

5G Private Network Seminar

CLEAN RF ENVIRONMENT INSIDE SMART FACTORY - INTERFERENCE HUNTING

Nellie Pang
Product Manager – Handheld Analyzers

ROHDE & SCHWARZ

Make ideas real



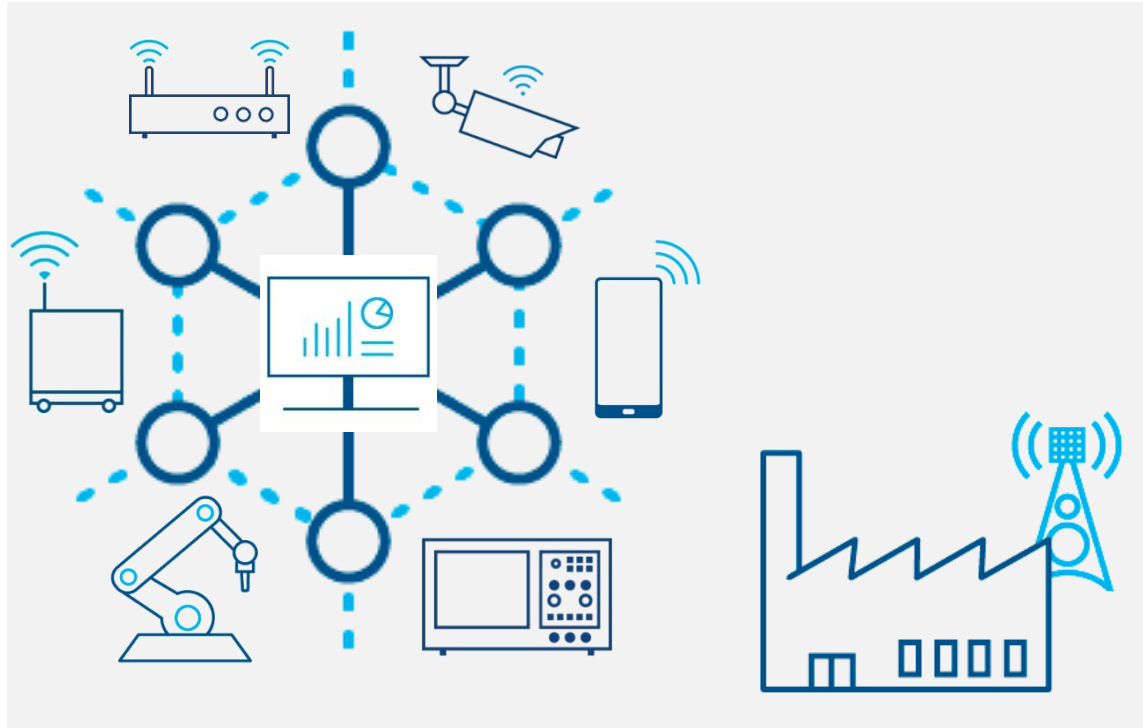
CONTENT

- ▶ RF communications in smart factory
- ▶ Why need clean RF environment inside the factory?
- ▶ Potential interference sources
- ▶ How to find the interference source?

RF COMMUNICATIONS IN SMART FACTORY INDUSTRY 4.0

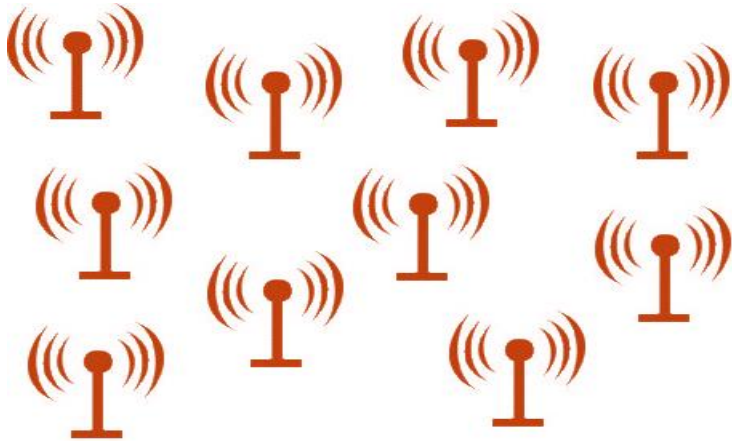
Multiple communication technologies are deployed in the factory

- NFC – RFID, Bluetooth
- IIOT, Zigbee, LoRa WAN
- WiFi
- LTE / 5G (cellular-IOT) [NB-IoT, eMTC, etc.]



WHY NEED CLEAN RF ENVIRONMENT INSIDE THE FACTORY?

- ▶ Internet of things → Interference of things
 - "dirty" transmitters will emit excessive out-of-band energy, some receivers will contain little or no filtering to reject out-of-band energy
 - many connected devices won't be designed well enough to withstand outside EMI
 - Reduce reliability if smart sensors are unable to transmit or receive due to interference

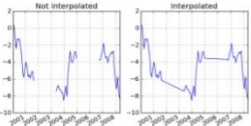
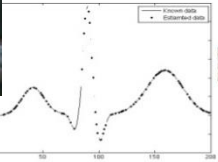
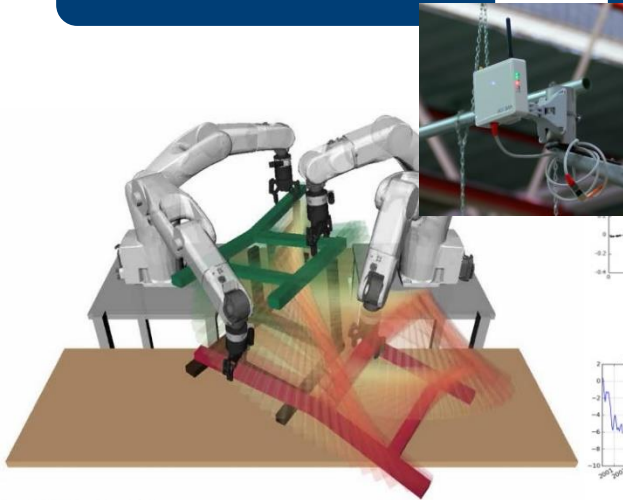


WHY NEED CLEAN RF ENVIRONMENT INSIDE THE FACTORY?

Misplacement

Collision

Data loss



	A	B	C	D	E	F	G	
1	Eliminate missing data from a sample							
2								
3	Poverty	White	Crime	Doctors	University	Income		
4	Alabama	15.7	71.0	448	218.2	22.0	42,466	
5	Alaska	6.4	70.6	661	218.5	27.3	66,460	
6	Arizona	14.7	86.5	641	209.7	25.1	50,958	
7	Arkansas	17.5	80.8	325	203.4	18.8	38,615	
8	California	14.8	76.6	525	268.7	29.6	61,021	
9	Colorado	8.1	85.7	348	259.7	35.6	54,993	
10	Connecticut	9.1	84.1	206	276.4	35.6	65,395	
11	Delaware	10.0	74.3	689	206.9	27.5	57,989	
12	Florida	13.2	79.8	723	247.9	25.8	47,778	
13	Georgia	14.7	65.4	493	217.4	27.5	50,861	
14	Hawaii	25.7	77.3	273	517.0	25.1	67,214	
15	Idaho	14.7	84.6	239	188.8	24.0	47,576	
16	Illinois	22.1	76.3	533	200.2	26.4	50,235	
17	Indiana	13.1	76.3	216.5	184.3	24.1	47,566	
18	Iowa	11.5	82.7	285	189.3	24.1	48,880	
19	Kansas	11.3	88.7	435	232.5	25.6	50,177	
20	Kentucky	17.3	89.9	295	232.3	15.7	41,518	
21	Louisiana	17.3	64.8	730	262.7	20.3	43,713	
22	Maine	12.3	86.4	138	278.4	25.4	46,581	
23								
24								

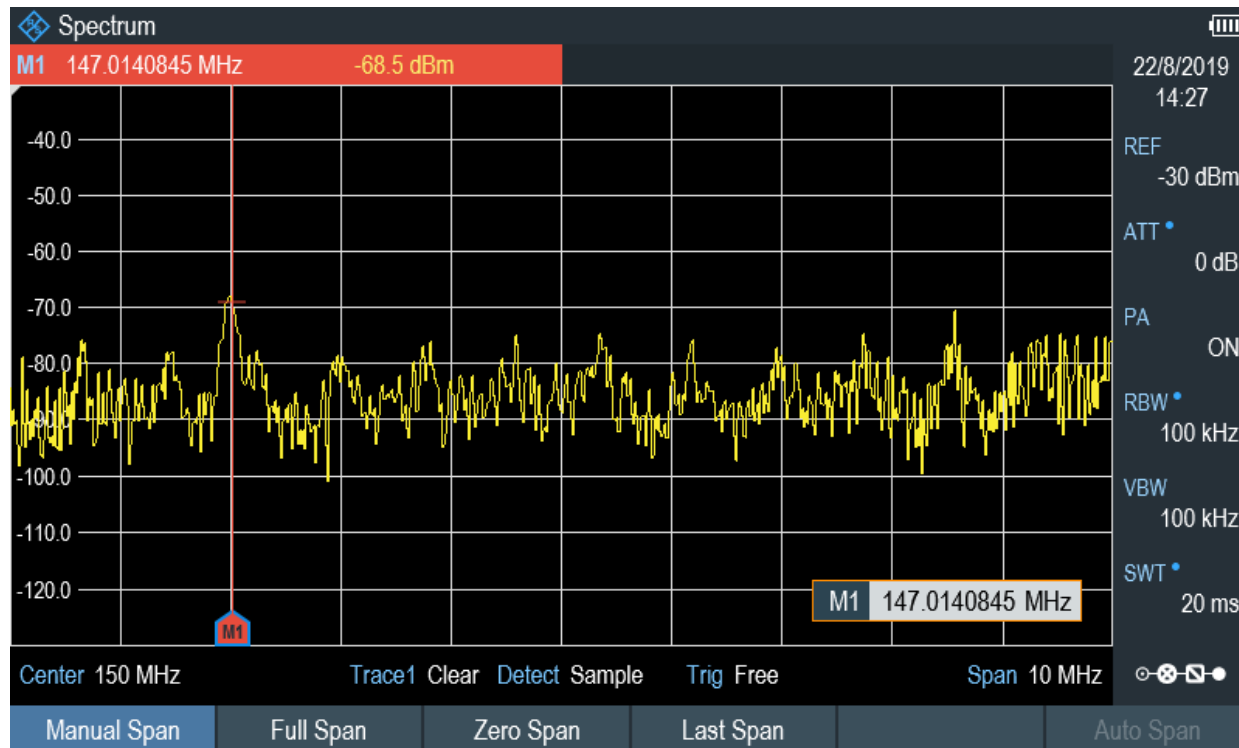
POTENTIAL INTERFERENCE SOURCES

► Anything is Possible!



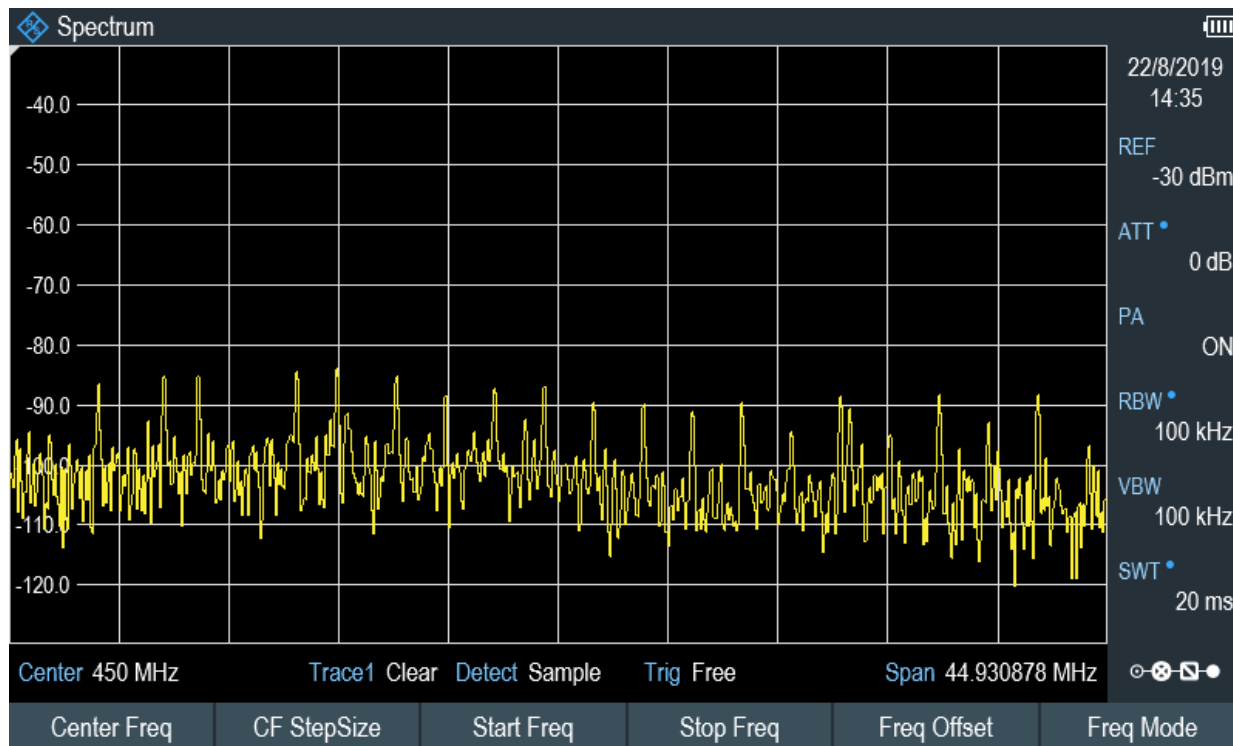
POTENTIAL INTERFERENCE SOURCES

► LED light noise



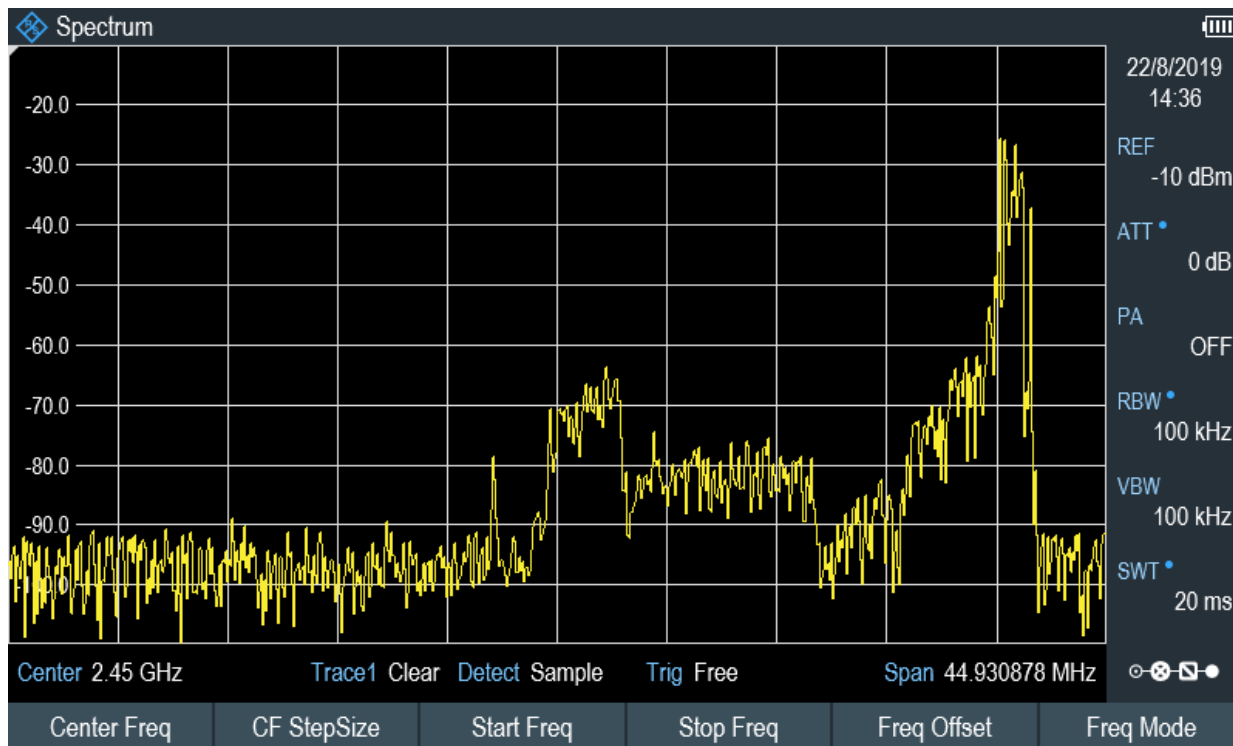
POTENTIAL INTERFERENCE SOURCES

- ▶ Harmonics from RFID access control system



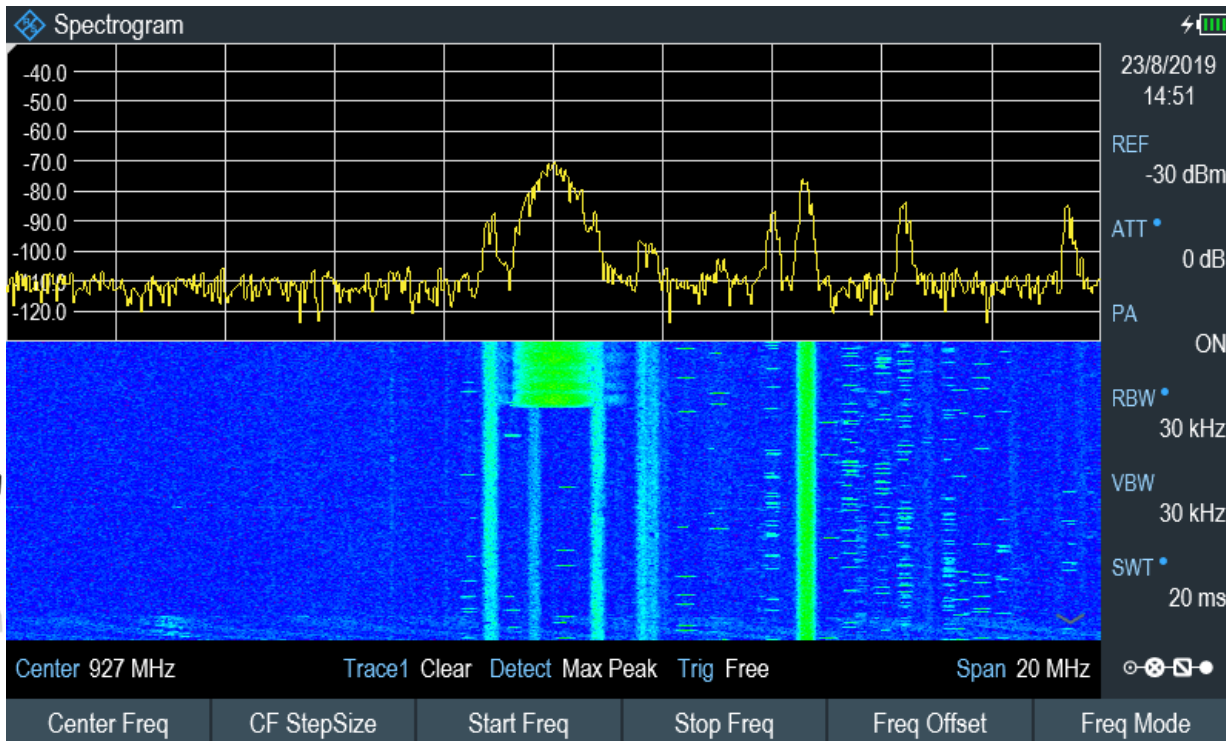
POTENTIAL INTERFERENCE SOURCES

► Microwave oven emission

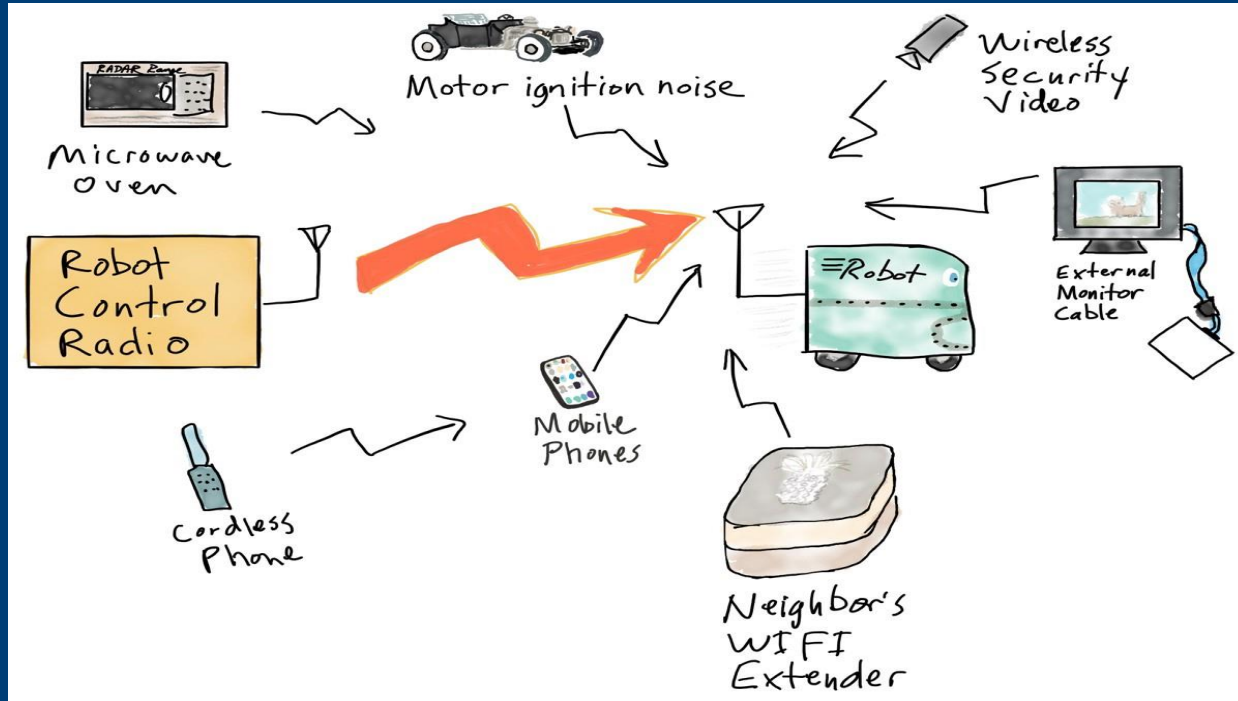


POTENTIAL INTERFERENCE SOURCES

► DECT Phone



POTENTIAL INTERFERENCE SOURCES



HOW TO FIND THE INTERFERENCE SOURCE?

INTERFERENCE HUNTING IN 1-2-3 STEPS

1. DETECT

The Effects of Interference

- Abnormality in frequency spectrum caused by interference
- Effects of interferer on parameters like RSSI, Signal strength, C/I, C/N => interference causes high RSSI / Noise floor (UL), low C/I (DL)

2. CHARACTERIZE

The Interferer

- Spectrogram : check for signal time pattern and periodicity
- Spectrum analyzer measurements (Channel power, OBW, ACLR, SEM)
- Max hold, save on event (can be applied to all measurements) to capture the interferer in action

3. LOCATE

The Interferer

- Triangulation used to locate the position of an interferer using directional antennas and handheld spectrum analyzers
- Outdoor/Indoor mapping and tone features to also help narrow down the interferer location

HOW TO FIND THE INTERFERENCE SOURCE? ROHDE & SCHWARZ SOLUTIONS

- ▶ Handheld Spectrum Analyzer with directional antenna

R&S® Spectrum Rider FPH + R&S® HA-Z900 Yagi Antenna



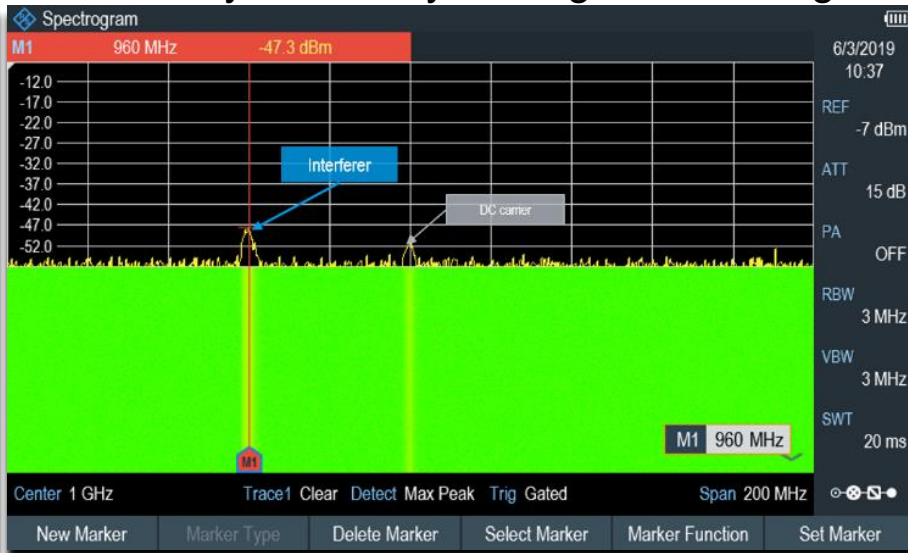
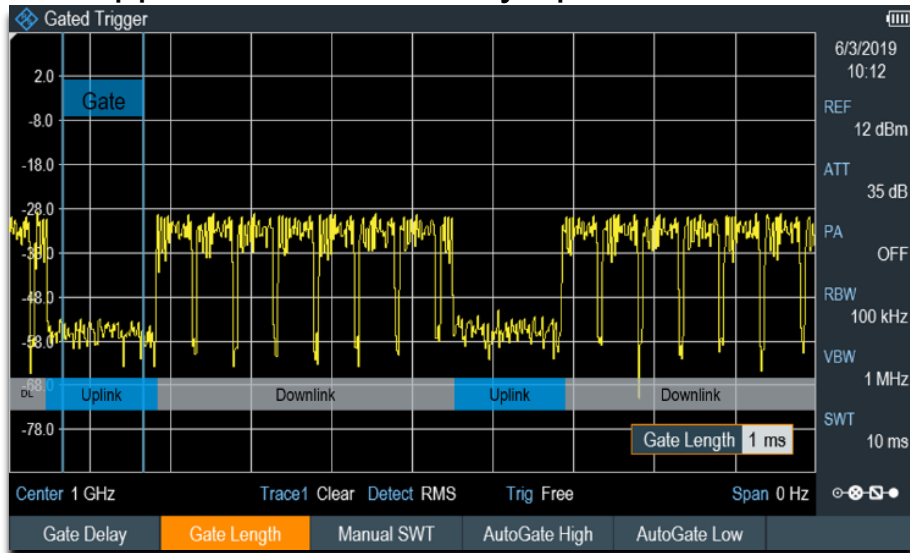
R&S® HE400 Directional Antenna



HOW TO FIND THE INTERFERENCE SOURCE?

ROHDE & SCHWARZ SOLUTIONS

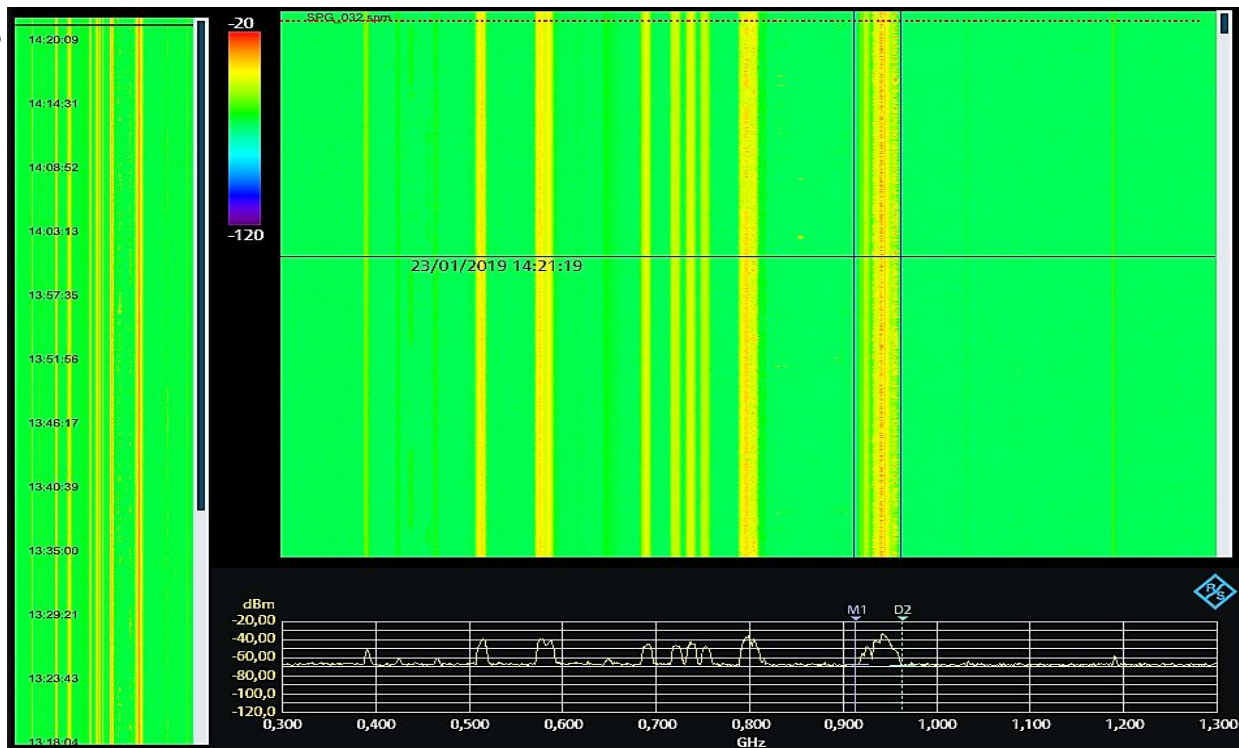
- ▶ Separating uplink from downlink with **gated trigger**
- ▶ Support in Spectrum, Channel Power and Spectrogram mode.
- ▶ Application : To identify uplink interferer which is normally “buried by” strong downlink signal.



HOW TO FIND THE INTERFERENCE SOURCE?

ROHDE & SCHWARZ SOLUTIONS

- ▶ Can record the RF activities for up to 999* hours using R&S®Spectrum Rider FPH (required R&S®FPH-K15)
- ▶ Post-analysis can be done using R&S®InstrumentView software (free)

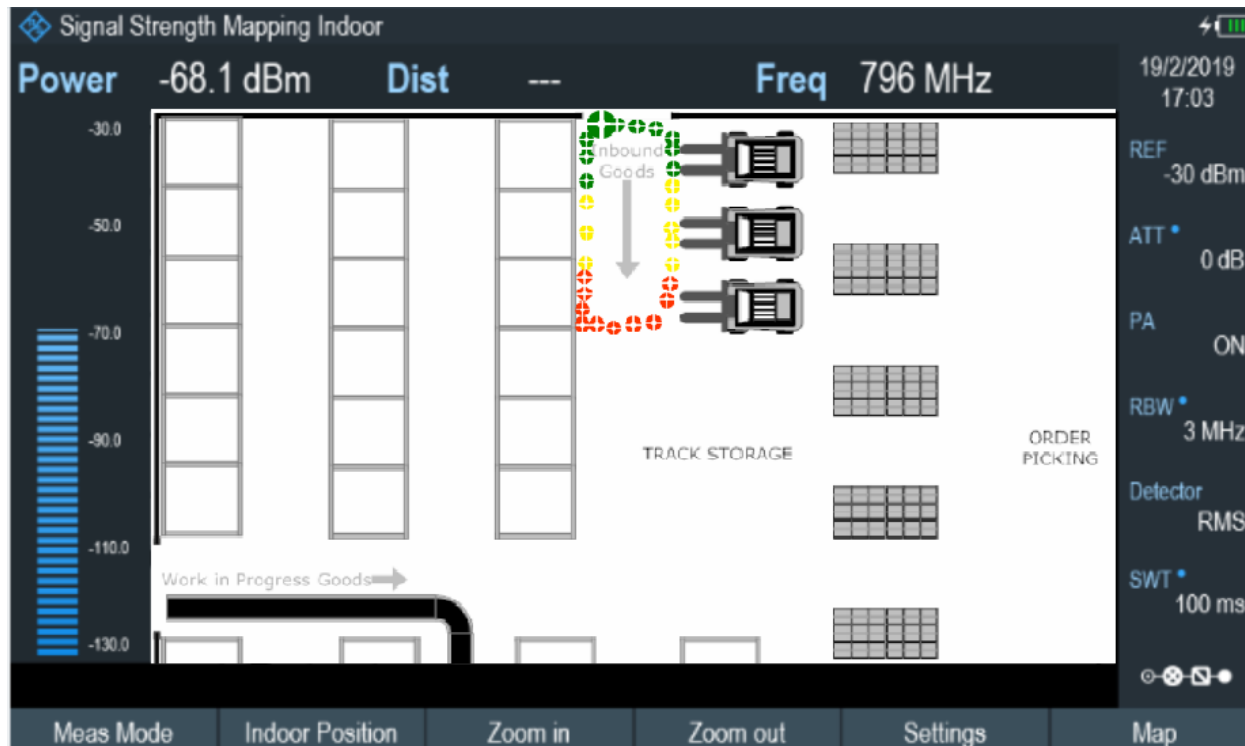


*Depend on recording interval setting

HOW TO FIND THE INTERFERENCE SOURCE?

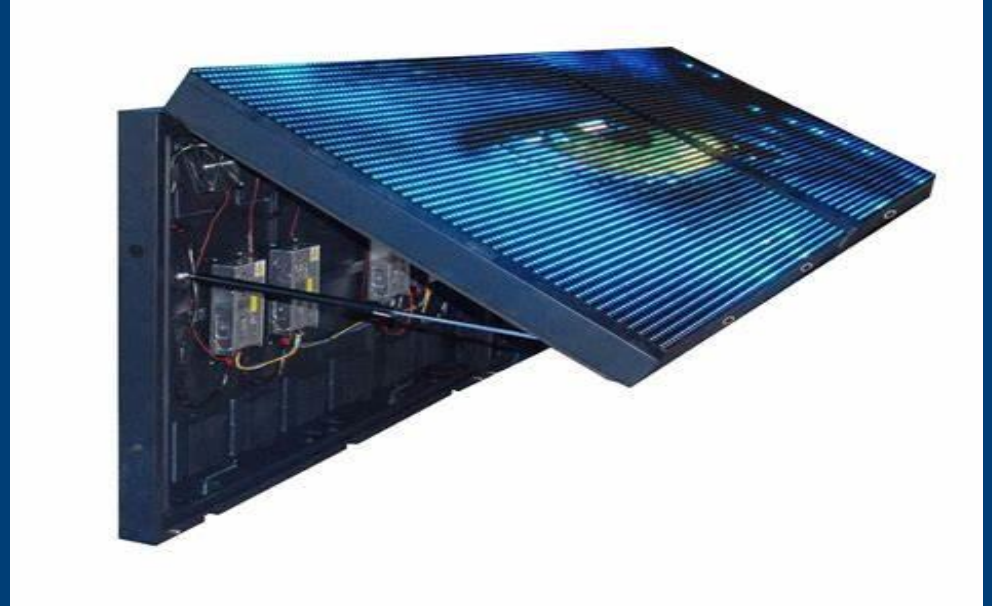
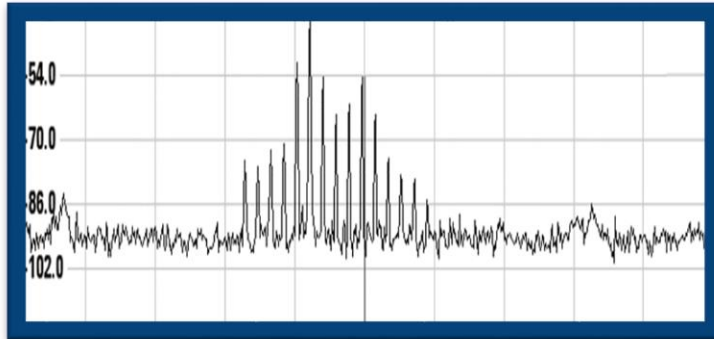
ROHDE & SCHWARZ SOLUTIONS

- ▶ Download factory/production floor plan into R&S® Spectrum Rider FPH (required R&S®FPH-K16)
- ▶ The green dots gave an indication of where the potential interferer located



HOW TO FIND THE INTERFERENCE SOURCE? ROHDE & SCHWARZ SOLUTIONS

- ▶ In this example, faulty components in the digital advertising board near the entrance is the interferer to IOT sensor at a assembly line



THE R&S® SPECTRUM RIDER FPH APPLICATION CARDS

Interference hunting in smart factories

Smart factories rely heavily on wireless communications technology to automate production processes and increase productivity. Any source of RF interference can disrupt the production process or delay the output.



Your task
RF interference signals are invisible to the naked eye. Their source can be generated intentionally or unintentionally, be modulated or unmodulated, appear at any time and be located anywhere on the production floor.

Determining the location of the interferer can be challenging and time consuming. If the source of interference is not identified, however, the smart factory loses its business agility.

Rugged portable spectrum analyzers can be used anywhere in the factory to display all RF signals. Recording features allow users to perform post-processing and analyze occurrence patterns to determine the similar source.

Rohde & Schwarz solution
R&S®Spectrum Rider FPH is a handheld spectrum analyzer with frequency ranges from 5 kHz up to 31 GHz. Depending on the model, the analyzer can operate for up to eight hours on a single charge.

It has a small form factor and ergonomic design. It weighs

► Interference hunting in smart factories

Fast 5G waveform verification in the field

Verifying 5G transmitted signals in the field with the R&S®Spectrum Rider FPH handheld spectrum analyzer



Your task

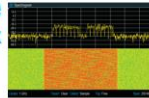
5G, the next generation wireless standard, promises to deliver an enhanced user experience by offering new applications and services through extremely high speeds and significantly improved latency. The excitement about the rollout of 5G networks is drumming up. Many operators have already

During trials and providers will critical depend

5G download
Based on 5G NR and FDD, 5G covers 24.25 GHz. 5G are mainly synchronous and use subcarriers four OFDM symbols

An 5G occurs over 5G, meaning for different frequencies. 5G where PSS, SSB occupy different

5G NR – interference hunting in the uplink of TDD networks



Spectrum and occupancy measurement of a 5G NR signal. 5G NR (red) and 4G LTE (blue) are visible.

Even when the operations center issues an alarm about the presence of an interferer, for the technicians in the field, it is impossible to identify this in conventional spectrum measurements, not to mention locating the interferer.

Rohde & Schwarz solution

Handheld solutions from Rohde & Schwarz, such as the R&S®Spectrum Rider FPH handheld spectrum analyzer, support a gated trigger, enabling users to separate uplink and downlink signals in the time domain.

Clear separation of uplink and downlink slots

In time domain measurements using user models, uplink and downlink slots can be visualized. In this mode, the user can configure a window or gate with a specific length. For the application described here, the user configures a gate that falls into an uplink slot.

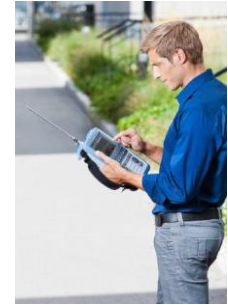
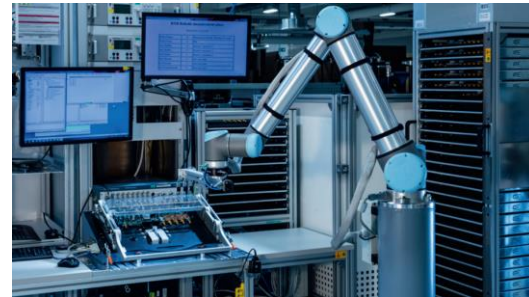


The configuration on an uplink slot will trigger the measurement.

In TDD networks, the downlink and the uplink use the same frequency, meaning that downlink signals mask the uplink and any other present signals.

► Fast 5G waveform verification in the field

► 5G NR interference hunting in the uplink of TDD networks



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Together, we shape the future of communications ...



R&S®Spectrum Rider FPH with R&S®HE400 antenna

...to enable a safer and connected world

