Why/When I need a Spectrum Analyzer

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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)

Amplitude (power)
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

Spectrum Analyzer mainly intends to test RF/modulated signal

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

## Differences between a Scope and a Spec’an - Bandwidth

<table>
<thead>
<tr>
<th>Oscilloscope</th>
<th>Spectrum Analyzer</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Relatively <strong>narrower</strong> frequency range, typically</td>
<td></td>
</tr>
<tr>
<td>- DC to 100sMHz</td>
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<tr>
<td>- DC to a few GHz</td>
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<tr>
<td>• Relative narrower in amp(Y) axis</td>
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<tr>
<td>- mVolt to Volt</td>
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<tr>
<td>• Oscilloscope’s a <strong>wide band analyzer</strong> in term of real time BW</td>
<td></td>
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<tr>
<td>- Typically same as frequency range</td>
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<tr>
<td>• Relatively <strong>wider</strong> frequency range, typically</td>
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<tr>
<td>- A few kHz to GHz</td>
<td></td>
</tr>
<tr>
<td>- A few kHz to 10s GHz</td>
<td></td>
</tr>
<tr>
<td>• Much wider range in Amp(Y) axis</td>
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<tr>
<td>- -170 ~ -160 dBm to +30 dBm</td>
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<tr>
<td>• SA is a <strong>narrow bands analyzer</strong> in term of real time BW, but SAs are able to tune</td>
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<tr>
<td>- Typically Hz to 10s or 100s MHz</td>
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</table>
Differences between a Scope and a Spec’an
- Measurement item

**Oscilloscope**

- **Voltage** vs **Time**
- Measures
  - Voltage
  - Period
  - Rising/falling edges
  - Overshoot
  - Glitch
  - Timing sequence

**Spectrum Analyzer**

- **Power** vs **Frequency**
- Measures
  - Spectrum monitoring
  - Spurious emission
  - Noise Figure
  - Phase Noise
  - Harmonic & Intermodulation Distortion
  - Electromagnetic Interference
  - Demodulation Analysis
# Differences between a Scope and a Spec’an - Sensitivity

<table>
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<tr>
<td>- Oscilloscope tests voltage</td>
<td></td>
</tr>
<tr>
<td>- Conductive connected</td>
<td></td>
</tr>
<tr>
<td>- Bridge to DUT with <strong>high impedance</strong></td>
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</tr>
<tr>
<td>- Wide band receiver and analysis means higher internal noise</td>
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</tbody>
</table>

**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

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<tr>
<td>Bandwidth</td>
<td>Frequency range</td>
</tr>
<tr>
<td>Sample rate</td>
<td>DANL</td>
</tr>
<tr>
<td>Qty of channels</td>
<td>TOI</td>
</tr>
<tr>
<td>Memory depth</td>
<td>Phase noise</td>
</tr>
<tr>
<td></td>
<td>Demodulation bandwidth</td>
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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.