High Resolution, High Speed Measurements at RF and Microwave Frequencies Using the HP3589A Baseband Analyzer

Compared to their RF and microwave counterparts, spectrum analyzers designed specifically for baseband frequencies generally offer better accuracy, resolution and dynamic range. This tradeoff of frequency coverage for performance is no accident; baseband systems, i.e. those that handle the actual information content of a signal (voice, video, data, etc.), are always among the most performance-critical elements of any system and require the most exacting tools.

More and more, engineers working in the gigahertz region are finding that the resolution and speed offered by a baseband analyzer would be ideal for their applications, too. Measurements of closely-spaced sidebands or time varying signals may be well beyond the capability of their traditional RF/uW analyzers. However, by using such an analyzer as a down-converting front end for the HP3589A baseband spectrum/network analyzer, most of these measurements can nonetheless be readily made, using the techniques discussed in this paper.

Measurement Principles:

Most RF/uW spectrum analyzers provide an auxiliary output following their final IF stages (but preceding the detector), designated IF OUT or equivalent (see figure 1). Such an output will typically be in the 10-30 MHz range, and can thus be easily used as an input signal to the HP3589A. Having done this, virtually any signal input to the RF/uW analyzer can be analyzed with the powerful measurement features of the HP3589A, including high resolution zoom, time-gated sweep, IBASIC programming, etc.

This technique works because the signal at the IF output exactly duplicates the input signal, except that it is translated in frequency by the analyzer's local oscillator(s) and band-limited by its resolution BW filters. (In some cases its spectral content may also be reversed, depending on the number and type of frequency conversions in the preceding stages). The appropriate measurement setup can insure that none of these factors degrade the results obtained.

Equipment Selection:

Other factors exist which are not so readily compensated, and which may influence the choice of RF/uW analyzer used. These include:

1) **frequency stability:** any drifting of the down-conversion L.O.(s) will cause a corresponding shift in signal frequency at the IF output. While 100-200 Hz of drift would normally be insignificant in the gigahertz region, it could cause the output to drift completely outside of the baseband analyzer's measurement span. Many applications will require a fully synthesized analyzer sharing a common frequency reference with the HP3589A.

2) **linear IF output:** most RF/uW analyzers incorporate a log-response amplifier somewhere in the signal path, to allow amplitude display in dB. If this occurs prior to the IF OUT port, some means must be available to disable it (perhaps via a "linear scale" display mode). Otherwise, the resultant compressed signal will not be accurately measured by the baseband analyzer.

figure 1 - RF/uW Analyzer Block Diagram

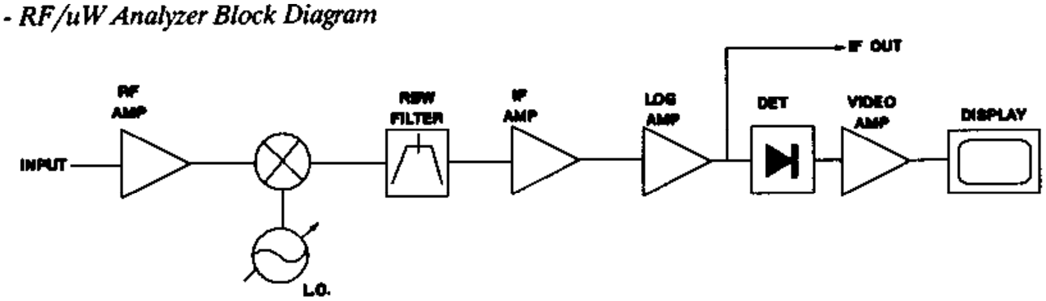
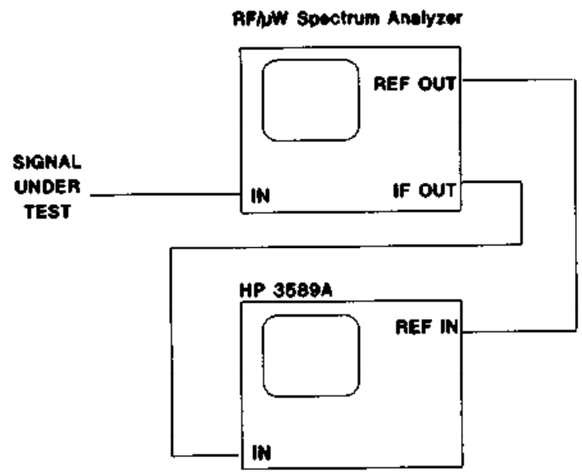


figure 2 - Measurement Setup



Measurement Setup:

Once the equipment is connected as shown in figure 2, settings for the individual analyzers should be established as follows:

RF/uW analyzer:

1. Using the analyzer's built-in frequency counter and/or successively narrower frequency sweeps, determine the precise frequency of the signal to be analyzed (to within a few percent of the smallest frequency span anticipated on the HP3589A).

2. Select a fixed sweep mode (manual sweep or zero span) at this exact frequency. Be aware that most RF/uW analyzers are frequency locked only at the beginning or center of their sweep. Thus, even in zero span mode, there may be a significant frequency transient or "jump" with each retrace, as the L.O. is re-synchronized.

3. Choose the analyzer's widest resolution bandwidth (RBW) - at least wide enough to pass the entire input signal, including sidebands.

4. Adjust the RF (input) and IF (reference level) gains until the input signal is displayed at full scale. Disable any auto-range or auto-scale functions on the analyzer.

5. Select the linear display mode.

HP3589A:

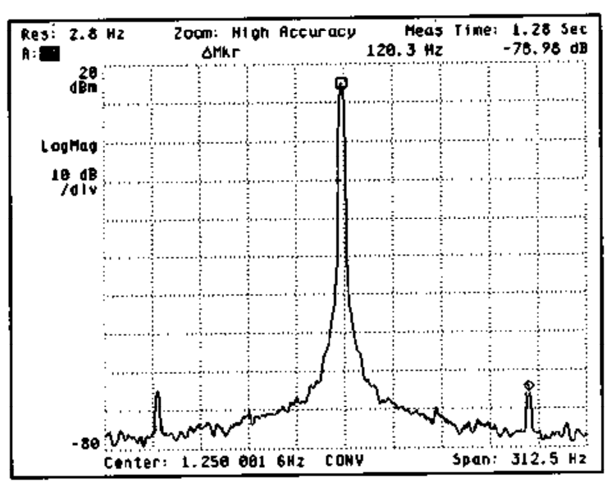
1. Set the analyzer's center frequency to the IF of the RF/uW analyzer. Set the frequency span as desired, *but not greater than about half the RBW of the RF/uW analyzer.*

2. Frequency calibration - on the HP3589A's front panel, press the SPECIAL FCTN key and the DOWN CONV SETUP softkey. Next, select CONVERT CTR FREQ and USER CTR FREQUENCY, and enter the exact center frequency, as programmed on the RF/uW analyzer. This will cause the HP3589A's frequency display and markers to be automatically corrected for the translation that has taken place. Also, if required, select the MIRROR FREQ AXIS softkey to re-invert the displayed spectrum.

3. Amplitude calibration: - To determine the amplitude calibration factor, subtract the value of the signal peak, as displayed on the HP3589A marker, from the level shown on the RF/uW analyzer (all values in dB). If the signal displayed on the HP3589A is too broad to show a definite peak, temporarily increase the measurement span and/or RBW until only a single peak appears. Returning to the DOWN CONV SETUP menu, select AMPLITUDE OFFSET and enter this value. *This amplitude calibration factor must be recalculated every time the RF/uW analyzer's range or reference level is changed.*

With the above techniques, high resolution analyses of signals high in the RF and microwave ranges can be easily performed. Figure 3 shows the results of a typical measurement.

figure 3 - HP3589A Display of 120 Hz Sidebands on a 1.25 GHz Carrier (measurement time 1.28 sec.)



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