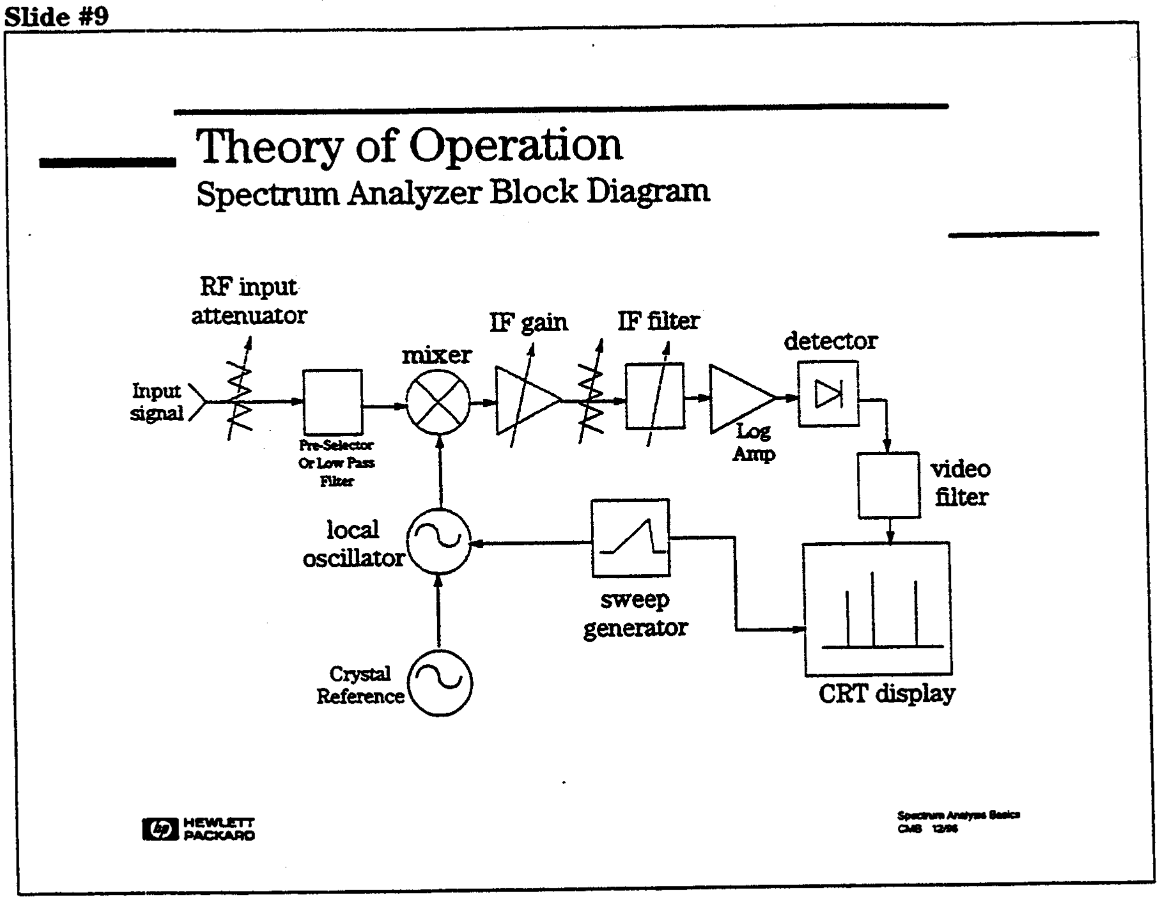
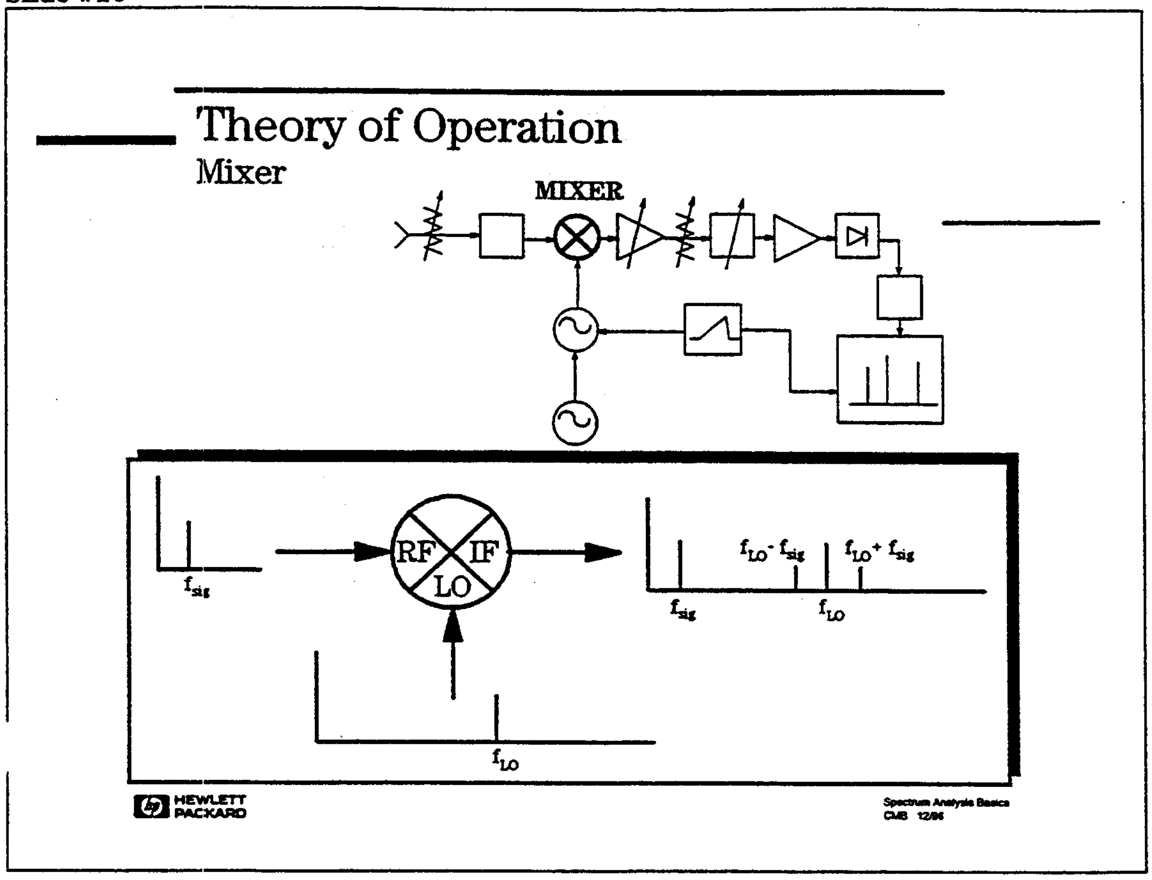
Slide #9



The major components in a spectrum analyzer are the RF input attenuator, mixer, IF (Intermediate Frequency) gain, IF filter, detector, video filter, local oscillator, sweep generator, and CRT display. Before we talk about how these pieces work together, let's get a fundamental understanding of each component individually.

Slide #10

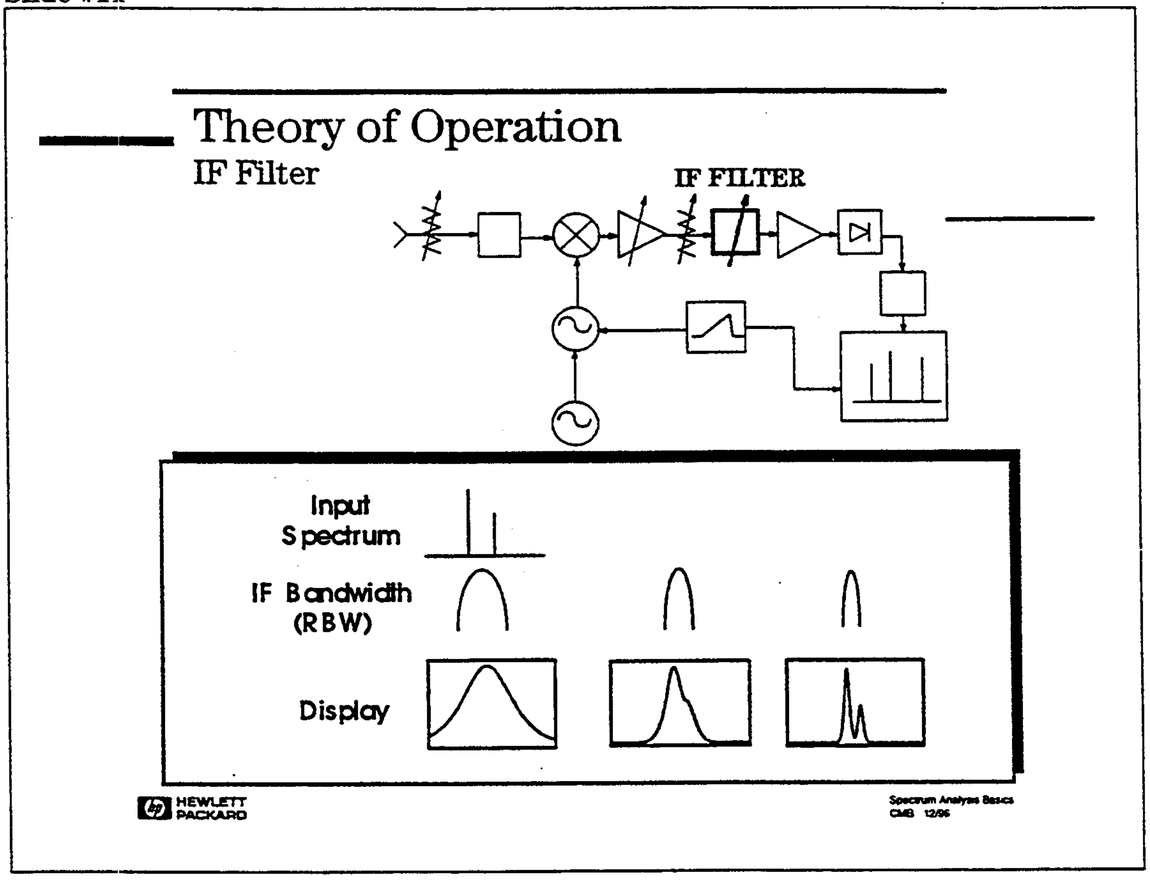


A mixer is a device that converts a signal from one frequency to another. Therefore, it is sometimes called a frequency-translation device.

By definition, a mixer is a non-linear device (frequencies are present at the output that were not present at the input). The local oscillator signal (f_{LO}) is applied to one port of the mixer and the signal to be converted (f_{sig}) is applied to the second port. The output of a mixer consists of the two original signals (f_{sig} and f_{LO}) as well as the sum ($f_{LO}+f_{sig}$) and difference ($f_{LO}-f_{sig}$) frequencies of these two signals.

In a spectrum analyzer, the difference frequency is actually the frequency of interest. The mixer has converted our RF input signal to an IF (Intermediate Frequency) signal that the analyzer can now filter, amplify and detect for the purpose of displaying the signal on the screen. We will see how this is done shortly.

Slide #11



The IF filter is a bandpass filter which is used as the "window" for detecting signals. It's bandwidth is also called the resolution bandwidth (RBW) of the analyzer and can be changed via the front panel of the analyzer.

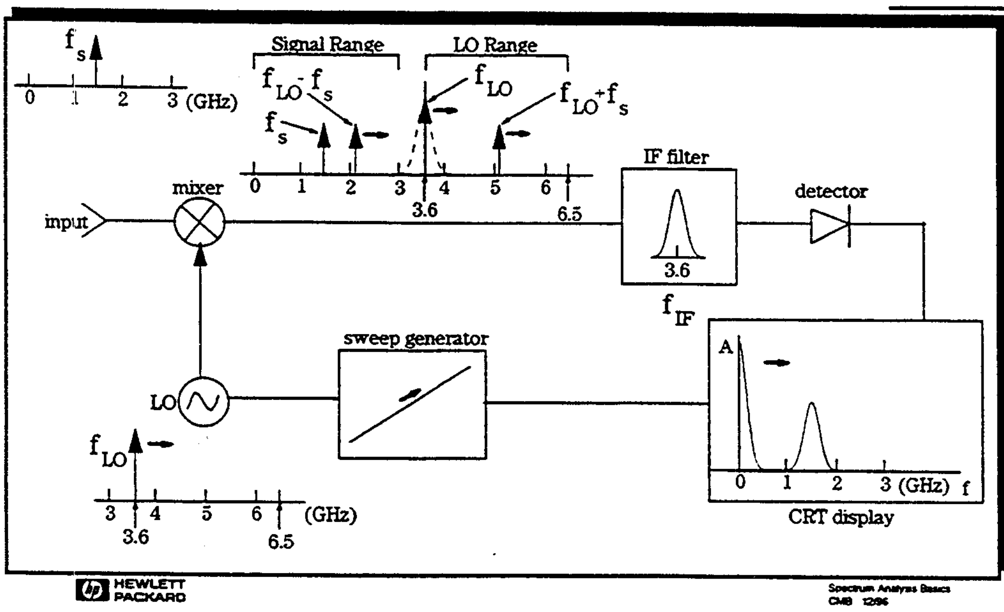
By giving you a broad range of variable resolution bandwidth settings , the instrument can be optimized for the sweep and signal conditions, letting you trade-off frequency selectivity (the ability to resolve signals), signal-to-noise ratio (SNR), and measurement speed.

We can see from the slide that as RBW is narrowed, selectivity is improved (we are able to resolve the two input signals). This will also often improve SNR. The sweep speed and trace update rate, however, will degrade with narrower RBWs. The optimum RBW setting depends heavily on the characteristics of the signals of interest.

Slide #15

Theory of Operation

How it all works together



Let's see how these components work together to make a spectrum analyzer. Note that while the RF input attenuator, IF gain, and video filter are important components, they are not critical when describing how the analyzer works.

First of all, the signal to be analyzed is connected to the input of the spectrum analyzer. This input signal is then combined with the LO through the mixer, to convert (or translate) it to an intermediate frequency (IF). These signals are then sent to the IF filter. The output of this filter is detected, indicating the presence of a signal component at the analyzer's tuned frequency. The output voltage of the detector is used to drive the vertical axis (amplitude) of the analyzer display. The sweep generator provides synchronization between the horizontal axis of the display (frequency) and tuning of the LO. The resulting display shows amplitude versus frequency of spectral components of each incoming signal. Let's use the figure above to illustrate this point.

The horizontal arrows are intended to illustrate the "sweeping" of the analyzer. Starting with our LO at 3.6 GHz, the output of the mixer has four signals, one of which is at 3.6 GHz (f_{LO}). Notice that our IF filter is also at 3.6 GHz (it's shape has been imposed onto the frequency graph for clarity). Therefore, we expect to see this signal on the display. At 0 Hz on the CRT, we do indeed see a signal - this is called "LO Feedthrough". Now let's visualize our sweep generator moving to the right, causing our LO to sweep upward in frequency. As the LO sweeps, so too will three of the mixer output signals (the input signal is stationary). As our LO Feedthrough moves out of the IF filter bandwidth, we see it taper off on the display. As soon as our difference frequency (f_{LO}-f_s) comes into the skirt of the IF filter, we start to see it. When it is at the center (e.g. 3.6 GHz) we see the full amplitude of this signal on the display. And, as it moves further to the right, it leaves the filter skirt, and no signal is seen on the display.

So there it is. We've just seen our signal being swept through the fixed IF filter, and be properly displayed on the analyzer screen. That's how it works!