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Technical Report

**PowerLine Telecommunications (PLT);
Report from Plugtests™ 2007 on
coexistence between PLT and
short wave radio broadcast;
Test cases and results**

Reference
DTR/PLT-00024

Keywords
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Foreword

This Technical Report (TR) has been produced by ETSI Technical Committee Powerline Telecommunications (PLT) (STF 332).

The present document is the report from a Plugtests™ event in 2007 on coexistence between PLT and short wave radio broadcast, and is structured in two parts as identified below:

Part 1: "Test cases";

Part 2: "Results".

Introduction

In order to verify draft TS 102 578 of Work Item 21 (WI21) [5] which deals with coexistence between PLT and short wave radio services including DRM (Digital Radio Mondiale) a Plugtests™ event was requested by many ETSI members.

During the coexistence Plugtests™ event different PLT modems from different vendors implementing the draft TS related to TS 102 578 will be evaluated. A Special Task Force (STF) 332 has been established to perform the Plugtests™ event.

The STF will validate the concept of 'Smart Notching' which is specified in TS 102 578 [5]. Measurements demonstrating the ingress of SW radio broadcasts to the electrical installation in a building will be made. Further, using real implementations of PLT modems the practicality of the draft TS will be verified. Verification of levels and thresholds will be carried out along with the performance of the coexistence implementations. Recommendations for possible improvement to the current draft TS 102 578 of Work Item 21(WI21) will be made as appropriate.

The tasks of the STF are in detail:

- validate or revise the thresholds and resolution bandwidths needed to detect ingress from a receivable radio broadcast;
- verify test bench levels and thresholds;
- provide feedback from implementations to the ongoing work in TS 102 578 [5] as well as to PLT modem implementers;
- check the feasibility of detecting and notching narrow bands;
- determine, if it is possible to detect SW radio ingress without demodulating signals by PLT PHY;
- determine probability of false detection by PLT modems;
- verify if there is a way of classifying the narrow band signals' source (radio station or switching power supply, or class D amp).

Therefore STF 332 will organize the Plugtests™event. At the execution of the Plugtests™ event any ETSI member is free to participate in the execution of any or all of the Plugtests™ event proposed in the present document.

1 Scope

Results of the verification of the proposed mechanism to improve coexistence between PLT and short wave radio broadcast.

2 References

References are either specific (identified by date of publication and/or edition number or version number) or non-specific.

- For a specific reference, subsequent revisions do not apply.
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  - if it is accepted that it will be possible to use all future changes of the referenced document for the purposes of the referring document;
  - for informative references.

Referenced documents which are not found to be publicly available in the expected location might be found at http://docbox.etsi.org/Reference.

For online referenced documents, information sufficient to identify and locate the source shall be provided. Preferably, the primary source of the referenced document should be cited, in order to ensure traceability. Furthermore, the reference should, as far as possible, remain valid for the expected life of the document. The reference shall include the method of access to the referenced document and the full network address, with the same punctuation and use of upper case and lower case letters.

NOTE: While any hyperlinks included in this clause were valid at the time of publication ETSI cannot guarantee their long term validity.

2.1 Normative references

The following referenced documents are indispensable for the application of the present document. For dated references, only the edition cited applies. For non-specific references, the latest edition of the referenced document (including any amendments) applies.

Not applicable.

2.2 Informative references

[1] ITU-R Radio Regulations, edition of 2004.

[2] ETSI ES 201 980 (V2.2.1): "Digital Radio Mondiale (DRM); System Specification".

[3] ITU-R Recommendation BS.1284: "General methods for the subjective assessment of sound quality".

NOTE: See http://stason.org/TULARC/radio/shortwave/08-What-is-SINPO-SIO-Shortwave-radio.html.

[4] CISPR 16-1-1 (2006-11): "Specification for radio disturbance and immunity measuring apparatus and methods - Part 1-1: Radio disturbance and immunity measuring apparatus - Measuring apparatus".

[5] ETSI TS 102 578 (draft version of 12 October 2007): "PowerLine Telecommunications (PLT); Coexistence between PLT Modems and Short Wave Radio broadcasting services".

NOTE: See http://webapp.etsi.org/WorkProgram/Report_WorkItem.asp?WKI_ID=24584.

[6] ITU-R recommendation BS.1615: ""Planning parameters" for digital sound broadcasting at frequencies below 30 MHz".

[7] ITU-R Recommendation P372: "Radio noise".

3 Abbreviations

3.1 Abbreviations

For the purposes of the present document, the following abbreviations apply:

AE	Auxiliary Equipment
AM	Amplitude Modulation
CE	Consumer Electronics
DRM	Digital Radio Mondiale

NOTE: See ES 201 980 [2] (http://www.drm.org/).

EUT	Equipment Under Test
HFCC	High Frequency Co-ordination Conference

NOTE: See http://www.hfcc.org.

LI	Level of Ingress (in dBm)
NHB	Noise higher frequency block (in dBm)
NLB	Noise lower frequency block (in dBm)
PLT	PowerLine Telecommunications

NOTE: See http://www.etsi.org/plt.

S	second
SINPO	Signal Strength, Interference, Noise, Propagation, Overall
SW	Short Wave

4 Test cases

4.1 Plugtests™ specification

There are 2 tests to be performed:

1) The concept, as specified in the current draft TS 102 578 [5] shall be verified.
Levels, Thresholds, Timing, definition of useable radio service reception quality, lower level and slopes of the notch, verification method, etc.
This test will be performed on 10th / 11th of October 2007 in Stuttgart area (Germany).
Revised values will be published by 17th of October 2007.

2) Tests with participants. Implementations from modem manufacturers will be verified versus this test specification.
These tests will be performed from 19th to 23rd of November 2007.

4.1.1 Verification of concept in a Building

4.1.1.1 Test environment

Test will be carried out in a private home. The detailed installation of the power infrastructure is unknown to test participants. The 300 kW SW radio broadcast station in Skelton (UK) will schedule some radio transmission according to the demands of this test. A Spectrum Analyser, Test Receiver and a selection of DRM and AM SW radio receivers are available to perform the tests. A calibrated active biconal antenna verifies the field strength in the air.

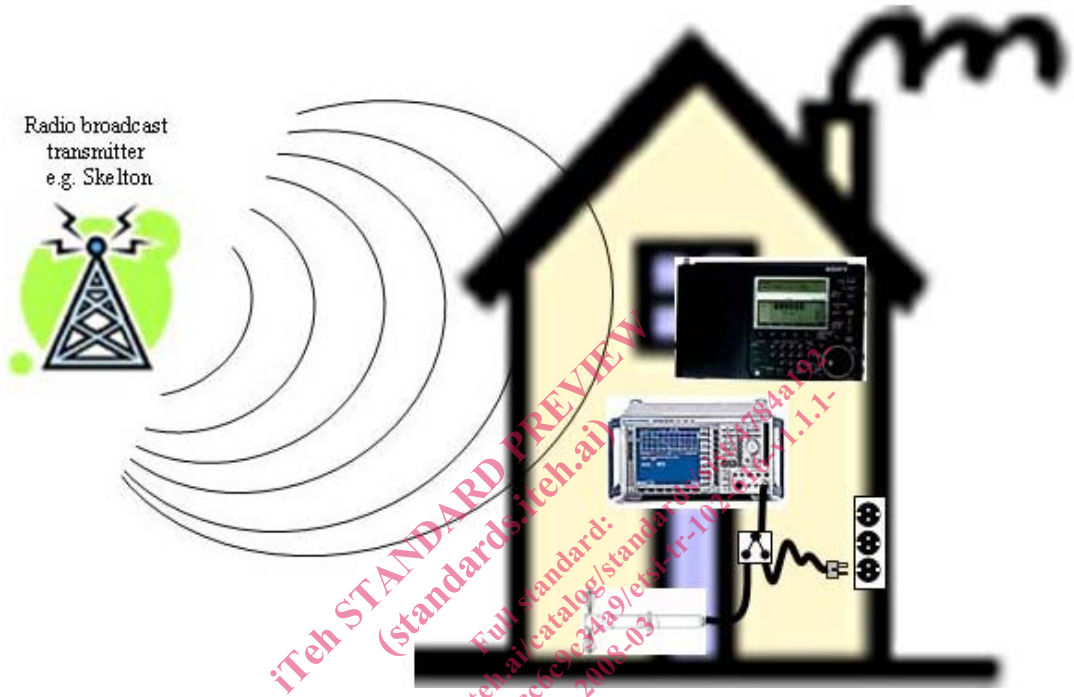

Figure 1: Test Setup in a private living unit

Equipment needed:

- CE SW Radio receiver:
  - AOR AR7030, Sony ICF-SW77, ICF-1000, Sangean ATS909, TECSUN 9700, etc.
- DRM: Roberts MP-40, etc.
- Cable snap ferrites.
- Spectrum Analyser, PLT coupler 50:100 Ω Impedance matching.
- Calibrated antenna in 1 MHz < f < 30 MHz, wooden tripod.
- Artificial white noise generator:
  - Coupler to feed noise to the mains grid.
  - Antenna to broadcast noise inside the building.

4.1.1.2 Verify Reception Quality of Radio Stations

This test will be done on the 10th of October 2007.

Using a SW radio receiver, scan the SW radio band and record the frequency, service name and reception quality wherever the automatic scan stops. Check for a good position of the receiver in the living unit and monitor the field strength there.

Connect the Spectrum Analyser to the mains (sequentially at several outlets) and measure the level of ingress of HF broadcast signals there. Do this process in turn 3 times and take the average from the numeric reading as result.

Classification for reception quality of AM stations shall be according to SINPO system [3]. The empirical rating of the signal quality will be done "democratically" by the three STF 332 experts. Tables 1 and 2 will be compiled during the tests.

Table 1: Reception quality, field strength and level of ingress of AM services

			Used AM Radio					In dBm				
Frequency in kHz	Station name	Field strength in dB (µV/m)	SINPO Signal	SINPO Interference	SINPO Noise	SINPO Propagation	SINPO Overall	Measured at outlet No: Level of Ingress noise levels of adjacent frequency block: Lower Block / Higher Block				
									1	2	3	4
								LI				
6 123	Example AM	50	3	4	4	5	4	NLB				
								NHB				
								LI				
								NLB				
								NHB				
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								NHB				
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								NLB				
								NHB				
								LI				
								NLB				
								NHB				

Classification for reception quality of DRM stations shall be done according the reception of a DRM channel:

- DRM Radio Stations using e.g. Roberts MP-40.

Table 2: Reception quality, field strength and level of ingress of DRM services

Frequency in kHz	Station name	Field strength in dB(µV/m)	Used DRM Radio: Service receivable? Y/N	In dBm: Measured at outlet No: Level of Ingress / noise levels of adjacent frequency block: Noise Lower Block / Noise Higher Block				
					1	2	3	4
	Example DRM	50	Y	LI	-75	-70	-69	-73
				NLB				
				NHB				
				LI				
				NLB				
				NHB				
				LI				
				NLB				
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				LI				
				NLB				
				NHB				

After monitoring radio broadcast services at the Plugtests™ location, the HFCC Database (see http://www.hfcc.org) provides information on day and seasonal variations of reception quality. The HFCC Database may help to give an estimate of the necessity of notch parameters.

4.1.1.3 Revise thresholds, Level and Timings

Revise threshold of ingress as defined in draft TS 102 578 [5], where an ingress shall be identified as a receivable radio broadcast service, to create a notch.

Revise lower level of Notch defined in draft TS 102 578 [5], by feeding known noise level to the mains in vicinity of outlet where radio receiver is connected to. Record the level when reception quality gets worse (using SINPO).

Revise response timings defined in draft TS 102 578 [5] to activate notch and reuse the frequencies. Monitor fading behaviour in time domain of a transmission to the test location.

Schedule Skelton (UK) test broadcast transmission with 300 kW to monitor its field strength at various times in the test location. Compare it with 2nd location.

4.1.1.4 More Tests in the Building

If there is enough time at the test day, following tests shall be performed.

Check various receiver positions

Pick out smallest receivable service, verify reception quality using CE radio devices:

- AOR AR7030, Sony ICF-SW77, ICF-1000, Sangean ATS909, TECSUN 9700, etc.; and
- verify the field strength of this frequency at various locations in the building.

Check how far mains filters might remove interferences in Radio reception, when the receivers are powered by a mains adaptor.

Check level of interference to adjacent (neighbour) living unit.

4.1.1.5 Further tests to verify the concept in Lab / Anechoic chamber

This test will be done on the 11th of October 2007.

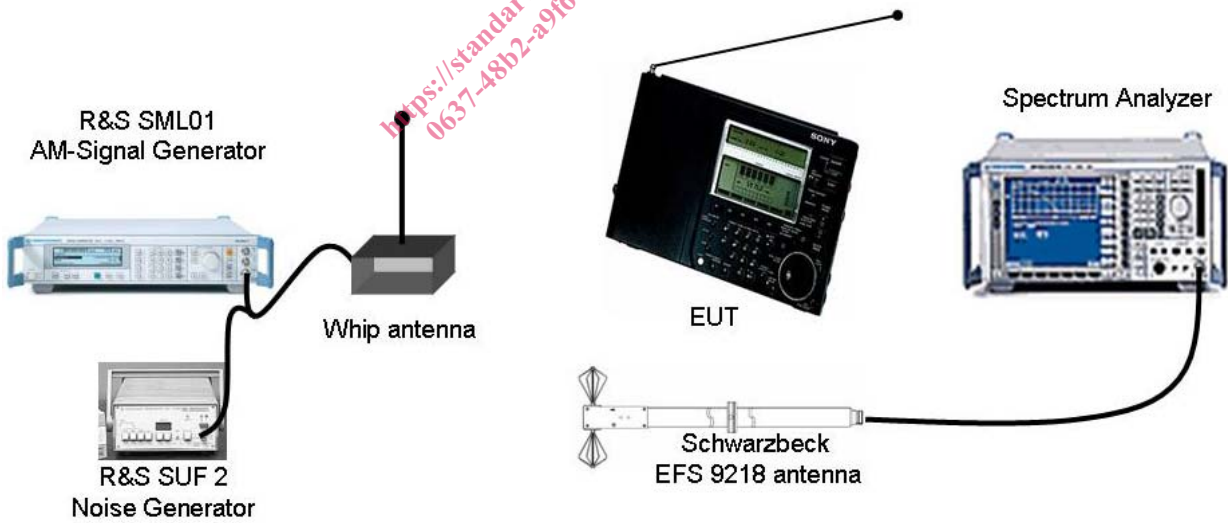

Figure 2: Test Setup anechoic chamber

Revise noise floor and relative level of ingress above noise floor defined in draft TS 102 578 [5] in an anechoic chamber. An AM signal with added noise will be generated and fed into the antenna input of a radio receiver. Check the SNR when the signal becomes an acceptable quality.

Check Consumer Electronic Radio devices when they identify a service as useable when scanning the band.

4.1.2 Laboratory Test with Participants

4.1.2.1 Test environment

Test will be done in a laboratory. Depending on organization and logistics of the Plugtests™ event the lab equipment might be transported into one of the private homes.

The tests will be carried out as described in the current draft of TS 102 578.

Equipment needed:

- Measurement apparatus.
- Ground plane, 1 m^2.
- Signal Ingress Generator:
  - Test signals known to participants: PLT43_TD_08 / PLT43_TD_09 TS102578_V1.1.8_VerifyPattern.
  - More Test signals not known to participants before tests:
    - more or less carriers, DRM and / or AM;
    - use other frequencies;
    - incl. noise.
- Spectrum Analyser.
- PLT Modems.
- Data traffic generation for PLT modems.

Specification of the unknown signals will be published after the Plugtests™event. Test Signals will be shared with participants, so these tests could be reproduced by participants in their laboratories.

4.1.2.2 Test Procedure

Follow the test procedure as described in TS 102 578 [5] (see clause Test Procedure).

Data throughput will be measured using IPERF: transmit UDP traffic monitoring packet loss and throughput

Modems will be connected to data source and sink via Ethernet plugs.

Table 3 will be compiled during the lab tests.

Table 3: Results sheet of TS 102 578 Laboratory tests

Participant A	Max PLT throughput without any notches in Mbit/s			Timing from switch on artificial ingress signal till notch is established in s	Max PLT throughput with notches in Mbit/s			Are all frequencies notched where a carrier ingress? Yes / No	Are more frequencies notched? (Where no carrier ingress?) Which?	Lower Level of the notch in dBm Readout value as described in current draft of TS 102 578	Timing from switch off artificial ingress signal till frequency is reused by PLT in s
	Attenuation from EUT to AE in dB				Attenuation from EUT to AE in dB						
	20	40	60		20	40	60				
Known signal PLT43_TD_08											
Unknown Signal A											
Unknown Signal B											
Unknown Signal C											

Record screen shot of Spectrum Analyser of each ITU-R Radio band.

Monitor notch slopes for checking AM- / DRM Protection ratios: Fine Sweep using Spectrum analyser on 1-2 notches.

Additionally the threshold at which notches are inserted may be measured by changing the power of artificial signal ingress.