FFT BASED MEASUREMENT FOR EMI TESTING

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90 YEARS
OF ENSURING A SAFER AND CONNECTED WORLD

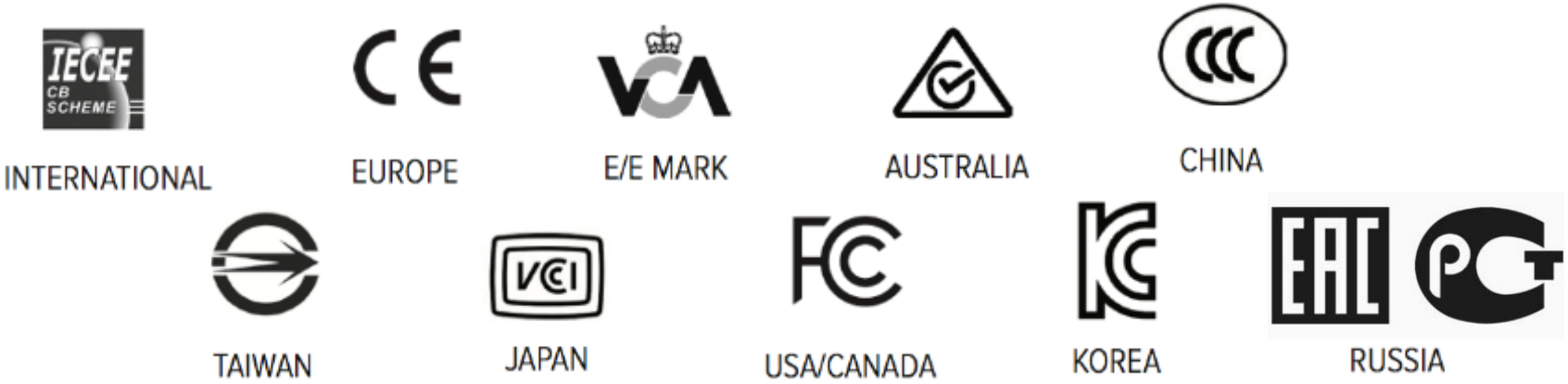
ROHDE&SCHWARZ
Make ideas real

INTRODUCTION

EMC Regulations & Certification

- Each country or commercial trade region published their own regulations defining the standards that have to apply for goods sold in their market.
- Market surveys ensure manufacturers and importer obey the rules

Examples for EMC regulation marks:



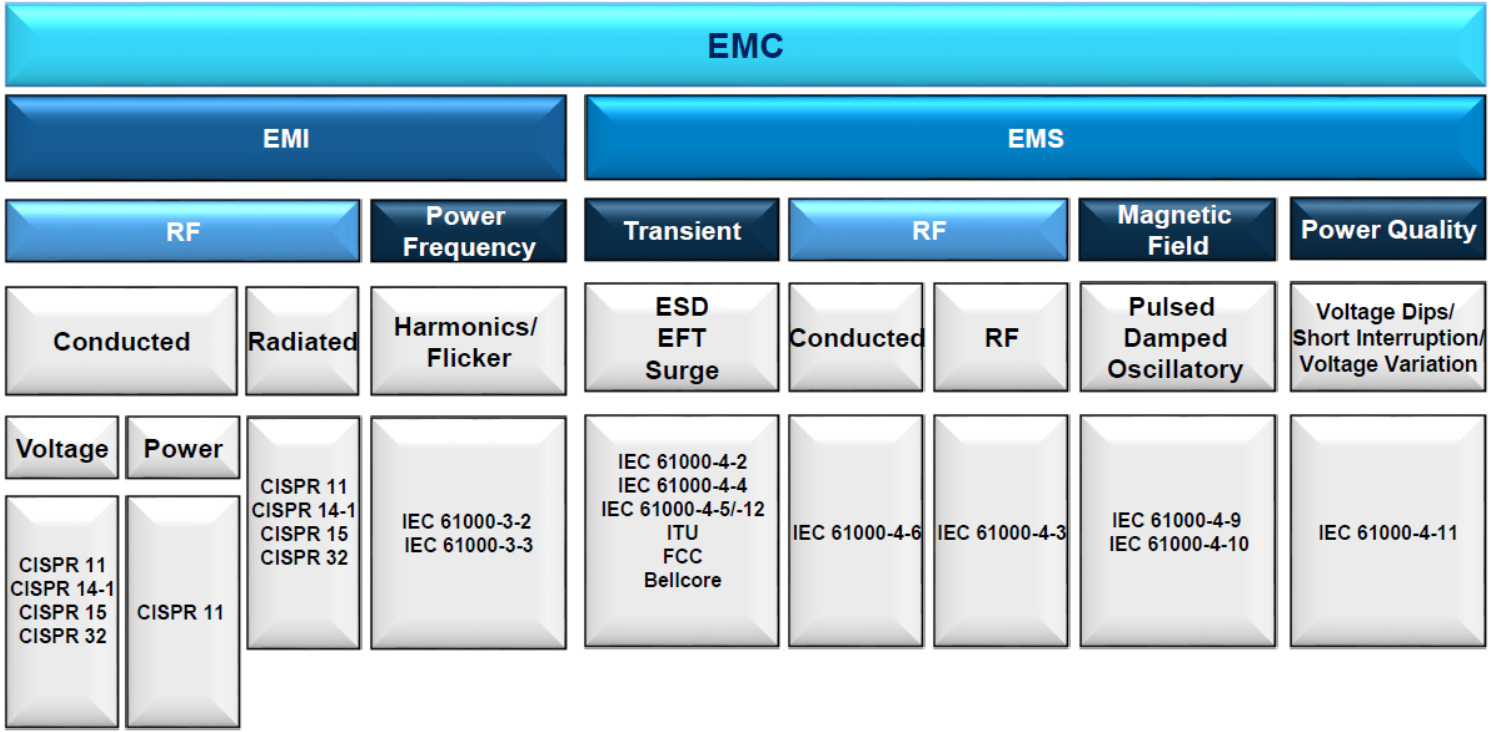
EMC (Electro Magnetic Compatibility)?

- EMC (Electromagnetic Compatibility)
  - 전자파 환경의 양립성, **적합성** 통칭
  - 전자파를 주는 측과 받는 측의 양쪽에 적용하여 의도된 성능을 확보할 수 있는 능력, 즉 기기나 부품이 전자파를 발생하거나, 외래 전자파의 영향을 받지도 않는 것

- EMI (Electromagnetic Interference)
  - 전자파 **장해** 또는 전자파 간섭
  - 기기가 전자파를 외부로 방출하여 복사(Radiation)와 전도(Conduction)의 형태로 다른 기기나 제어 회로에 방해를 주는 것

- EMS (Electromagnetic Susceptibility or Immunity)
  - 전자파 **내성**
  - 각종 전자파 방해로부터 기기나 부품의 성능 저하가 발생되지 않도록 견딜 수 있는 정도

EMC Standard Overview



EMC Standards

► Different Electronic Equipment require compliance to different Standards

Commercial Equipment:

- ISM Equipment
- Consumer Electronics Equipment
- IT / Household Equipment
- Lighting Equipment

Applicable Standards:

- CISPR 11 to 35
- IEC/EN61000-X-X series
- Product Specific Standards

A&D Equipment:

- Aircraft Equipment
- Ship & Submarine Equipment
- Land Based Equipment

Applicable Standards:

- Mil-Std 461
- Mil-Std 464
- RTCA DO 160

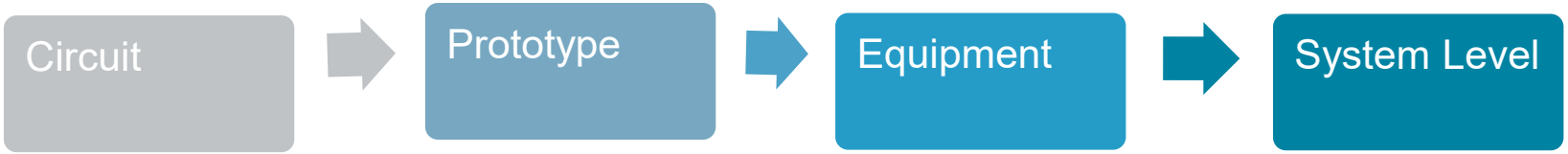
Automotive Equipment:

- Control Equipment
- Infotainment Equipment
- Communication Equipment

Applicable Standards:

- CISPR 12, 25
- ISO11451, ISO11452
- Country specific standards
- OEM Specific Standards

Introduction
EMC Testing Process



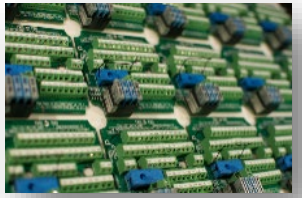
Introduction
EMC Testing Process

Circuit

- Investigative Test
  - Discovering Internal Interference Sources
  - Ensuring Internal Immunity
  - Implement Circuit Design changes
  - Reinforce shielding of PCB boards, pins,
    soldering points Investigative Instruments to pinpoint exact source of emissions within a PCB or circuit.

Introduction
EMC Testing Process

Prototype



- Pre-compliance Test
  - Having an idea of the EMC interference.
  - Detecting weak spots in the prototype and eliminating them.
  - Improving chances for getting certification
  - System catered to lower cost (e.g. smaller chamber) and more towards debugging.
  - System designed for fast turnaround time and critical test cases.
  - The test result must correlate with the final ones.

Introduction
EMC Testing Process

Equipment

R&S EPL1000 Test Receiver

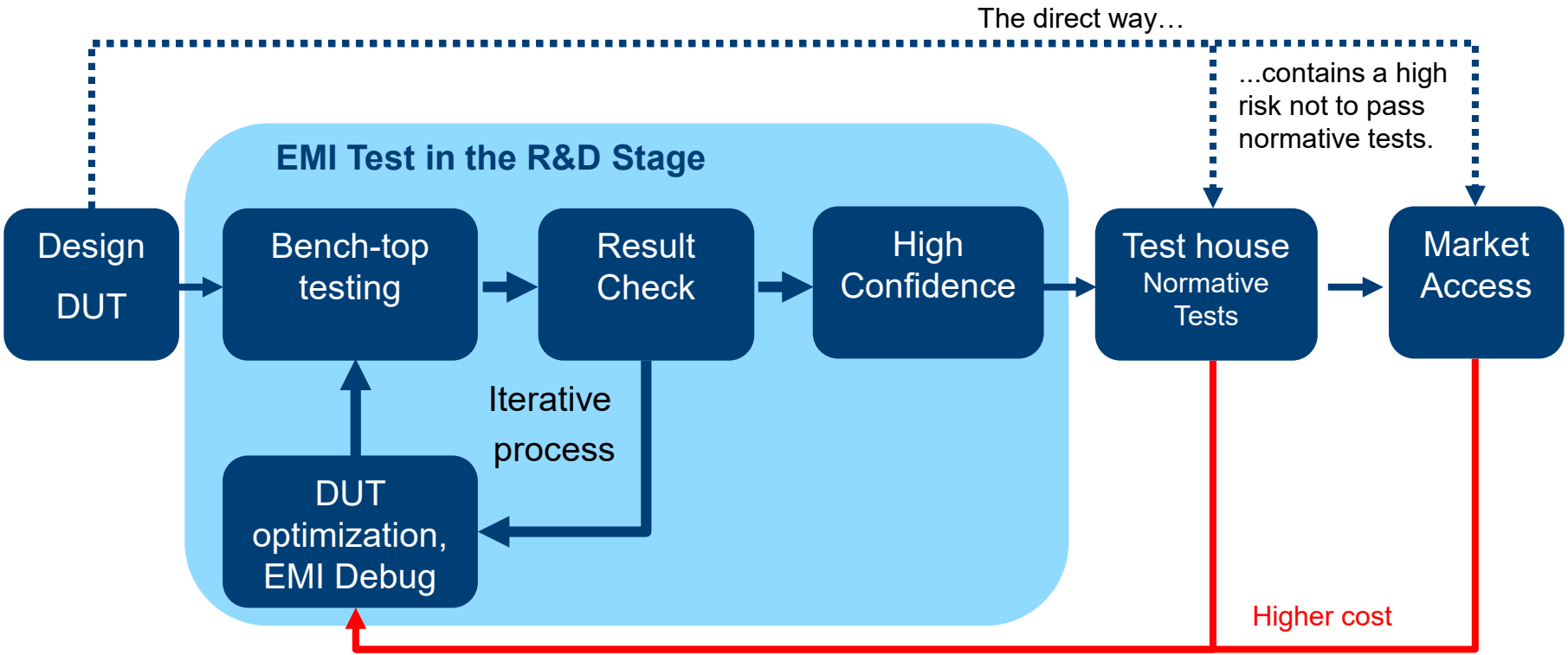
- Certification Test
  - Fully compliance testing at an accredited test-lab
  - Competent / Notified bodies may be involved
  - Long process lasting several days
  - Full Certification test.
    - All testing equipment calibrated and compliant to full standard requirements.

Introduction
EMC Testing Process

System Level

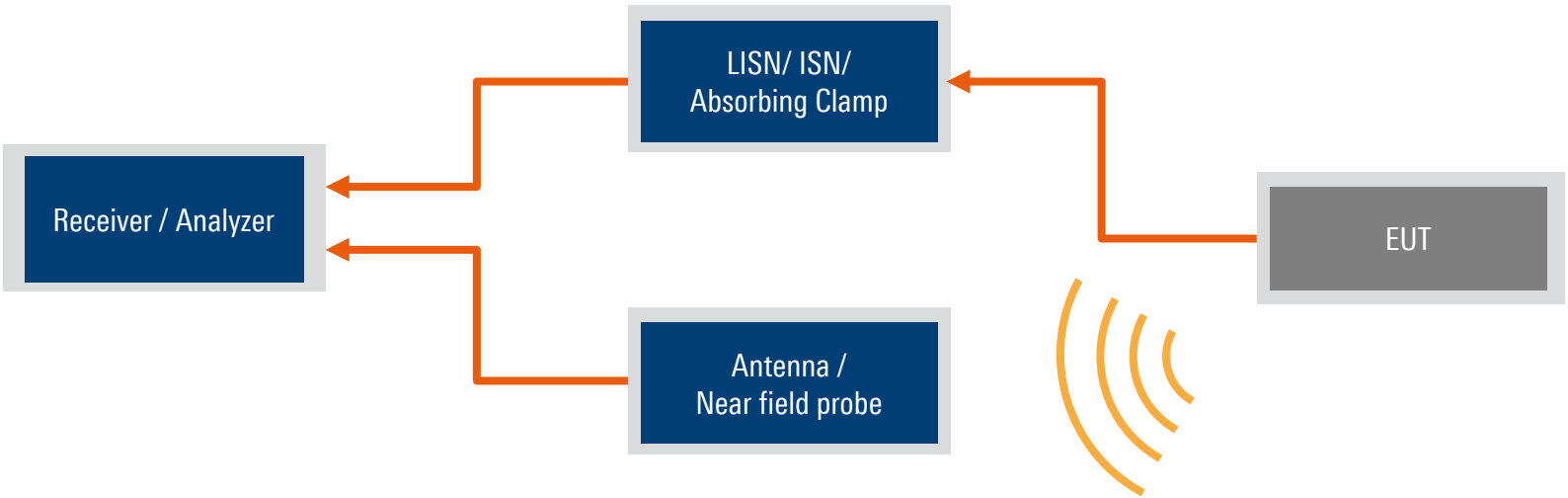
- Full Platform Testing
  - After all individual equipment has already been certified.
  - Concern is sources of interference external to the platform or unexpected internal interference
  - Larger systems, higher testing levels and larger scale facilities and equipment.

Typical Process

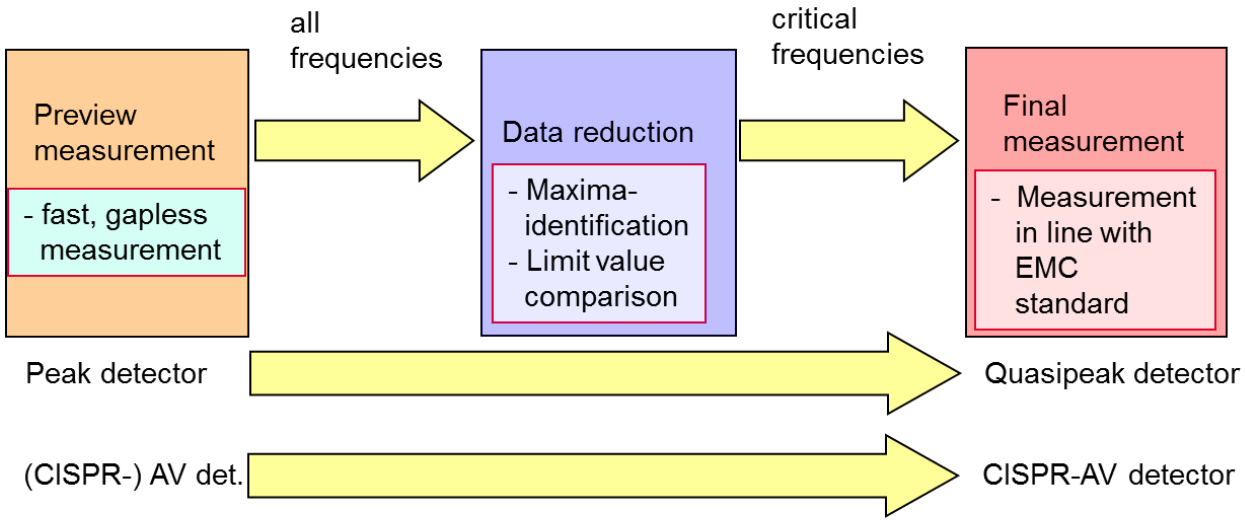


EMI MEASUREMENT

EMI Measurement



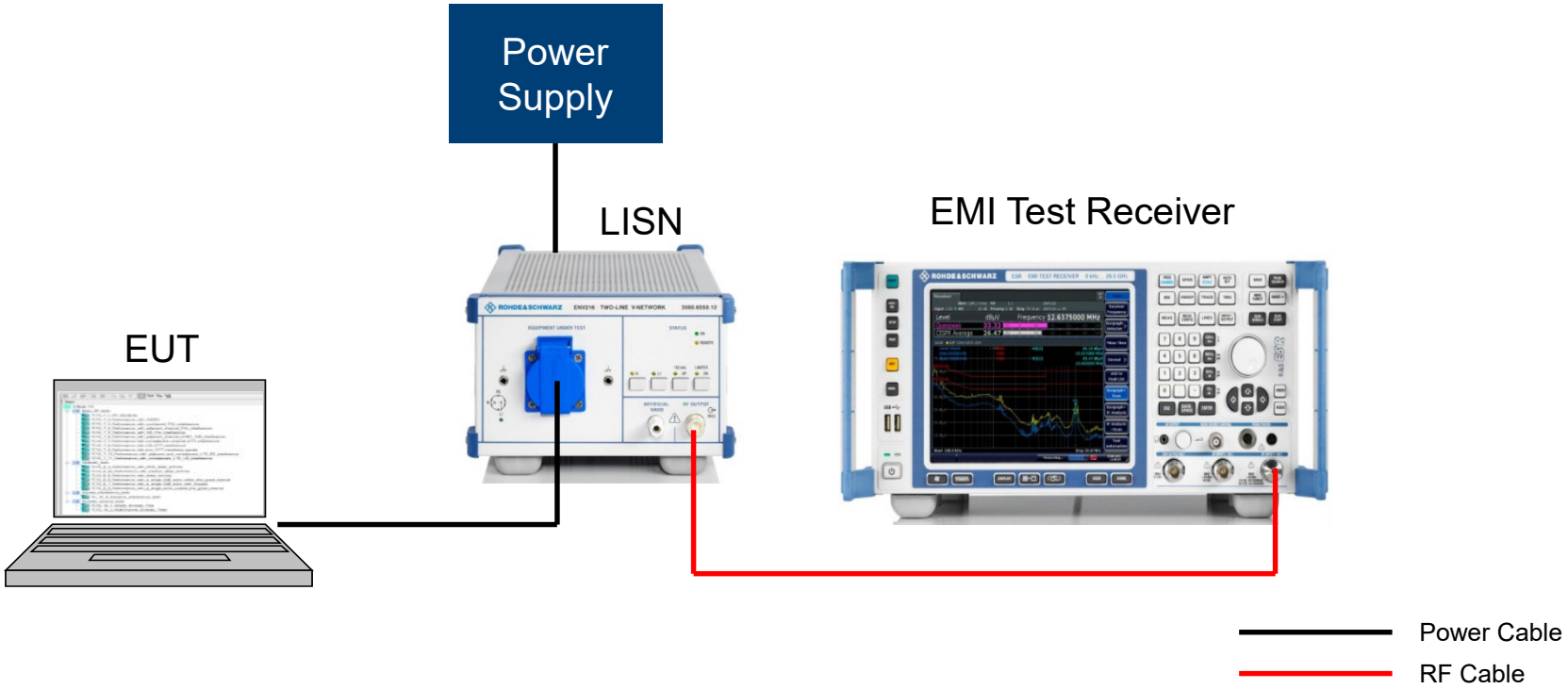
General Test Process



Conducted Emission Test
Main Voltage

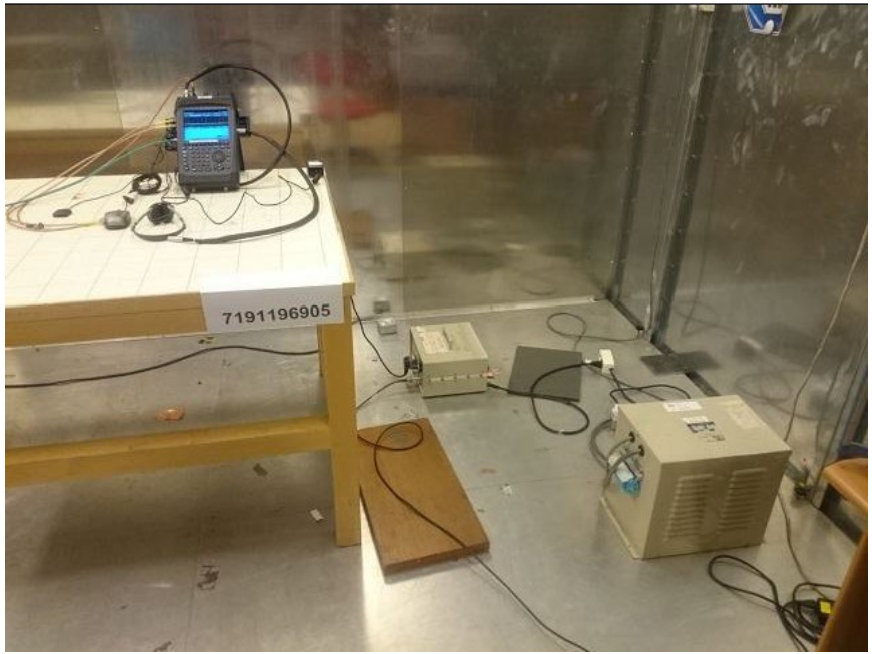
- 시험 개념
  - EUT의 전원 케이블을 통하여 전도되는 방해 파를 LISN을 통해서 측정함.
- 측정 주파수 범위 : (9)150 kHz ~ 30 MHz
- Standards : CISPR 11, 14-1, 15, 32 등
- 주요 측정 설비 및 장비 : Shielded room, EMI Test Receiver, LISN
- 시험 방법
  - EMI Test Receiver로 Pre-scan(측정대상이 되는 전 주파수 대역을 빠른 속도로 측정) 후 Limit Line 대비 6dB Margin 이내의 스펙트럼 성분을 재 scan하여 Test Receiver로 최종 평가 (QP / AV 검파기 이용)

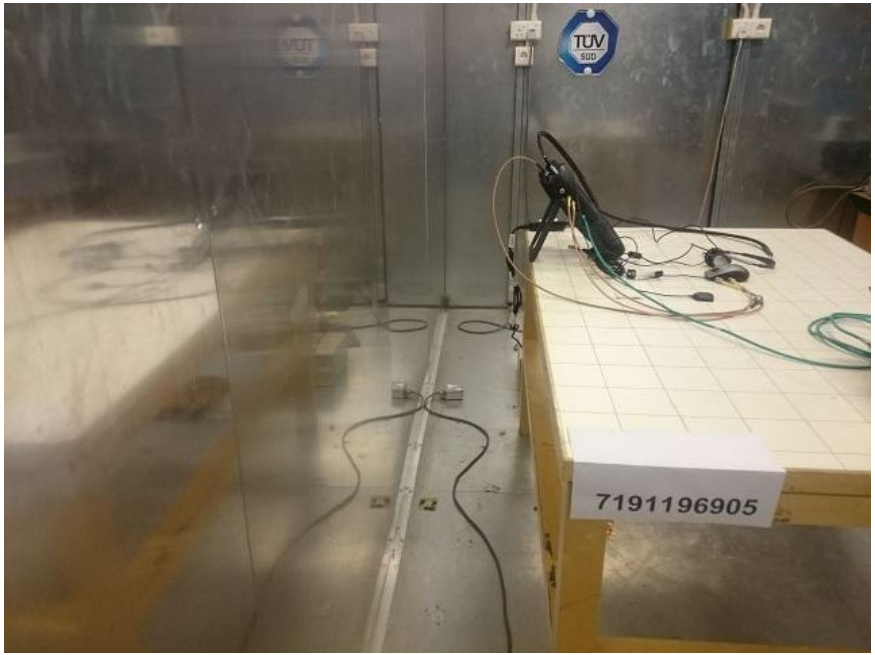
Conducted Emission Test
Main Voltage



Conducted Emission Test
Main Voltage

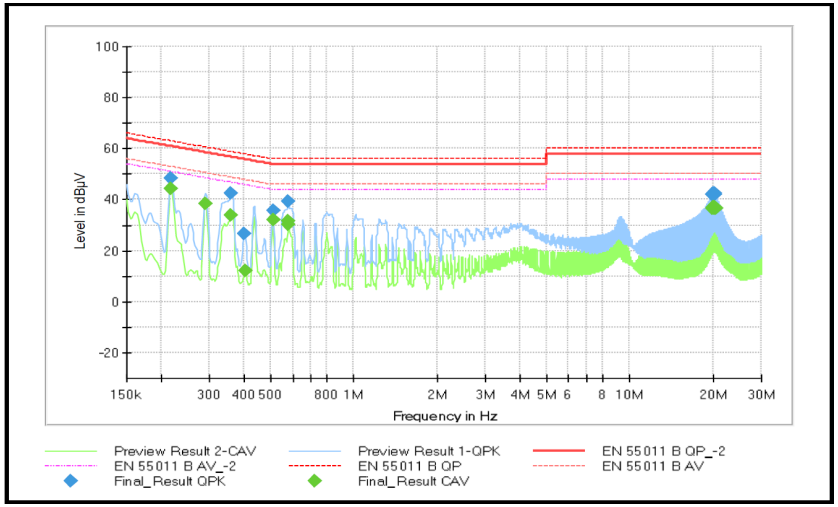
- Test Configuration





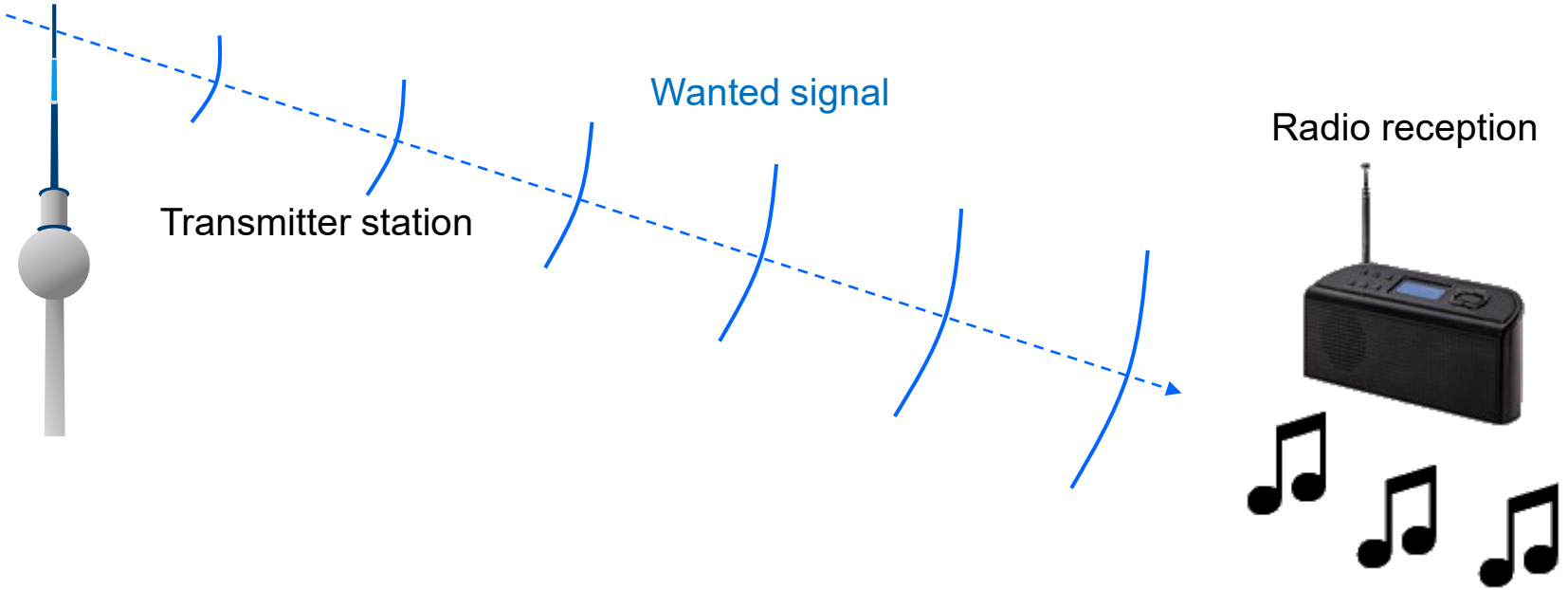
General Measurement Result

- kl



Frequency (MHz)	QuasiPeak (dBµV)	CAverage (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Line	Comment
0.218	48.5	---	60.9	12.4	5000.0	L1	13:02:28 - 15.12.2022
0.218	---	44.3	50.9	6.6	5000.0	L1	13:02:29 - 15.12.2022
0.290	---	38.2	48.5	10.4	5000.0	L1	13:02:29 - 15.12.2022
0.359	---	33.8	46.8	13.0	5000.0	L1	13:02:29 - 15.12.2022
0.359	42.4	---	56.8	14.4	5000.0	L1	13:02:28 - 15.12.2022
0.400	26.6	---	55.9	29.3	5000.0	L1	13:02:28 - 15.12.2022
0.402	---	12.2	45.8	33.6	5000.0	L1	13:02:29 - 15.12.2022
0.508	---	31.9	44.0	12.1	5000.0	L1	13:02:29 - 15.12.2022
0.508	35.5	---	54.0	18.5	5000.0	L1	13:02:28 - 15.12.2022
0.578	---	30.2	44.0	13.8	5000.0	L1	13:02:29 - 15.12.2022
0.580	---	31.5	44.0	12.5	5000.0	L1	13:02:29 - 15.12.2022
0.580	39.3	---	54.0	14.7	5000.0	L1	13:02:28 - 15.12.2022
19.939	---	36.5	48.0	11.5	5000.0	L1	13:02:29 - 15.12.2022
19.939	41.9	---	58.0	16.1	5000.0	L1	13:02:28 - 15.12.2022
20.011	---	36.7	48.0	11.3	5000.0	L1	13:02:29 - 15.12.2022
20.011	42.1	---	58.0	15.9	5000.0	L1	13:02:28 - 15.12.2022
20.085	42.3	---	58.0	15.7	5000.0	L1	13:02:28 - 15.12.2022
20.085	---	36.8	48.0	11.2	5000.0	L1	13:02:29 - 15.12.2022
20.157	---	36.9	48.0	11.1	5000.0	L1	13:02:29 - 15.12.2022
20.157	42.3	---	58.0	15.7	5000.0	L1	13:02:28 - 15.12.2022
20.229	42.3	---	58.0	15.7	5000.0	L1	13:02:28 - 15.12.2022
20.229	---	36.9	48.0	11.1	5000.0	L1	13:02:29 - 15.12.2022
20.301	42.2	---	58.0	15.8	5000.0	L1	13:02:28 - 15.12.2022
20.301	---	36.8	48.0	11.2	5000.0	L1	13:02:29 - 15.12.2022
20.373	---	36.6	48.0	11.4	5000.0	L1	13:02:29 - 15.12.2022
20.375	42.1	---	58.0	15.9	5000.0	L1	13:02:28 - 15.12.2022
20.447	---	36.4	48.0	11.6	5000.0	L1	13:02:29 - 15.12.2022

Influence of RF Emissions



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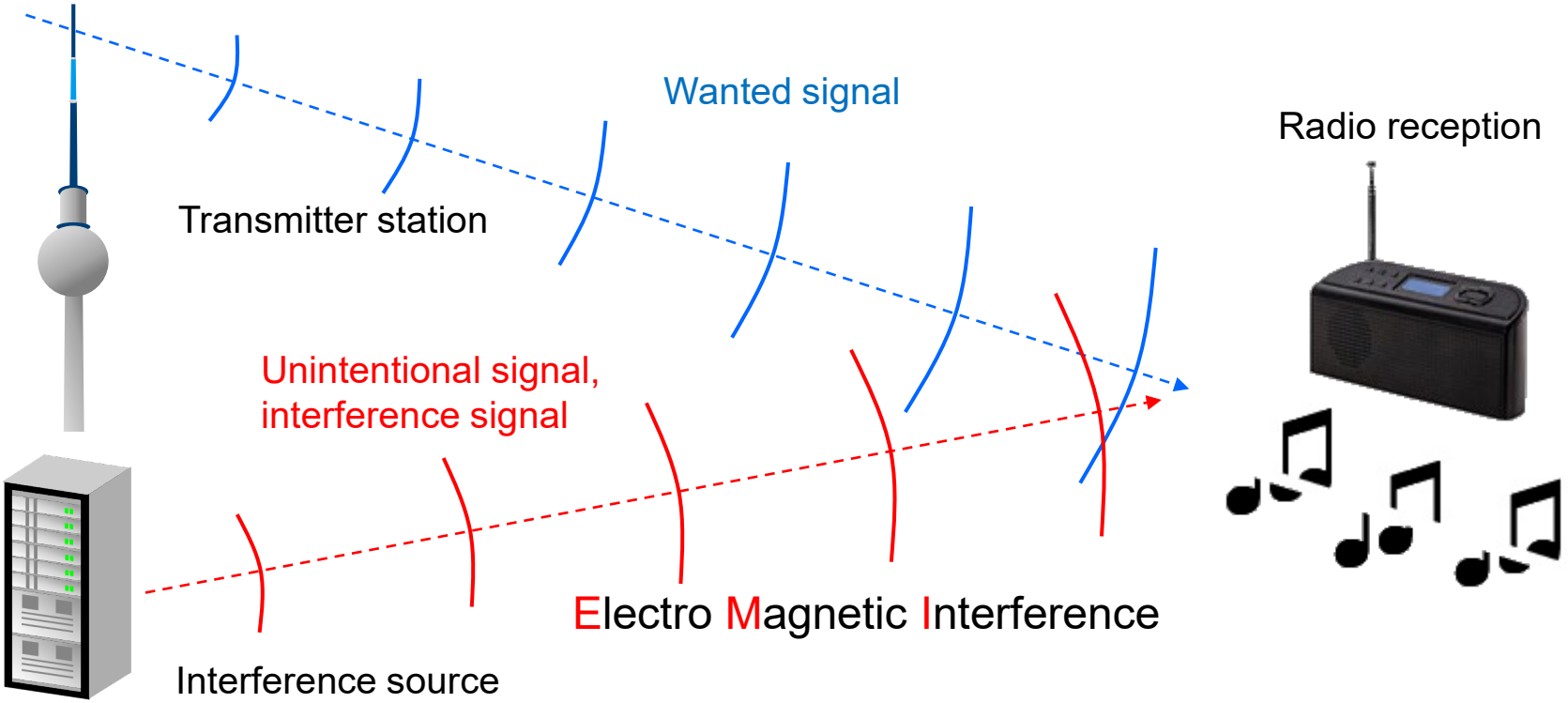
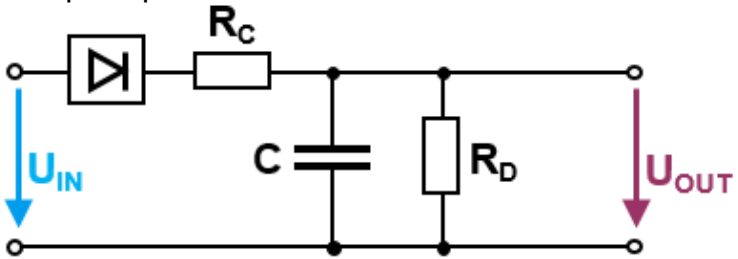


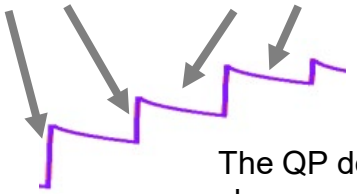
WEIGHTING OF EMISSIONS
Quasi Peak

Circuit principle

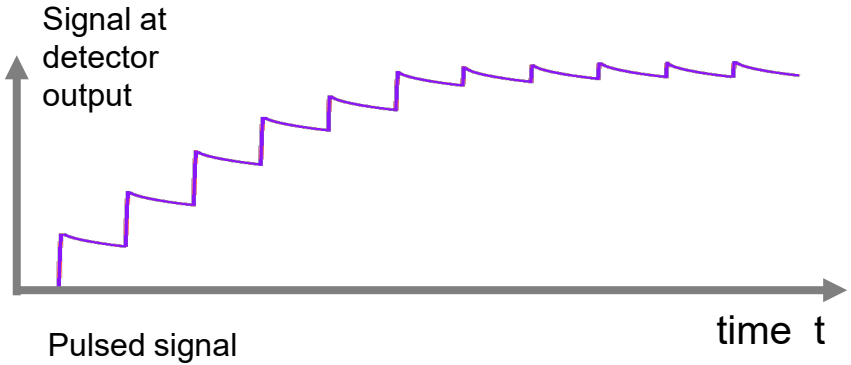


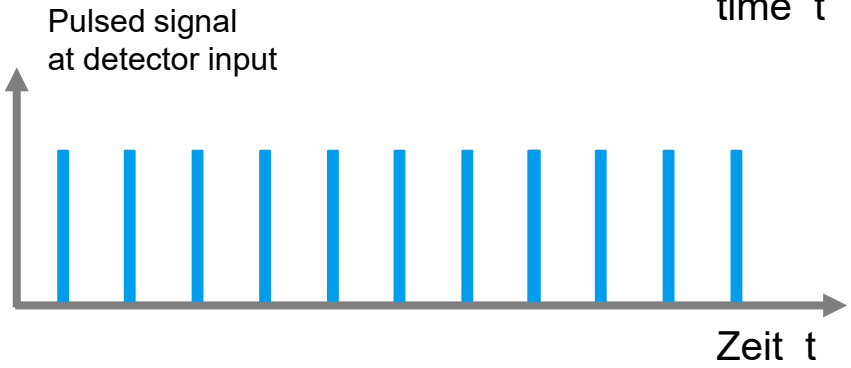
Steep edges:
charging during
pulse "high" period

Flat descent:
discharge during the break
between two pulses



The QP detector
shows an integrating
behavior.





In Zero Span mode, the interference signal may appear like that. The behavior depends on the DUT.

WEIGHTING OF EMISSIONS
Quasi Peak

- Minimum measurement times
  - The minimum measurement (dwell) times are given in Table 2. The minimum measurement (dwell) times for scanning receivers and FFT-based measuring instruments in Table 2 and the scan times for spectrum analyzers in Table 1 apply to CW signals. The minimum scan times of Table 1 were derived to perform measurements in the entire CISPR band.

Frequency band		Scan time T_s for peak detection	Scan time T_s for quasi-peak detection
A	9 to 150 kHz	14.1 s	2820 s = 47 min
B	0.15 to 30 MHz	2.985 s	5970 s = 99.5 min = 1 h 39 min
C and D	30 to 1000 MHz	0.97 s	19400 s = 323.3 min = 5 h 23 min

  - Depending on the type of disturbance, the scan time may have to be increased, especially for swept quasi-peak measurements. In extreme cases, the measurement time T_m at a certain frequency may have to be increased to 15 s, if the level of the observed disturbance is not steady.

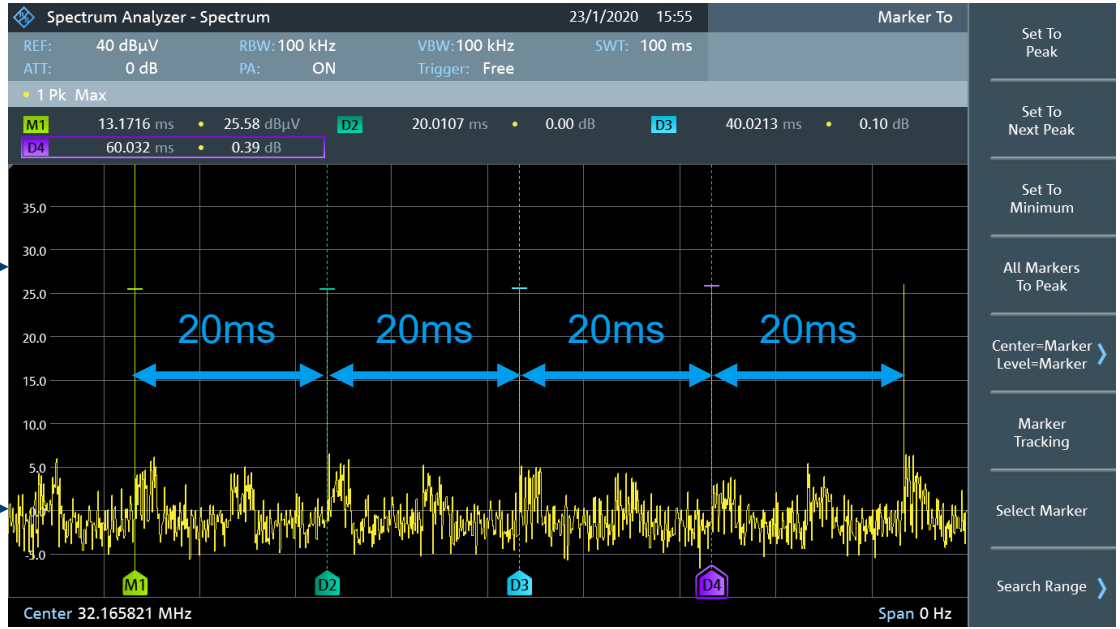
WEIGHTING OF EMISSIONS
Quasi Peak

- Minimum Measurement Time for one point
  - Calculation :

$$\frac{Minimum\ Measurement\ time}{(Maximum\ Frequency\ -Minimum\ Frequency)\ \div Step\ Size}$$

  - CISPR Band B (150k~30MHz) ⇒ RBW = 9 kHz, Step Size = 4.5 kHz
    - Quasi Peak 측정을 위한 최소 measurement time = 5970(s)/29.85(MHz) x 4.5(kHz) = 0.9 s
    - Max Peak 측정을 위한 최소 measurement time = 2.985(s)/ 29.85(MHz) x 4.5(kHz) = 0.45 ms

Conducted Noise from Main Lines



Power : 230 V, 50 Hz
Switching Interval : 20ms

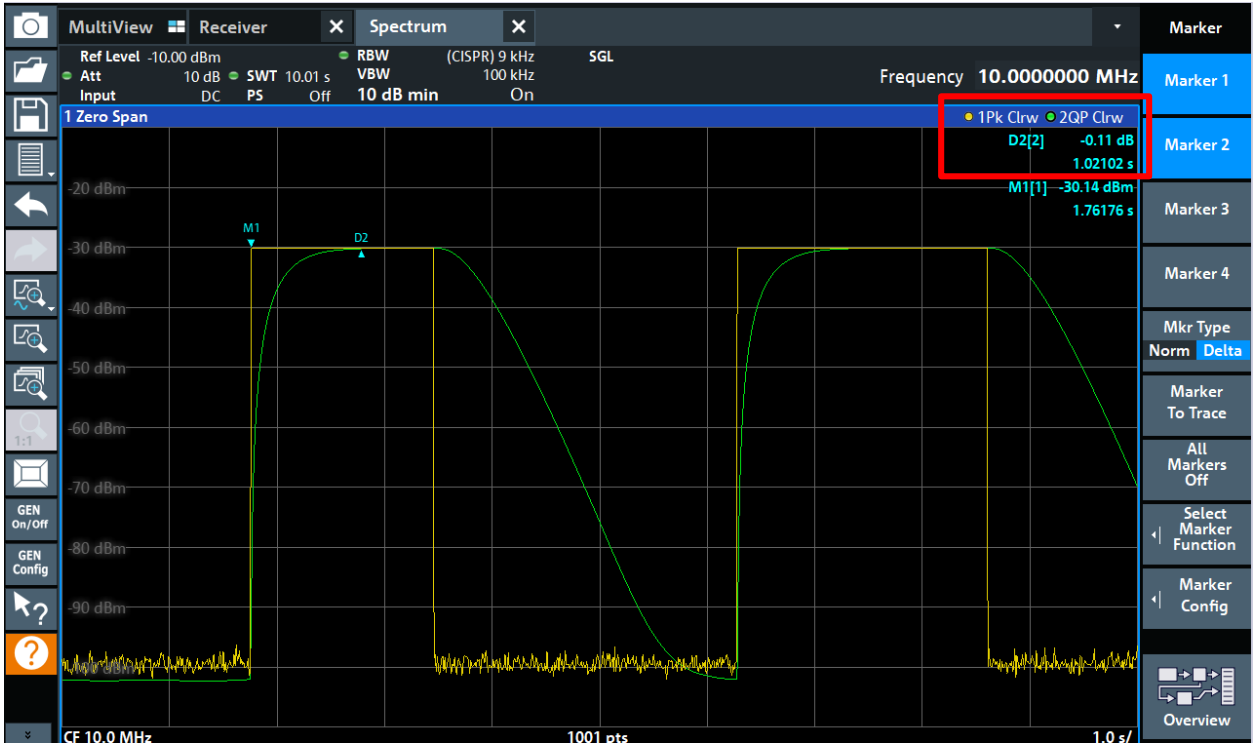
Scan Speed

Video available on Webinar

Quasi Peak Response

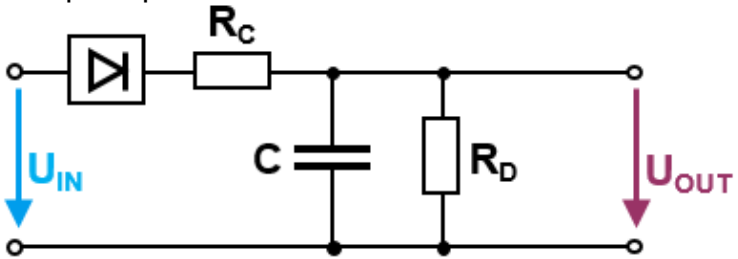
Video available on Webinar

Quasi Peak Response



WEIGHTING OF EMISSIONS
Quasi Peak

Circuit principle



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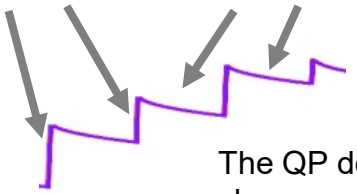

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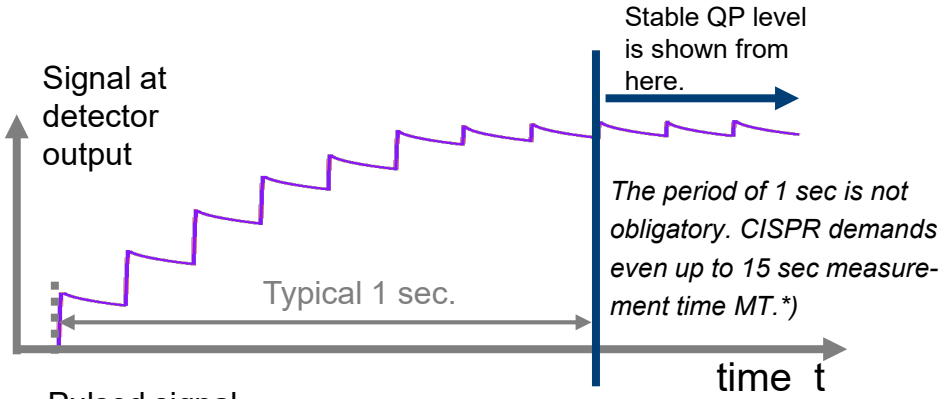
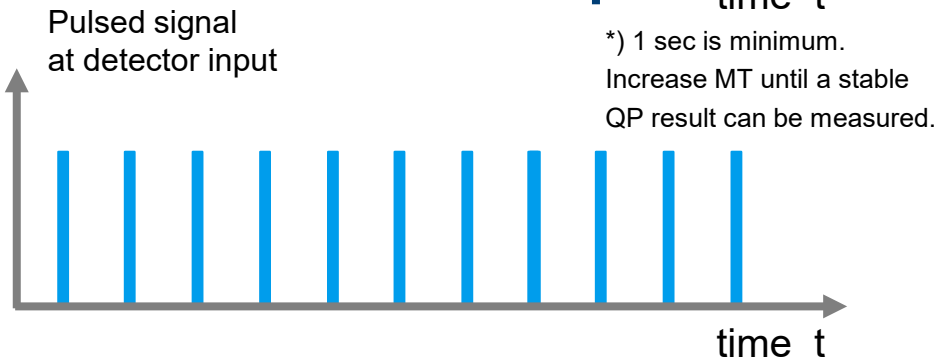


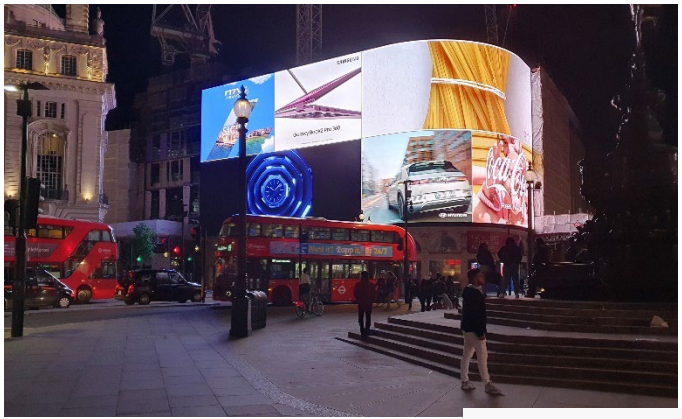


*) 1 sec is minimum.
Increase MT until a stable
QP result can be measured.

In Zero Span mode, the interference signal may appear like that. The behavior depends on the DUT.

Challenge of Testing

- Nosie is changing in real time
  - Short operating modes
- CISPR 37
  - Measurements in situ and at defined sites
  - Direct QP measurement recommended
    - High variability in ambient noise
    - Reproducability
    - Constant operating mode
- EN 50121
  - Railway EMI Test

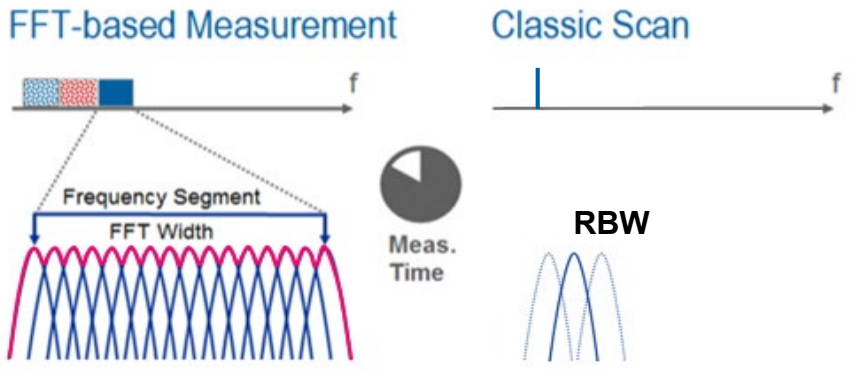


FFT BASED MEASUREMENT

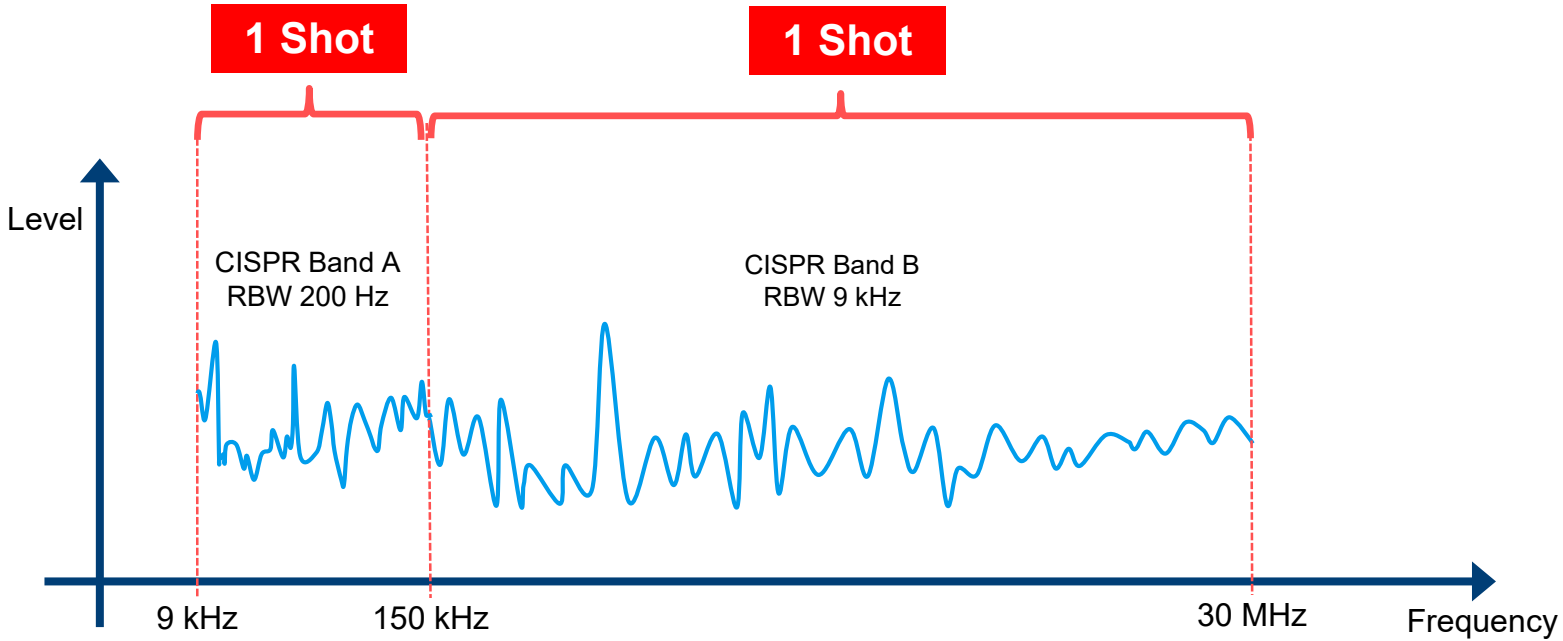
FFT Based Measurement Time Domain Scan

- Conducted band (150 kHz – 30 MHz) fits in **one** FFT analysis BW
- Perform QP & CISPR Avg in real-time on the conducted band

FFT is faster by numbers of magnitude than the classic scan



FFT Based Measurement



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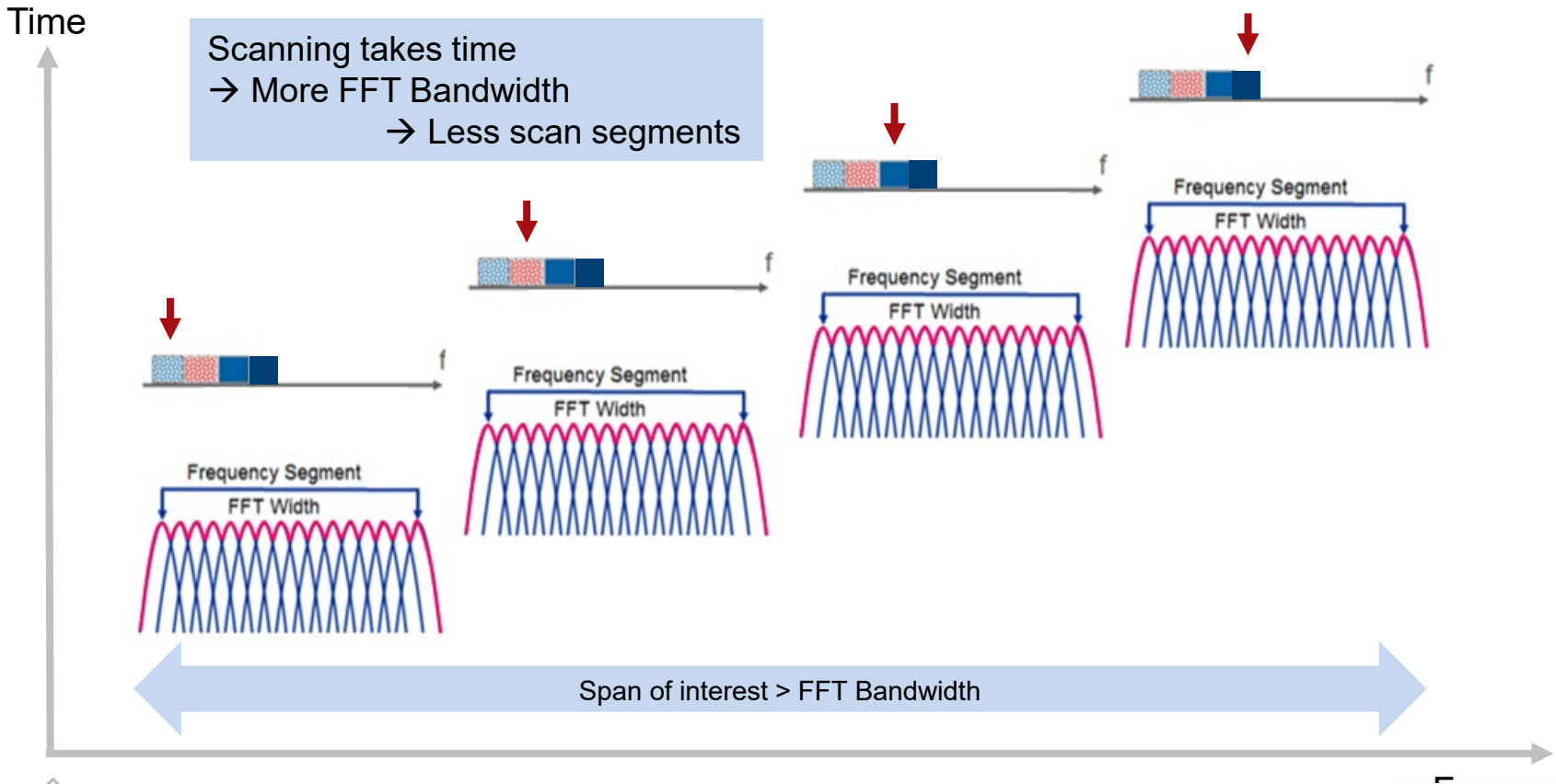


FFT Based Measurement
Measurement Speed

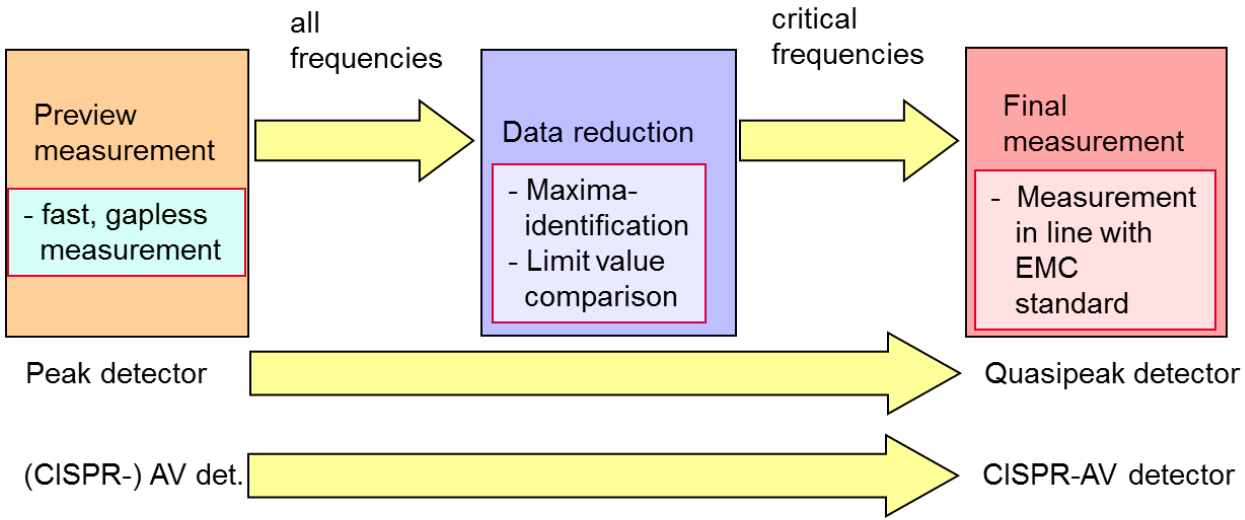
- Time domain scan with 3 optimization modes
  - **Automatic**
    full compliant to CISPR 16-1-1
  - **Fast**
    Compliant to CISPR 16-1-1 for pulses with a repetition frequency ≥ 10 Hz
  - **Dynamic**
    Enhanced dynamic in CISPR band D for applications with requirements beyond CISPR 16-1-1

	Measurement times	R&S ESW	
		Automatic TDS (full compliant)	Fast TDS
	150 kHz – 30 MHz 9 kHz, QP + CAV, 1 s	2 s	2 s
	150 kHz – 30 MHz 9 kHz, Peak, 100 ms	110 ms	110 ms
	30 MHz – 1000 MHz 120 kHz, Peak, 10 ms	380 ms	380 ms
CISPR 25 Automotive	**30 MHz – 1000 MHz** 9 kHz, QP + CAV, 1 s	64 s (- 37 %)	40 s
	30 MHz – 1000 MHz 120 kHz, QP + CAV, 1 s	50 s (- 20 %)	40 s
CISPR 11 Microwave oven	**1 GHz – 6 GHz** 1 MHz, Peak + CAV, 100 ms	216 s (- 51 %)	111 s
	1 GHz – 18 GHz 1 MHz, Peak, 10 ms	8 s	8 s
FCC	1 GHz – 26.5 GHz 1 MHz, Peak + AV, 10 ms	13 s	13 s
MIL	**1 GHz – 40 GHz** 1 MHz, Peak, 10 ms	21 s	21 s

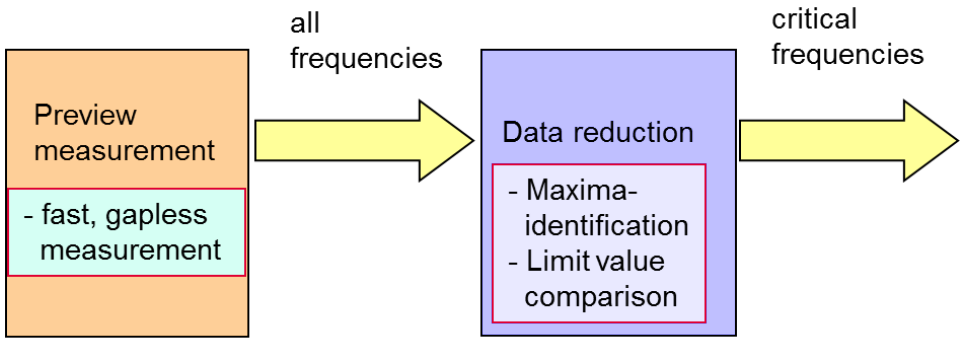
FFT Based Measurement
Measurement Speed

Frequency Band	RBW	Detector	Dwell Time	ESR	ESW	Stepped Scan
30 Hz - 1 kHz	10 Hz	Peak	1 s	1.42 s	**1.42 s**	137 s
1 kHz - 10 kHz	100 Hz			1.06 s	**1.06 s**	13 s
10 kHz - 150 kHz	1 kHz			1.01 s	**1.01 s**	7 s
150 kHz - 10 MHz	10 kHz			1.02 s	**1.02 s**	39 s
10 MHz - 30 MHz			150 ms	0.17 s	**0.17 s**	79 s
30 MHz - 1 GHz	100 kHz			7.7 s	**4.0 s**	6 min
1 GHz - 18 GHz	1 MHz		15 ms	26.4 s	**8.9 s**	11 min
18 GHz - 40 GHz					**14.5 s**	14 min

Test Process with FFT based measurement



Test Process with FFT based measurement



Quasipeak detector

CISPR-AV detector

Measurement with FFT Scan

Video available on Webinar

Measurement with FFT Scan Continuous Scan

Video available on Webinar

Test Setup for EMI-Debugging in a car

- CISPR 25 – protection of on-board receivers
- Impedance converter EZ12
- Measure what the car‘s antennas are picking up
- Real-time can look at whole frequency bands

AM Band, Engine Start and Stop

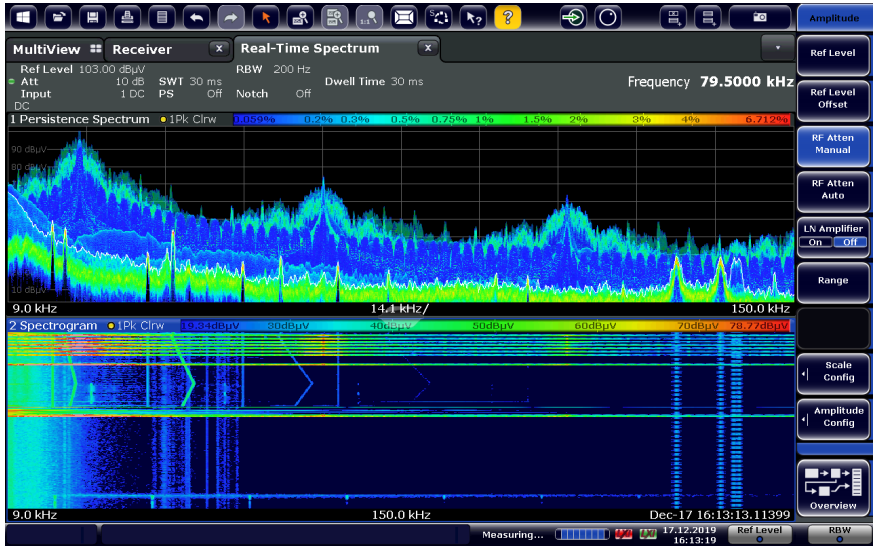
Video available on Webinar

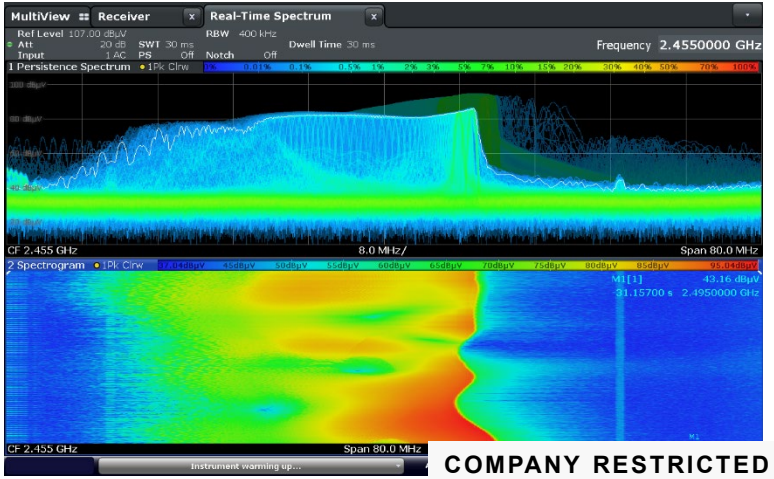
Power Windows

Video available on Webinar

REAL-TIME SPECTRUM

- **Detect complex signals at first**
- **Persistence mode**
  - Shows probability of amplitude appearence with colors. Signals with different behavior in time become visible even if hidden behind broadband interferers
- **Spectrum mode**
  - Displays behavior of traces in time for easy identification of drifting or pulsed signals





Benefit of FFT Based Measurement

- 기존 측정 방식 보다 빠른 측정 시간과 정확도를 가짐.

- EMI 시험 인증으로 사용 가능.

- 전 주파수에 대해 직접적인 Quasi Peak 결과 측정 가능
  - Quasi Peak Detector의 실시간 변화 확인

- 짧은 시간안에 변하는 노이즈를 정확하게 검출 가능
  - 운행 중인 기차 측정
  - 가속 또는 감속 중인 차량 측정

- Real Time Spectrum 기능을 이용해 높은 노이즈에 숨어 있는 노이즈 측정 가능

RECEIVER FOR FFT MEASUREMENT

What makes an EMI receiver Compliant?

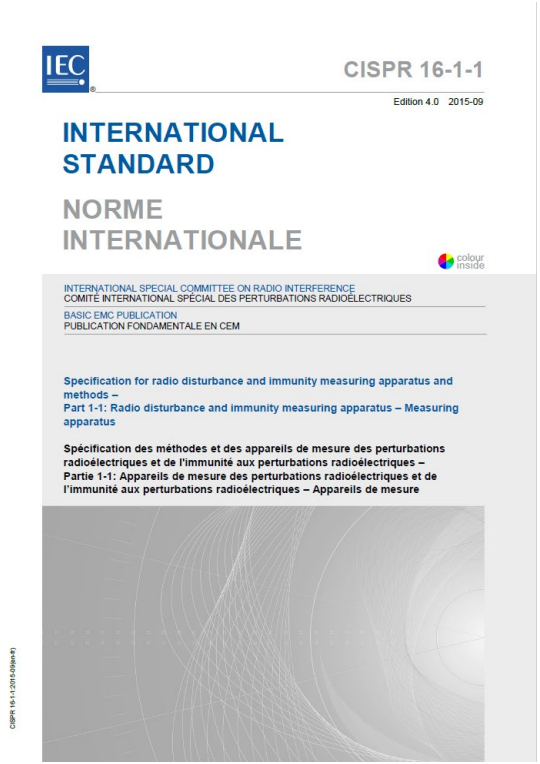
Conformity with CISPR 16-1-1
(commercial products)

This includes

- Specific VSWR
- Specific Selectivity (RBW filters)
- Specific detectors (“CISPR detectors”) with
  - Minimal sine wave accuracy
  - Defined response to pulses

Further requirements for product testing

- Preamplifier (sensitivity)
- Preselection



What are „pre-compliance measurements“?

- The EMI measurement standards define
  - T&M Equipment characteristics,
  - Set-up, procedure and operation of the EUT
  - Limits
- If a measurement is not compliant in one or more of these points it can be referred to as “pre-compliant”.
- Pre-compliant measurements should be done as close as possible to the related standards (reasonable effort)
- They typically give a pass / fails result (quantitative measurement)

→ There are no binding standards for pre-compliant measurements!

R&S Receivers

FSWT
Top notch test receiver with outstanding performance by narrow preselection for wideband TEMPEST measurements

ESRP
Precompliance measurements – fast and straightforward with preselection for excellent performance up to 7 GHz

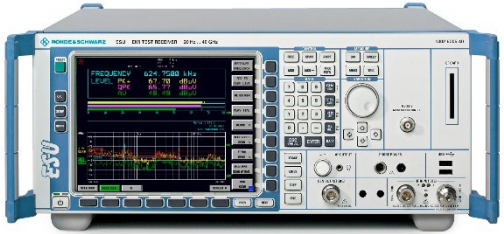
ESW
High-end compliant EMI receiver with maximum measurement speed, superior HF performance and multifunctional applications up to 44 GHz

ESR
Compliance receiver for lab and mobile testing with high speed and best insight using real-time spectrum analysis up to 26.5 GHz

EPL1000
Compliance receiver for conducted and magnetic field testing up to 30 MHz

FFT Based Measurement
R&S Receiver for Compliance Testing

2006 ESU



8 MHz FFT-Bandwidth

2012 ESR

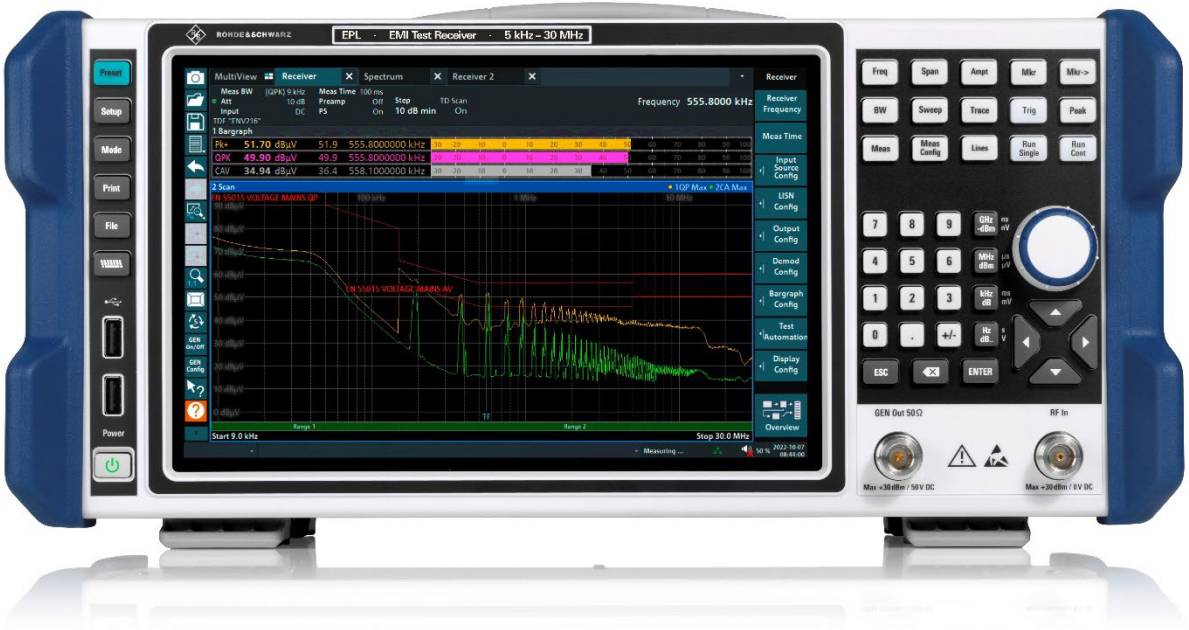
30 MHz FFT-Bandwidth

2016 ESW

60 MHz FFT-Bandwidth

EPL1000 OVERVIEW

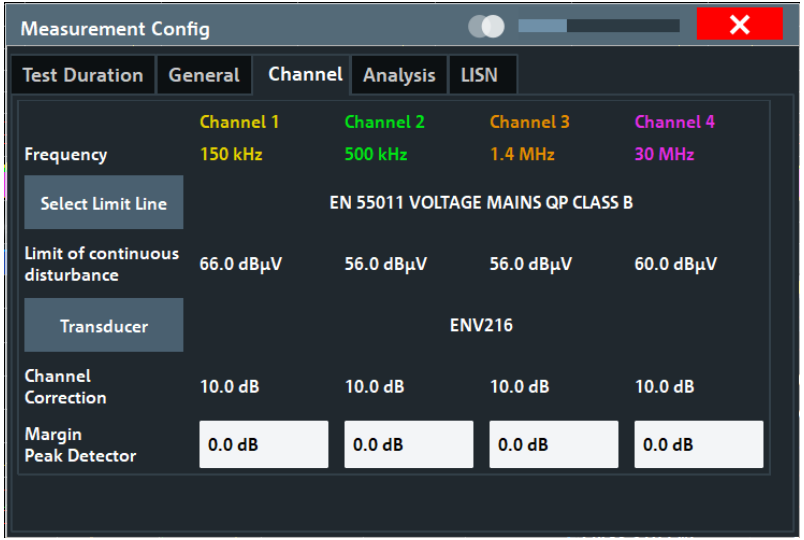
- CISPR 16-1-1 compliant
- 5kHz – 30MHz, targeting conducted EMI measurement applications
- Includes
  - Preselection
  - Time domain scan
  - Input protection
  - Spectrum analysis
- Several option like
  - Internal tracking generator
  - Battery operation
  - DC input



Speed. Flexibility. Compliance.

Discontinuous Disturbance – Clicks

- Mandatory for most devices of CISPR 14-1 - “Requirements for household appliances, electric tools and similar apparatus”
- Typically tested are ovens, irons, rice cookers, refrigerators, air conditioners and washing machines
- The measurement takes as long as one operating cycle of the EUT but at least 2 hours or until 40 clicks are reached
- 4 frequencies of CISPR band B need to be measured continuously using peak and quasi-peak detector
- Higher limits are used in case the emissions are not too long (< 200 ms) and occur not too often (< 25% of clicks above limit for continuous disturbance)



EPL1-K59 Click Rate Analyzer

- Compliant with CISPR 14-1 editions 6 and 7
- Simultaneous and gapless measurement of all four frequencies defined by CISPR 14-1
- Optional frequency setting in line with DENAN law (Japan)
- Analyze 4 hours of measurement values within a few seconds

Eliminate all interference in your testing

With the R&S®ESW EMI test receiver – 1 GHz wideband extension

Watch the video on YouTube

ESW-B1000 970MHz FFT Bandwidth
Key features of New ESW Wideband option

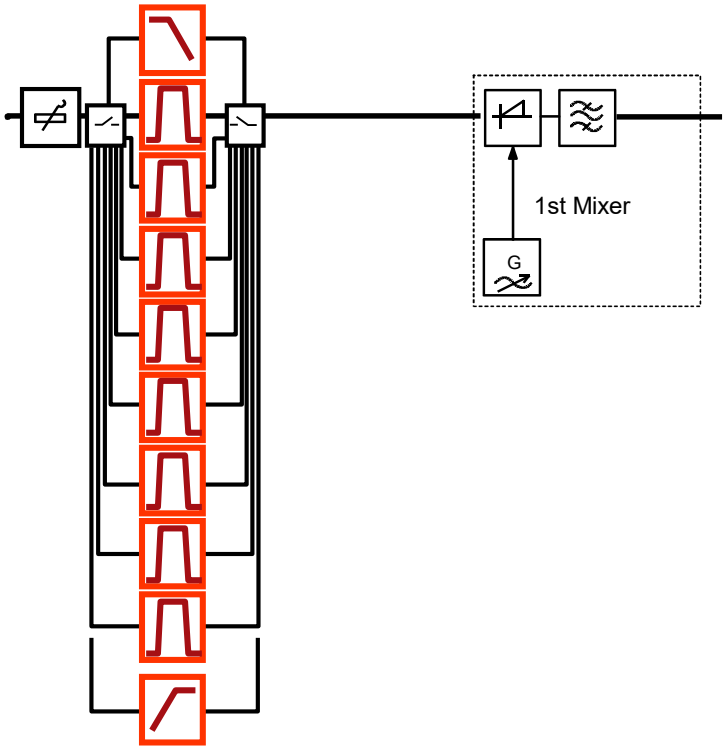
970 MHz
FFT bandwidth
- 120 kHz RBW
- 30 MHz – 1 GHz (CISPR Band C&D)

Real-time
Gapless measurements in receiver spectrogram

Quasi-peak
Simultaneous measurement of CISPR detectors at full bandwidth

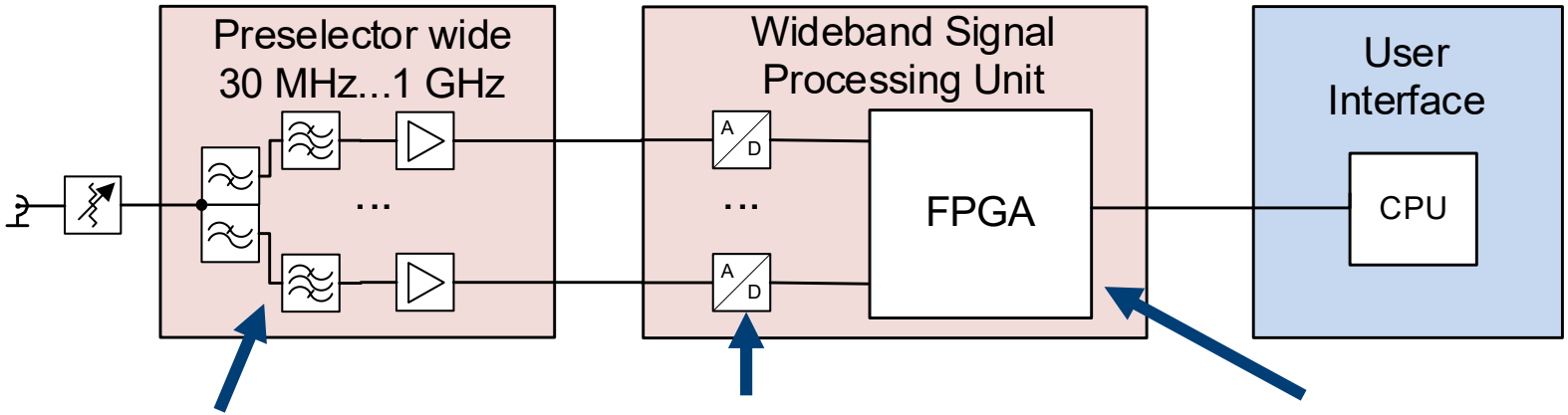
Pulse resolution 5 Hz - Fully compliant in CISPR Band D (300 MHz - 1 GHz)

FFT Based Measurement
R&S EMI Test Receiver Preselector



CISPR	ESR		ESW	
	Filter band	Filter type	Filter band	Filter type
Band A	< 150 kHz	Fixed LP	1 Hz – 150 kHz	Fixed LP
Band B	150 kHz - 30 MHz	Fixed BP	150 kHz – 30 MHz	Fixed BP
			2 MHz – 30 MHz	Fixed BP
			8 MHz – 30 MHz	Fixed BP
Band C	30 - 80 MHz	Fixed BP	30 – 125 MHz	Fixed BP
	80 - 130 MHz	Fixed BP	125 – 205 MHz	Fixed BP
	130 - 180 MHz	Fixed BP	205 – 285 MHz	Fixed BP
	180 - 230 MHz	Fixed BP	285 – 365 MHz	Fixed BP
	230 - 300 MHz	Fixed BP		
Band D	300 - 425 MHz	Fixed BP	285 – 365 MHz	Fixed BP
	425 - 570 MHz	Fixed BP	365 – 445 MHz	Fixed BP
	570 - 715 MHz	Fixed BP	445 – 525 MHz	Fixed BP
	715 - 860 MHz	Fixed BP	525 – 605 MHz	Fixed BP
	860 - 1005 MHz	Fixed BP	605 – 685 MHz	Fixed BP
			685 – 765 MHz	Fixed BP
			765 – 845 MHz	Fixed BP
			845 – 925 MHz	Fixed BP
			925 – 1001 MHz	Fixed BP
Band E	1005 - 1750 MHz	Fixed HP	1001 – 1795 MHz	Fixed BP
	1750 - 2850 MHz	Fixed HP	1795 – 2895 MHz	Fixed BP
	2850 - 4850 MHz	Fixed HP	2895 – 4895 MHz	Fixed BP
	4850 - 7000 MHz	Fixed HP	4895 – 6800 MHz	Fixed HP
	7 – 26.5 GHz	YIG BP	6.8 – 8 GHz	Fixed HP
			8 – 44 GHz	YIG BP

ESW-B1000 970MHz FFT Bandwidth
Concept of New ESW Wideband Option



Parallel signal paths cover **CISPR bands C and D**

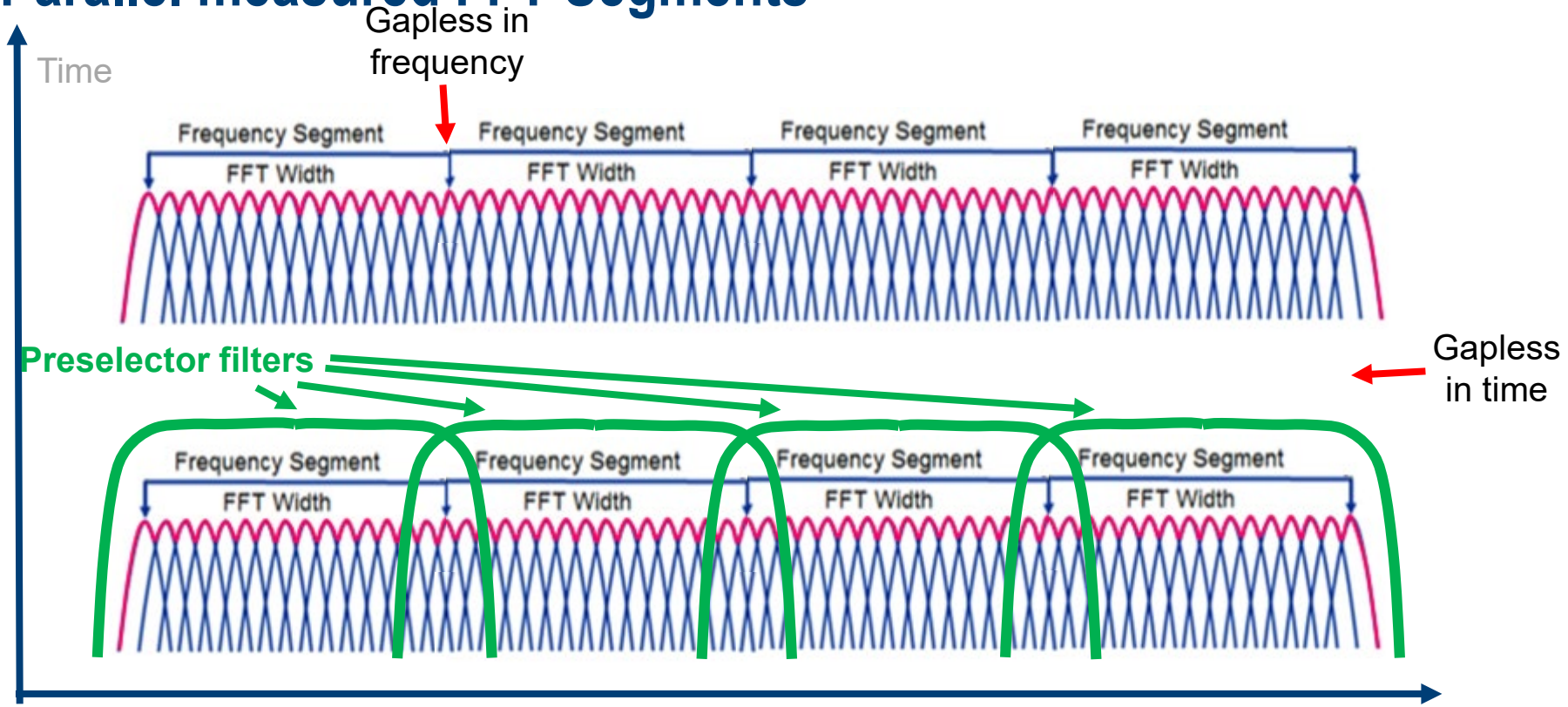
All eight paths have their own preselection and preamplifier to achieve **maximum dynamic range**

Parallel A/D converters

Split signal path increases dynamic range for pulses

Massive computing power to calculate the spectrum in **real-time**

ESW-B1000 970MHz FFT Bandwidth
Parallel measured FFT-Segments



ESW-B1000 970MHz FFT Bandwidth Testing Times

Frequency range	Resolution bandwidth	Measurement time	Detector(s)	Automatic TDS (base unit)	Automatic TDS (with R&S®ESW-B1000 or R&S®ESW-B1000R option)	Speed TDS (with R&S®ESW-B1000 or R&S®ESW-B1000R option)
30 MHz to 1 GHz	120 kHz	10 ms	Peak	380 ms	18 ms	
30 MHz to 1 GHz	**120 kHz**	**1 s**	**QP and CAV**	**50 s**	**18.5 s**	**1.8 s**
30 MHz to 1 GHz	9 kHz	1 s	QP and CAV	64 s	22.5 s	
1 GHz to 6 GHz	1 MHz	1 s	Peak and CAV	293 s	26 s	
30 MHz to 1 GHz	100 kHz	150 ms	Peak	4.1 s	155 ms	
1 GHz to 18 GHz	1 MHz	15 ms	Peak	13.1 s	11 s	
18 GHz to 40 GHz	1 MHz	15 ms	Peak	18 s		

Single 970 MHz segment

ESW-B1000 970MHz FFT Bandwidth Testing Times

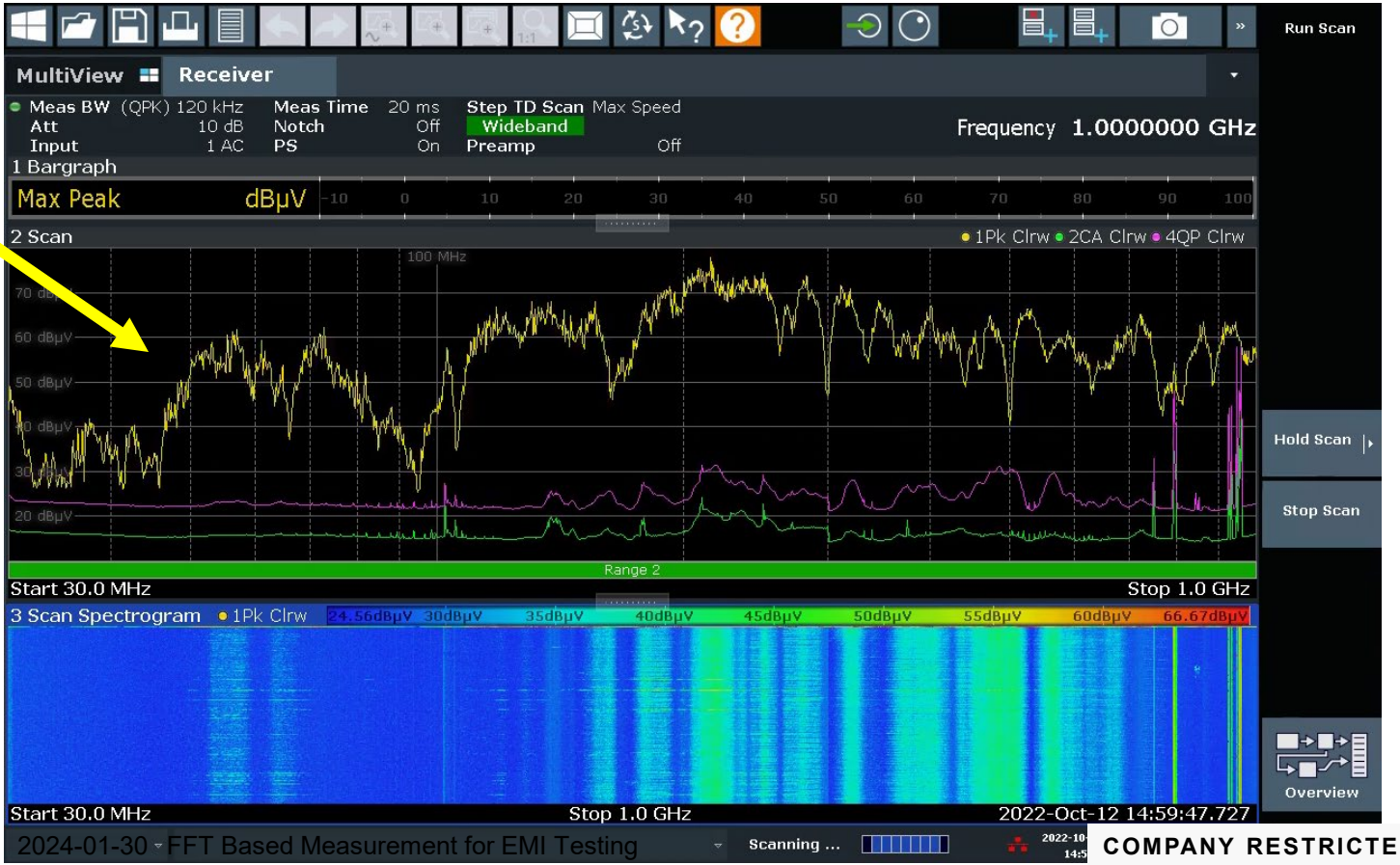
Video available on Webinar

ESW-B1000 970MHz FFT Bandwidth Testing Times

Video available on Webinar

Examples: Sparkling water tap compressor

- Short wideband pulse (switching process every 10 to 15 s)



Examples: Sparkling water tap compressor

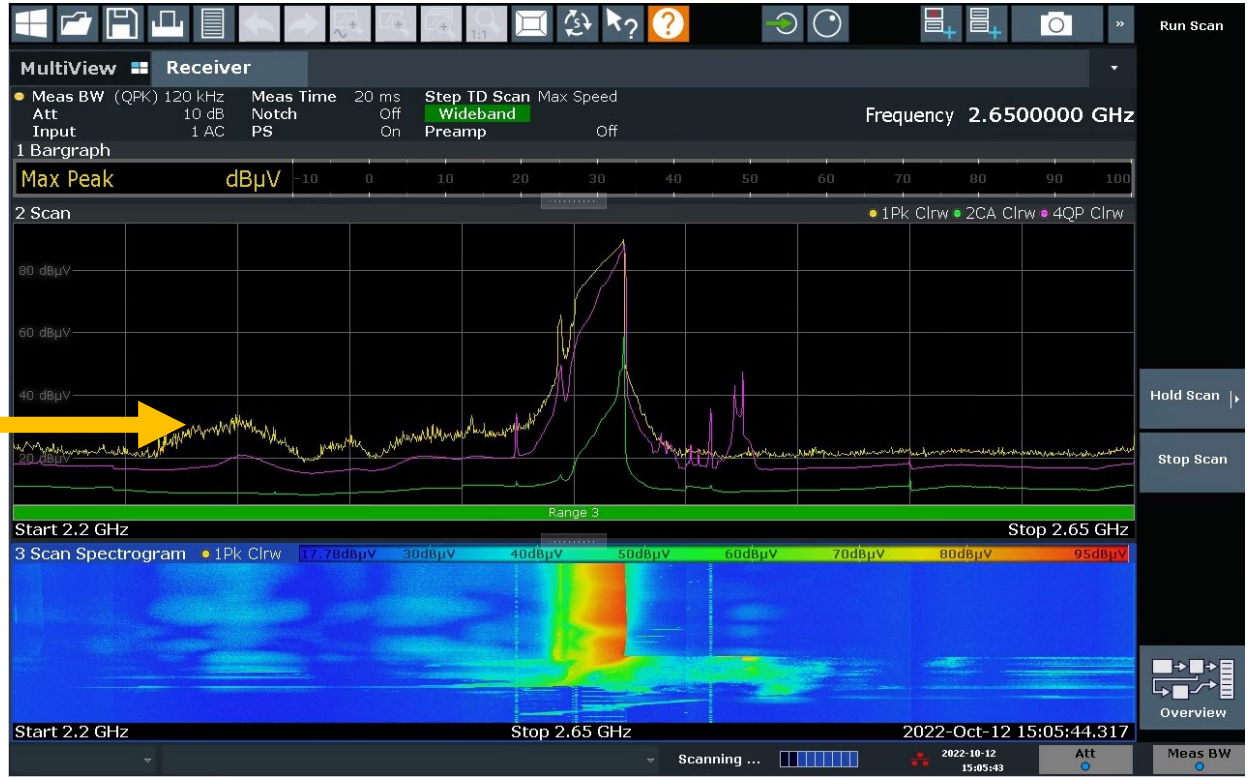
Video available on Webinar

Examples: Microwave oven

- Realtime bandwidth of 450 MHz above 1 GHz
- Oven turned **off**
- ISM spectrum at 2.4 GHz (Wifi, Bluetooth)

Examples: Microwave oven

- Realtime bandwidth of 450 MHz above 1 GHz
- Oven turned **on**
- Out of band interference



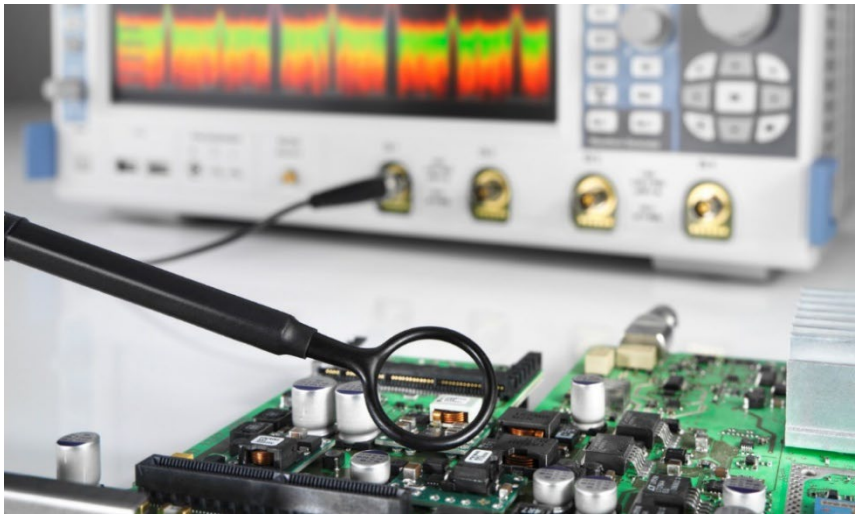
And what about „Debugging“ and „diagnostics“?

Debugging / diagnostics is done to

- ► locate the sources /
- ► identify the characteristics of

emissions of devices or Components.

Typically the measurements are qualitative



Oscilloscopes for EMI measurements

- Oscilloscopes are not suitable for compliant EMI measurements
- They can be very helpful to locate and analyze sources of EMI
- Strong feature is the combined signal analysis in time and frequency domain

→ Quick correlation analysis between spectral emission and time-domain signal parameters

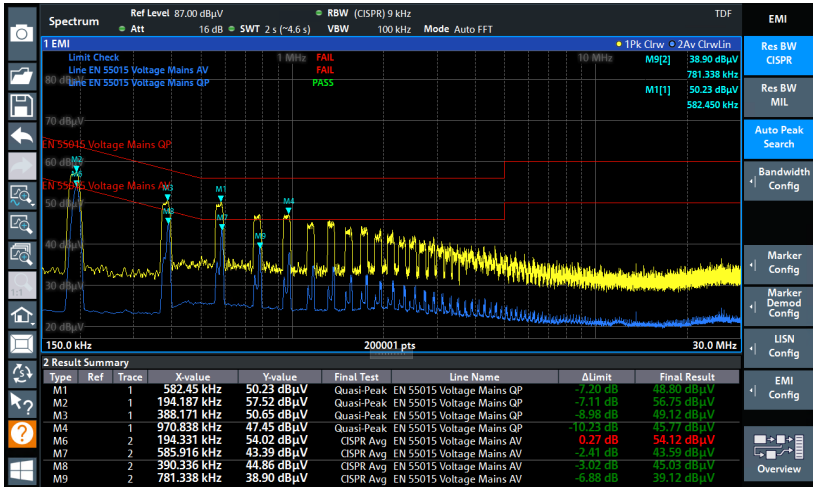
→ Intermittent signals can easily be captured and analyzed in the frequency domain by using a time-domain trigger

Oscilloscopes for EMI measurements

Video available on Webinar

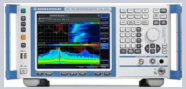
R&S®Fxx-K54 EMI Measurement application

- Detectors required by CISPR standard
  - Quasi-Peak, CISPR-Average and RMS-Average (CISPR-RMS)
- Resolution Bandwidths for CISPR- and MIL-Standard
- 200.001 sweep points (configurable)
- Preconfigured Limit Lines and transducer tables
- Logarithmic frequency-axis
- Marker functions with EMI-Detectors
- Peak search according to limit
- Marker AM/ FM demodulation
- Remote control for R&S LISNs



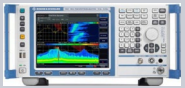
K54 on FPL1000

General functions

Type	R&S®FSW	R&S® FSV(A)3000	R&S®FPL1000	R&S®FSVR	R&S®FSV(A)
					
Lowest frequency	2 Hz	FSVA3000: 2 Hz FSV3000: 10 Hz	5 kHz	10 Hz	10 Hz
Highest frequency (according to model)	8, 13.6, 26.5, 43.5, 50, 67, 85 GHz	4, 7.5, 13.6, 30, 44 GHz	3, 7.5, 14, 26.5 GHz	7, 13.6, 30, 40 GHz	4, 7, 13.6, 30, 40 GHz
Real-time spectrum	Up to 800 MHz	-	-	Up to 40 MHz	-
Spectrogram	+	+	+	+	+
Tracking generator	Ext. gen. cont.	Ext. gen. cont.	+	-	+
DC operation	-	-	+	-	+
Battery operation	-	-	+	-	+

R&S FSV(A):
- Phased out Dec. 2020
- Key code options available until Dec. 2025

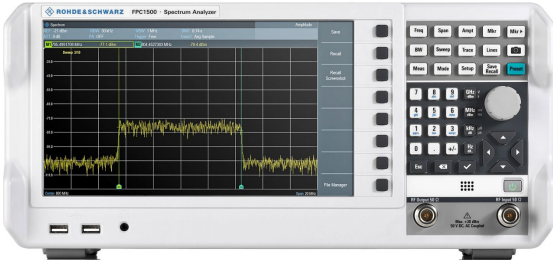
K54 related functions

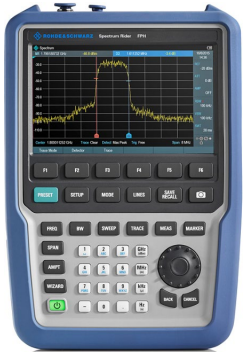
Type	R&S®FSW	R&S® FSV(A)3000	R&S®FPL1000	R&S®FSVR	R&S®FSV(A)
					
EMI option	FSW-K54	R&S®FSV3-K54	R&S®FPL1-K54	R&S®FSV-K54	R&S®FSV-K54
CISPR calibration option	FSW-K54CAL	R&S®FSV3-K54C	-	-	R&S®FSV-K54CAL
Report function	+	+	+	-	-
CISPR detectors for frequency sweep	+	Planned beginning of 2022	Released with FW 1.80	+	+
Support by R&S®ELEKTRA	+	+	+	-	R&S®FSV only
Support by R&S®EMC32	+	-	-	+	+

R&S FSV(A):
- Phased out Dec. 2020
- Key code options available until Dec. 2025

INSTRUMENTS WITH R&S®FXX-K43 RECEIVER MODE

- R&S®FPC Spectrum Analyzer
  - Frequency range 5 kHz – 3 GHz
  - Tracking generator
  - ELEKTRA support
- R&S®FPH Handheld Spectrum Analyzer
  - Frequency range 5 kHz – 31 GHz
  - ELEKTRA support
- R&S®FSH Handheld Spectrum Analyzer
  - Frequency range 9 kHz – 20 GHz
  - Tracking generator





- K43 option adds 6 dB bandwidths & Detectors (CISPR 16-1-1)
  -

Comparison R&S®FXX-K54 - R&S®FXX-K43

	K54	K43
Supported devices	R&S®FPL1000 R&S®FSV(A)3000 R&S®FSVR R&S®FSW	R&S®FPC R&S®FSH R&S®FPH
6 dB RBW (CISPR)	X	X
CISPR detectors	X	only quasi-peak
6 dB RBW (MIL-STD-461)	X	-
Log scale	X	X
Fixed frequency, channel scan and frequency scan	-	X
Limit line library	X	-
Transducer factor library	X	-
Measurement points	up to 200.001 (user selectable)	R&S®FSH: 631 R&S®FPH: 10.000 R&S®FPC: 20.000
LISN control	R&S®ENV216 / 432 / 4200	R&S®HM6050 with R&S®FPC (PC required)
Measurement automation	X	-
Report generation	X (not R&S®FSVR)	-
Use with R&S®ELEKTRA	X (not R&S®FSVR)	X (not R&S®FSH)

K54: EMI Measurement application
K43: Receiver mode (and channel scan measurement application)

R&S®ELEKTRA can add the following features not part of K43 but of K54 (relevant for R&S®FPC and R&S®FPH):

- Limit line library
- Transducer factor library
- LISN control
- Measurement automation
- Report generation

ROHDE&SCHWARZ

Make ideas real

COMPANY RESTRICTED