KC0WOX)

Test Measurements

Testpoint	Units	Nominal Value	Author's	Yours
With the limiting resistor	mA	< 12	7.3	
Without the limiting resistor	mA	< 20	14.1	

Voltage Tests

Test Setup

- Power the board

- Measure the testpoint voltages with respect to ground

Note that some of the voltages measured may have ac components, which, depending upon your DMM, may average in with the dc voltages to produce higher apparent dc voltages than theory would suggest.

Author measured the dc voltage at R17 using a scope and got ~2.6 Vdc

Test Measurements

Testpoint	Units	Nominal Value	Author's	Yours
R11 hairpin	Vdc	4.5 - 5	4.9	_____
R15 hairpin	Vdc	< R11 hairpin	4.7	_____
R12 hairpin	Vdc	< 2.5	2.3	_____
R17 hairpin	Vdc	> 2.5	4.2	_____

LO Output Test

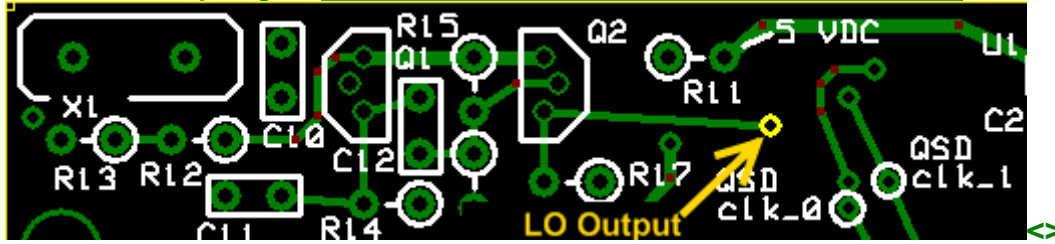
Test Setup

- On the 3 lower bands, the frequency of the LO's output should be 4 times the desired center frequency e.g., 28.224 MHz for a desired center frequency of 7.056 MHz).
- If your kit is the 30m, 20m, or 15m kit, this is a little different. The higher band SoftRock Lite kits use 1/3 sub-harmonic sampling to give receive function. The center frequency is approximately $3 * XtalFrequency / 4$ in MHz. The loss in sensitivity associated with the 1/3 sub-harmonic sampling, about 3 or 4 dB, is made up by 5x gain, (compared to the lower band SoftRock Lite kits), in the I / Q audio stage where a low-noise LT6231 op-amp is used in lieu of the TVL2462CD opamps
- The crystal frequency is band-specific, as follows:

Designation	Band	Frequency
X1	160m	7.3728 MHz
X1	80m	14.06 MHz
X1	40m	28.224 MHz
X1	30m	13.5 MHz
X1	20m	18.73 MHz
X1	15m	28.06 MHz

- You can use a ham receiver tuned to the appropriate crystal frequency. You should hear the LO's frequency.
- Scope measurements may be taken IF you have a high quality, calibrated scope with correctly compensated probes
- Note: 1/3 sub-harmonic sampling does reverse the spectrum. Changing the audio cable connections to the SoftRock Lite circuit board from tip to ring and ring to tip will correct the reversed spectrum so that the SDR

software works the same for the higher band receivers as with the lower band receivers. (See Cecil K5NWA's explanation of the sub-harmonic sampling in his message on the Yahoo Softrock group.)



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