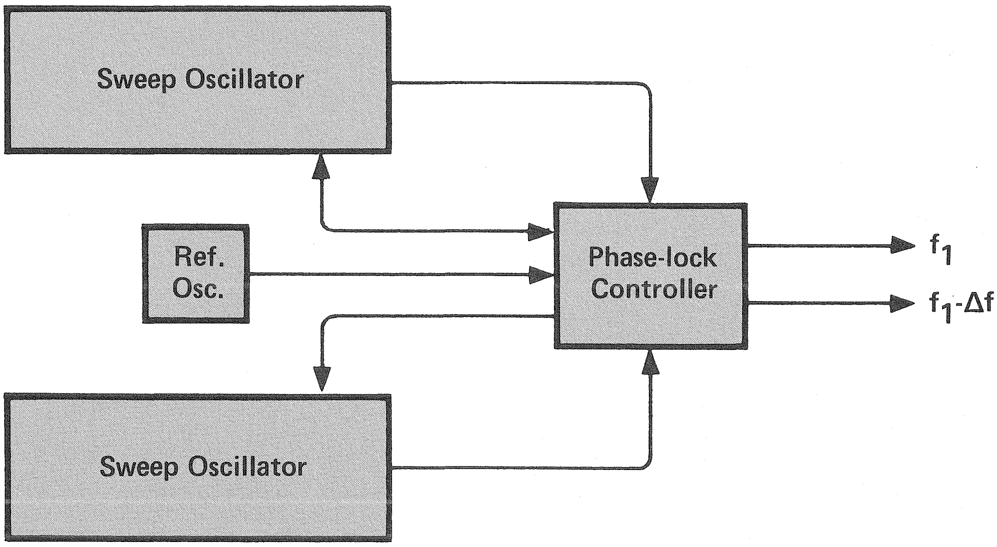
HEWLETT PACKARD 8620 SWEEP OSCILLATORS

Configuration of a Two-Tone Sweeping Generator



Designing and testing microwave mixers and receiver front-ends requires a local oscillator signal and the received signal, separated in frequency by the required IF. Broadband testing of such devices may be accomplished by taking CW measurements at discrete frequencies after manually tuning each of two signal sources. This method is both tedious and time-consuming, and it may result in the oversight of narrowband responses which occur between the discrete frequency points.

This application note describes a system which will produce the two required signals, offset from each other by a very accurate and stable difference. The system can then be used to sweep-test across multi-octave bands. The operator needs only set the controls of one sweeper to the desired frequency range between 2 and 18 GHz; the other sweeper will follow and always be separated by the desired offset, which can be anywhere between 1 and 300 MHz.

APPLICATION NOTE 187-4

INTRODUCTION

Testing microwave mixers involves characterizing a number of important parameters. Among these are conversion loss, RF and IF bandwidths, isolation, noise figure and phase and amplitude tracking. Often a point-by-point characterization was the only means for making these tests. Sweep testing across the required RF range can shorten test-time from many hours to only a few minutes. For example, phase or amplitude tracking between two mixers might be accomplished as in Figure 1. Mixer 1 might be a standard calibrated mixer with Mixer 2 being the DUT; or Mixers 1 and 2 might be a matched pair.

To analyze the signal characteristics of the IF across the RF band, the set-up in Figure 2 might be employed. This allows the user to sweep the required RF band, keeping the IF fundamental signal stable on the spectrum analyzer. Noise, harmonic suppression, gain/loss, and other signal characteristics could then be tested.

Since there are so many various applications for this source, this application note will not attempt to go into detail on specific test set-ups. Configuration of the source and the procedures for using it will be described.

Example of Tests that are simplified through use of a Two-Tone Source

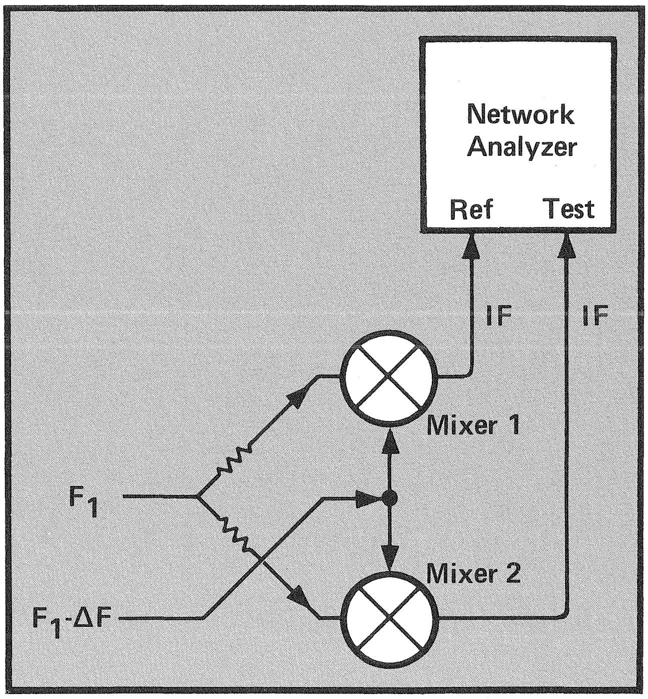


Figure 1. Mixer Test Set-up.

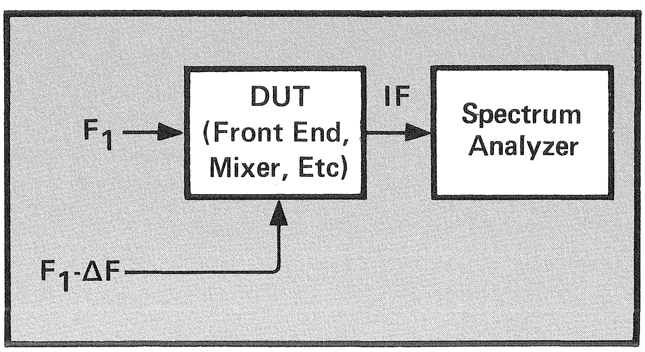


Figure 2. IF Signal Analysis Test Set-up.

BLOCK DIAGRAM AND THEORY OF OPERATION

In this application, one sweeper (the "master") is operator-controlled like a normal sweeper. Its frequency-control signals are processed by the phase-lock controller which inserts the necessary offset voltages and applies the resultant signal to the "slave" sweeper. Open-loop, this would result in one sweeper tracking the other with an offset equal to the desired offset ± the combined linearity of the two sweepers.

In order to improve the offset accuracy, a phase-lock scheme is used. Internal directional couplers sample the two sweeper signals, which are mixed producing a difference frequency approaching the desired IF. This difference frequency is then mixed with that of the reference oscillator which is 20 MHz above the required IF. The resultant difference frequency is compared in the synchronizer with a 20 MHz standard which can either be the synchronizer's internal crystal or, for more stability, an external standard which would then be injected into the synchronizer. The synchronizer outputs a correction voltage which drives the phase-lock input of the slave sweeper to phase-lock the offset between the two sweepers. This results in the slave sweeper being lower in frequency with an offset accuracy equal to the accuracy of the reference oscillator plus the accuracy of the 20 MHz standard.

SUGGESTED COMPONENTS

2 each Sweeper Mainframes w/RF plug-ins to cover required range	HP-8620C, Opt. H40
Synchronizer	HP-8709A, Opt. H08
Phase-lock Controller	HP-8709A, Opt. K50
Bandpass Filter	See text
Reference Oscillator	HP-8640A/B Signal Generator
RF Interconnect Cables (For Rack Mounted Systems)	HP-08709-60022 HP-08709-60023
Control Cables (2 required)	HP-08709-60032

OPERATION

Connect equipment as shown in Figure 3.

Offset Bandpass Filter: Select a bandpass filter with 10 MHz, 3 dB bandwidth centered at desired offset frequency, passband insertion loss of <3 dB, and rejection at ± 20 MHz of >30 dB. Insert between OFFSET FILTER connectors on rear of 8709A-K50. For an offset frequency less than 10 MHz, a 10 MHz low pass filter should be used.

8620C and RF Plug-ins: Set rear panel FM/NORM/PL switch to PL (Phase-lock). On some 86200 series plug-ins, switch is inside plug-in; set to FM2*. Set rear panel 1 kHz Square Wave and RF Blanking to OFF. Select proper bands with Master Band Select Lever. Set sweep time to >100 ms (except 86290A in Band 4 set to approx. 500 ms).

*86300 series plug-ins produced before March 1976 require resistor change to operate properly: phase-lock sensitivity of -6 MHz/Volt is required. Consult factory.

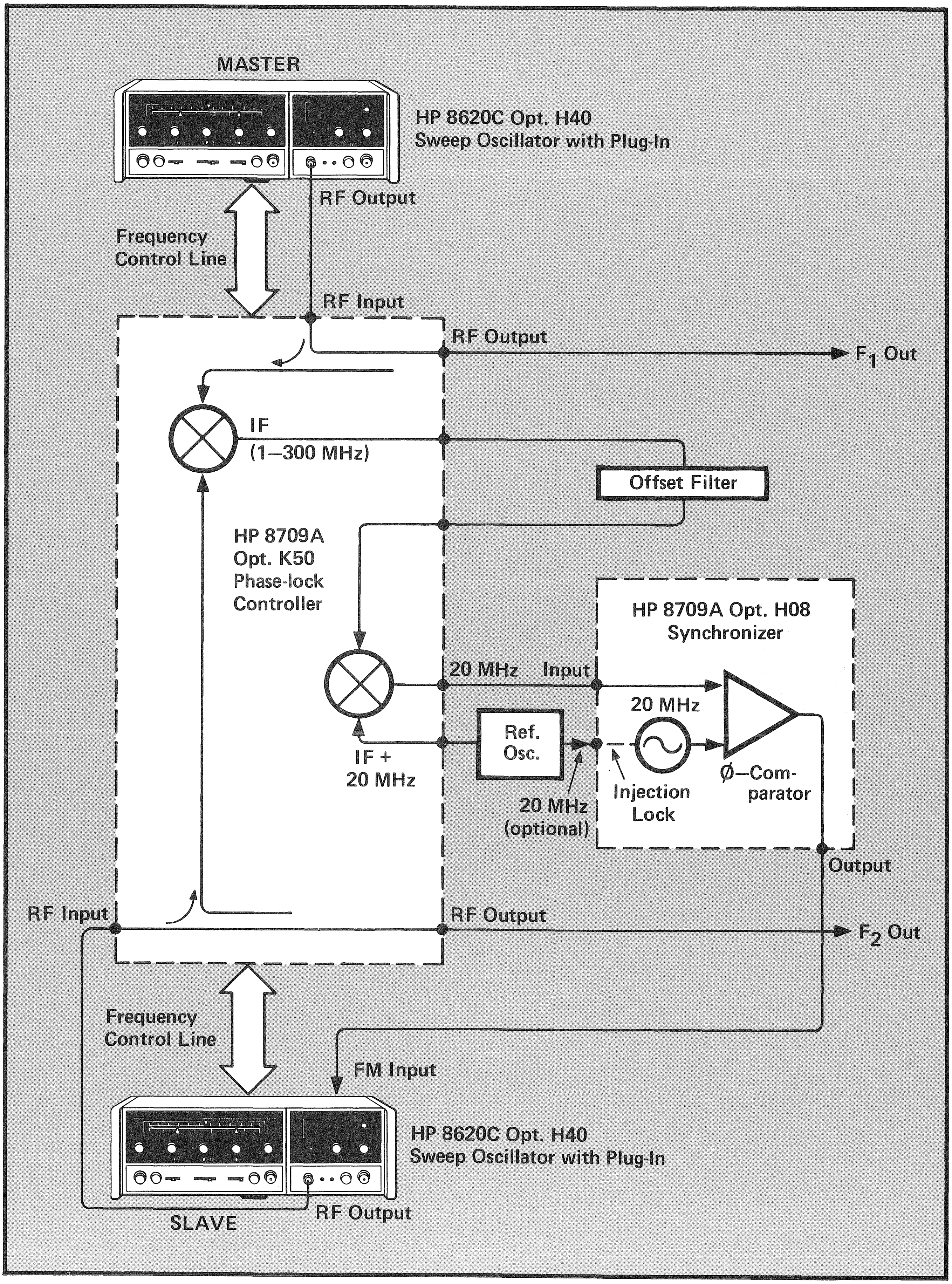


Figure 3. Two-Tone Sweeping Generator Block Diagram.

Synchronizer (8709A-H08): Set MOD SENS switch to 6.0 MHz/Volt.

Controller (8709A-K50): Select UPPER MASTER LOWER SLAVE or UPPER SLAVE LOWER MASTER with push-button switch. This determines which sweeper will be the controller.

Reference Oscillator: Set frequency to desired offset + 20 MHz. Set power level to + 5 dBm.

Set Master Sweeper to cover desired frequency range. Adjust controller GAIN control fully clockwise and adjust the OFFSET control for band in use until synchronizer UNLOCKED light goes out and phase error indicator is approximately centered. The Master Sweeper may then be set to sweep across any or all of the desired range and the Slave will follow at the desired offset frequency below the Master Sweeper.

PERFORMANCE CHARACTERISTICS

This system will operate with RF frequencies between 2 and 18 GHz and with offset frequencies of 1 to 300 MHz.

The offset frequency characteristics of the system are almost entirely dependent on the reference oscillator and the synchronizer. For example, with a 100 MHz IF and using the 8640B Signal Generator as reference, the offset accuracy will be approximately 1100 Hz, due primarily to the synchronizer's internal reference. If an external 20 MHz reference is used to injection lock the synchronizer or the internal reference error precalibrated, the accuracy will approach 100 Hz. Stability of the offset frequency may also be improved to that of the reference (approx. 0.05 ppm/hr with the 8640B) by injection locking the synchronizer with a stable 20 MHz signal.

The decision as to what reference oscillator is required for the application will also be affected by phase noise requirements of the offset. Some examples: the 8640B SSB phase noise in a 1 Hz bandwidth at a 20 kHz offset from the carrier is 120 to 140 dB down depending on its output frequency, while the 8660 Synthesizer with the 86602B plug-in (1-1300 MHz) is approximately 105 dB down. Of course, if the application requires only one specific IF offset frequency, a fixed tuned crystal oscillator may be adequate for the reference.

The absolute frequency characteristics of the Master Sweeper are basically independent of the rest of the system. Consult specifications of plug-in band in use. The absolute frequency characteristics of the Slave are equal to those of the Master ± the offset frequency characteristics.

Output power is determined by the specific plug-ins minus the insertion loss of the phase-lock controller which is approximately 0.5 dB at 2 GHz and 2 dB at 18 GHz. Internally leveled flatness of the outputs is equal to specified flatness plus the frequency response of the phase-lock controller which is typically ±0.2 dB over octave ranges and ±0.8 dB over 2-18 GHz. Of course, this may be improved through use of an external leveling loop.

Isolation between the two outputs is >50 dB. Sweep speed should be greater than 100 ms except when the 86290A 2-18 GHz plug-in used in Band 4; there it should be no less than 500 ms.

ADDITIONAL CAPABILITIES

With the proper programming option installed in one or both of the sweepers, the output frequencies can be controlled through BCD or the HP-Interface Bus (HP-IB). This permits the source to be used in an automatic measurement system after manually setting the proper offset. The user would be able to program specific output frequencies of the Master with a resolution of 10,000 points per band. The Slave would then be controlled by the Phase-Lock Controller.

With programming options in both sweepers, and in the reference oscillator (e.g., the HP8660A, Opt. 005 Synthesizer), the frequencies as well as the offset may be programmed. In addition, a programmable VHF switch (e.g., the HP59307A) would be required to switch in the proper Offset Filter. This system would then allow a very time-consuming series of tests to be performed with a minimum of effort.

Where frequency modulation is necessary, the reference oscillator is modulated at the desired rate and deviation. The slave frequency is then pulled by the phase-locked loop. Maximum rate is a function of the lock-loop bandwidth and in general should be <100 kHz. Deviation is limited by the Offset Filter characteristics and the sweeper plug-in used; range is approximately DC to 5 MHz.

Of course, for general purpose applications, either or both of the sweepers may be disconnected from the system and used in standard sweep testing. In addition, the accuracy, stability, linearity and flatness of the 86290A 2-18 GHz plug-in make it ideal for many CW generator applications.

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For more information, call your local HP Sales Office or East (301) 948-6370 • Midwest (312) 677-0400 • South (404) 434-4000 • West (213) 877-1282. Or, write: Hewlett-Packard, 1501 Page Mill Road, Palo Alto, California 94304. In Europe, Post Office Box 349, CH-1217 Meyrin 1, Geneva, Switzerland. In Japan, Yokogawa-Hewlett-Packard, 1-59-1, Yoyogi, Shibuya-Ku, Tokyo, 151.

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