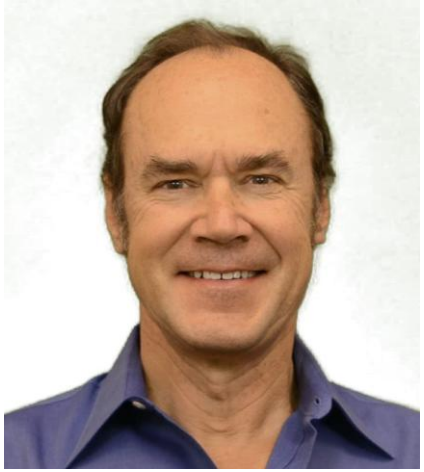
Streamline EMC Testing with Prescan Analysis Tools



Mark Terrien
EMC Business Manager
Keysight Technologies

Efficient EMC Testing Improves Revenue

Benefits both Compliance Test Houses and Manufacturers

Compliance testing

- Chamber time is limited resource
- Reducing test time improves efficiency and profitability

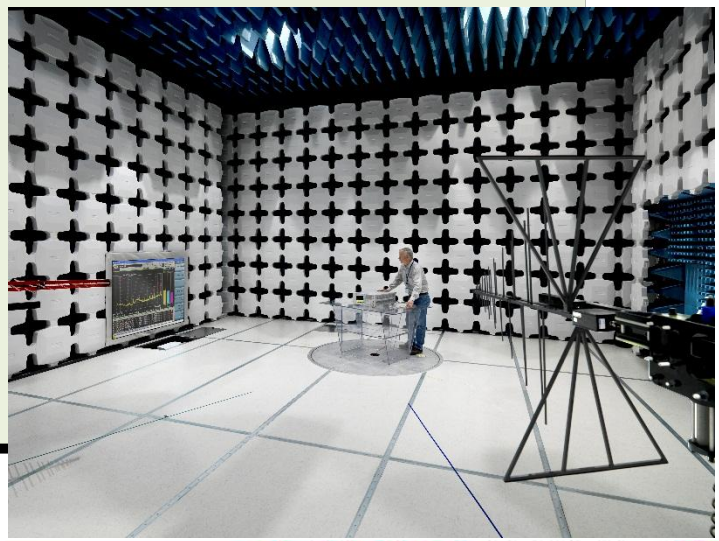
Precompliance testing

- Rapid diagnosis of early designs speeds time-to market, facilitating product sales

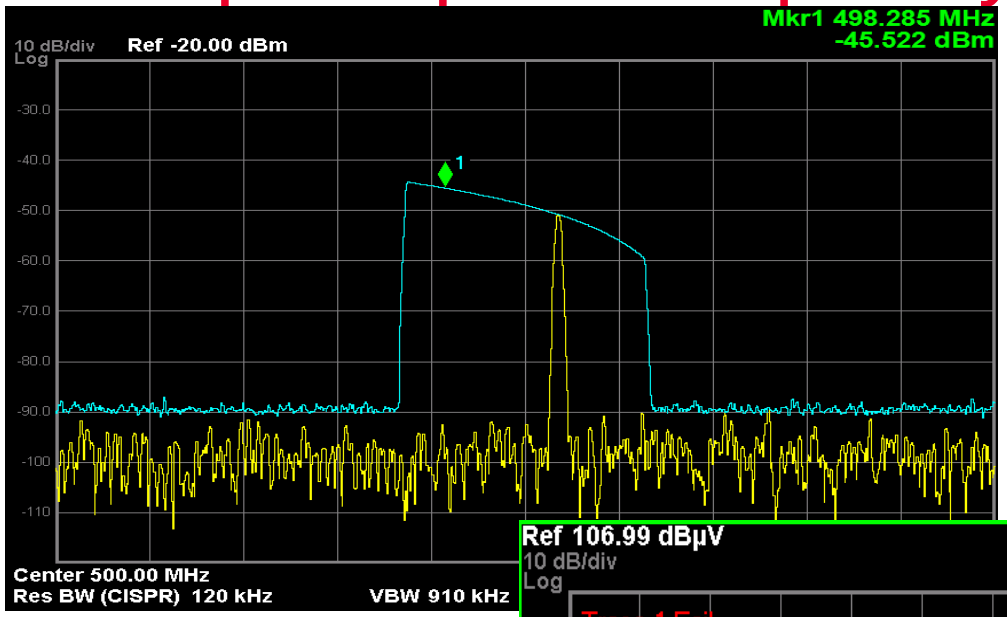
Factors Affecting EMC Test Times

Many factors affect both Compliance and Precompliance Test times:

- Device Under Test (DUT) setup time
- Receiver/ Spectrum Analyzer Scan times
- Turntable and Antenna movement times
- Suspect frequency analysis
- Final Measurement
- Report Generation

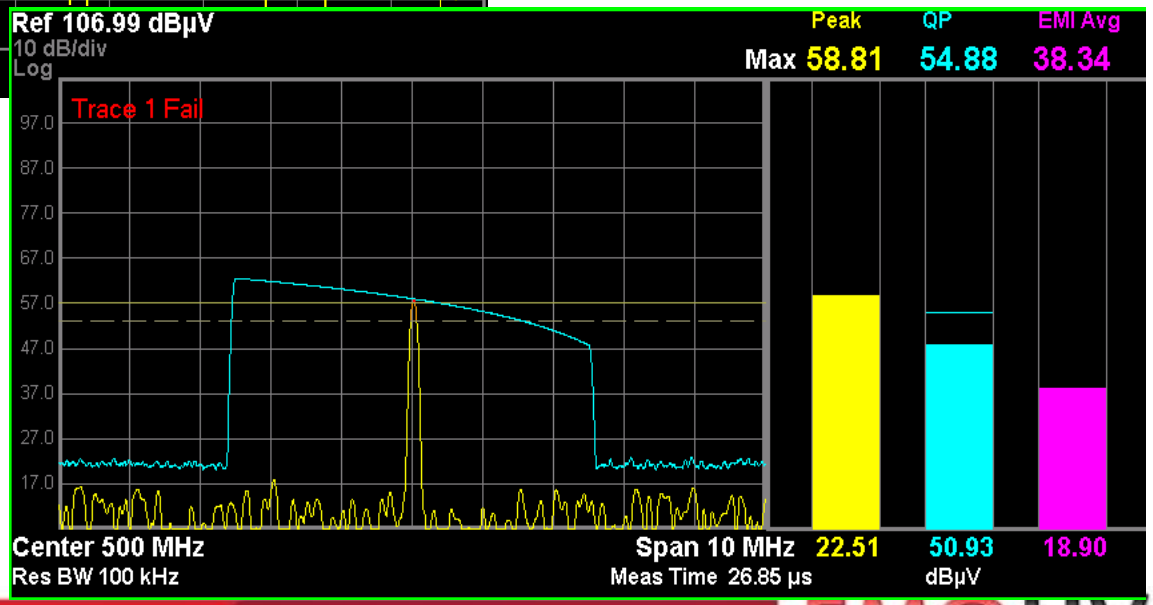


Presentation Will Discuss Tools Used to Speed up Suspect Frequency Analysis



Spectrum Analysis

IF Spectrum Monitoring



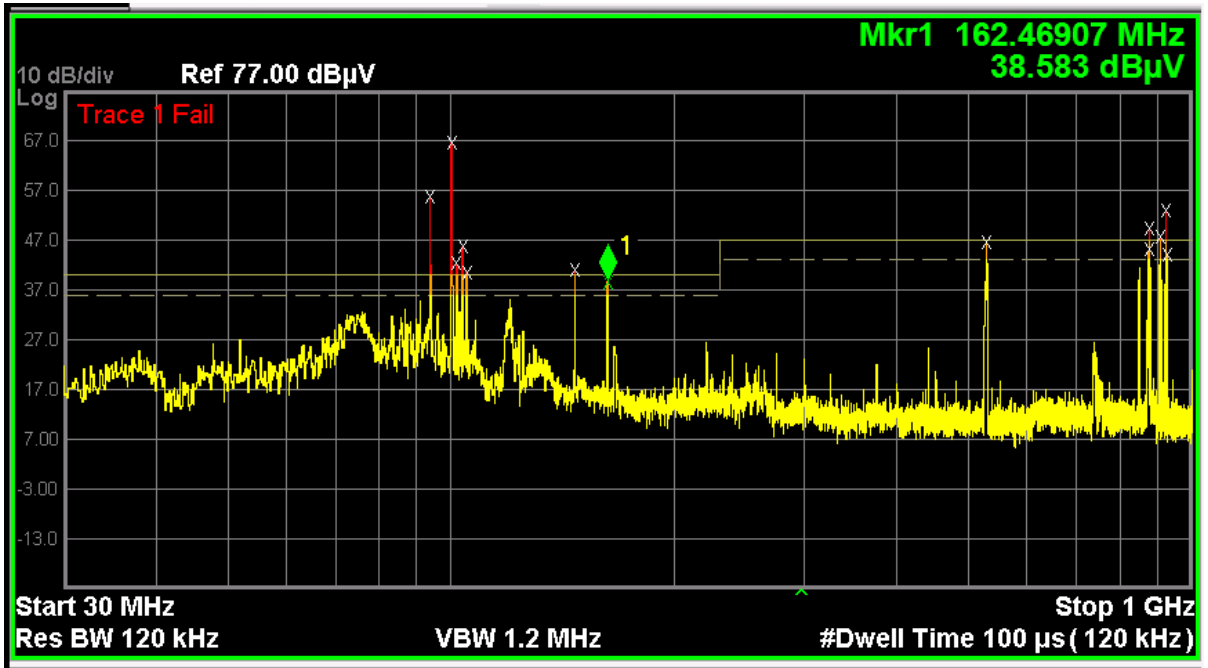
Agenda

- Suspect List Analysis
  - What are suspect emissions and why do we have to analyze them?
- Emissions Prescan Measurements
  - Benefits - why we make them
  - Challenges – errors associated with prescan
- Solutions to Speed Up Suspect List Analysis
  - Spectrum Analysis
  - IF Spectrum Monitoring

But First….What are Suspect Frequencies?

- Frequencies measured during fast prescan that may fail final measurements to CISPR limits

Prescan Display



Suspect List

SIG	TRC	FREQ	PEAK AMPTD	QPD AMPTD	EAVG AMPTD	PEAK LL1 Δ	QPD LL1 Δ	EAVG LL1 Δ
6	1	146.75 MHz	41.123 dBµV	---	---	1.123 dB	---	---
7	1	162.47 MHz	38.583 dBµV	---	---	-1.417 dB	---	---
8	1	527.72 MHz	46.545 dBµV	---	---	-0.455 dB	---	---
9	1	873.77 MHz	49.296 dBµV	---	---	2.296 dB	---	---
10	1	875.45 MHz	45.104 dBµV	---	---	-1.896 dB	---	---
11	1	904.25 MHz	47.618 dBµV	---	---	0.618 dB	---	---

Why do I Need to Analyze Suspect Frequencies?

Why can't I just directly scan and measure?

- CISPR requirements
  - Must maximize the signal and record azimuth and antenna orientation
  - Must ensure that you are measuring at the frequency of maximum emission
  - Must monitor emission Quasi-Peak (QP) amplitude to capture maximum value
    - If not constant, users must monitor QP value for 15 seconds or more (as per CISPR 16-2-3, section 6.5).
- Amplitude and frequency errors associated with prescan methods.

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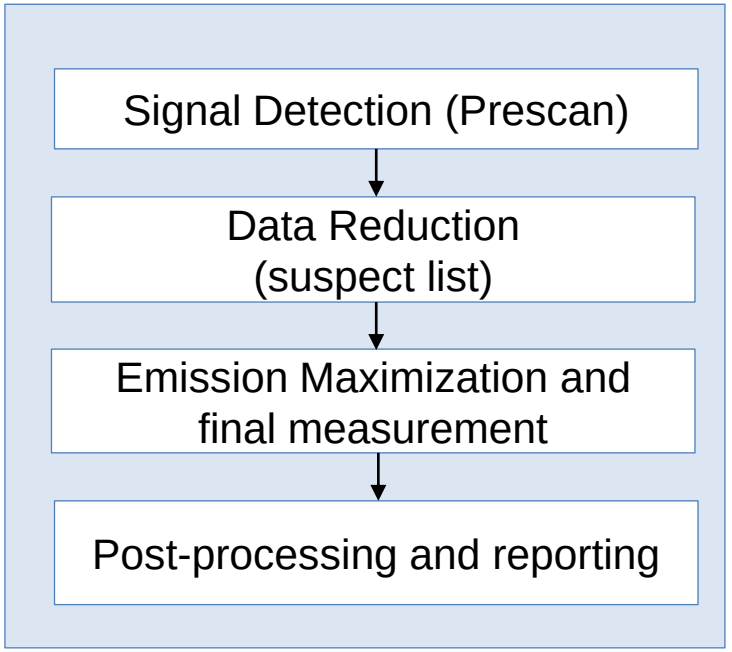
Prescanning Reduces Overall EMC Test Time

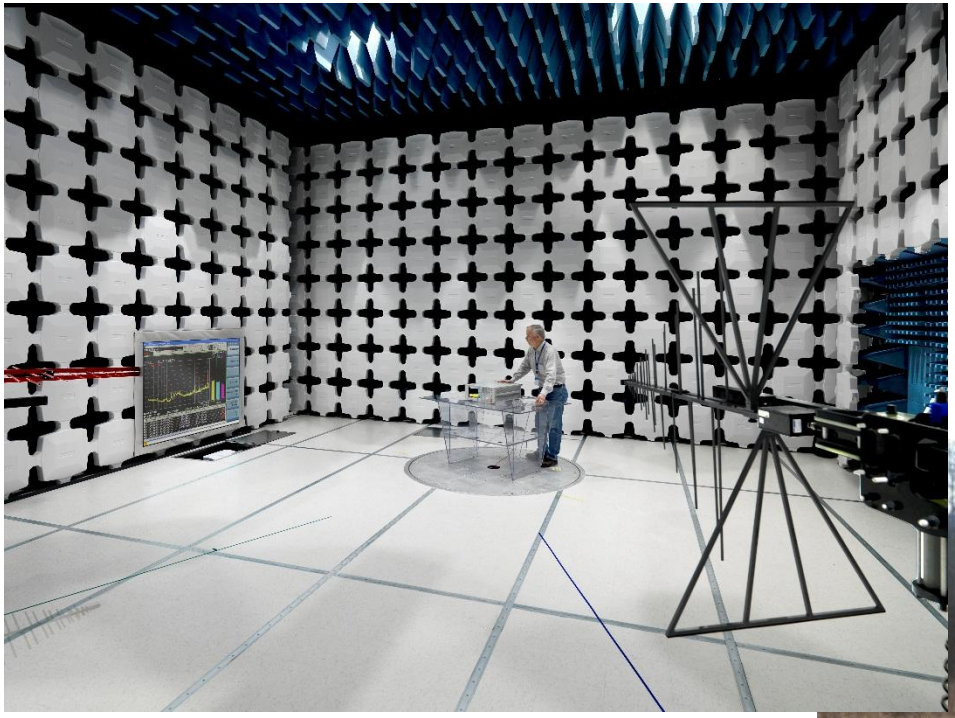
- **What is Prescanning?**
  - Methodology used to reduce overall EMC test time
  - Scan target frequency range with Peak detector to identify frequencies where emissions exist
  - Peak detector significantly faster than weighted detectors

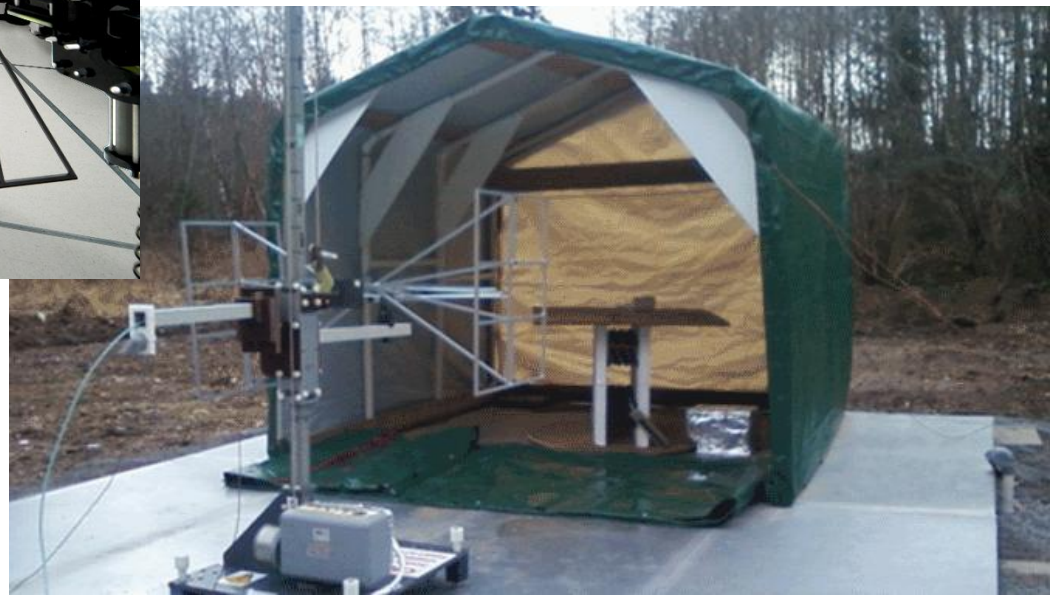
- ***Recommended* by CISPR**
  - Specifically to reduce test time



Recommended CISPR Test Flow

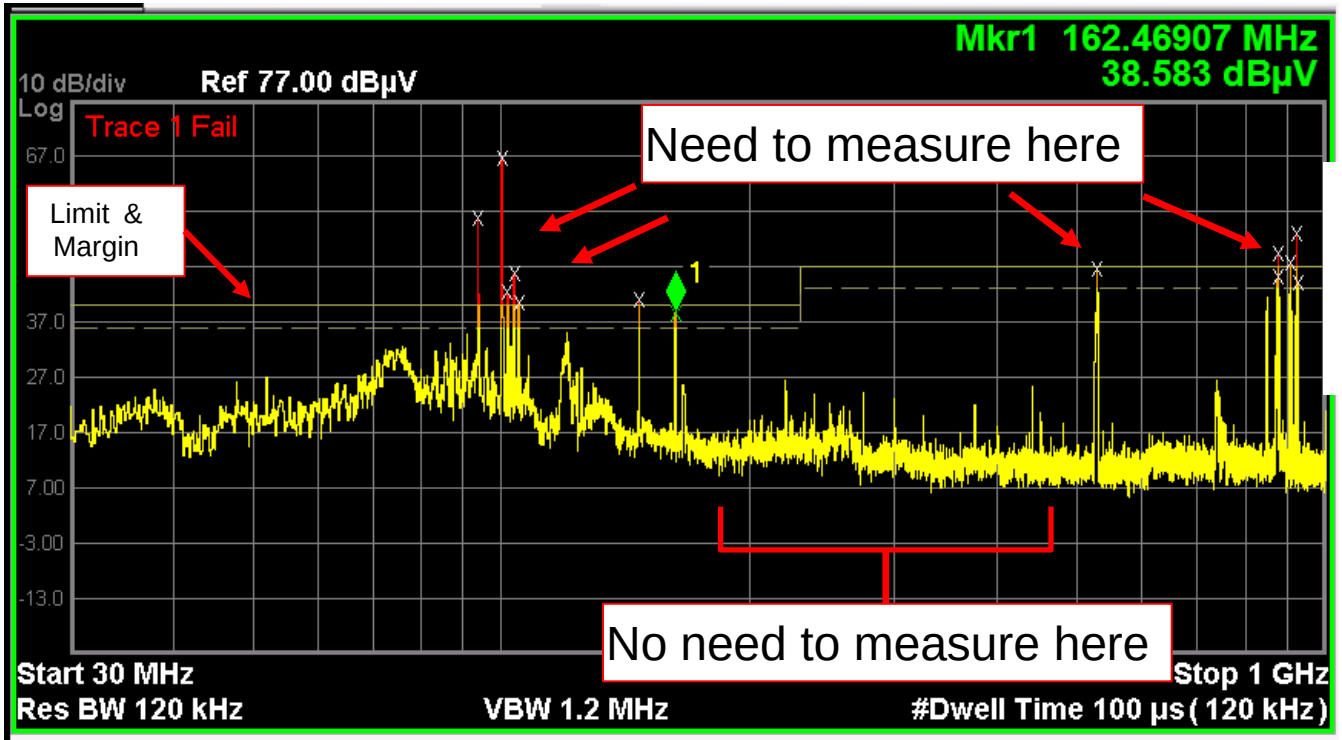
Prescan Saves Time for Both Compliance and Precompliance Testing





How Does Prescan Save Test Time?

- Focus final measurement efforts only on frequencies with emissions above or near the limit line



Peak Detected Values

Suspect List

SIG		TRC	FREQ	PEAK AMPTD	QPD AMPTD	EAVG AMPTD	PEAK LL1 Δ	QPD LL1 Δ	EAVG LL1 Δ
6		1	146.75 MHz	41.123 dBµV	---	---	1.123 dB	---	---
7		1	162.47 MHz	38.583 dBµV	---	---	-1.417 dB	---	---
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10		1	875.45 MHz	45.104 dBµV	---	---	-1.896 dB	---	---
11		1	904.25 MHz	47.618 dBµV	---	---	0.618 dB	---	---

How Does Prescan Save Test Time?

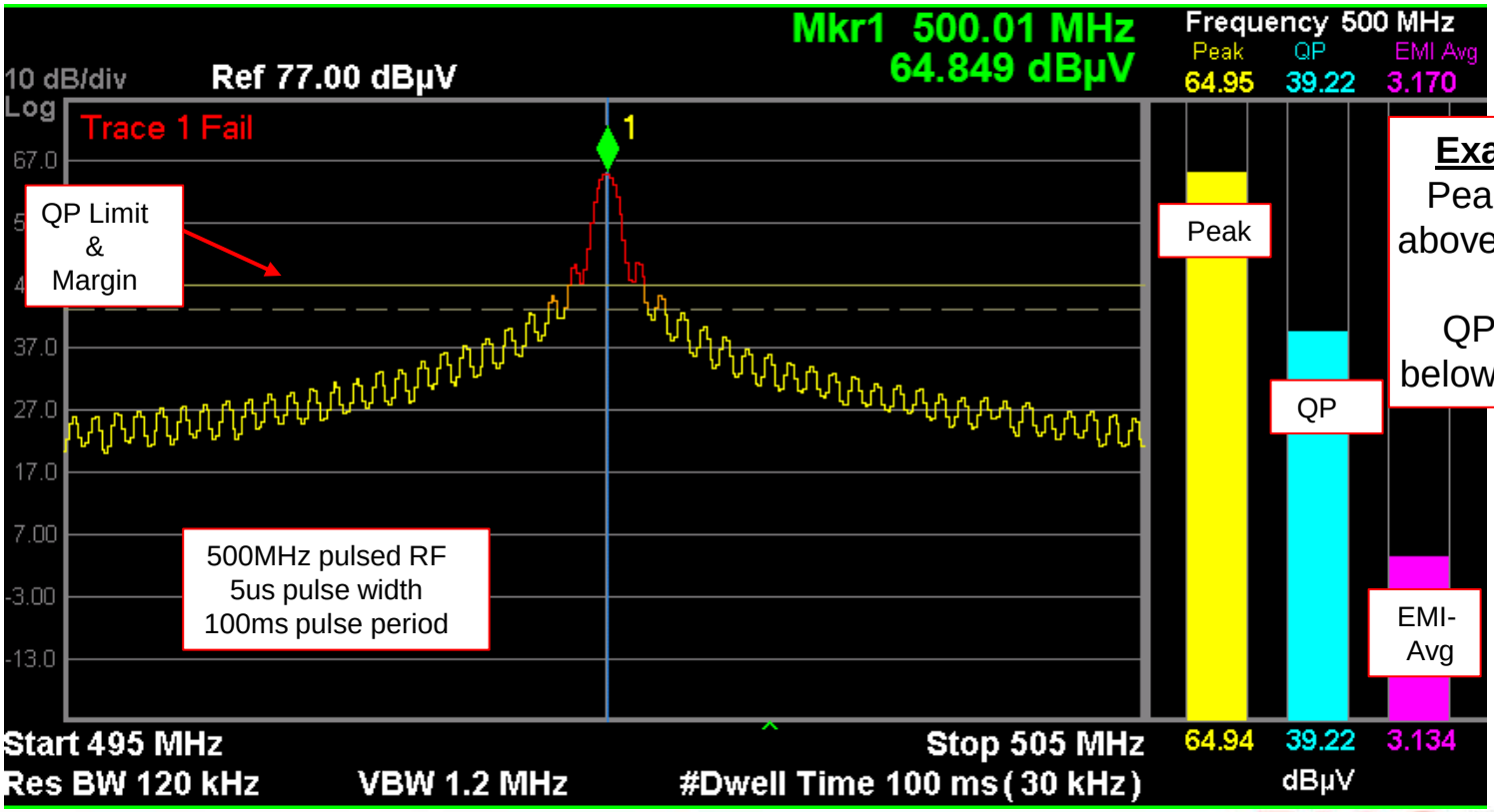
- Identify suspect frequencies more quickly by scanning with a *peak detector.*
  - Scanning with CISPR weighted detectors (Quasi-Peak, EMI Avg and RMS-Avg) slow due to defined charge and discharge times

Specified minimum scan times, as stated in CISPR 16-2-3

Frequency band		Scan time T_S for peak detection	Scan time T_S for quasi-peak detection
A	9 kHz to 150 kHz	14,1 s	2 820 s = 47 min
B	0,15 MHz to 30 MHz	2,985 s	5 970 s = 99,5 min = 1 h 39 min
C and D	30 MHz to 1 000 MHz	0,97 s	19 400 s = 323,3 min = 5 h 23 min

Why is Scanning with Peak Detector Allowed?

- Peak values will always be equal to or larger than the Quasi-Peak (QP), EMI-Average or RMS-Avg detected values
- If a peak value is over the limit (or margin), further measurement should be done with CISPR detector

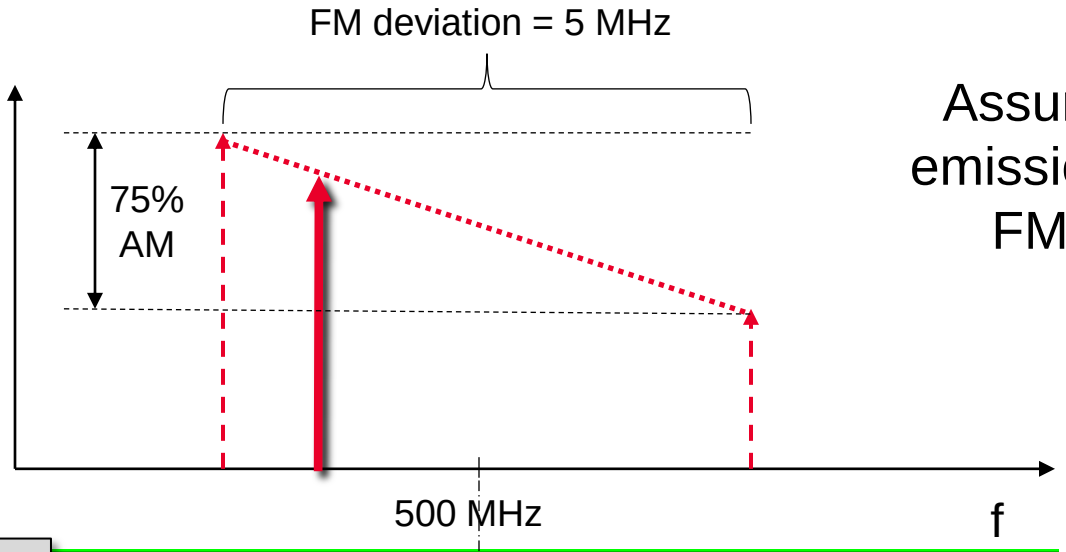


Challenges with Prescan

- Amplitude and Frequency Errors due to:
  - Amplitude or frequency modulation on detected signals
  - Receiver / Spectrum Analyzer sweeping/stepping

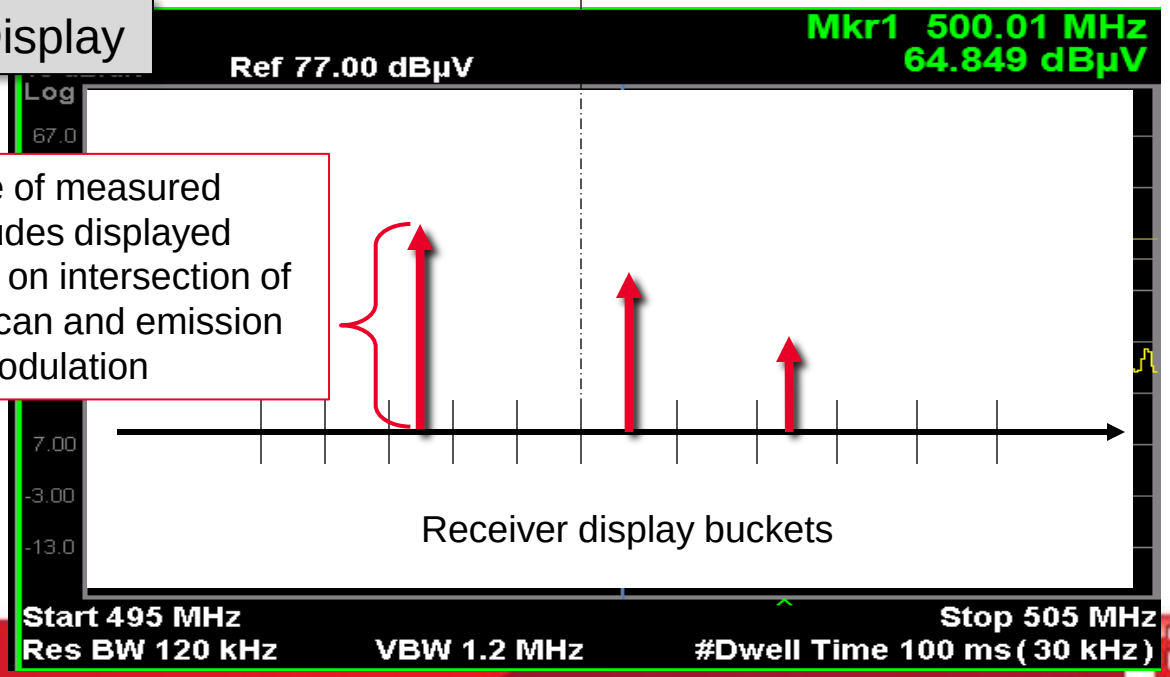
Signal Modulation Affects Measured Prescan Level

Emission



Assume a 500MHz emission with AM and FM modulation

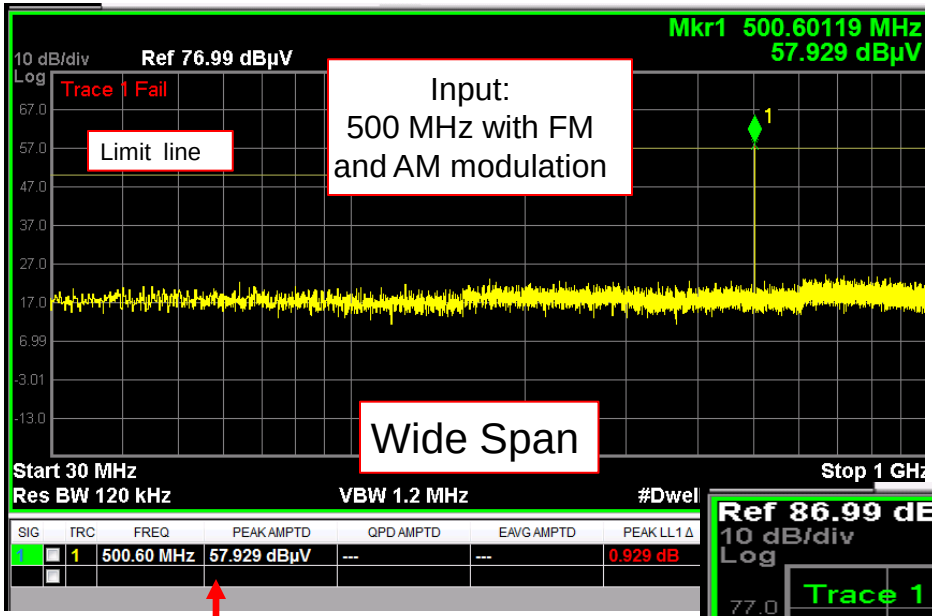
Receiver Display



Range of measured amplitudes displayed depending on intersection of receiver scan and emission modulation

Receiver display buckets

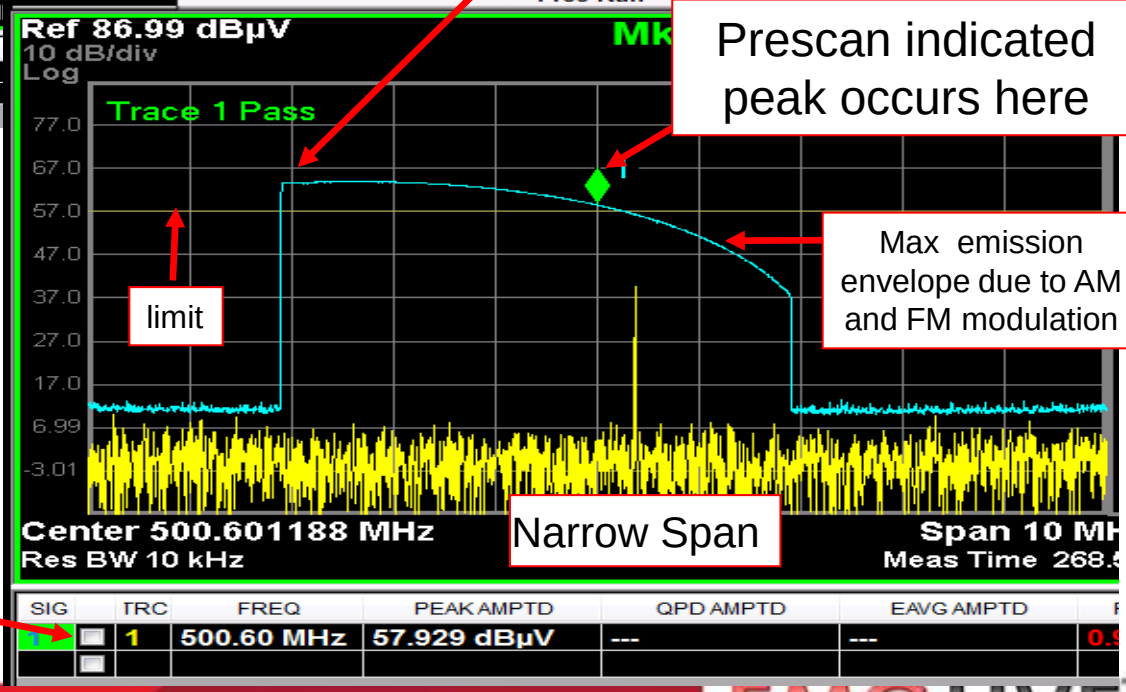
Prescan Errors due to Modulation on Emission



Modulation on emissions signal can indicate false peak frequency in signal list

Detail analysis indicates emission measurement really needs to be made here

Prescan indicated peak occurs here



Frequency List Entry

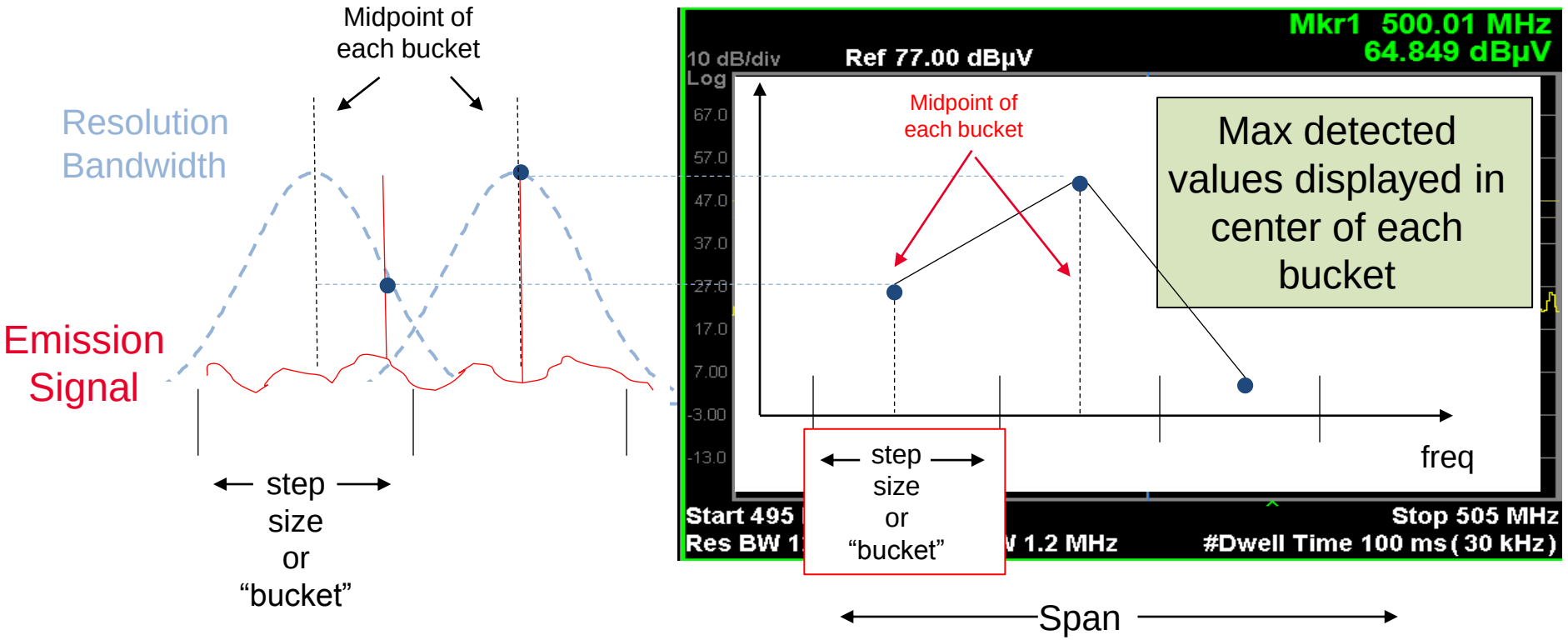
- w/o addition analysis, measurement would be made at this frequency

Challenges with Prescan

- Amplitude and Frequency Errors due to:
  - Amplitude or frequency modulation of detected signals
  - Receiver / Spectrum Analyzer sweeping/stepping

How Modern Receivers Display Amplitude Levels per Frequency Step…

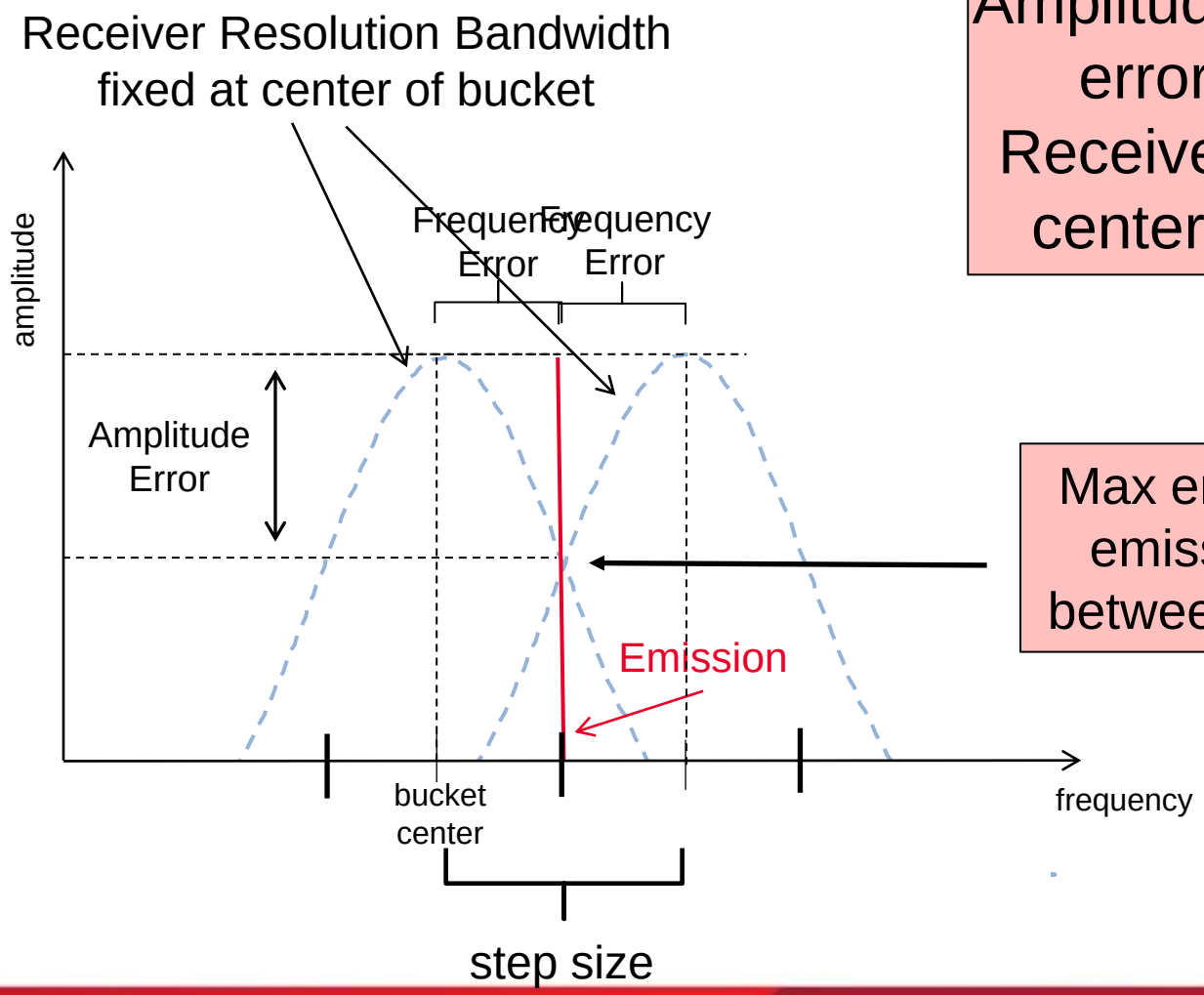
Receiver Display



Receivers display amplitudes and frequencies in display "buckets"

Number of measurement points = (Span/ step size)+1

Prescan Amplitude and Frequency Errors When Using a Stepping Receiver

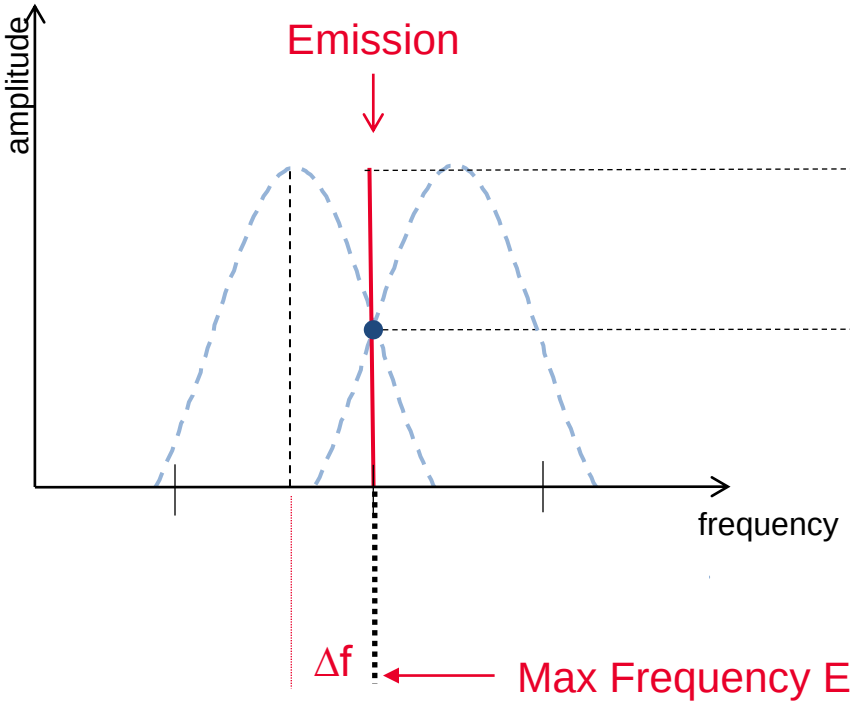


Amplitude and Frequency errors occur when Receiver Bandwidth not centered on emission

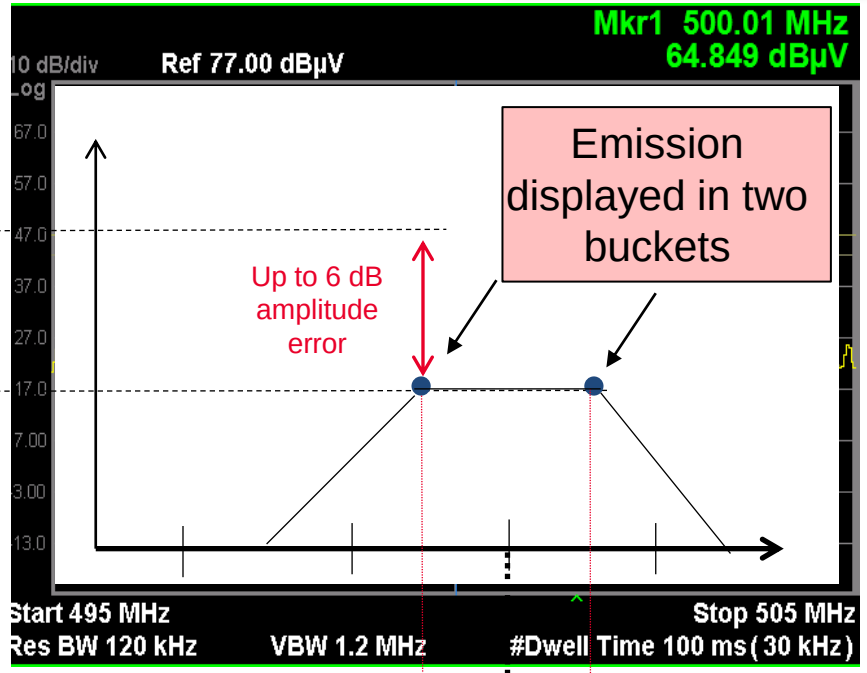
Max errors occur when emission is half-way between bucket centers

Prescan Amplitude and Frequency Errors When Using a Stepping Receiver (cont.)

Max errors occur when emission is half-way between bucket centers



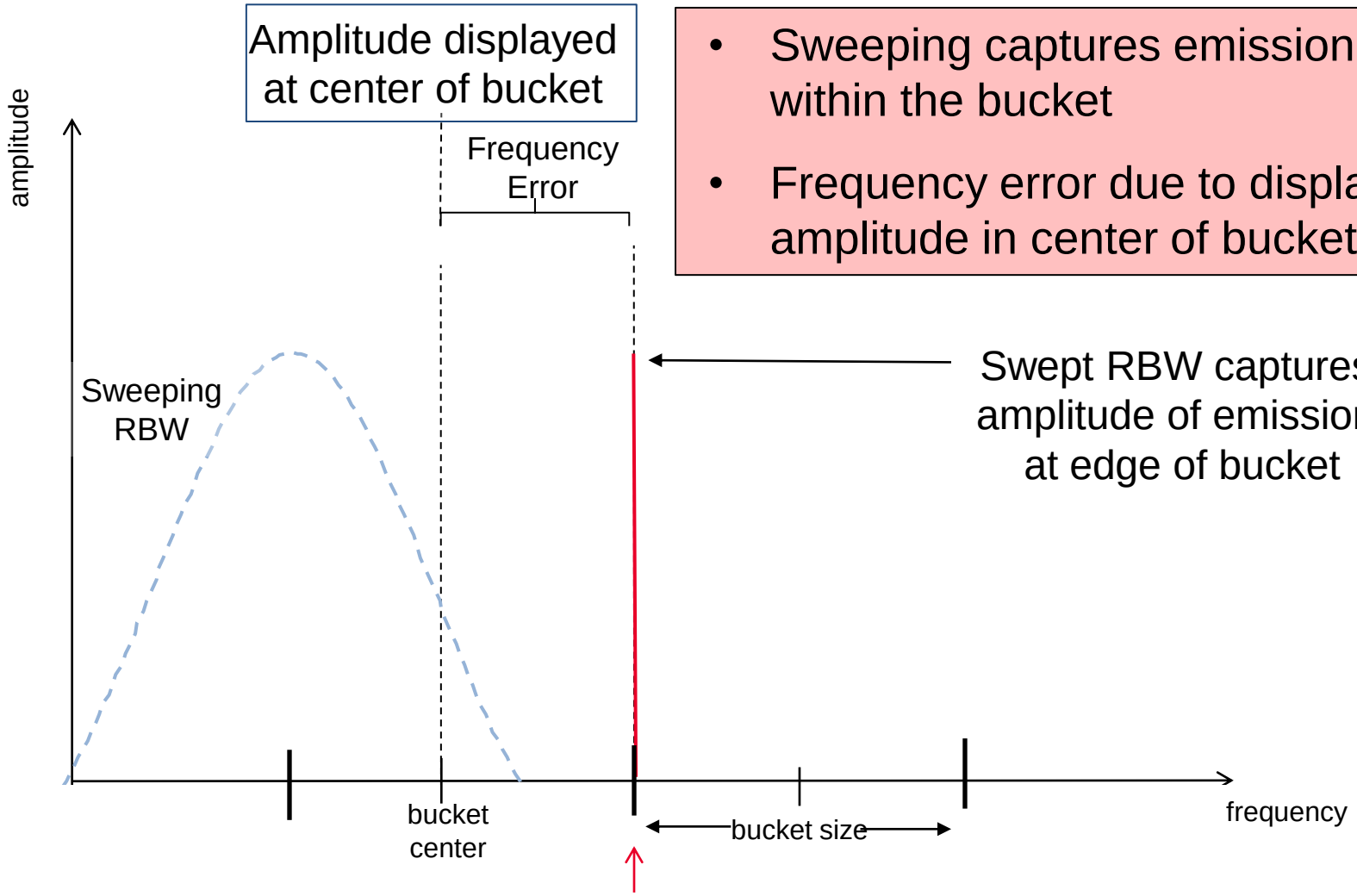
Receiver Display



Max Frequency Error = ½ step size

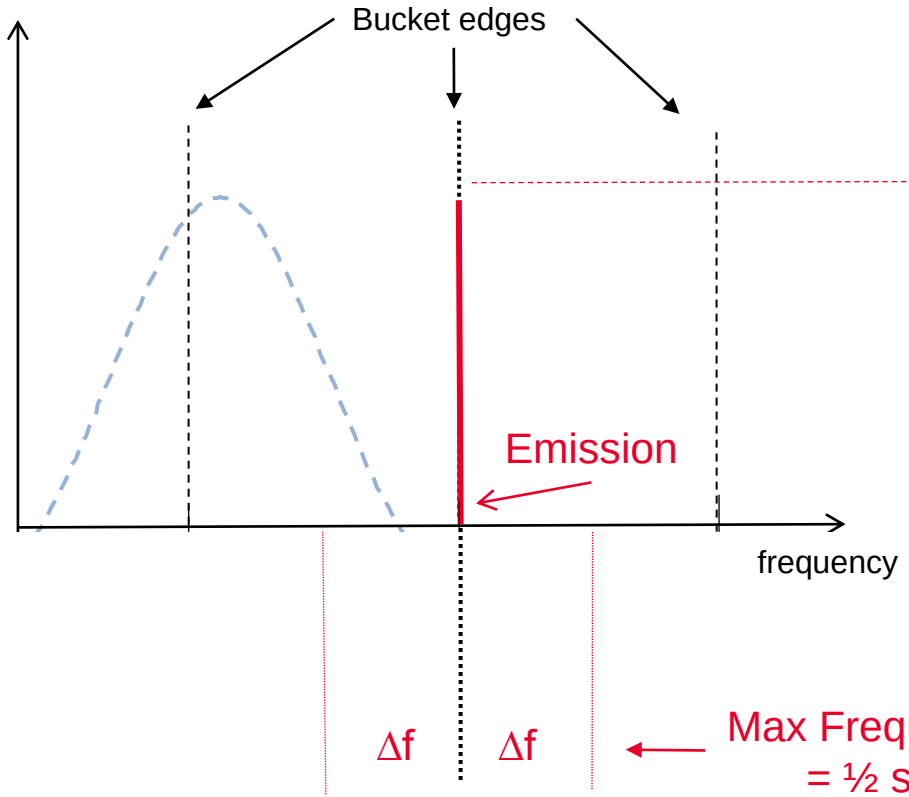
Δf Δf

Prescan Amplitude and Frequency Errors When Using a Swept Receiver

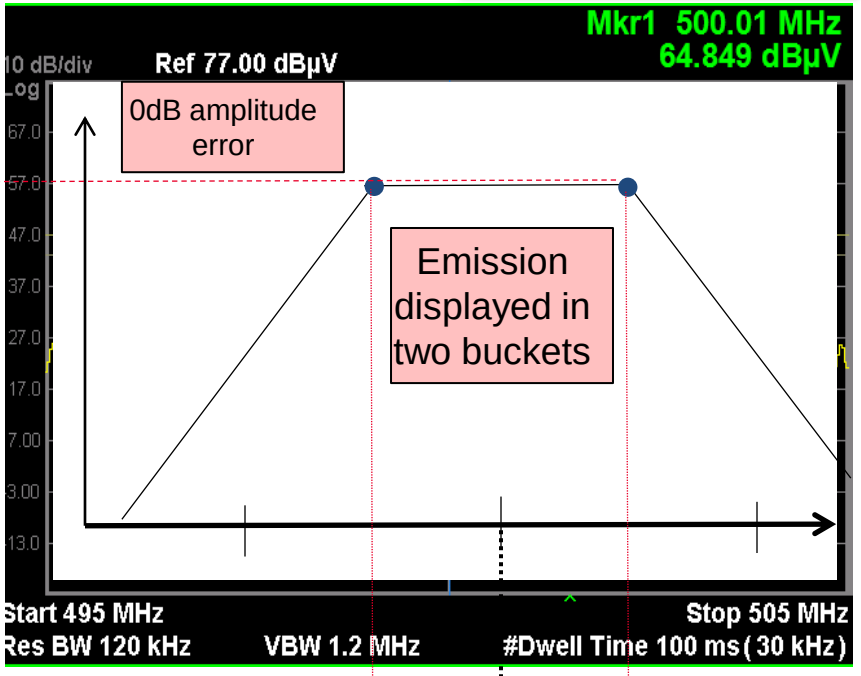


- Sweeping captures emission value within the bucket
- Frequency error due to displaying amplitude in center of bucket

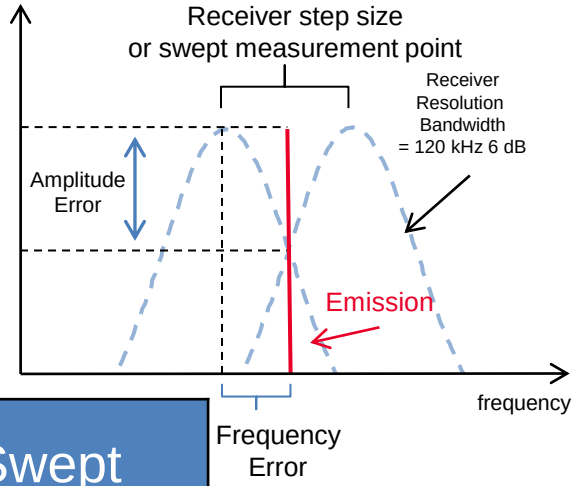
Prescan Amplitude and Frequency Errors When Using a Swept Receiver



Receiver Display



Example: Amplitude and Frequency Errors using 120kHz CISPR RBW



		Stepped and Swept	Stepped	Swept
# Meas. per RBW	**Step Size**	**Max Frequency Error**	**Max Amplitude Error**	**Max Amplitude Error**
1	120 kHz	60kHz	6 dB	0 dB
2	60 kHz	30 kHz	1.2 dB	0 dB
3	40 kHz	20 kHz	0.5 dB	0 dB
4	30 kHz	15 kHz	0.3 dB	0 dB

Tradeoff Between Error Magnitude and Test Time

Decreasing Step Size:

- improves accuracy
- adds data points
- increases scan time

(# of points x dwell time)

		Stepped and Swept	Stepped	Swept	30MHz – 1 GHz
# Meas. per RBW	**Step Size**	**Max Frequency Error**	**Max Amplitude Error**	**Max Amplitude Error**	**Scan Time using 10ms dwell**
1	120 kHz	60kHz	6 dB	0 dB	80 sec
2	60 kHz	30 kHz	1.2 dB	0 dB	160 sec
3	40 kHz	20 kHz	0.5 dB	0 dB	242 sec
4	30 kHz	15 kHz	0.3 dB	0 dB	320 sec

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- Emissions Prescan Measurements
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  - Spectrum Analysis
  - IF Spectrum Monitoring

Swept Spectrum Analysis versus IF Spectrum Monitoring

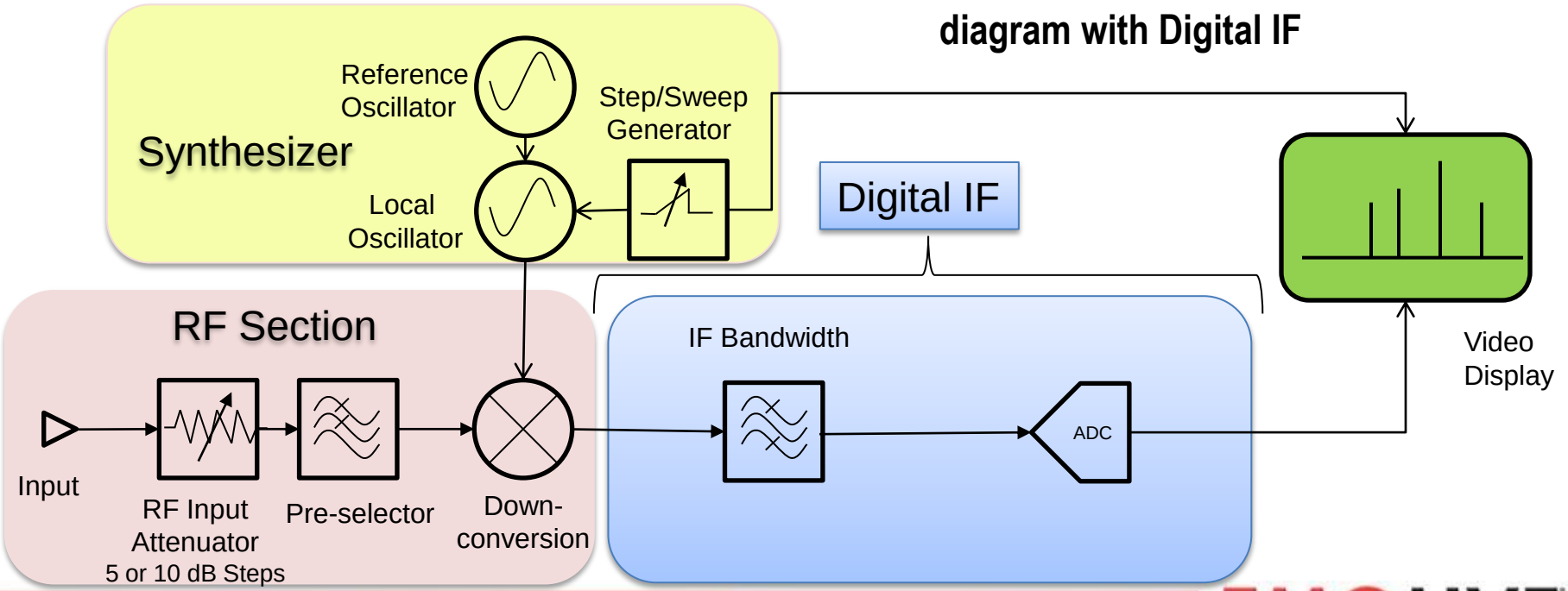
Swept Spectrum Analysis:

- Local Oscillator (LO) swept to generate spectral display

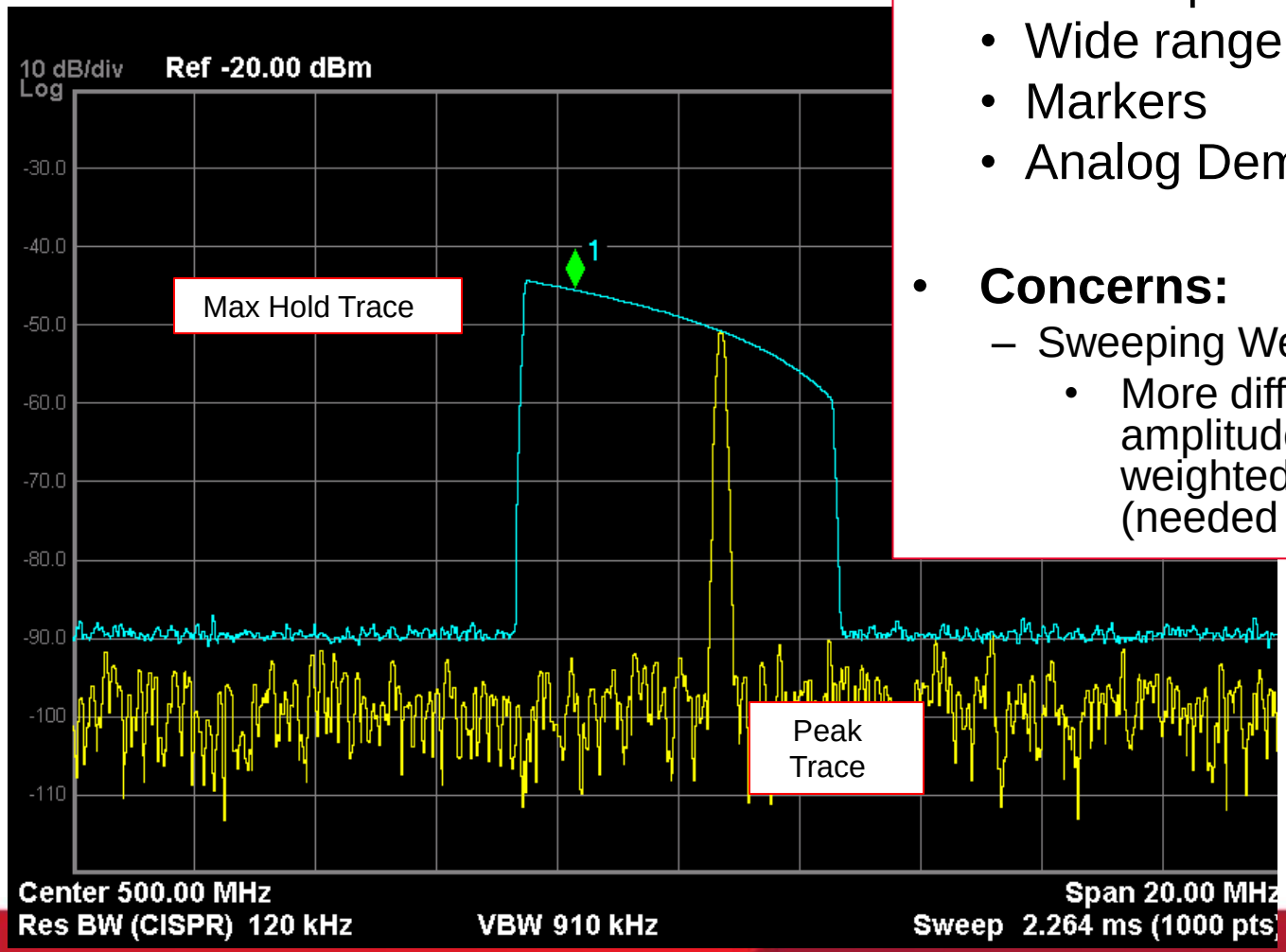
IF Spectrum Monitoring:

- LO fixed at display center frequency
- spectrum generated using FFT

Modern receiver block diagram with Digital IF



Spectrum Analysis Offers Excellent Flexibility

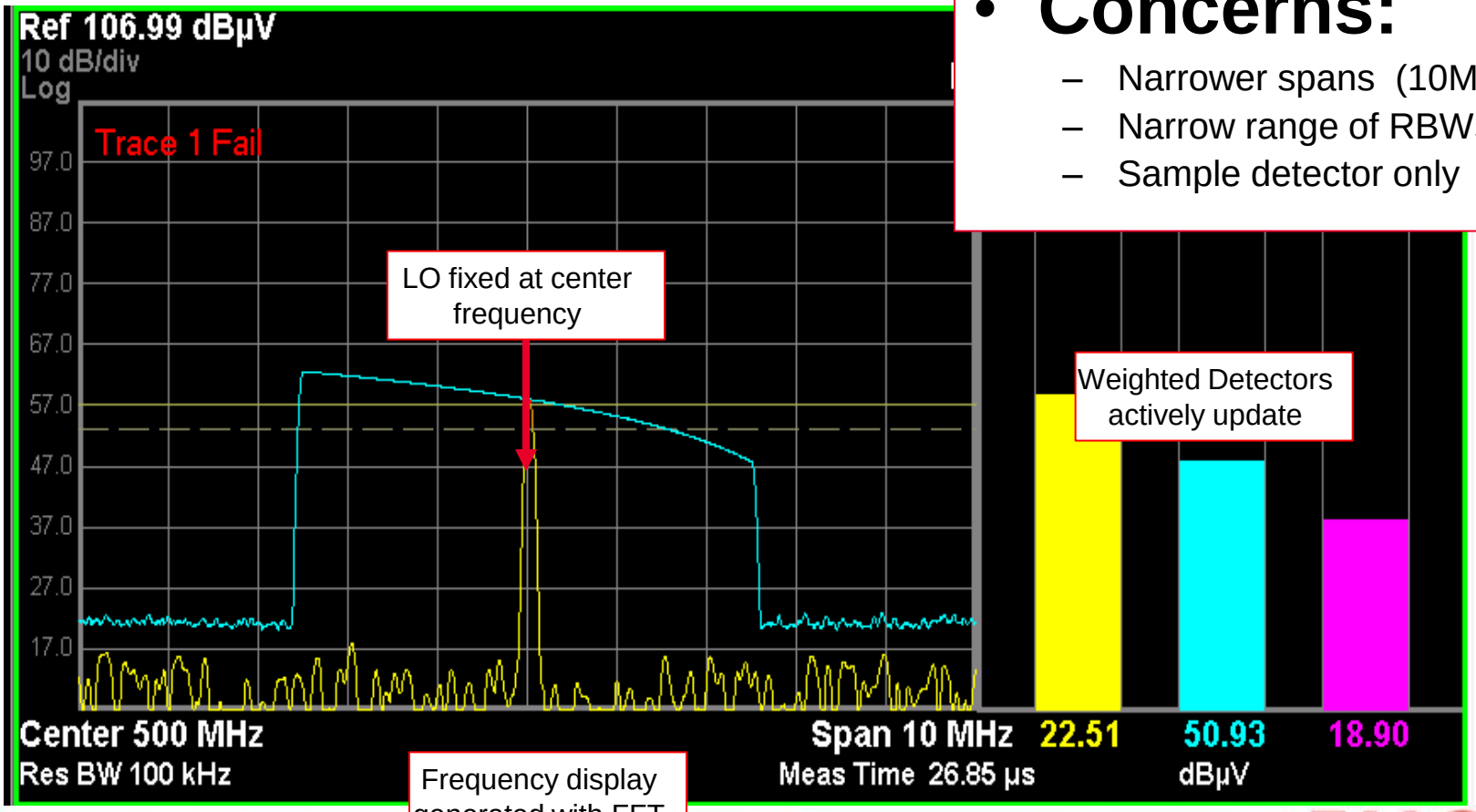


- **Benefits**
  - Multiple Traces
  - Broad range of resolution bandwidths, including CISPR RBWs
  - Wide Spans available
  - Wide range of detectors
  - Markers
  - Analog Demodulation

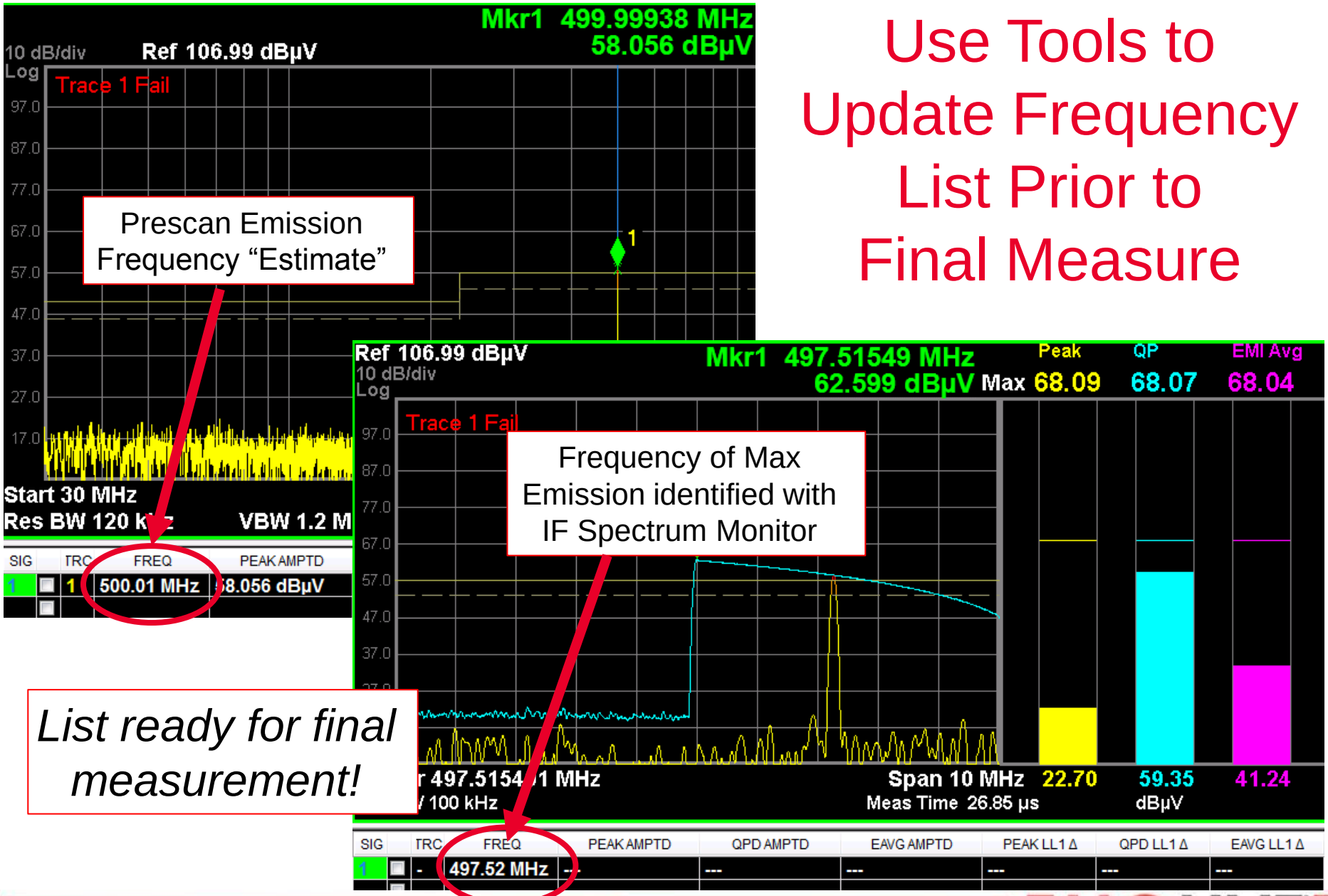
- **Concerns:**
  - Sweeping Weighted detectors is slow
    - More difficult to identify max amplitude and frequency of weighted detector response (needed for limit testing)

IF Spectrum Monitors Offer Both Active Span and Weighted Detector Display

- **Benefits:**
  - Active span and weighted detector amplitudes simplifies maximization
  - Multiple Traces
  - Markers
  - Analog Demodulation
- **Concerns:**
  - Narrower spans (10MHz typically)
  - Narrow range of RBWs (no CISPR)
  - Sample detector only



Use Tools to Update Frequency List Prior to Final Measure



List ready for final measurement!

Modern EMI Measurement Tools Contain Both

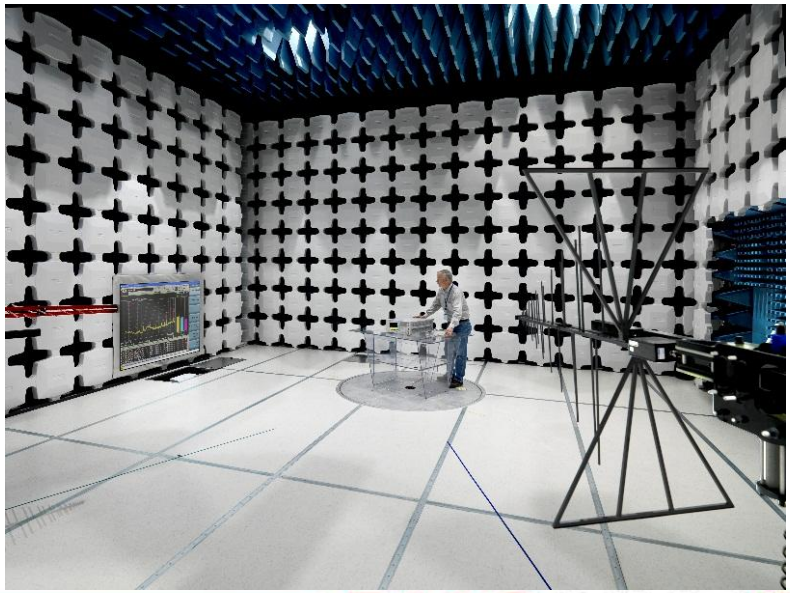
Prescan analysis tools widely available

- Compliance Receivers
  - spectrum analysis built-in
  - IF analysis tool available standard or as option
- Precompliance Spectrum Analyzers
  - IF analysis tool available as option

Prescan Analysis Tools
Improve EMC Lab Efficiency

Prescan Analysis Tools:

- Facilitate suspect list analysis
- Enhance measurement accuracy
  - Identify frequency of maximum emission
- Improve testing quality
- Reduce overall test time



Thanks for attending!

Don’t miss our Test Bootcamp!
November 16, 2016
www.emclive2016.com