



## Instruction

### Z-Wave Reliability Test Guideline

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**REVISION RECORD**

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8	20070411	JFR	4.2.3	Disable PC power down feature when conducting long-term experiments

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## 1 ABBREVIATIONS

Abbreviation	Explanation
ANZ	Australia/New Zealand
BER	Bit Error Rate
CER	Communication Error Rate
DUT	Device Under Test
EEPROM	Electrically Erasable Programmable Read Only Memory
EU	Europe
FER	Frame Error Rate
HK	Hong Kong
HW	HardWare
LED	Light Emitting Diode
OEM	Original Equipment Manufacturer
SAW	Surface Acoustic Wave
SW	SoftWare
US	United States

## 2 INTRODUCTION

### 2.1 Purpose

This document is aimed at giving some guidelines on how to perform different reliability tests of Z-Wave enabled products. The purpose is to help the OEM customer to optimize the RF reliability and communication range of their products.

### 2.2 Audience and prerequisites

The target audience of this document is OEM customers who want to test the reliability of their Z-Wave enabled products. It is recommended to carefully read the Application Note [1], which gives an overview of different tests performed to verify the reliability of a Z-Wave enabled product.

### 3 Z-WAVE RELIABILITY

Because of the intrinsic nature of the RF waves, RF technologies like Z-Wave need to prove that they are reliable. Different metrics are used by other companies to describe the RF performance of a RF chip/product, but most of the time the metric Bit Error Rate (BER) or Frame Error Rate (FER) are used. Zensys goes further and uses the metric Communication Error Rate (CER) as an expression for the reliability of the product. For detailed description of the metric CER, see [1]. A Z-Wave “Tester” is used in the tests described in the following chapters. The “Tester” transmits frames to the Device Under Test (DUT) and gets acknowledgement frames from the DUT. The “Tester” checks that the frames (Command Frame and Acknowledge Frame) have been received and transmitted without error(s) by the DUT(s). In this way the two-way communication is tested.

The reliability tests are split into two groups: (1) Point-to-Point tests and (2) Network test. The Point-to-Point tests are done without Retransmission and Routing (which per default is enabled in the Z-Wave Protocol) in order to verify the RF performance of the individual DUT's. The Network test is a test of a larger network containing multiple units of the DUT. In this test the Retransmission and the Routing is enabled. The following Point-to-Point and Network tests are described within this document.

1. Point-to-Point
  - a. Temperature Reliability Test
  - b. Static Range Reliability Test
  - c. Variable Range Reliability Test
2. Network Test
  - a. Network Reliability Test

This document first describes the HW and SW parts necessary to perform the reliability tests, and then describes each of the above listed tests.

Chapter 4 describes what hardware and software are needed and how to prepare it for testing. Chapter 5 describes how to do the test setup and chapter 6 the different Z-Wave reliability tests.

## 4 WHAT IS NEEDED

The HW used to test the DUT(s) are all to be found in the Developer's Kit and the SW required is found in the "Z-Wave Reliability Test Tool" package (also supplied in the Developer's Kit).

### 4.1 Hardware:

The following HW is required to perform the reliability tests.

#### 4.1.1 Device Under Test (DUT)

The device under test can be any Z-Wave enabled product to be tested. As an example, in this document, the DUT(s) is a ZM1220 Z-Wave Module [3] implemented on an Interface Module acting as a "LED Dimmer", see Developer's Kit documentation for detailed description.

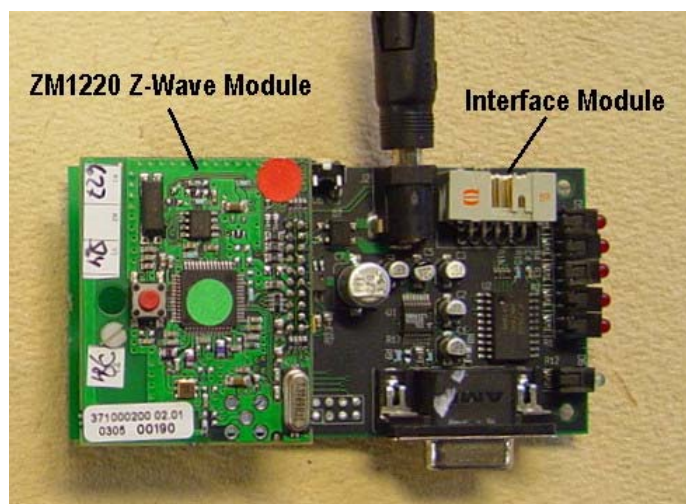


Figure 1 DUT

As the "Tester" transmits Z-Wave Commands to the DUT(s) it must be programmed to be in constant RX mode in order to receive and acknowledge the received frames. This means that battery powered products, which powers down periodically needs to be powered up constantly while performing the tests described within this document.

**Note:** As the "Tester" only supports the "Multilevel Switch Device Class" the LED Dimmer sample SW may be downloaded into the Z-Wave Module integrated into the OEM customer product. A future version of this Reliability Test SW will enable the user to insert the Device Class Type supported by the DUT in order for the DUT to operate with its final Application SW.

#### 4.1.2 "Tester"

For all the tests described within this document, a Z-Wave Controller that will act as a "Tester" is needed. The Z-Wave controller can be any Z-Wave module with an EEPROM (ZM1220 [3], ZM2120C [4], ZM3120C [5] or ZM2106C/ZM3106C mounted on ZMxx06 [7]). The example in Figure 2 shows the controller as a ZM1220 Z-Wave Module mounted on an Interface Module. The Interface Module is connected to COM1 on a PC via the serial RS232 interface as shown in the figure below.

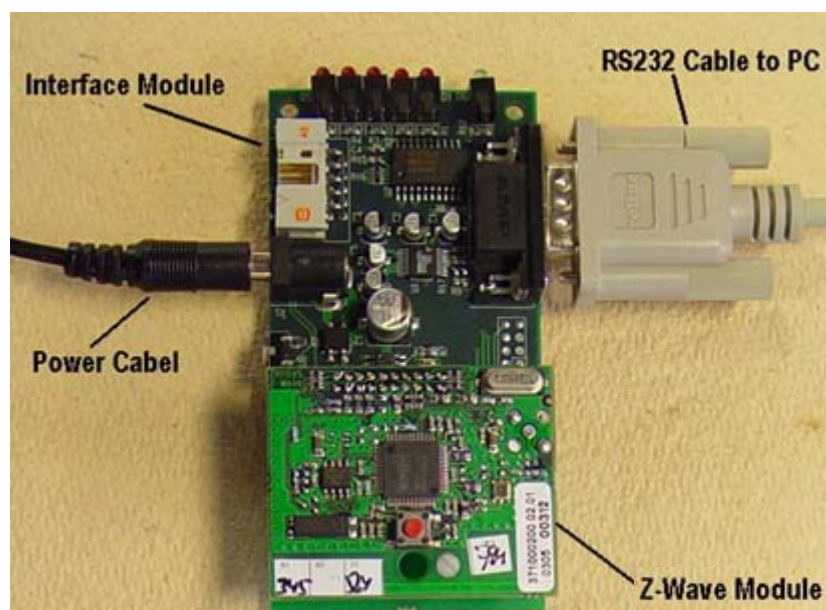


Figure 2 "Tester"

The reliability test uses the above-mentioned HW in conjunction with the PC application Enhanced Reliability Test Tool (ERTT).

**Note 1:** The "Tester" can currently only be used with DUT's supporting the "Multilevel Switch Device Class".

**Note 2:** The serial RS232 port on some computers creates an extensive amount of electrical noise, which may couple to the Z-Wave Module and decreases the RF performance of the Z-Wave Module. The solution may be to use a different PC or use optocouplers to galvanic separate the PC with the Z-Wave Module/Interface Module.

## 4.2 Software:

All the necessary software are available on the Developer's Kit CD. Refer to [2] regarding a detailed description of the software. A detailed description regarding how to program the flash and external EEPROM on the embedded modules refer to [8].

### 4.2.1 DUT

The DUT must have the LED Dimmer Application Sample code loaded to it, but it can be any Z-Wave enabled product developed by an OEM. Use the correct leddimmer\_ZW0x0x\_XX.hex file depending on the single chip (ZW0102, ZW0201 or ZW0301) and frequency (ANZ, EU, HK or US) used. It is not necessary to initialize the external EEPROM in this case.

### 4.2.2 "Tester"

The "Tester" must have the ERTT firmware code loaded to it. Use the correct serialapi\_ctrl\_single\_ZW0x0x\_XX.hex file depending on the single chip (ZW0102, ZW0201 or ZW0301)

and frequency (ANZ, EU, HK or US) used. Remember also to initialize the external EEPROM using the `extern_eep.hex` file located in the same directory.

#### 4.2.3 ERTT PC Program

The “Tester” is connected to a PC that runs the “Enhanced Reliability Test Tool” program (ERTT), which acts as a user interface for sending Z-Wave Frames and analyzing the acknowledged frames, sent back by the DUT(s). A screen dump of ERTT is shown in Figure 4.

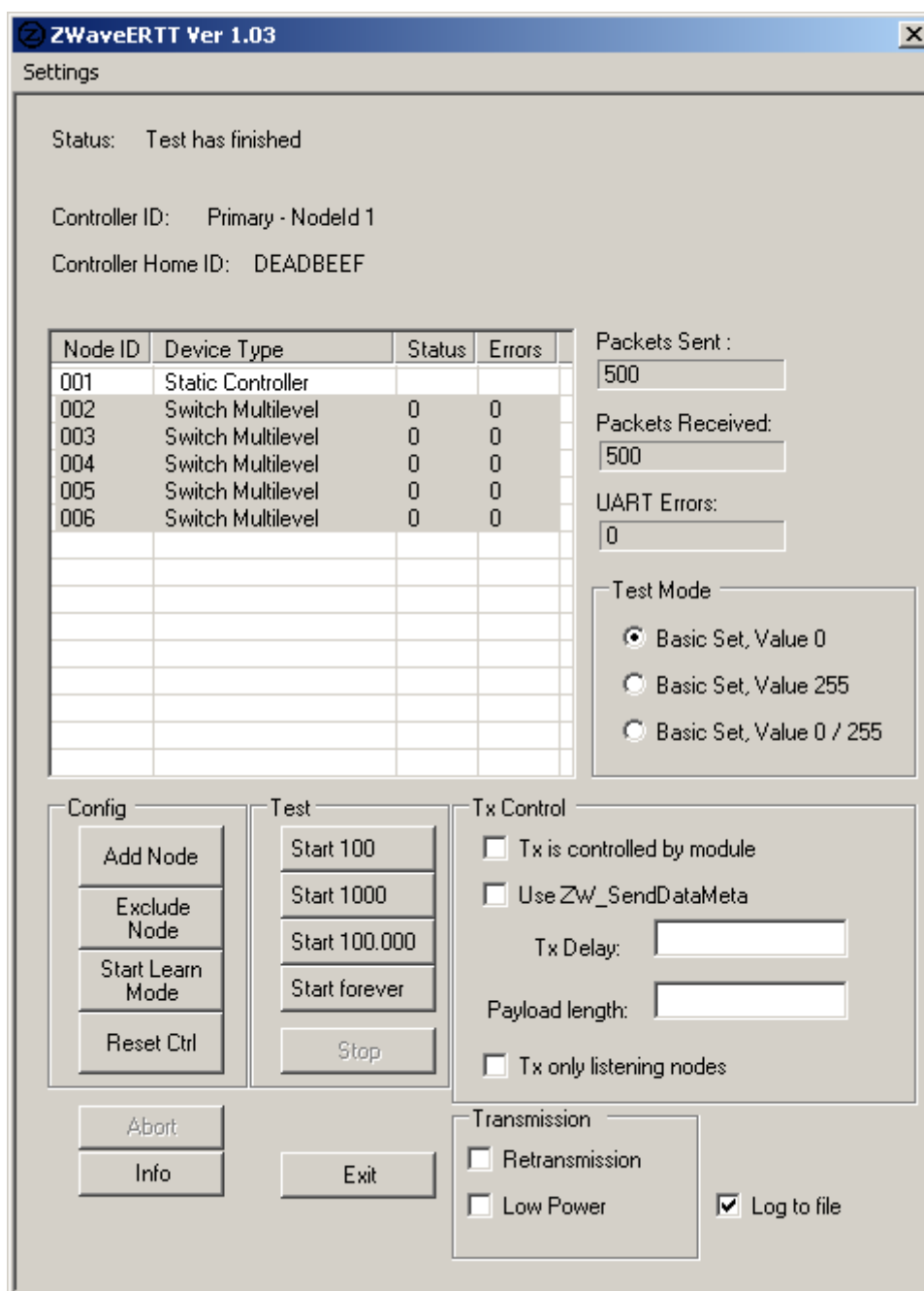


Figure 4 ERTT Screen Dump



Remember to disable PC power down feature when conducting long-term experiments.

***Retransmission Enable/Disable:***

As mentioned in section 3 the Point-to-Point tests should not use Frame Retransmission, which is enabled by not selecting the "Retransmission" field. Where as the Network test requires retransmission the "Retransmission" field should be marked.

***Test Setup:***

Before starting the test the "Tester" can be configured to transmit Basic Set Values of '0' or '255' by selecting it in the "Test Mode" field. The "Test Mode" field also allows you to shifting between '0' and '255' but should be used with care as each time the Basic Set Value changes it is written to flash in the LED Dimmer application. When writing to flash the RF reception is put "on hold". Depending on the number of nodes in the system a node may be in the process of writing to flash and will therefore not hear the Z-Wave Command sent to it.

Using the LED Dimmer Basic Set Value of '0' is equal to Dim Level 0% meaning light OFF, whereas Basic Set Value '255' is equal to Dim Level 100% meaning light full ON.

A pre-fixed or continuously number of frames can be transmitted by the "Tester". Either 100, 1000 or 100,000 frames can be transmitted by pressing the corresponding button. Continuously transmission is initiated by pressing the "Start (forever)" button. Any test can be stopped by pressing the "Stop" button.

***Test Result Window:***

The Test Result window shows the Node ID, Device Type, and current test status of each individual DUT ("Switch"). The packet transmission errors are listed for each DUT. To the right of Test Result window are the accumulated packets sent and received shown.

## 5 TEST SETUP

Before performing the different tests described in chapter 6 the test setup need to be made as follows:

- Press the “Add Node” button on the ERTT program. Immediately after press the push button on the Z-Wave Module (DUT). The DUT should now appear in the Test Result window. In case more than one DUT is needed in the network; repeat this step for each DUT.
- Select the DUT(s) in question in the Test Result window.
- Start the test by pressing the relevant button in the “Test” field.

The “Tester” and/or DUT(s) must be reset in case they are not excluded from a previously network installation. Follow the below steps to reset the DUT(s) and the “Tester” and:

- To reset a DUT press the “Exclude Node” button on the ERTT program. Immediately after press the push button on the Z-Wave Module (DUT) to be reset.
- To reset a “Tester” press the “Reset Ctrl” button on the ERTT program.

**Note:** In the Point-to-Point tests described in chapter 6 the Routing feature should ***not*** be used. Therefore only the DUT being included to the “Tester” must be powered, the remaining should be powered off in order to not be a part of a routing network.

In the Network test on the other hand Routing is used why ***all*** DUT’s must be powered while including them to the “Tester”. This ensures that they will all be a part of a routing network.

## 6 RELIABILITY TESTS:

In this chapter four different tests will be described. The three first tests are Point-to-Point tests where the RF reliability of the DUT is tested. In this case, no retransmission or routing is used. The last test is a network test, which uses retransmission and routing.

### 6.1 Temperature Test:

This test is aimed at ensuring that the Z-Wave Communication works within the temperature limits specified for the Z-Wave Enabled Product. It is recommended that the tests are performed 10-15° beyond the temperature limits specified for the product, in order to assure a margin.

#### 6.1.1 Preparation

For this test, only one DUT is required. The DUT and the "Tester" should be programmed as explained in section 5 for a non-retransmission mode.

#### 6.1.2 Setup

The DUT is placed in a temperature chamber. To avoid interferences coming from other RF sources, the DUT and the "Tester" should be RF connected with a coax cable. Note that the ZM1220/ZM2120C/ ZM3120C and ZMxx06 Z-Wave Modules have a mounting option for a SMA connector on the RF port.

As the DUT and the "Tester" is connected via a coax cable an attenuator ("Att." box in Figure 6-1) is required in order to attenuate the RF signal and thereby assure that RF Transceiver in the ASIC is not saturated. A receive level of approximately -70dBm is desired.

The "No retransmission" field should be checked. The number of frames to transmit during the ERTT test depends on the wanted error rate precision. Normally 100,000 to 1,000,000 frames are used. Any "Basic Set Value" can be used.

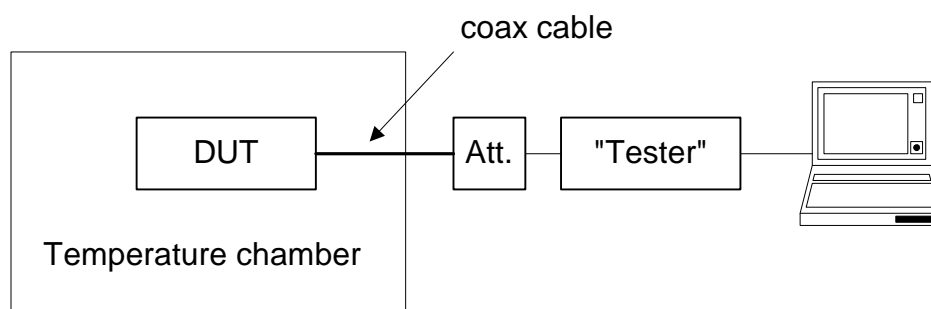


Figure 6-1 Temperature Test setup

## 6.2 Static Range Test:

This test is aimed at ensuring that the Z-Wave Communication works reliable within a given range. In this test, three different DUT's could be used in order to simulate interaction between Z-Wave Nodes. The antenna of the "Tester" and the DUT's will be used. Neither retransmission nor routing is used in this test.

### 6.2.1 Preparation:

The three DUT's need to be included in the same network done as described in section 5. It is important to note that, when including each DUT's to the "Tester" the other two DUT's should be powered off. This is done to avoid routing in the test.

### 6.2.2 Setup:

The three DUT's could be placed at 10, 20 and 30 meters respectively from the "Tester" in an unobstructed room (see Figure 6-2). The "No retransmission" field should be checked. 500,000 are an example on the number of frames that are transmitted to each of the DUT individually. Any "Basic Set Value" can be used.

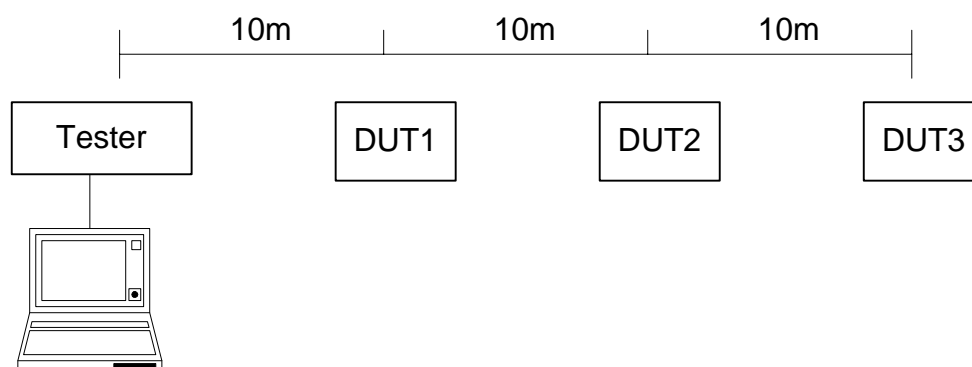


Figure 6-2 Static Test setup

## 6.3 Variable Range Test:

This test is aimed at ensuring that the Z-Wave Communication performs well even with RF fading effects. For that, 5 DUT's (or less) can be used in this test. Because the "Tester" will have to be moved during the test, it is recommended that the PC (laptop) and the "Tester" is placed on a rolling table making it easy to move.

### 6.3.1 Preparation:

The five DUT's need to be included in the same network done as described in section 5. It is important to note that, when including each DUT's to the "Tester" the other four DUT's should be powered off. This is done to avoid routing in the test. For each location, 100 frames (for instance) are sent to each of the DUT.

### 6.3.2 Setup:

The five DUT's should be located 1 meter above the floor and 0.4 meter from each other in a large unobstructed room. The "No retransmission" box should be checked. The "Tester" should be placed at 5-meter intervals. A possible range could be from 5 to 50 meters. For each 5 meter "step", the "Tester" is located four different positions (4 angles of a 30 cm square) and sends 100 frames to each DUT at each position. Figure 6-3 shows the setup of this test. Each small circle represents a location of the "Tester".

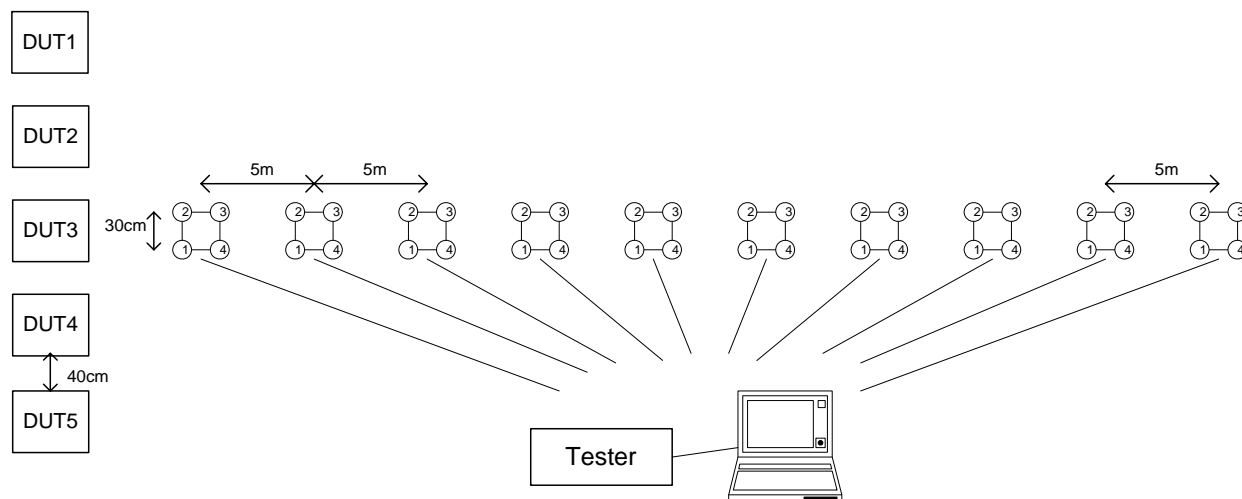


Figure 6-3 Variable Distance Test setup

## 6.4 Z-Wave Network Reliability Test:

This test is aimed at testing the Z-Wave Communication in real life environment. For that purpose, retransmission and routing are used. This test can for instance contain 15 DUT's in order to have a good representation of a "normal home" scenario.

### 6.4.1 Preparation:

The 15 DUT's need to be included in the same network done as described in section 5. It is important to note that, when including each DUT's to the "Tester" all 15 DUT's should be powered on. This is done to enable the routing in the test.

### 6.4.2 Setup:

The 15 DUT's should be placed in what is believed to be a worse case office/home environment, with walls, doors and windows etc. The placement of the DUT's should be done so as the distance between them is roughly equal. Any "Basic Set Value" can be chosen. The "No retransmission" field should be left unchecked.

## 7 REFERENCES

- [1] Zensys, APL10044, Application Note, Z-Wave Reliability
- [2] Zensys, INS10247, Instruction, Z-Wave ZW0102/ZW0201/ZW0301 Application Programming Guide
- [3] Zensys, DSH10033, Datasheet, ZM1220 Z Wave Module
- [4] Zensys, DSH10275, Datasheet, ZM2120C Z-Wave Module Datasheet
- [5] Zensys, DSH10857, Datasheet, ZM3120C Z-Wave Module Datasheet
- [6] Zensys, DSH10086, Datasheet, Datasheet ZW010x Interface Module
- [7] Zensys, DSH10088, Datasheet, ZMxx06 Converter Module
- [8] Zensys, INS10679, Instruction, Z-Wave Programmer User Guide