

**PowerLine Telecommunications (PLT);  
Plugtests™ 2007 on coexistence  
between PLT modem systems;  
Test cases**

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Reference

DTR/PLT-00023

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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 describes test cases prepared for a Plugtests™ event on coexistence between PLT modem systems.

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## Introduction

The Plugtests on the coexistence between PLT modem systems are performed to confirm the robustness of the CDCF as defined in PLT WI20 [PLT39\_TD\_19a1.zip] and to verify the protocol by tests on prototypes of different vendors, as available. A Special Task Force (STF) 332 was established to model the CDCF mechanism on sub MAC layer, to define suitable test cases for the Plugtests and to perform and report the results of the Plugtests. The aim of the Plugtests is to verify the coexistence protocol given in the PLT WI20 drafts.

The tasks of the STF with regard to PLT WI20 Plugtests are in detail:

- Describe and identify Plugtests to be done;
- Prepare test beds for the Plugtests;
- Perform the Plugtests; and
- Report the results of the Plugtests.

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# 1 Scope

The test cases defined in the present document are designed to verify the coexistence mechanism as defined in PLT-WI20 drafts. They are applicable to PLT modems (Access and Inhouse), in which the coexistence mechanisms are at least partly implemented. Since a monitorable reference device is not yet available, it is required that the PLT modems used for the tests have built-in monitoring abilities.

Results of the verification of the proposed mechanism may be used to improve coexistence between PLT systems.

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## 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] IEC 61000-4-4: "Electromagnetic compatibility (EMC) - Part 4-4: Testing and measurement techniques - Electrical fast transient/burst immunity test".

### 3 Abbreviations

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

AC	Alternating Current
BNC	Bayonet Nut Connector
CDB	coupling/decoupling box
CDCF	Commonly-Distributed Co-ordination Function
FDM	Frequently Division Multiplexing
MTU	Maximum Transmission Unit
PLT	PowerLine Telecommunications ( <a href="http://www.etsi.org/plt">http://www.etsi.org/plt</a> )
PSD	Power Spectral Density
RF	Radio Frequency
TCP	Transmission Control Protocol
UDP	User Datagram Protocol

### 4 General Test Conditions, Traffic Generation and Traffic Monitoring

Usually the PLT modems build a bridge between the powerline as transport media and a standard communication line (e.g. ethernet). For the tests, in which traffic is to be generated and to be monitored, the use of the public domain tool IPERF (<http://dast.nlanr.net/>) will be used. The participant should bring with him the required computer with appropriate interfaces for his modem.

In case of UDP traffic the following settings apply:

stream type	packet size	data rate
UDP	1 500 byte (MTU)	10 % to 100 % of maximum for PLT system as determined in pretests in steps of 10 %

Since TCP uses congestion mechanisms, which may limit the traffic due to packet losses, some tests will be performed using TCP instead of UDP. This may be more realistic for quality perceived by the user.

Since a monitorable reference device is not yet available, it is required that the PLT modems used for the tests have built-in monitoring abilities for the coexistence mechanism. This monitoring should include:

- Master or Slave
- synchronised with CDCF frames
- which resources do a modem try to acquire
- which S- or D-slot(s) are allocated
- which priority slots are reserved
- amount of traffic is received or transmitted
- amount of traffic within the own system

The coexistence mechanism also needs to be stimulated by generation of specific CDCFs. This stimulation should allow to realise

- Access / Inhouse (if possible)
- high / low priority streaming
- S-Slot, D-Slot, tacit D-slot allocation
- passive / active resynchronisation

The participant is free to select the tests listed in the following sections he wants to perform. For each given selected tests, the part of it that can not be performed will be noted and the rest will be performed.

Many of the coexistence tests require two PLT systems of different vendors or types. These tests can only be performed in agreement with all participants concerned.

## 4.1 Coupling and Decoupling of the PLC-Signal

The central element of the modular artificial test environment is a coupling/decoupling box (CDB) as shown in figure 4.1. It consists of a decoupling filter (>60 dB for both symmetric and asymmetric signals) between power plug and mains connector and a coupling network (two capacitors, transformer and several resistors). The resistors are designed for a 50  $\Omega$  termination seen from each BNC connector. An RF-impedance of 100  $\Omega$  can be measured into the power plug.

The attenuation between the coaxial inputs and power plug depends on the dimensioning of the resistors and the RF-transformer.

For all tests the resistors will be chosen to have an attenuation of about 16 dB between coaxial input and power plug, whereas the attenuation between two coaxial inputs is about 11 dB (see figure 4.2).

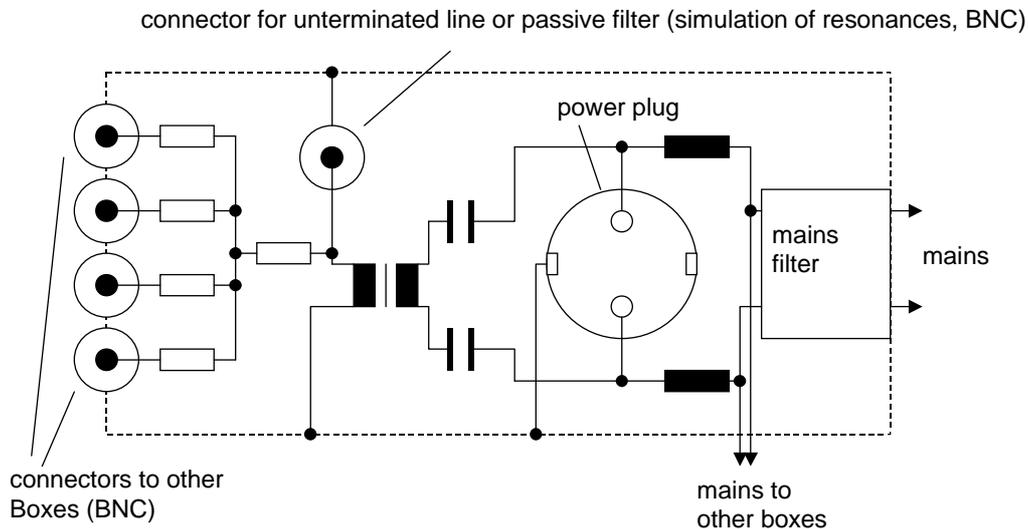


Figure 4.1: Coupling/decoupling box as central element of the modular artificial test environment

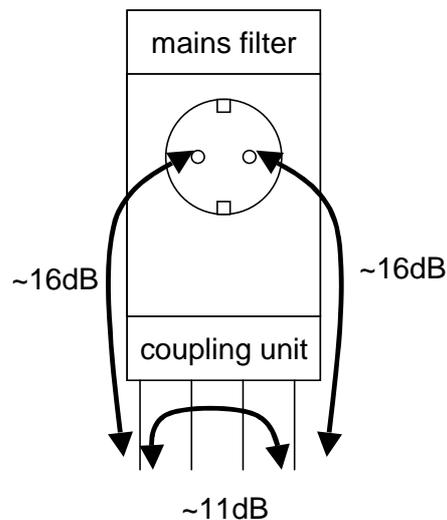


Figure 4.2: Attenuation of the CDB

With several of the boxes connected via cables and attenuators complex network structures can be realised. Unused BNC connectors (intended for connections to other boxes) shall be terminated with 50  $\Omega$ .

## 4.2 Shielding of the Test Set-up

Shielding the entire test set-up is mandatory for reproducibility. For small set-ups simple metal cases can be used. For larger set-ups the occupied space is more and more a problem. For the proposed set-up a locker with the corresponding number of sockets is the best solution. This needs some work for RF-improvement as well as some modifications like holes for cabling.

Because of the flexible cabling concept any scenario can be tested as long as the maximum number of needed compartments is not exceeded. The dimension of the boxes provided by ETSI is 457 mm  $\times$  457 mm  $\times$  460 mm (outer dimensions). If the modem does not fit into this box the participant is invited to bring four suitable shielding cases / methods. Alternatively the tests will be performed without shielding. If the parasitic coupling between the modems is too large, the interpretation of the test results may be difficult.

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## 5 Tests with one PLT system

In the following tests the PLT modem/system means:

- a) a single PLT modem; or
- b) a pair of PLT modems combined in a multiple socket.

depending on the properties of the PLT system.

### 5.1 CDCF Timing - Comparison with Simulation Model

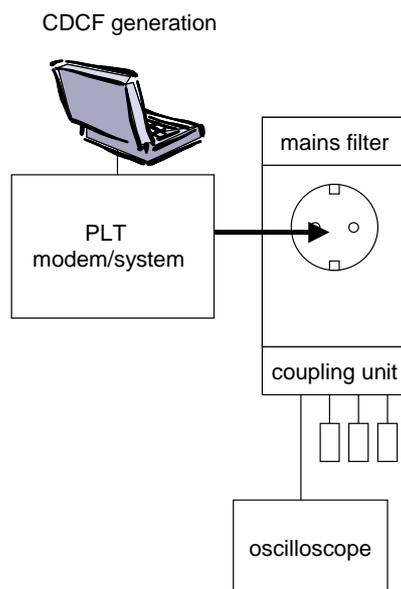
#### Necessary PLT equipment

- PLT-modem / system with ability to initiate transmission of CDCF and to define slot usage.

#### Test instrumentation

- CDB.
- Oscilloscope, AC line cycle triggered.
- Modelling Tool.

## Test Set-Up



### Operation condition of PLT modem/system

Generation of CDCF (no data).

### Setting of test instrumentation

Modem switched on -> Start of synchronisation.

### Collected data

Timing of the CDCF.

## 5.2 CDCF - PSD

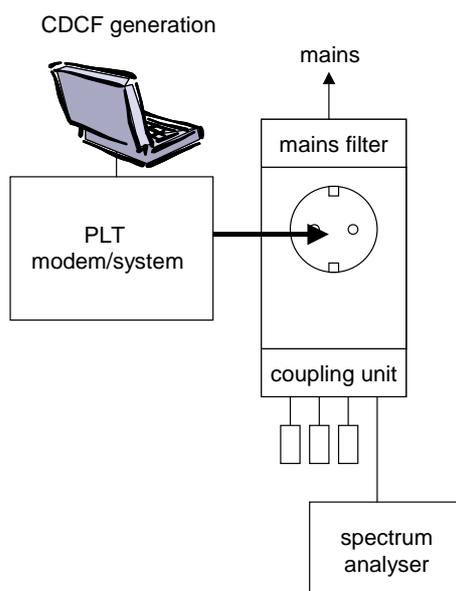
### Necessary PLT equipment

- PLT-modem / system with ability to initiate transmission of CDCF and to define slot usage.

### Test instrumentation

- CDB.
- Spectrum Analyser.
- Modelling Tool.

## Test Set-Up



### Setting of test instrumentation

#### Operation condition of PLT modem/system

Generation of CDCF (no data).

For Access Modems: Dynamic Frequency allocation.

#### Collected data

Nominal slot usage.

PSD of the CDCF.

## 5.3 CDCF Timing - Sync Point and AC line cycle

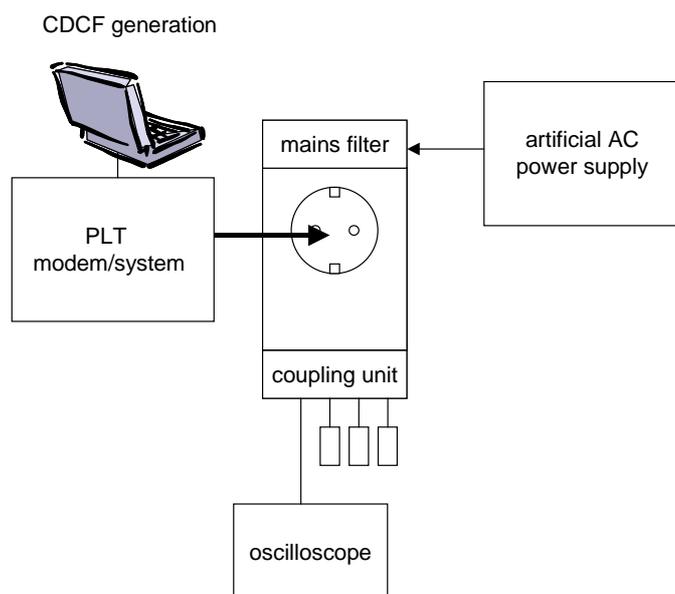
### Necessary PLT equipment

- PLT-modem / system with ability to initiate transmission of CDCF and to define slot usage.

### Test instrumentation

- CDB.
- Oscilloscope.
- Artificial power supply with ability to produce harmonics.

## Test Set-Up



### Operation condition of PLT modem/system

Generation of CDCF (no data).

### Setting of test instrumentation

Artificial power supply:

Fundamental: 50 Hz, 230 V.

25<sup>th</sup> Harmonic, 15 % of fundamental.

### Collected data

Timing of the CDCF.

## 5.4 CDCF Timing - Burst

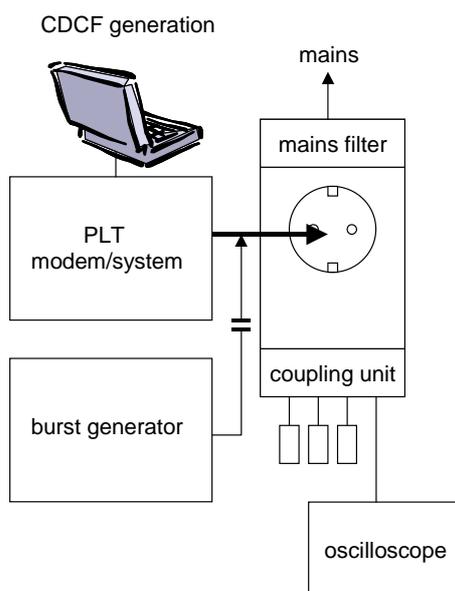
### Necessary PLT equipment

- PLT-modem / system with ability to initiate transmission of CDCF and to define slot usage.

### Test instrumentation

- CDB.
- Oscilloscope.
- Burst-Generator according IEC 61000-4-4 [1].

## Test Set-Up



### Operation condition of PLT modem/system

Generation of CDCF (no data).

### Setting of test instrumentation

Burst generator:

Burst signal 5 n/50 ns, 5 kHz repetition frequency, burst length 15 ms, burst period 300 ms, amplitude 500 V.

### Collected data

Timing of the CDCF.

## 6 Tests with more PLT systems

### 6.1 CDCF reception in dependence of attenuation

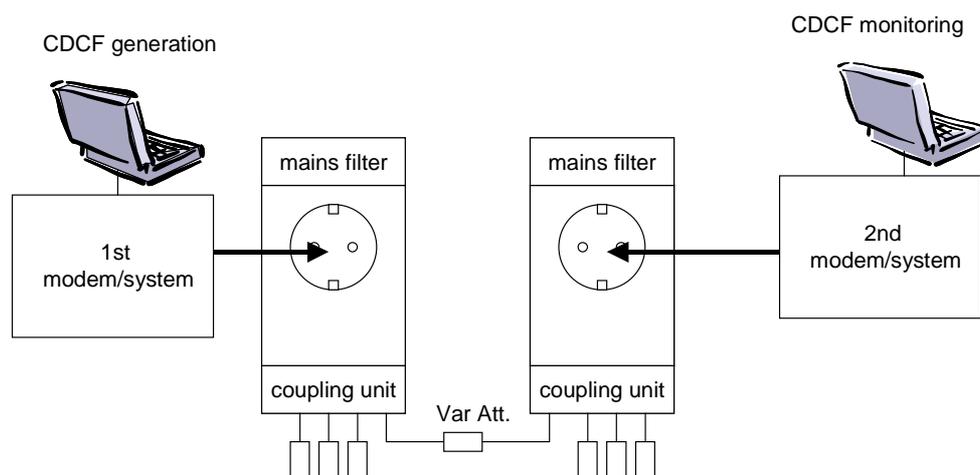
#### Necessary PLT equipment

- PLT-modem / system with ability to initiate transmission of CDCF and to define slot usage.
- PLT-modem / system from another participant with ability to monitor CDCF reception.

#### Test instrumentation

- 2 CDB.
- Attenuator.

## Test Set-Up



### Operation condition of PLT modem/system

1<sup>st</sup> PLT modem/system: Generation of CDCF (no data).

2<sup>nd</sup> PLT modem/system: Observation of received CDCF.

### Setting of test instrumentation

Attenuation is increased by steps of 10 dB.

### Collected data

Received CDCF in dependence of attenuation

## 6.2 CDCF reception in the presence of a narrowband disturbance source

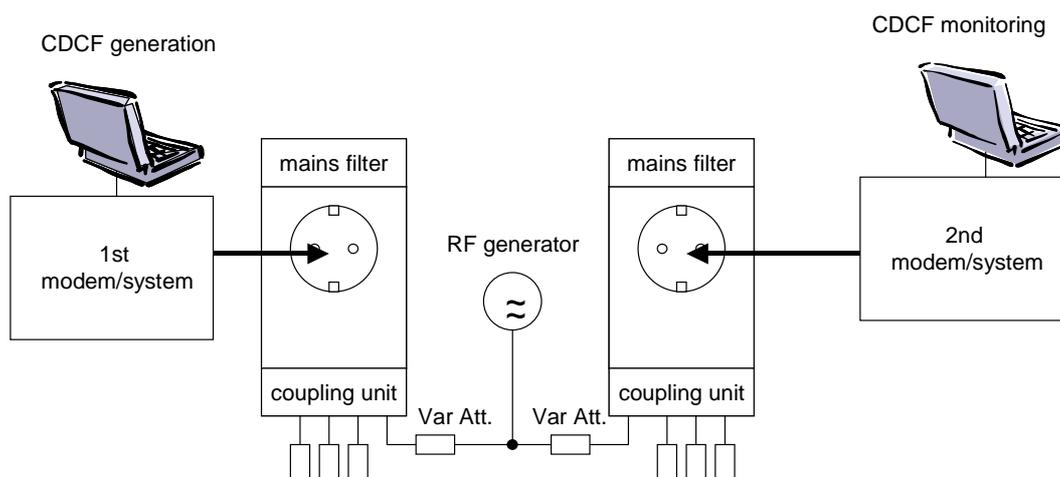
### Necessary PLT equipment

- PLT-modem / system with ability to initiate transmission of CDCF and to define slot usage.
- PLT-modem / system from another participant with ability to monitor CDCF reception.

### Test instrumentation

- 2 CDB.
- 2 Attenuators.
- RF-Signal-generator.

## Test Set-Up



### Operation condition of PLT modem/system

1<sup>st</sup> PLT modem/system: Generation of CDCF (no data).

2<sup>nd</sup> PLT modem/system: Observation of received CDCF.

### Setting of test instrumentation

Attenuation of both attenuators adjusted for a total attenuation of 40 dB.

RF generator successively at 1 MHz, 5 MHz, 10 MHz, 15 MHz, 20 MHz and 25 MHz.

Level is increased by steps of 10 dB.

### Collected data

Received CDCF in dependence of RF generator level for the different frequencies

## 6.3 CDCF reception in the presence of a broadband disturbance source

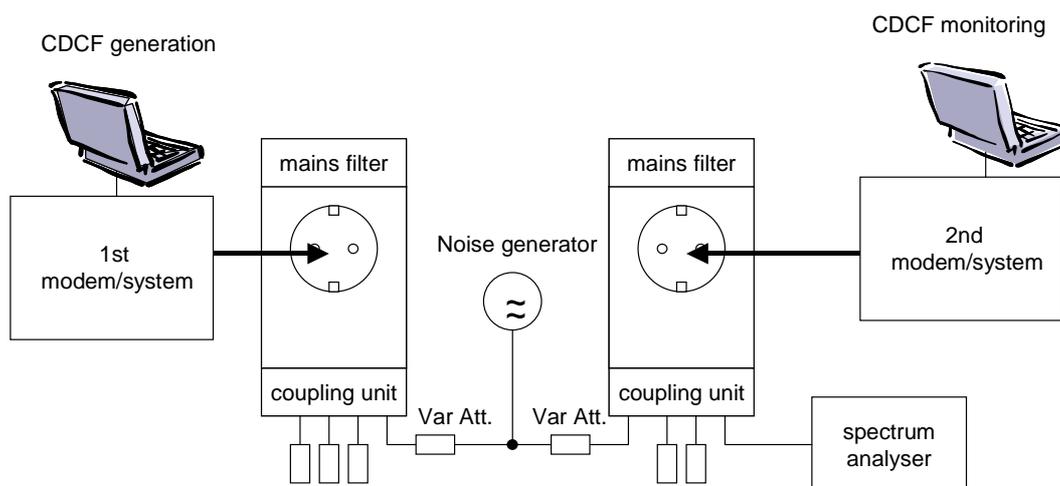
### Necessary PLT equipment

- PLT-modem / system with ability to initiate transmission of CDCF and to define slot usage.
- PLT-modem / system from another participant with ability to monitor CDCF reception.

### Test instrumentation

- 2 CDB.
- 2 Attenuators.
- Noise-generator.
- Spectrum analyser.

## Test Set-Up



### Operation condition of PLT modem/system

1<sup>st</sup> PLT modem/system: Generation of CDCF (no data).

2<sup>nd</sup> PLT modem/system: Observation of received CDCF.

### Setting of test instrumentation

Attenuation of both attenuators adjusted for a total attenuation of 40 dB.

RF generator successively at 1 MHz, 5 MHz, 10 MHz, 15 MHz, 20 MHz and 25 MHz.

Level is increased by steps of 10 dB.

### Collected data

Received CDCF in dependence of noise generator level for the different frequencies.

Spectrum at the receiver's side.

## 6.4 Coexistence - Slot allocation

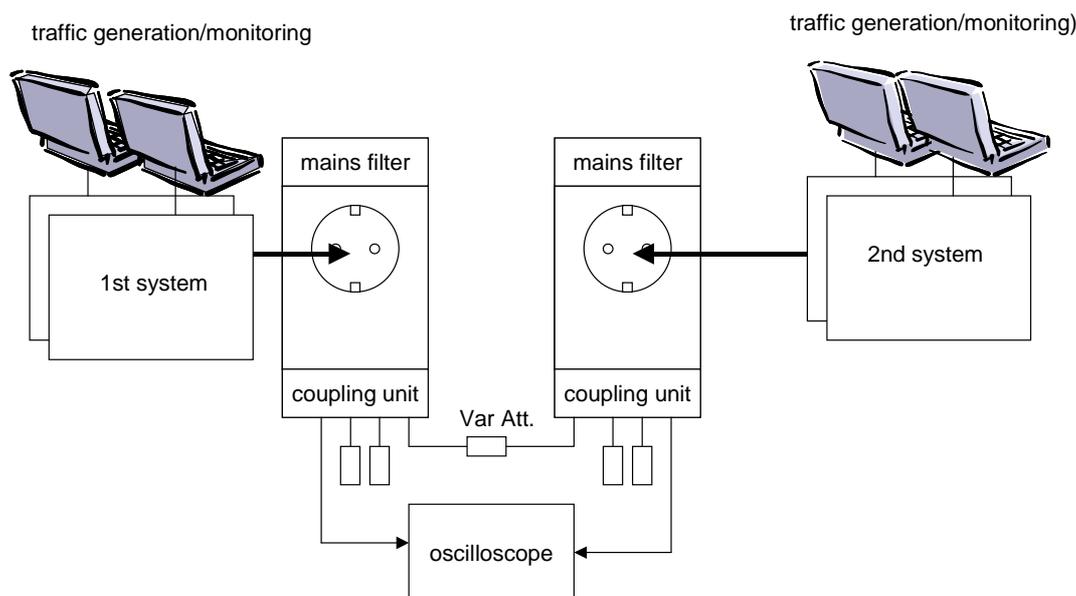
### Necessary PLT equipment

- PLT- system with ability to allow different CDCF (e.g. priority) and to monitor state of CDCF.
- PLT-system from another participant with ability to allow different CDCF (e.g. priority) and to monitor state of CDCF.

### Test instrumentation

- 2 CDB.
- Attenuator.
- Oscilloscope.

## Test Set-Up



### Operation condition of PLT modem/system

1<sup>st</sup> PLT system: CDCF with different slot usage.

2<sup>nd</sup> PLT system: CDCF with different slot usage.

The slot usage shall cover the following scenarios:

- Allocate S-Slot (Low Priority).
- If all slots are allocated: Allocate S-Slot with High priority.
- Release of S-Slots.
- Allocate D-Slots.

### Setting of test instrumentation

Attenuation of both attenuators adjusted for a total attenuation of 40 dB.

### Collected data

Captured CDCFs (due to limited memory of scope only over a certain time period).

State information provided by the modems.

## 6.5 Coexistence - Frequency allocation

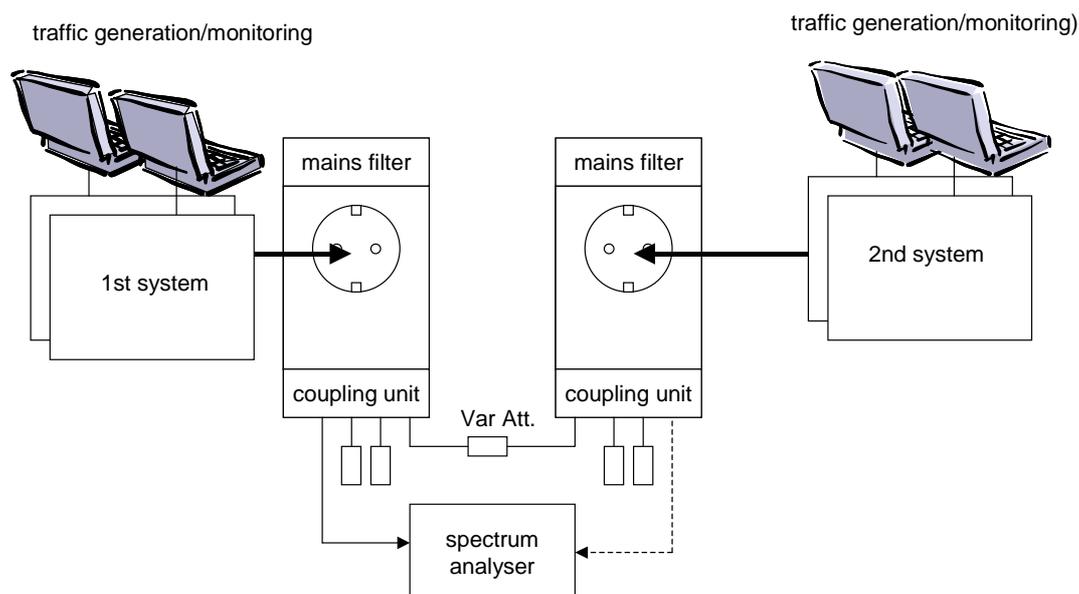
### Necessary PLT equipment

- PLT- system with FDM and the ability to monitor state of CDCF.
- PLT-system from another participant with FDM and the ability to monitor state of CDCF.

### Test instrumentation

- 2 CDB.
- Attenuator.
- Spectrum Analyser.

## Test Set-Up



### Operation condition of PLT modem/system

1<sup>st</sup> PLT system: CDCF with different slot usage.

2<sup>nd</sup> PLT system: CDCF with different slot usage.

Setup Dynamic Frequency allocations, if possible.

### Setting of test instrumentation

Spectrum analyser is successively connected to 1<sup>st</sup> and 2<sup>nd</sup> system.

### Collected data

Spectrum of both systems.

State information provided by the modems.

## 6.6 System Join Process

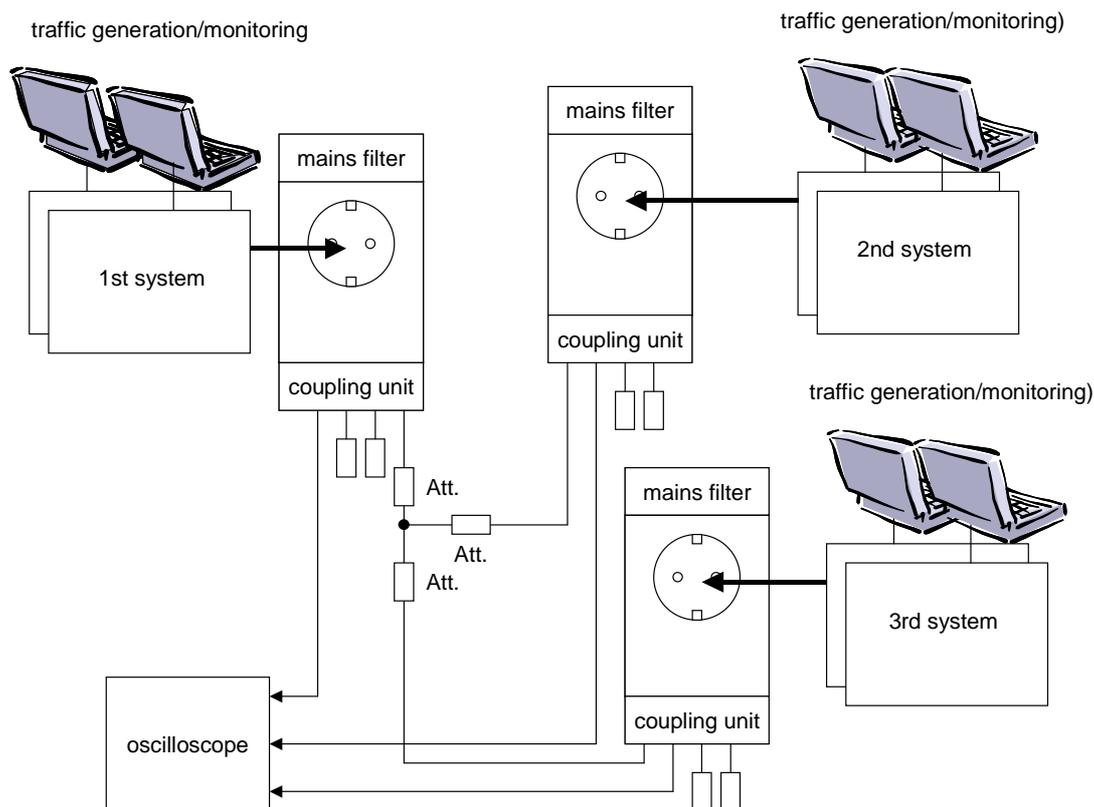
### Necessary PLT equipment

- 3 PLT- systems with the ability to monitor state of CDCF.

### Test instrumentation

- 3 CDB.
- 3 fixed Attenuators (15 dB).
- Oscilloscope.

## Test Set-Up



### Operation condition of PLT modem/system

1<sup>st</sup> PLT and 2<sup>nd</sup> system: synchronised.

3<sup>rd</sup> PLT system: switched on (start of synchronisation).

### Setting of test instrumentation

None.

### Collected data

Captured CDCFs / traffic (due to limited memory of scope only over a certain time period)

State information provided by the modems.

## 6.7 Throughput

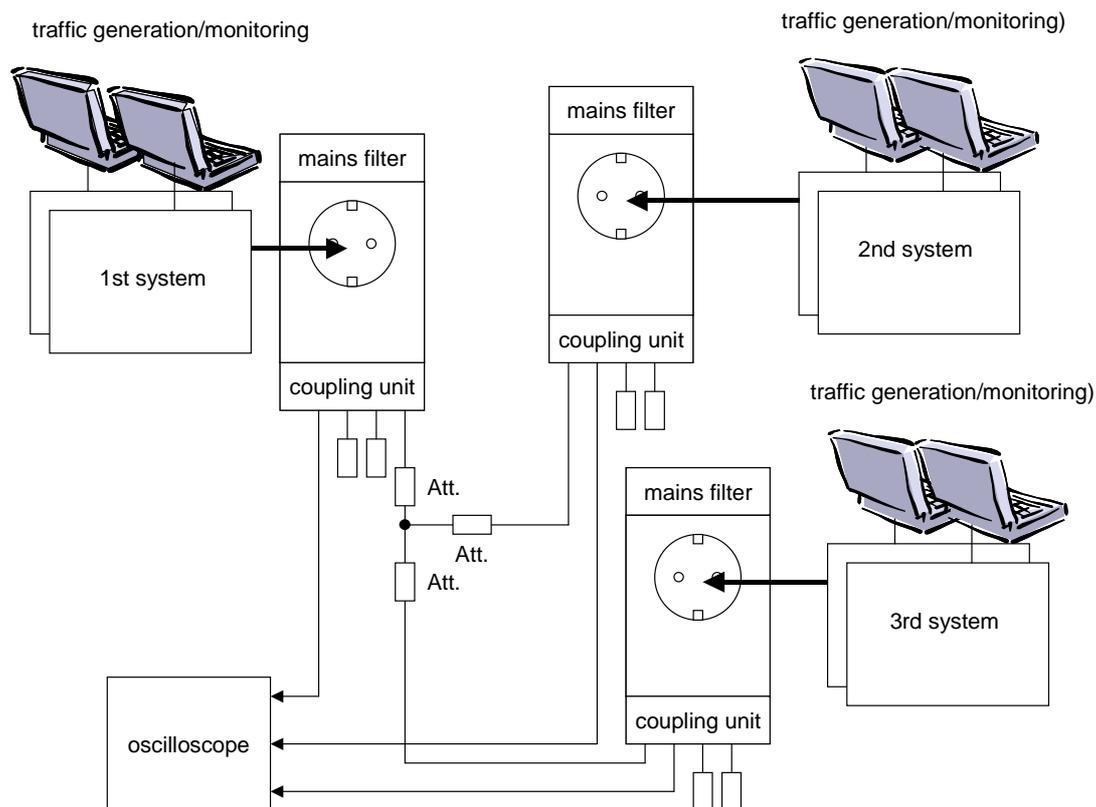
### Necessary PLT equipment

- 3 PLT- systems, (one of them preferably access system).

### Test instrumentation

- 3 CDB.
- 3 fixed Attenuators (15 dB).
- Oscilloscope.

## Test Set-Up



### Operation condition of PLT modem/system

TCP traffic on all three systems.

### Setting of test instrumentation

None.

### Collected data

Throughput.

State information provided by the modems.

## 6.8 Hidden Node Situation

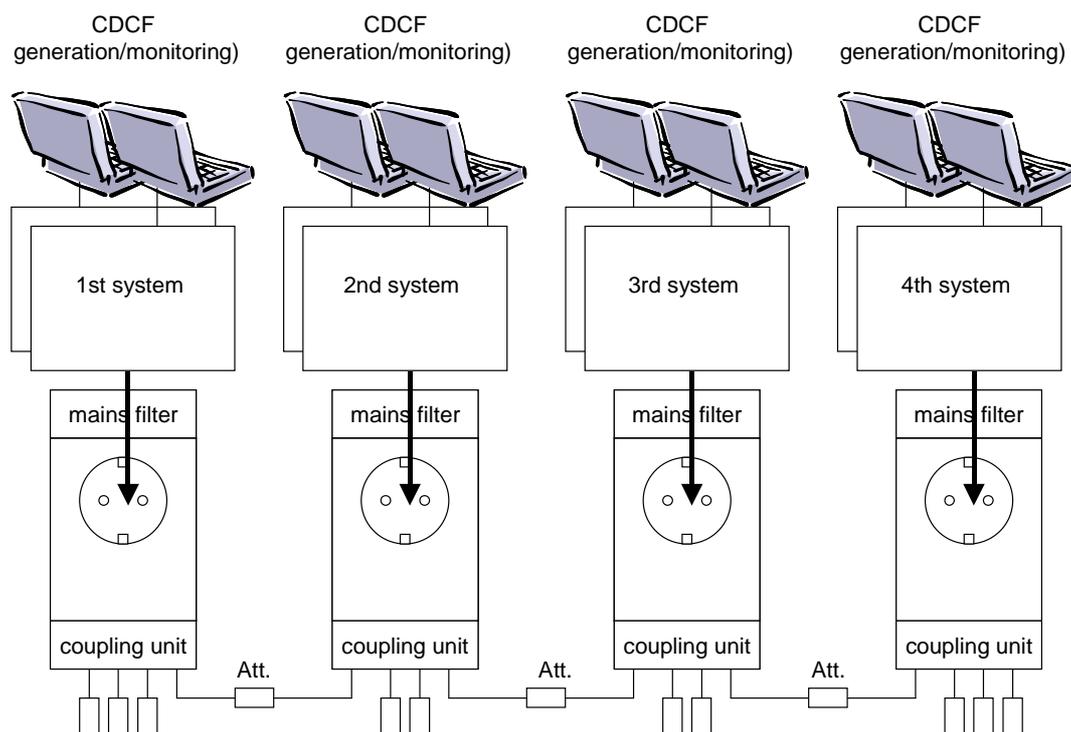
### Necessary PLT equipment

- 4 PLT- systems with the ability to monitor state of CDCF.

### Test instrumentation

- 4 CDB.
- 3 fixed Attenuators (15 dB).
- Oscilloscope.

## Test Set-Up



### Operation condition of PLT modem/system

1<sup>st</sup> and 2<sup>nd</sup> System synchronised, 4<sup>th</sup> system in idle operation (due to high attenuation to 2<sup>nd</sup> system).

3<sup>rd</sup> system is switched on.

### Setting of test instrumentation

None.

### Collected data

State information provided by the modems.

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## History

<b>Document history</b>		
V1.1.1	February 2008	Publication