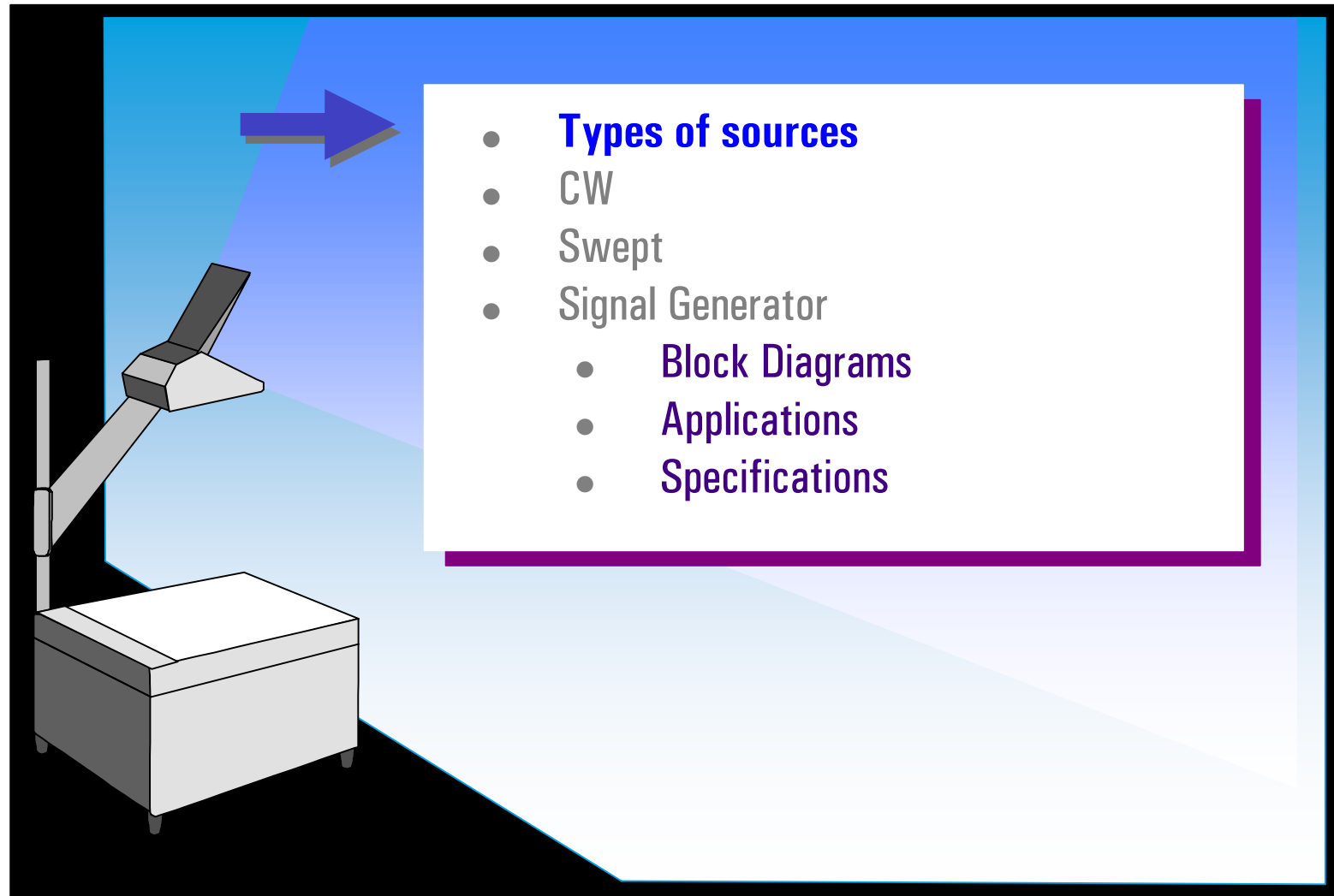
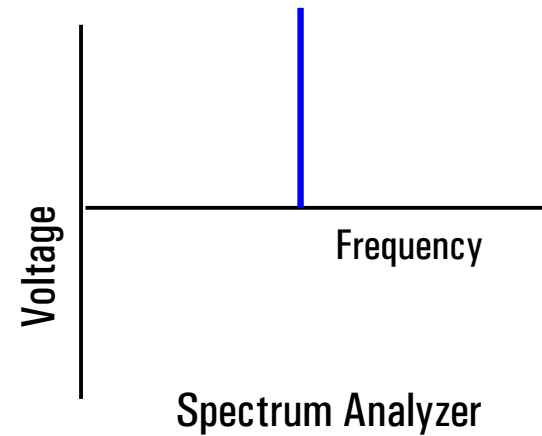
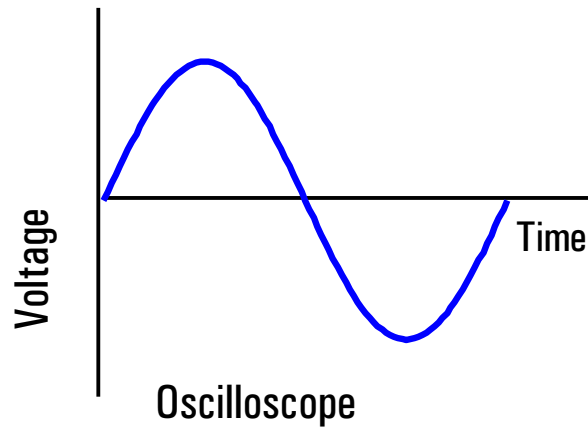


Agenda



Sources Generate Sine Waves



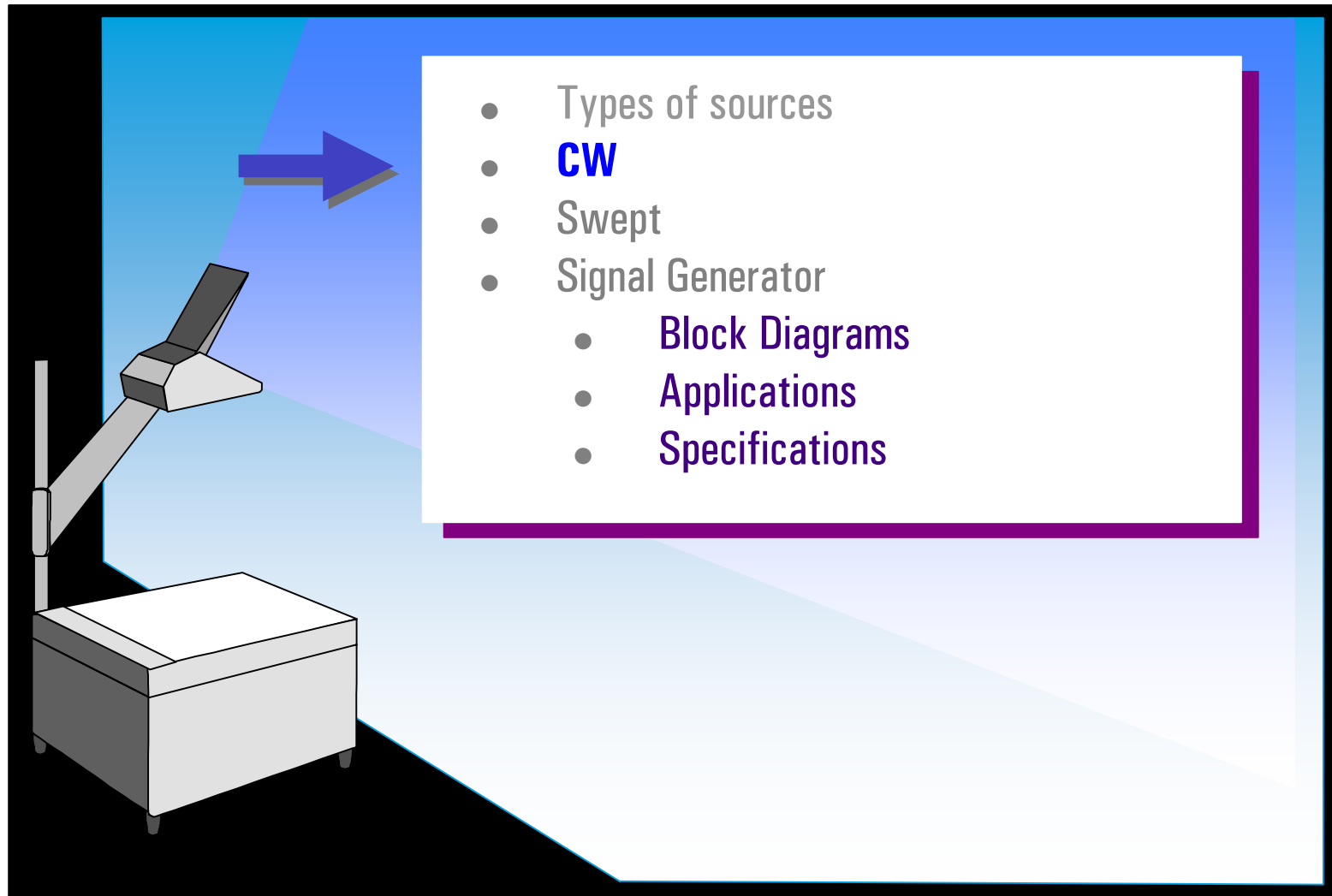
This is the ideal output: most specs deal with deviations from the ideal and adding modulation to a sine wave



Types of Sources

- **CW**
 - generates a single frequency, fixed sine wave
- **Swept**
 - sweeps over a range of frequencies
 - may be phase continuous
- **Signal Generator**
 - adds modulation
 - produces “real world” signal

Agenda

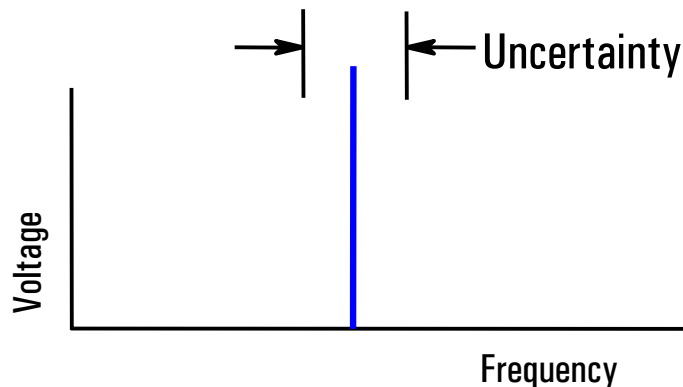


CW Source Specifications

...Frequency

- **Range:** Range of frequencies covered by the source
- **Resolution:** Smallest frequency increment.
- **Accuracy:** How accurately can the source frequency be set.

EXAMPLE



$$\text{Accuracy} = \pm f_{\text{CW}} * \tau_{\text{aging}} * \tau_{\text{cal}}$$

f_{CW}	=	CW frequency = 1 GHz
τ_{aging}	=	aging rate = 0.152 ppm/year
τ_{cal}	=	time since last calibrated = 1 year

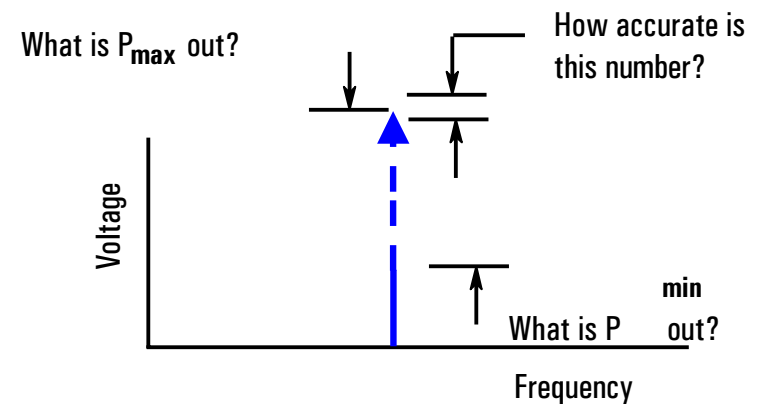
→ Accuracy = ± 152 Hz

CW Source Specifications

...Amplitude

- Range (-136dBm to +13dBm)
- Accuracy (+/- 0.5dB)
- Resolution (0.02dB)
- Switching Speed (25ms)
- Reverse Power Protection

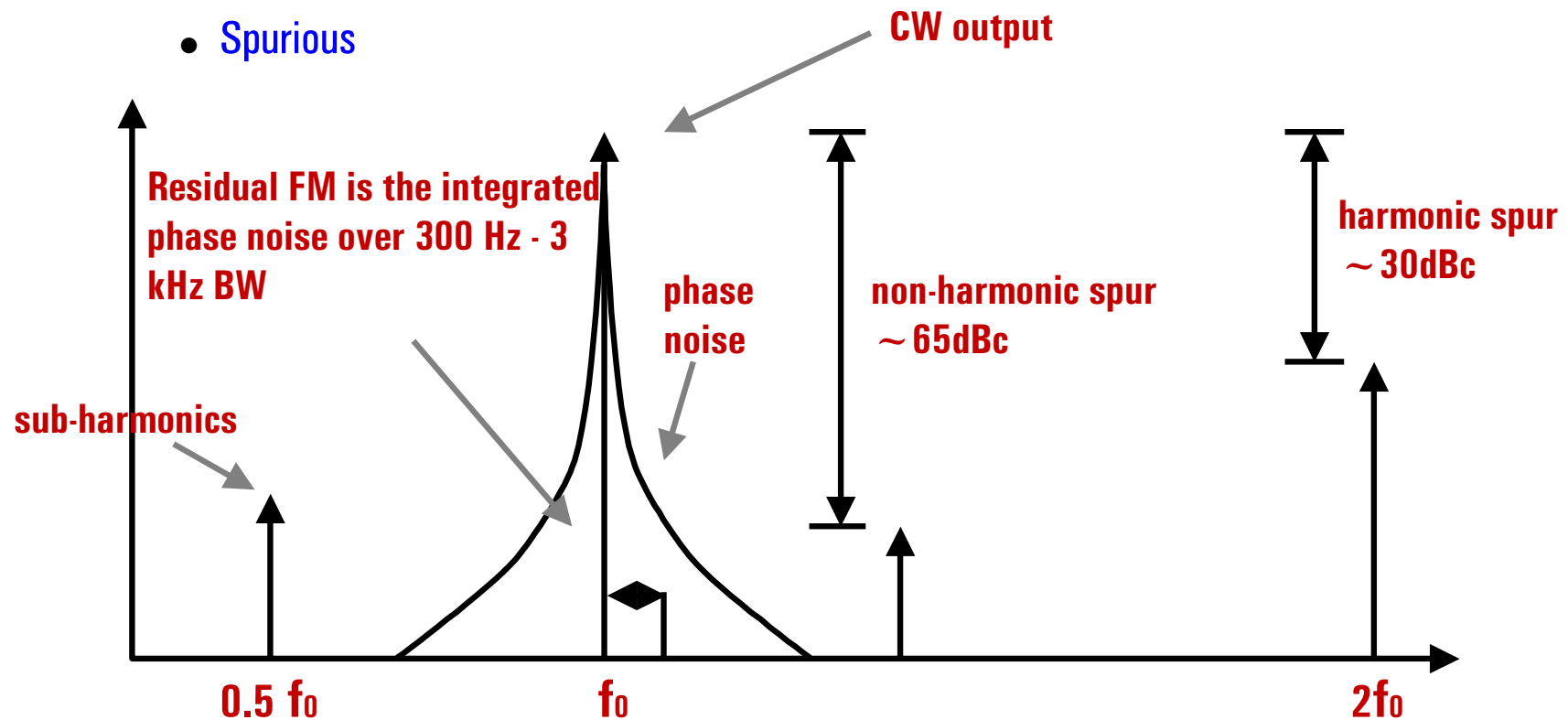
Source protected from accidental transmission from DUT



CW Source Specifications

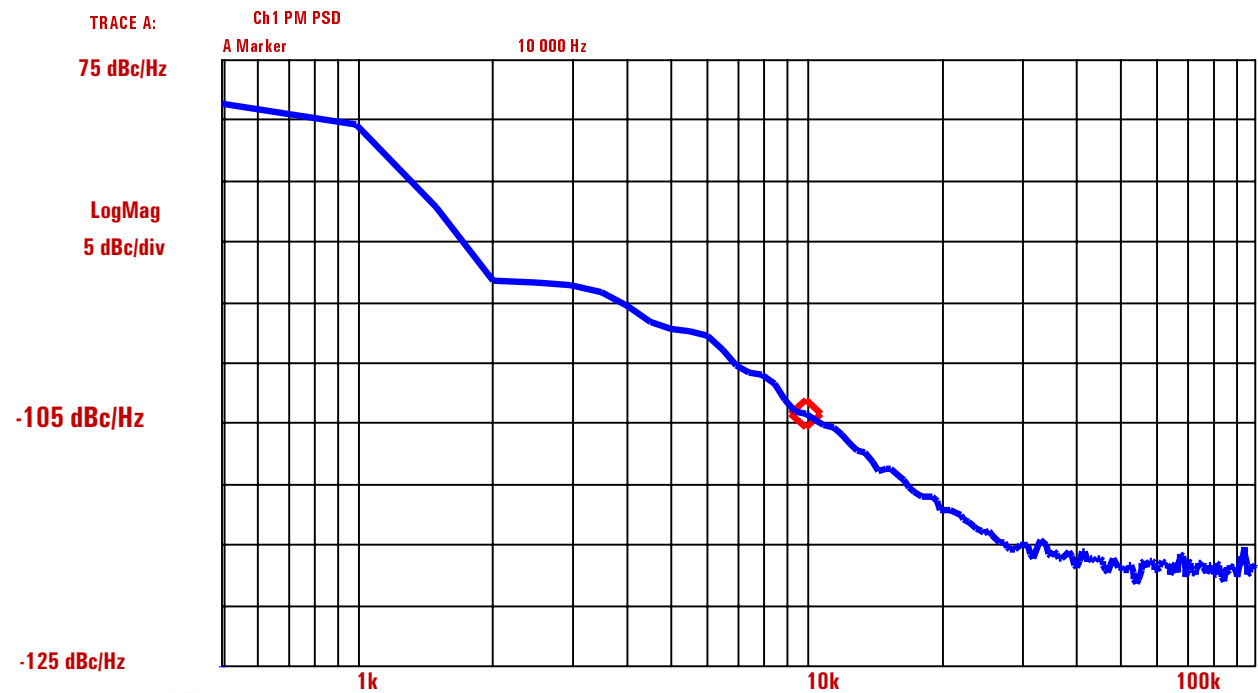
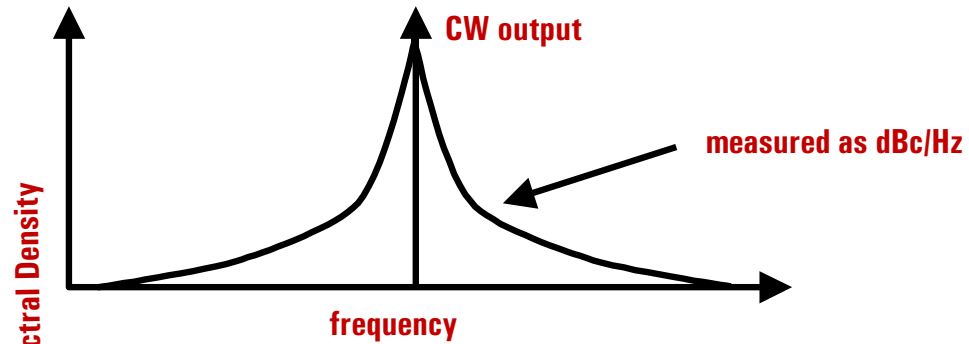
...Spectral Purity

- Phase Noise
- Residual FM
- Spurious



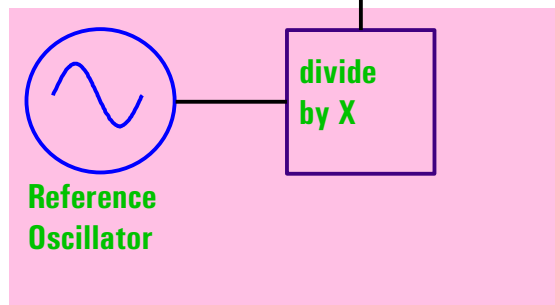
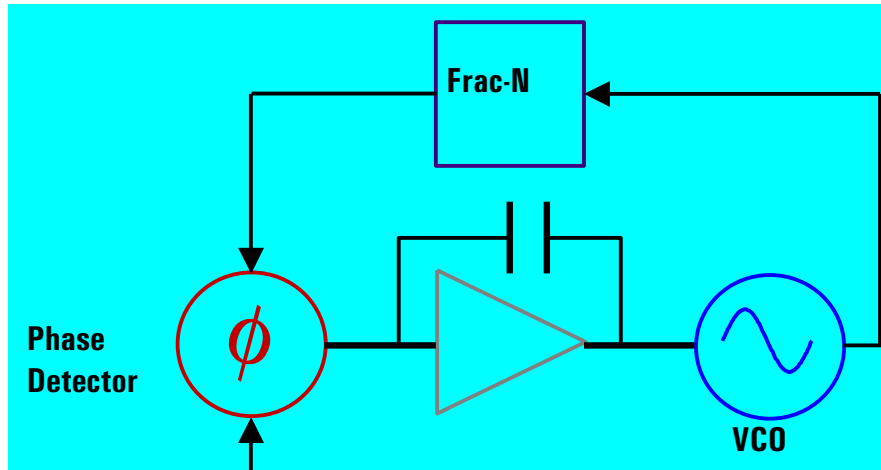
CW Source Specifications

... Spectral Purity: Phase Noise



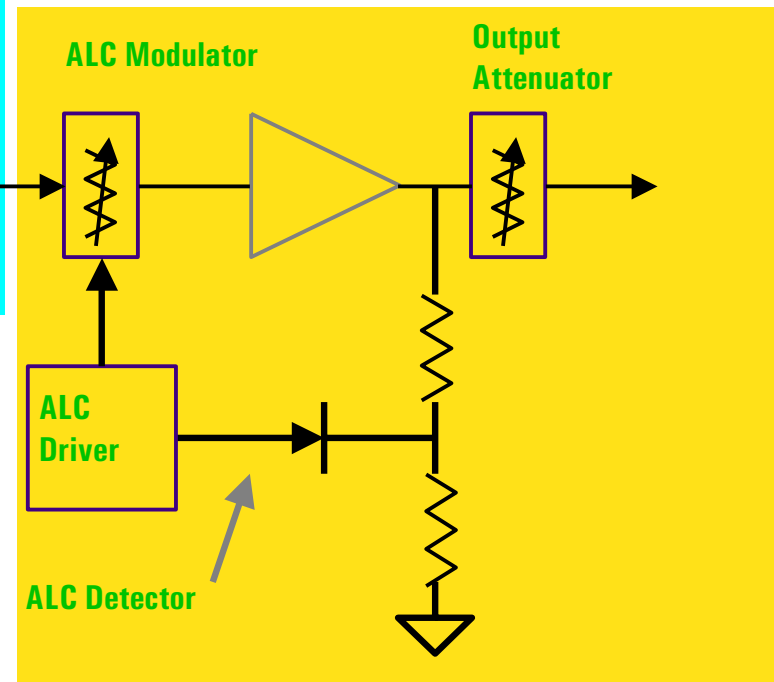
RF CW Block Diagram

Synthesizer Section



Reference Section

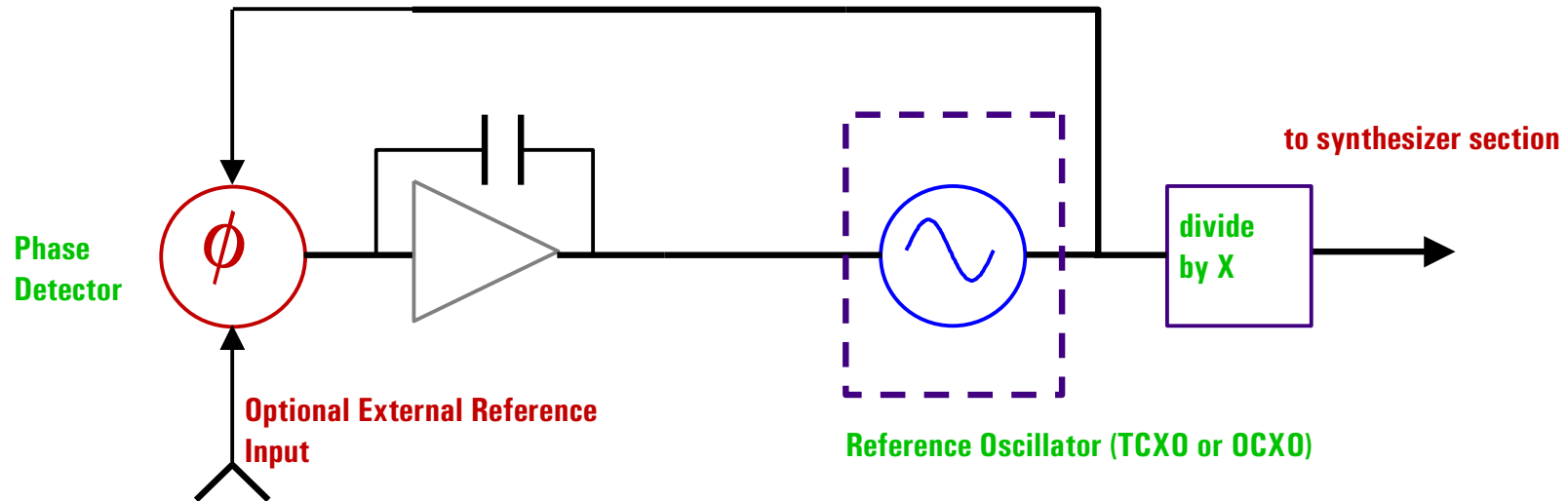
Output Section



ALC = automatic level control

RF CW Block Diagram

Reference Section

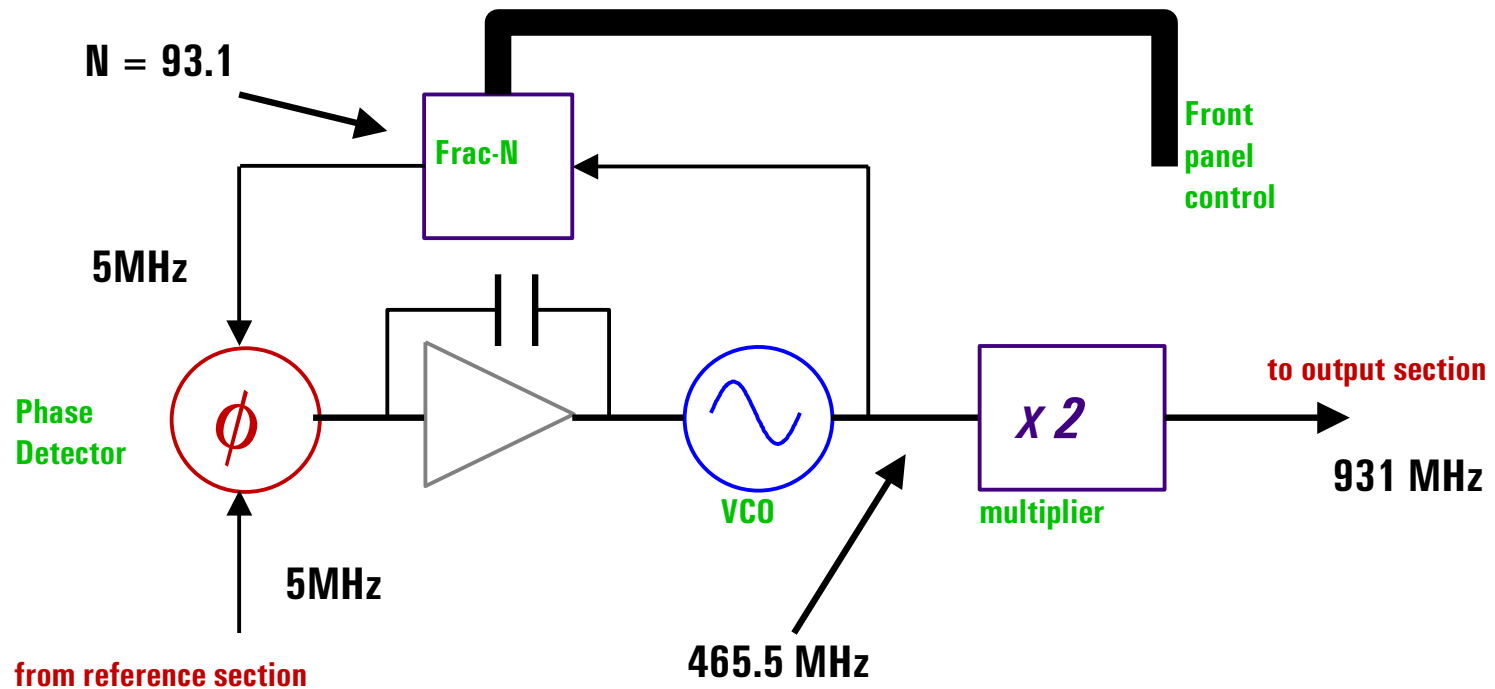


	TCXO	OCXO
Aging Rate	+/- 2ppm/year	+/- 0.1 ppm /year
Temp.	+/- 1ppm	+/- 0.01 ppm
Line Voltage	+/- 0.5ppm	+/- 0.001 ppm

RF CW Block Diagram

Synthesizer Section

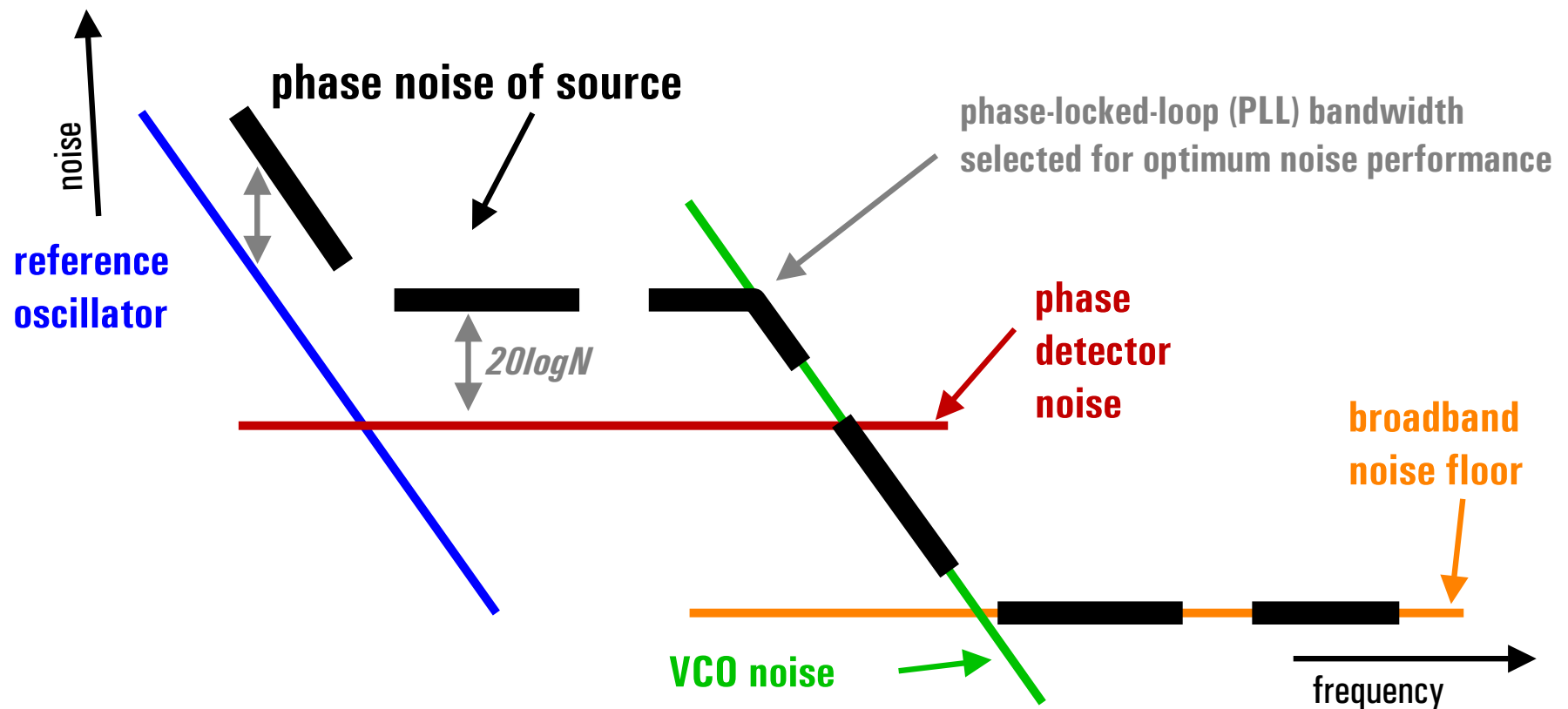
...produces accurate, clean signals



RF CW Block Diagram

Synthesizer Section

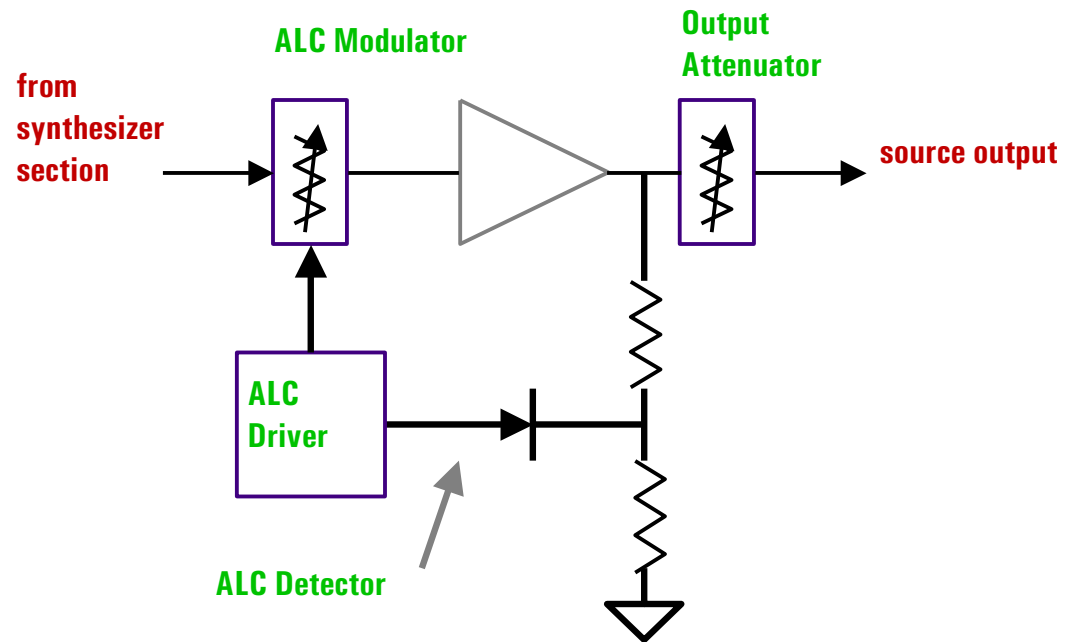
PLL / Fractional - N
...suppresses phase noise



RF CW Block Diagram

Output Section

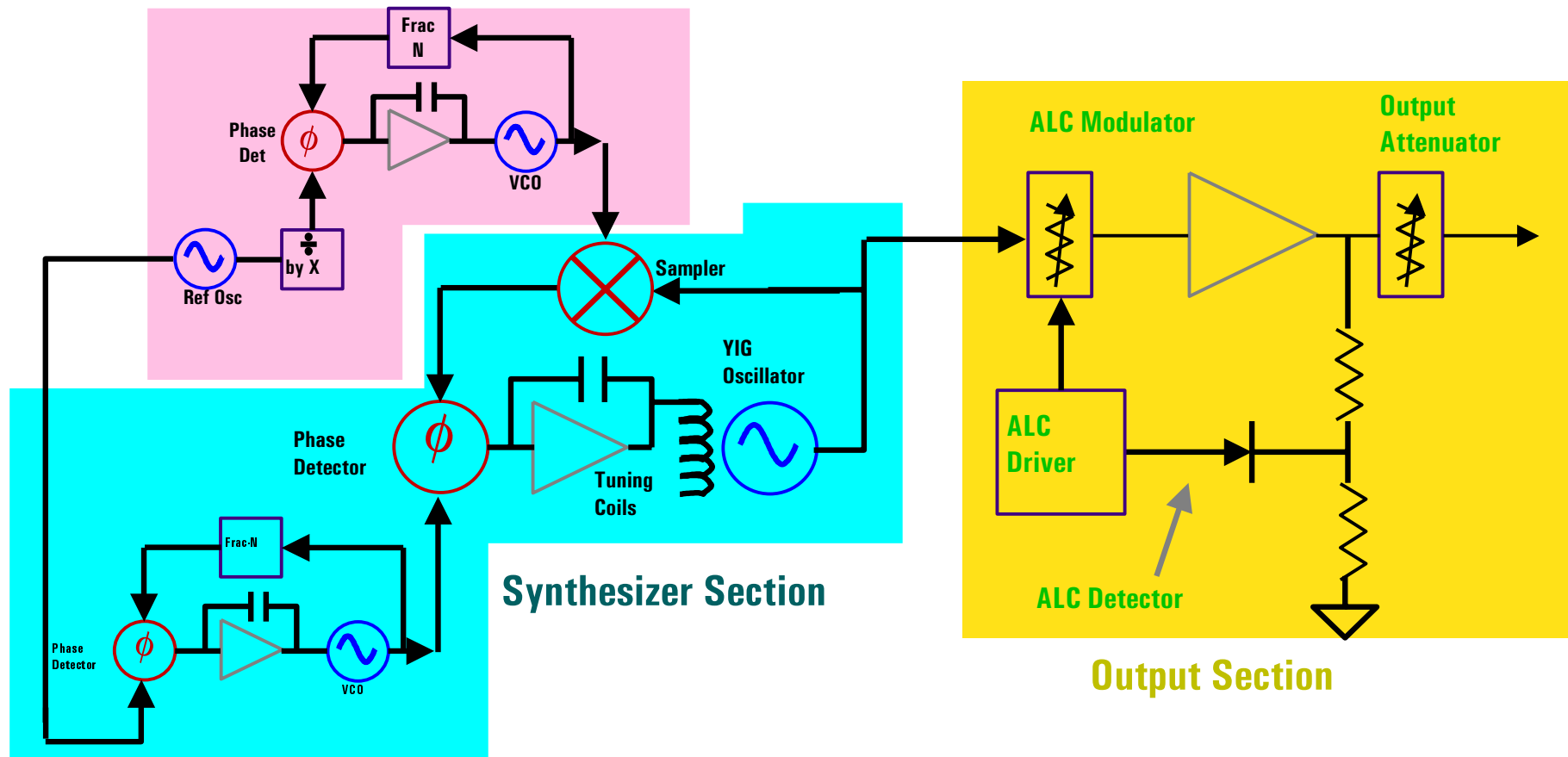
- **ALC**
 - maintains output power by adding/subtracting power as needed
- **Output Attenuator**
 - mechanical or electronic
 - provides attenuation to achieve wide output range (e.g. -136dBm to +13dBm)



ALC = automatic level control

μ Wave CW Block Diagram

Reference Section

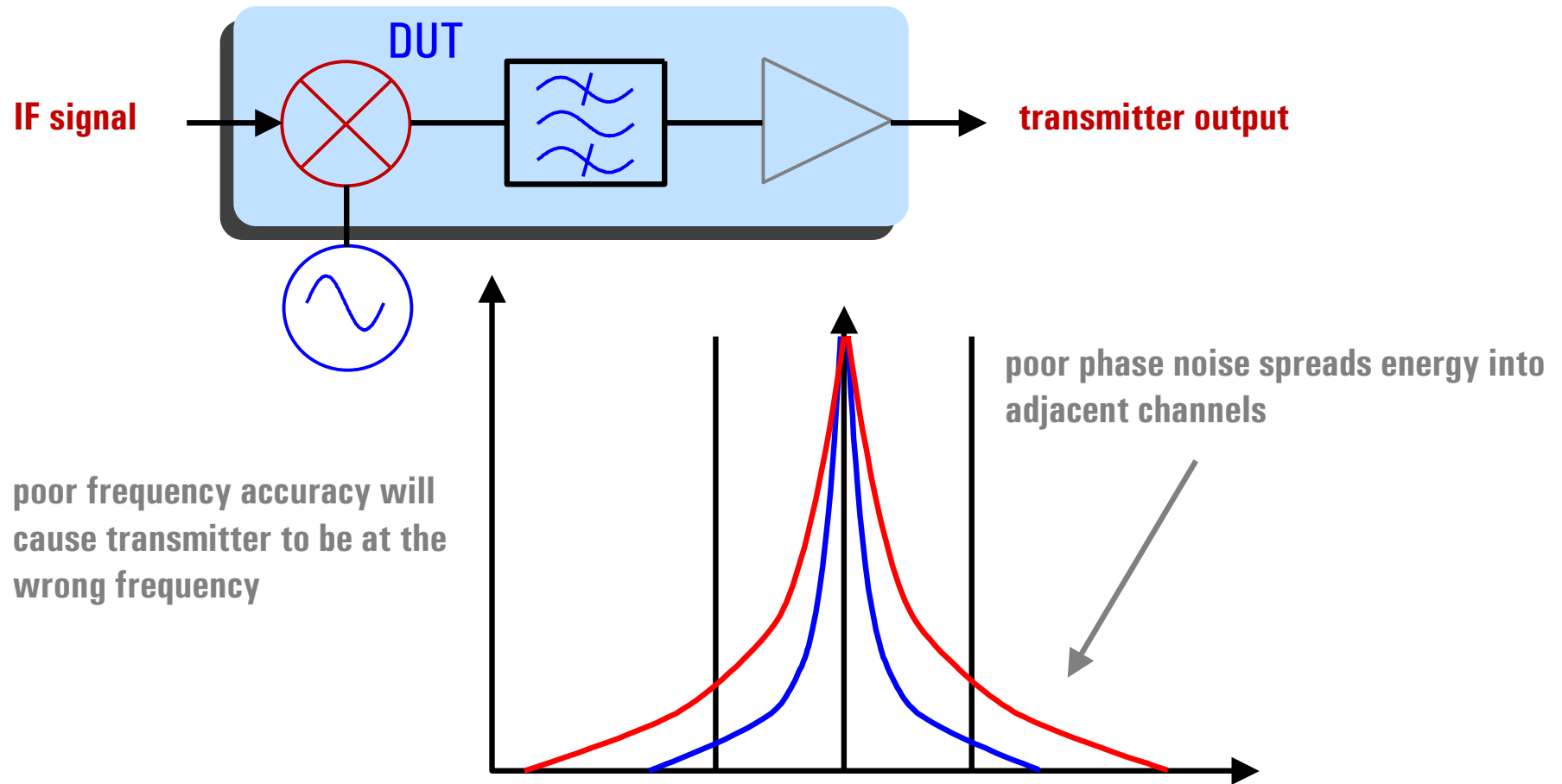


Applications & Critical Specifications

- **Local Oscillator**
 - phase noise
 - frequency accuracy
- **Amplifier Distortion**
 - spurious
 - TOI (for system)
- **Receiver Testing**
 - Spurious
 - spurious
 - level accuracy

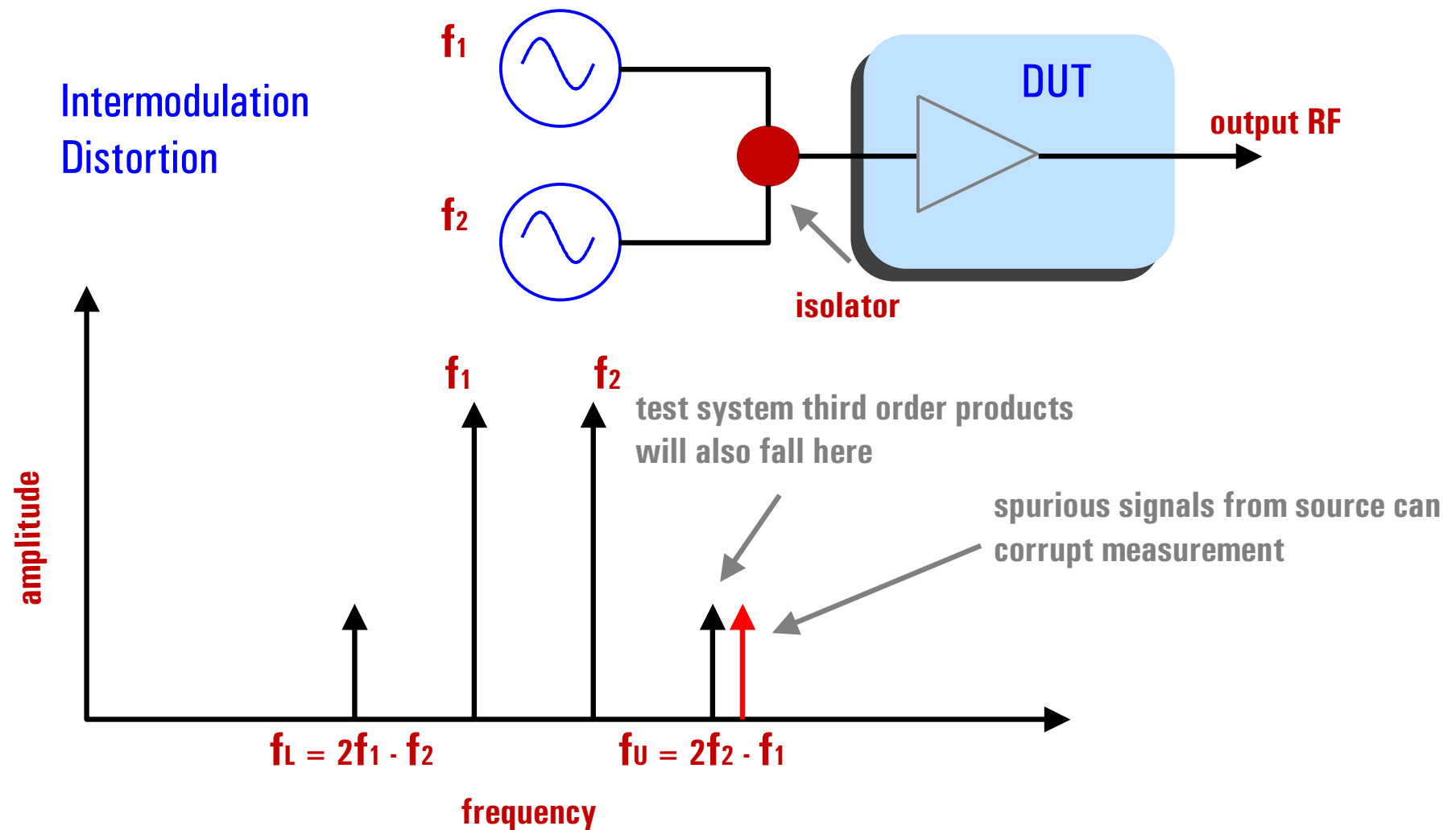
Applications & Critical Specifications

As a Local Oscillator



Applications & Critical Specifications

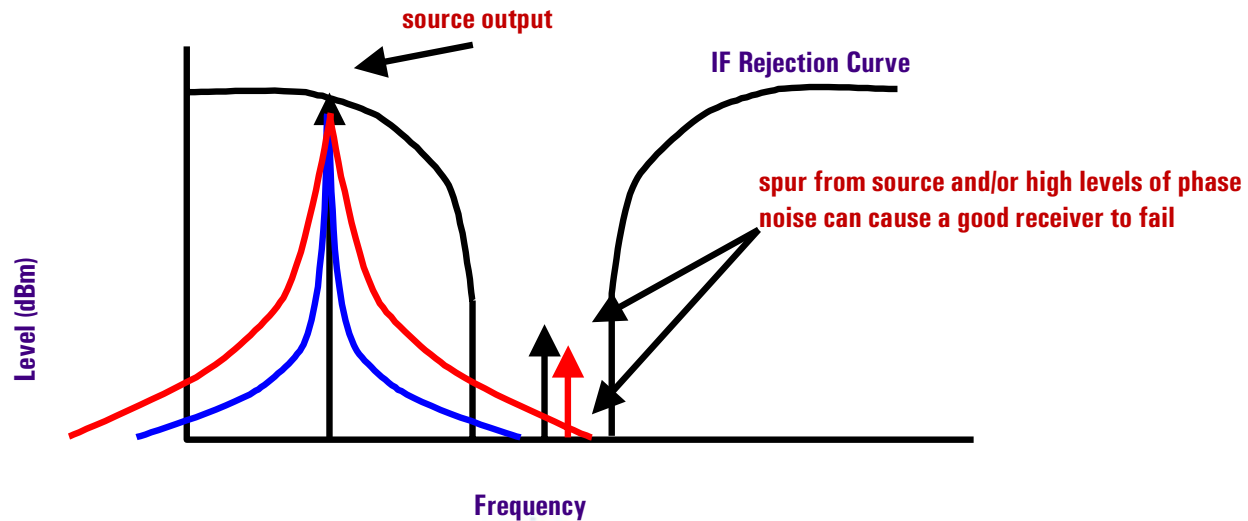
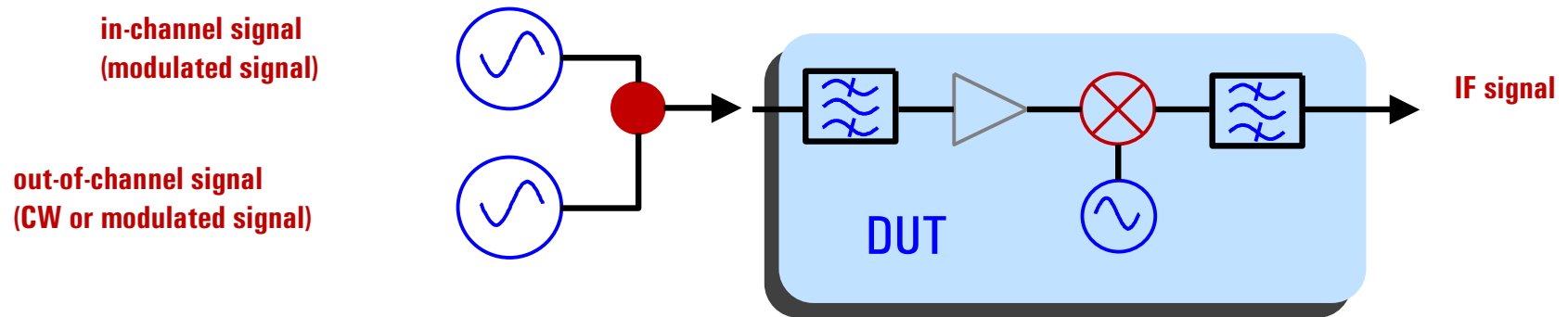
Amplifier Testing



Applications & Critical Specifications

Receiver Testing

Receiver Selectivity



Agilent Families of CW Generators

RF



Agilent 8662/63 family

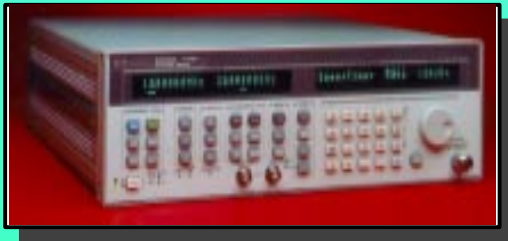
- 100 KHz - 2.5 GHz
- Low in channel noise
- AM/FM/Phase/Pulse



Agilent 8664/65 family

- 100 MHz - 6 GHz
- Low out channel noise
- AM/FM/Pulse.

Microwave

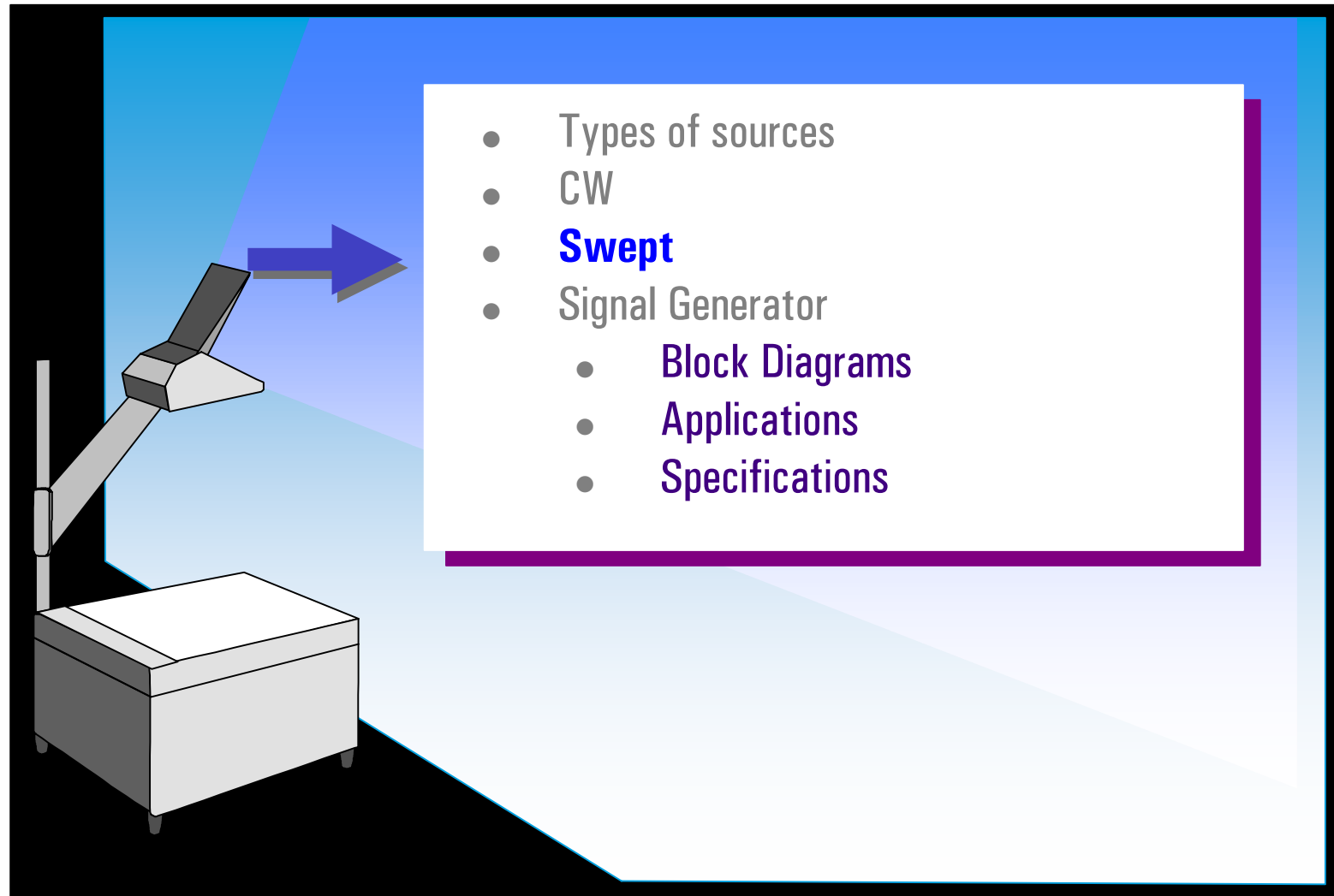


Agilent 83711/12B family

- 10 MHz - 20 GHz
- CW only



Agenda

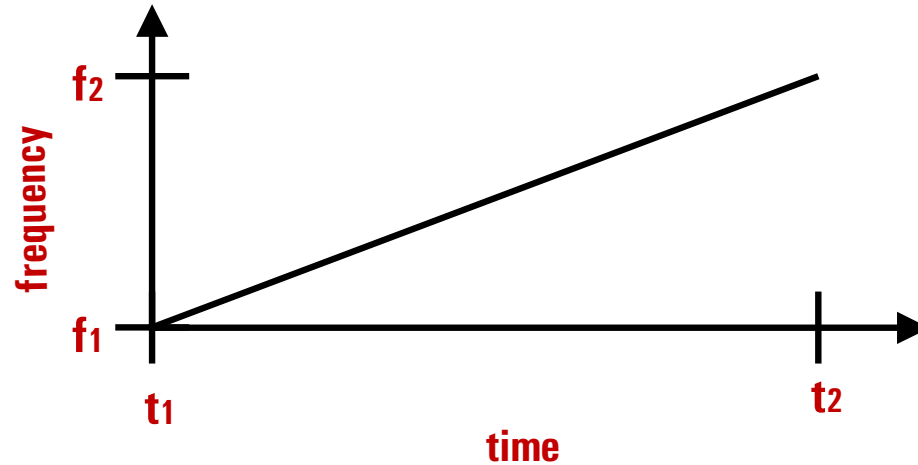


Sweeper Specifications

...Frequency

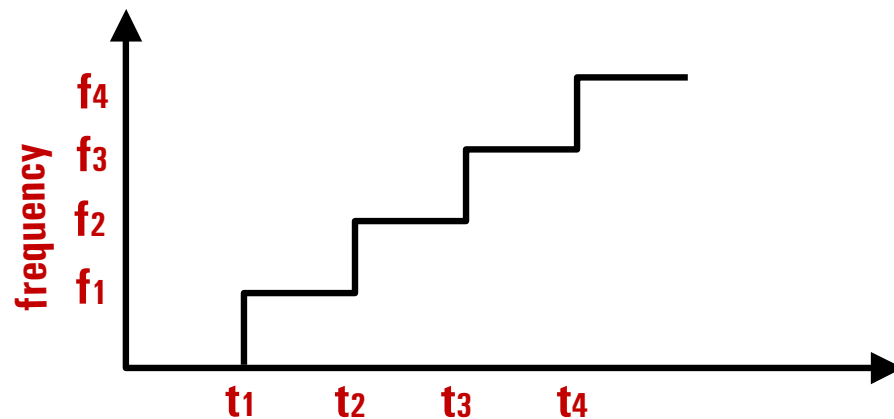
- **ramp sweep**

- accuracy
- sweep time
- resolution



- **step sweep**

- accuracy
- number of points
- switching time

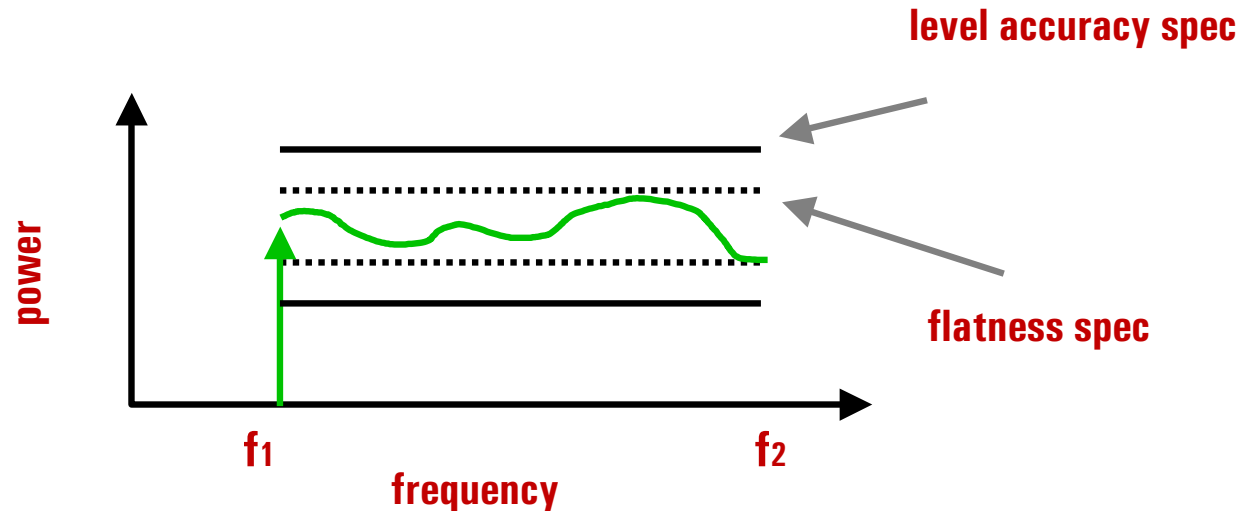


Sweeper Specifications

...Amplitude

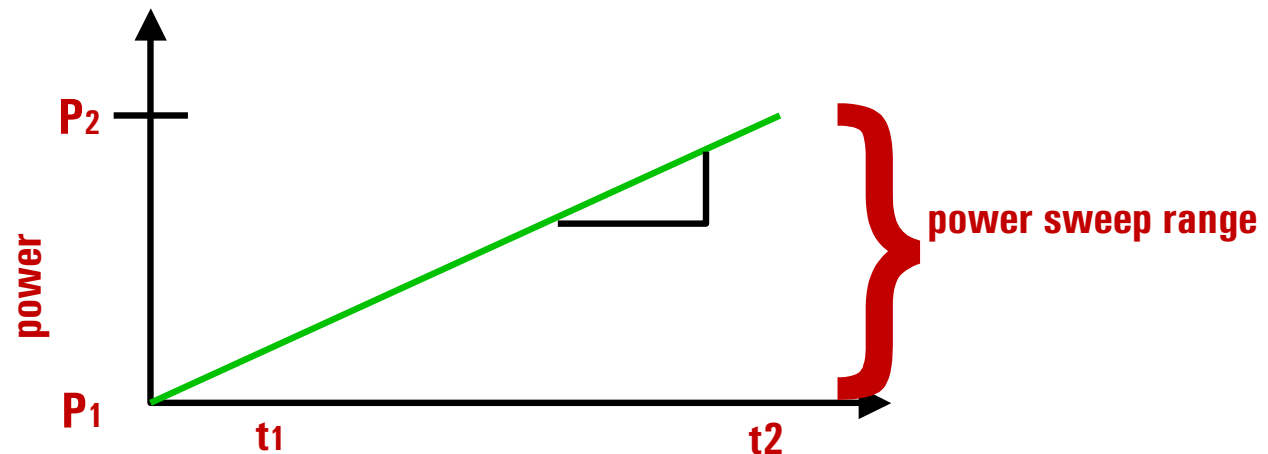
Frequency Sweep

- Level Accuracy
- Flatness
- Source Match (SWR)



Power Sweep

- Power Sweep Range
- Power Slope Range
- Source Match (SWR)



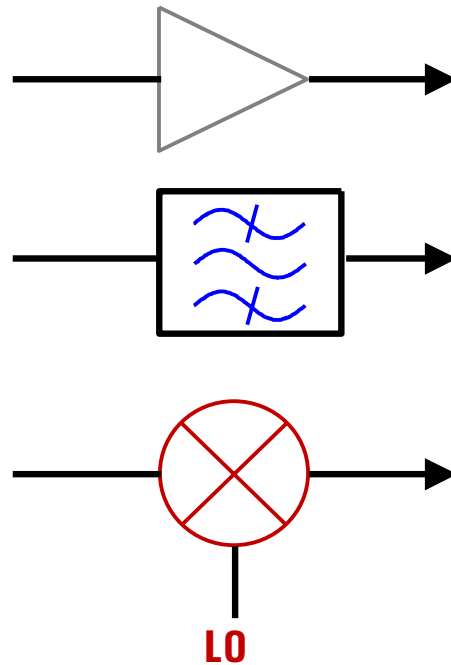
Applications & Critical Specifications

- **Frequency Response**
 - Frequency Accuracy
 - Output Power (Level) Accuracy
 - Flatness
 - Speed
 - residual FM
- **Amplifier Compression**
 - Power Range

Applications & Critical Specifications

Frequency Response Testing

Sweeper Input

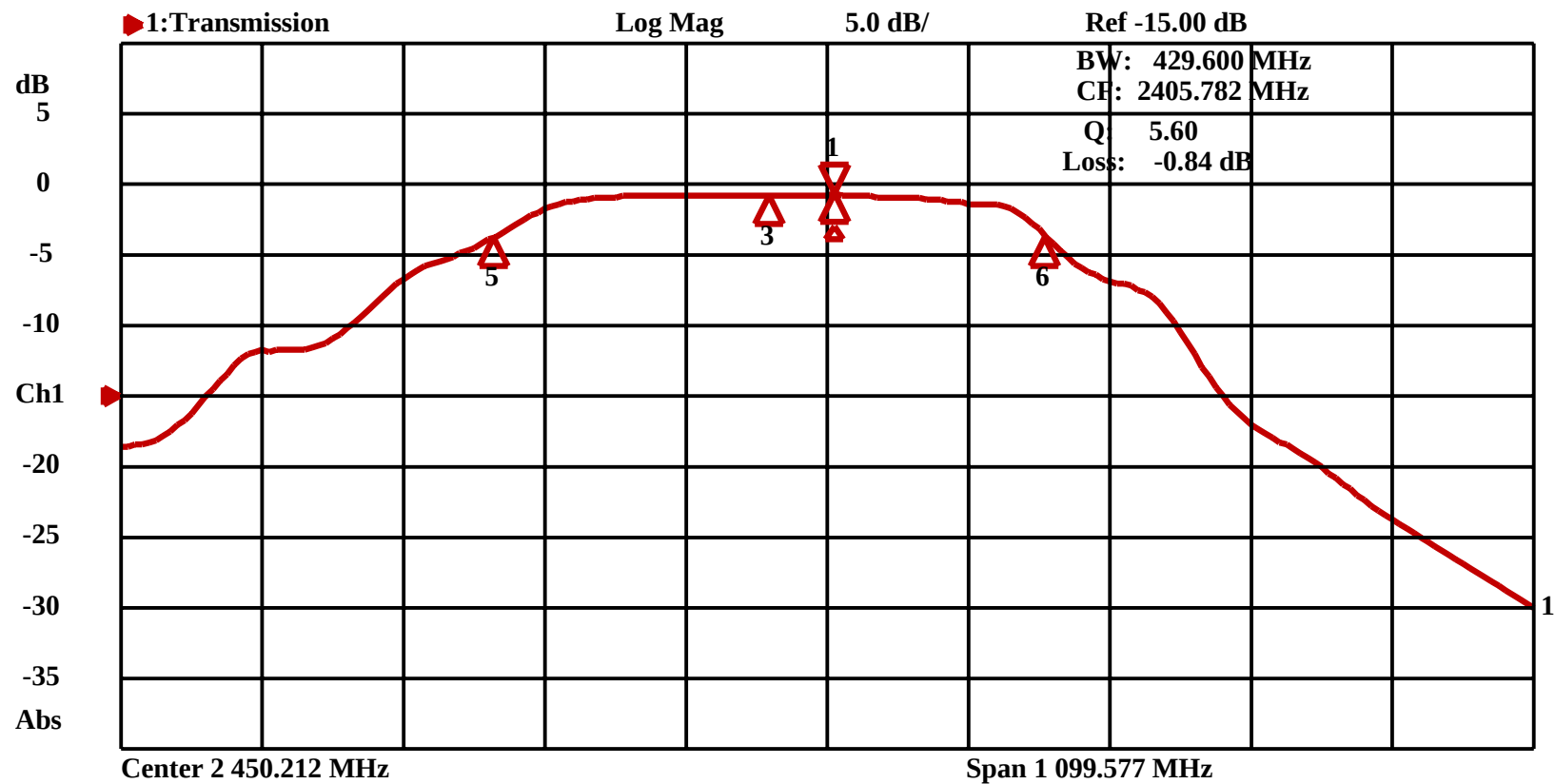


- Frequency Accuracy
- Output Power (Level) Accuracy
- Flatness
- Speed
- residual FM

Applications & Critical Specifications

Frequency Response Testing

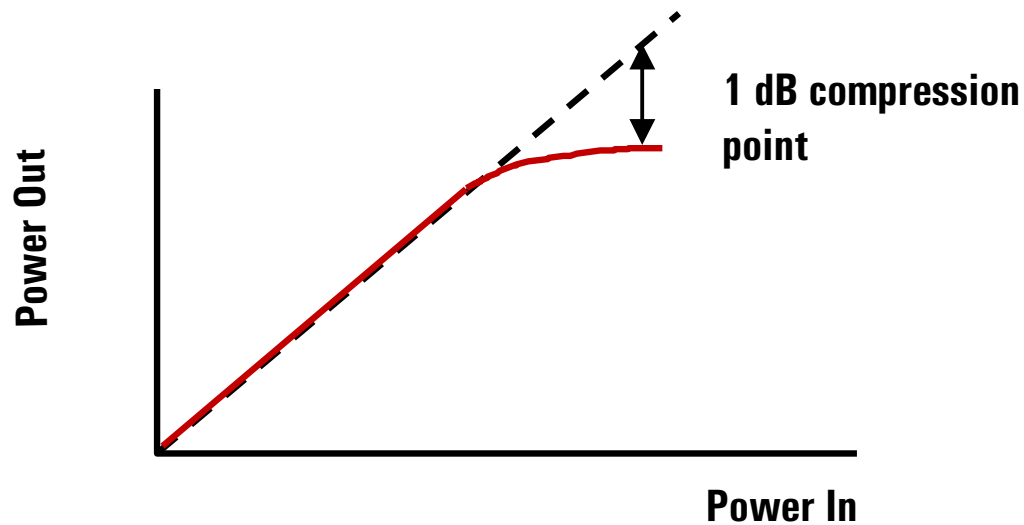
Who Cares About Accuracy?



Applications & Critical Specifications

Amplifier Compression

- Power Range



The 1 dB compression point is a common amplifier specification used to identify the linear operating range of an amplifier. Power sweep is available on some Agilent sources.

Synthesized Sweep Generators

× Agilent 83750 Series

- Step/Analog sweep
- AM/FM/Phase modulation
- 10MHz to 20GHz
- up to 110GHz with 83550 series
- modules and amplifier

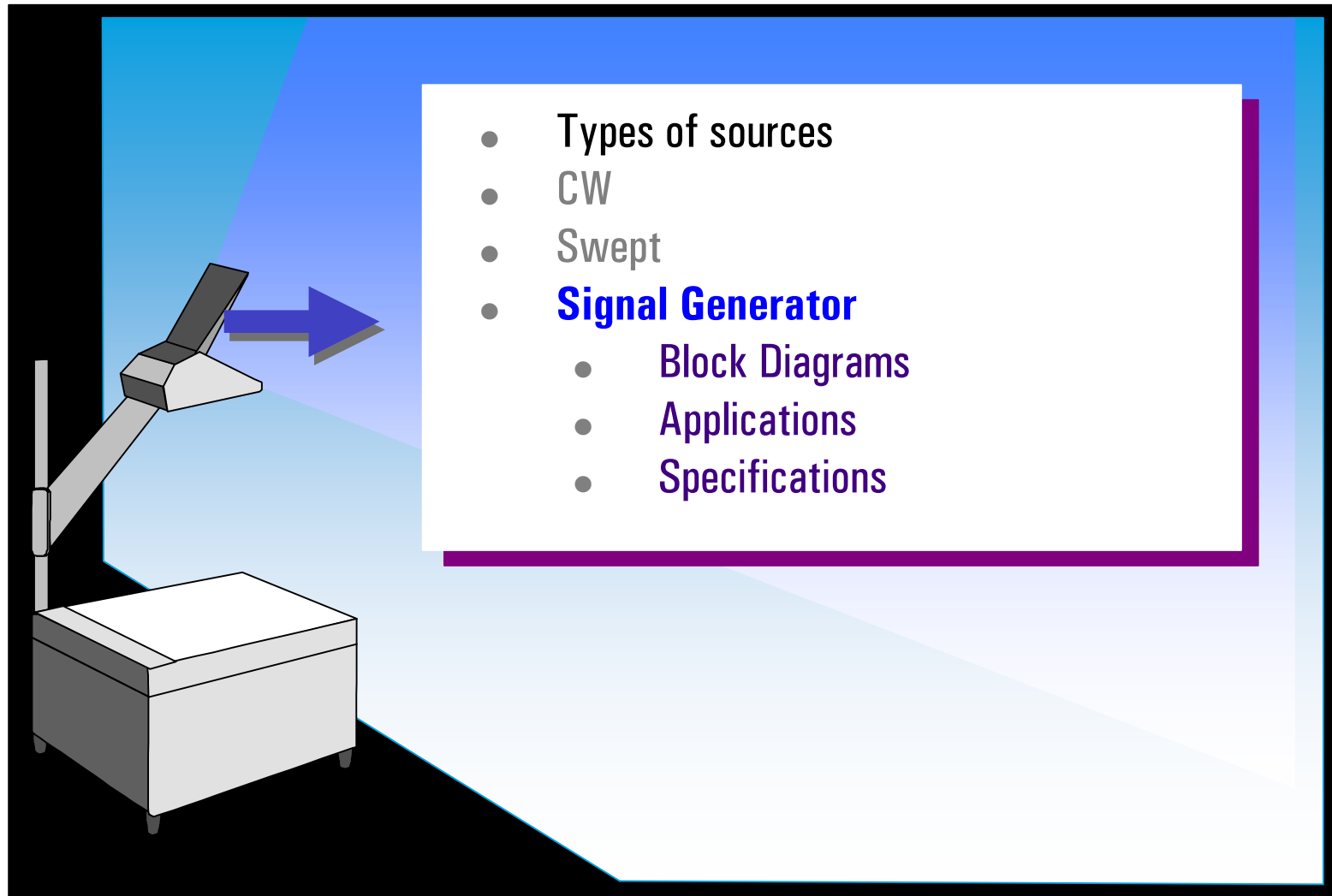


× Agilent 8360L Series

- Step/Analog sweep
- 8510/8757 Compatibility
- 10MHz to 50GHz
- up to 110GHz with 83550 series modules



Agenda

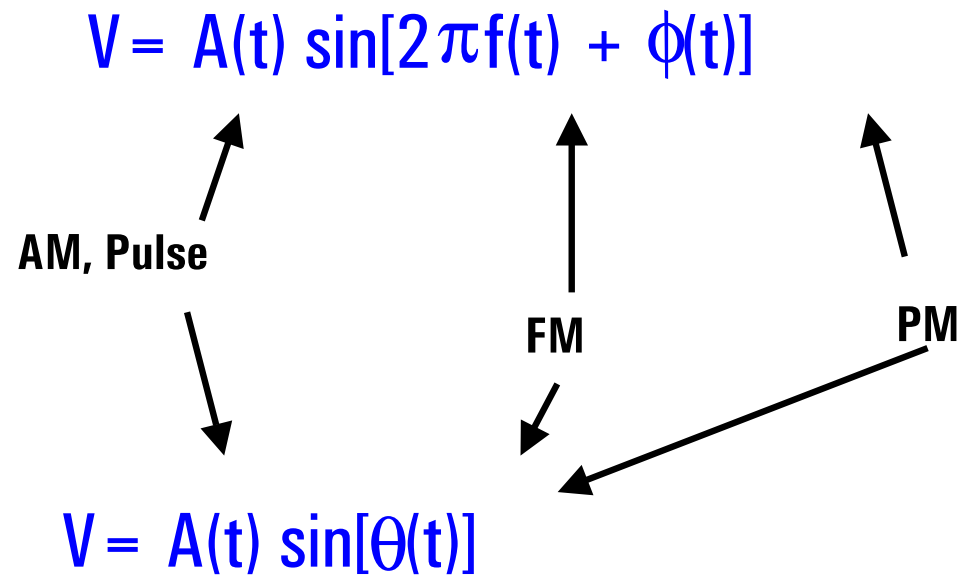


Signal Generators

- **Calibrated modulation**
 - Analog (AM, FM, PM, Pulse)
 - Digital (I-Q)
 - Format Specific (TDMA, CDMA, etc.)

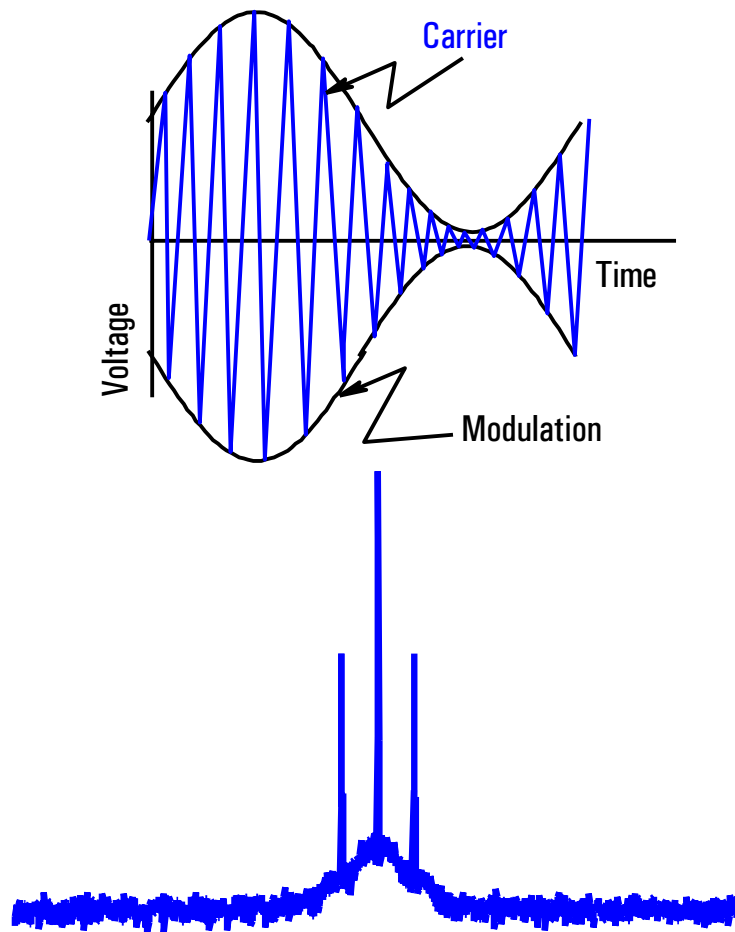
Modulation

...Where the information resides



Modulation: Analog

Amplitude Modulation



Important Signal Generator Specs for Amplitude Modulation

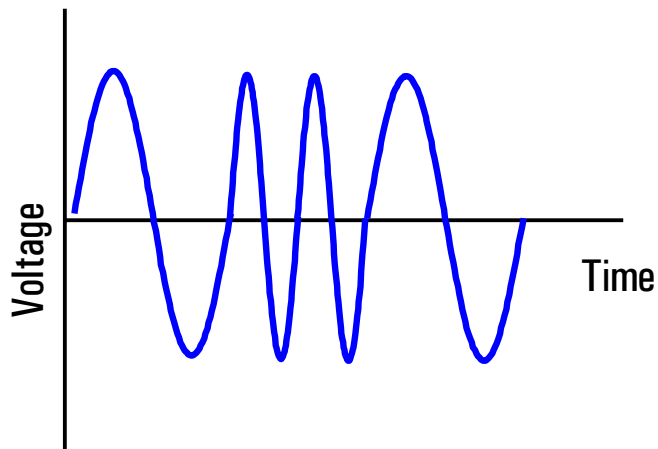
- Modulation frequency
- Linear AM
- Log AM
- Depth of modulation (Mod Index)

Modulation: Analog

Frequency Modulation

$$V = A \sin[2\pi f_c t + \beta m(t)]$$

$$\beta = \Delta F_{\text{dev}} / F_{\text{mod}}$$



Important Signal Generator Specs for Frequency Modulation

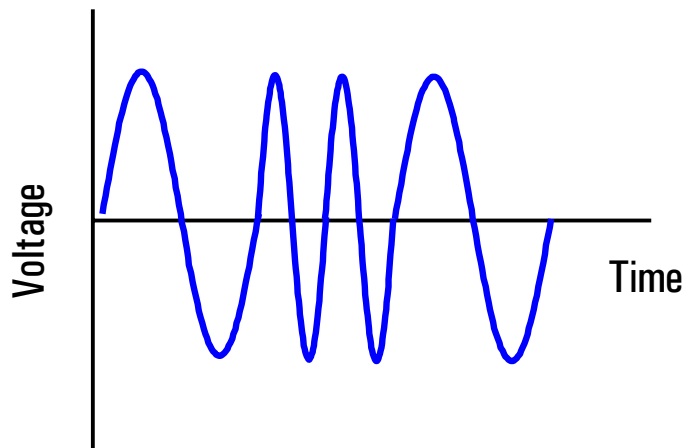
- Frequency Deviation
- Modulation Frequency
- dcFM
- Accuracy
- Resolution

Modulation: Analog

Phase Modulation

$$V = A \sin[2 \pi f_c t + \beta m(t)]$$

$$\beta = \Delta\phi_{\text{peak}}$$

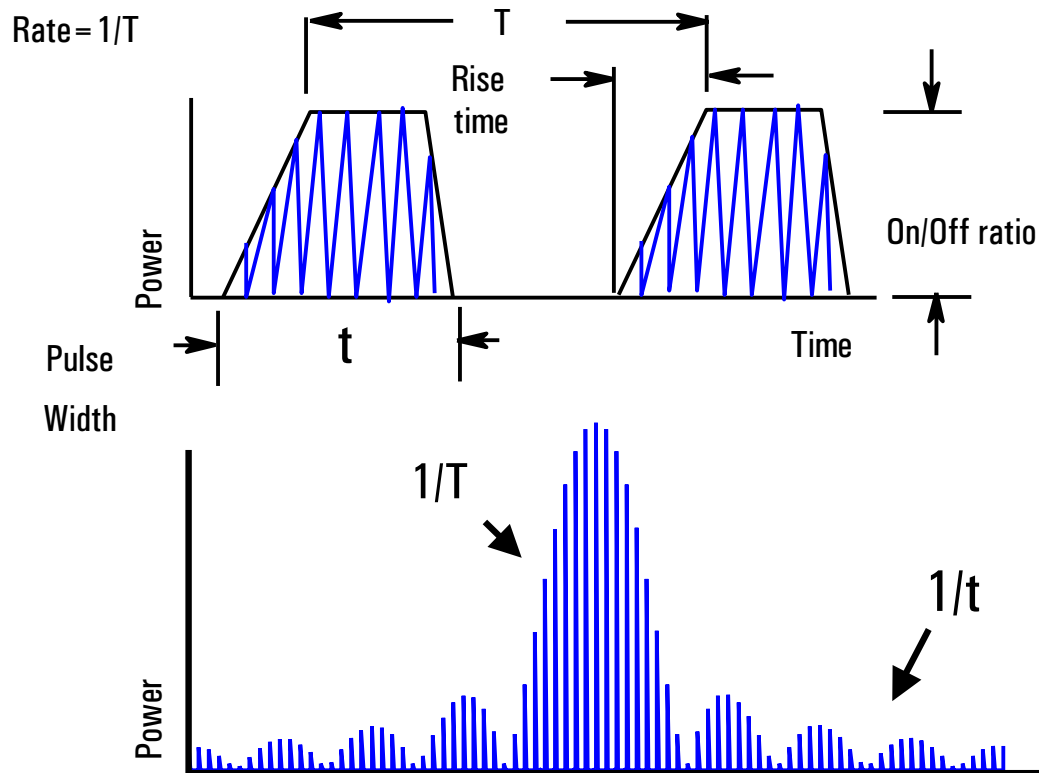


Important Signal Generator Specs for Phase Modulation

- Phase deviation
- Rates
- Accuracy
- Resolution

Modulation: Analog

Pulse Modulation



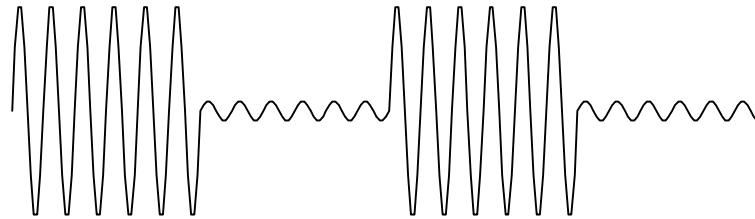
Important Signal Generator Specs for Pulse Modulation

- Pulse width
- Pulse period
- On/Off ratio
- Rise time

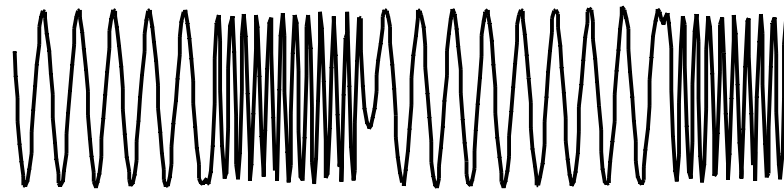
Digital Modulation

...signal characteristics to modify

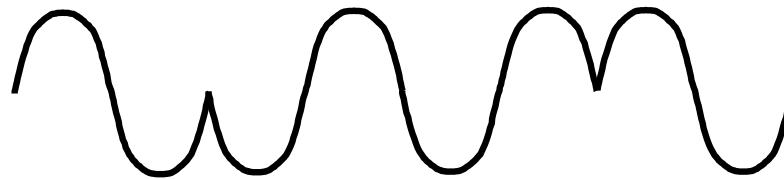
Amplitude



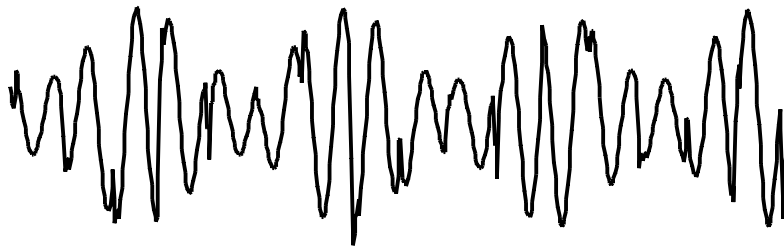
Frequency



Phase

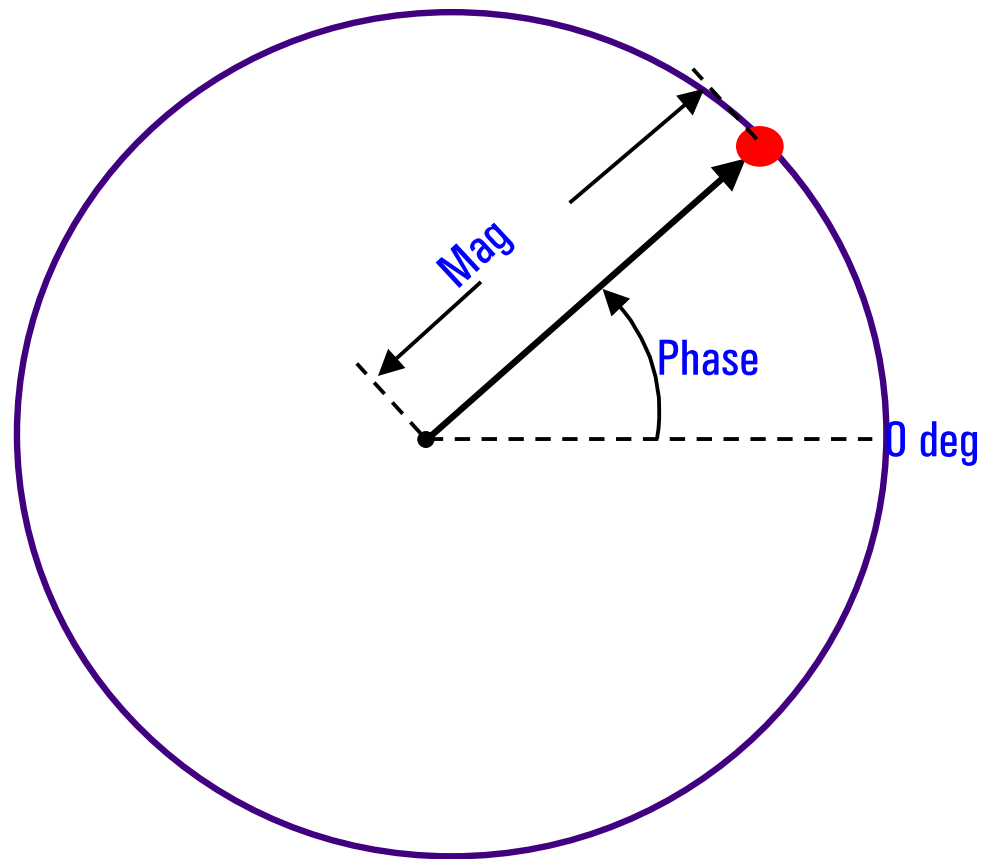


**Both Amplitude
and Phase**



Digital Modulation

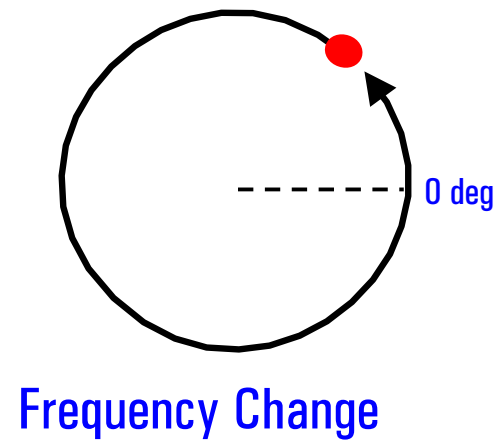
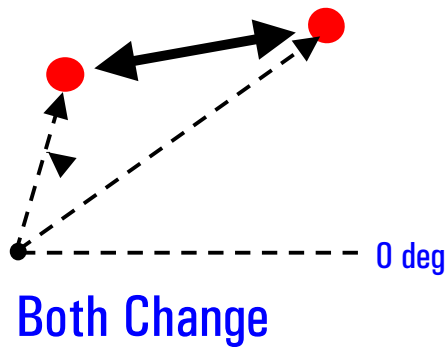
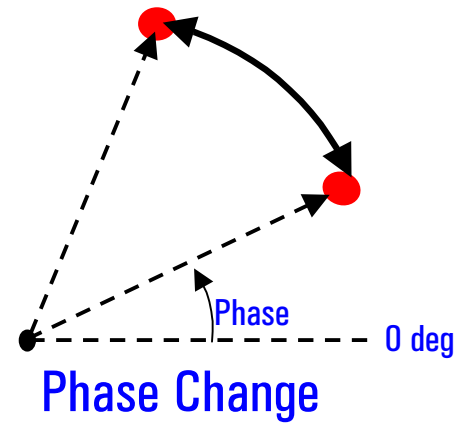
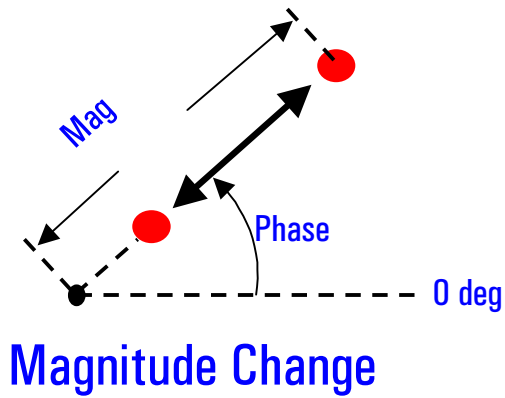
Polar Display: Magnitude & Phase Represented Together



- Magnitude is an absolute value
- Phase is relative to a reference signal

Digital Modulation

Signal Changes or Modifications

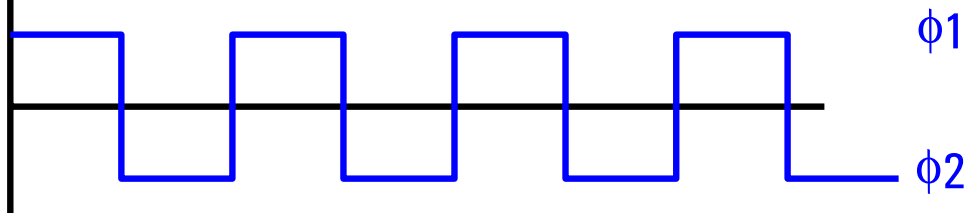


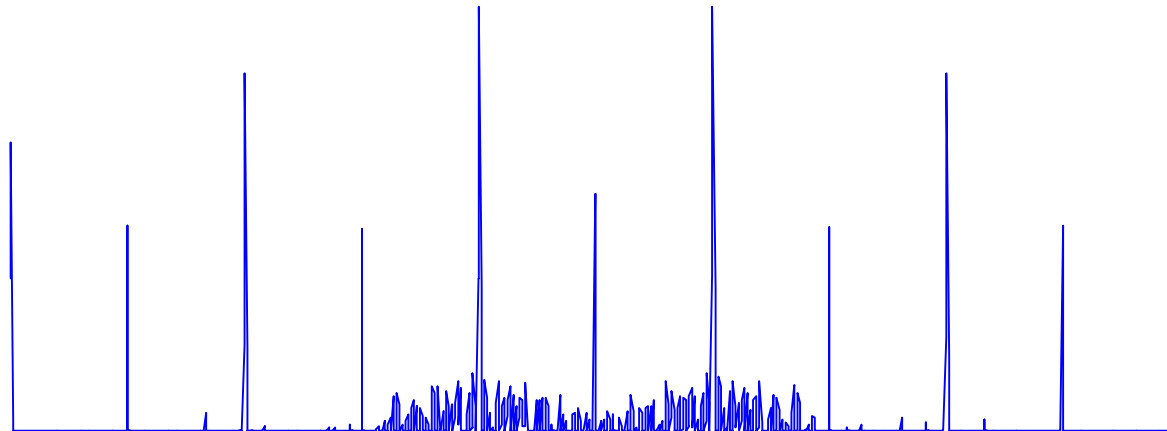
Digital Modulation

...Binary Phase Shift Keying (BPSK)

$$V = A \sin[2\pi ft + \phi(t)]$$

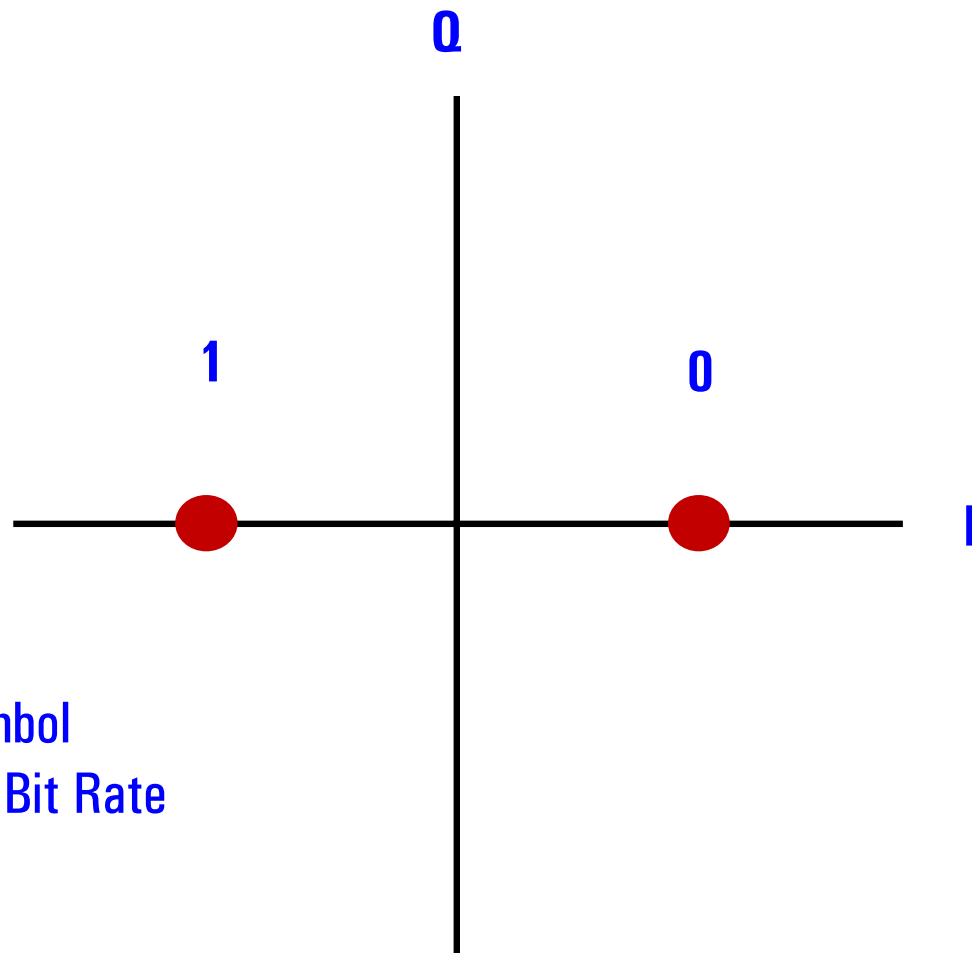
$\phi(t) =$





Digital Modulation

BPSK IQ Diagram



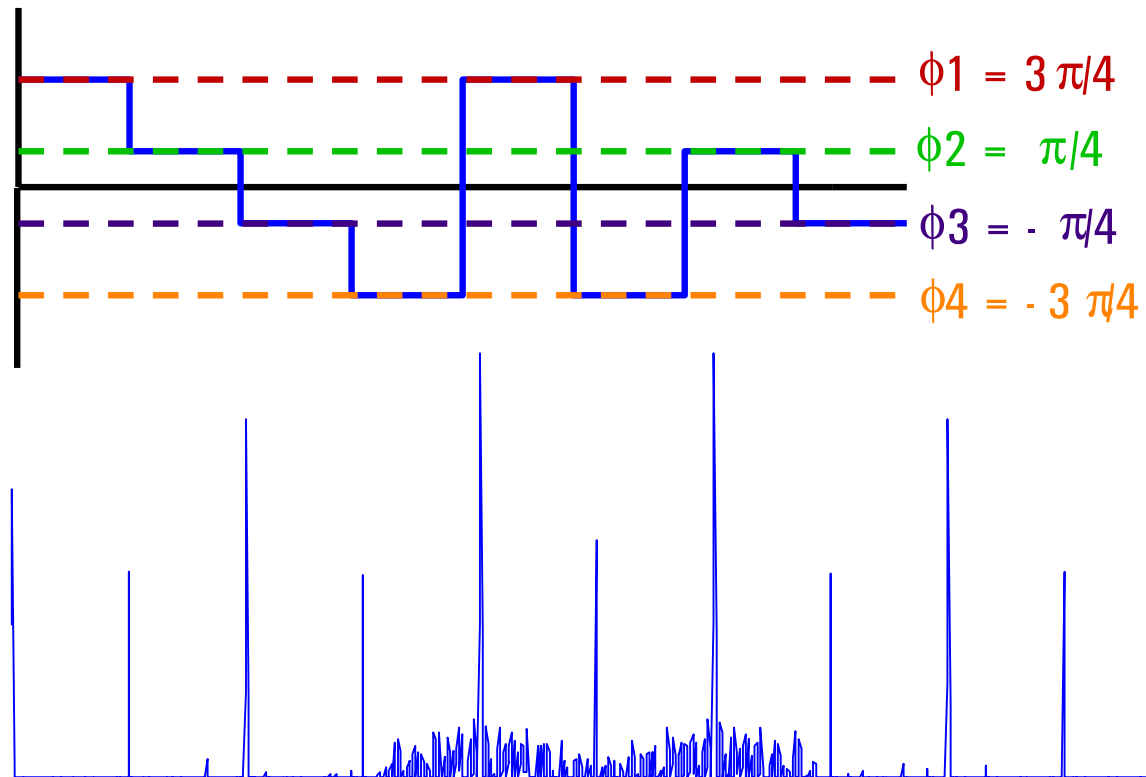
One Bit Per Symbol
Symbol Rate = Bit Rate

Digital Modulation

...Quadrature Phase Shift Keying (QPSK)

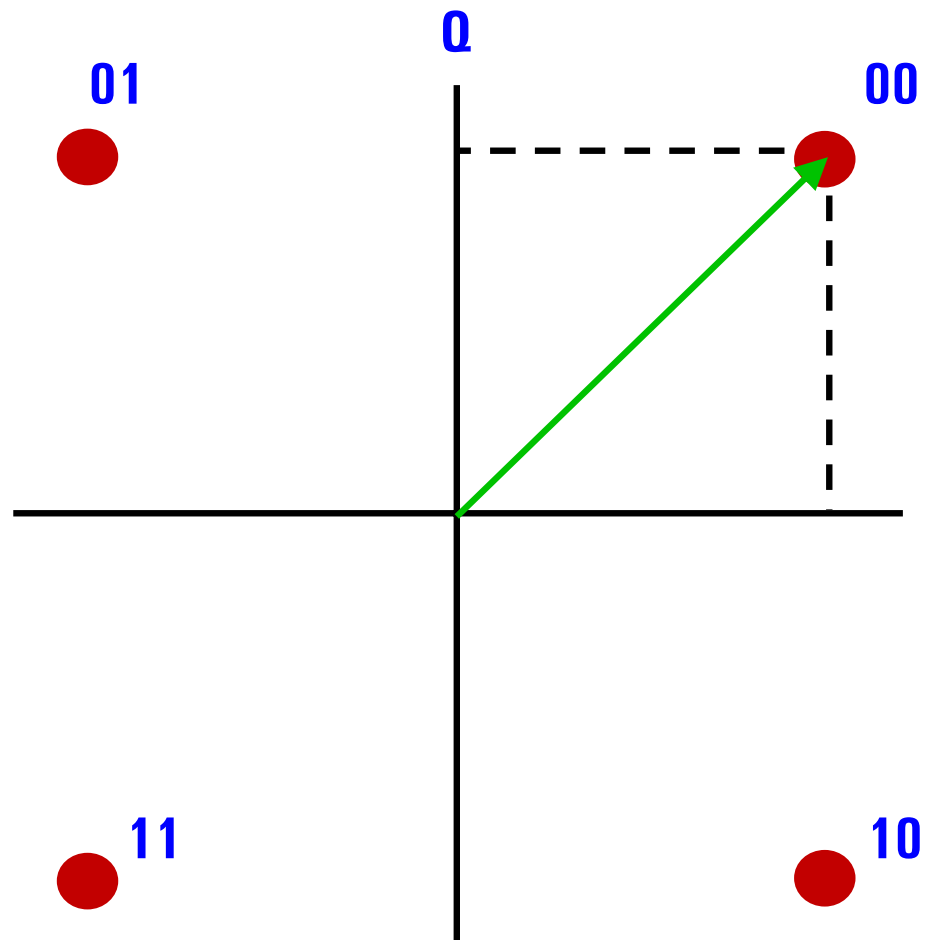
$$V = A \sin[2 \pi f t + \phi(t)]$$

$\phi(t) =$



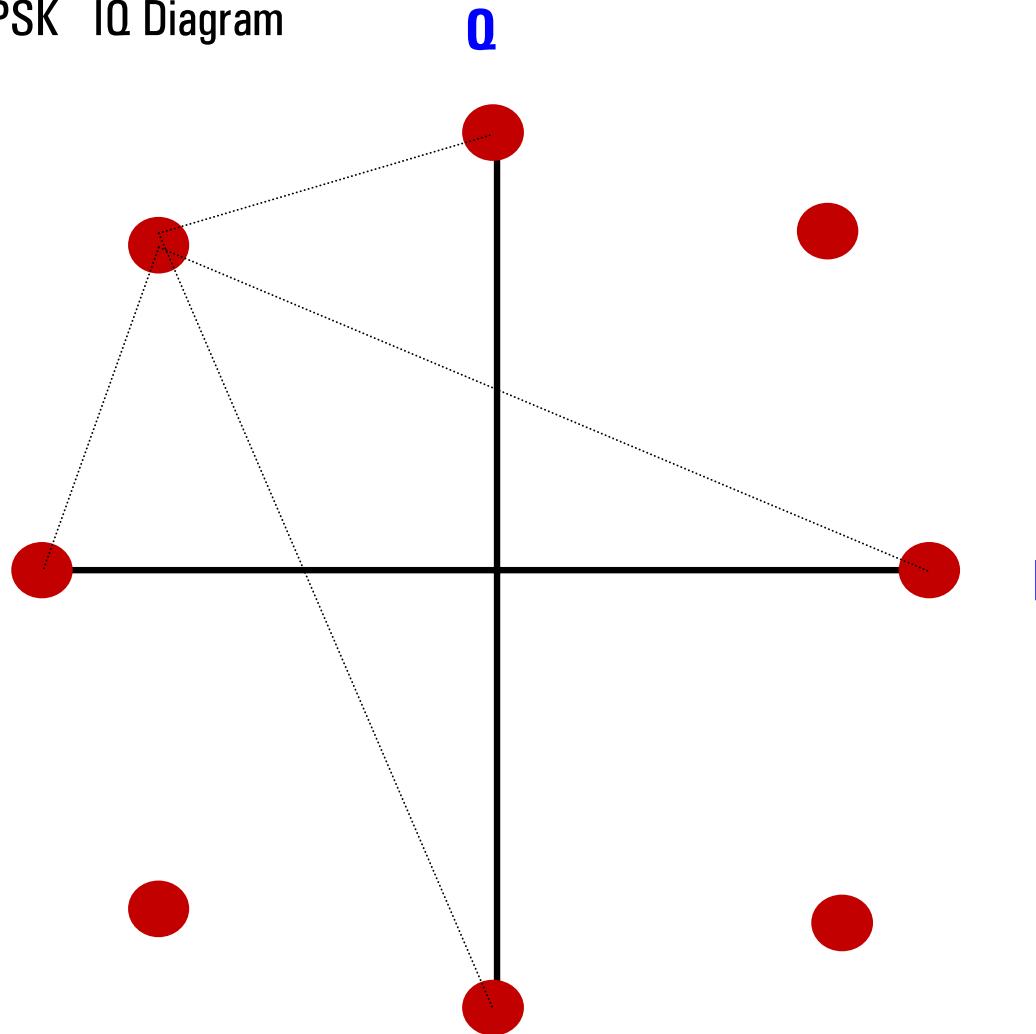
Digital Modulation

QPSK IQ Diagram



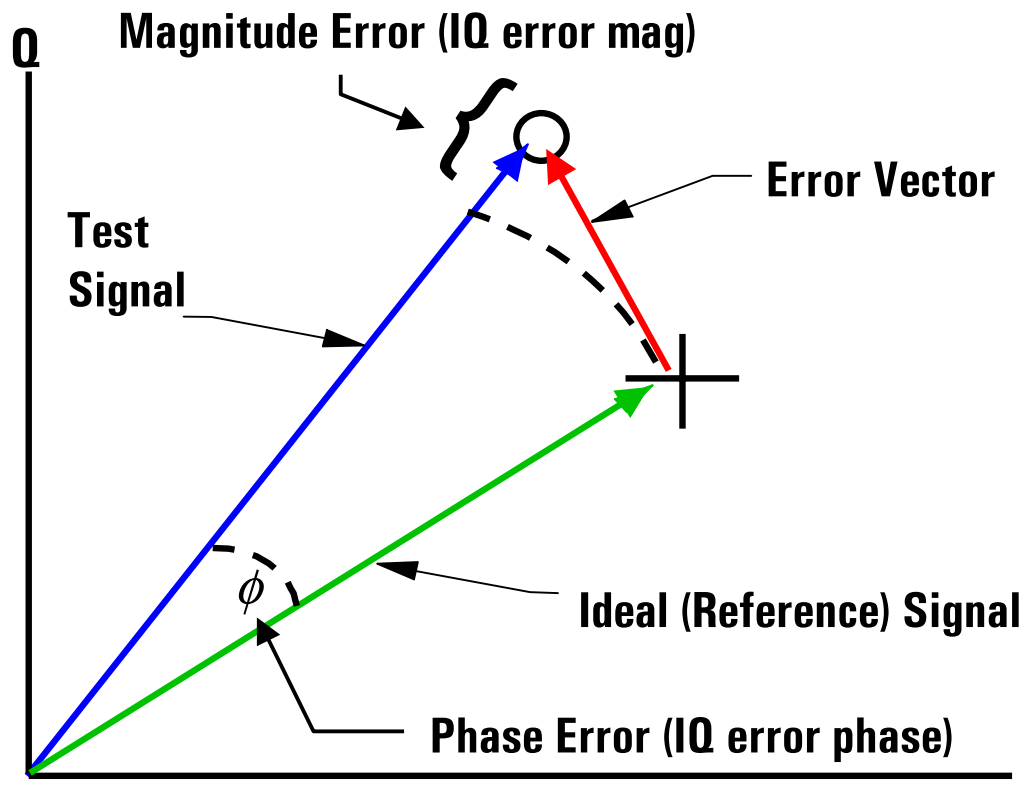
Digital Modulation

$\pi/4$ DQPSK IQ Diagram

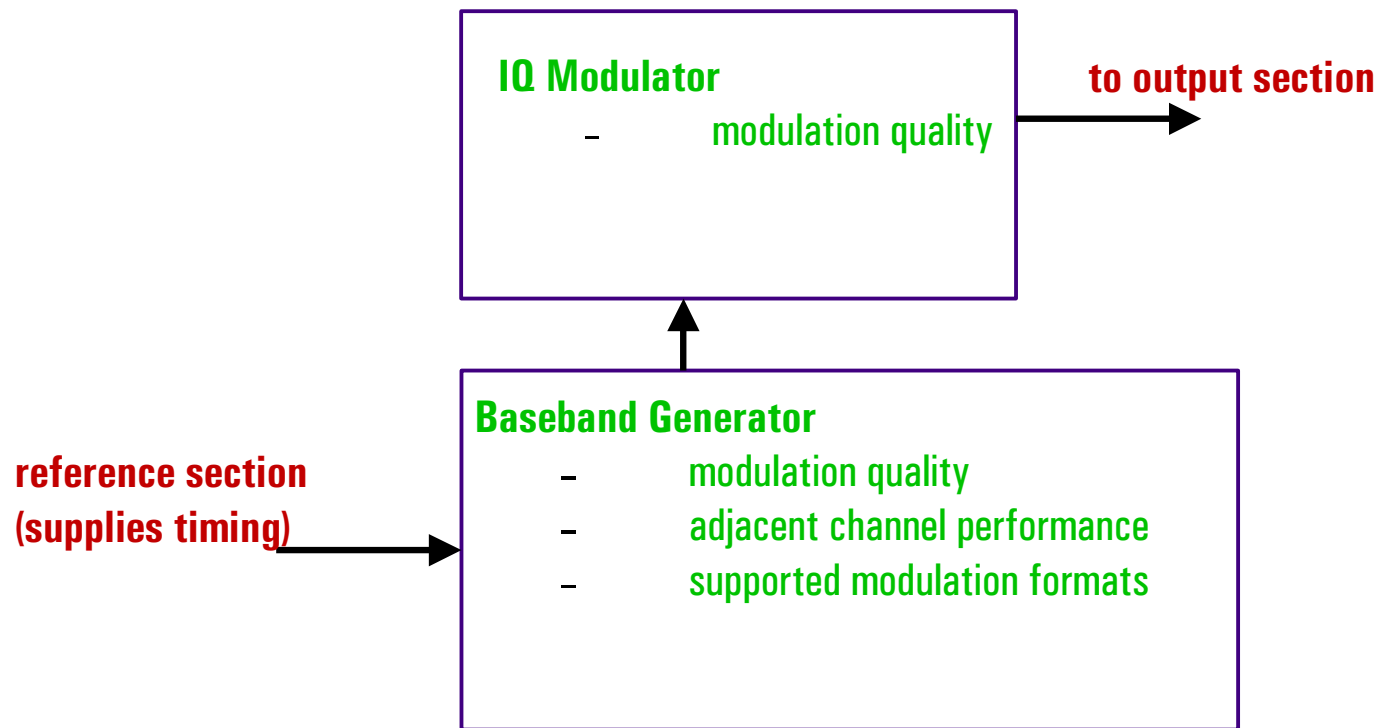


Digital Modulation

Modulation Accuracy

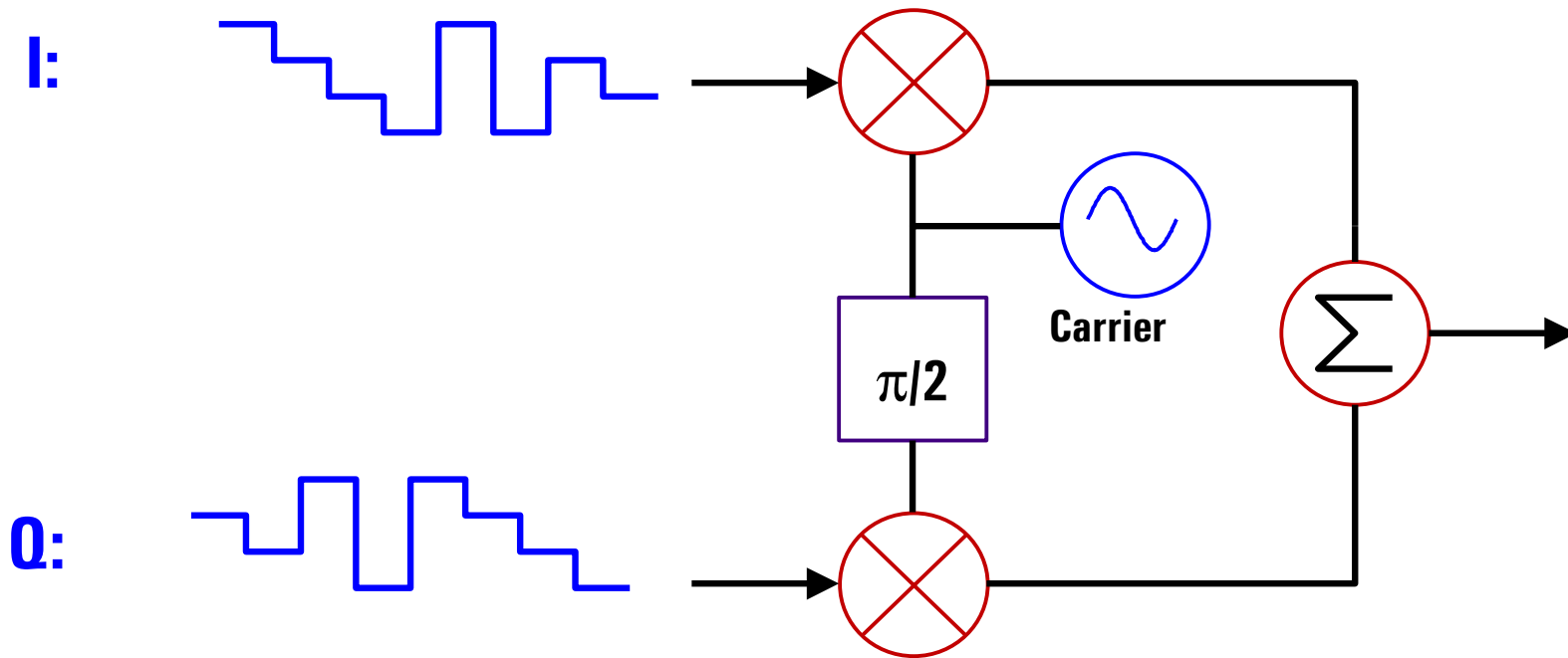


Digital Signal Generator Block Diagram



Digital Modulation

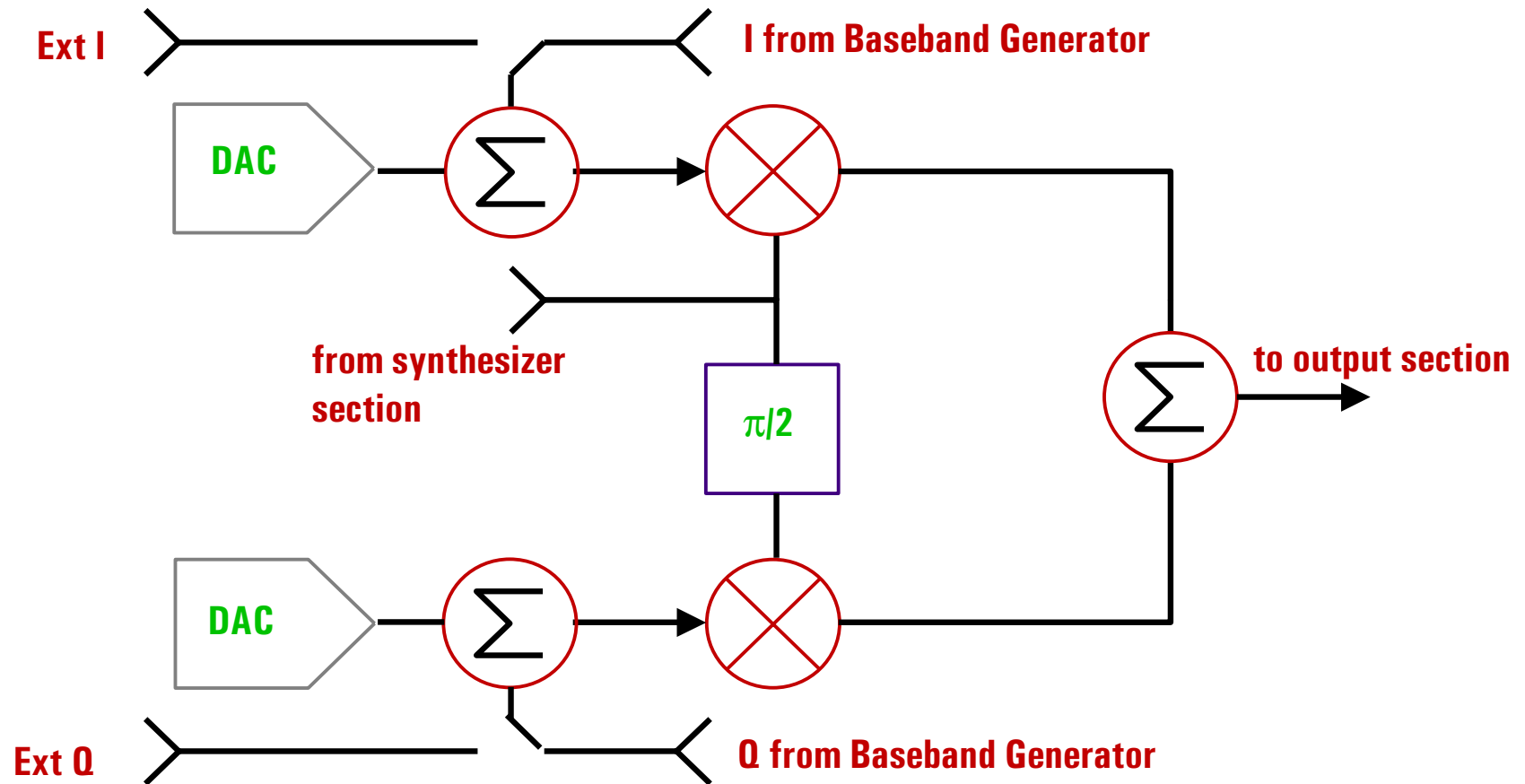
PSK Implementation: IQ Method



- Good Interface with Digital Signals and Circuits
- Can be Implemented with Simple Circuits
- Can be Modified for Bandwidth Efficiency

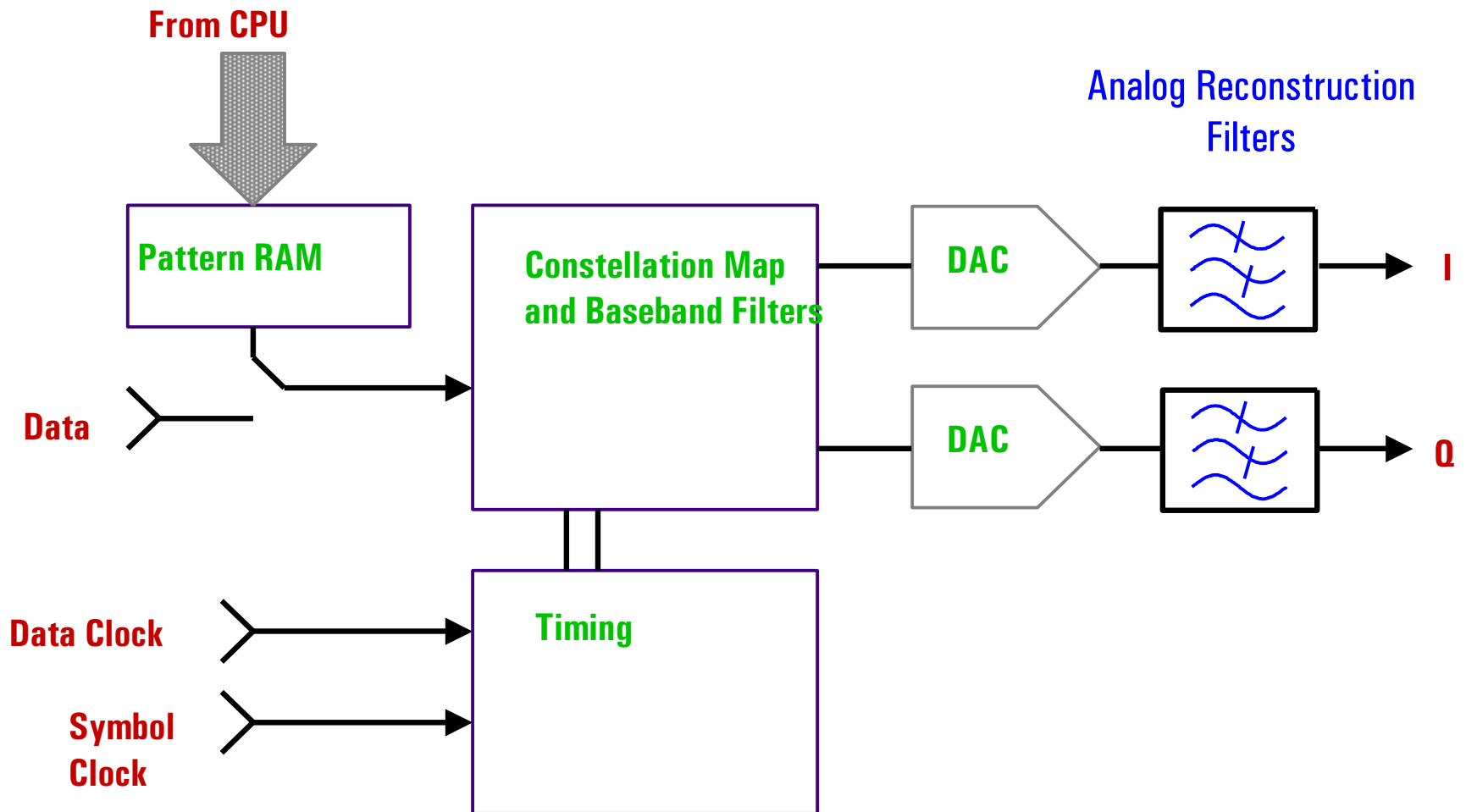
Digital Signal Generator Block Diagram

IQ Modulator



Digital Signal Generator Block Diagram

Baseband Generator



Digital Signal Generator

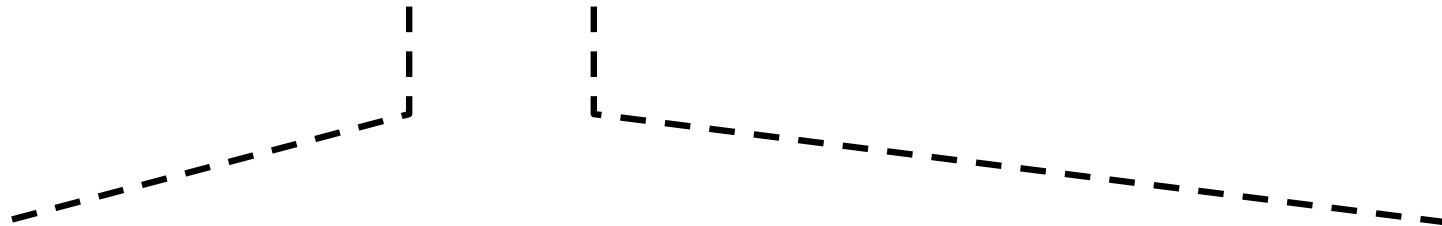
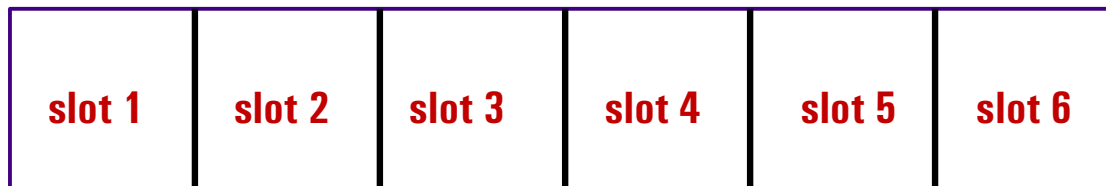
Format Specific Digital Signals

NADC (TDMA IS-54)	
Parameter	Specification
Access Method	TDMA/FDD
Modulation	$\pi/4$ DQPSK
Channel Bandwidth	30 kHz
Reverse Channel Frequency Band	824 - 849 MHz
Forward Channel Frequency Band	869 - 894 MHz
Filtering	0.35 RRC

Digital Signal Generator

Access and Framing

one frame = 1944 bits (972 symbols) = 40ms; 25frames/sec



324 bit (162 symbols) = 6.667ms



Mobile to Base Station

Applications and Critical Specifications

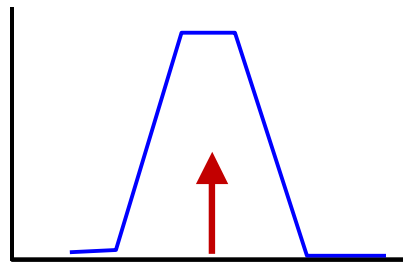
Analog and Digital

- **Receiver Sensitivity**
 - frequency accuracy
 - level accuracy
 - error vector magnitude
- **Receiver Selectivity**
 - phase noise
 - spurious
 - spectral accuracy
- **Spectral Regrowth**
 - ACP performance

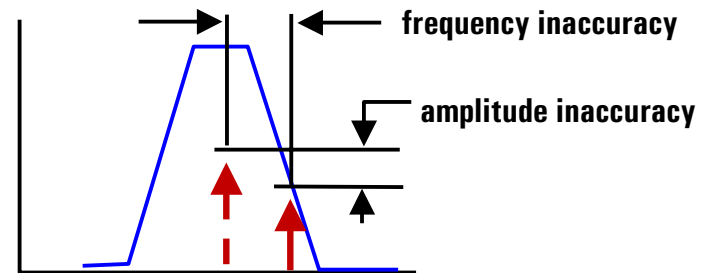
Applications and Critical Specifications

Receiver Sensitivity

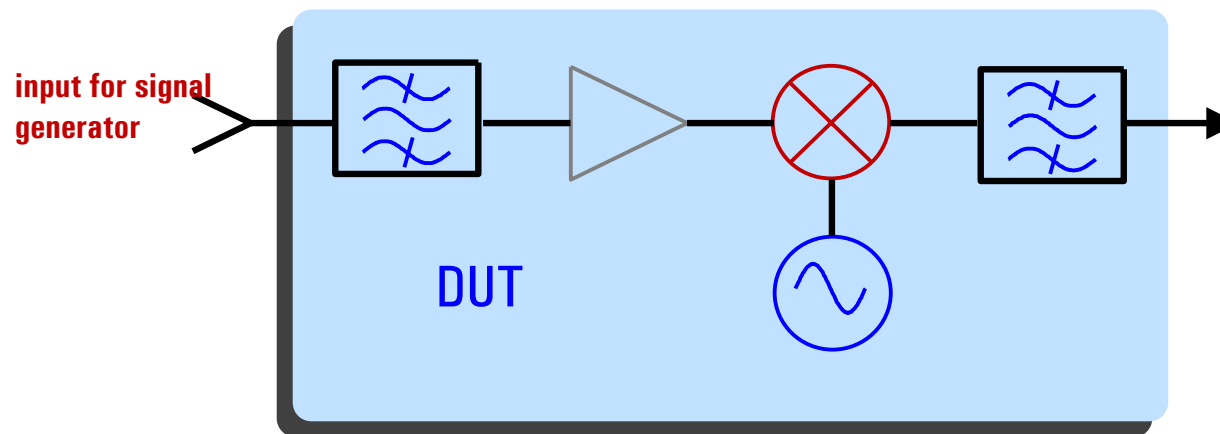
- Frequency Accuracy



Want to measure sensitivity in a channel



Measurement impaired by frequency inaccuracy



Applications and Critical Specifications

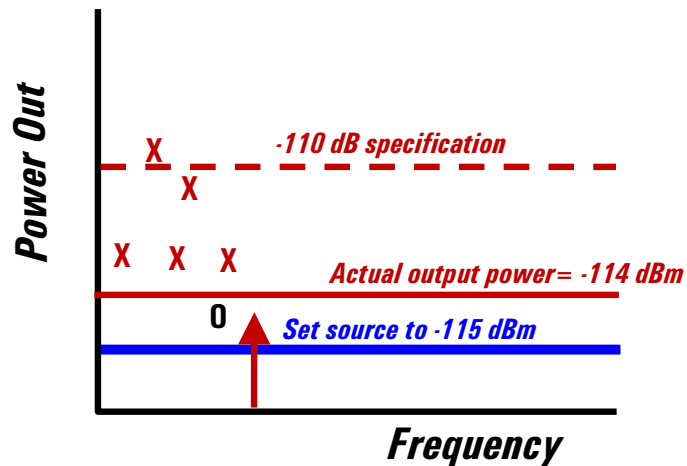
Receiver Sensitivity

- Level Accuracy

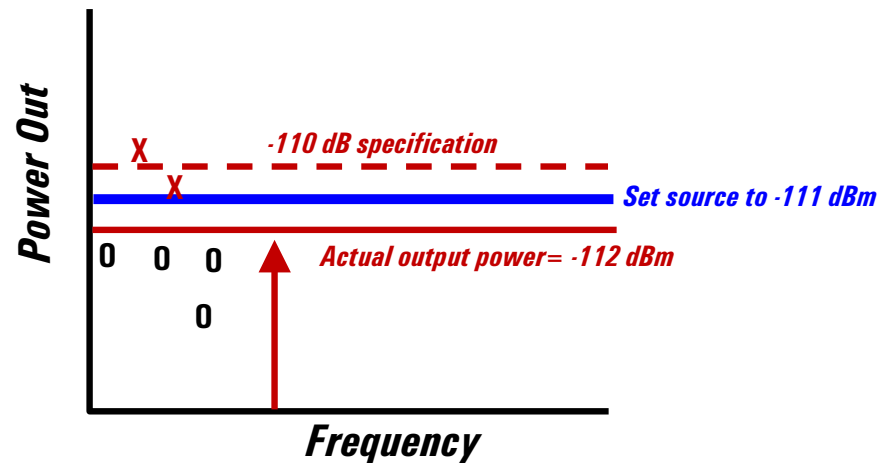
Customer is testing a -110 dB sensitivity pager:

X = Failed unit

0 = Passed unit



Case 1: Source has +/-5 dB of output power accuracy at -100 to -120 dBm output power.



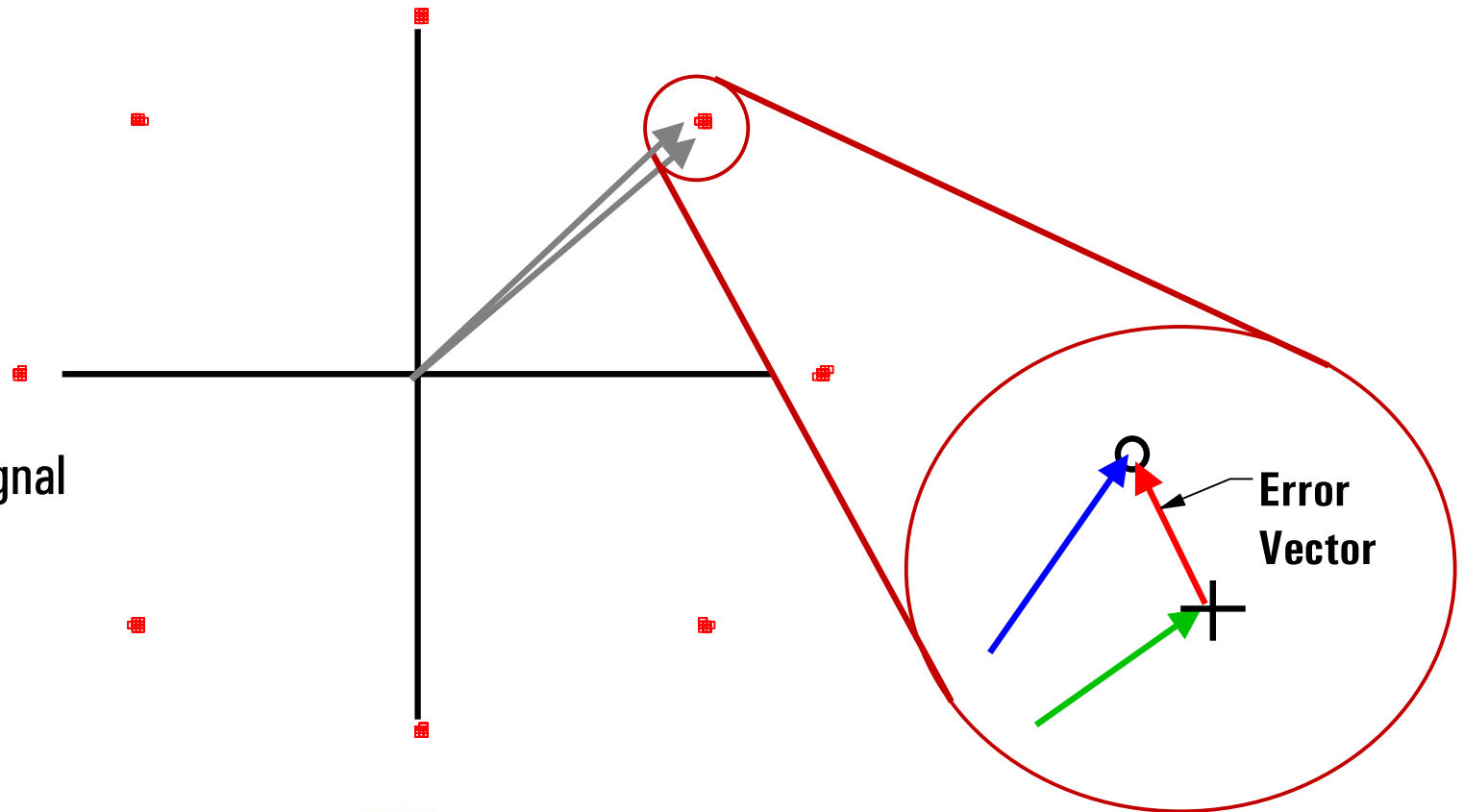
Case 2: Source has +/-1 dB of output power accuracy at -100 to -120 dBm output power.

Applications and Critical Specifications

Receiver Sensitivity

- Error Vector Magnitude (EVM)

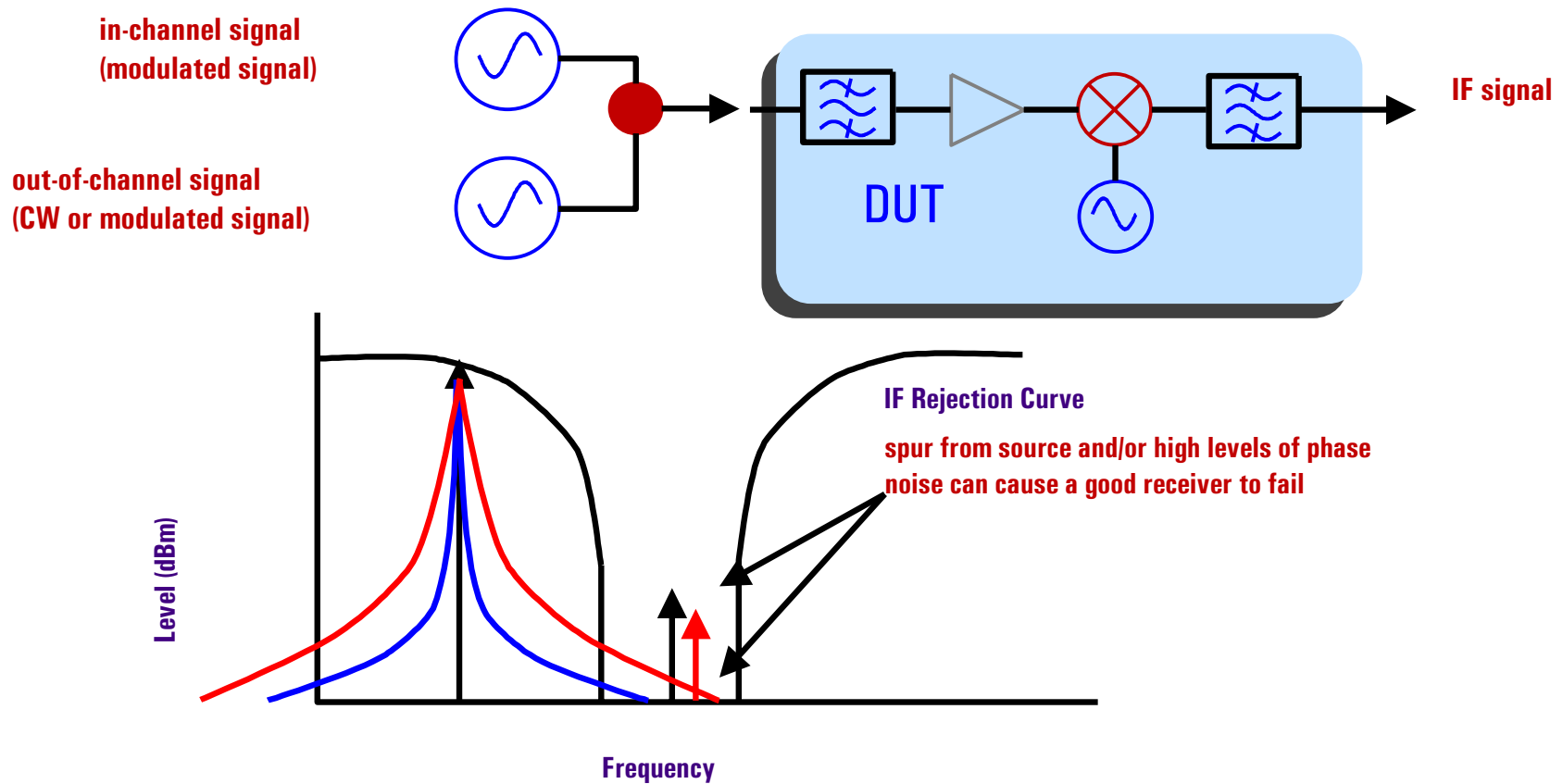
e.g. TETRA Signal
 $\pi/4$ DQPSK
EVM < 1.0%



Applications and Critical Specifications

Receiver Selectivity

- Phase Noise
- Spurious



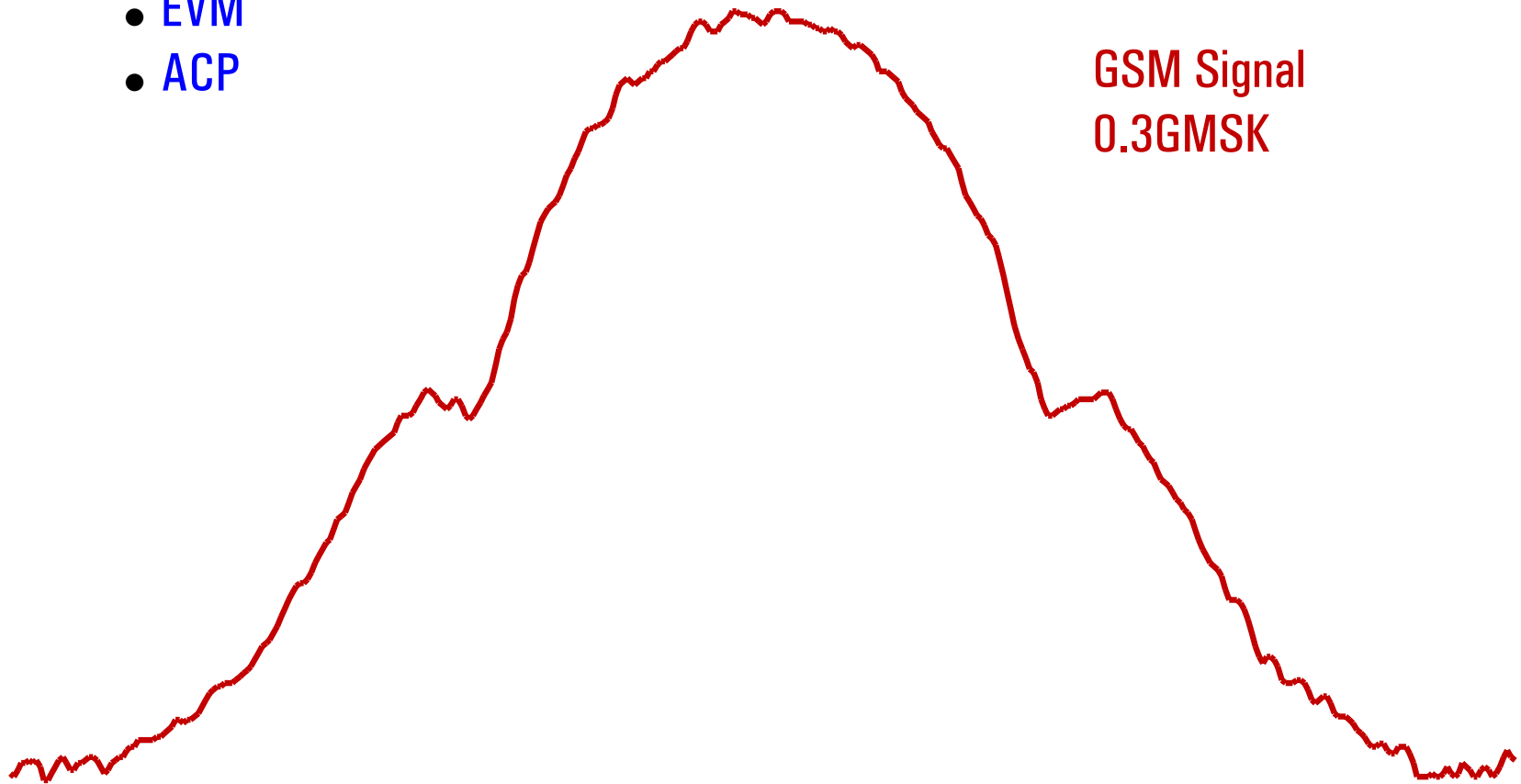
Applications and Critical Specifications

Receiver Selectivity

Spectral Accuracy:

- EVM
- ACP

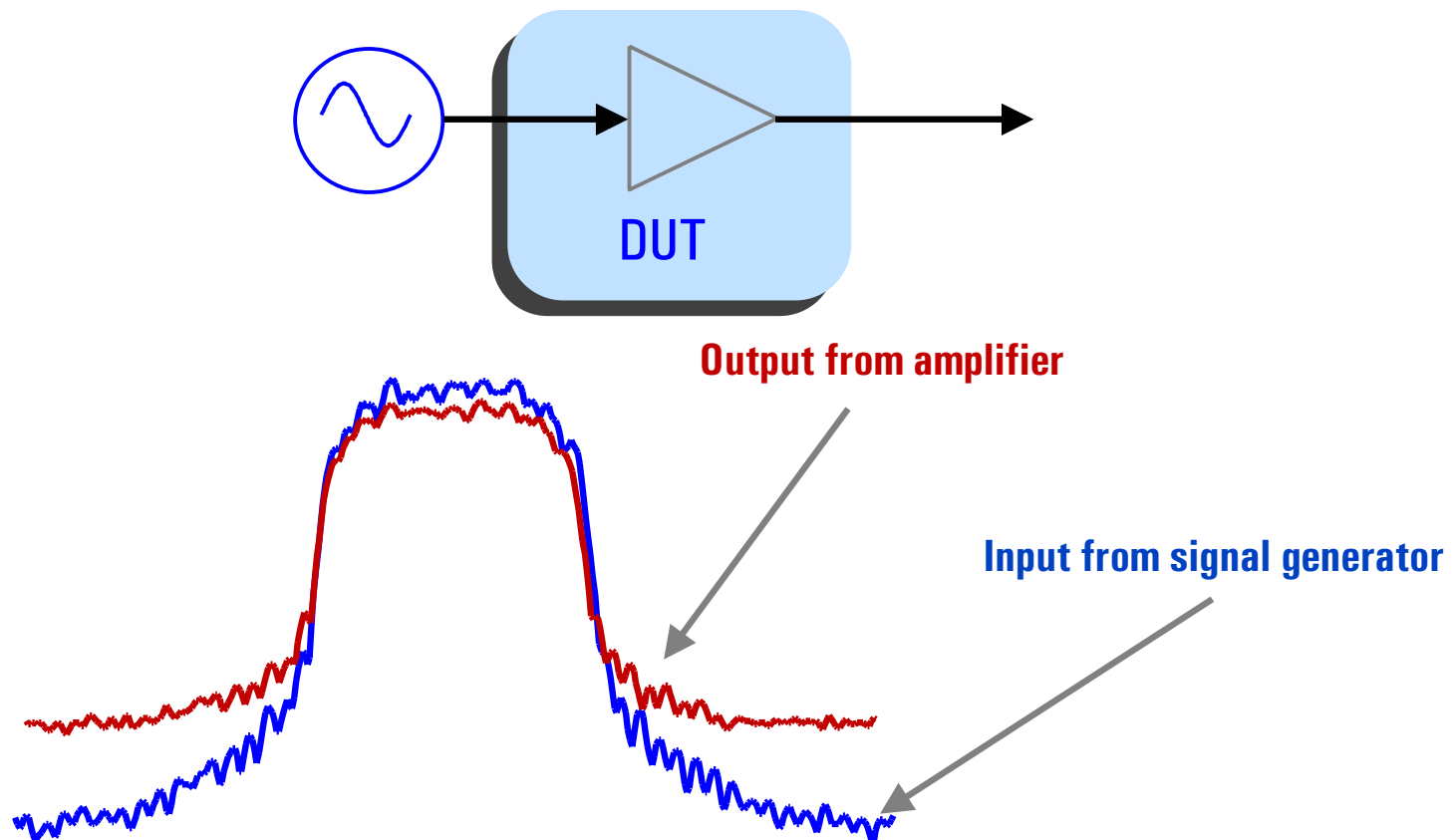
GSM Signal
0.3GMSK



Applications and Critical Specifications

Spectral Regrowth

- ACP Performance



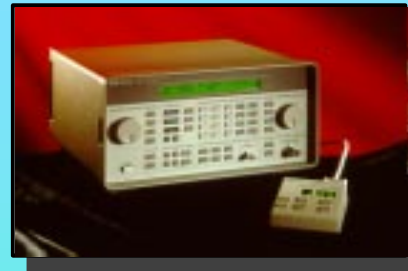
Agilent Families of Signal Generators

RF



Agilent ESG family

- 250 KHz - 4 GHz
- AM/FM/Phase/Pulse
- Digital/I-Q Mod
- GSM, CDMA, DECT...



Agilent 8647/48 family

- 9 KHz - 4 GHz
- AM/FM/Phase
- Paging, SMR, Cordless

Microwave



Agilent 8360B family

- 10 MHz - 50 GHz
- AM/FM/Pulse
- 110 GHz with ext. module



Agilent 83730 family

- 10 MHz - 20 GHz
- AM/FM/Pulse

Agenda

- Types of sources
- **CW**
- Swept
- Signal Generator
 - **Block Diagrams**
 - **Applications**
 - **Specifications**

