



Products: SMIQ

Generating Bluetooth™ RF Test Signals With SMIQ Signal Generator

Application Note

With SMIQ Signal Generator you can generate the most important Bluetooth RF test signals fast and conveniently. This application note comes with files containing modulation data for various payload patterns and burst lengths. A list of patterns is included. With the transfer software, also enclosed with this application note, you can load the data records into SMIQ and start testing immediately.

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1 Overview

With SMIQ Signal Generator you can generate the most important Bluetooth RF test signals fast and conveniently. This application note comes with files containing modulation data for various payload patterns and burst lengths. A list of patterns is included. With the transfer software, also enclosed with this application note, you can load the data records into SMIQ and start testing immediately.

The test signals discussed here provide bursts with constant, repeated data patterns. They are intended for use in development and production, for example as stimulus signals for receiver and transmitter tests (in loopback mode).

You can also use the test signals to simulate the transmitter signal of a Bluetooth module, and so configure test assemblies for transmitter tests before a DUT is available. Measurements on Bluetooth transmitters with Analyzers FSE, FSIQ and FSP are described in Application Notes 1MA26 and 1MA33 [4], [5].

To generate Bluetooth signals, your SMIQ must be fitted with options Modulation Coder SMIQB20 and Data Generator SMIQB11.

Note: *Bluetooth test signals can also be generated using a combination of an AMIQ I/Q Modulation Generator, an SMIQ Signal Generator and the software application WinIQSIM. This configuration is described in Application Note 1GP38 [3], with the emphasis on how to define each information element of the burst data separately. The test signals described here – with constant, continuously repeated data contents – are sufficient for most practical applications.*

2 Structure of Bluetooth Signals

Slots, Packets and Payload Patterns

Bluetooth operates in the Time Division Duplex (TDD) mode. This means that transmit and receive bursts continuously alternate in a pattern organized in time slots. Each time slot is 625 µs wide.

Bursts for voice transmission require one slot, bursts for data transmission can require one, three or five slots. So, links with different transmit and receive data volumes can be set up.

In each slot, a different frequency is used (fast frequency hopping). The bit rate is 1 Mbit/s, the modulation method is GFSK with BT = 0.5.

Each burst transmits a data referred to as a packet. A packet contains all the valid bits of a burst. A Packet consists of an access code field, a header field and a payload field. Fig. 1 shows the general structure of a packet:



Fig. 1: General structure of a Bluetooth packet

The 72-bit access code contains a 4-bit preamble, a 64-bit synchronization word derived from the module address, and four filler bits.

The 54-bit header field contains link controller information such as active member address, type code, flow control, etc.

The payload field, which contains the useful data, is of main interest for the Bluetooth RF tests. The Bluetooth Test Specifications [2] define three different stimulus patterns:

- pseudo-random sequence 9 (PR9) for power and spectrum measurements,
- 1111.0000 (= F0 hex) for measurement of modulation deviation,
- 1010 1010 (= AA hex) for measurement of modulation deviation and drift.

For Bluetooth tests, packets are referred to as DH (data-high-rate) packets. Depending on the payload length, a packet requires one, three or five coherent slots. Hence, the designations of DH1, DH3 or DH5 packet.

Since the Bluetooth module synthesizer takes some time to switch to the frequency of the next slot, the actual packet length (and the corresponding RF burst) is clearly less than one, three or five slots: a DH1 packet, for example, has a maximum length of 366 bits. This corresponds to 366 µs (in a slot of 625 µs). During the remaining time, there is no data transfer.

Supplied Data Records

This application note comes with data records for each useful pattern and packet length mentioned in the previous Section:

- PR9_DH1, PR9_DH3, PR9_DH5 with pseudo-random pattern PRBS9,
- F0_DH1, F0_DH3, F0_DH5 with four ones and four zeros alternating,
- AA_DH1, AA_DH3, AA_DH5 with alternating ones and zeros.

The data records contain modulation data exceeding the duration of a packet. They contain a continuous data stream for the full slots in which the burst is active (1, 3 or 5 slots) and for the complete slot that follows (without RF signal). The modulation data outside the packet consists of dummy bits. The range covered by a data record is shown in Fig. 2 for a DH3 packet.

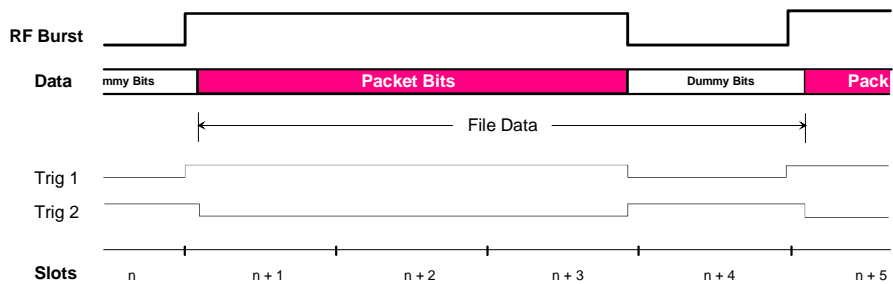


Fig. 2: Burst and packet for DH3

Each slot is 625 μs long. With the Bluetooth bit clock of 1 MHz this corresponds to 625 bits.

The data records are therefore 2·625 bits, 4·625 bits or 6·625 bits long. They are continuously fed to the SMIQ modulator to generate the Bluetooth signal.

TYPE	PACKET	PAYLOAD	DATA RECORD
DH1	366 bits	240 bits	1250 bits (2 slots)
DH3	1622 bits	1496 bits	2500 bits (4 slots)
DH5	2870 bits	2744 bits	3750 bits (6 slots)

When the data records are loaded into SMIQ, not only a data list but also a control list is generated for each record in the SMIQ memory. The control list controls the burst ramp. The RF output stage of SMIQ is activated approximately 5 bits before the start of the packet and deactivated after the last bit of the packet.

The control list also generates two trigger signals synchronous with the RF signal, which are present at the SMIQ PAR DATA connector of SMIQ (see Fig. 2):

TRIG1 has TTL high level during the burst (RF present).

TRIG2 has TTL low level during the packet (data is valid).

How to generate Bluetooth burst test signals using the above data records is described in Section 3.

For some measurements continuous signals are more suitable, for example to reduce test times. How to generate continuous test signals with fixed data pattern with SMIQ is described in Section 4.

3 Generating Burst Test Signals

Loading Supplied Data Records

To generate burst test signals from the supplied Bluetooth data, the data must be loaded into the SMIQ memory. However, data transfer needs only be performed once. The data remains stored in the SMIQ when it is switched off.

- Load the supplied Bluetooth data records into SMIQ. Follow the instructions given in "Loading Bluetooth Data into SMIQ" in the annex.

The data records can be called on SMIQ by name (AA_DH1 to PR9_DH5) from the SOURCE DATA_LIST menu.

Note: *To load Bluetooth data into SMIQ using the supplied transfer software, GPIB bus card PS-B4 from Rohde & Schwarz or an equivalent GPIB bus card from National Instruments, plus suitable driver software, must be installed on your computer.*

Configuring SMIQ

Once the supplied data records are loaded, set up the SMIQ:

The modulation parameters for the Bluetooth standard are preprogrammed in SMIQ and can be activated at the push of a button. To generate the test signals, set the frequency and level and activate the Bluetooth standard. Then select a data pattern from the list of records.

A burst Bluetooth modulated RF carrier with the desired pattern is created. Such signals are suitable, for example, as stimulus signals for drift measurements on transmitters (see Application Note 1MA26 [3]).

When generating the test signals for the first time, we recommend that you start from the SMIQ default setting as follows:

1. Press the (blue) key on SMIQ:

PRESET

2. Set the frequency and level:

FREQUENCY ...,

LEVEL ...

3. Select:

DIGITAL MOD

STANDARD

BLUETOOTH

The following settings will be obtained:

MODULATION TYPE 2 GFSK

SYMBOL RATE 1 Msymbol/s

FILTER Gaussian, BT = 0.5

CODING off

Do not change these standard-specific settings.

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4. Select the SMIQ memory as the modulation data source:

```
SOURCE DATA_LIST
```

5. Select the desired data list, for example:

```
SELECT DATA LIST AA_DH1
```

6. Select the corresponding control list, for example:

```
SELECT CONTROL LIST AA_DH1
```

7. Activate the control list with:

```
CONTROL STATE ON
```

8. Return to the DIGITAL MOD menu.

9. Activate the digital modulator with:

```
STATE ON
```

10. Activate ramp control with:

```
POWER RAMP CONTROL SOURCE INT
```

The desired signal is now available at the RF output of SMIQ.

The following figures show three test signals generated with SMIQ. In the lower half, the burst ramp is displayed, in the upper half the demodulated signal. In the case of patterns AA and F0, the payload can be clearly identified from the regular structure of the signal (see also Fig. 1).

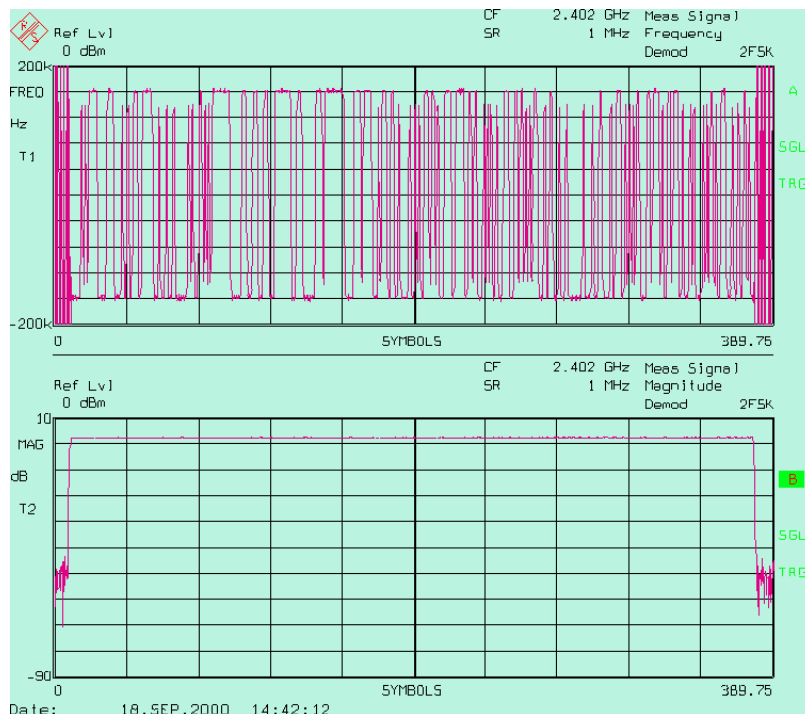


Fig. 3: Burst with PR9_DH1 data displayed

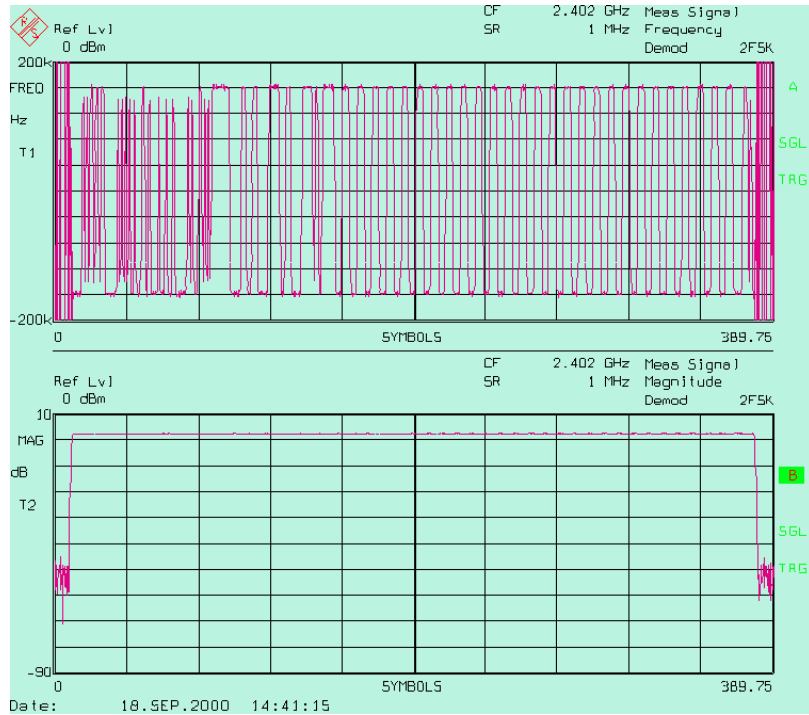


Fig. 4: Burst with F0_DH1 data displayed

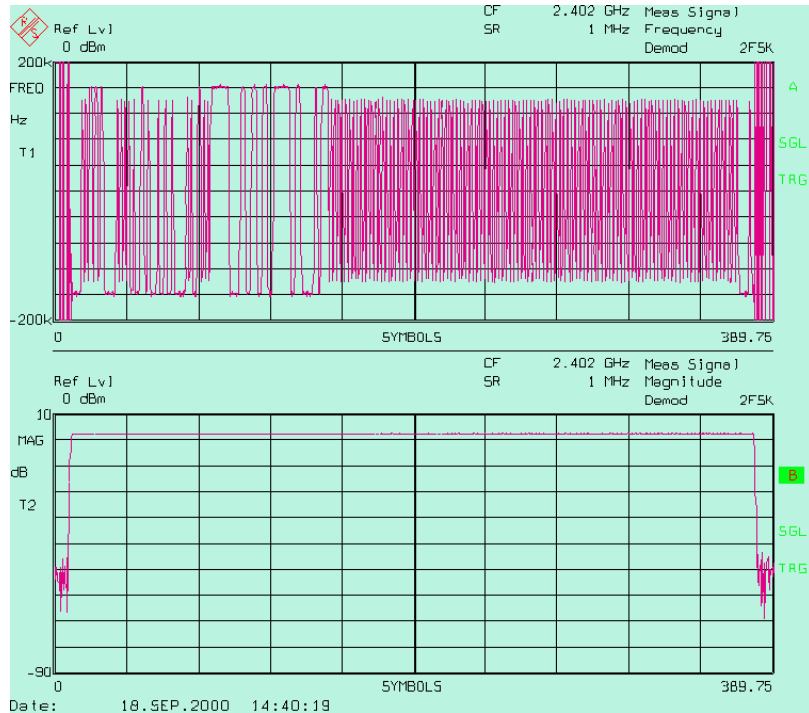


Fig. 5: Burst with AA_DH1 data displayed

- To change to another test signal, select a new data list and the corresponding new control list, for example:

```
SELECT DATA LIST    AA_DH3    and
SELECT CONTROL LIST  AA_DH3
```

4 Generating Continuous Test Signals

For some measurements continuous signals are more suitable as they reduce measurement times.

To generate continuous test signals, set the frequency, level, and the Bluetooth standard, as for burst test signals. Then select a data pattern from a list of standard patterns.

A continuous Bluetooth modulated RF carrier with the selected pattern is generated. Such signals are suitable, for example, for bit error measurements or as stimulus signals for spectrum measurements on transmitters (see Application Note 1MA26 [3]).

When generating the test signals for the first time, we recommend that you start from the default setting of SMIQ, as for burst signals:

1. Press the (blue) key on SMIQ:

PRESET

2. Set the frequency and level:

FREQUENCY ...,

LEVEL ...

3. Select:

DIGITAL MOD

STANDARD

BLUETOOTH

The following settings will be obtained:

MODULATION TYPE	2 GFSK
SYMBOL RATE	1 Msymbol/s
FILTER	Gaussian, BT = 0.5
CODING	off

Do not change these standard-specific settings.

4. Select SOURCE ... as the modulation data source.

- Select the PATTERN menu item as SOURCE to generate continuous data patterns or pseudo-random data.
- Select one of menu items EXT_PAR, EXT_SER or SERDATA as SOURCE if the data are available as TTL signals.

5. In the next higher menu, activate digital modulation (DIGITAL MOD) with:

STATE ON.

The signal is now generated as RF output from SMIQ.

5 Editing and Modifying Data Packets

The previous sections described how to load preconfigured data records into the SMIQ memory and how to generate a desired output signal by means of the data and control lists.

The data and control lists can be modified in two ways:

- You can edit the lists directly on SMIQ (under the EDIT DATA / CONTROL LIST menu item).
- You can use the software package SMIQ-K1 on a PC. The package is available free of charge from your local Rohde & Schwarz representative.

Discussing the two methods in detail would however go beyond the scope of this application note. Please refer to the SMIQ manual for detailed instructions on how to edit data lists and control lists on the signal generator. The software package SMIQ-K1 likewise comes with a manual providing detailed information on the various functions (loading, inserting, stuffing, copying, ramp control, generation of trigger signals, and many more).

6 References

- [1] Bluetooth RF Test Specification, Revision 0.9, 14.3.2000
- [2] Bluetooth Core Specification, Revision 1.0b, 12.6.1999
- [3] Creating Test Signals for Bluetooth with AMIQ / WinIQSIM and SMIQ, Application Note 1GP38, Rohde & Schwarz, 1999
- [4] Transmitter Measurements on Bluetooth Modules, Application Note 1MA26, Rohde & Schwarz, 2000
- [5] Transmitter Measurements on Bluetooth Modules with FSP, Application Note 1MA33, Rohde & Schwarz, 2000

7 Ordering Information

Vector Signal Generator SMIQ:

SMIQ02B	300 kHz to 2.2 GHz	1125.5555.02
SMIQ03B	300 kHz to 3.3 GHz	1125.5555.03
SMIQ04B	300 kHz to 4.4 GHz	1125.5555.04
SMIQ06B	300 kHz to 6.4 GHz	1125.5555.06
Options:		
SMIQB11	Data Generator	1085.4502.04
SMIQB12	Memory Extension	1085.2800.04
SMIQB20	Modulation Coder	1125.5190.02

8 Appendix

Loading Bluetooth Data into SMIQ

Requirements:

To run the transfer program on your computer, GPIB bus card PS-B4 from Rohde & Schwarz or an equivalent GPIB bus card from National Instruments is required. The appropriate driver software must be installed on your computer.

Note:

If you use a 32-bit Windows version, the virtual 16-bit DOS drivers have to be activated (after installation). Proceed as follows:

For Windows 95 and Windows 98:

1. Go to the 'Device Manager' (via 'Control Panel', 'System').
2. Click 'National Instruments GPIB Interfaces'.
3. Click 'Properties'.
4. Activate 'Enable Support for DOS NI-488.2 Applications'.

For Windows NT:

1. Open the config.nt file in the c:\winnt\system32 path.
2. Delete the 'rem' command word in line
3. `rem device=D:\APP\NATION~1\NI-488.2\DosWin16\Gpib-nt.com`

If, with a 32-bit Windows version, the config.sys file includes the 16-bit gpib.com driver, remove the driver.

Installation:

The self-expanding load_31.exe file contains the Bluetooth data records described in this application note, the smiq_k1.exe transfer program and the load_31.bat batch program.

smiq_k1.exe is basically a DOS program. It therefore operates with 16-bit and 32-bit Windows versions. Install the program as follows:

1. Copy load_31.exe to a directory of your choice.
2. Start load_31.exe.

The c:\temp_31 directory containing all the files named will be created on your hard disk.

Data transfer to SMIQ:

1. Switch SMIQ on.
2. Select device address 28 on SMIQ.
3. Connect your computer to SMIQ with an IEEE-bus cable.
4. Start the load_31.bat batch job (in c:\temp_31).

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You can watch the data transfer in a DOS window on your computer monitor.

5. When file transfer is completed, terminate the batch job by pressing any key on the computer keyboard.

You can check on SMIQ whether the data records are accessible. Select:

DIGITAL MOD

SOURCE / SOURCE DATA_LIST

SELECT DATA LIST or CONTROL LIST

Make sure that all data records from AA_DH1 to PR9_DH5 are contained in the list.

Note: *When data transfer to SMIQ is completed, you can delete load_31.exe and the c:\temp_31 directory. There are no further files created nor any existing files modified by the installation and execution of the transfer program.*

List of Patterns for Transmitter Tests

The following table shows the data record suitable as a stimulus signal for each Bluetooth transmitter test.

TRANSMITTER Test	Data Record	Packet Type	Payload-Pattern
Output Power	PR9_DH5 PR9_DH3 PR9_DH1	For longest supported type	PRBS 9
Power Density	PR9_DH5 PR9_DH3 PR9_DH1	For longest supported type	PRBS 9
Power Control	PR9_DH1	DH1	PRBS 9
TX Output Spectrum - Frequency Range	PR9_DH1	DH1	PRBS 9
TX Output Spectrum - 20 dB Bandwidth	PR9_DH1	DH1	PRBS 9
TX Output Spectrum - Adj. Channel Power	PR9_DH1	DH1	PRBS 9
Modulation Characteristics	F0_DH5 F0_DH3 F0_DH1 AA_DH5 AA_DH3 AA_DH1	For longest supported type	11110000 10101010
Initial Carrier Frequency Tolerance	PR9_DH1 (AA_DH1)*	not specified	PRBS 9 (10101010) *
Carrier Frequency Drift	AA_DH5 AA_DH3 AA_DH1	For longest supported type	10101010

* Pattern AA_DH1 is required for measurements included in Application Notes 1MA26 and 1MA33.



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