

EMI 電磁波干擾訊號量測介紹

AGENDA

▶ EMC 電磁波基本概念介紹

- EMI 電磁波基本概念介紹
- EMS 電磁波基本概念介紹
- EME 複雜性電磁波基本概念介紹

▶ EMI 電磁波干擾訊號量測介紹

- 頻譜分析儀與EMI Test Receiver 的差異性
- 如何依據規範正確的量測EMI Emission 訊號
- 如何快速(Time Domain Scan)與正確的量測EMI Emission 訊號

▶ Q&A

EMI 電磁波干擾介紹

頻譜分析儀與EMI TEST RECEIVER差異性

- ▶ Start Frequency from 1Hz
- ▶ Preselector in the input of Mixer
- ▶ Amplitude Level Define to dBuV, dBuA.....
- ▶ RBW BW definition is 6dB BW, not 3 dB BW
- ▶ Measurement method is used Scan Measurement, not Sweep Measurement
- ▶ Sweep Type_01: it is used a logarithmic Measurement, not Linear Measurement
- ▶ Sweep Type_02: Sweep Time and Sweep points Definition
- ▶ Detector Type: QP, CISPR-AV.....
- ▶ Transducer Factor Setting: dBuV, dBuA, A/m.....
- ▶ Transducer Test Fixture: LISN, Current Probe, Antenna, Slider Bar.....

EMI 電磁波干擾介紹

EMI TEST RECEIVER FEATURE AND FUNCTION



Highlights

- **Sensitivity:** Built-in preamplifier, optional LNA and notch filters
- **Speed:** Unique time-domain scan with parallel CISPR detectors
- **Usability:** Big high resolution touch screen
- **MultiView:** All needed measurements in one display

High-end compliance receiver based on proven FSW platform

- 1 Hz to 8 / 26.5 / 44 GHz
- All relevant standards from commercial to military
- Best HF performance receiver and spectrum analyzer in one device



EPL1000 EPL1001 EPL1007

- ▶ EMI measurement application
- ▶ EMI Compliance testing in line with commercial, automotive, avionic and military standards (CISPR, EN, FCC, DO 160, MIL-STD-461)

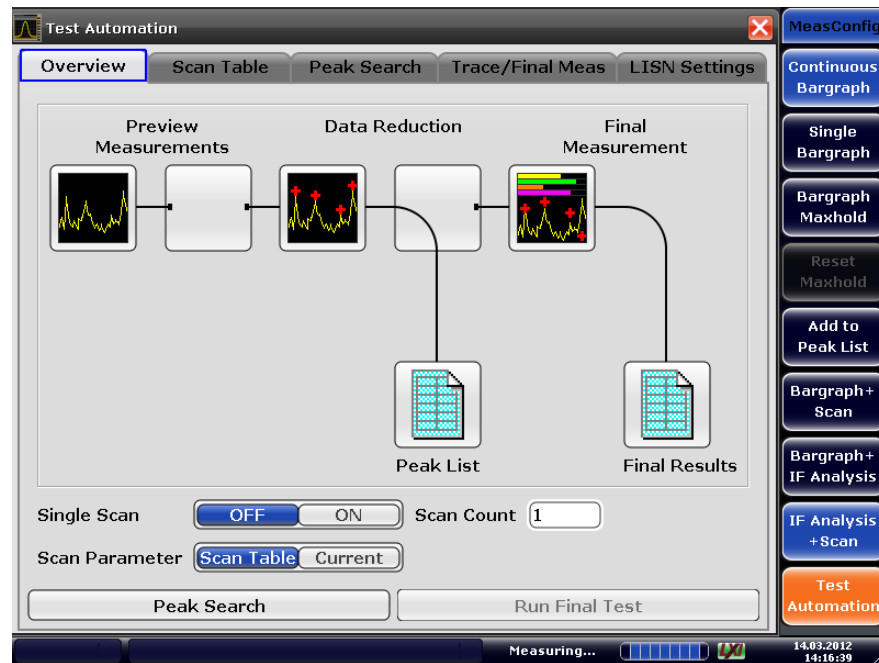


EMI MEASUREMENT KEY SPECIFICATION

EMI filters (6 dB)	CISPR 16-1-1: 200 Hz, 9 kHz, 120 kHz, 1 MHz MIL-STD-461: 10 Hz, 100 Hz, 1 kHz, 10 kHz, 100 kHz, 1 MHz
EMI detectors (CISPR 16-1-1)	Peak, Quasi-peak, CISPR-average, RMS-average
Number of sweep points	101 to 200001
Number of meas. markers	1-16
Limit line library, transducer factor library, LISN control, AM/FM demodulation, logarithmic display, reporting, ...	

EMI MEAS. ON TEST RECEIVER TEST AUTOMATION SETTING

- I Semi / fully automatic EMI test sequences including
 - I Fast preview measurement
 - Pk or Pk/Avg detection
 - TD scan or stepped frequency
 - I Data reduction
 - Evaluation of the critical frequencies for final measurement
 - I Final measurement
 - Quasipeak or Quasipeak/CAV detection
 - Measurement on a frequency list
- I Remote control for **automatic phase switching** of Rohde & Schwarz artificial mains networks (LISNs)



EMI MEAS. ON TEST RECEIVER SCAN TABLE SETTING

Test Automation

Overview | **Scan Table** | Peak Search | Trace/Final Meas | LISN Settings

Scan Start: 150.0 kHz | Time Domain Scan: **OFF** **ON** | Adjust Axis | Delete Range

Scan Stop: 7.0 GHz

Step Mode: AUTO | Insert Range Before | Insert Range After

	Range 1	Range 2	Range 3
Range Start	150.0 kHz	30.0 MHz	1.0 GHz
Range Stop	30.0 MHz	1.0 GHz	7.0 GHz
Step Size	2.25 kHz	30.0 kHz	250.0 kHz
Res BW	9.0 kHz	120.0 kHz	1.0 MHz
Meas Time	1 s	100 ms	10 ms
Auto Ranging	OFF ON	OFF ON	OFF ON
RF Attenuation	10 dB	0 dB	0 dB
Preamplifier	AUTO	AUTO	AUTO
RF Input	1 2	1 2	1 2

Prev Range | Next Range

Sweep

Run Continuous

Run Single

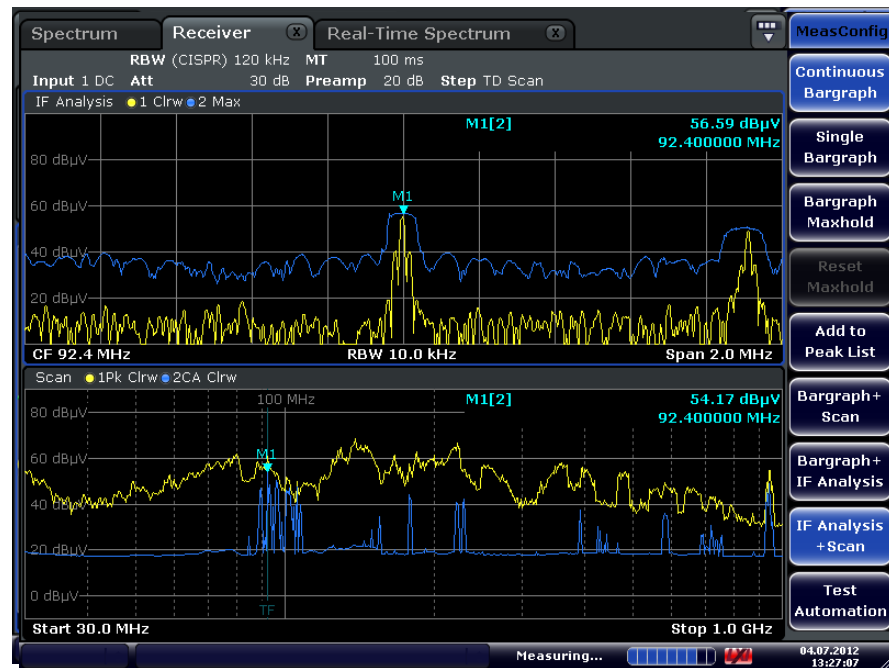
Edit Scan Table

Freq Axis
LIN LOG

Measuring... 05.07.2012 11:48:30

EMI MEASUREMENT ON TEST RECEIVER WITH IF ANALYSIS

- I Spectrum display around the receiving frequency
 - I Level measurement with simultaneous display of bar-graph & adjacent spectrum and audio demodulation (AM, FM)
 - I or
 - I Measurement of adjacent spectrum and display of overview scan
- I Max. span 10 MHz
- I Sample detector



FPL1-K54 FSV3-K54 FSW-K54

- ▶ EMI measurement application
- ▶ EMI Precompliance testing in line with commercial, automotive, avionic and military standards (CISPR, EN, FCC, DO 160, MIL-STD-461)



EMI MEASUREMENT OVERVIEW

EMI MEASUREMENTS ON SA WITH K54



EMI measurement

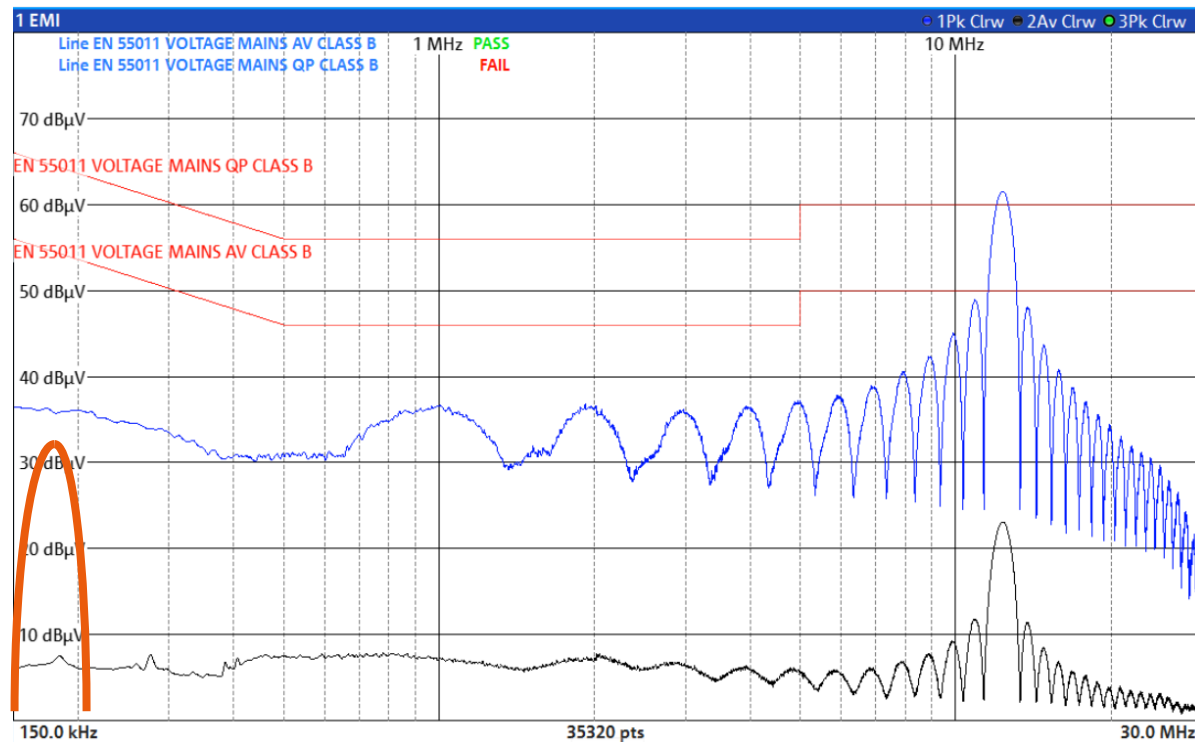


Sweep points

Pre-scan, overview + final

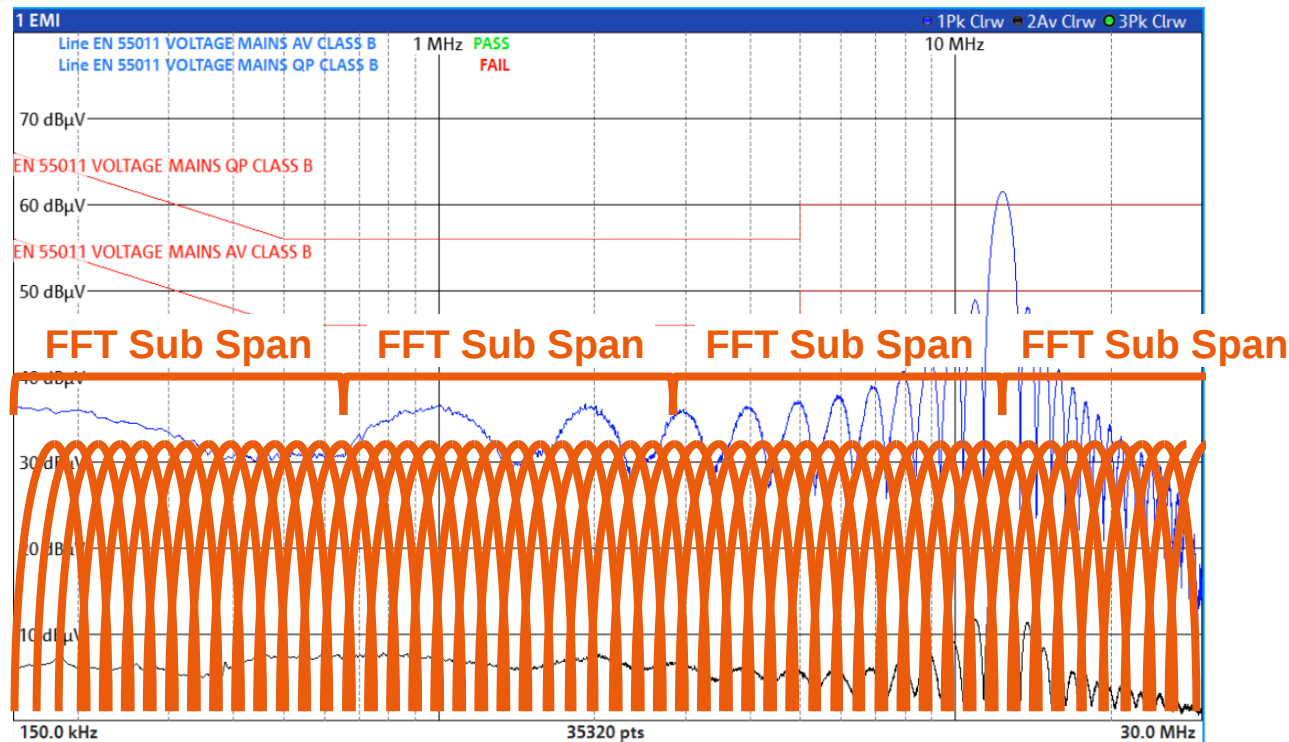
EMI MEASUREMENT OVERVIEW

EMI MEASUREMENTS ON SA WITH K54_SWEEP MODE



EMI MEASUREMENT OVERVIEW

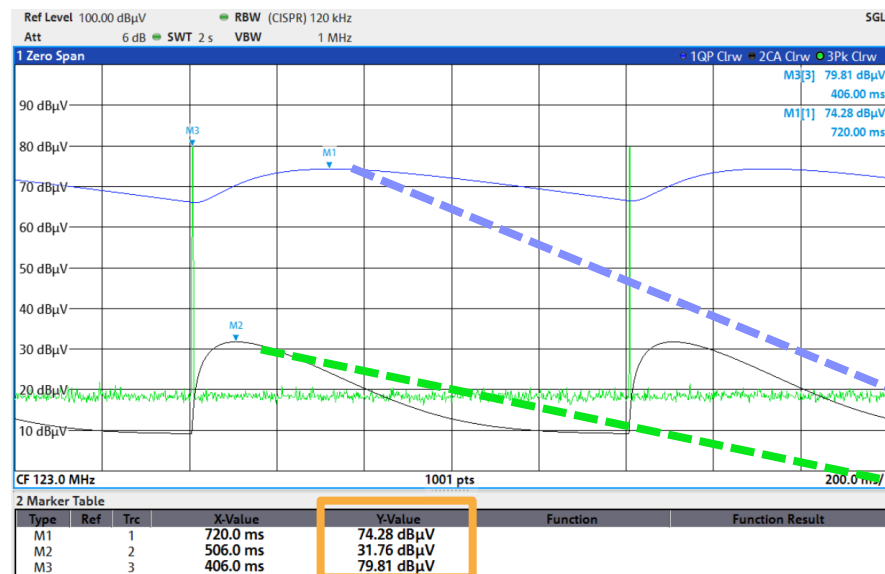
EMI MEASUREMENTS ON SA WITH K54_FFT MODE



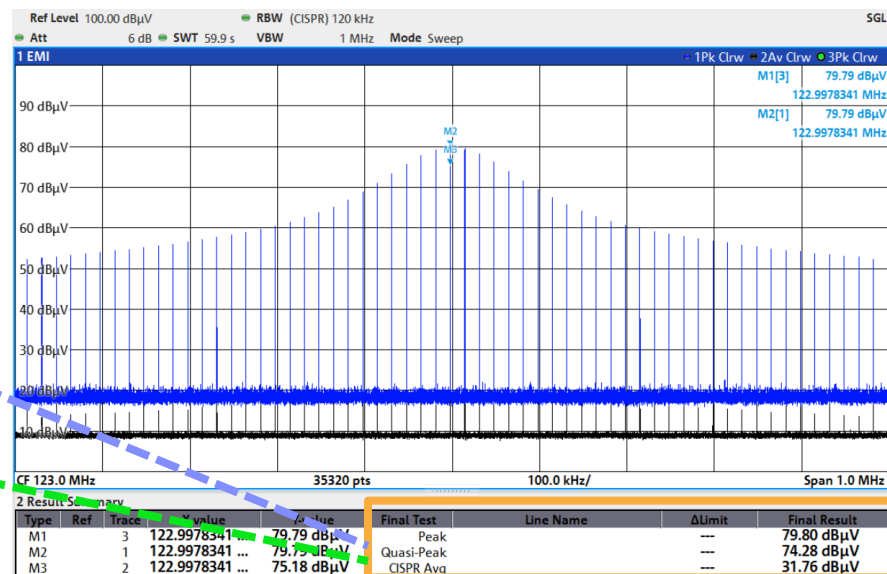
EMI MEASUREMENT OVERVIEW

EMI DETECTORS RESPONSE IN TIME AND FREQUENCY

◆ Time Domain

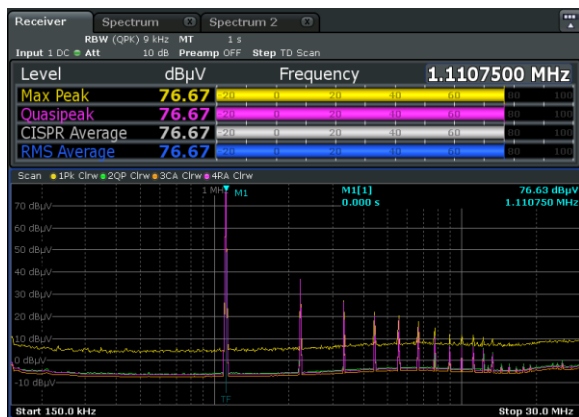


◆ Spectrum Domain



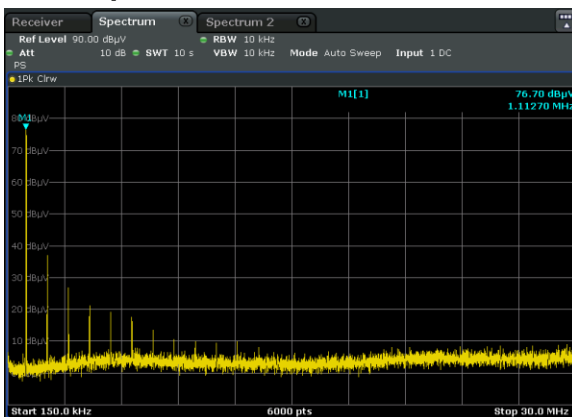
EUT | CW TYPE | STATIONARY SIGNAL

- ▶ EMI Test Receiver
- ▶ Scan



All detectors show same readings

- ▶ Spectrum Analyzer
- ▶ Spectrum



Spectral components can be clearly identified (if $\Delta f \gg \text{RBW}$)

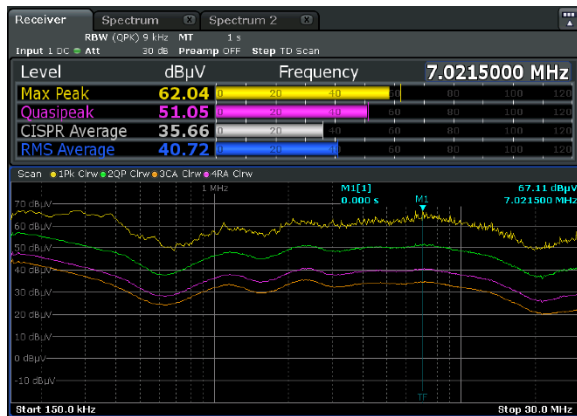
- ▶ Spectrum Analyzer
- ▶ Time Domain



Steady reading over time

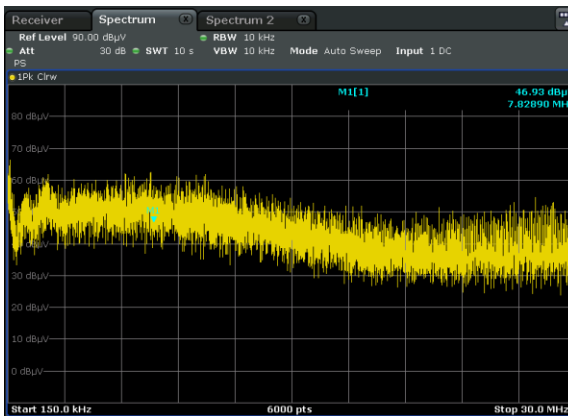
EUT | COMMUTATOR MOTOR | “BRUSH FIRE”

- ▶ EMI Test Receiver
- ▶ Scan



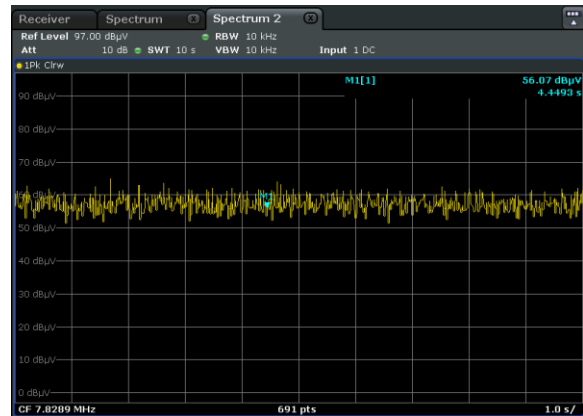
Short signals create
broadband spectrum

- ▶ Spectrum Analyzer
- ▶ Spectrum



Noise like spectrum

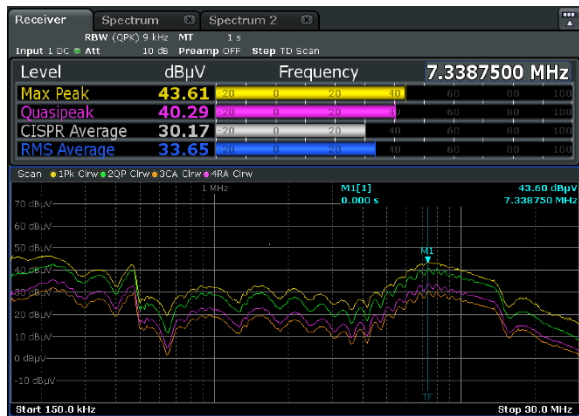
- ▶ Spectrum Analyzer
- ▶ Time Domain



Noise like

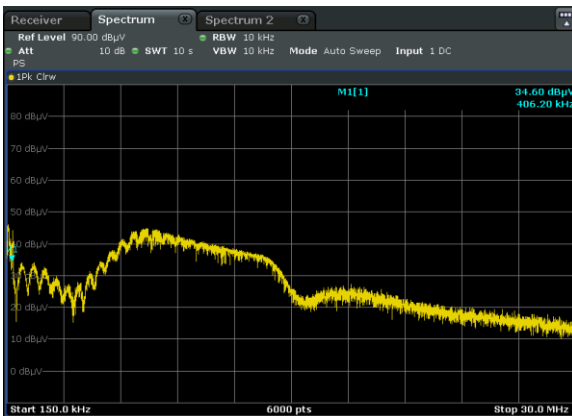
EUT | PULSED WITH “SHORT” PULSE REPETITION INTERVAL

- ▶ EMI Test Receiver
- ▶ Scan



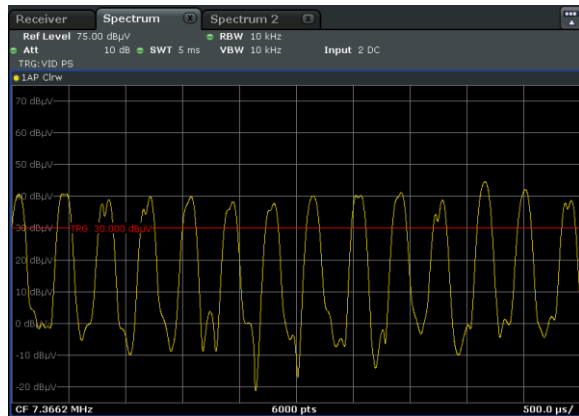
Short signals create
broadband spectrum

- ▶ Spectrum Analyzer
- ▶ Spectrum



Individual spectral lines
cannot be resolved with
RBW

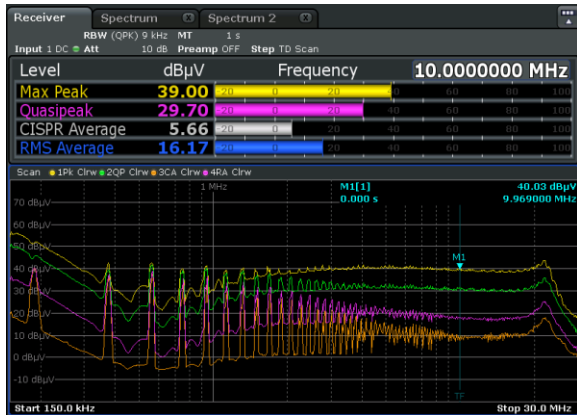
- ▶ Spectrum Analyzer
- ▶ Time Domain



Short PRI enables short
dwell times ($\approx 500 \mu\text{s}$)

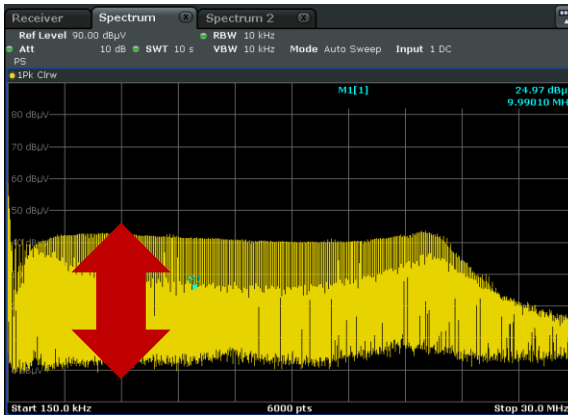
EUT | PULSED WITH “LONG” PULSE REPETITION INTERVAL

- EMI Test Receiver
- Scan



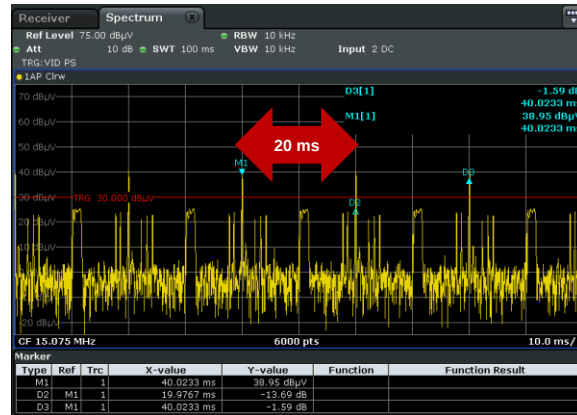
Short signals create broadband spectrum

- Spectrum Analyzer
- Spectrum



“Wide trace” indicates intermittent capturing

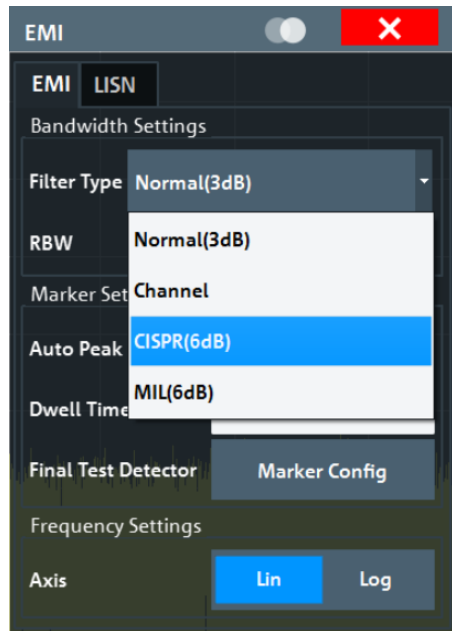
- Spectrum Analyzer
- Time Domain



Lowest PRI in time domain. Defines shortest dwell time!

FREQUENCY RANGES & RBWS | CISPR STANDARDS

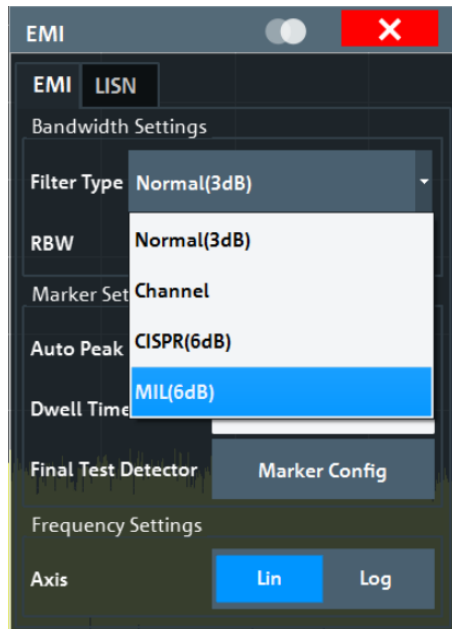
► Commercial & Industrial Standards



Frequency range	Band	RBW (6 dB)	EMI Detectors
9 kHz to 150 kHz	A	200 Hz	PK, QKP, CAV
150 kHz to 30 MHz	B	9 kHz	PK, QKP, CAV
30 MHz to 300 MHz	C	120 kHz	PK, QKP, CAV
300 MHz to 1000 MHz	D	120 kHz	PK, QKP, CAV
30 MHz to 1000 MHz	C/D	120 kHz	PK, QKP, CAV
1 GHz to 18 GHz	E	1 MHz	PK, CAV

FREQUENCY RANGES & RBWS | MIL STANDARDS

► Military standards



Frequency range	RBW (6 dB)	EMI Detector
30 Hz to 1 kHz	10 Hz	PK
1 kHz to 10 kHz	100 Hz	PK
10 kHz to 150 kHz	1 kHz	PK
150 kHz to 30 MHz	10 kHz	PK
30 MHz to 1 GHz	100 kHz	PK
Above 1 GHz	1 MHz	PK

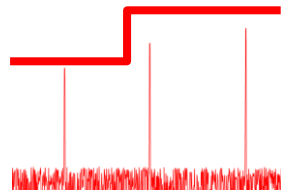
EMI 電磁波干擾介紹

如何依據規範正確的量測 EMI EMISSION訊號 RADIATION

Target: defined and reproducible test

- The receiver evaluates the received field strength and compares the result with a defined limit.

Evaluation of
the RF Emission

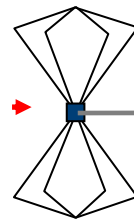


Test chamber with defined test distance



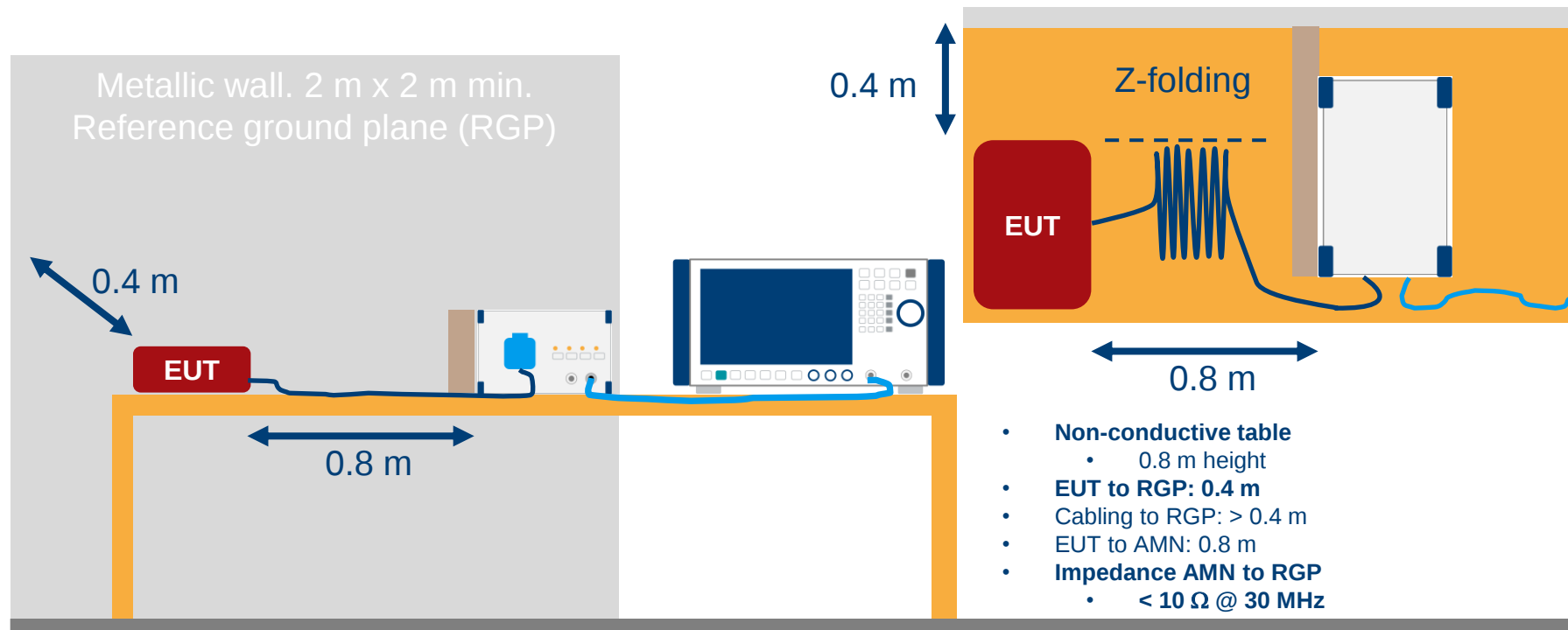
Interference source

Electro Magnetic Interference



EMI 電磁波干擾介紹

如何依據規範正確的量測 EMI EMISSION訊號 CONDUCTIVE



EXAMPLE: DISTURBANCE VOLTAGE LIMITS | MAINS

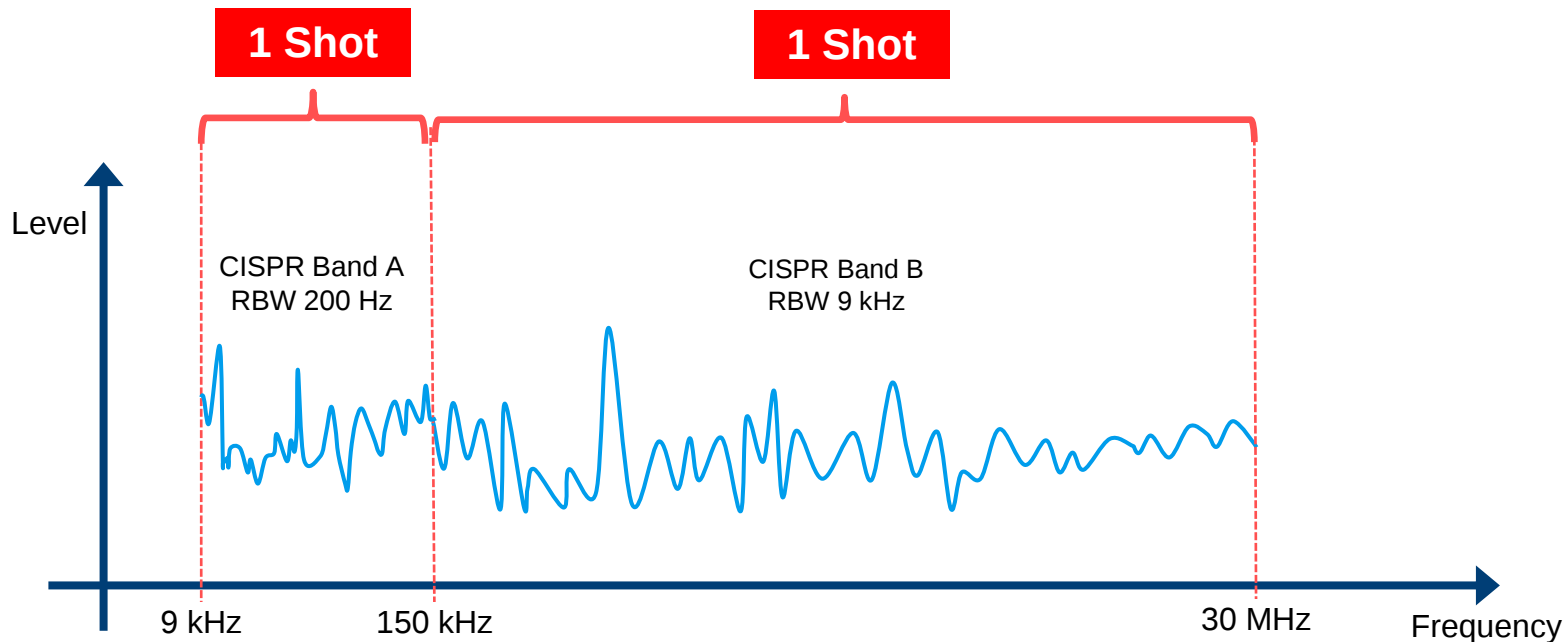
Frequency range	Limits		Method
	Quasi-peak	Average NOTE: CISPR-average	
9 kHz to 50 kHz	110	-	CIPR 16-2-1 8.3
50 kHz to 150 kHz	90 to 80 ^{b)}	-	
150 kHz to 0.5 MHz	66 to 56 ^{b)}	56 to 46 ^{b)}	
0.5 MHz to 5.0 MHz	56	46	
5 MHz to 30 MHz	60	50	

a) At the transition frequency, the lower limit applies.

b) The limit decreases linearly with the logarithm of the frequency in the ranges 50 kHz to 150 kHz and 150 kHz to 0.5 MHz.

EMI 電磁波干擾介紹

如何快速(TD SCAN)與正確的量測EMI EMISSION訊號



EMI 電磁波干擾介紹

如何快速(TD SCAN)與正確的量測EMI EMISSION訊號

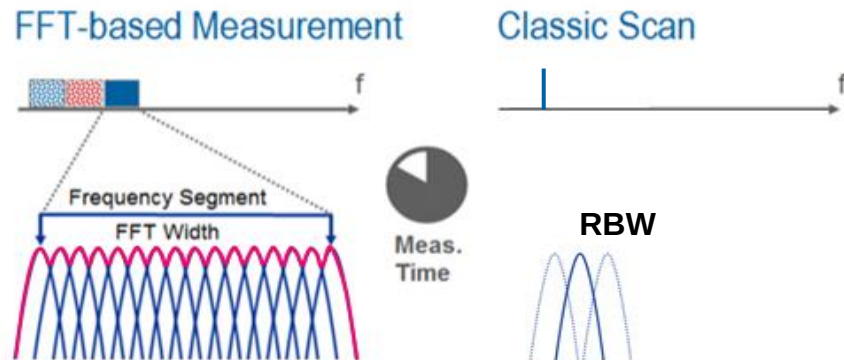


EMI 電磁波干擾介紹

如何快速(TD SCAN)與正確的量測EMI EMISSION訊號

- ▶ Rohde & Schwarz was the lead manufacturer in the Tri Services Working Group on the integration of Time Domain Scan within MIL-STD-461G
- ▶ 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



TEST RECEIVER WITH IF ANALYSIS ON EMI MEASUREMENT

TIME DOMAIN SCAN VS STEP SCAN ON TEST RECEIVER

Frequency range	Weighting detector; measurement time; IF bandwidth; step width for stepped scan (SS) and Time Domain Scan (TD)	R&S ESR26	
		Stepped frequency scan	Time Domain Scan option
CISPR Band B 150 kHz to 30 MHz	P; 10 ms; 9 kHz; SS: 4 kHz, TD: 2.25 kHz	82 s	0.11 s (745 x)
CISPR Band B 150 kHz to 30 MHz	QP, 1 s, 9 kHz SS: 4 kHz, TD: 2.25 kHz	approx. 3.8 h	2 s (6 940 x)
CISPR Bands C/D 30 to 1000 MHz	Pk, 10 ms, 120 kHz SS: 40 kHz, TD: 30 kHz	114 s	0.99 s (115 x)
CISPR Bands C/D 30 to 1000 MHz	Pk, 10 ms, 9 kHz SS: 4 kHz, TD: 2.25 kHz	3 693 s	1.08 s (3 420 x)
CISPR Bands C/D 30 to 1000 MHz	QP, 1 s, 120 kHz SS: 40 kHz, TD: 30 kHz	approx. 10 h	80 s (450 x)

TEST RECEIVER WITH IF ANALYSIS ON EMI MEASUREMENT

TIME DOMAIN SCAN VS STEP SCAN ON TEST RECEIVER

Frequency range	Weighting detector; measurement time; IF bandwidth; step width for stepped scan (SS) and Time Domain Scan (TD)	R&S ESR26	
		Stepped frequency scan	Time Domain Scan option *
CISPR Band E 1 GHz to 18 GHz	Pk, 1 ms, 1 MHz SS: 400 kHz, TD: 250 kHz	63 s	21 s (3 x)
CISPR Band E 1 GHz to 18 GHz	Pk, 10 ms, 1 MHz SS: 400 kHz, TD: 250 kHz	448 s	34 s (13.2 x)
CISPR Band E 1 GHz to 18 GHz	Pk, 15 ms, 1 MHz SS: 400 kHz, TD: 250 kHz	663 s	40 s (16.6 x)
1 GHz to 26.5 GHz	Pk, 1 ms, 1 MHz SS: 400 kHz, TD: 250 kHz	94 s	35 s (2.7 x)
1 GHz to 26.5 GHz	Pk, 15 ms, 1 MHz SS: 400 kHz, TD: 250 kHz	995 s	66 s (15 x)
* FFT width for frequencies > 7 GHz: max. 10 MHz (use of YIG filter)			

THANK YOU FOR YOUR ATTENTION