# TECHNICAL REPORT

# CISPR 16-3

2003

AMENDMENT 1
2005-07

INTERNATIONAL SPECIAL COMMITTEE ON RADIO INTERFERENCE

Amendment 1

## Specification for radio disturbance and immunity measuring apparatus and methods –

## Part 3: CISPR technical reports





International Electrotechnical Commission, 3, rue de Varembé, PO Box 131, CH-1211 Geneva 20, Switzerland
Telephone: +41 22 919 02 11 Telefax: +41 22 919 03 00 E-mail: inmail@iec.ch Web: www.iec.ch

Commission Electrotechnique Internationale
International Electrotechnical Commission
Международная Электротехническая Комиссия

PRICE CODE S

*For price, see current catalogue*

# FOREWORD

This amendment has been prepared by CISPR subcommittee A: Radio interference measurements and statistical methods.

The text of this amendment is based on the following documents:

| DTR | Report on voting |
|---|---|
| CISPR/A/572/DTR | CISPR/A/586/RVC |

Full information on the voting for the approval of this amendment can be found in the report on voting indicated in the above table.

The committee has decided that the contents of this amendment and the base publication will remain unchanged until the maintenance result date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.



---

Page 10

## 4 Technical reports

*Add, on page 186, after the existing subclause 4.6, the following new subclause:*

### 4.7 Correlation between amplitude probability distribution (APD) characteristics of disturbance and performance of digital communication systems

#### 4.7.1 Introduction

The relationship between the degradation in quality of digital communication systems and APD of disturbance is shown in the following experimental results. Actual microwave ovens (MWO), such as the transformer and the inverter types, and a noise simulator, were used as a noise source in the following experiment. Bit Error Rate without error correction was basically used as a parameter of communication system performance (e.g., W-CDMA and PHS). Throughput is used if error correction could not be removed (e.g., W-LAN, Bluetooth and PHS).

Quantitative correlation between noise parameters and system performance is shown in 4.7.6 and 4.7.7 by using measured and simulated results.

These results show that APD measurement of disturbance is suitable for evaluating its interference potential on digital communication systems. Therefore APD measurement may be applicable to the compliance test of some products or product families, such as microwave ovens.

### 4.7.2 Influence on a wireless LAN system

The set-up for measuring communication quality degradation is shown in Figure 4.7.1, and measurement conditions are shown in Table 4.7.1. Throughput was chosen as a measure for communication quality evaluation. It was calculated from the time taken to transmit and time to receive data of a fixed size.

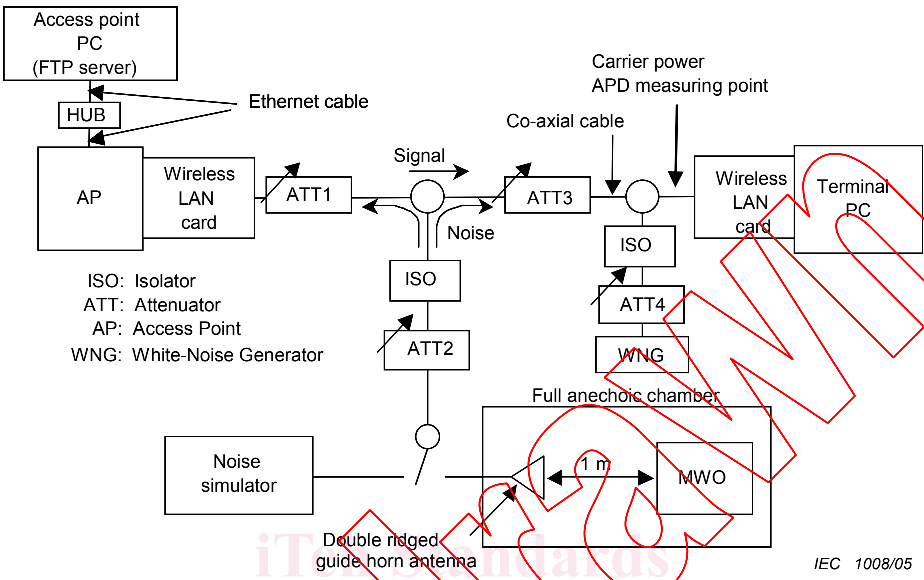



**Figure 4.7.1 – Set-up for measuring communication quality degradation of a wireless LAN**



**Table 4.7.1 – Conditions for measuring communication quality degradation**

| | | |
|---|---|---|
| **Wireless LAN** | Frequency (channel) | 2 462 MHz (11ch) |
| | Transmission data | 20 Mbyte |
| | Protocol | FTP (GET command from terminal PC) |
| | Transmission mode | Packet transmission |
| **Others** | Noise power density $N_0$ (dBm/Hz) | –154 dBm/Hz (set by ATT4) |

The APDs of disturbance are shown in Figure 4.7.2. The horizontal axis shows the level of radiated noise normalized by $N_0$, which has been approximated as the noise level from the white noise generator. The main frequency for measuring APD was 2462 MHz. The average and root-mean-square (RMS) values of the noise level normalized by $N_0$ derived from APD of the MWO noise and noise simulator noise are shown in Table 4.7.2.

APD of the noise simulator at *ATT2* = 0 dB was in good agreement with APD of the inverter type MWO at *ATT2* = 10 dB.

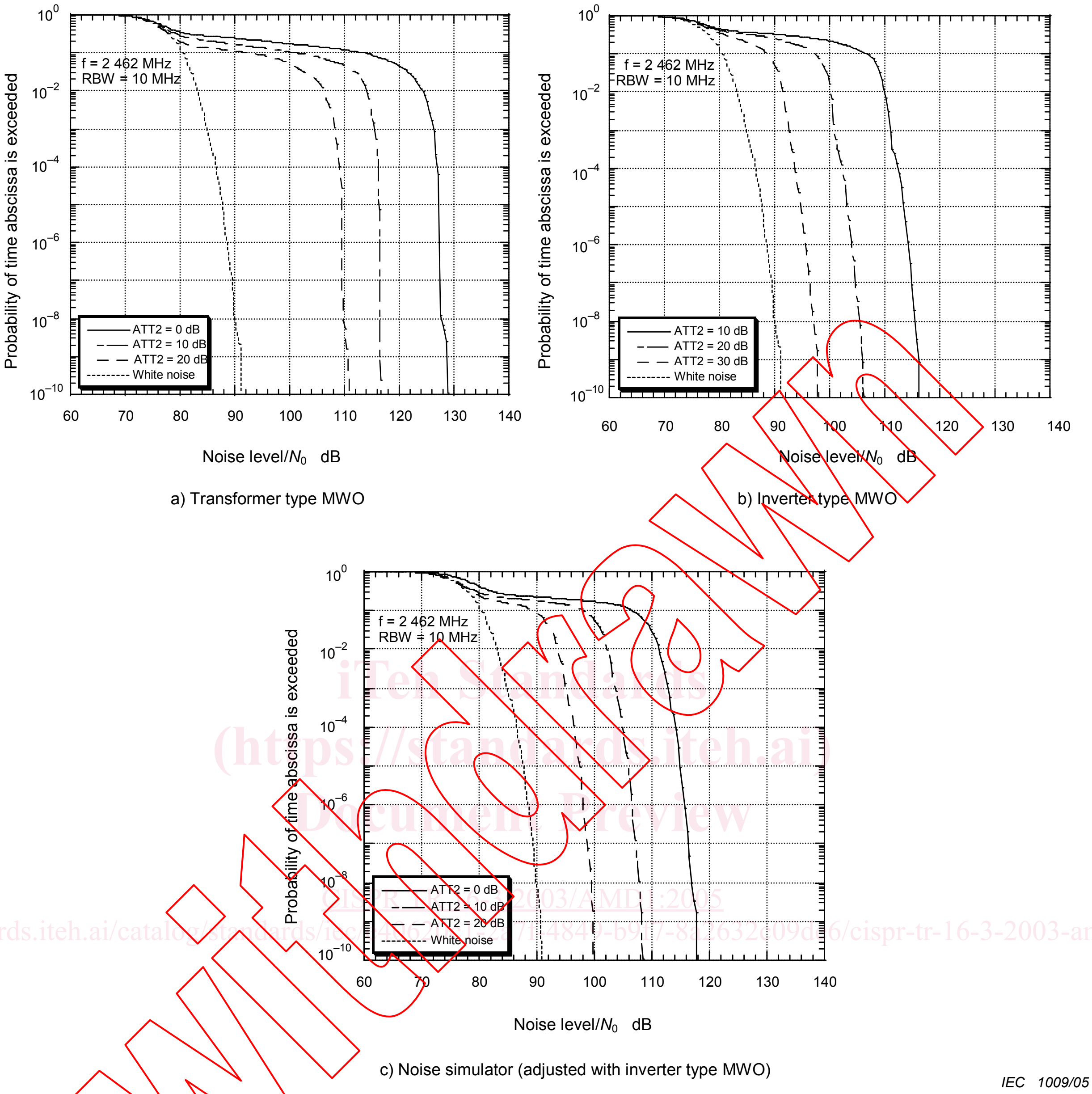



**Figure 4.7.2 – APD characteristics of disturbance**

**Table 4.7.2 – Average and RMS values of noise level normalized by $N_0$**

| | | ATT2 | | | | White noise |
|---|---|---|---|---|---|---|
| | | 0 dB | 10 dB | 20 dB | 30 dB | |
| **Transformer type MWO** | Average (dB) | 111,2 | 101,0 | 92,6 | | 77,6 |
| | RMS (dB) | 117,1 | 107,0 | 98,8 | | 78,7 |
| **Inverter type MWO** | Average (dB) | | 100,6 | 91,4 | 83,4 | 77,6 |
| | RMS (dB) | | 104,4 | 94,8 | 86,2 | 78,7 |
| **Noise simulator** | Average (dB) | 100,6 | 91,9 | 83,8 | | 77,5 |
| | RMS (dB) | 105,1 | 96,2 | 87,6 | | 78,6 |

The measured communication quality degradation for various amounts of attenuation of injected noise is shown in Figure 4.7.3.

The horizontal axis shows $C/N_0$, where $C$ is the sub-carrier power and $N_0$ is the noise power density.

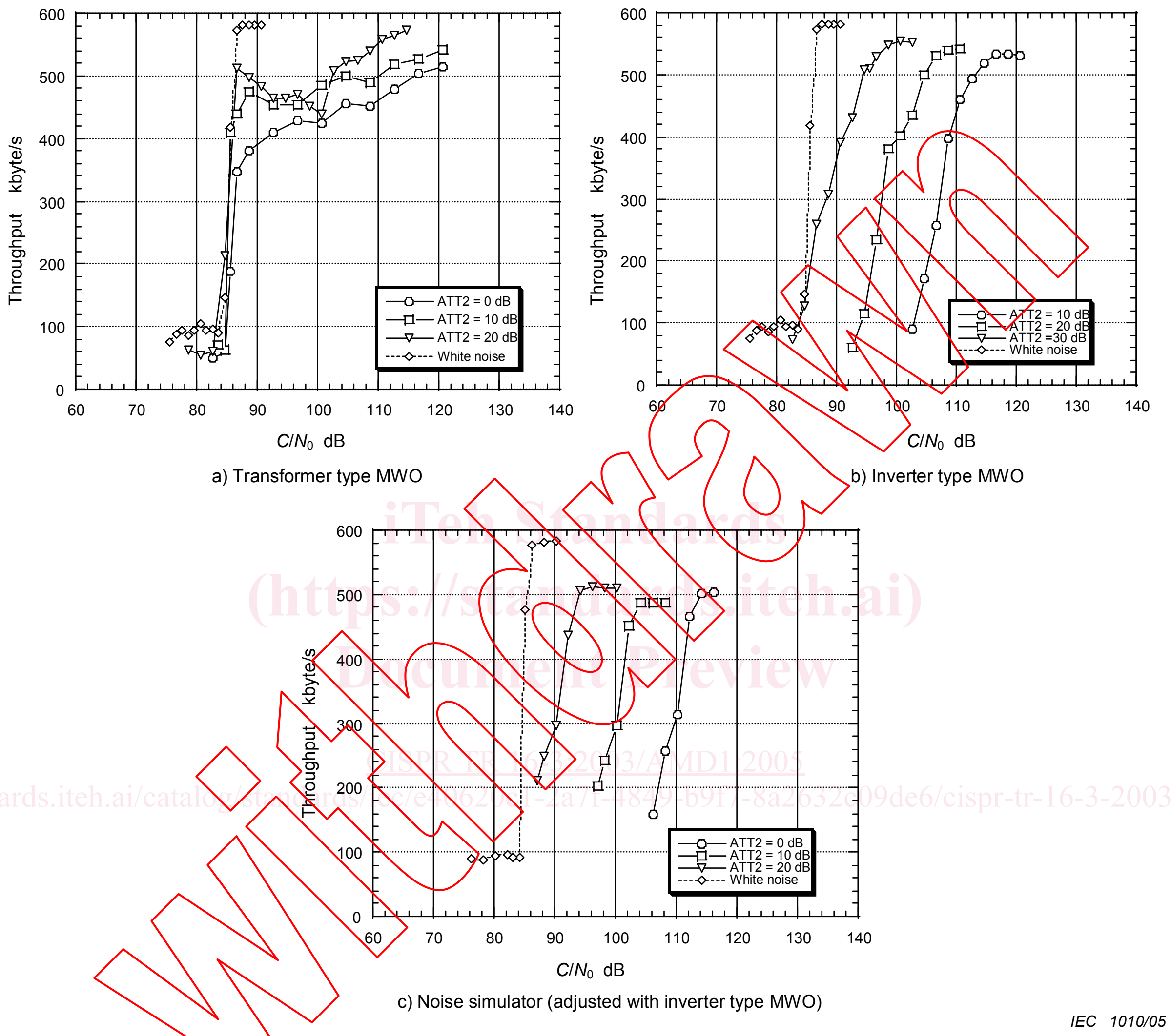





**Figure 4.7.3 – Wireless LAN throughput influenced by noise**

The throughput influenced by a transformer type MWO is 400 kbytes/s or more when $C/N_0$ is 90 dB or more, and decreases rapidly when $C/N_0$ is below 90 dB. This tendency is almost the same irrespective of the noise level. On the other hand, the throughput influenced by an inverter type MWO decreases almost in proportion to the noise level. The throughput influenced by a noise simulator has almost the same degradation characteristics as that for an inverter type MWO.

### 4.7.3 Influence on a Bluetooth system

The setup for measuring communication quality degradation is shown in Figure 4.7.4, and measurement conditions are shown in Table 4.7.3.

Throughput was chosen as the measure for communication quality evaluation.

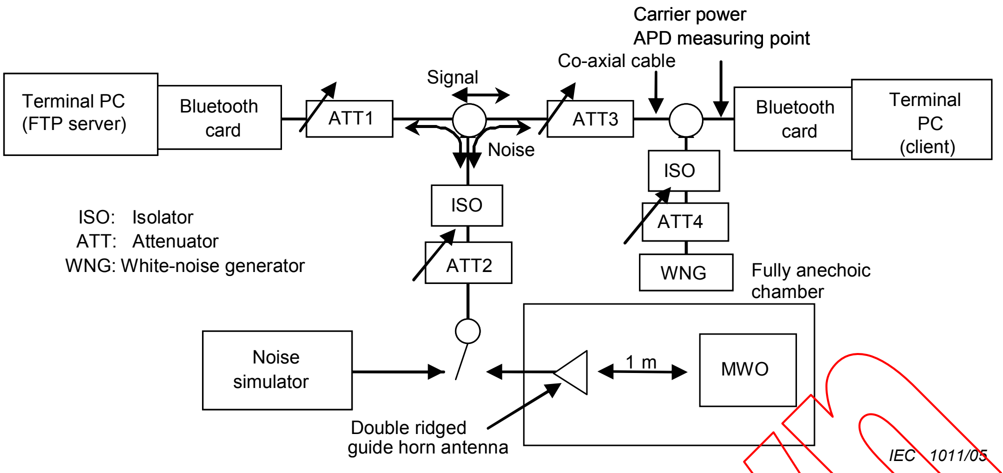
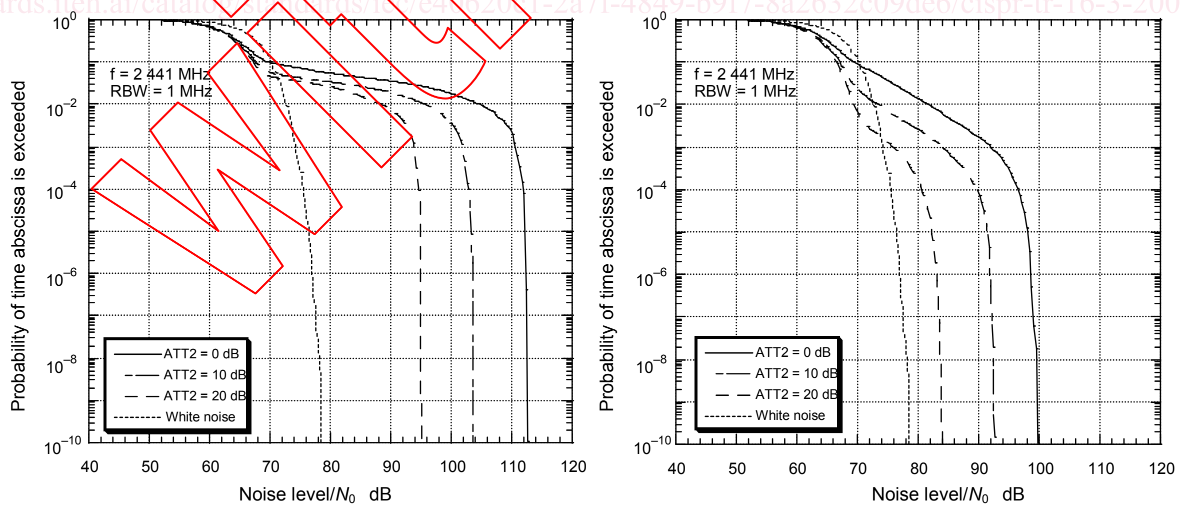



**Figure 4.7.4 – Set-up for measuring the communication quality degradation of Bluetooth**

**Table 4.7.3 – Conditions for measuring communication quality degradation of Bluetooth**

| | | |
|---|---|---|
| **Bluetooth** | Frequency | 2 400 – 2 483,5 MHz |
| | Transmission data | 2,5 Mbyte |
| | Protocol | FTP (GET command from terminal PC) |
| | Transmission mode | Packet exchange data transmission mode |
| **Others** | Noise power density $N_0$ (dBm/Hz) | -148 dBm/Hz (set by ATT4) |

The APDs at a frequency of 2 441 MHz are shown in Fig. 4.7.5, and the average and RMS values of noise level normalized by $N_0$ are shown in Table 4.7.4.




a) Transformer type MWO

b) Inverter type MWO

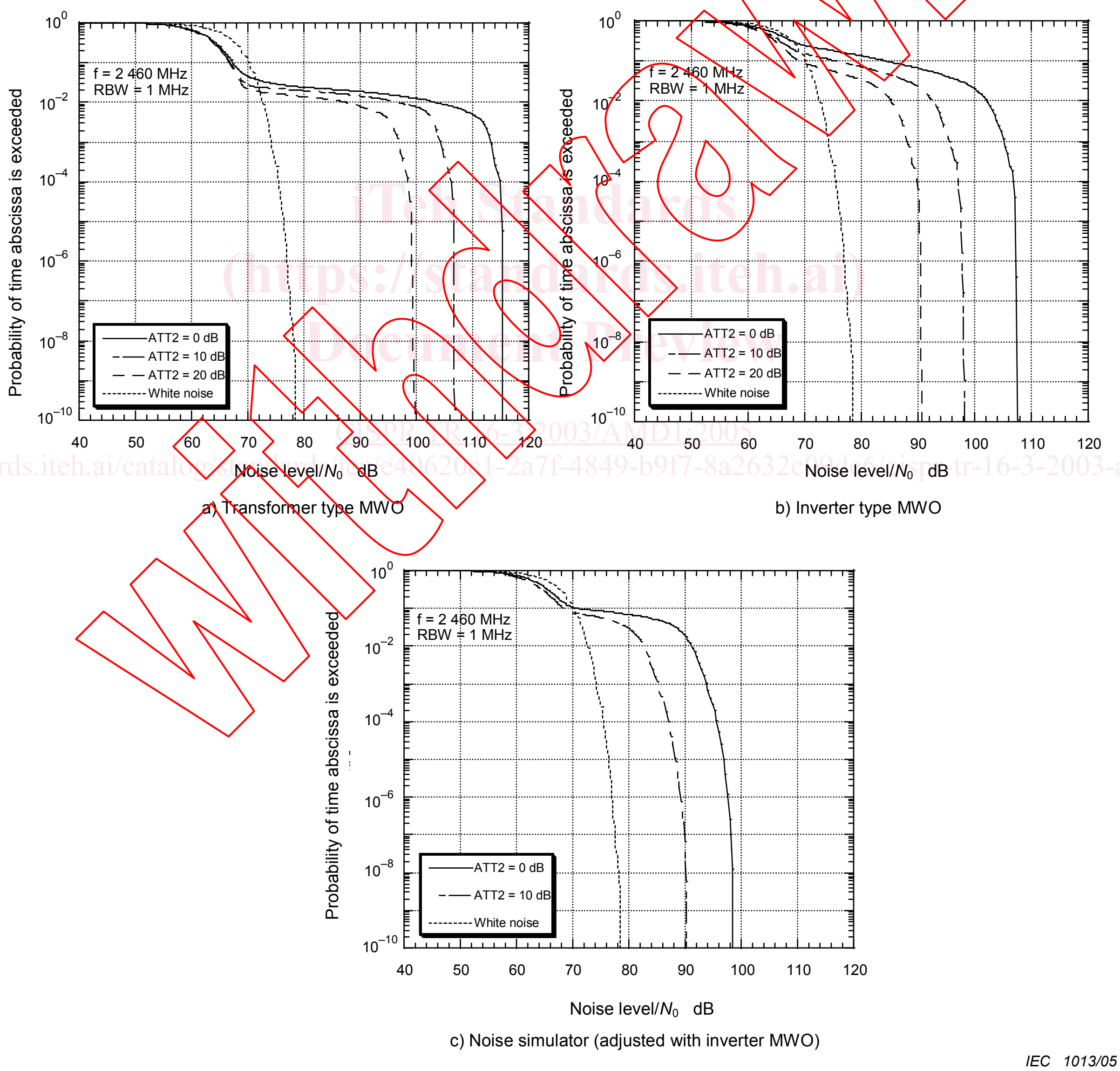
IEC 1012/05

**Figure 4.7.5 – APD of disturbance of actual MWO (2 441MHz)**

**Table 4.7.4 – Average and RMS values of noise level normalized by $N_0$**

| | | ATT2 | | | | White noise |
|---|---|---|---|---|---|---|
| | | 0 dB | 10 dB | 20 dB | 30 dB | |
| **Transformer type MWO** | Average (dB) | 89,8 | 80,8 | 73,7 | | 67,1 |
| | RMS (dB) | 99,2 | 90,2 | 82,5 | | 68,3 |
| **Inverter type MWO** | Average (dB) | 70,7 | 65,4 | 63,5 | | 67,1 |
| | RMS (dB) | 80,6 | 73,3 | 66,0 | | 68,3 |

The APDs measured at 2 460 MHz, where the noise level of an MWO is at maximum, are shown in Figure 4.7.6, and the average and RMS values of noise normalized by $N_0$ are shown in Table 4.7.5. The noise level is about 10 dB larger than that at the frequency of 2 441 MHz. The APD of the noise simulator at *ATT2* = 0 dB is in good agreement with that of the inverter type MWO at *ATT2* = 10 dB.




a) Transformer type MWO

b) Inverter type MWO

c) Noise simulator (adjusted with inverter MWO)

IEC 1013/05

**Figure 4.7.6 – APD characteristics of disturbance (2 460 MHz)**

**Table 4.7.5 – Average and RMS values of noise level normalized by $N_0$**

| | | ATT2 | | | | White noise |
|---|---|---|---|---|---|---|
| | | 0 dB | 10 dB | 20 dB | 30 dB | |
| **Transformer type MWO** | Average (dB) | 87,8 | 78,4 | 71,4 | | 67,1 |
| | RMS (dB) | 94,9 | 85,4 | 78,0 | | 68,3 |
| **Inverter type MWO** | Average (dB) | 70,7 | 65,4 | 63,5 | | 67,1 |
| | RMS (dB) | 80,6 | 73,3 | 66,0 | | 68,3 |
| **Noise simulator** | Average (dB) | 77,6 | 69,8 | | | 67,1 |
| | RMS (dB) | 84,1 | 75,5 | | | 68,3 |

The measured communication quality degradation for various amounts of attenuation of injected noise is shown in Figure 4.7.7.

There is only a minor difference in degradation caused by the level of noise between a transformer and an inverter type MWO. This is because Bluetooth performs frequency hopping, and is hard to be influenced by noise continuously. Furthermore, there is almost no difference in communication quality degradation for a noise simulator.



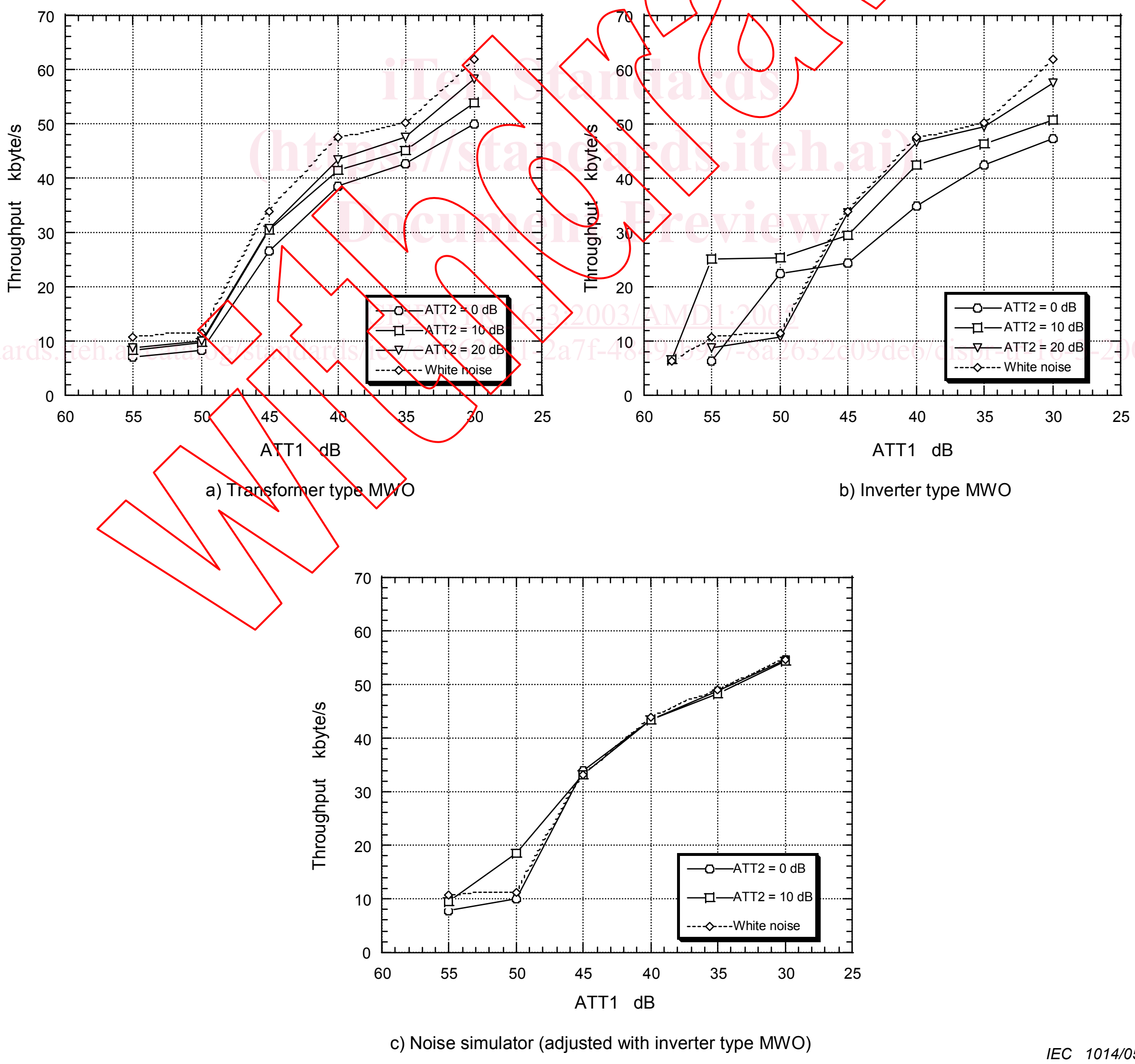



**Figure 4.7.7 – Throughput of Bluetooth influenced by noise**

According to the specifications, Bluetooth controls the transmission power automatically depending on the communication situation. The sub-carrier power at the reception point cannot be obtained uniquely since transmission power may change when ATT1 is changed. The horizontal axis in this figure shows the attenuation of signal power.

### 4.7.4 Influence on a W-CDMA system

The set-up for measuring communication quality degradation is shown in Figure 4.7.8, and measurement conditions are shown in Table 4.7.6.

Bit error rate (BER) was chosen as the measure for communication quality evaluation.

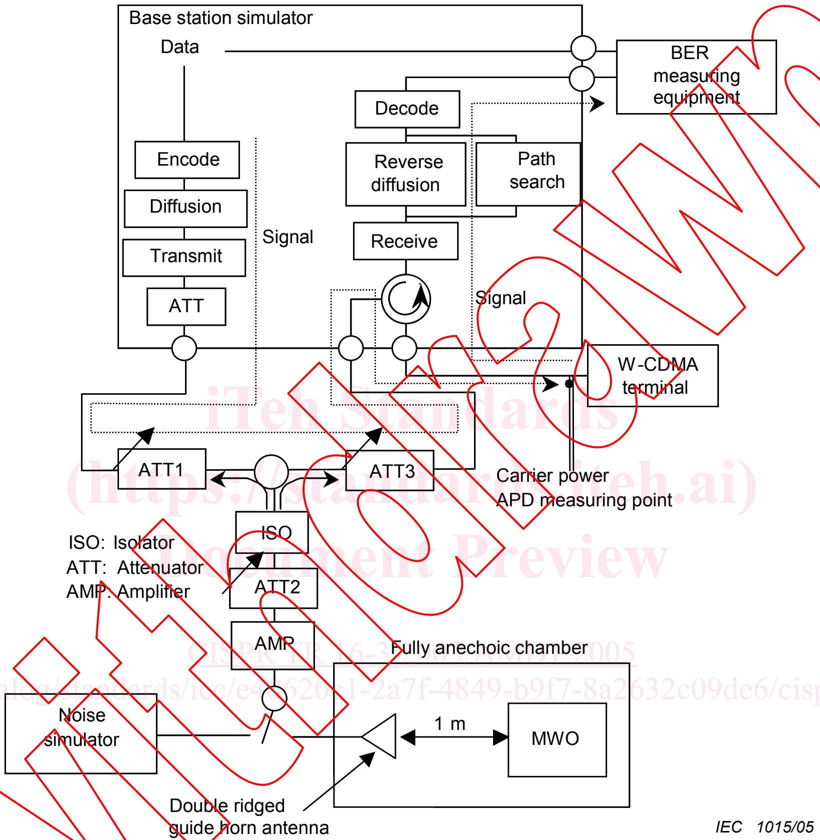


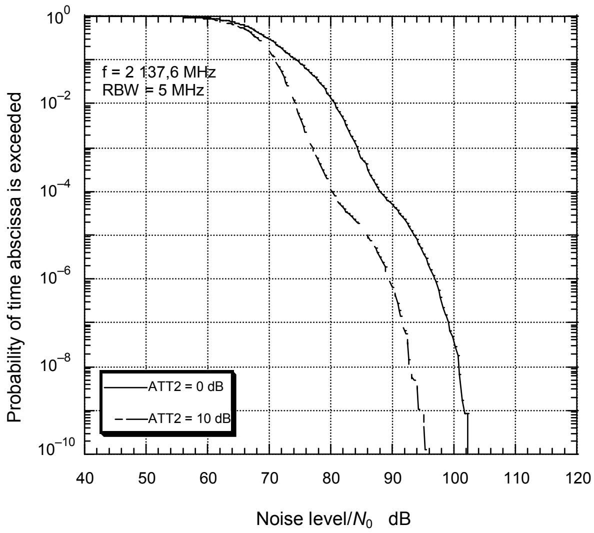



**Figure 4.7.8 – Setup for measuring the BER of W-CDMA**

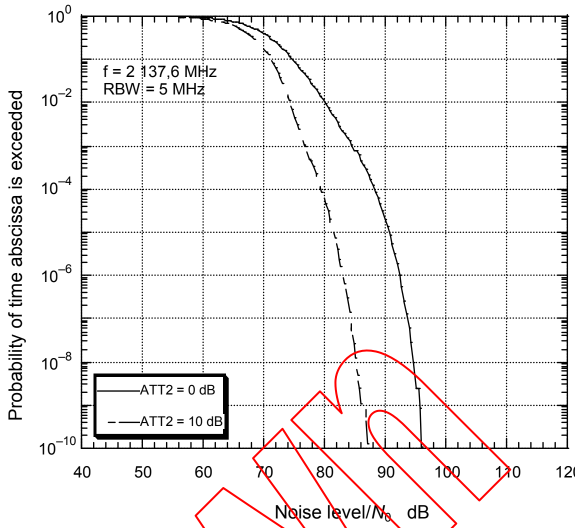
**Table 4.7.6 – Conditions for measuring communication quality degradation of W-CDMA**

| | | |
|---|---|---|
| **Base band simulator** | Frequency | 2 137,6 MHz (downlink) |
| | Chip rate | 3,84 Mcps |
| | Spread rate | Uplink: DPDCH 64 / downlink: DPCH 128 |
| | Data rate | 12,2 kbps (acoustic) |
| | Transmission data | 6 Mbit |
| | Transmission mode | RMC communication test (UE turn)<br>3GPP TS34.121 |

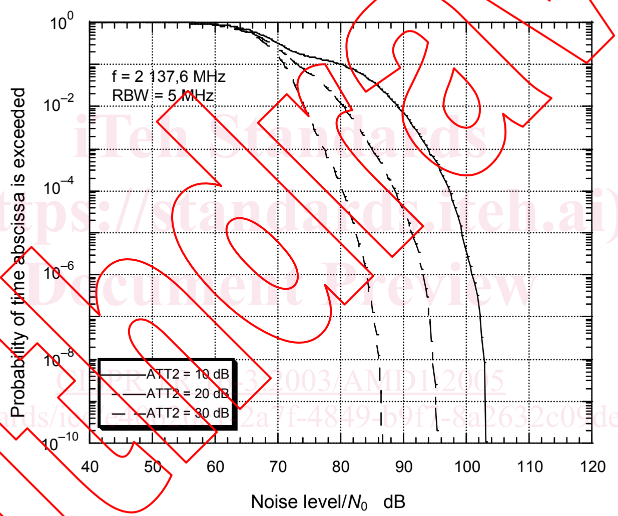
The measured APDs of the noise are shown in Figure 4.7.9, and the average and RMS values of the noise level normalized by $N_0$ are shown in Table 4.7.7. The APD of the noise simulator at *ATT2* = 0 dB is in good agreement with the APD of the inverter type MWO at *ATT2* = 10 dB.




a) Transformer type MWO




b) Inverter type MWO




c) Noise simulator (adjusted with inverter MWO)

*IEC 1016/05*



**Figure 4.7.9 – APD characteristics of disturbance**

**Table 4.7.7 – Average and RMS values of noise level normalized by $N_0$**

| | | ATT2 | | | | Receiver noise |
|---|---|---|---|---|---|---|
| | | 0 dB | 10 dB | 20 dB | 30 dB | |
| **Transformer type MWO** | Average (dB) | 71,1 | 67,7 | | | 67,2 |
| | RMS (dB) | 75,1 | 69,4 | | | 68,6 |
| **Inverter type MWO** | Average (dB) | 71,6 | 68,0 | | | 67,2 |
| | RMS (dB) | 74,7 | 69,4 | | | 68,6 |
| **Noise simulator** | Average (dB) | | 77,1 | 70,4 | 67,7 | 67,2 |
| | RMS (dB) | | 83,3 | 74,7 | 69,3 | 68,6 |

The measured communication quality degradation for various amounts of attenuation of injected noise is shown in Figure 4.7.10.