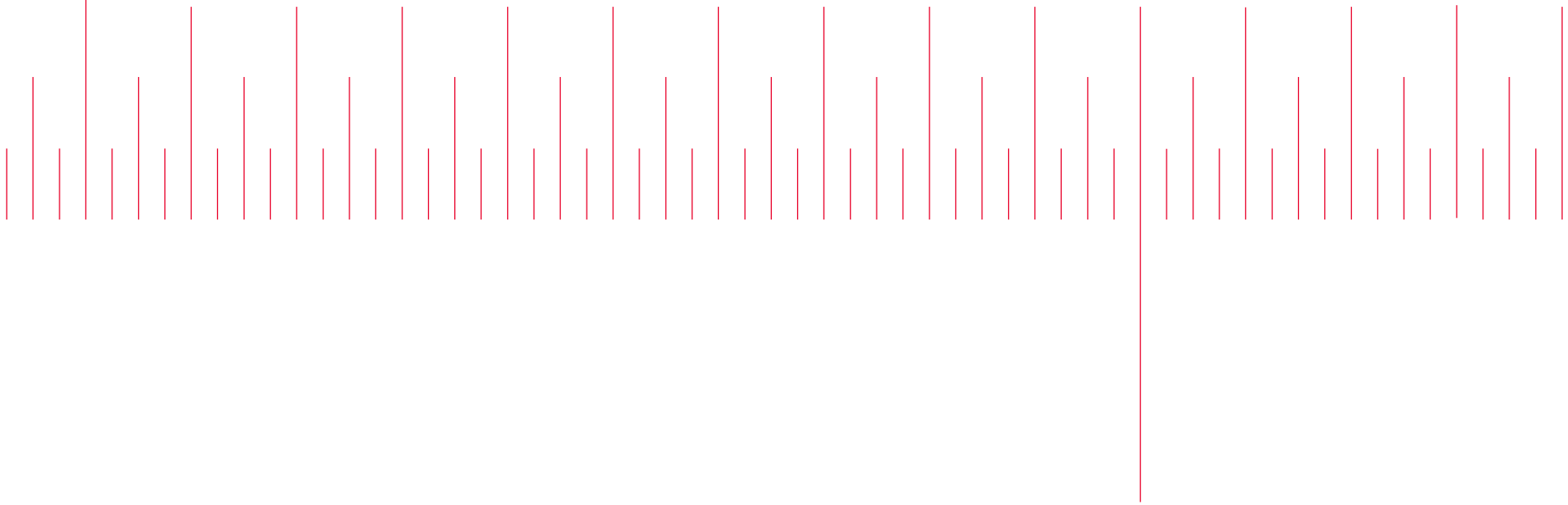
Why/When I need a Spectrum Analyzer

Jan 12, 2017

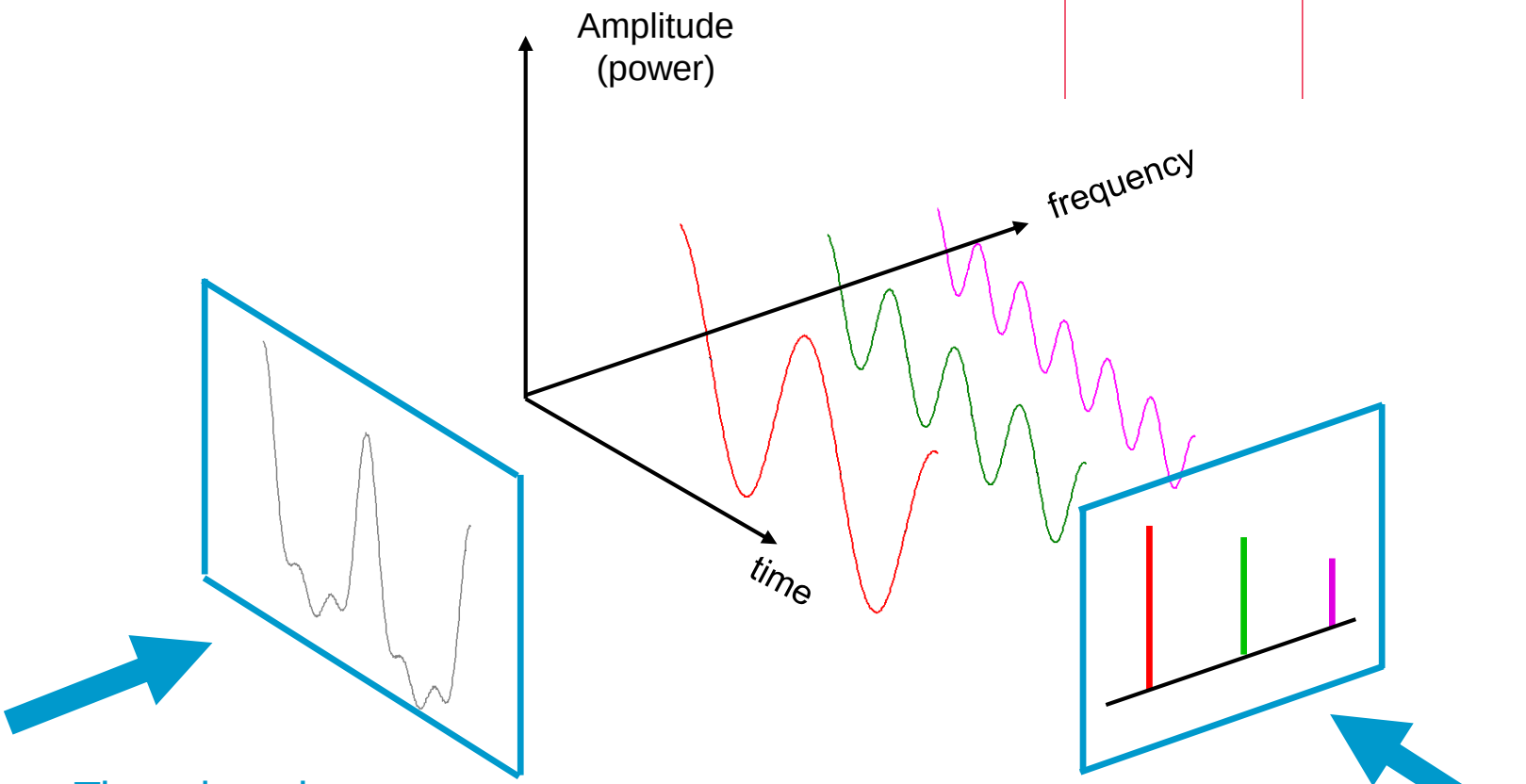


KEYSIGHT TECHNOLOGIES

Common Questions

- What's the difference of Oscilloscope and Spectrum Analysis
- Almost all Oscilloscope has FFT for a spectrum view, why I need a spectrum analyzer?
- When shall I using a spectrum analyzer instead of oscilloscope?

View Angles of a Signal



Time domain
Measurements
(Oscilloscope)

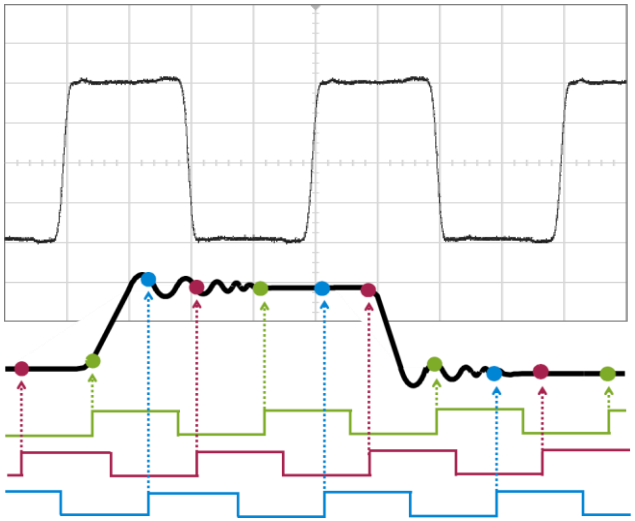
Frequency Domain
Measurements
(Spectrum Analyzer)

KEYSIGHT
TECHNOLOGIES

Differences between a Scope and a Spec'an – Signal Type

Oscilloscope mainly intends to test base band signal

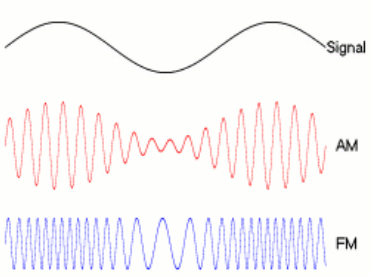
- **Baseband** is the band of frequencies from close to 0 hertz up to a higher cut-off frequency or maximum bandwidth
- Synonymous: **low-pass** or **non-modulated**

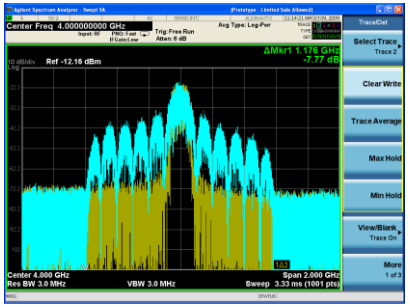


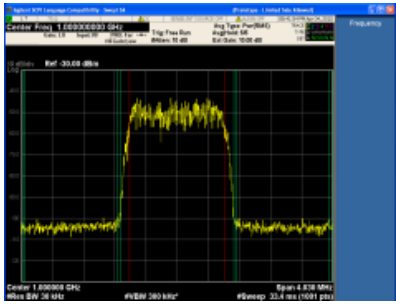
- http://en.wikipedia.org/wiki/Baseband

Spectrum Analyzer mainly intends to test RF/modulated signal

- A **modulated RF** signal allowed information transmitted over distance via radiation







- http://en.wikipedia.org/wiki/Modulation

Differences between a Scope and a Spec'an - Bandwidth

Oscilloscope

- Relatively **narrower** frequency range, typically
  - DC to 100sMHz
  - DC to a few GHz
- Relative narrower in amp(Y) axis
  - mVolt to Volt
- Oscilloscope's a **wide band analyzer** in term of real time BW
  - Typically same as frequency range

Spectrum Analyzer

- Relatively **wider** frequency range, typically
  - A few kHz to GHz
  - A few kHz to 10s GHz
- Much wider range in Amp(Y) axis
  - -170 ~ -160 dBm to +30 dBm
- SA is a **narrow bands analyzer** in term of real time BW, but SAs are able to tune
  - Typically Hz to 10s or 100s MHz

Differences between a Scope and a Spec'an - Measurement item

Oscilloscope	Spectrum Analyzer
• **Voltage** vs **Time**	• **Power** vs **Frequency**
• Measures	• Measures
- Voltage	- Spectrum monitoring
- Period	- Spurious emission
- Rising/falling edges	- Noise Figure
- Overshoot	- Phase Noise
- Glitch	- Harmonic & Intermodulation Distortion
- Timing sequence	- Electromagnetic Interference
	- Demodulation Analysis

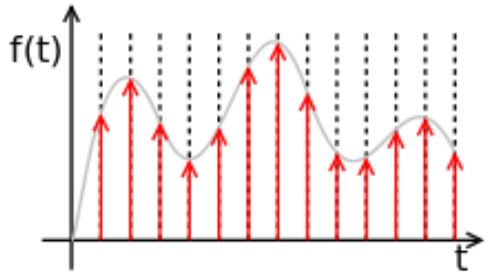
Differences between a Scope and a Spec'an - Sensitivity

Oscilloscope	Spectrum Analyzer
• Oscilloscope tests voltage	• SA tests power
• Conductive connected	• Either terminated or radiated
• Bridge to DUT with **high impedance**	• Directly bridge to DUT is not allowed
• Wide band receiver and analysis means higher internal noise	• Narrow band receiver and analysis means lower internal noise
• **For Signal in circuits** - Down to mV level	• **For Signal to/from radiated** - Down to -160 dBm or even -170 dBm (equally to 0.01mV level)

Differences between a Scope and a Spec'an - Dynamic Range

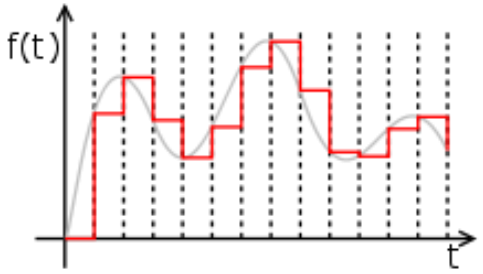
Oscilloscope

- DAC in Scope is just 6~8 digits
  - 36 ~ 48 dB dynamic range
  - Linear scale in volt is enough
- Baseband signals are transmitted on conducted circuit board, it means low path lose
- Wider dynamic range is not a strong desire for oscilloscope



Spectrum Analyzer

- DAC in SA is 12~14 digits
  - 72 ~ 84 dB dynamic range
  - Typically using log scale in power
- RF signal is intended to be radiated, it means very high propagation lose
- Both large signal and very small signal might be tested simultaneously
- Wide Dynamic Range is strongly desired



Sample rate and digits of DAC is a pair conflicted parameters

Difference Between Scope and SA - Money Specifications

Oscilloscope	Spectrum Analyzer
• Bandwidth	• Frequency range
• Sample rate	• DANL
• Qty of channels	• TOI
• Memory depth	• Phase noise
	• Demodulation bandwidth

When I Need a Spectrum Analyzer

- Signal under test or device under test is mainly about RF, like mobile phone, WIFI devices
- To test unknown RF signal, like interference monitoring, EMI detection
- To measure high level and lower level signal components simultaneously, like harmonic, intermodulation and spur test
- Very low signal on/around PCB board, like unwanted coupling on PCB, interference from switching DC power supply, digital clock
- To troubleshooting board/device mixed with both digital and analog RF receiver, like CE devices integrating GPS receiver, IOT device include 2.4GHz transceiver module, etc

Wrap Up

- **I am not telling you that spectrum analyzer is better than oscilloscope.**

- **Shall you use oscilloscope or spectrum analyzer is quite determined by the DUT types and what you are caring about.**