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HOCHFREQUENZTECHNIK
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Bachelor Thesis Presentation

Development and Implementation of an Automated Measurement System for RF Parameters of a DECT System

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- Task Description
- Introduction to DECT
- Remote Controlling Measurement Equipment
- Automation of DECT Measurements
- Conclusion

Task Description

- Developing an automated measurement system to test RF parameters of a DECT system

- Measurements according to ETSI EN 301 406

- Test cases as an extension to Lantiq's software *Coreco* written in TCL/TK

- Performing the measurements for a DECT system

Introduction
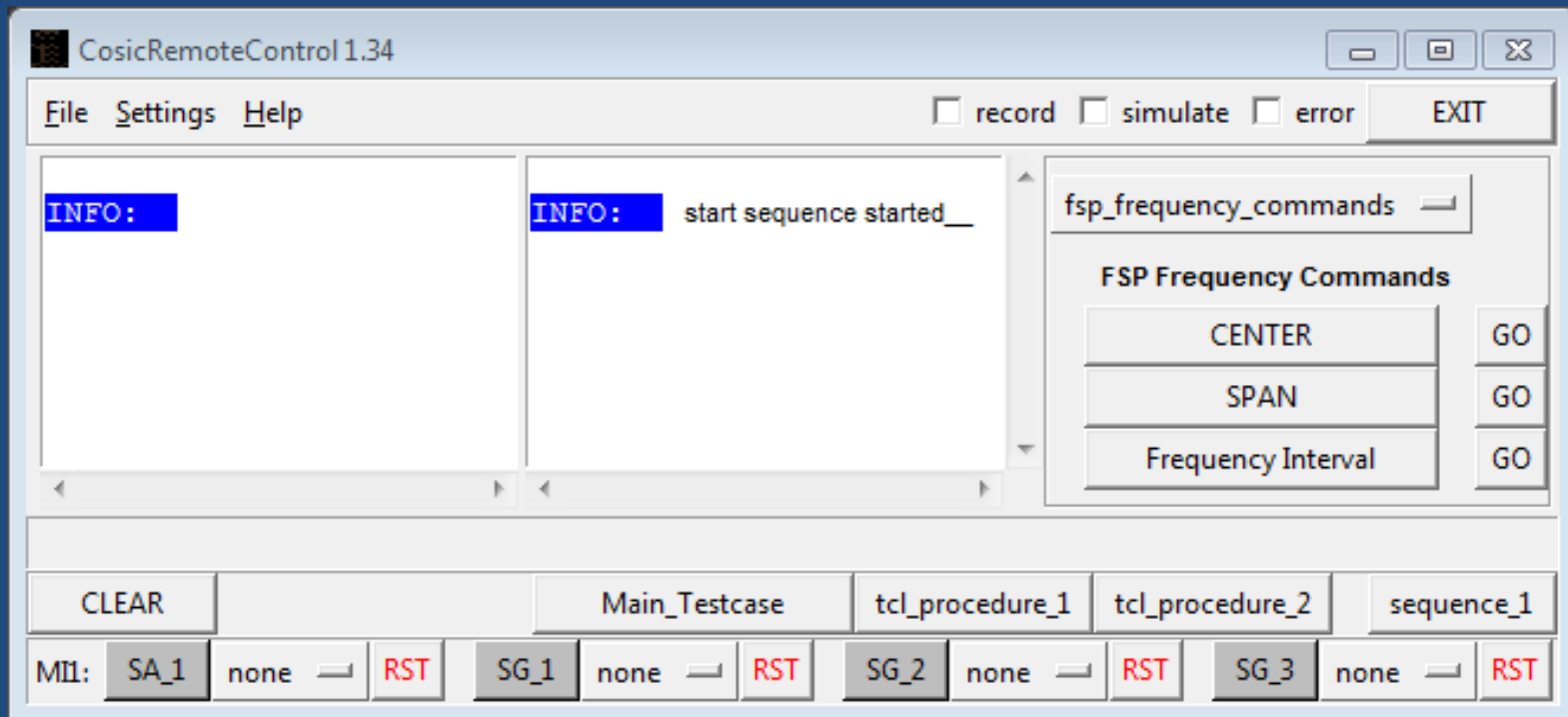
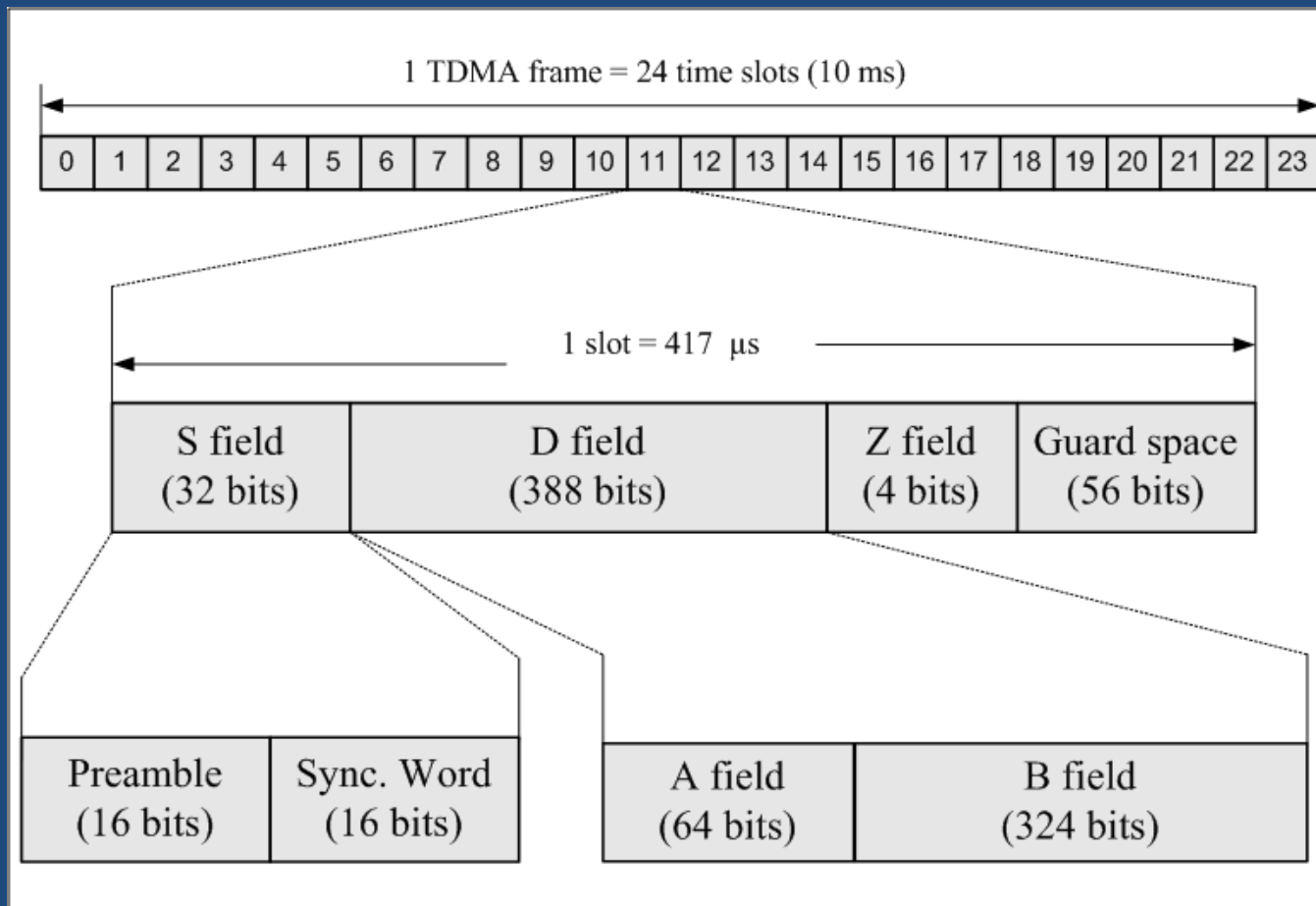## DECT

- A standard for Cordless telephone systems
- 1880 MHz to 1900 MHz
- FDMA: 10 channels
- TDMA: 24 time slots
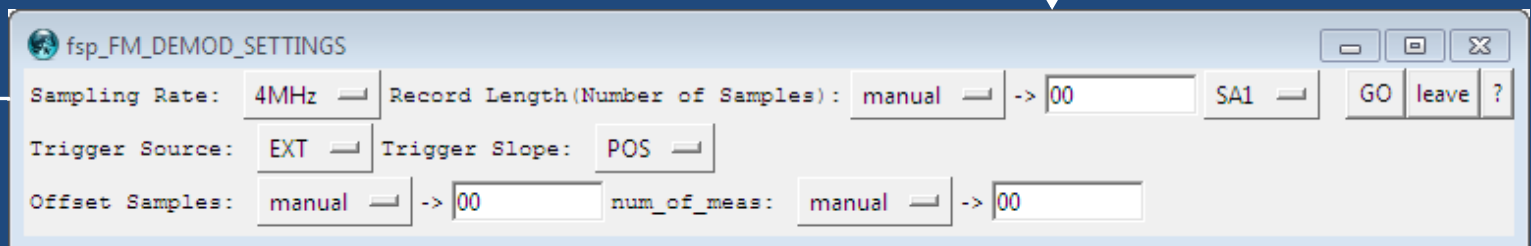- Modulation scheme: GFSK with Δf = ± 288 kHz

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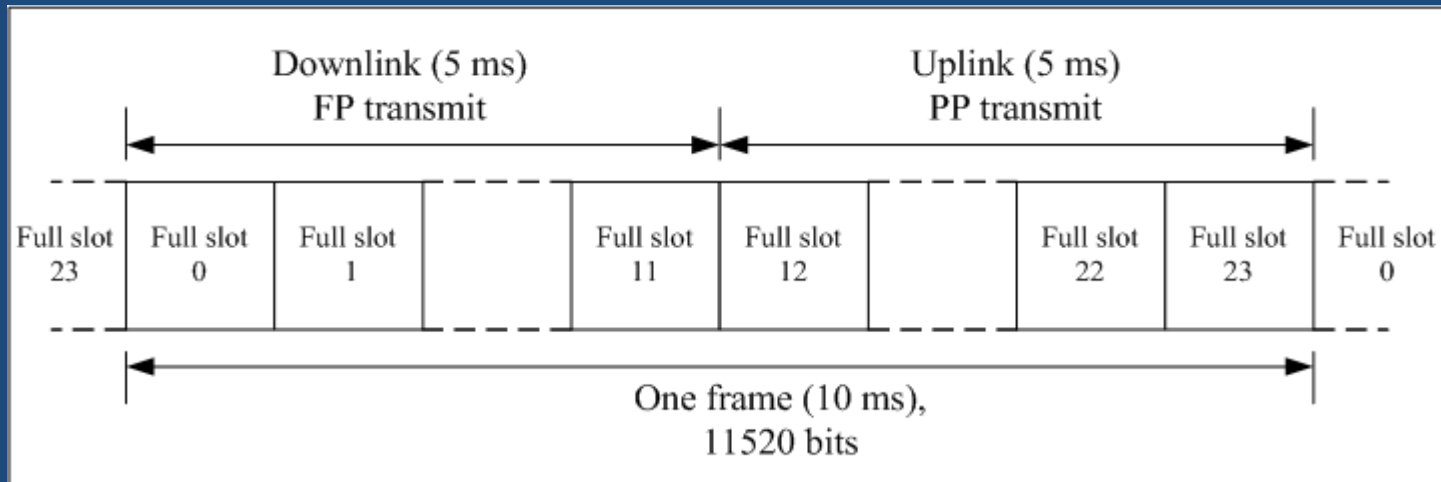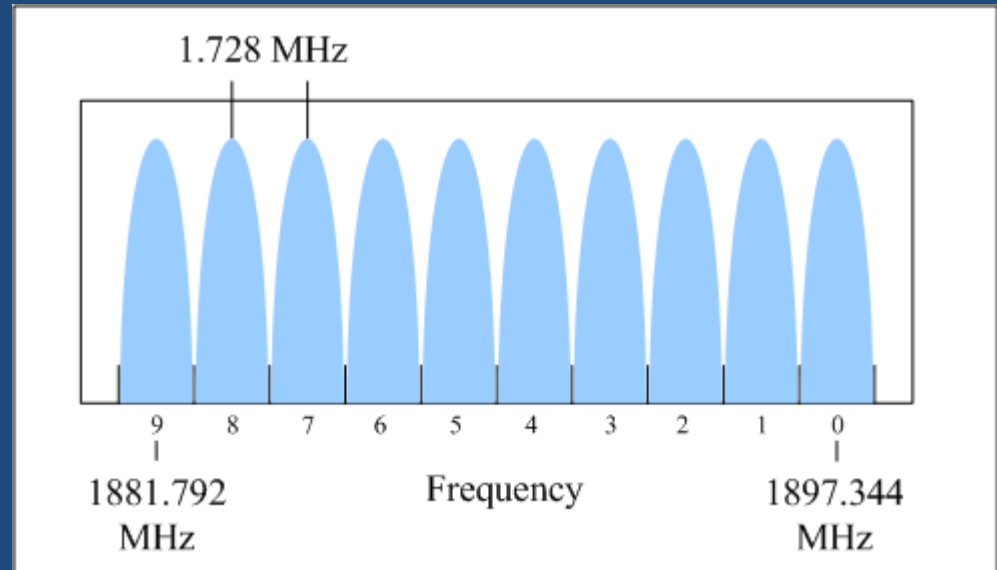
Packet Structure

- Data is transmitted within slots in physical packets
- Bit p0: beginning of the packet

- Measurement Equipment:
  - General: PC, temperature chamber, power supply
  - Tx tests: Spectrum analyzer
  - Rx tests: signal generator, function generator
- Connection via GPIB or RS-232
- Define SCPI command and corresponding button for each instrument function
- Use *Coreco* record function to build test cases

```
fsp_demod_commands

SELECT MODE          GO
Demod Settings       GO
FM Demod Settings    GO
DEMOD RESULTS        GO
```

```
fsp_FM_DEMOD_SETTINGS

Sampling Rate:   4MHz   Record Length(Number of Samples):  manual  -> 00    SA1    GO  leave  ?
Trigger Source:  EXT    Trigger Slope:  POS
Offset Samples:  manual  -> 00    num_of_meas:  manual  -> 00
```
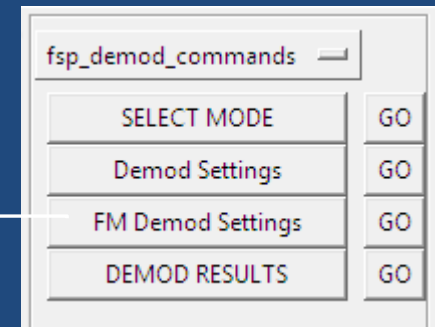
":SENS:ADEM:SET $sample_rate,$record_length,$trigger_source,$trigger_slope,$offset_samples,$num_of_meas"

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Implemented DECT test cases

Transmitter test cases:

- Accuracy and stability of RF carriers
- Measurement of packet timing jitter
- Transmission burst and transmitted power
- RF carrier modulation parts 1-4
- Emissions due to modulation
- Emissions due to transmitter transients
- Spurious emissions when allocated a transmit channel

Receiver test cases:

- Radio receiver sensitivity
- Radio receiver interference performance
- Radio receiver blocking
- Radio receiver intermodulation performance
- Spurious emissions when not allocated a transmit channel

General measurement procedure

User enters test conditions

↓

Connection to test equipment

↓

Set a given combination of temperature and voltage

↓

Position DUT in the specified channel

↓

Test case specific procedure

↓

Compare results with specifications

→

Test done for all combinations of temperature and voltage ?

No → (back to Set a given combination of temperature and voltage)

Yes → Write test results to excel
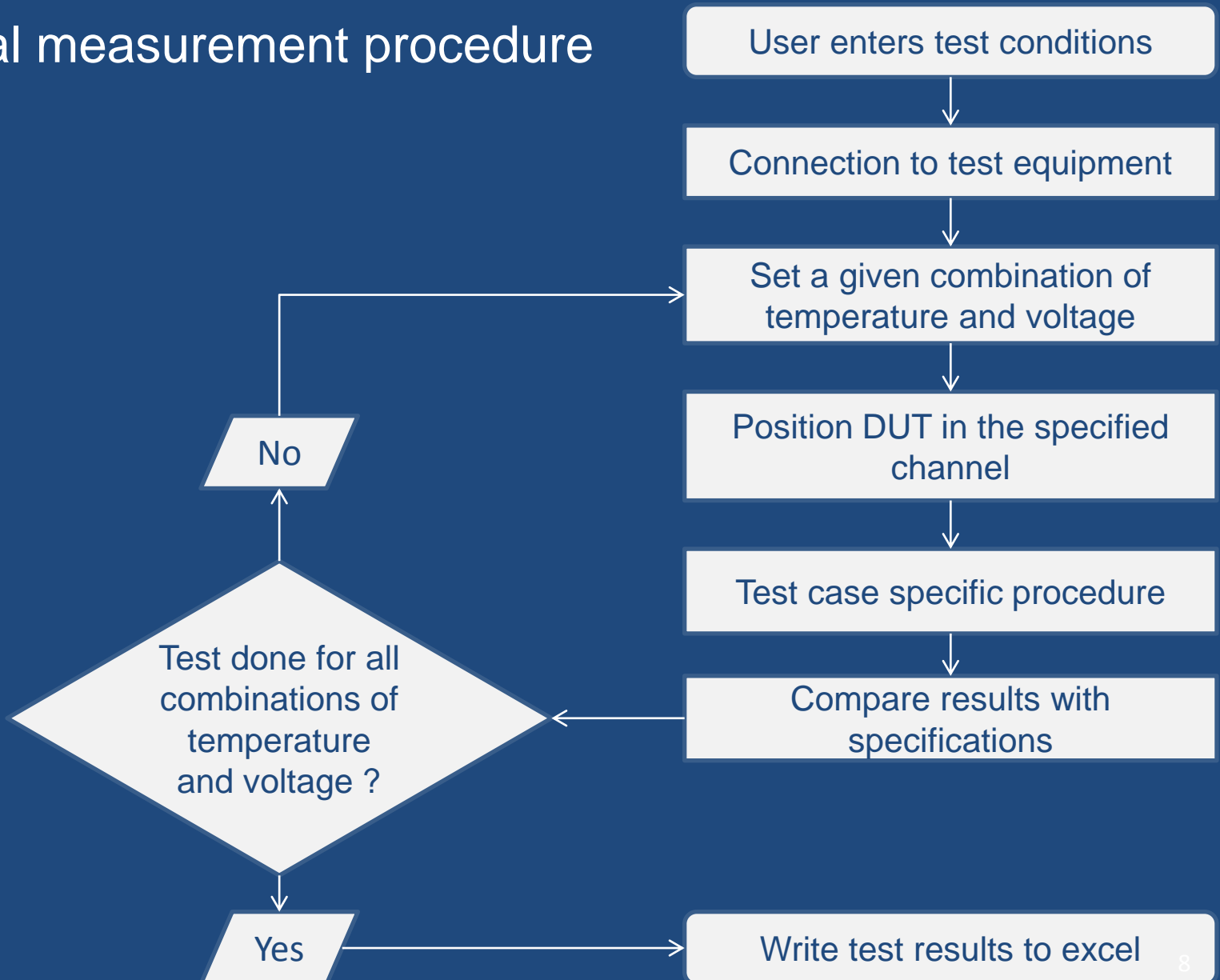
Accuracy & Stability of RF Carriers : test setup

Accuracy & Stability of RF Carriers


```
DUT transmits an RF signal
with 000011110000… in B-field
        ↓
Demodulation of the signal at
      spectrum analyzer
        ↓
Sample demodulation data and
      transmit to PC
        ↓
        Find bit p0
        ↓
Calculate the frequency offset
      in B-field
```

Is the given number of (10) measurements performed?

No → (back to DUT transmits)

Yes →

```
Average the recorded results
        ↓
    Limits: ± 50 kHz
```

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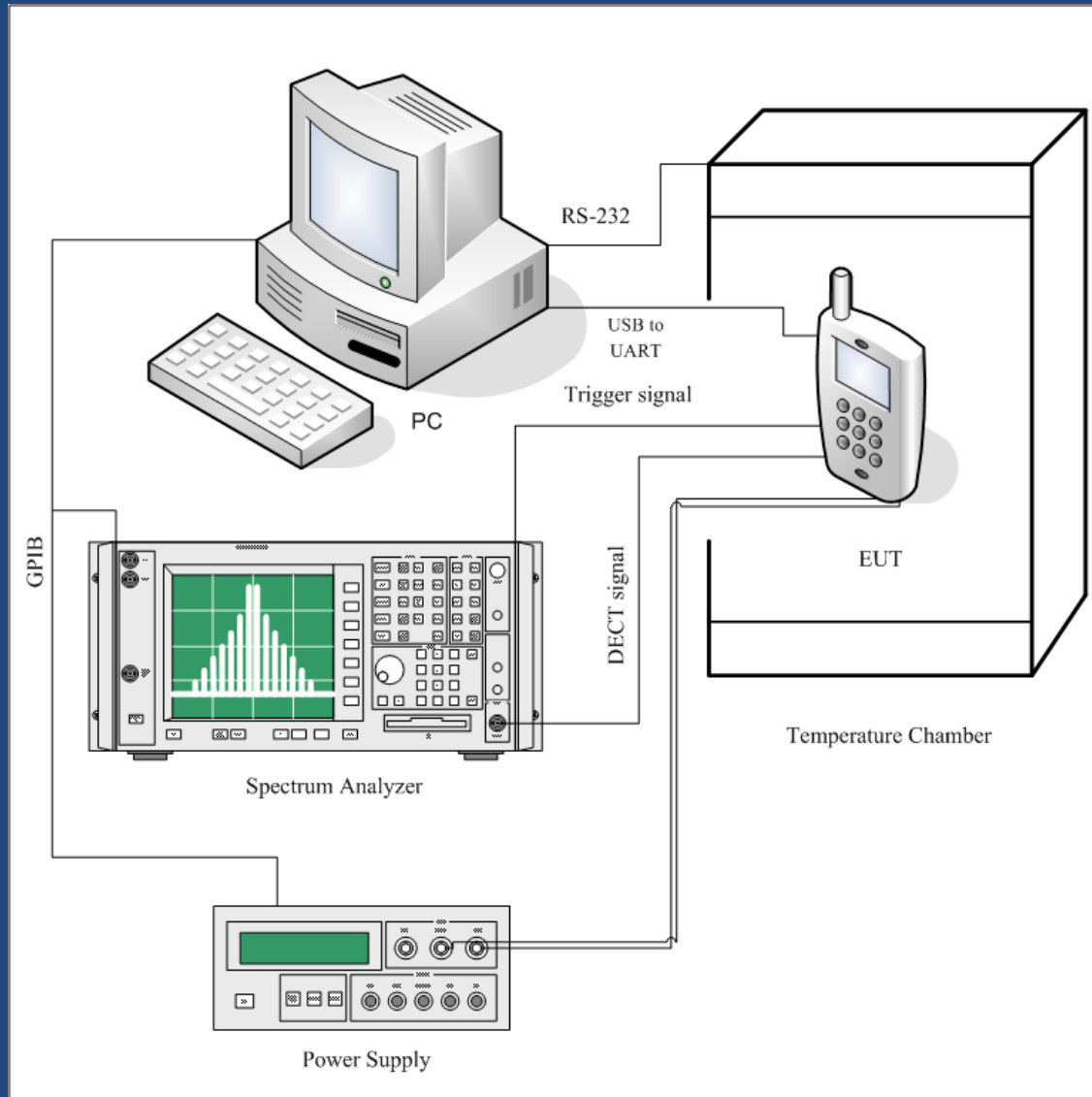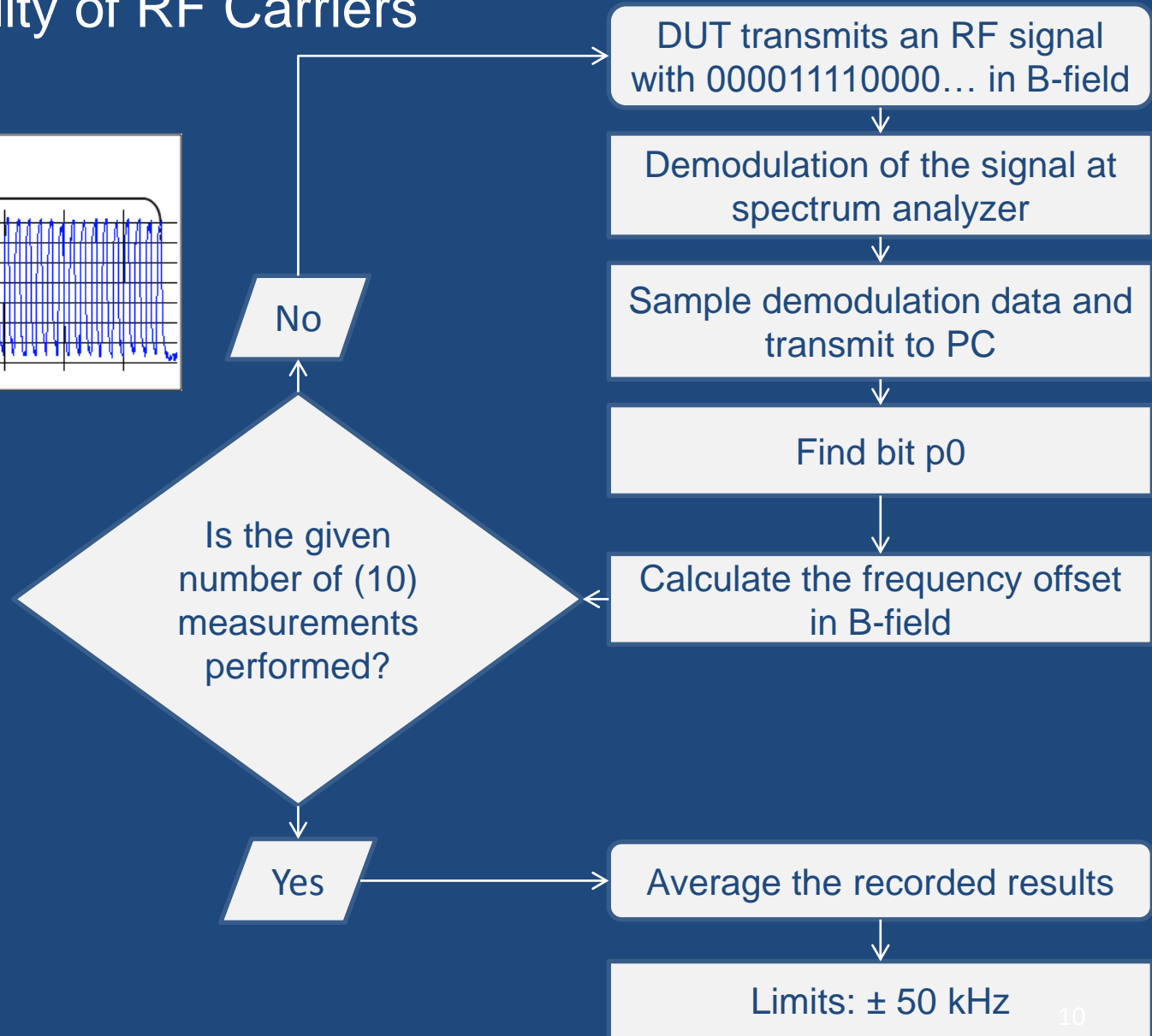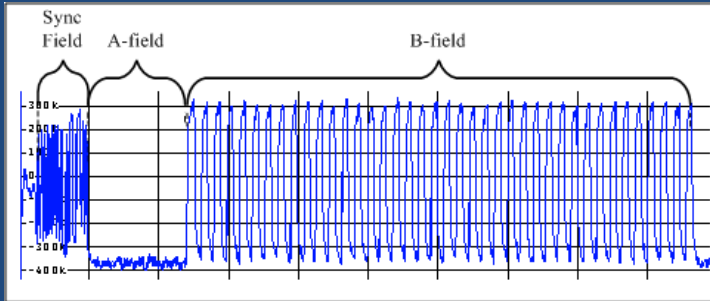
Accuracy & Stability of RF Carriers: results

- Verdict criteria:
  frequency offset between ± 50 kHz

- Results all within the limits

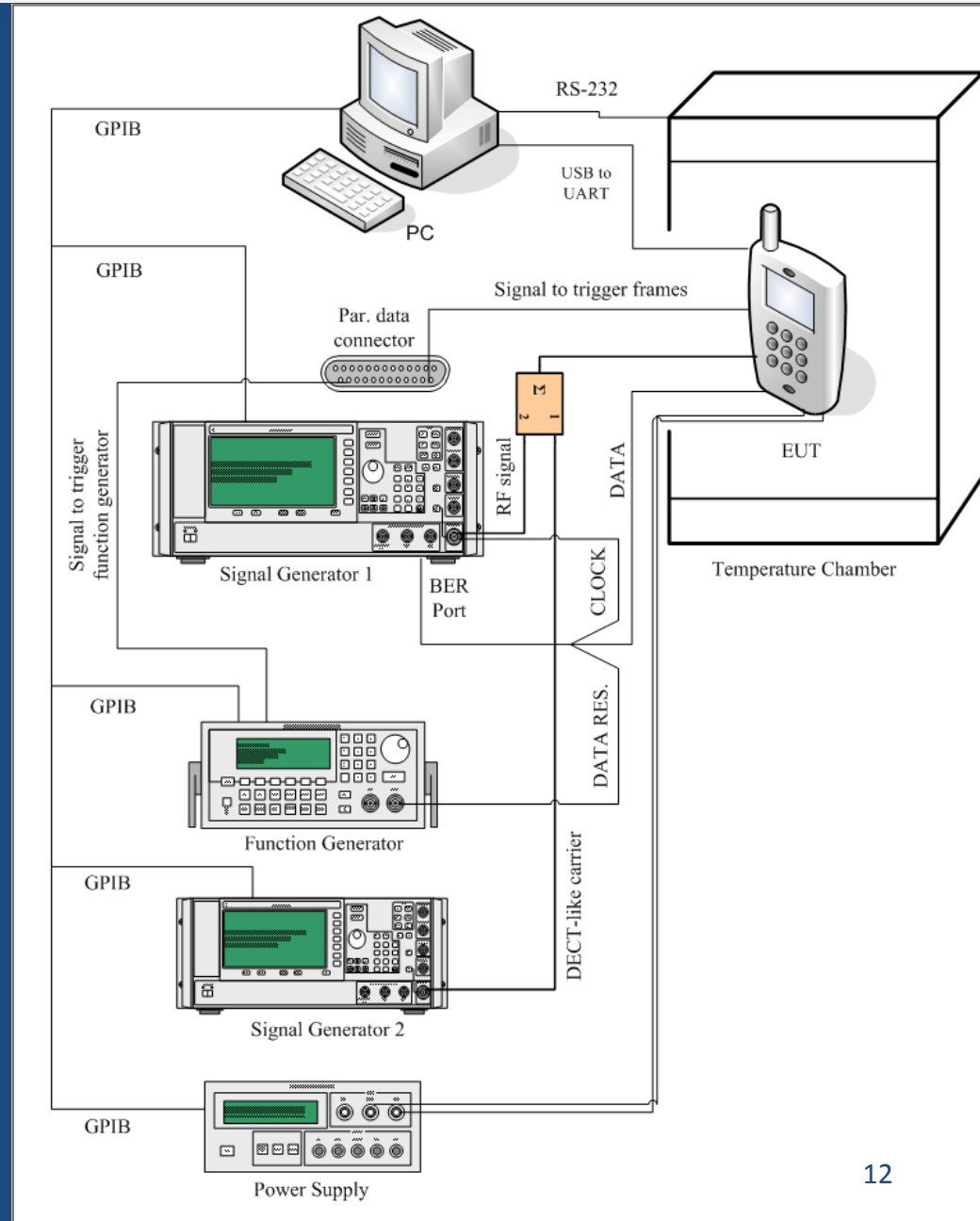| Temp (°C)	Volt (V)	Channel	Average Freq offset (kHz)	Compliance with standard
-12	2.6	5	-25.34	passed
-12	2.6	0	-25.62	passed
-12	2.6	9	-25.36	passed
-12	3.0	5	-25.56	passed
-12	3.0	0	-25.91	passed
-12	3.0	9	-25.60	passed
-12	2.2	5	-25.80	passed
-12	2.2	0	-26.06	passed
-12	2.2	9	-25.77	passed
25	2.6	5	-23.96	passed
25	2.6	0	-23.88	passed
25	2.6	9	-23.66	passed
25	3.0	5	-23.84	passed
25	3.0	0	-23.86	passed
25	3.0	9	-23.64	passed
25	2.2	5	-23.50	passed
25	2.2	0	-23.72	passed
25	2.2	9	-23.36	passed
65	2.6	5	-23.00	passed
65	2.6	0	-23.10	passed
65	2.6	9	-22.83	passed
65	3.0	5	-23.01	passed
65	3.0	0	-23.13	passed
65	3.0	9	-22.84	passed
65	2.2	5	-22.88	passed
65	2.2	0	-23.00	passed
65	2.2	9	-22.66	passed

Receiver Interference: test setup

- Signal generator 1 generates desired RF DECT signal on channel M with PRBS sequence in B-field and power level of -73 dBm.

- Signal generator 2 generates a DECT-like interferer signal on channel Y with the corresponding level.

Interferer on RF channel Y	Interferer signal strength (dBm)
Y = M	-84
Y = M ± 1	-60
Y = M ± 2	-39
Y = any other DECT channel	-33

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Automation of DECT measurements

Receiver Interference Performance:
Measurement method

Signal generator 1 generates desired RF DECT signal on channel M with power level of -73 dBm

Signal generator 2 generates a DECT-like interferer signal on channel Y with the corresponding level

Combine two signals at RF splitter and feed into the EUT.

EUT sends the received and demodulated data stream to signal generator 1.

A series of successive BER measurements to find maximum interferer level which leads to a BER of 0.001

Is the interferer signal put on all neighbor channels ?

No

Yes

The interferer power levels recorded should be larger than the limits in the standard.

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Successive approximation

The initial level step = 3 dB.

↓

Signal generator 1 computes BER.

↓

BER > 0.001 ?

No → The level of the interferer signal is increased by current level step.

Yes

↓

Step = 0.1 dB?

No → The level of the signal is changed by a smaller step.

Yes

↓

Interferer Level is reduced 0.1 dB and recorded.
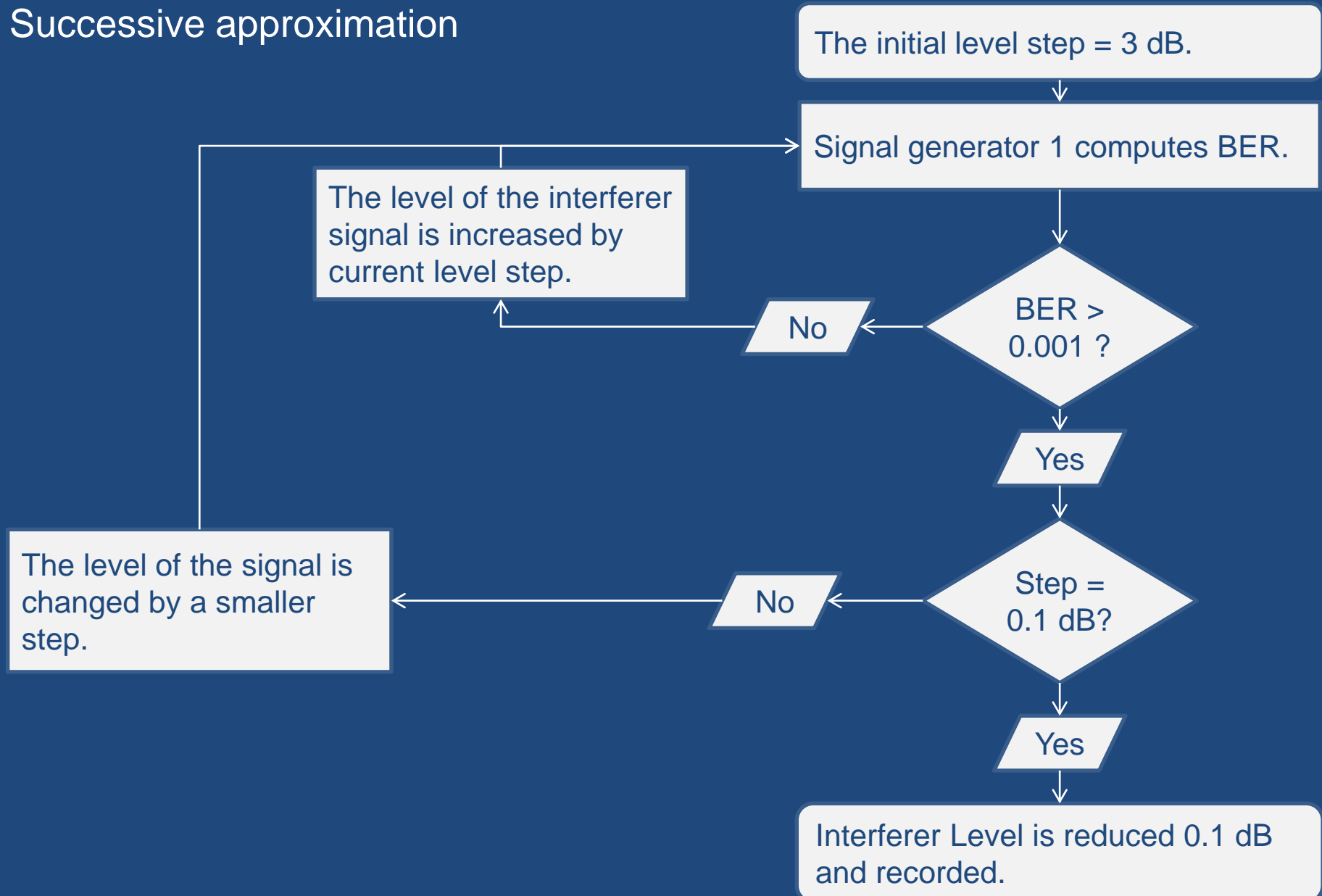
Receiver Interference Performance: results

• Verdict criteria:

Interferer on RF channel Y	Interferer signal strength (dBm)
Y = M	-84
Y = M ± 1	-60
Y = M ± 2	-39
Y = any other DECT channel	-33

• Results all within the limits

Temp (°C)	Voltage (V)	Channel	Interferer Channel	Interferer level (dBm)	Compliance with standard
25	2.6	0	-3	-21.4	passed
25	2.6	0	-2	-25.5	passed
25	2.6	0	-1	-50.2	passed
25	2.6	0	0	-80.7	passed
25	2.6	0	1	-51.7	passed
25	2.6	0	2	-25.8	passed
25	2.6	0	3	-22.1	passed
25	2.6	0	4	-20.9	passed
25	2.6	0	5	-20.2	passed
25	2.6	0	6	-19.7	passed
25	2.6	0	7	-20.5	passed
25	2.6	0	8	-15.8	passed
25	2.6	0	9	-15.1	passed
25	2.6	0	10	-14.1	passed
25	2.6	0	11	-14.4	passed
25	2.6	0	12	-20.8	passed
25	2.6	5	-3	-18.3	passed
25	2.6	5	-2	-18.2	passed
25	2.6	5	-1	-18.6	passed
25	2.6	5	0	-19.3	passed
25	2.6	5	1	-19.4	passed
25	2.6	5	2	-21.5	passed
25	2.6	5	3	-25.3	passed
25	2.6	5	4	-50.2	passed
25	2.6	5	5	-80.9	passed
25	2.6	5	6	-51.6	passed
25	2.6	5	7	-25.9	passed
25	2.6	5	8	-22.4	passed
25	2.6	5	9	-21	passed
25	2.6	5	10	-20.4	passed
25	2.6	5	11	-20	passed
25	2.6	5	12	-20.8	passed
25	2.6	9	-3	-13.2	passed
25	2.6	9	-2	-18.1	passed
25	2.6	9	-1	-18.2	passed
25	2.6	9	0	-19.4	passed
25	2.6	9	1	-18.4	passed
25	2.6	9	2	-18.2	passed
25	2.6	9	3	-18.9	passed
25	2.6	9	4	-19.4	passed
25	2.6	9	5	-19.7	passed
25	2.6	9	6	-21.5	passed
25	2.6	9	7	-25.4	passed
25	2.6	9	8	-50.1	passed
25	2.6	9	9	-80.4	passed
25	2.6	9	10	-51	passed
25	2.6	9	11	-26	passed
25	2.6	9	12	-22.6	passed

Advantages of the developed automated system

- Flexibility: extend it to be used for WDCT
- Ease of use
- Documentation

Drawbacks

- Timing: time to transfer data to PC