OVERVIEW

The Solid State Local Oscillator (SSLO) consists of a 1 GHz voltage controlled oscillator (VCO) and a frequency multiplier. The VCO is a power transistor which is mounted on a mechanically adjustable resonant cavity (coarse frequency adjust). It also has a varactor diode in the base circuit (fine frequency adjust).

The free-running (coarse) frequency is determined by adjustment of the mechanical cavity. This is accomplished with the "POWER OSC TUNING" or "FREQ ADJ" slug which is a relatively large slotted screw head. The label varies with manufacturer. The fine frequency adjustment, or frequency correction of the power oscillator is controlled by a phase-locked loop (PLL) consisting of the following circuits:

1. An ultra stable, tunable, crystal "reference" oscillator.

2. A buffer amplifier with an RF test point (usually labeled "XTAL") for monitoring the crystal oscillator frequency.

3. A sampling phase detector.

4. A loop amplifier/"search" generator.

The reference oscillator generates a signal which is fed to the buffer amplifier. The buffer isolates the oscillator from the following circuitry and provides the "XTAL" test point. The buffer output is fed to a sampling phase detector. VCO output is also fed to the phase detector. These two signals are divided down to a frequency of less than 20 Hz and compared in a "strobe" or sampling circuit. The resulting DC voltage represents the phase relationship of the two signals and is fed as an "error voltage" to the loop amplifier. The loop amplifier elevates the error voltage to a level suitable to "drive" the varactor diode in the power oscillator cicuit, thereby providing fine frequency control.

The loop amplifier "block" also contains a low frequency (75 Hz) sawtooth "search" generator. When the voltage from the sampling phase detector exceeds limits set by "DC BAL" control, the sawtooth generator is enabled. It varies power oscillator frequency by vaying the voltage on the varactor. The oscillator frequency is tuned in this manner until frequency lock is established and the search generator is disabled.

ALIGNMENT

1. The SSLO should be "warmed up" for at least one hour.

2. The crystal oscillator should be adjusted +/- 100 Hz of desired frequency (Xtal osc freq is in the range of 96 - 110 MHz.):

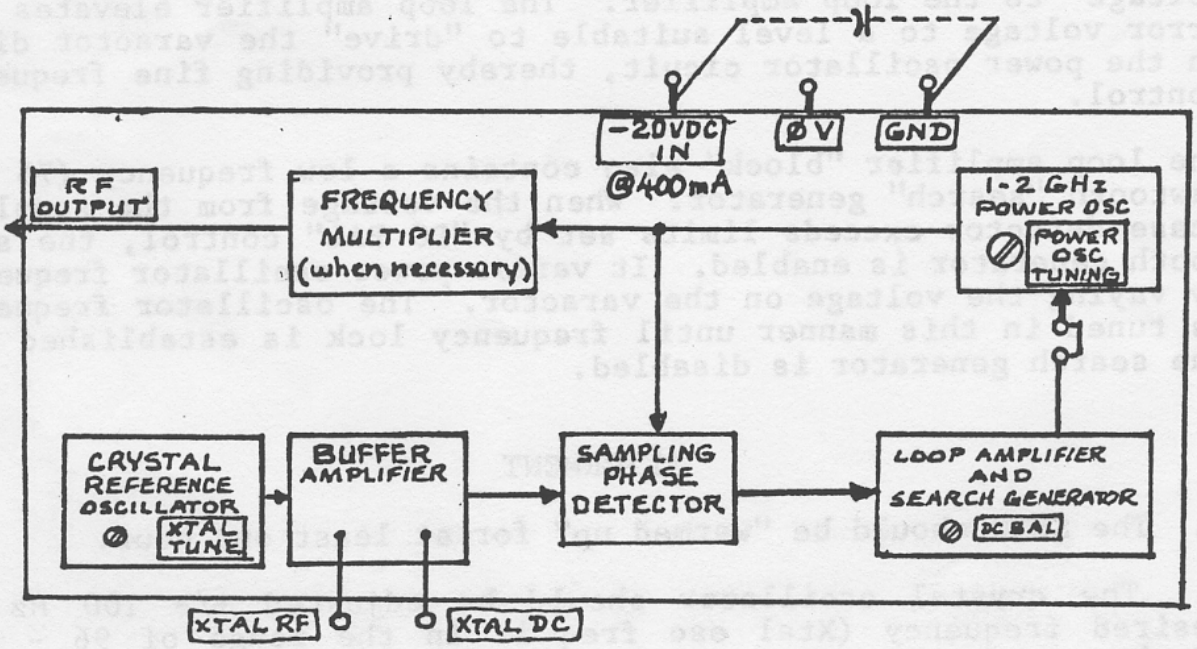
a. Adjust using "XTAL TUNE" screw.
b. Monitor frequency at "XTAL RF TEST" jack.
c. Allow several minutes for the PLL to stabilize before proceeding furthur.

3. Connect a DC voltmeter to the test pin labeled "0 V" on the housing:

a. A DC voltage between -3.2 and -15 V indicates that the PLL is properly locked.
b. Fifteen volts peak-to-peak indicates the search generator is driving the power oscillator varactor through its range in an attempt to achieve lock.
c. Anything else means your brick is broke.

4. No matter what you read, adjust the cavity resonance slowly and carfully, as discussed below:

a. If a steady DC voltage is present, adjust cavity tuning for a value of 8.5 volts (this has been shown to provide the largest VCO range).
b. If the pk-pk voltage is present, adjust cavity tuning through its entire range until the voltmeter shows a drop to a DC voltage which varies inversely with cavity tuning adjustment (CCW screw adjustment yields voltage increase & vice versa).
c. If lock cannot be established:
(1) The most common maleady has been found to be problems in the power oscillator circuit, most often a defective varactor.
(2) Occasionally the loop amplifier circuit is defective and will not disable the search generator when it should.



CRYSTAL INSTALLATION

Sources without Ovens

1. Remove the side plate bearing the Frequency-West logo from the unit (held by four screws).

2. Clip the replacement crystal leads to between 0.150 and 0.190 inch in length. Insert the crystal in its socket. See Figure 2. For best results use crystals meeting Frequency-West Specifications 37-051990 and 37-051991.

3. Replace the side plate.

4. Proceed to Alignment — *All Phase Locked Oscillators and Sources.*

Sources with Ovens

1. Remove the side plate bearing the Frequency-West logo from the unit, the oven insulator, and the crystal. See Figure 3.

2. Clip the replacement crystal leads to between 0.150 and 0.190 inch in length. Insert the crystal into its socket. For best results use crystals meeting Frequency-West Specification 37-052243. Replace the oven insulator and side plate.

3. Proceed to Alignment — *All Phase Locked Oscillators and Sources.*

ALIGNMENT PROCEDURES

1. Apply the specified input (supply) voltage between the DC input terminal and ground. The required input voltage is indicated above the terminal. Be sure to observe polarity.

Preliminary Setup — Sources Using External Reference Oscillator

1. While monitoring the source frequency with a frequency meter or counter, turn the fundamental oscillator tuning screw counterclockwise until the source is tuned to the lowest frequency of its operating band.

2. Divide the desired output frequency by the net multiplier ratio (see Table 1) to obtain the required reference input frequency from the external oscillator or frequency synthesizer.

3. Connect the external oscillator to the source reference oscillator input jack. (Input power requirement is –3 to +3 dBm; 50 ohms nominal impedance).

4. Proceed to Alignment — *All Phase Locked Oscillators and Sources*

Alignment — All Phase Locked Oscillators and Sources

1. Connect a VOM to the crystal oscillator test point (XTAL). Set the VOM on the 1.5 VDC scale. The typical voltage level at this point will be 0.1V volts minimum.

NOTE

Step 2 does not apply to units using external reference oscillators.

2. Tune the crystal oscillator coil, or capacitor (through a hole in the side plate or the front plate, depending on the configuration) until a reading is obtained (approximately 0.1V minimum). Maximize this reading.

   A maximized VOM reading at this point can be expected to yield a crystal oscillator accuracy within approximately 5 ppm of the marked crystal frequency.

   If a frequency counter is available, connect the counter to the crystal oscillator monitor connector and tune the crystal oscillator to the exact frequency. Make sure that the crystal oscillator is not near dropout by rocking the tuning screw back and forth. The unit should tune a minimum of 5 ppm, or 500 Hz at 100 MHz

   Reset the crystal frequency to the correct frequency.

3. Connect an oscilloscope or VOM to one of the phase voltage terminals (øV). The two terminals should be jumpered together on units with two terminals. For sources that have a lock limit alarm, connect the scope or VOM to the single phase voltage terminal. The scope should show a waveform of between 50 and 500 Hz, with an amplitude greater than 12V p-p. The VOM should read approximately 9 volts on the AC (rms) scale.

4. Slowly tune the fundamental oscillator tuning screw clockwise until the waveform drops out of the AC voltage drops to zero on the VOM.

   If the unit has a crystal that places the output frequency at the high end of the band, it may be necessary to continue to tune until a second lock occurs. Check for the proper lock point with a frequency meter or counter to insure locking on the correct harmonic of the reference oscillator.

5. Switch the scope to DC (2V/cm scale) or the VOM to 30 VDC full scale. (The lead should still be connected between the phase lock terminal and ground.)

6. Check for lock by rocking the fundamental oscillator tuning screw slightly. The absolute magnitude should decrease as the tuning screw is rotated clockwise.

   If the voltage does not change, the unit has not locked and has stopped sweeping. Repeat steps 3 and 4, then continue tuning the fundamental oscillator until lock occurs.

INTERNATIONAL XTAL CO

P/N 585132

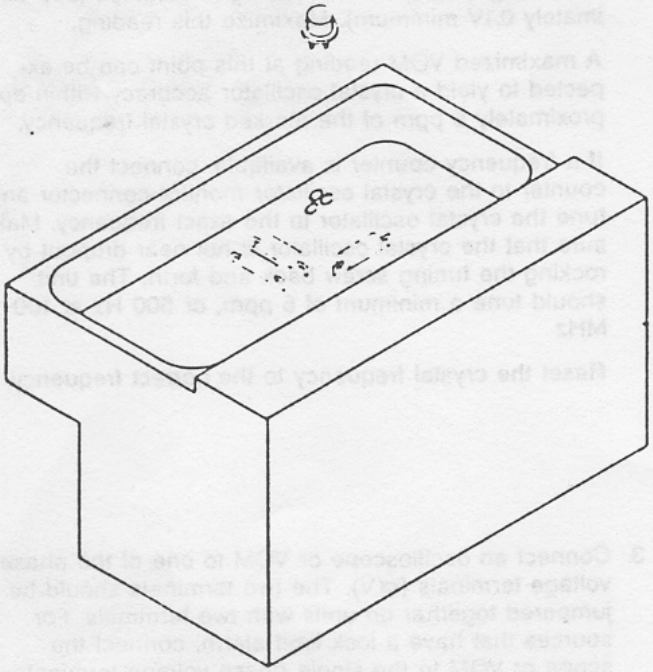


Figure 2

7. Tune the fundamental oscillator to the edge of the phase lock range. This should be between —3V ±2V and —16V ±2V. The unit should remain locked between these voltages and go into sweep as the fundamental oscillator is tuned further. This verifies that the unit remains phase locked over the appropriate tuning voltage range.

   Note: The voltage polarities will be + for positive DC input units.

8. Set the fundamental oscillator so that the voltage at the phase lock terminals is —7.5 volts. Tuneup is complete.

Note

For units with lock limit alarm: To verify the operation of the lock limit alarm circuitry, connect a VOM (x10 ohm scale) between the lock limit terminal and ground. As the unit is tuned from one end of the lock range to the other (—3V ±2V to —16V ±2V), the VOM will read either zero or infinity. It will be infinity between approximately 4.5 and 13 VDC (as read at the phase lock terminals) and zero elsewhere.

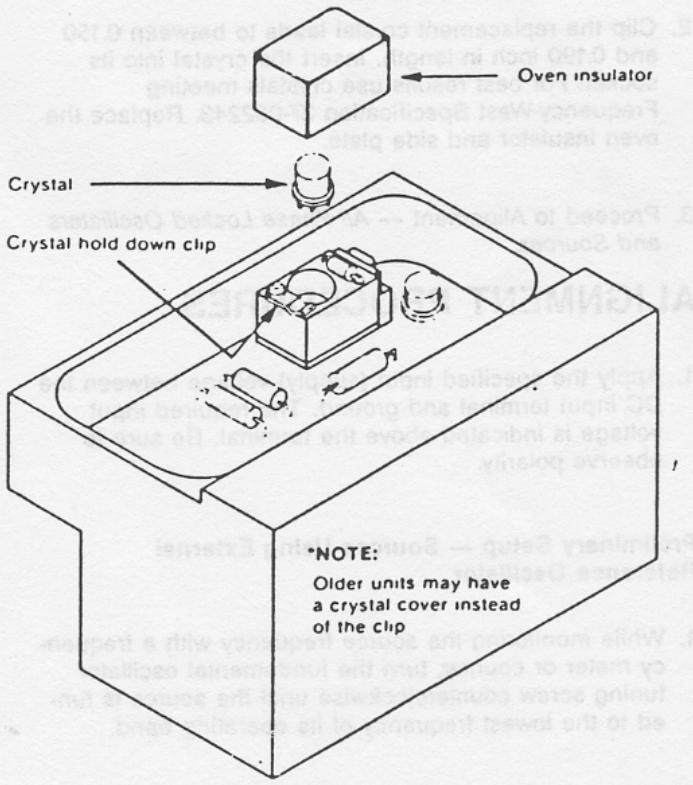


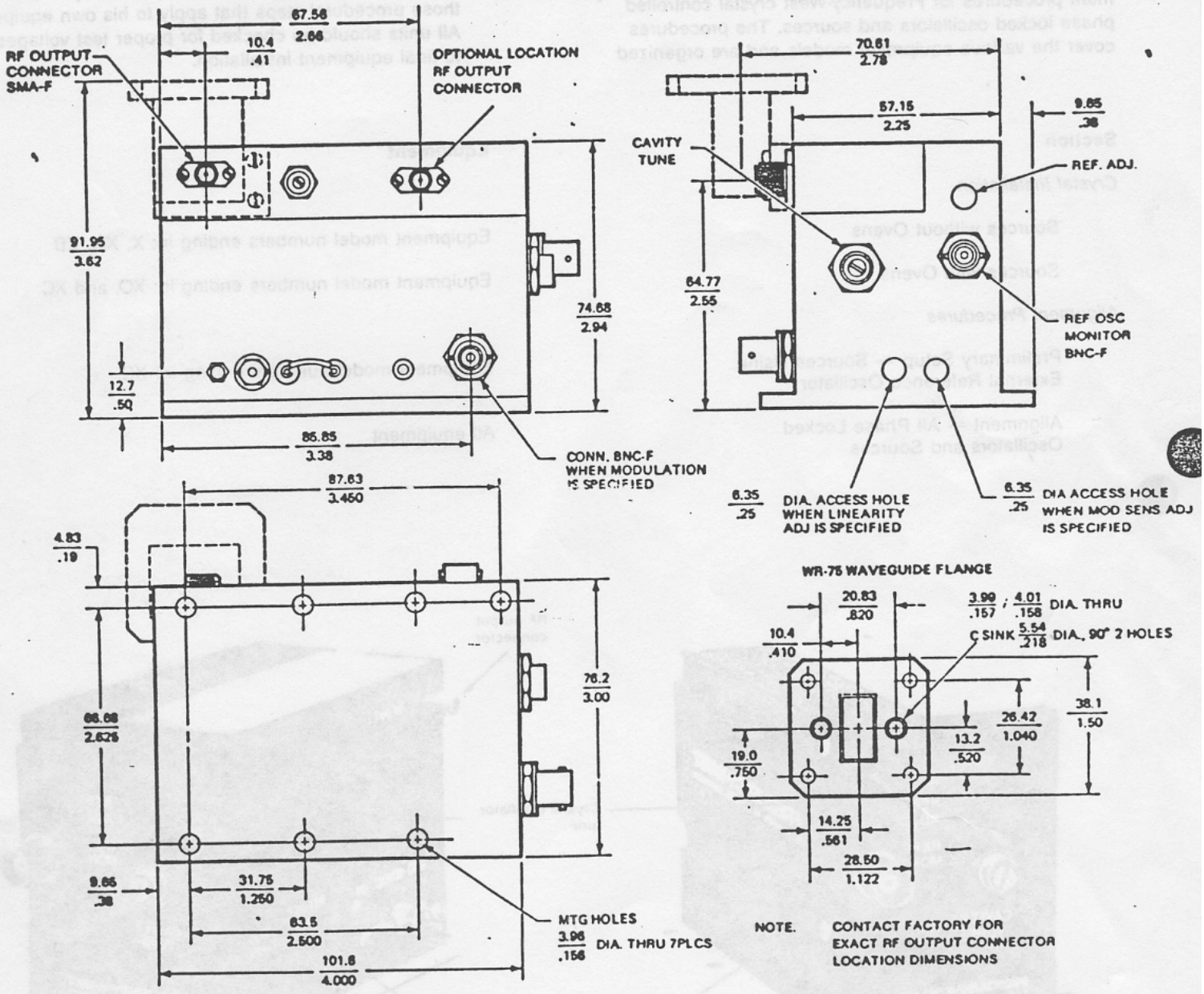
Figure 3

3-4. **Other Options**

	Letter Designator
Lock Limit Alarm	L
Standard Modulation Input	M
Low Capacity Insert Modulation (120 channels or less plus alarm tones) with baseband above 36 kHz	S
High Capacity Insert Modulation (greater than 120 channels plus alarm tones) with baseband above 50 kHz	K
Sweep Disable Alarm	H

5. **Dash Number** — Two digit number, assigned upon receipt of order by the Factory ONLY when units are other than standard.

MECHANICAL DATA



Frequency West manufactures a complete line of solid state microwave signal sources, synthesizers and subsystems for use in troposcatter, point-to-point radio relay, satellite earth station and tactical military communications systems.

For applications assistance or additional technical information on these Microwave Signal Sources, please contact the Frequency West Marketing Department.

Specifications subject to change without notice.

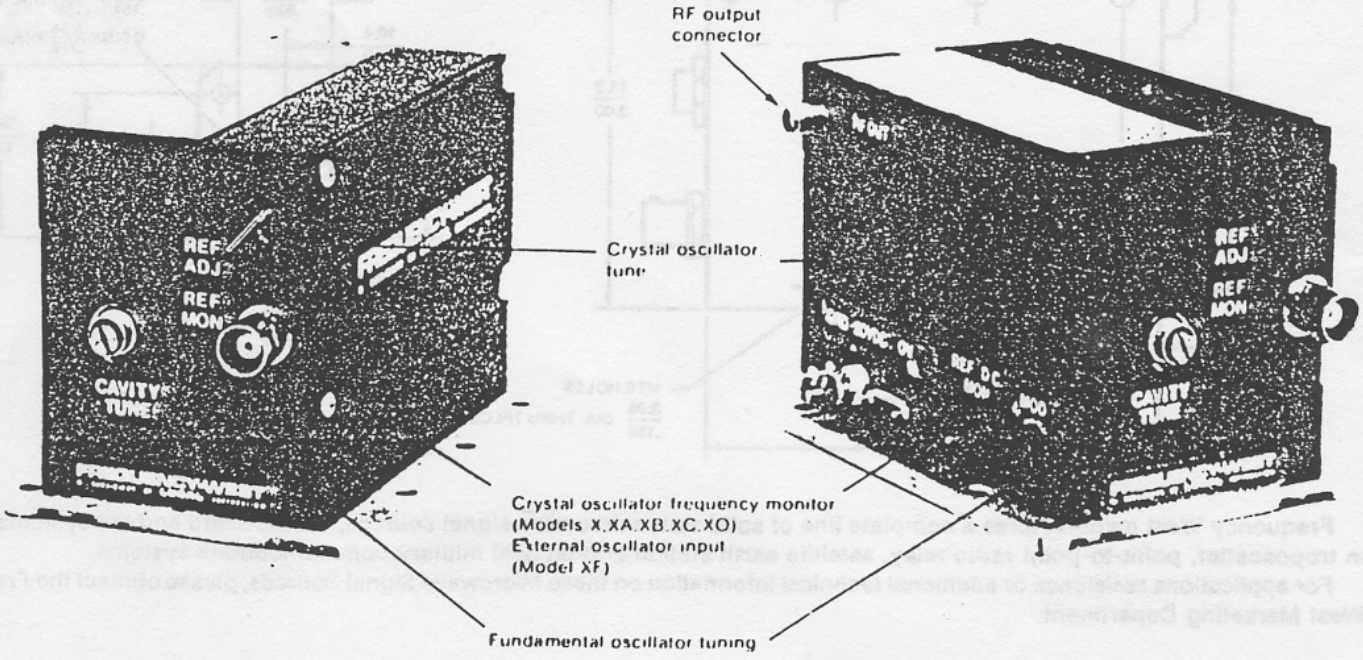
Tuneup Procedure

Phase Locked Oscillators And Sources

INTRODUCTION

These instructions cover the crystal installation and alignment procedures for Frequency-West crystal controlled phase locked oscillators and sources. The procedures cover the various equipment models and are organized by sections listed below. The user should perform only those procedural steps that apply to his own equipment. All units should be checked for proper test voltages prior to final equipment installation.

Section	Equipment
Crystal Installation	
Sources without Ovens	Equipment model numbers ending in: X, XA, XB
Sources with Ovens	Equipment model numbers ending in: XO, and XC
Alignment Procedures	
Preliminary Setup — Sources Using External Reference Oscillator	Equipment model numbers ending in: XE
Alignment — All Phase Locked Oscillators and Sources	All equipment



The Better Source 2.32 to 8.50 GHz

Phase Locked Microwave Signal Sources

FEATURES

- Field Tunable
- High Reliability
- Low Residual AM & FM Noise
- High Stability to ±0.0005% with Internal Crystal Oscillator

DESCRIPTION

The Frequency West signal sources described in this bulletin are specifically designed for applications where high stability and low noise are of prime concern. Frequency West sources utilize fundamental transistor oscillators with high Q coaxial cavities, followed by broadband stable step recovery diode multipliers. This design allows single screw mechanical adjustment of frequency over standard communications bands. Broadband sampling circuits are used to phase lock the oscillator to a high stability reference which may be either an internal self-contained crystal oscillator, external primary standard or VHF synthesizer. This unique technique allows for optimization of both FM noise and long term stability.

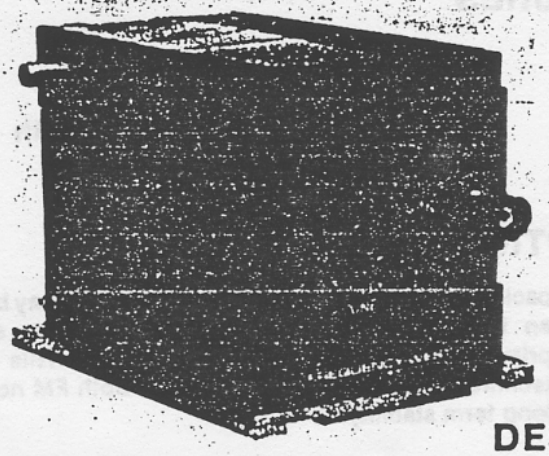
Applications include microwave radio transmitter and receiver local oscillators, radar STALO's and instrumentation systems

Model Number	Mechanically Tunable Frequency Range (MHz)	Minimum Output Power (mW)	Overall Multiplier Ratio	Internal Crystal Oscillator Frequency Range (MHz)	Maximum Input Current (mA)	
					Option A, B, E	Option C, O
MS-32X	2320—2500	10	24	96.66—104.16	300	500
	2500—2720		26	96.15—104.61		
MS-320X	2320—2500	50	24	96.66—104.16	450	650
	2500—2720		26	96.15—104.61		
MS-34X	2700—2960	10	28	96.42—105.71	300	500
	2960—3220		30	98.66—107.33		
MS-340X	2700—2960	50	28	96.42—105.71	450	650
	2960—3220		30	98.66—107.33		
MS-36X	3200—3500	10	32	100.0—109.3	400	600
	3500—3700		34	102.9—108.8		
MS-360X	3200—3500	50	32	100.0—109.3	450	650
	3500—3700		34	102.9—108.8		
MS-38X	3600—3900	10	36	100.0—108.4	300	500
MS-380X	3600—3900	50	36	100.0—108.4	450	650
MS-42X	3630—4130	10	36/39	100.8—109.2	300	500
MS-44X	3850—4200	10	39	98.7—107.7	300	500
MS-440X	3850—4200	50	39	98.7—107.7	450	650
MS-46X	4100—4450	10	42	97.5—105.9	300	500
MS-48X	4330—4930	10	44	98.4—112.1	300	500
MSA-480X	4330—4630	50	44	98.4—105.3	450	650
MSB-480X	4600—4930	50	44	104.5—112.1	450	650
MS-50X	4800—5320	10	48	100.0—110.8	300	500
MS-500X	4800—5320	50	48	100.0—110.8	450	650
MS-52X	5400—5900	10	52	103.8—113.5	300	500
MS-54X	5855—6455	10	60	97.5—107.6	300	500
MS-540X	5855—6355	50	60	97.5—106.0	450	650
MSA-540X	5855—6105	50	60	97.5—101.7	450	650
MSB-540X	6065—6355	50	60	101.0—105.9	450	650
MS-56X	6425—6925	10	65	98.8—106.6	300	500
MS-560X	6355—6855	50	65	97.4—105.5	450	650
MS-58X	6800—7200	10	65	104.6—110.8	300	500
MS-580X	6805—7055	25	65	104.7—108.5	400	600
MS-60X	7000—7525	5	70	100.0—107.5	300	500
MS-600X	7377—7680	25	70	105.4—109.7	400	600
MS-62X	7500—8000	5	75	100.0—106.7	300	500
MS-620X	7680—8005	25	75	102.4—106.7	400	600
MS-64X	7980—8500	5	80	97.7—106.3	400	600
MS-640X	8005—8330	25	80	100.0—102.8	400	600

3732074 FREQUENCY SOURCES INC; 69C 00098 D

The Better Source 8.50 to 18.73 GHz

Phase Locked Microwave Signal Sources N5BH



FEATURES

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Applications include microwave radio transmitter and receiver local oscillators, radar STALO's and instrumentation systems.

MODELS

Model Number	Mechanically Tunable Frequency Range (MHz)	Minimum Output Power (mW)	Overall Multiplier Ratio	Internal Crystal Oscillator Frequency Range (MHz)	Maximum Input Current (mA)	
					Option A, B, E	Option C, O
MS-66X	8500—9050	10	85	100.0—106.5	400	600
MS-68X	9000—9600	10	90	100.0—106.7	400	600
MS-70X	9600—10200	10	96	100.0—106.3	400	600
MS-72X	10200—10700	10	102	100.0—104.9	400	600
MS-74X	10630—11230	10	108	98.4—104.0	400	600
MS-740X	10630—11230	20	108	98.4—104.0	550	750
MS-76X	11200—11770	10	108	103.7—109.0	400	600
MS-760X	11200—11770	20	108	103.7—109.0	550	750
MSA-76X	10630—11630	5	108	98.4—107.7	400	600
MS-78X	11630—12230	5	114	102.0—107.3	400	600
MS-780X	11630—12230	20	114	102.0—107.3	550	750
MS-80X	12130—12700	5	120	101.1—105.8	400	600
MS-800X	12130—12700	20	120	101.1—105.8	550	750
MS-82X	12630—13230	5	126	100.2—105.0	400	600
MS-820X	12630—13230	20	126	100.2—105.0	550	750
MS-84X	13130—13700	5	133	99.5—103.8	500	700
MS-86X	13630—14230	5	133	102.5—107.0	500	700
MS-88X	14130—14730	5	140	100.9—105.2	500	700
MS-90X	14630—15230	5	140	104.5—108.8	500	700
MS-92X	15130—15730	5	147	102.9—107.9	500	700
MS-94X	15630—16230	5	160	97.6—101.4	500	700
MS-96X	16130—16730	5	160	100.8—104.5	500	700
MS-98X	16630—17230	5	170	103.9—107.6	500	700
MS-1100X	17130—17730	5	170	107.0—110.8	500	700
MS-1102X	17630—18230	5	180	97.9—101.2	500	700
MS-1104X	18130—18730	5	180	100.7—104.0	500	700

OPTIONS

Frequency Stability With internal crystal oscillator, ±50 ppm, ±20 ppm, or ±5 ppm can be specified.

External Reference Allows locking to external clock oscillators or frequency synthesizers with a specified frequency band within the range from 5 MHz to 150 MHz. This option can also be supplied on units with an internal crystal oscillator.

Frequency Modulation Up to 1800 channels CCIR with 300 Hz order-wire can be provided. For a more complete description see Bulletin 220.

DC Voltage Positive or negative voltages can be accommodated.

Alarms Lock limit or sweep alarms are available to warn system maintenance personnel of possible loss of lock due to aging or component changes.

Ruggedized Construction All standard units can be ruggedized to withstand the environments of military systems.

Non-Translating Tuning Shaft Ideal for front panel tuning operations.

ELECTRICAL CHARACTERISTICS

Frequency Range and Output Power See Table.

Note: Other frequency ranges and higher output power may be specified.

Frequency Stability (over operating temperature range)
Option "A" ±0.005%
"B" ±0.002%
"C" ±0.0005%
"E" dependent on external reference input

Output Power Stability +1.0, —1.5 dB maximum over operating temperature range; 3 dB typical over frequency range.

Spurious Rejection
8500 thru 13230 MHz
In-band: —75 dBc minimum
Out-of-Band: —45 dBc minimum
13230 thru 18730 MHz
In-Band: —75 dBc minimum
Out-of-Band: —35 dBc minimum

FM Noise See noise curve figure 1.

Crystal Frequency Monitor Output
Level 0 dBm ±3 dB
Impedance 50 ohms nominal
Connector BNC-F standard; SMA-F, Amphenol 27-21, Selectro 50-043-000, or TNC-F available

External Reference Input (Optional)
Frequency Range 97-115 MHz standard (see table) Other ranges 5 MHz or higher can be provided.
Level 0 dBm +3, -0 dB
Impedance 50 ohms nominal
Connector BNC-F standard; SMA-F, Amphenol 27-21, Selectro 50-043-000, or TNC-F available

Load VSWR 1.3:1 maximum, all phases

Output Connector SMA-F standard for all bands. WR-75 & WR-90 available.

Power Supply Voltage
—20 Vdc ±1.5% standard
+20 Vdc ±1.5% optional
Other voltages may be specified.

Lock Limit Alarm (Optional) Relay contact to ground at lock limit or loss of lock. Relay rating is: 100V max., 0.5 A max., 10 VA max.

Environmental

Operating -30 to +60° C, baseplate; 0 to 80% RH; 0 to 10,000 ft.

Storage -40 to +85° C; 0 to 95% RH; 0 to 50,000 ft.

Weight 30 oz. (0.86 kg.) maximum

MODULATION OPTIONS

Standard Modulation Provides typical varactor tuning characteristic, (see figure 2), suitable for order-wire or other low channel capacity applications
FM Rate: 200 kHz — 10 MHz.
Deviation: 0.7 of FM to a maximum of ±2 MHz
Impedance: 75 ohms nominal
Connector: BNC-F

Low Capacity Insert Modulation

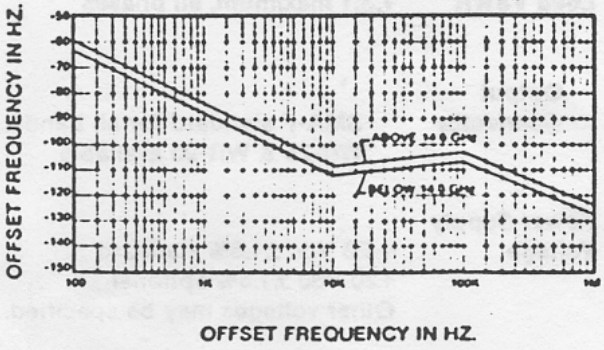
Order-wire, alarm tones plus 120 multiplex channels or less; baseband above 36 kHz
Baseband Response: 36 kHz to 6 MHz ±0.5 dB; 6 MHz to 12 MHz ±1.0 dB
Peak Deviation: 0.7 fm to ±2 MHz maximum
Modulation Sensitivity: 1.0 MHz/volt minimum @ maximum sensitivity
Linearity (±2 MHz): <2%
Return Loss: > 26 dB over baseband
Input Impedance: 75 ohms
Input Connector: BNC-F

High Capacity Insert Modulation

Order-wire, alarm tones, plus 120 or more multiplex channels; baseband above 50 kHz
Baseband Response: 50 kHz to 6 MHz ±0.5 dB; 6 MHz to 12 MHz ±1.0 dB
Peak Deviation: 0.7 fm to ±2 MHz maximum
Modulation Sensitivity: 1.0 MHz/volt minimum @ maximum sensitivity
Linearity (±2 MHz): <1.5%
Return Loss: > 26 dB over baseband
Input Impedance: 75 ohms
Input Connector: BNC-F

PERFORMANCE

SSB PHASE NOISE
USING A FREQUENCY WEST
100 MHz. CRYSTAL OSCILLATOR



OFFSET FREQUENCY IN HZ.

FIGURE 1

TYPICAL TUNING DIODE CHARACTERISTICS FOR AFC AND APPLIED MODULATION

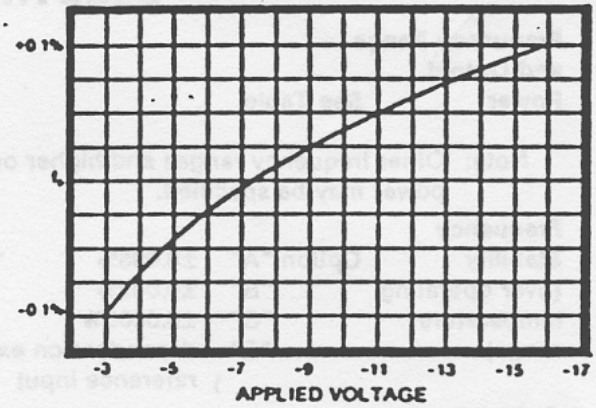
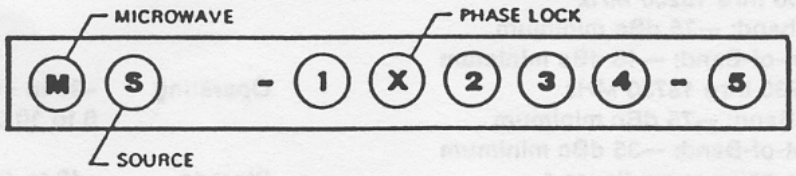


FIGURE 2

MODEL NUMBERING SYSTEM



1. **Type Number** — Two digit number: Low power sources (5-10 mW); Three digit number: High power sources (20-50 mW)

   Note: When positive voltage (negative ground) unit is specified this number is one digit higher. For example, a MS-80X is a negative voltage unit, while a MS-81X is a positive voltage version of the same unit.

2.

Stability Options	Letter Designator
±0.005% with crystal	A
±0.002% with crystal	B
±0.0005% with crystal	C
±0.005% or ±0.002% without crystal	See Notes 1 and 2
±0.0005%, internal oven without crystal (See Notes 1 and 2)	0
External reference oscillator input (less oscillator)	E

Note 1. Delete the crystal letter designator when the crystal is not supplied by Frequency West except when the 0 option is specified which is defined as an oven unit WITHOUT crystal.

Note 2. Crystals manufactured to Frequency West specifications must be used to meet the specified stability and to be mechanically compatible.

(Continued on back page)