# Annex to Test Report 4_DIGI_0602_ERF_FCCa

# Processing gain Measurement

for

Motorola Bluetooth™ Phone Module II
BTP2M100

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## Introduction

This report describes the results of the processing gain measurement for the Motorola Bluetooth Phone Module II using the FCC CW jamming margin method.

## Requirement

Hybrid systems that employ a combination of both direct sequence and frequency hopping modulation techniques shall achieve a processing gain of at least 17 dB from the combined techniques.

## Modification of measurement method

Despreading is accomplished by correlating the received bit stream with the bit pattern of the access code. Then with the value of the correlator output will be decided if the access code is valid or not.
That means if the access code is not valid a "bit error" occurs for the Bluetooth device.
For this reason in CW jamming margin method the ratio of invalid access codes (IACR) is used instead of the BER.
Another reason to use this criteria is the fact, that the Bluetooth technology uses the access code to find the correct sampling point. That means if the access code cannot be found, all other bits in the transmission cannot be sampled successfully.

## System loss

In the formula to calculate the processing gain the term system loss appears. In Bluetooth there are two major causes for the system loss:

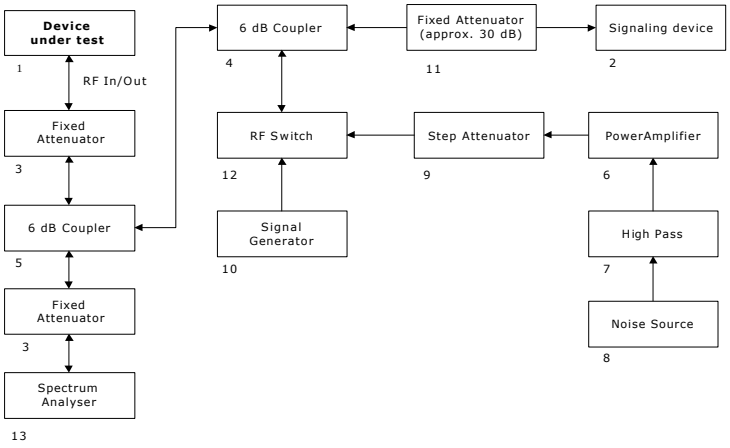
1. The non optimal sampling time. The CW jamming method assumes that the optimal sampling time as determined before, in fact, as described above, will be determined via the access code.

2. Loss due to attenuation in the RF part.

Although these two points produce a system loss which will be much greater than 2 dB, we took that value for the calculation, because this is the maximum which will be accepted by the FCC.

## Measurement Set-up

To measure the IACR the following test set-up was used:




*RF block diagram*
*Note: For detailed information about the equipment please see test equipment list*

For the measurement of the invalid access codes a special test program was used. It was installed on the laptop and controlled the Motorola Bluetooth Development Kit.

In the result the number of invalid access codes for a packet of 255 transmissions is given. For this test 200 packets (51000 bursts) were measured.
For the selected IACR of 0.1% it means that 51 access codes are not valid.

The level of the wanted signal was set for all single measurements to -48.3 dBm.

# Measurement Results

## S/N Measurement

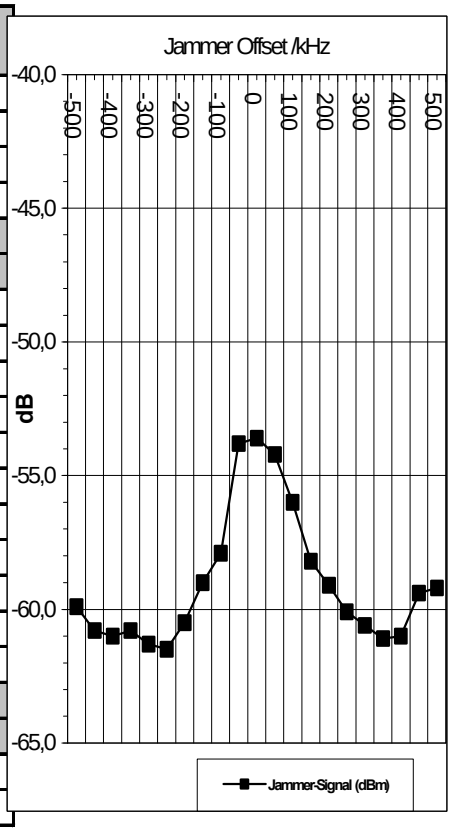
The measurement for S/N was performed by adding noise to the wanted signal. The noise level was adjusted until the IACR reached 0.1%.

With this measurement configuration the S/N ratio was 18.7 dB.

## Jammer-Signal Measurement

The jammer signal was stepped in 50 kHz steps over the receiving channel.
For every step the jammer level was adjusted until the IACR was 0.1 %. The ratio between wanted signal power and the jammer power at the RF input of the device is the required Jammer to Signal ratio (JSR).
With this measurement configuration the Jammer-signal measurement results are as follows:

| Jammer Offset/kHz | Jammer-Signal (dBm) |
|---|---|
| -500 | -59,9 |
| -450 | -60,8 |
| -400 | -61,0 |
| -350 | -60,8 |
| -300 | -61,3 |
| -250 | -61,5 |
| -200 | -60,5 |
| -150 | -59,0 |
| -100 | -57,9 |
| -50 | -53,8 |
| 0 | -53,6 |
| 50 | -54,2 |
| 100 | -56,0 |
| 150 | -58,2 |
| 200 | -59,1 |
| 250 | -60,1 |
| 300 | -60,6 |
| 350 | -61,1 |
| 400 | -61,0 |
| 450 | -59,4 |
| 500 | -59,2 |




Disregarding the marked data points (-300, -250, 350, 400 kHz) the worst data point is at -400 kHz (Jammer-signal -61,0 dBm) with a Jammer / wanted Signal value of –12.7 dB.

## Processing gain calculation

With these values the processing gain for the DSS part of the system is calculated to:
Mj = JSR = -12.7 dB
S/N = 18.7 dB
Gp = S/N + Mj + Lsys = 18.7 – 12.7 + 2.0 = **8.0 dB**

The processing gain for FHSS part is calculated as:
10 * log 32 = 15 dB (32 hopping channels in **hybrid mode**)

This means for the **total processing gain** of the **hybrid system**:
15 dB + 8.0 dB = **23.0 dB**

This is above the minimum value of 17 dB stated in FCC rules.

**The device passes the requirement of this clause.**

## Test equipment

| no | Single Devices | Type | Serial No | Manufacturer |
|---|---|---|---|---|
| 2 | Motorola Bluetooth Development Kit | BTP2M100 | - | Digianswer |
| 3 | Attenuator, 3 dB | Model 4T-3 | D9355 | Weinschel |
| 4 | Broadband Resist. Power Divider N | 1506A / 93459 | LM390 | Weinschel |
| 5 | Broadband Resist. Power Divider SMA | 1515 / 93459 | LN673 | Weinschel |
| 6 | Broadband Amplifier 45MHz-27GHz | JS4-00102600-42- | 619368 | Miteq |
| 7 | High Pass Filter | 5HC2700/12750-1.5-KK | 9942012 | Trilithic |
| 8 | Noise Emitter | CNE III | 99/016 | York |
| 9 | RF Step Attenuator | RSP | 833695/001 | Rohde & Schwarz |
| 10 | Signal Generator | SMIQ 03B | 832492/061 | Rohde & Schwarz |
| 11 | Attenuator, 30 dB | - | - | Weinschel |
| 12 | Manual Switch | - | - | 7 layers |
| 13 | EMI Analyzer | ESI 26 | 830482/004 | Rohde & Schwarz |