

INTRODUCTION TO SPECTRUM ANALYSIS & HANDS-ON USE OF A SPECTRUM ANALYSER

ECE 328 – PRINCIPLES OF COMMUNICATION SYSTEMS

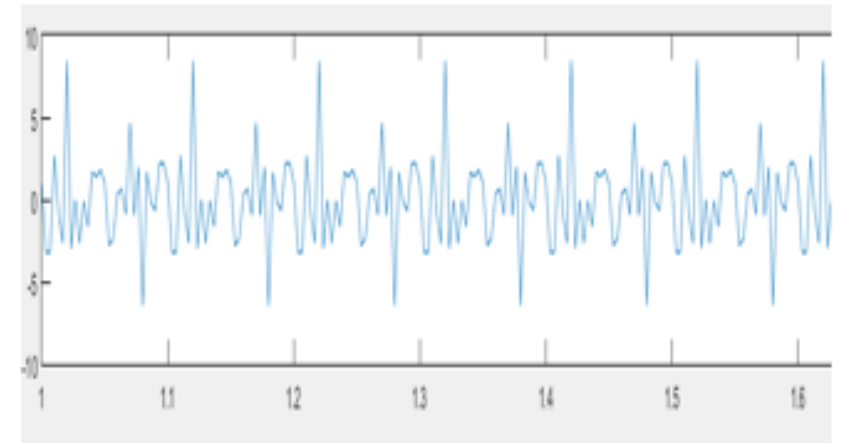
Sunday, 09 July 2017

WHAT IS A SPECTRUM ANALYSER?

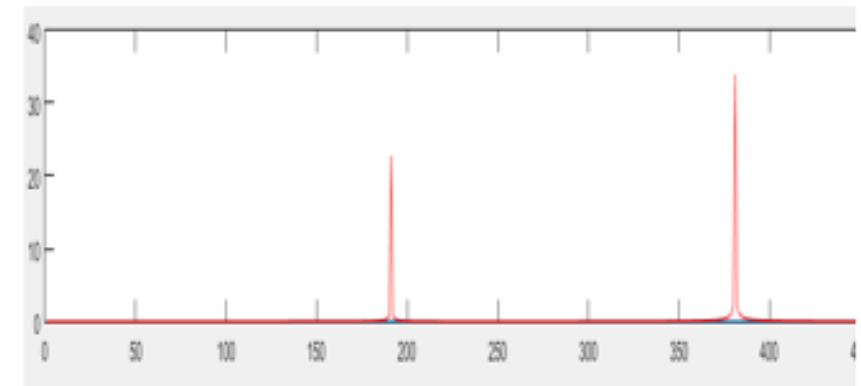
- At the most basic level, a spectrum analyser can be described as a frequency selective, peak-responding voltmeter calibrated to display the RMS values of individual sine wave components.
- It is important to understand that the spectrum analyzer is not a power meter, even though it can be used to display power directly.
- As long as we know some value of a sine wave (for example, peak or average) and know the resistance across which we measure this value, we can calibrate our voltmeter to indicate power.

TIME & FREQUENCY DOMAIN ANALYSIS

1. Fourier theory tells us any time-domain electrical phenomenon is made up of one or more sine waves of appropriate frequency, amplitude, and phase.
2. The Fourier Transform transforms a time-domain signal into its frequency domain equivalent.
3. Measurements in the frequency domain tell us how much energy is present at each particular frequency.
4. With proper filtering, a waveform can be decomposed into separate sinusoidal waves, or spectral components, which we can then evaluate independently.
5. Each sine wave is characterized by its amplitude and phase.
6. If the signal we wish to analyse is periodic, the constituent sine waves are separated in the frequency domain by $1/T$, where T is the period of the signal.



(a) Signal in Time domain



(b) Signal in Frequency domain

WHAT IS A SPECTRUM?

A spectrum is a collection of sine waves that, when combined properly, produce the time-domain signal under examination.

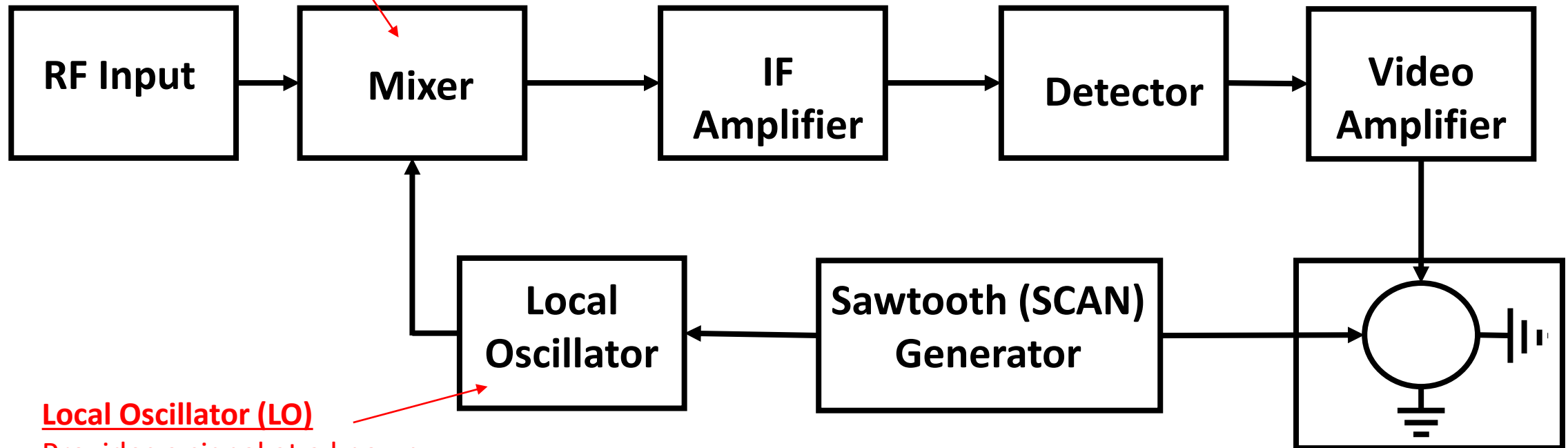
WHY MEASURE SPECTRA

- To determine the harmonic content of a signal.
- To measure out of band spurious emissions.
- To measure distortion of messages through intermodulation.
- To monitor the use of the spectrum by regulatory agencies to minimize electromagnetic interference.
- To measure signal and noise parameters such as SNR and Noise Figure.

BLOCK DIAGRAM OF SUPERHETRODYNE SPECTRUM ANALYSER

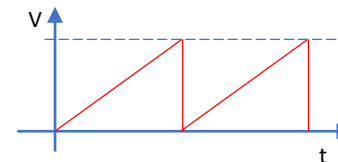
Mixer

Three-port circuit element that takes two input signals and creates an output signal that is a combination of both the RFIN and LO

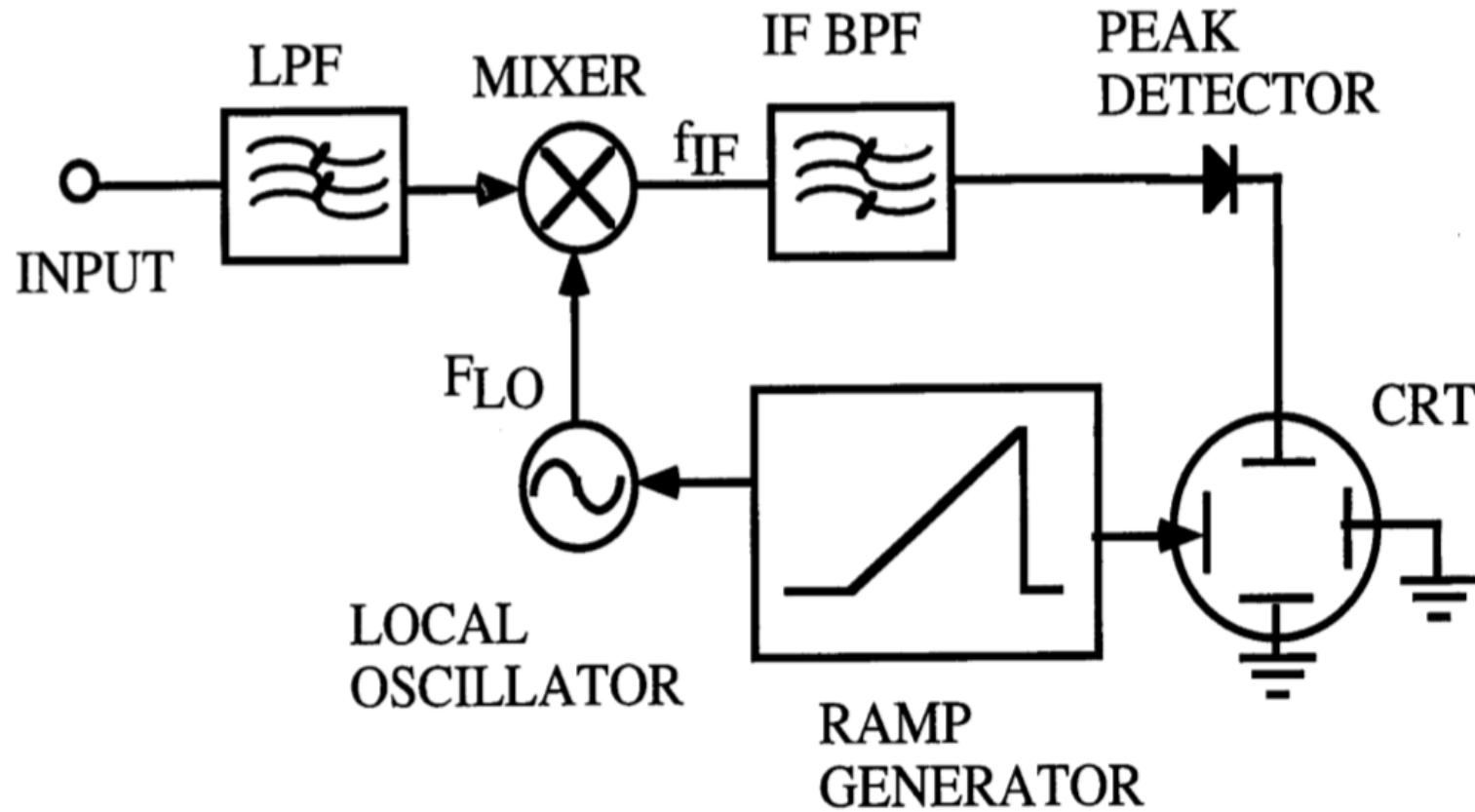


Local Oscillator (LO)

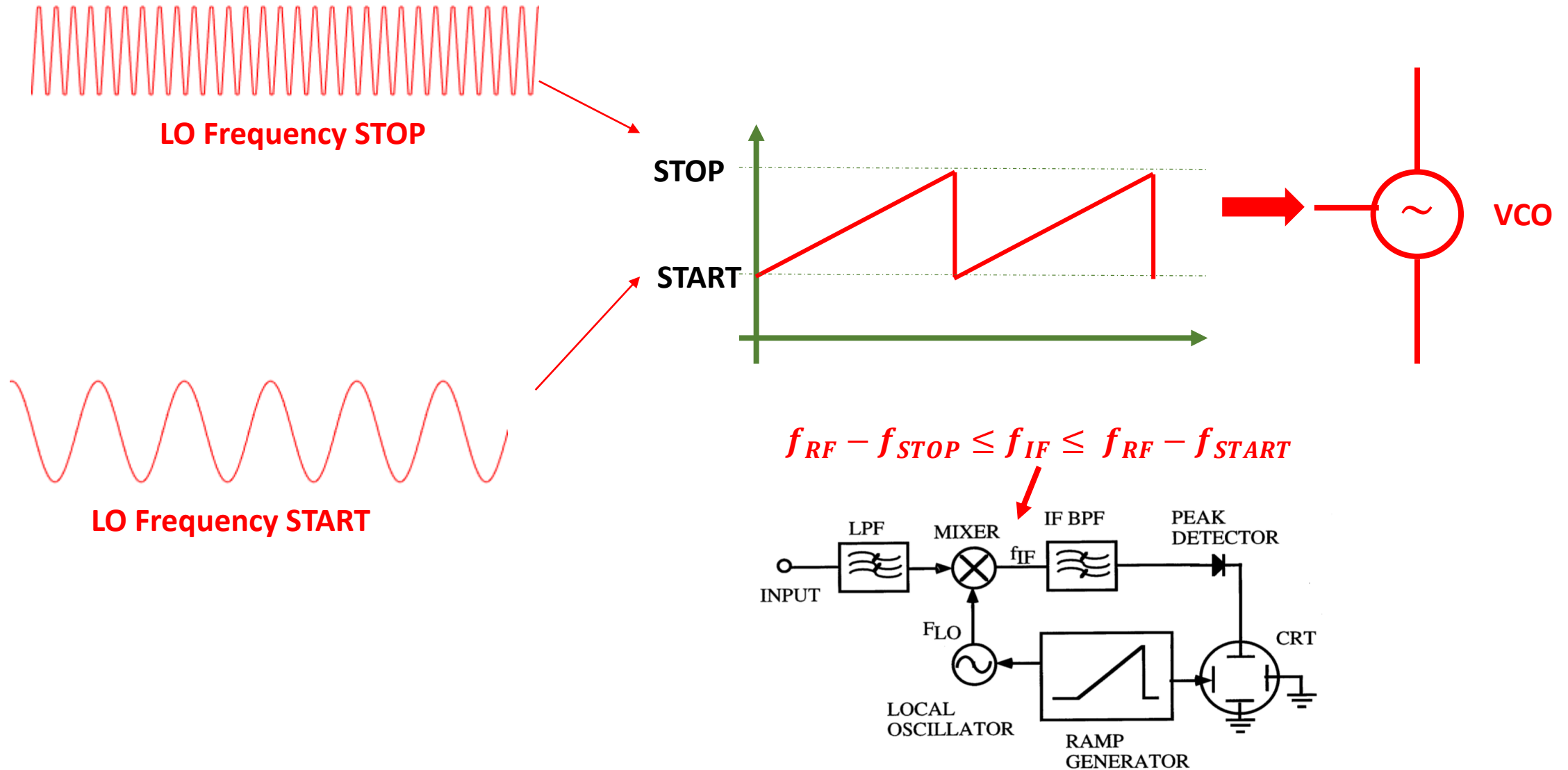
Provides a signal at a known frequency and amplitude.



BLOCK DIAGRAM OF SUPERHETRODYNE SPECTRUM ANALYSER USING A DIODE DETECTOR

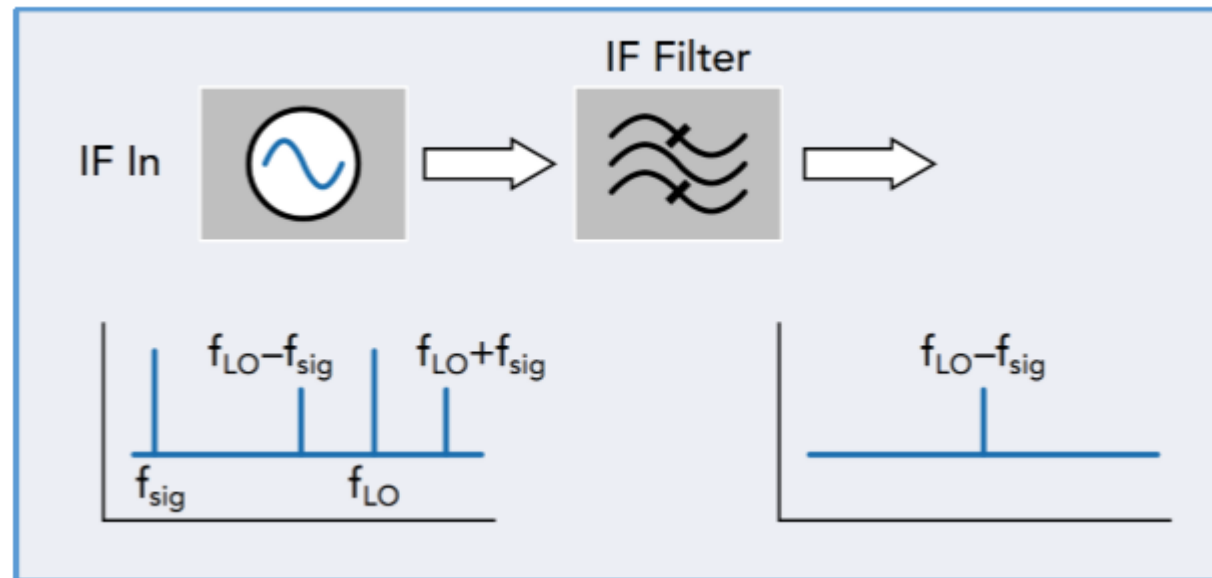


SPECTRUM ANALYSER LOCAL OSCILLATOR CONTROLS

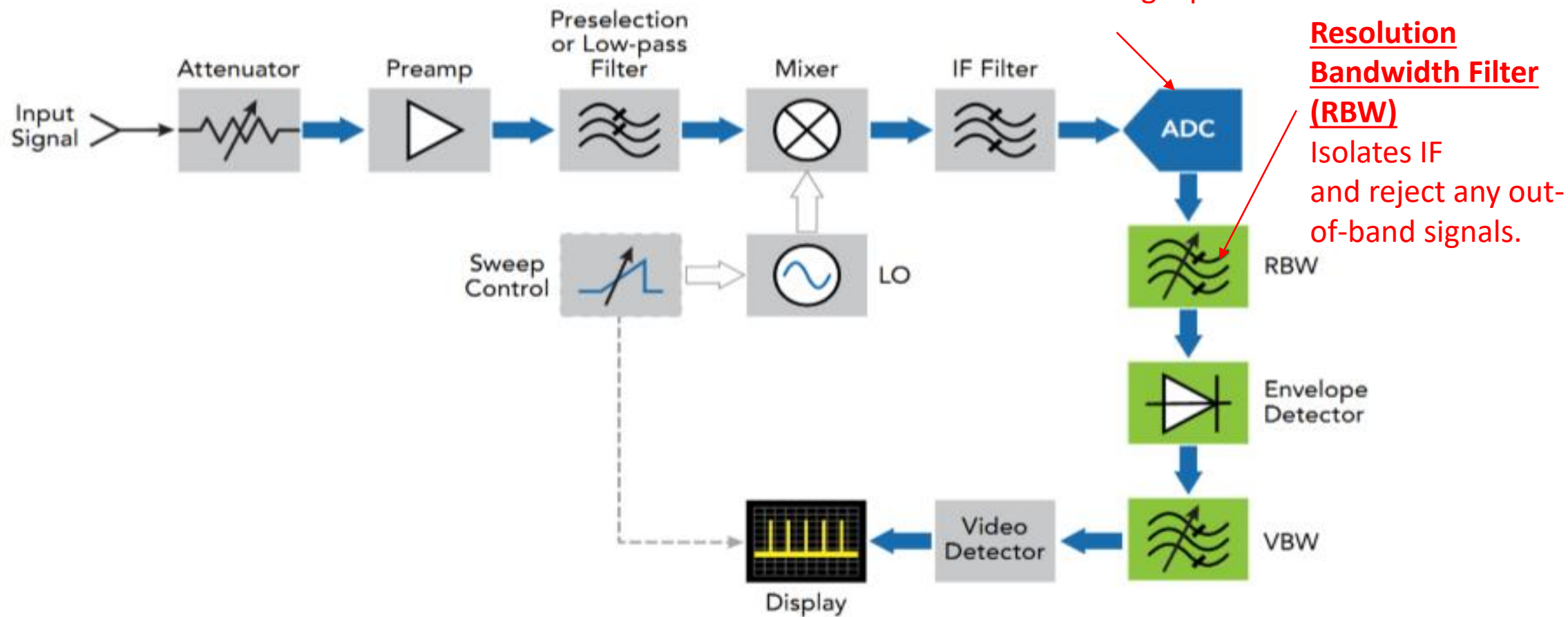


SPECTRUM ANALYSER – IF FILTER

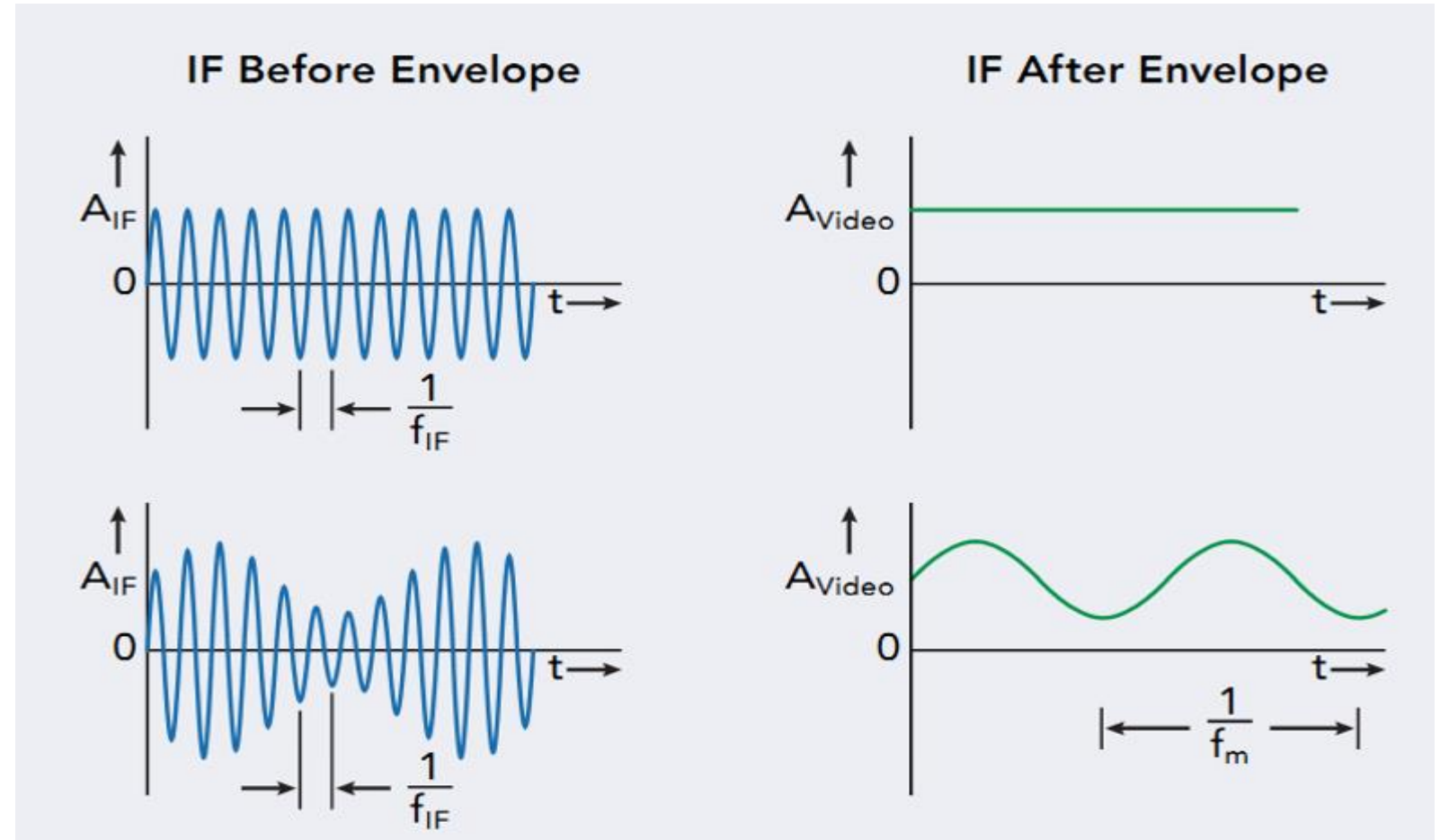
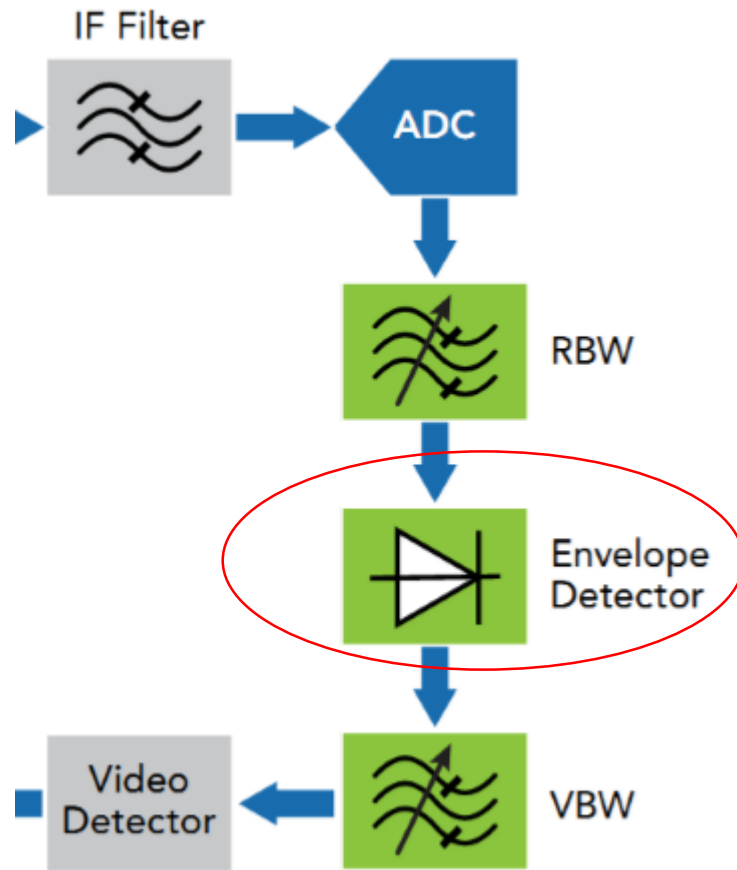
IF filter selects the $f_{\text{sig}} - f_{\text{LO}}$, and leaves either the upconverted ($f_{\text{LO}} + f_{\text{sig}}$) or the down-converted signal $f_{\text{LO}} - f_{\text{sig}}$.



MODERN SPECTRUM ANALYSER WITH ADC, RBW & VBW

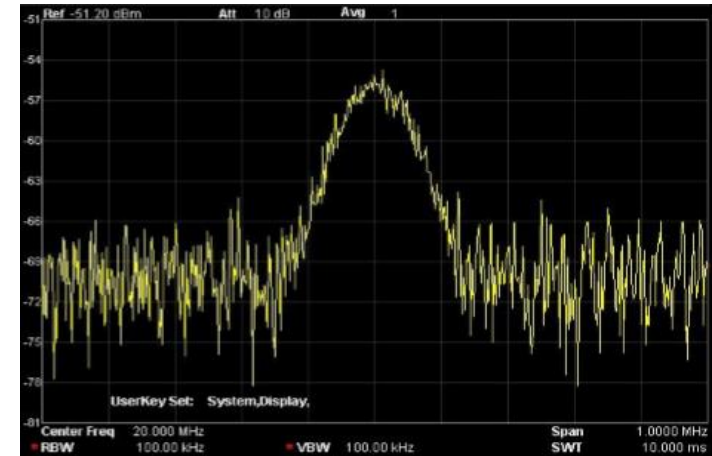


MODERN SPECTRUM ANALYSER – ENVELOPE DETECTOR

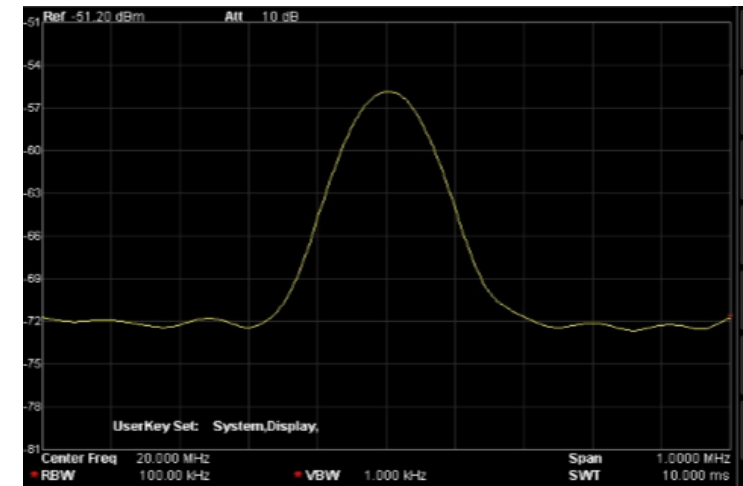


VIDEO BANDWIDTH (VBW) FILTER

1. **Video Bandwidth (VBW) filter** is a low pass filter that is applied to each frequency bin before sending the appropriate amplitude value to the display.
2. **VBW** effectively averages (smoothens) the signal and can be used to minimize the effects of noise on the displayed trace.
3. **VBW** is especially useful when dealing with low power signals that are close to the noise floor of the instrument.

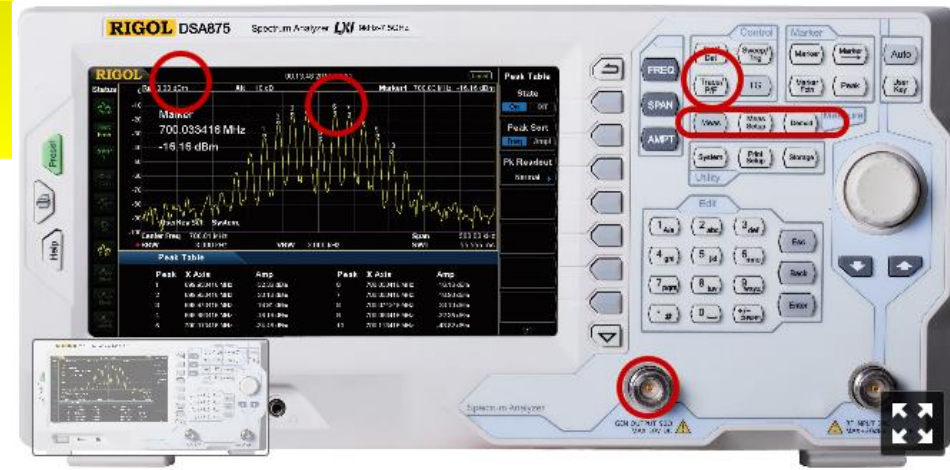


(a) VBW set to 100 KHz



(a) VBW set to 10 KHz

DSA 815 SPECTRUM ANALYSER



SPECIFICATIONS

1. 9 kHz to 1.5 GHz Frequency Range
2. Displayed Average Noise Level (DANL) normalized to 1 Hz ranging from -135 dBm to -161 dBm typical
3. -80 to -98 dBc/Hz @10 kHz offset Phase Noise
4. Total Amplitude Uncertainty from <1.5 dB to <0.8 dB nominal
5. 100 or 10 Hz Minimum Resolution Bandwidth (RBW) available
6. All-Digital IF Technology

AMPT

Set the reference level, RF attenuator, scale and the unit of Y-axis, etc

SPAN

Set the frequency span of the sweep.

FREQ

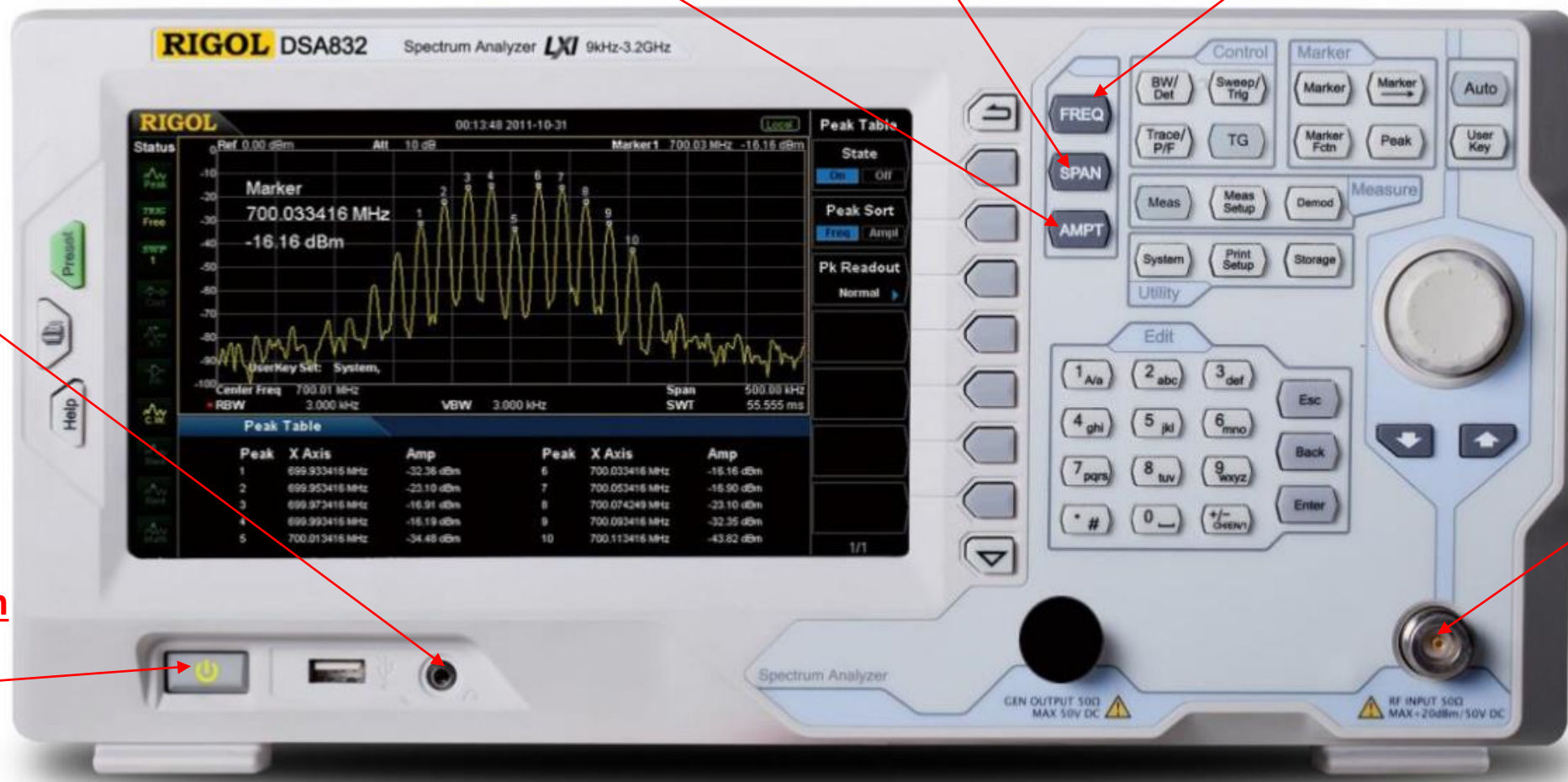
Set the centre, start and stop frequency, etc; enable the signal tracking function.

Earphone jack

Listen to demodulated signal

Power Switch

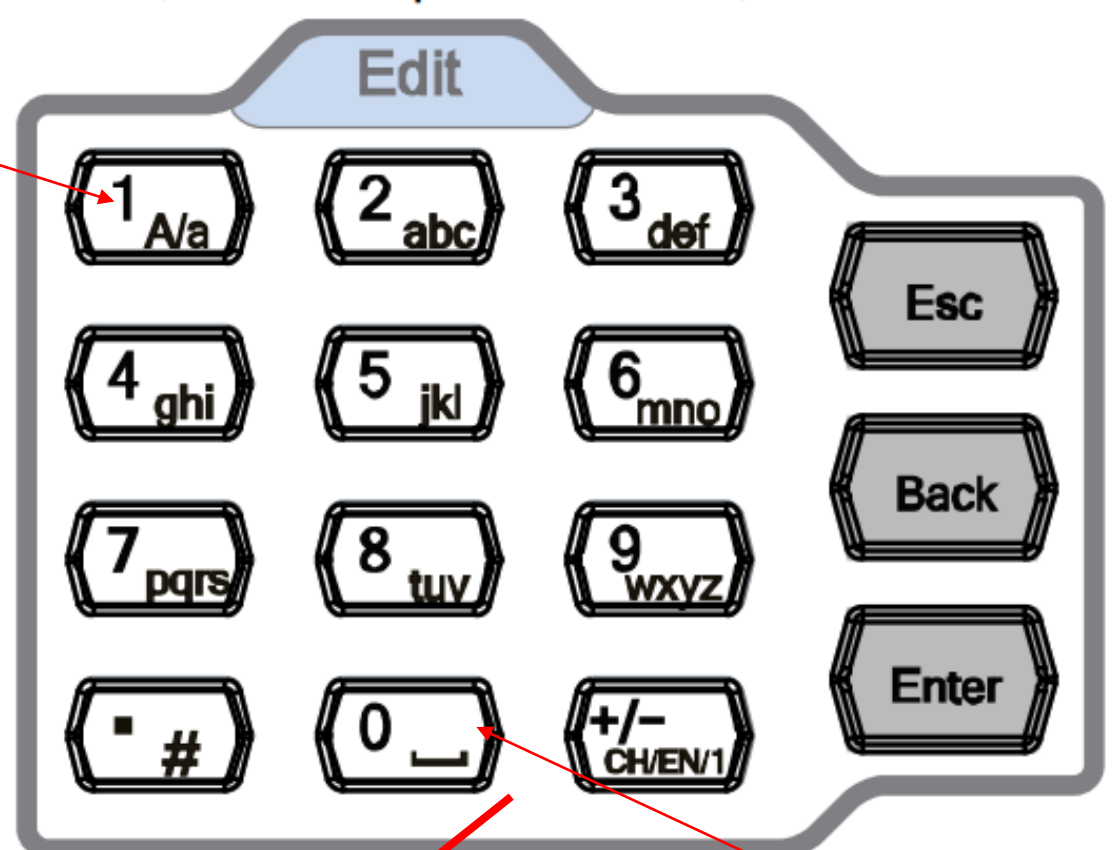
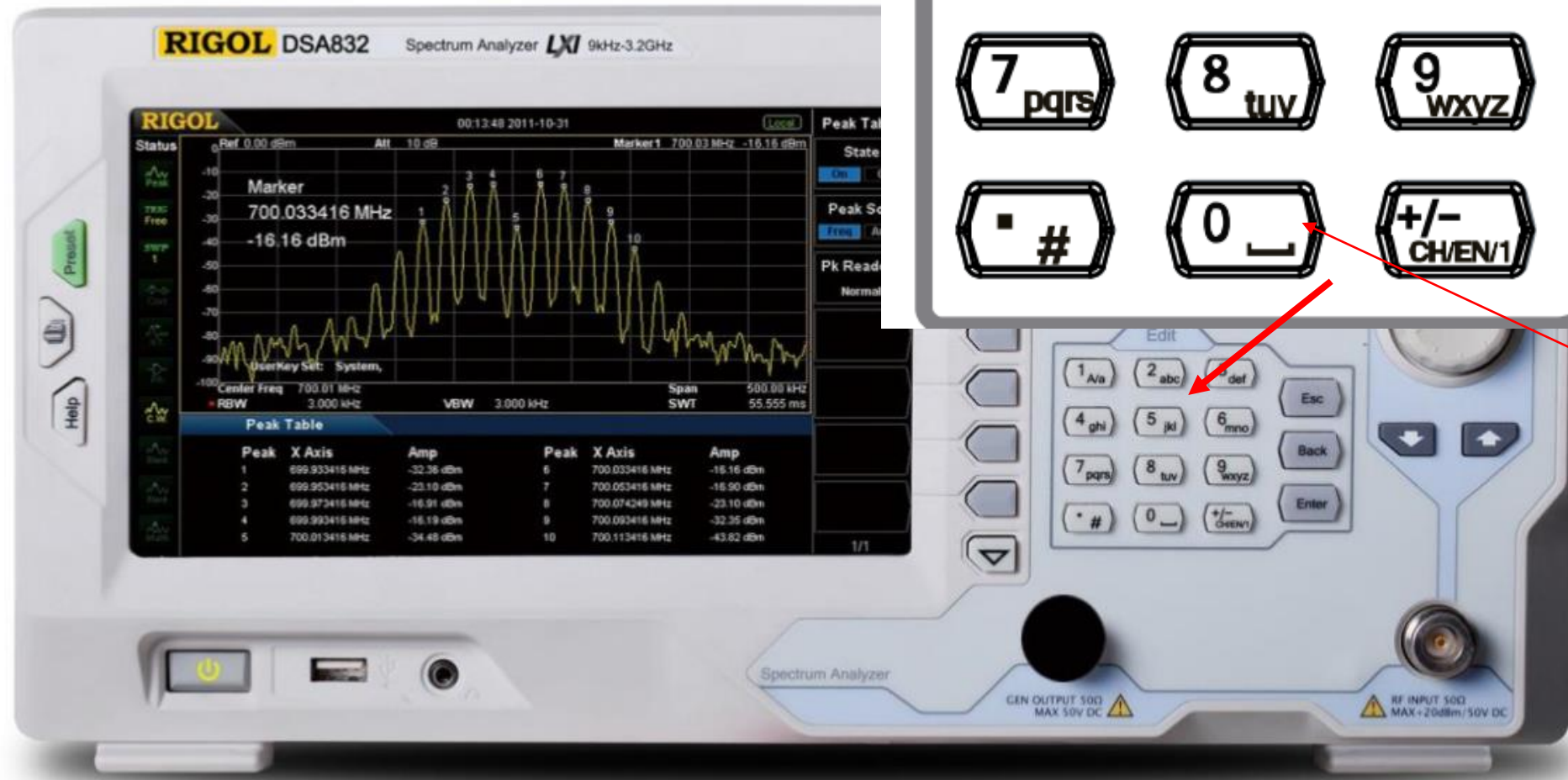
Switch on or off



RF IN

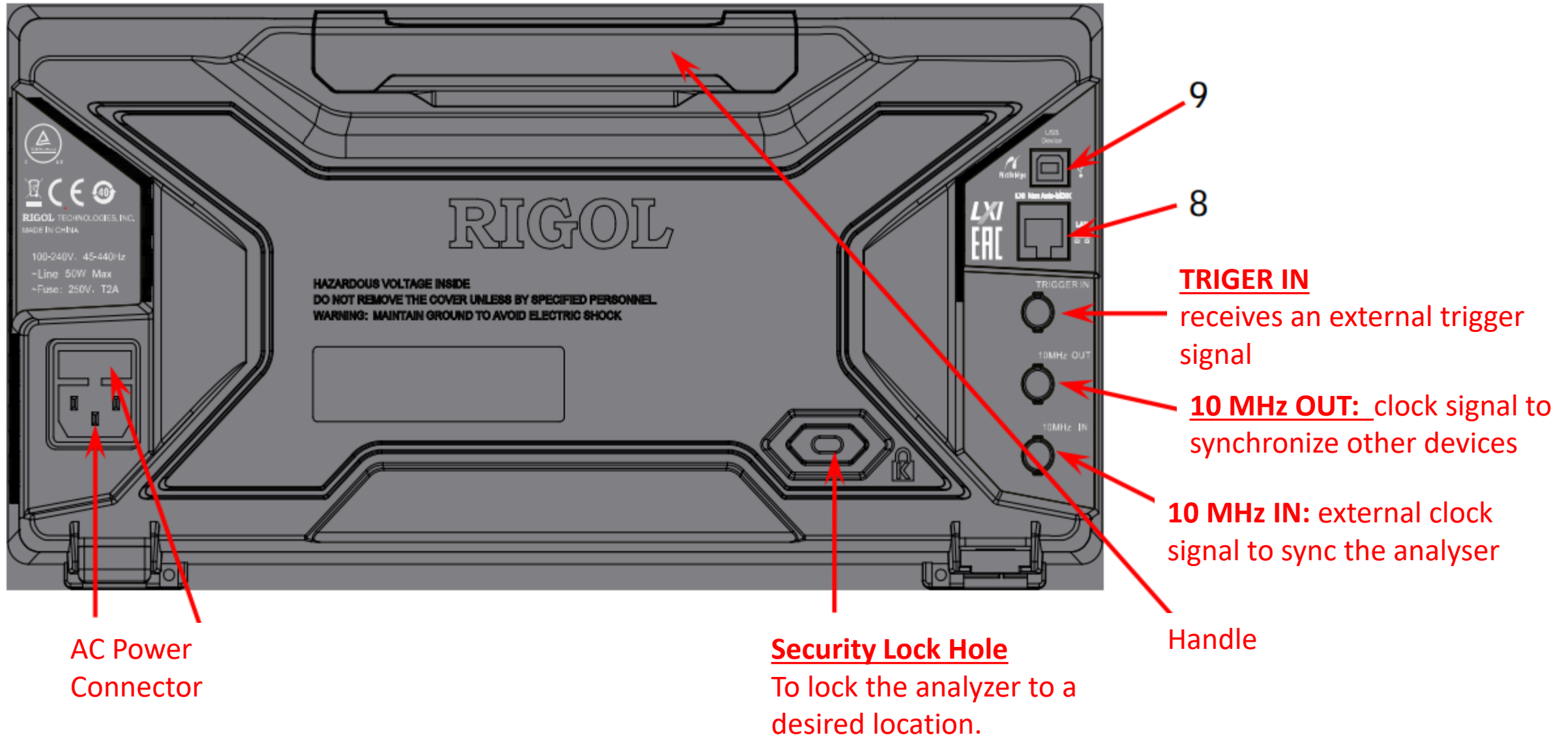
Connect RF signal source test here

input 1 in number input and
switch between uppercase(A)
and lowercase letter (a)



Multiplexing key
for 0 and space

DSA 832 SPECTRUM ANALYSER – REAR VIEW



LCD SCREEN DISPLAY

