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Measuring arrangement for the power lock feature

Elaboration of the measuring arrangement

Summary

This document describes the elaboration of the measuring arrangement for the power lock feature, which is required for validation.

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1 Introduction

1.1 Initial situation

The power lock feature (Automatische Leistungsbegrenzung) is part of the Nachtrag zur Vollzugsempfehlung [1]. The activation of this feature is a prerequisite for operating the new adaptive antennas while a correction factor K_{AA} is applied.

A team of experts exists to work out the measurement arrangement, taking into account the various aspects such as the specifications from the Nachtrag zur Vollzugsempfehlung [1], the metrological principles and future requirements for certification.

Neutral experts come from:

- 1) OFCOM (management, measurement technology)
- 2) METAS (metrology, knowledge certification)
- 3) FOEN (conformity with the Nachtrag zur Vollzugsempfehlung [1])

Experts from the operators and manufacturers are to be included as technical experts. They come from:

- 4) Salt
- 5) Sunrise
- 6) Swisscom
- 7) SBB: Since they will not be using adaptive antennas in the foreseeable future, they are abstaining from participating as experts.

1.2 Definitions

For the scope of this document we use the following definitions:

<p>Maximum effective radiated power (ERP) (Symbol: $ERP_{max,n}$)</p> <p><i>Maximale Sendeleistung ERP (gemäss [1])</i></p>	<p>Corresponds to the total input power of the antenna multiplied with the gain of the adaptive antenna</p>
<p>K_{AA}</p>	<p>Correction factor according to [1]</p>
<p>Permitted ERP (Symbol: ERP_n)</p> <p><i>Bewilligte Sendeleistung ERP (Begriff gemäss [1] und [2])</i></p>	<p>Maximum permitted ERP of the antenna according to the Standortdatenblatt.</p> <p>According to [1]: $ERP_n = K_{AA} \times ERP_{max,n}$</p>
<p>Actual ERP</p> <p><i>Aktuelle ERP Sendeleistung (gemäss [3])</i></p>	<p>Actual ERP of the antenna as configured by the operator. This information is available in the Betriebsdaten of the NIS-DB. The actual ERP of the antenna must (legally) be smaller than the Permitted ERP.</p>
<p>Total ERP (Symbol: $ERP_{total,n}$)</p> <p><i>Abgestrahlte Gesamtleistung (gemäss [1])</i></p>	<p>This value corresponds to the dynamic ERP of the antenna as provided by the log-file of the base station multiplied with the gain of the antenna. It is an instantaneous value changing typically in milliseconds-intervals.</p> <p>The gain of the antenna is understood as the worst case gain used for the calculation of the field strength in the reference operating mode.</p> <p>This value can be as high as the Maximum ERP for a short period of time and its average over 6 minutes must never be higher than the Permitted ERP.</p>

<p>Total ERP averaged over 6 minutes (Symbol: $ERP_{total,avg,n}$)</p> <p><i>Über einen Zeitraum von 6 Minuten gemittelte Sendeleistung (gemäss [1])</i></p>	<p>The Total ERP averaged over 6 minutes must always be smaller than the Permitted ERP. Due to the fact that at the measurement time the Actual ERP might be smaller than the Permitted ERP, the Total ERP averaged over 6 minutes must be smaller or equal than the Actual ERP.</p>
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1.3 References

- [1] Adaptive Antennen. Nachtrag vom 23. Februar 2021 zur Vollzugsempfehlung zur Verordnung über den Schutz vor nichtionisierender Strahlung (NISV) für Mobilfunk- und WLL-Basisstationen, BUWAL 2002.
- [2] Verordnung über den Schutz vor nichtionisierender Strahlung (NISV) vom 23. Dezember 1999 (Stand am 1. Juni 2019).
- [3] Nachtrag Messempfehlung; Mobilfunk-Basisstationen (GSM); Bundesamt für Umwelt, Wald und Landschaft BUWAL; 2003.

2 The specifications of the Nachtrag zur Vollzugsempfehlung [1]

The addendum to the Nachtrag zur Vollzugsempfehlung [1] requires the following:

3.3.4 Automatische Leistungsbegrenzung adaptiver Antennen

Die automatische Leistungsbegrenzung detektiert dauernd die abgestrahlte Gesamtleistung einer adaptiven Antenne. Wenn kurzzeitige Leistungsspitzen über der im Standortdatenblatt deklarierten Sendeleistung ERPn auftreten, wird die Leistung soweit gedrosselt (und damit verbunden die zur Verfügung gestellte Kapazität), dass die über einen Zeitraum von 6 Minuten gemittelte Sendeleistung die deklarierte Sendeleistung nicht überschreitet.

Das Funktionieren der automatischen Leistungsbegrenzung wird im Qualitätssicherungssystem sichergestellt. Die automatische Leistungsbegrenzung muss wie das Qualitätssicherungssystem von einer unabhängigen, externen Prüfstelle periodisch auditiert werden. Eine Akkreditierung dieser Prüfstelle für die Durchführung von Audits ist erwünscht. Die Auditberichte sind den zuständigen Behörden vorzulegen.

Ausfälle der automatischen Leistungsbegrenzung müssen rapportiert werden; ebenso Überschreitungen des 6-Minutenmittelwertes der Sendeleistung über die deklarierte Sendeleistung ERPn hinaus.

Die Funktionsweise und Software-Lösung der automatischen Leistungsbegrenzung müssen transparent und von der Behörde überprüfbar sein.

Die Fehlermeldungen aus den Qualitätssicherungssystemen werden wie bis anhin der Behörde gemeldet.

Thus, the following must be recorded during the control measurement of the automatic power lock:

- 1) The Actual ERP of the adaptive antenna;
- 2) The Total ERP;
- 3) The Total ERP averaged over 6 minutes, this value is actualized for every new "Total ERP" value (same sampling intervals);
- 4) The specification of the software solution used (version).

For verifying the functionality of the power lock feature, operating situations which provokes a power reduction must be specifically created using a load simulator under normal configuration of the base station.

Furthermore, the correct functioning of the power lock feature must be evident in the QSS and failures of the feature as well as exceedances of the limit value of the Total ERP averaged over 6 minutes must be listed in the report.

As long as the Total ERP averaged over 6 minutes is continuously updated and is below the limit value, it can be assumed that the power lock feature is working correctly. If the Total ERP averaged over 6 minutes is no longer updated (failure of the power lock feature) or its limit value is exceeded (malfunction of the power lock feature), an error message must appear in the QSS report.

In a later phase, periodic audits must be carried out by an accredited body and the audit reports are sent to the FOEN.

3 The principle of the measuring arrangement

The measuring arrangement will be structured as follows.

- 1) A load simulator shall be used to generate a data download function over several 6 min. cycles, putting the antenna into power lock mode. The load simulator shall be adjustable by the testing personal on site. The load simulator records the data rate during the data download function.

Requirements:

- Data rate: large enough to put the system into power lock mode (~1Gbit/s).
- Resolution of data rate in log file: 10Mbit/s (1% of 1Gbit/s)
- Timestamp in log file: one entry of data rate per second
- Technology/frequency band lock: Uncontrolled technology and frequency band changes falsify the field strength and transmission power measurement, as the data streams are transmitted via other frequency bands and are thus not detected by the measurements. If necessary, the other services (2G, 3G, 4G) and frequency bands must be temporarily deactivated for this purpose prior to measurement. So a careful selection of the location might be needed and use of a dedicated "power lock feature control app" might be needed in order to carry out the validation.
- Header in the log file: Load simulator ID, terminal ID, GPS position if possible, date and other information for a unique identification.
- Format of the log file: .csv file

Note: If the antenna cannot be put into power lock mode due to operational settings, it will not be possible to evaluate the power lock feature (since it is not activated) and therefore no K_{AA} can be permitted.

- 2) A frequency-selective measurement is carried out using an external measuring device for the purpose of detecting and confirming the download.

Requirements:

- Field strength: in V/m
- Resolution of field strength: +/- 0.01V/m
- Timestamp: $\leq 1/s$
- RBW: $\geq 30MHz$
- VBW: between 10kHz and 30kHz
- GPS: on
- MR: 0 ... 5.0 V/m
- AVG: 0.48s
- Noise Suppression: off
- Format of the log file: .csv file

An equivalent channel power measurement is also possible.

- 3) During the data download function, the base station generates a log file of the Total Transmit Power and the Total Transmit Power averaged over 6 minutes, both with an associated graph. This allows to verify the operation of the power lock feature.

Requirements:

- Recording of the Total Transmit Power in [W]. Resolution $\leq 1\%$ of the maximum value. If the Total Transmit Power is not measured directly, the calculation path is required per measured value.
- The Total Transmit Power averaged over 6 minutes in [W]. Resolution $\leq 1\%$ of the maximum value. If the Total Transmit Power averaged over 6 minutes is not measured directly, the calculation path is required per measured value.
- System-specific parameters used for the measurements must be explained.
- Timestamp: $\leq 1/s$.
- Factor K_{AA} with a resolution of one decimal (can also be provided in a separate file with a timestamp).
- Header in the log file: Base station ID, cell ID, antenna ID, date, hardware module ID (antenna types), software module ID, the Actual Transmit Power corresponding to the Actual ERP, Gain

according to the used enveloping antenna diagram and other information for a unique identification.

- Format of the log file: .csv file.

The comparison of the three recordings of the data rate (load simulator), field strength (frequency-selective measurement) and transmit power (base station) is done by using the time stamps and it documents the functionality of the power lock feature.

This measurement can take place with the presence of commercial customers, if the necessary settings allow this. Any associated additional data traffic within the cell will affect the timing of the power lock feature, but not the power lock feature itself. This additional data volume is shown in the log file of the base station.

4 Control measurement, evaluation of results and report

Once this measurement arrangement has been defined, OFCOM and the neutral expert group will carry out a corresponding measurement to validate the power lock feature on site (site selection by experts and operators). During this measurement, the technical experts of the operators and manufacturers will be present. OFCOM will write a summary assessment of the measurement in a report and publish it.

A confirming report from OFCOM provides sufficient evidence that the power lock feature is working correctly and permits its use until the proof of the function of the power lock feature is obtained.

5 Proof of the function of the power lock feature (outside of this project)

The Nachtrag zur Vollzugsempfehlung [1] specifies:

Das Funktionieren der automatischen Leistungsbegrenzung wird im Qualitätssicherungssystem sichergestellt. Die automatische Leistungsbegrenzung muss wie das Qualitätssicherungssystem von einer unabhängigen, externen Prüfstelle periodisch auditiert werden. Eine Akkreditierung dieser Prüfstelle für die Durchführung von Audits ist erwünscht. Die Auditberichte sind den zuständigen Behörden vorzulegen.

This proof of the function of the power lock feature is done outside of this project.