

# MS2760A

a new approach for mm-wave and 5G  
spectrum measurements

RF Technology Days 2018

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**RF 2018**  
TECHNOLOGY DAYS

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18 APRIL 2018

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# Agenda

- ➔ **Anritsu SPA product portfolio**
- ➔ **MS2760A feature overview**
- ➔ **What is NLTL? The magic of NLTL**
- ➔ **NLTL in a SPA (block diagram)**
- ➔ **Pros and cons of MS2760A**
- ➔ **Competitive positioning**
- ➔ **Using the MS2760A**

# Perfect Complement to Anritsu SPA portfolio

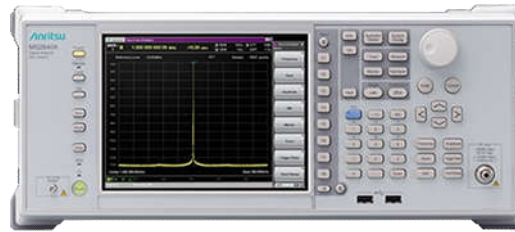
# Anritsu Spectrum Analyzer Family

## Full SPA Product Portfolio



### MS2830/40/50A

- ▶ Full featured signal analysis in the lab up to 43 GHz (1 GHz)
- ▶ Up to 300 GHz with external mixers



### MS2710xA

- ▶ Monitoring, Multilateration, Demodulation
- ▶ Ext. SW Packages
- ▶ Up to 6 GHz



### MS2760A

- ▶ mmWave spectrum analysis
- ▶ 32, 44, 50, 70, 90, 110 GHz solutions for the lab, field or manufacturing line



### MS2720T

- ▶ Full featured spectrum analysis in the field
- ▶ Up to 43 GHz

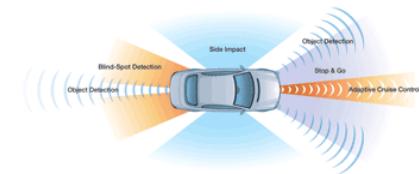


# Target Markets

# Emerging mmWave market

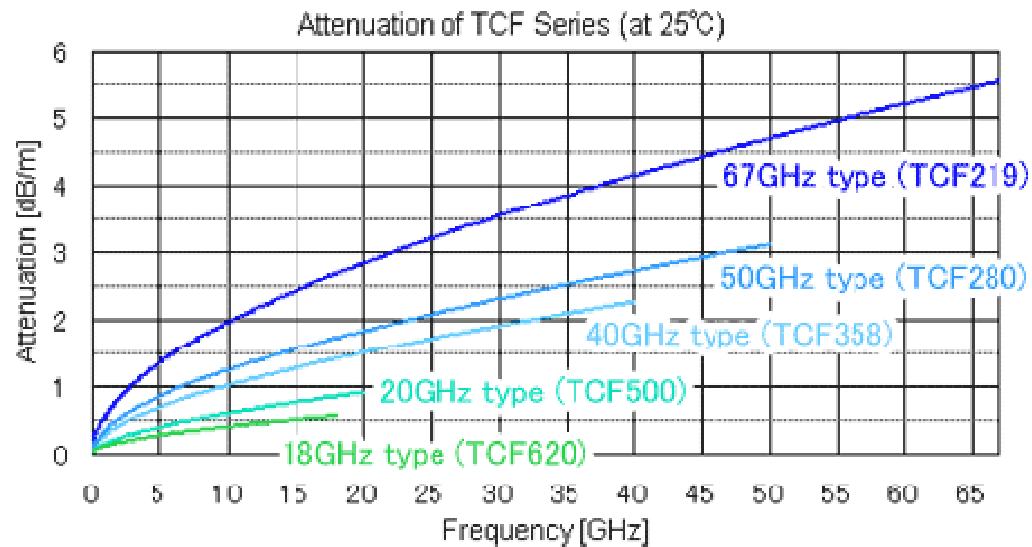
## ➔ Users making basic spectrum measurements from 9 kHz up to 110 GHz

- ▶ 5G: 28, 39, 60 GHz
- ▶ Microwave Radios: 70/80 GHz, 90 GHz
- ▶ IEEE 802.11ad (WiGig): 57 - 66 GHz
- ▶ Automotive Radar: 76 - 81 GHz
- ▶ Satellite: 27 - 40 GHz (Ka band), 40 - 75 GHz, (V band)
- ▶ Electronic warfare: 40 - 75 GHz (V band)
- ▶ SRW and ISM Devices: 45, 60, 75, 92 GHz
- ▶ TSCM: Any frequency



# Emerging mmWave market

## mmWave Trade-Offs



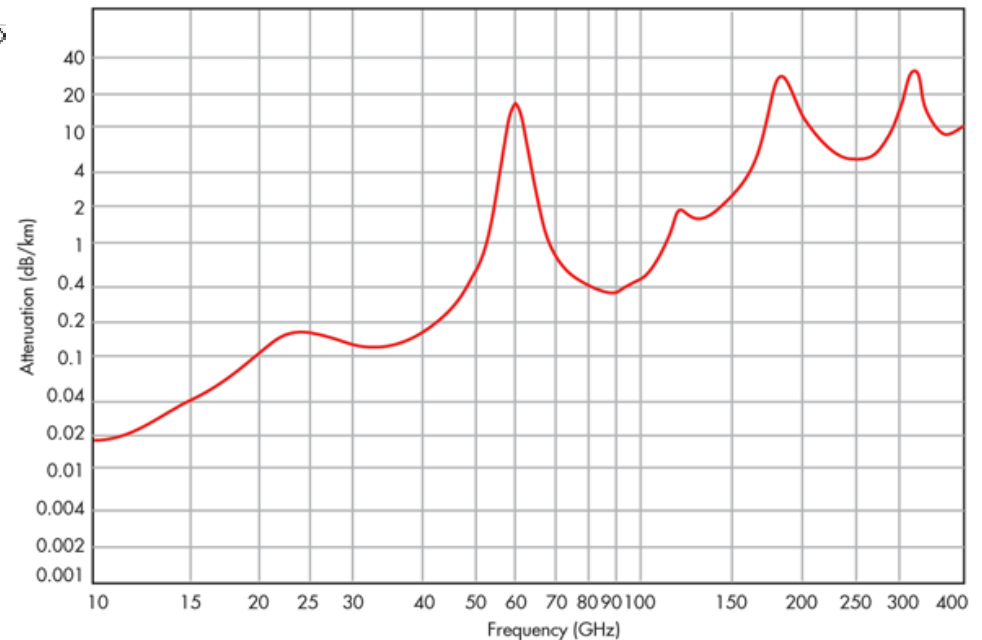
$$FSPL = \left( \frac{4\pi df}{c} \right)^2$$

Where:

**d** = the distance from the transmitter (meters)

**f** = the signal frequency (hertz)

**C** = the speed of light in a vacuum



# MS2760A Features

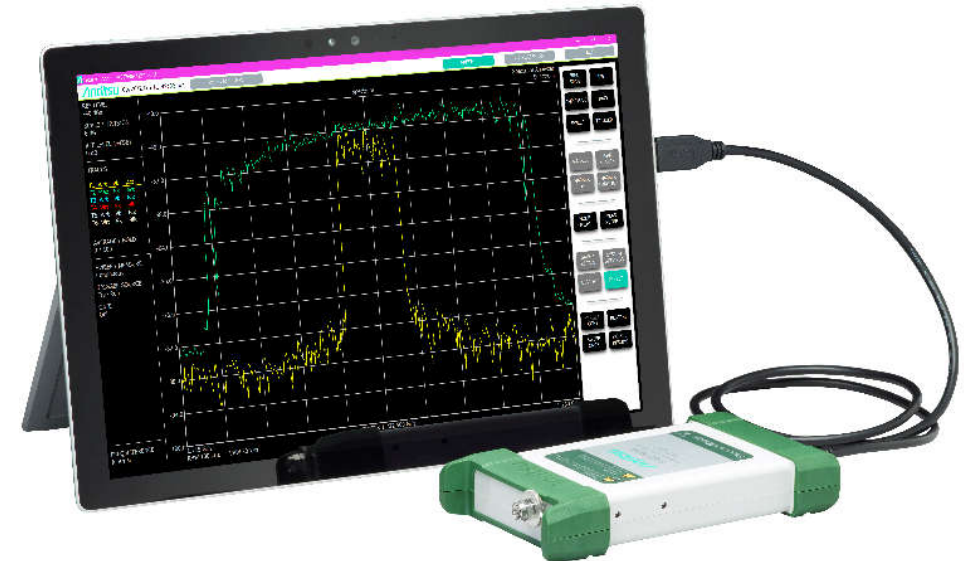


# Introducing MS2760A Spectrum Master

## Ultraportable USB-powered Spectrum Analyzer



- ➔ FFT analyzer
- ➔ 9 kHz up to 110 GHz
- ➔ 32, 44, 50, 70, 90, 110, 125 GHz models
- ➔  $\pm 0.5$  dB amplitude accuracy, typical
- ➔ 7 seconds to sweep 70 GHz
- ➔ > 100 dB dynamic range up to 110 GHz

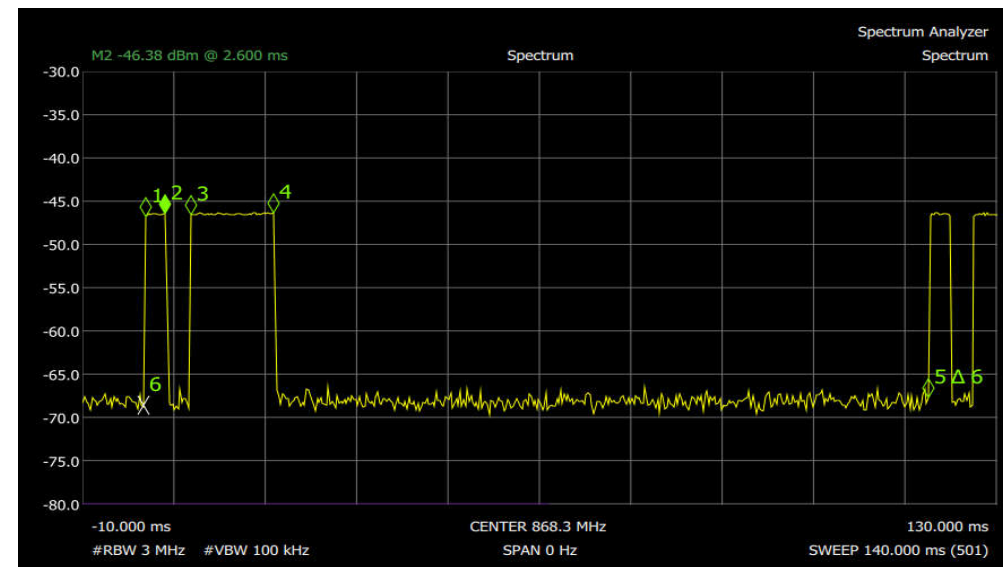
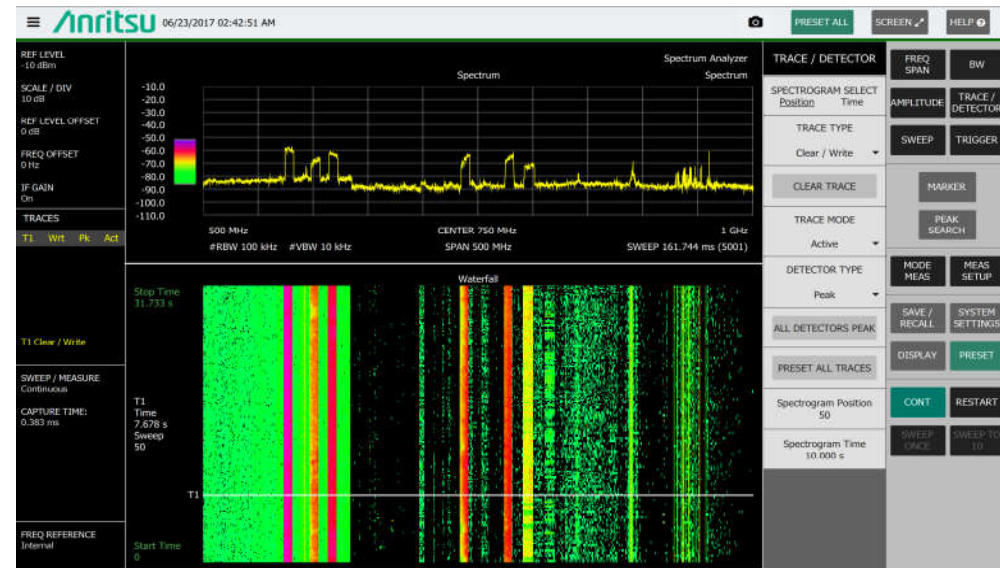


- ➔ Quad Core i7 CPU or better
- ➔ Windows 7, 8.1 or 10 (64-bit), 16 GB RAM, USB 3.0
- ➔ Sweep speed depends mainly of number crunching power of PC/Laptop

# MS2760A mmWave SPA

## Features

- ➔ Spectrogram with time markers
- ➔ Zero Span with Time Gating
- ➔ Sweep Time boost due to image reject switch off
- ➔ POI improvement by sweep time increase
- ➔ Triggers: Video and External
- ➔ Trace Math and Functions
- ➔ Noise and Counter Markers
- ➔ Masks and Limit Lines
- ➔ Measurement Functions
  - ▶ Channel Power
  - ▶ OccBw
  - ▶ ACLP
  - ▶ Harmonics
  - ▶ Burst Power



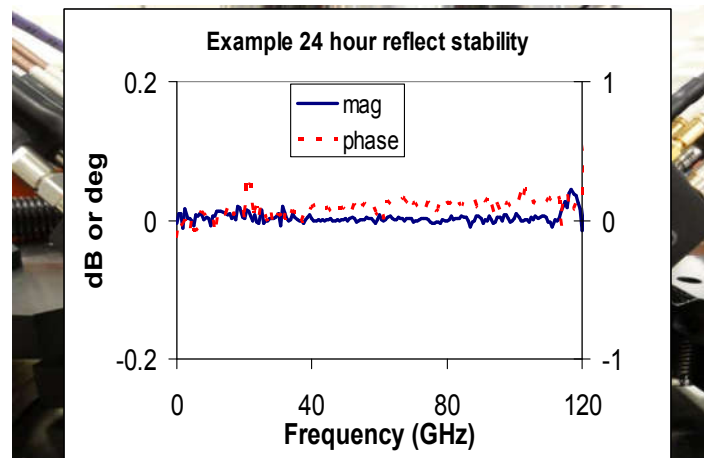
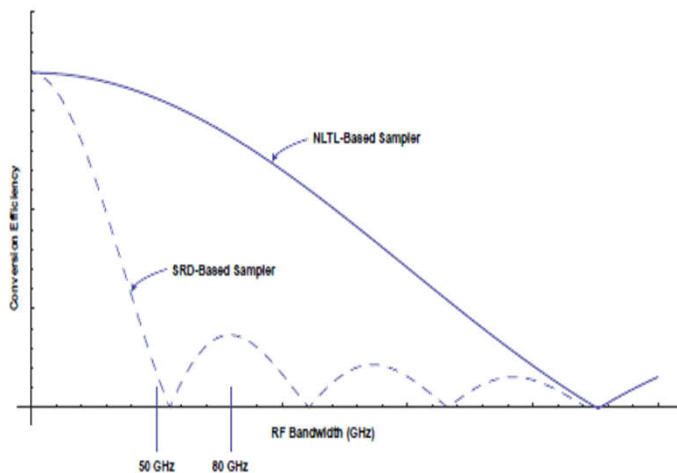
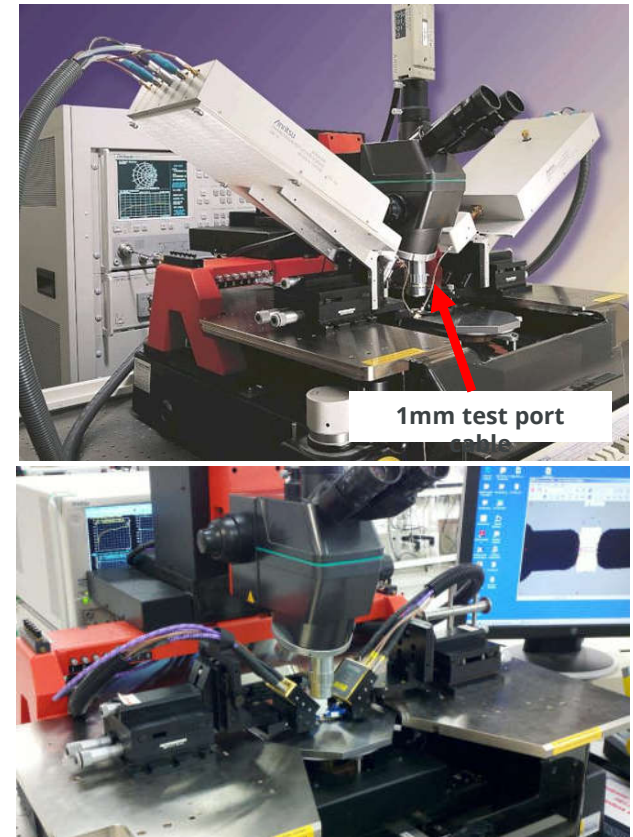
# Non Linear Transmission Line (NLTL) What is this?

# NLTL Technology

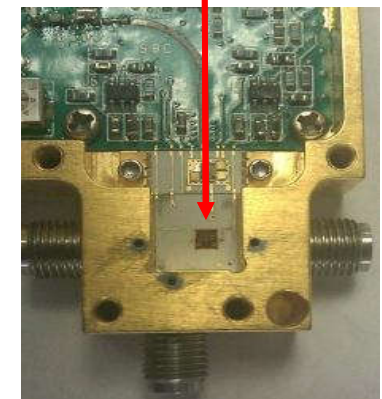
## Principle of Nonlinear Transmission-Line (NLTL)

### ➔ Shock Line Technology Benefits

- ▶ Smaller size
- ▶ Wider frequency range
- ▶ Improved measurement stability
- ▶ Longer intervals between calibrations
- ▶ Better measurement accuracy and repeatability
- ▶ Lower cost of test



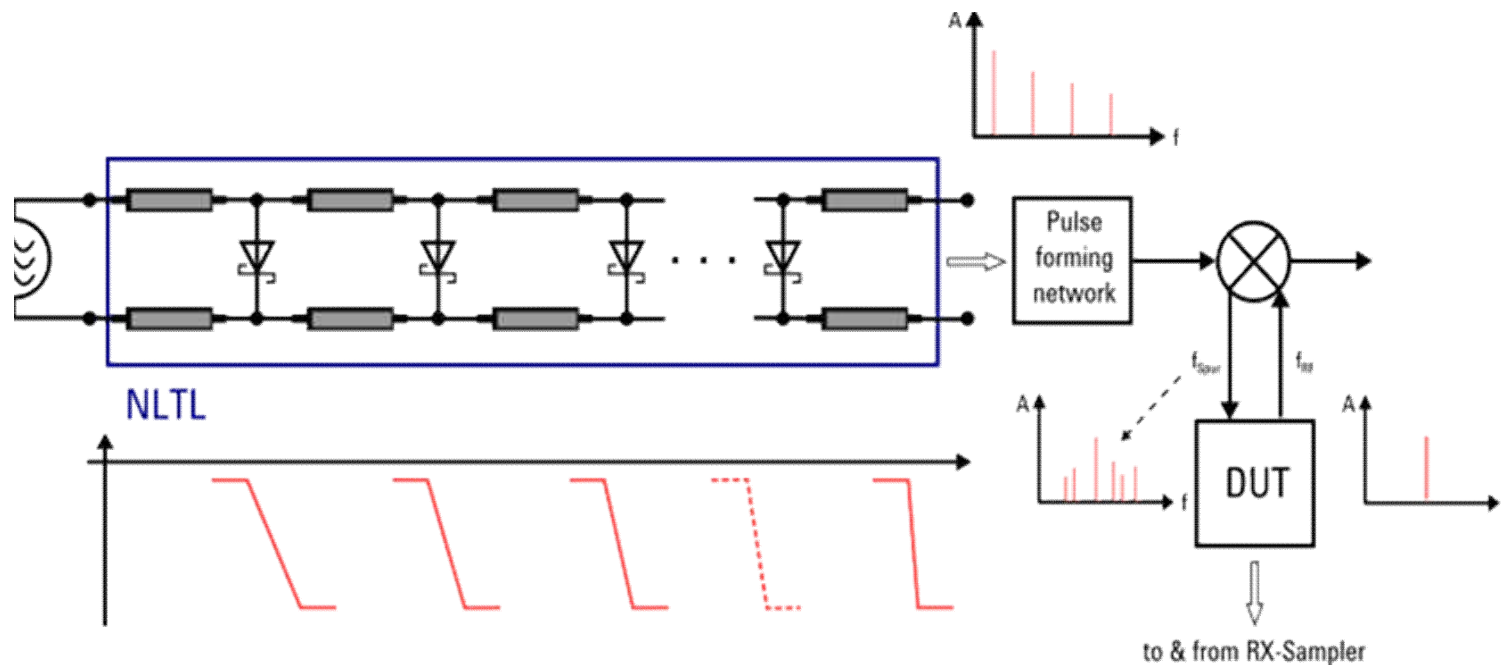
### Shock Line ASIC



# NLTL Technology

## Principle Nonlinear Transmission-Line (NLTL) based Sub-Harmonic Sampler

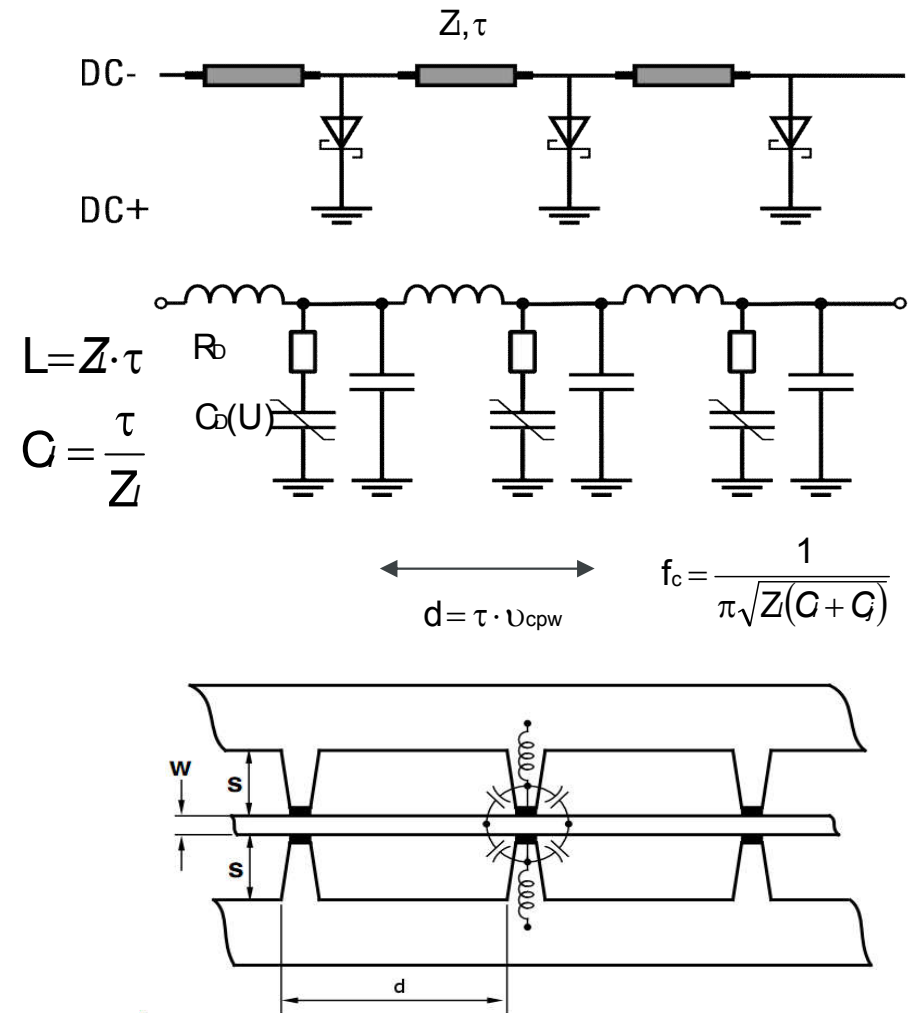
- ➔ Anritsu VNA/SPAs incorporate patented NLTL technology made at an in-house chip fab.
  - ▶ Used in sampling receivers to measure amplitude and phase of the VNA stimulus.
  - ▶ Generates power for VNA source and RX LO signals.



# NLTL Technology

## Principle of Nonlinear Transmission-Line (NLTL)

- ➔ A uniform Non-Linear-Transmission-Line (NLTL) is a high-impedance line loaded periodically by reverse biased Schottky diodes serving as voltage-variable capacitors.
- ➔ Under reverse bias, a diode behaves as a non-linear capacitance
- ➔ Strong input signals will generate harmonics and mixing products of the applied input signal
- ➔ The NLTL cell consists of a diode connected between the center conductor and ground at the junction between two sections of CPW.



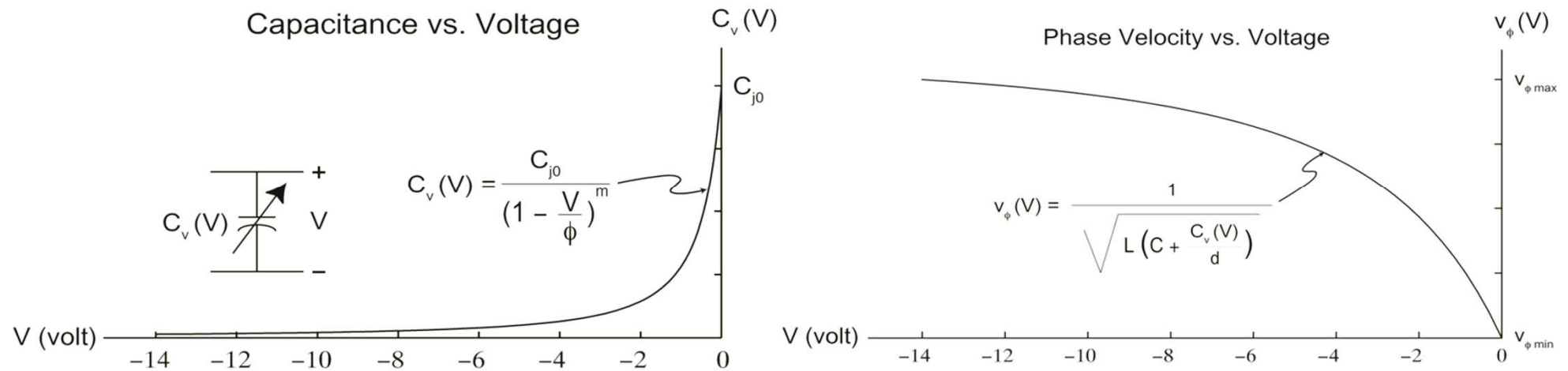
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# NLTL Technology

## Principle of Nonlinear Transmission-Line (NLTL)

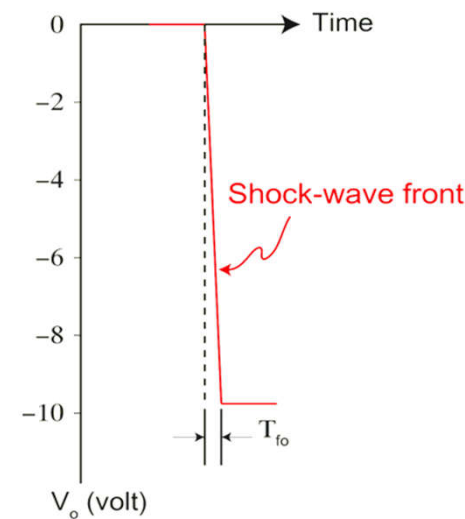
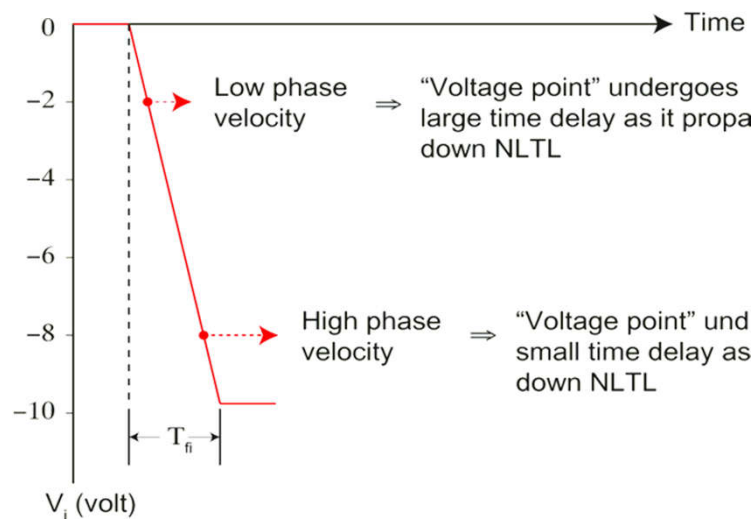
- ➔ NLTL form a propagation medium whose phase velocity and thus, time delay, is a function of the instantaneous voltage.



# NLTL Technology

## Principle of Nonlinear Transmission-Line (NLTL)

- ➔ For a step-like waveform, the trough of the wave travels at a faster phase velocity than the peak
- ➔ This results in compression of the fall time and as a result, the formation of a steep wave front that approaches that of a shock wave.



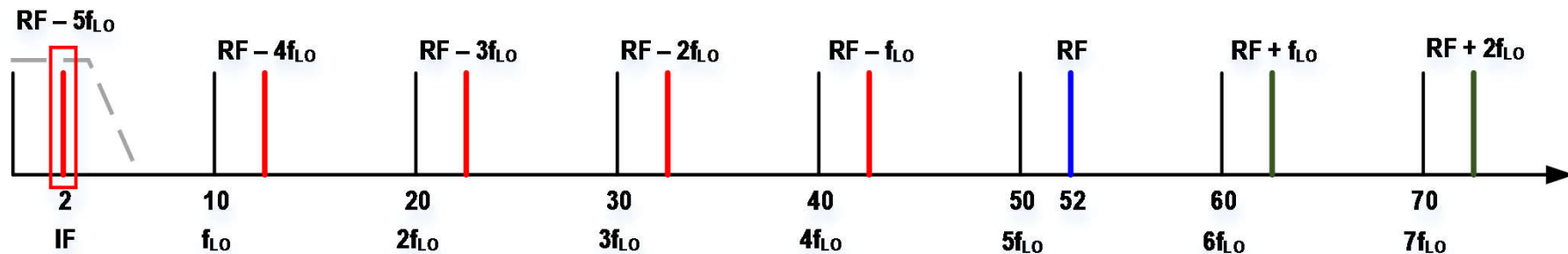
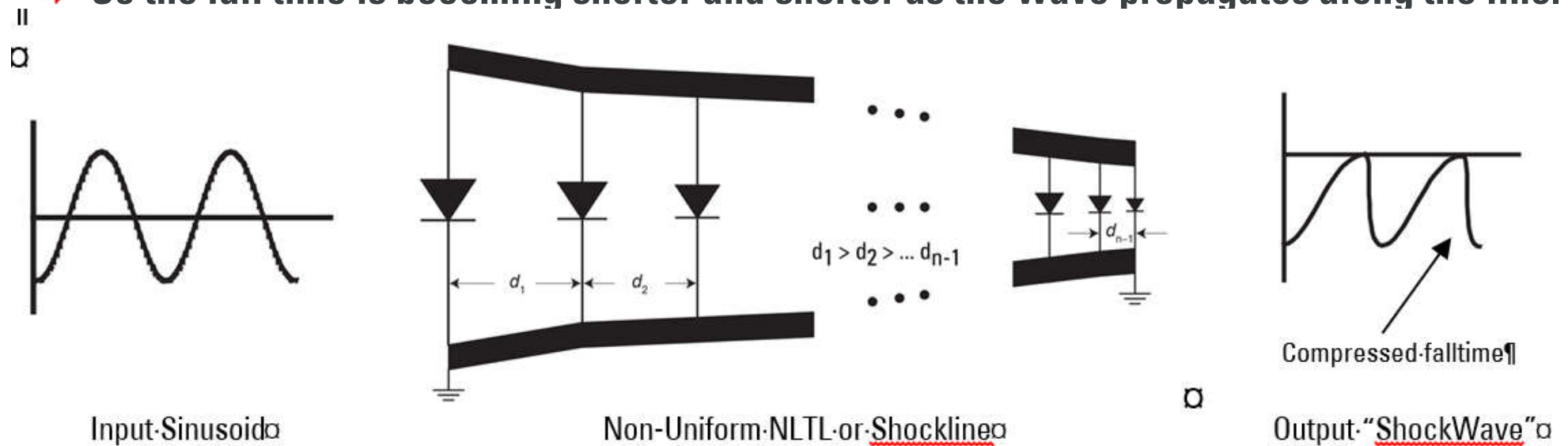




# NLTL Technology

## Principle of Nonlinear Transmission-Line (NLTL)

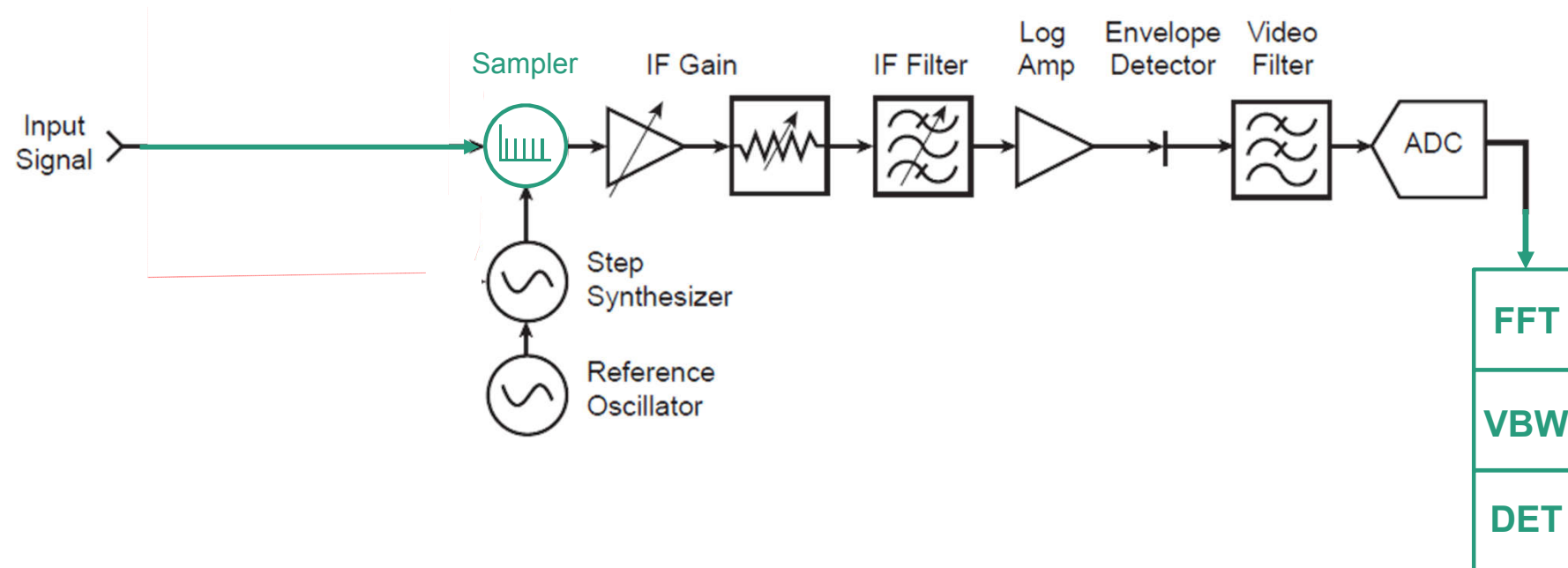
- ➔ At high negative voltages, the capacitance of the diodes is small and the velocity is fast. If the input voltage waveform has a negative going function, the first part of the wave propagate slower as the following parts.
- ➔ So the fall time is becoming shorter and shorter as the wave propagates along the line.



# MS2760A Block Diagram

# MS2760A Blockdiagramm

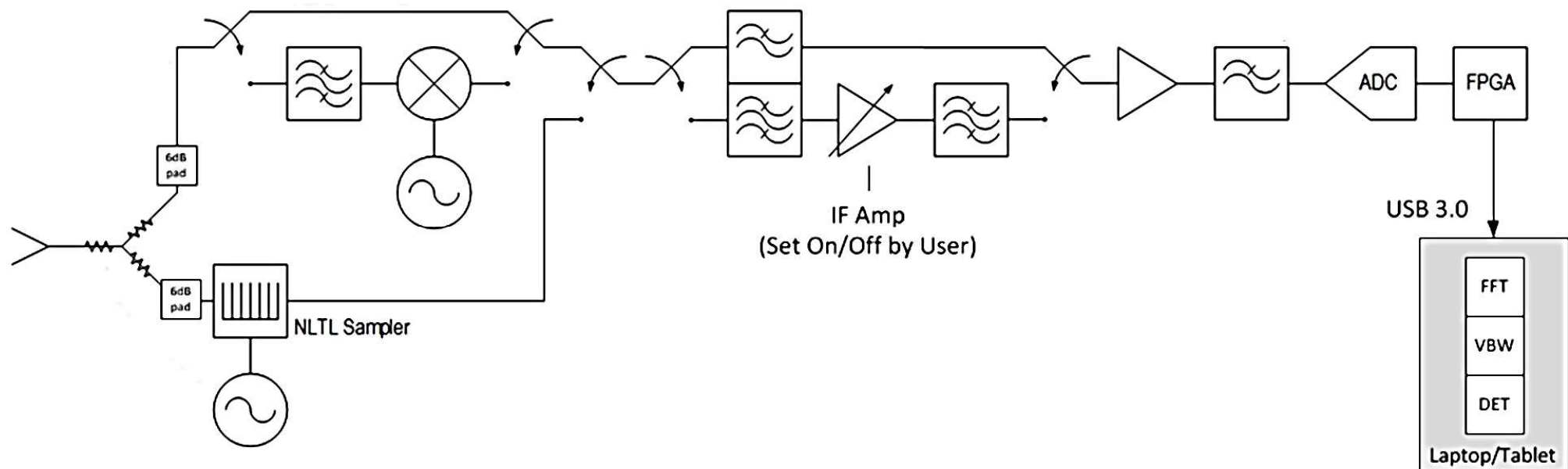
## NLTL in a spectrum analyzer



# MS2760A Blockdiagramm

## MS2760A basic function principle

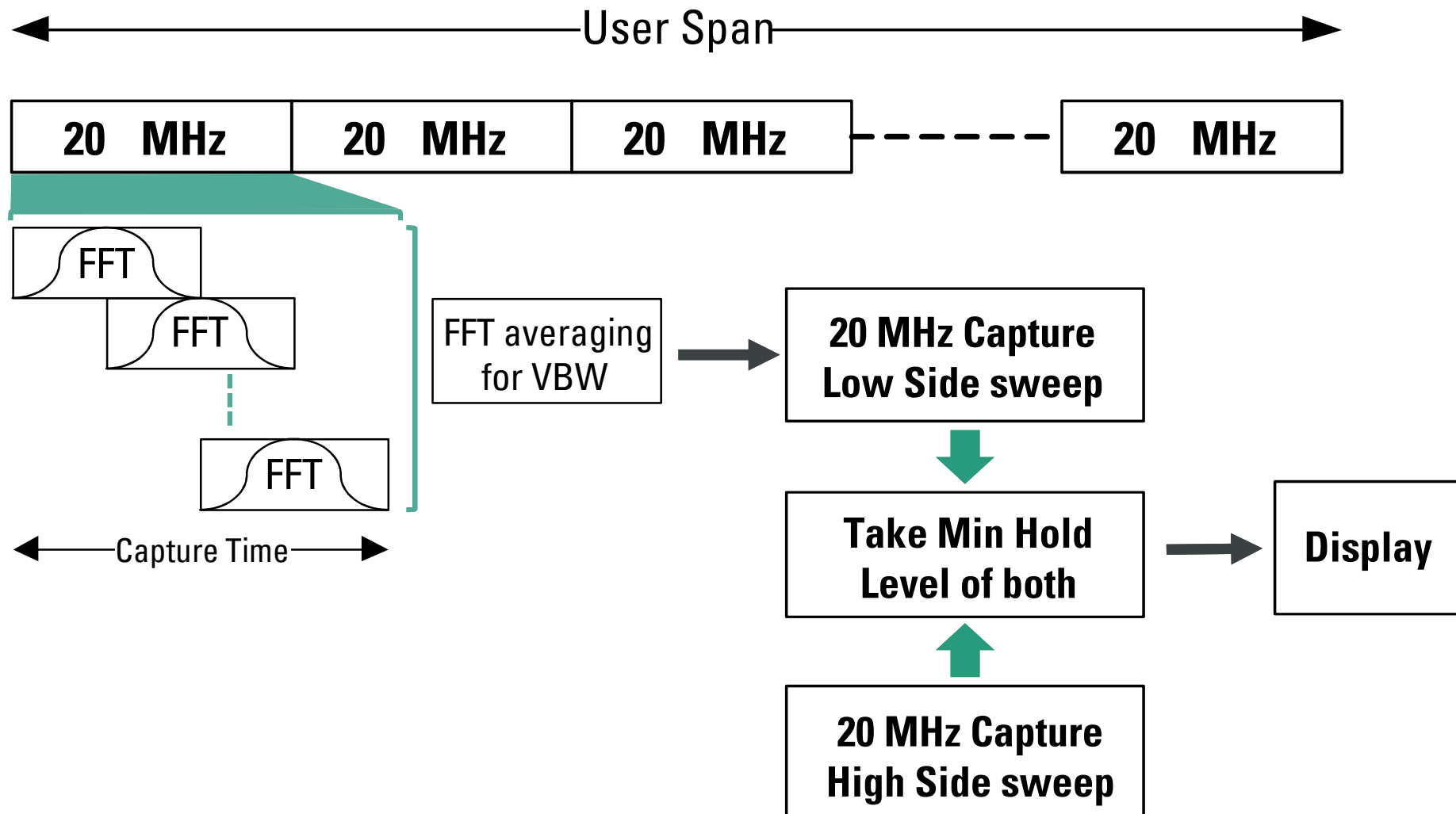
- ➔ **Direct ADC sampling for 9 kHz to 24.5 MHz**
- ➔ **Conventional mixer used for 24.5 MHz to 6.15 GHz without preselection filtering**
- ➔ **NLTL sampler-based conversion for 6.15 - 125 GHz in a customized MMIC**
- ➔ **unique software algorithms to minimize image responses which may appear under certain use cases when wideband modulated and multi-tone signals are being analyzed.**



# MS2760A Blockdiagramm

## Stepped FFT frequency representation

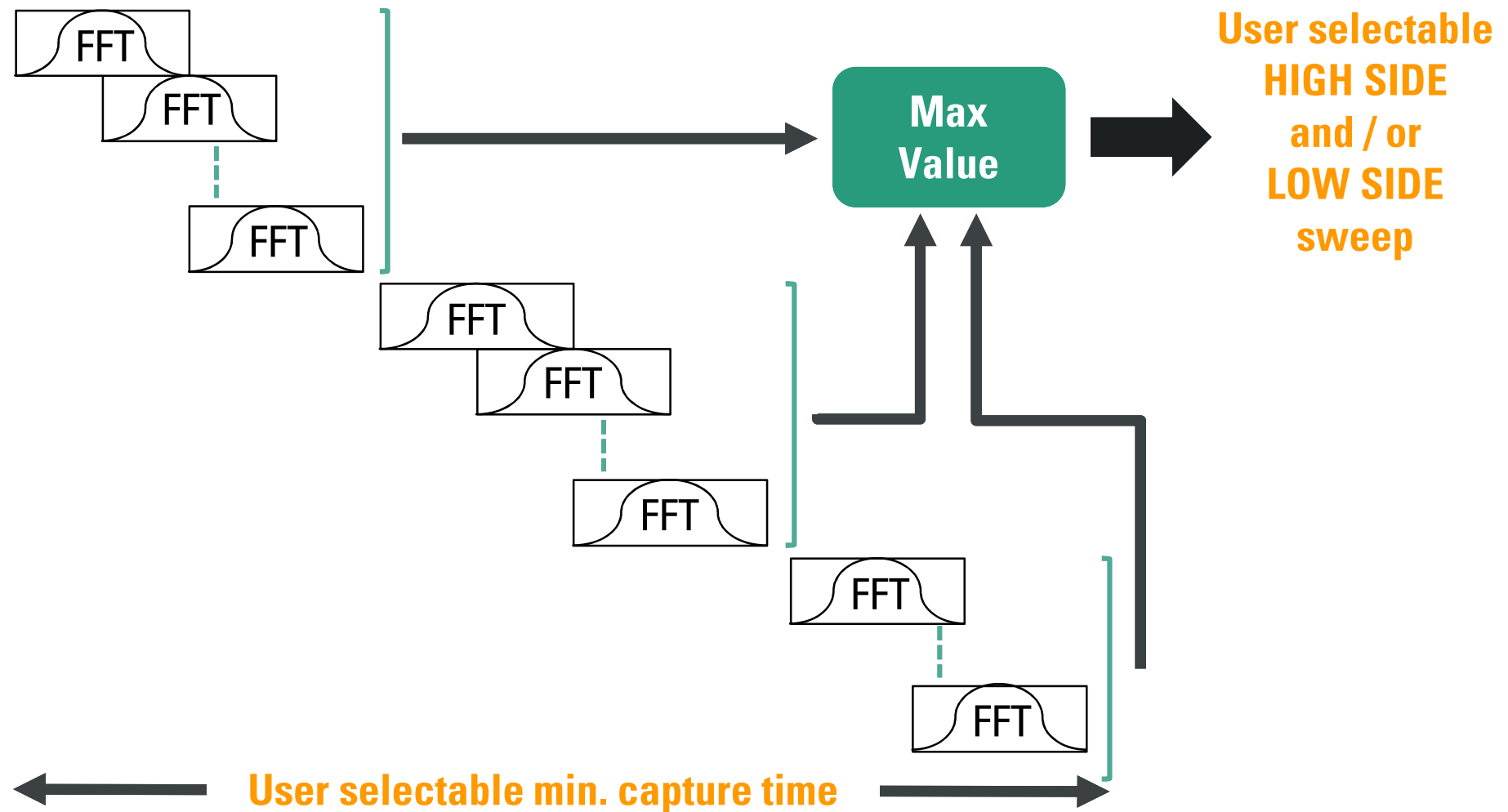
➔ **Stitching together FFTs to cover span**



# MS2760A Blockdiagramm

## Stepped FFT frequency representation

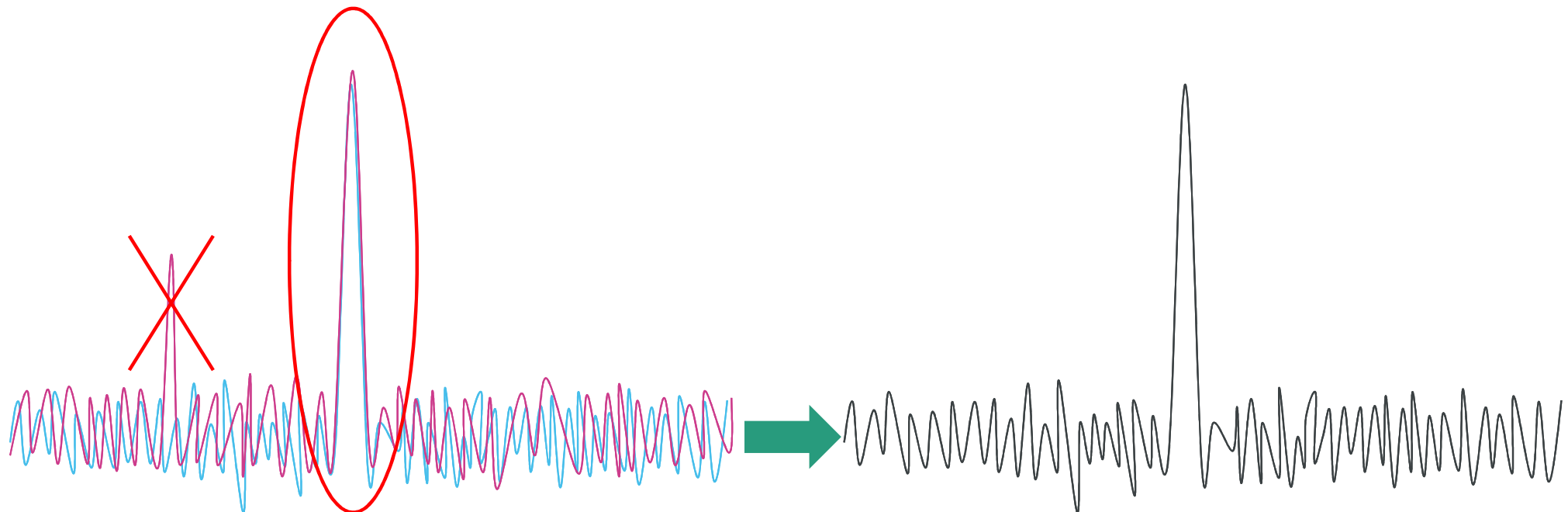
➔ To improve capturing transient events, user can select either automatic (min.), or set minimum capture time and image reject for each 20 MHz wide capture



# MS2760A Blockdiagramm

## High side / low side spur rejection

- ➔ Low-side LO conversion:  $f_{LO} < f_{RF}$   
High-side LO conversion:  $f_{LO} > f_{RF}$
- ➔ Take a **HIGH SIDE** and a **LOW SIDE** measurement compare and take the min value at each point sample and display the results

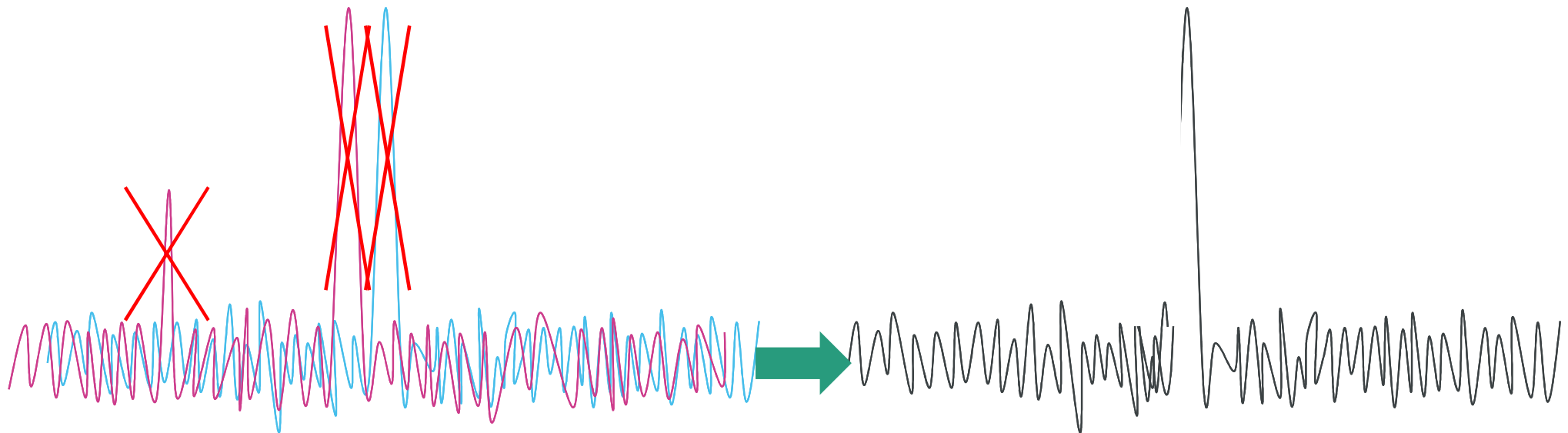




# MS2760A Blockdiagramm

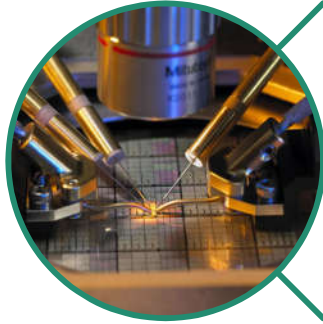
## Impact on frequency hopping signals

- ➔ Every trace is a comparison of a **HIGH SIDE** and a **LOW SIDE** sample to remove unwanted images and spurs



# Applications

# MS2760A Advantages



## R&D

- Improve measurement repeatability by measuring closer to your DUT  
- Reduce uncertainty and loss by eliminating cables
- Increase productivity - affordable option for multiple labs / groups that must share equipment
- Save time - leave it in the chamber for environmental or RF testing



## Manufacturing

- Priced for scalability
- SCPI programmable for easy automated test systems
- Improve product quality/reliability by carrying over more R&D tests to the production line



## Field

- Ultraportability helps minimize size of equipment required to carry
- Most affordable option for mmWave test in the field
- Extendable up to 20 meters for remote monitoring

# MS2760A mmWave SPA

## On-Wafer spectrum and CP measurements



➔ Forget the cables and take the measurement right where you want it with the MS2760A

*The Ultraportable Spectrum Master is even equipped with mounting holes for connection to various surfaces*

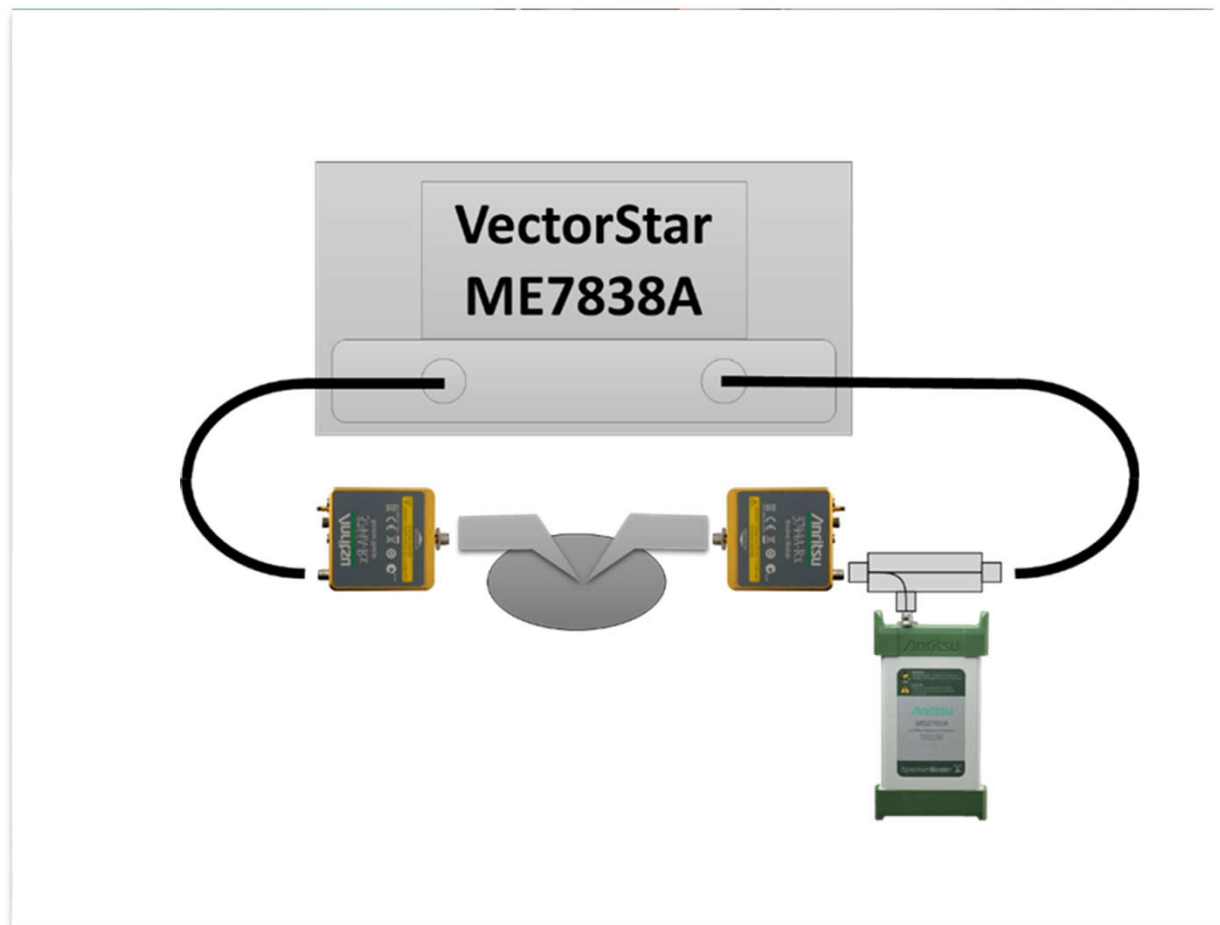


Even connect the MS2760A directly to a wafer probe!

# MS2760A mmWave SPA

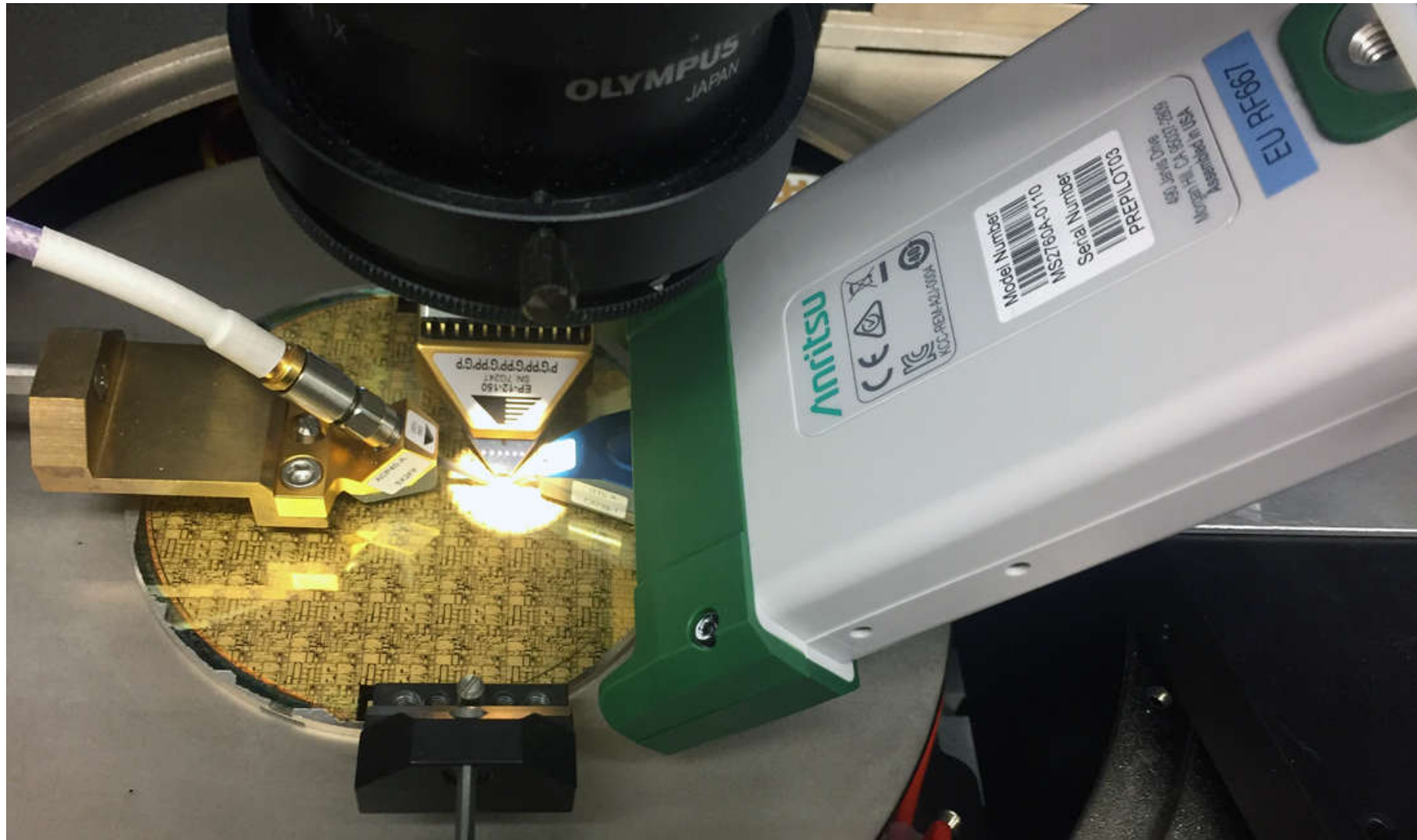
## Simultaneous VNA and Spectrum Analyzer On-wafer Measurements to 110 GHz

- ➔ NLTL module direct connect to probe.
- ➔ Spa measurements thru 10-110 GHz Anritsu coupler.
- ➔ Full band sent to Spa through V connector and 10-12 dB coupled port.



# MS2760A mmWave SPA

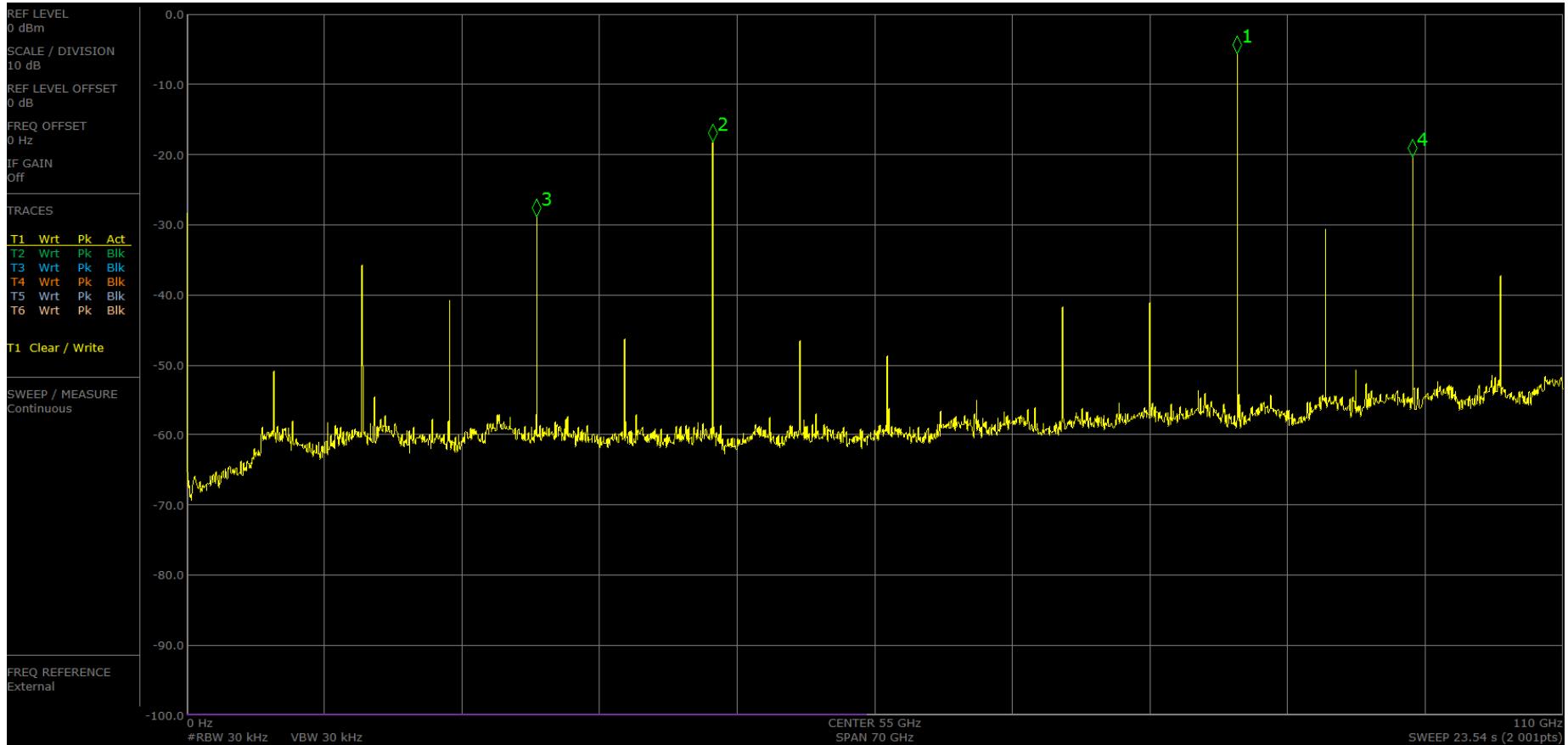
On-Wafer spectrum mm-wave multiplier measurement





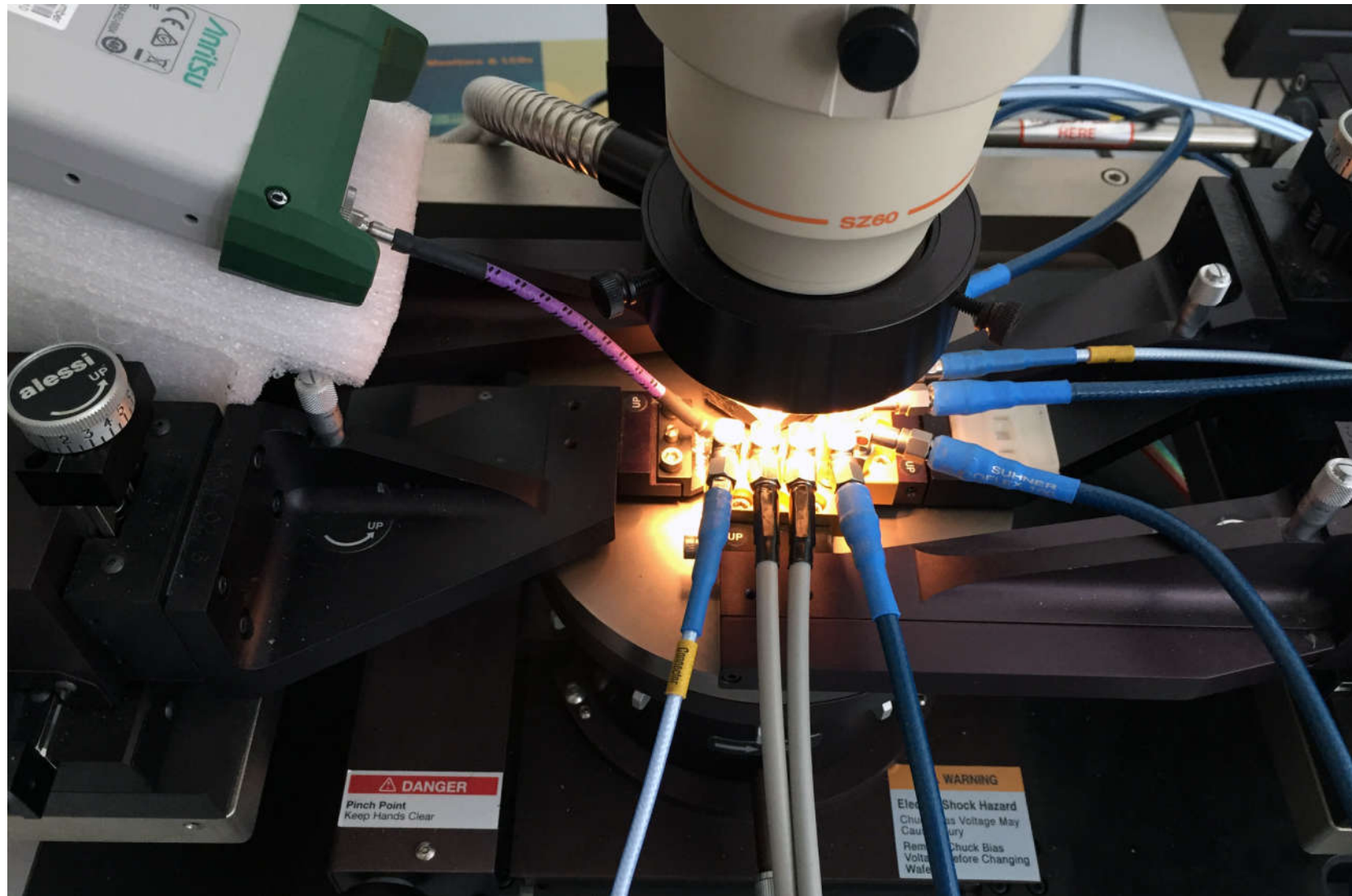
# MS2760A mmWave SPA

## On-Wafer spectrum mm-wave multiplier measurement



# MS2760A mmWave SPA

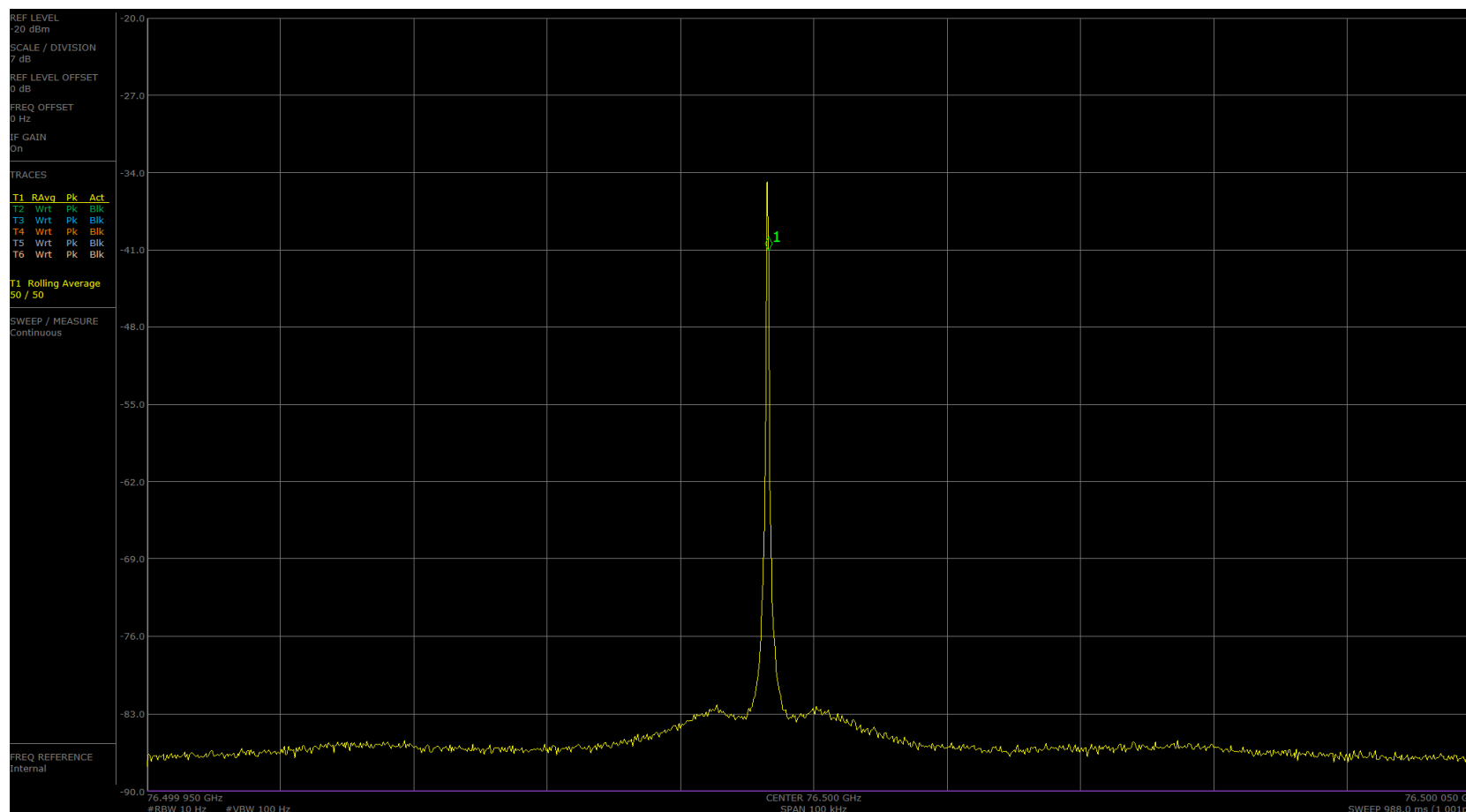
## On-Wafer spectrum mm-wave LO measurement





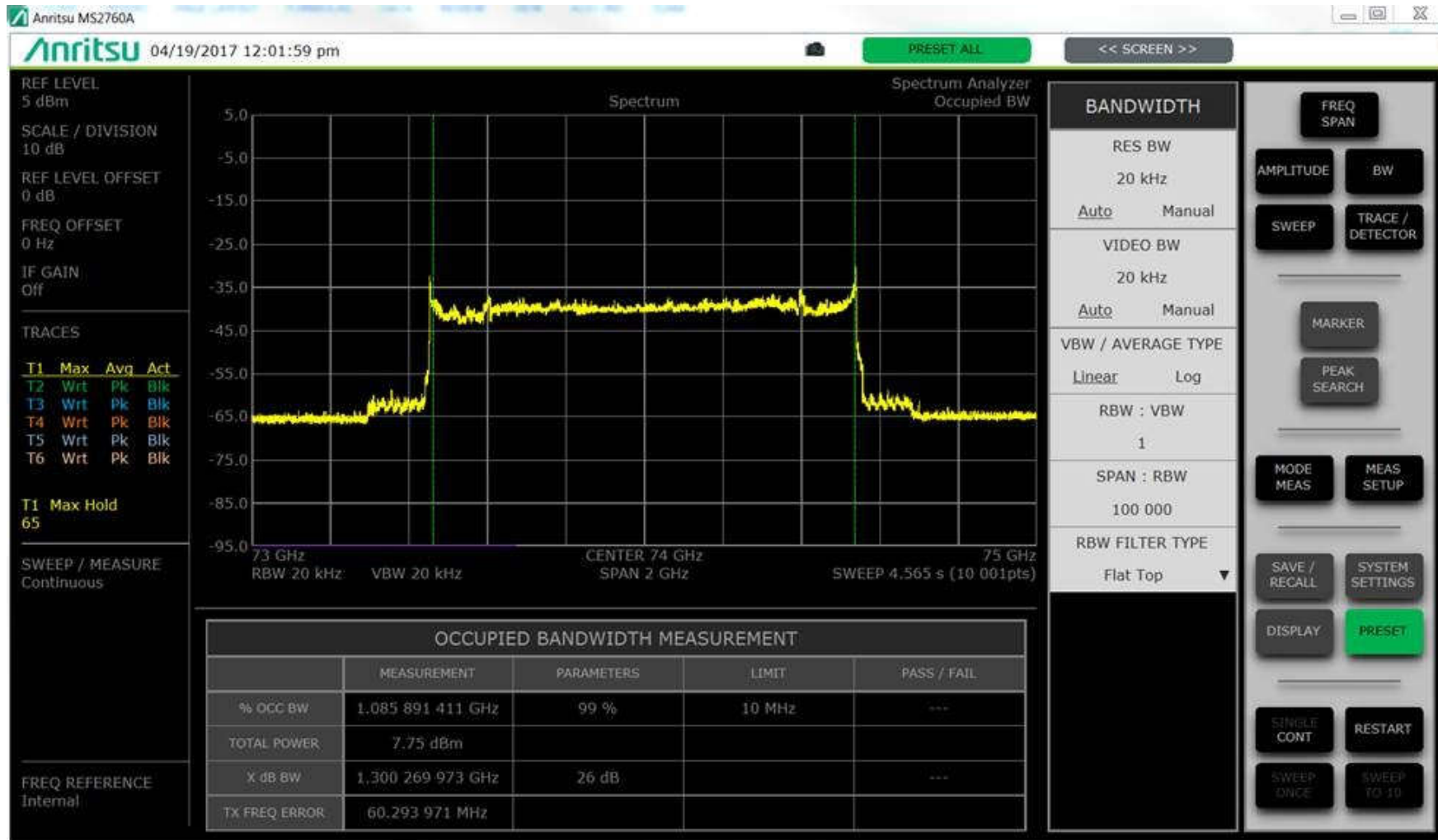
# MS2760A mmWave SPA

## On-Wafer spectrum mm-wave LO measurement



# MS2760A mmWave SPA

## Car Radar FMCW measurements



# Live Demo MS2760A



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