ITU-R Workshop
Interference to DAB Reception

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Agenda

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2.	Measurement Campaign
3.	Measurement Procedure
4.	Identified Interfering Devices
5.	Measured MMN interference levels in the DAB+ band acc. CISPR
6.	Measured MMN interference levels in the DAB+ band to DAB ref. Rx
7.	Conclusion - Allowance needed in the DAB+ band
8.	Swiss Mitigation «ad hoc»

Background and Motivation

Background

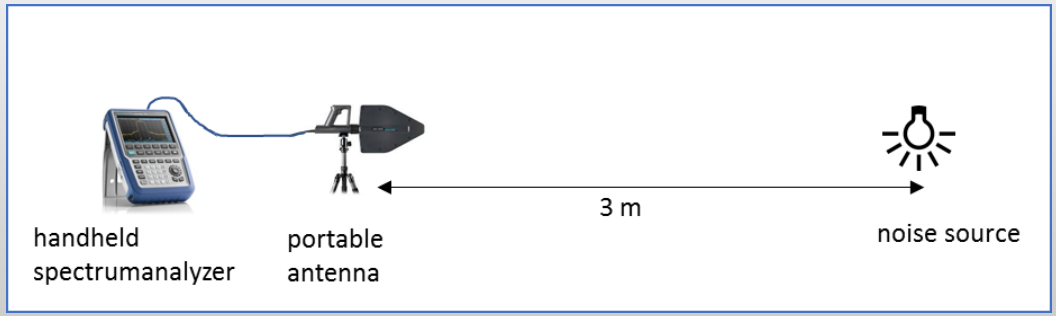
- In Switzerland FM-switch-off is planned until 2024
- Digital radio (DAB+ and internet streaming) to remain the main services
- SRG to provide a coverage of 99% PI95 indoor reception for DAB+
- DAB+ reception shall equal FM reception as best as possible, from a user perspective and at the given place of the receiver
- Interference, man-made noise and building penetration loss are the main challenges for DAB+ indoor reception

Motivation for the Measurement Campaign 2016/17

- Swiss DigiMig technical working group decided 2016 to assess man-made-noise for DAB+ indoor reception
- EMC experts from Swiss Ofcom proposed to perform indoor measurements and to identify real interferers rather than to perform measurements in the lab

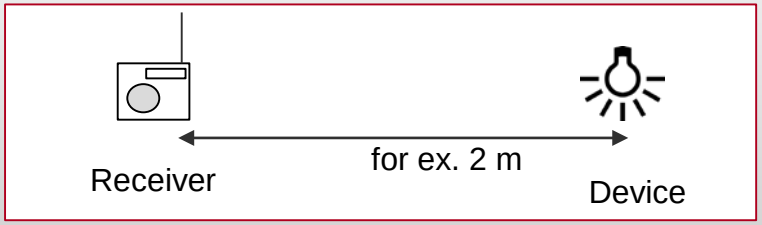
Measurement Procedure

- The target was to find the most interfering device and its influence on the FM and DAB+ receiver.
- Each measurement was performed indoor as near as possible to be according CISPR standard (3m, 120kHz, quasi-peak detector) even when not in a lab through the VHF II and VHF III band.
- The whole VHF III band was measured and the worst frequency-block was detected. The worst interfered frequency-block was assumed to be relevant for the whole VHF II and VHF III band even when not occupied by a DAB+ or FM service.
- Measurements have been performed in winter time during the day



Measurement Campaign Measurement Procedure

- The proximity of the interferer to the DAB+ receiver was considered as well. This proximity was assessed by a recalculation rather than through another measurement to keep the time of measurement short.
- After having identified and measured the most interfering device, this device was switched-off and the process was restarted for the next most interfering device. So, to say when no further interfering device could be identified the general noise floor of the room was reached.
- All identified devices are effectively compliant with the relevant CISPR standard.
- Most interference was in the DAB band and at close proximities (0.5m) which are typical of use.



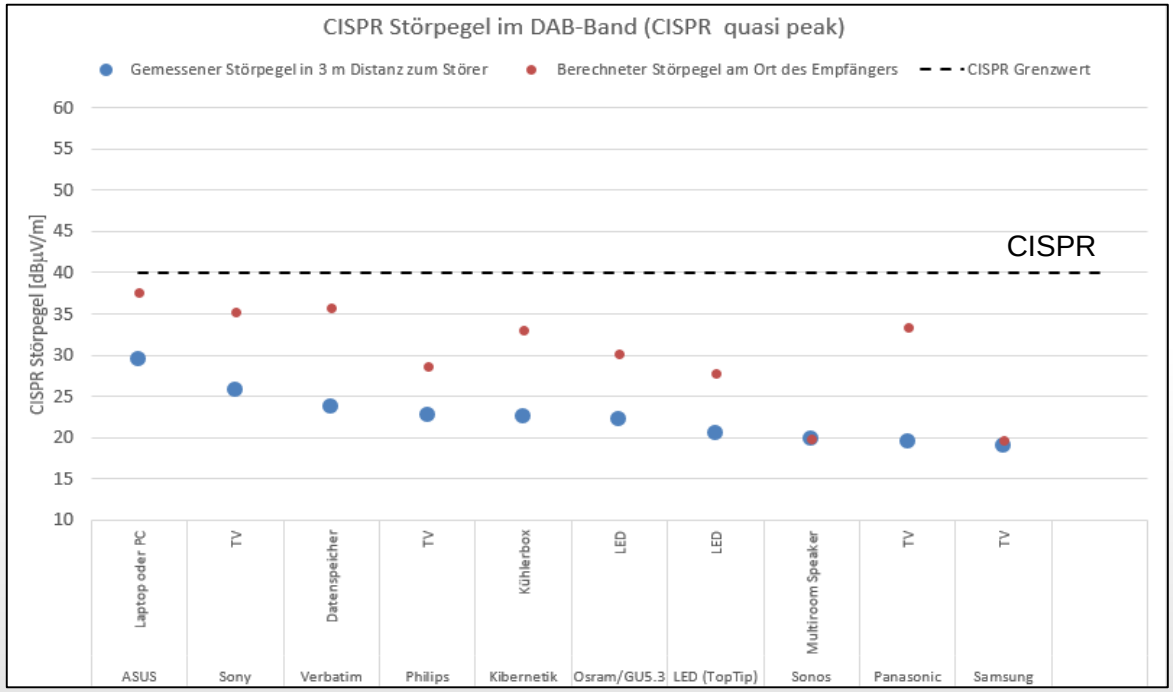
Identified Interfering Devices

Eleven interferers have been identified until 14.02.2017

- 3x LED
- 4x TV
- 1x Multiroom Speaker
- 1x Harddisk
- 1x Personal Computer
- 1x Cooling Box

- The influence of LED was less pronounced than assumed. The most interfering categories are screens.

Results
Interfering fieldstrengths measured according CISPR



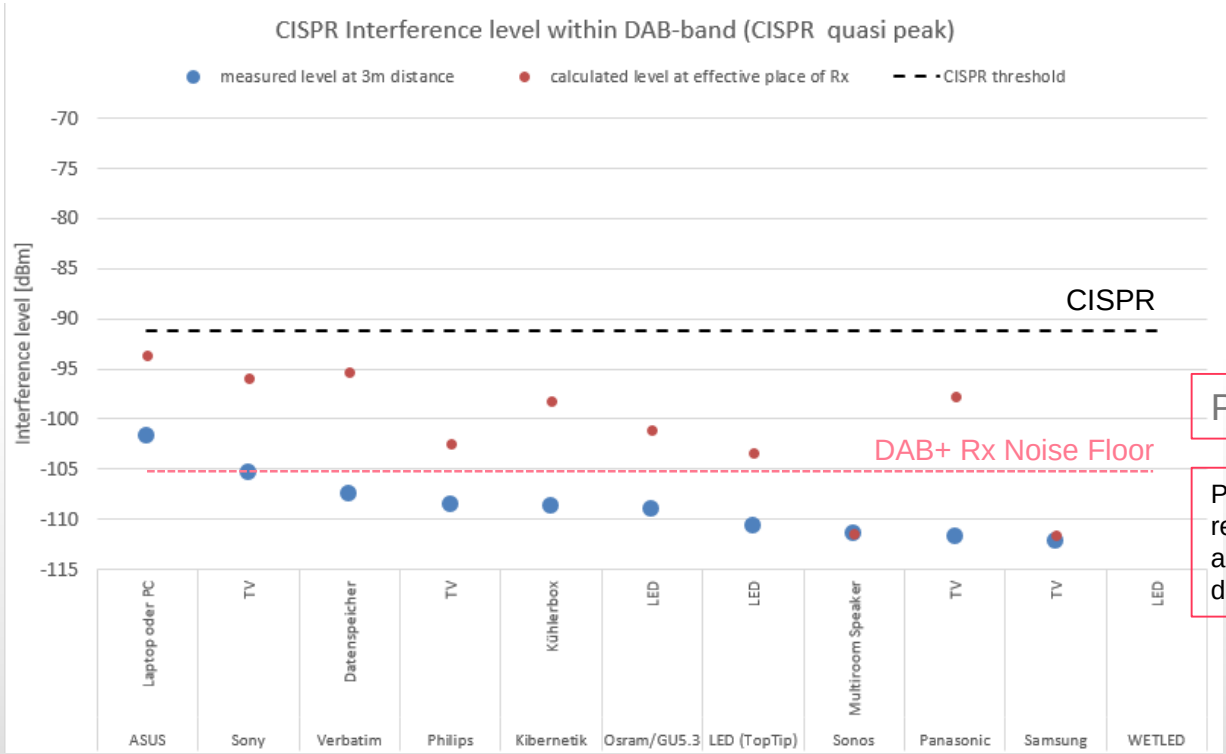
Dotted line – CISPR limit (3m, 120kHz, quasi-peak detector)
Blue dots- interference level measured at 3m
Red dots- interference level at actual installed distance

Results
Interfering fieldstrengths measured according CISPR

All devices below CISPR specification

…so where is the problem?

Results
Interfering fieldstrengths received by the EBU DAB+ reference receiver

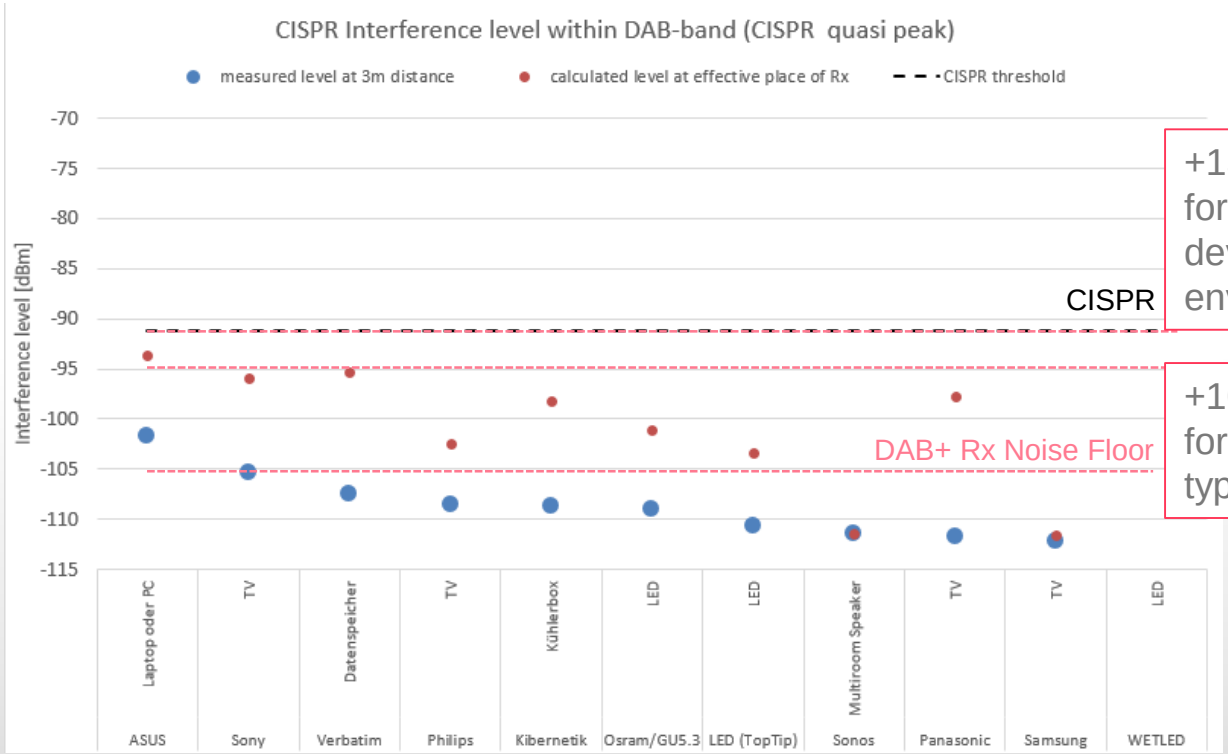


Proximity !

Please refer to annex for recalculation of bandwidth and quasipeak detection for dab+ reception

Dotted line – CISPR limit received by the EBU DAB reference receiver
Blue dots - interference level received by the EBU DAB reference receiver at 3m (G_{ANT} -8dBi)
Red dots - interference level received at actual installed distance (G_{ANT} -8dBi)
Red line – typical noise floor of the DAB+ receiver (channel bandwidth 1’534kHz)

Results
Interfering fieldstrengths received by the EBU DAB+ reference receiver



+13dB allowance needed for CSIPR compliant devices in typical environments

+10dB allowance needed for these devices in typical environments

Dotted line – CISPR limit received by the EBU DAB reference receiver
Blue dots - interference level received by the EBU DAB reference receiver at 3m (G_{ANT} -8dBi)
Red dots - interference level received at actual installed distance (G_{ANT} -8dBi)
Red line – typical noise floor of the DAB+ receiver (channel bandwidth 1’534kHz)

Swiss Decision for «ad hoc» Mitigation

Why is mitigation needed?

- To allow FM switch-off until 2024

Mitigation means revised DAB+ network planning

- Higher minimum fieldstrengths
- Higher transmitting power

However …

- Critical for international coordination (-> GE06 minimum usable fieldstrength to be lifted)
- Additional costs for complex antenna systems and higher transmit power
- Higher demand for power supply and cooling, less energy efficient
- Not affordable for many European countries and for commercial radios

Annex

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Limits

The following formula was used to convert the CISPR limit value:

Für FM: $40\frac{dB\mu V}{m} - 11.6\frac{dB}{m} - 107 = -78.6\ dBm$ | Antennengewinn: -1.4 dBi, Frequenz: 100 MHz

Für DAB: $40\frac{dB\mu V}{m} - 24.2\frac{dB}{m} - 107 = -91.2\ dBm$ | Antennengewinn: -8 dBi, Frequenz: 200 MHz

Noise Power of CISPR interferer received by the FM reference receiver

In CISPR 32 specification 2015 (EN 55032:2015) for Class B devices in the frequency band 30-230 MHz and for a distance of **3 meters** a threshold value of **40 dBµV/m** is allowed for **quasi peak** detection and a measurement bandwidth of **120kHz** (see page 27, OATS/SAC). For the calculation of the received noise power the following formula is applied, respecting frequency and antenna gain.

FM: $40\frac{dB\mu V}{m} - 11.6\frac{dB}{m} - 107dB = -78.6\ dBm$

CISPR limit | antenna factor | calculation of power | received noise power

antenna gain: -1.4 dBi
frequency: 100 MHz
impedance: 50 Ohm

The bandwidth of 120kHz and the quasi peak detector have been introduced for compatibility with FM reception. Both are applicable for FM without any recalculation.

Noise Power of CISPR interferer received by the DAB+ reference receiver

In CISPR 32 specification 2015 (EN 55032:2015) for Class B devices in the frequency band 30-230 MHz and for a distance of **3 meters** a threshold value of **40 dBµV/m** is required for **quasi peak** detection and a measurement bandwidth of **120kHz** (see page 27, OATS/SAC). For the calculation of the received noise power the following formula is applicable and respecting the antenna gain.

For DAB: $40\frac{dB\mu V}{m} - 24.2\frac{dB}{m} - 107dB = -91.2\ dBm$

CISPR limit | antenna factor | calculation of power | received CISPR noise power 120kHz quasi peak

antenna gain: -8 dBi
frequency: 200 MHz
impedance: 50 Ohm

The quasi peak detector with a bandwidth of 120kHz was introduced for EMC compatibility with FM reception. For DAB+ reception both values have to be recalculated (next slides)

Noise Power of CISPR interferer received by the DAB+ reference receiver

In CISPR 32 specification 2015 (EN 55032:2015) for Class B devices in the frequency band 30-230 MHz and for a distance of **3 meters** a threshold value of **40 dBµV/m** is required for **quasi peak** detection and a measurement bandwidth of **120kHz** (see page 27, OATS/SAC). For the calculation of the received noise power the following formula is applicable and respecting the antenna gain.

For DAB: $40\,\frac{dB\mu V}{m} - 24.2\,\frac{dB}{m} - 107dB = -91.2\,dBm$

antenna gain: -8 dBi
frequency: 200 MHz
impedance: 50 Ohm

CISPR limit	antenna factor	calculation of power	received CISPR noise power 120kHz quasi peak

The quasi peak detector with a bandwidth of 120kHz was introduced for EMC compatibility with FM reception. For DAB+ reception both values have to be recalculated (next slides)

Calculation of noise power of CISPR interferer in the FM and DAB+ reception Channel

Noise Power Ratio

- For a steady broadband interferer with an equal power flux over the channel
- $noise\ power\ ratio\ npr\ = 10 * log(channelbandwith[kHz]/CISPR[kHz])$

Noise Power Ratio for the FM channel

- $\mathrm{npr}_{\mathrm{FM}} = 10 * log\left(\frac{120kHz}{120kHz}\right) = 0dBHz$

Noise Power Ratio for the DAB+ channel

- $\mathrm{npr}_{\mathrm{DAB}} = 10 * log\left(\frac{1'534kHz}{120kHz}\right) \sim 11dBHz$

Resulting Noise Power of CISPR interferer received by the DAB+ reference receiver

For the impact of CISPR noise power on DAB+ reception the bandwidth and detector have to be recalculated

For DAB: $-91.2\ dBm + 11dBHz\ - 11\ dB = -91.2dBm$

- $-91.2\ dBm$: received CISPR noise power
- $11dBHz$: recalculation for bandwidth
- $-11\ dB$: recalculation for detector
- $-91.2dBm$: effective received average noise power In DAB channel

identical values to keep calculation simple (slide 11)

(DAB receiver noise floor: -105dBm)

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Antenna Factor for the FM and DAB+ Reference Receiver

Calculation of the Antenna Factor [ak]

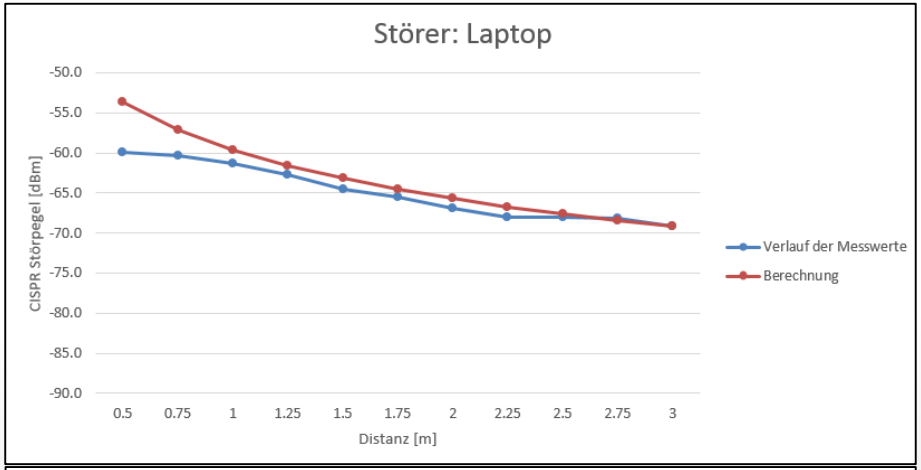
- $\mathbf{ak} = -29.8 + 20 * log(MHz) - gi$

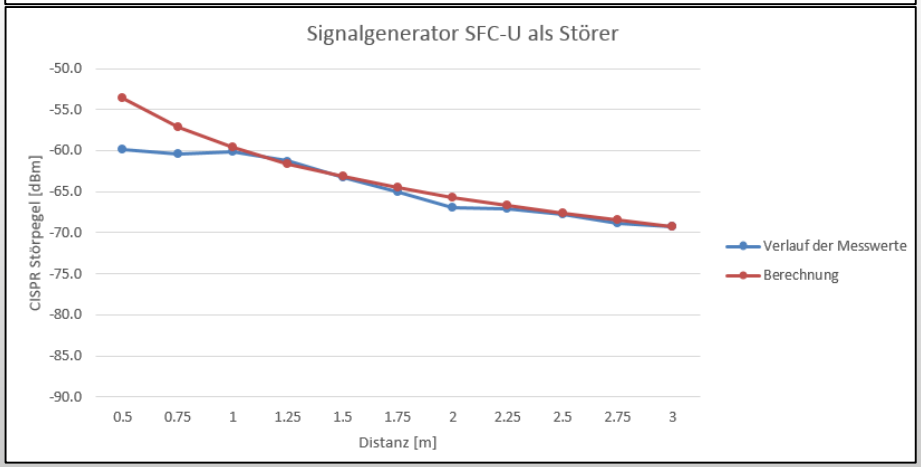
Antenna factor for DAB+ receiver

- $\mathbf{ak} = -29.8 + 20 * log(200\ MHz) - (-8dBi) = 24.2 \frac{dB}{m}$

Annex 1

Calculation confirmed with :





Die Messwerte und die theoretischen Berechnungen zeigen eine plausible Übereinstimmung bei beiden gemessenen Störquellen zwischen 1- 3m.

Unterhalb von 1m driften die Linien auseinander. Dort ist eine Messung gemäss Messmethode nicht mehr sinnvoll (Stichwort Nahfeld/Fernfeld).

Prüfung und Freigabe

Version	Datum	Stelle / Name	Aufgabe	Visum
V100	18.10.2018	Roberto Moro	Workshop ITU	rmo