Standard-compliant NFC signals defined in detail at the press of a button

Near field communications (NFC) has everyday applications. It has become a standard feature for high-end mobile phones, in particular. The standard-compliant NFC signals required for the development and production of these devices are generated by the Rohde&Schwarz family of signal generators equipped with the R&S®SMx-K89 option.

NFC – just another short-range transmission standard?

Unlike the technologies typically used for data transmission over short ranges, such as Bluetooth®, transmission via NFC is limited to significantly shorter distances (see box on page 19). Although this initially appears to be a limitation, it is in fact the basis for using NFC to open up new and different areas of applications than those available with Bluetooth®, for example. Whereas connections with ranges of more than several meters need to be explicitly activated or authorized on mobile devices in order to save energy and protect data, NFC connections are established using a more intuitive process: The devices are simply held next to one another or placed onto a terminal. This ease of use makes NFC ideal for a number of new applications. Some examples:

- Cashless payments using a mobile phone or a payment card
- Easy activation of a WLAN connection in a restaurant. On entering the restaurant, guests simply hold their mobile device briefly up to a terminal, and the rest is taken care of automatically. There is no more need for cumbersome codes, and the restaurant still ensures that only guests use its free access
- More exotic applications are also already available, such as an app for smartphones that replaces the old-fashioned hiking pass (Fig. 1)

NFC testing during development and production

In many of these applications, devices from different manufacturers must communicate with one another. To ensure interoperability, the NFC Forum has defined standardized test procedures. These tests, which are described in the "Test Specifications / Cases for the NFC RF Analog Specification", can be used by manufacturers of NFC-capable devices during development and production to verify that their devices meet the NFC standard requirements.

A device plays one of two roles in NFC communications. The device that provides the energy required for the transmission is the polling device, or simply the poller. If it uses the energy from another NFC-capable device to respond to that device, it is the listening device (the listener). A short overview of NFC transmission technology is provided in the box on page 19. The NFC Forum test specification mentioned above includes tests for both types of NFC devices.

Example of an NFC application

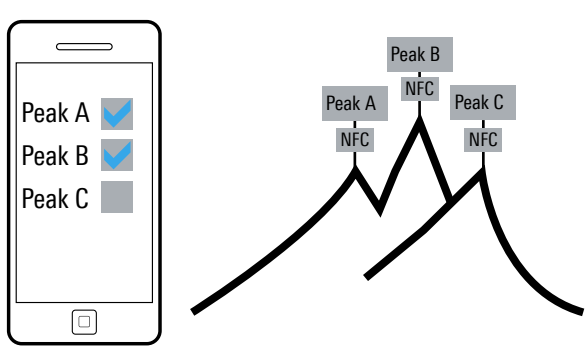

Fig. 1 In High Tatras National Park in Poland, NFC tags are placed at the mountain peaks. Using an NFC-capable smartphone and an app, hikers can fill out their electronic hiker pass by briefly holding the phone next to the NFC tag each time they reach a mountain peak.

Tests on listening devices

In this group of tests, the device under test (DUT) is a listener (Fig. 2). A generator, such as the R&S®SMBV100A from Rohde&Schwarz, generates the poller signals and also provides the energy required for the transmission during the entire test sequence by generating a carrier signal at 13.56 MHz. An additional NFC reference antenna (the reference polling device) is needed in order to apply this RF signal along with the carrier and the modulated poller signal to the DUT. The structure of this antenna – and associated electronics – has been specified in detail by the NFC Forum.

If the listening DUT functions correctly, it responds by modulating the electromagnetic field of the poller (load modulation). The reference antenna registers this response and makes it available at its connector as an electrical signal. An NFC signal analysis system – such as the R&S®RTO oscilloscope in combination with the R&S®FS-K112 PC software – analyzes the signal and helps to determine whether the listening device has passed the test.

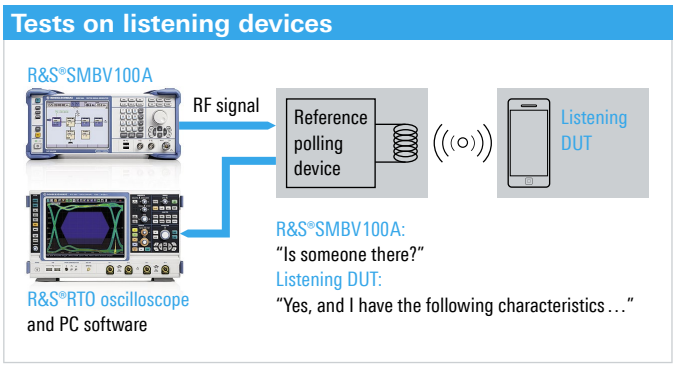

Fig. 2 Typical setup for listening device tests.

The principle behind near field communications

With NFC, transmission takes place over distances of only a few millimeters; for example, by laying a payment card onto a terminal or holding two mobile telephones next to each other. One of the devices generates an electromagnetic field with a frequency of 13.56 MHz (Fig. 3). Unlike mobile radio transmission, however, this signal is not broadcast into open space (into the far field), but is inductively coupled with the other device in the near field, much like in a transformer.

The device that generates the field is called polling device or poller, and the second device is the listening device or listener (in this context, a payment card is also a "device"). Data transmission from poller to listener involves the poller modulating the amplitude of its field, which is registered by the listener.

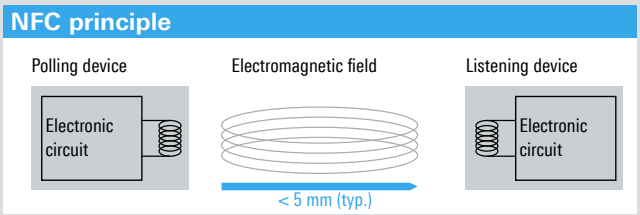

Fig. 3 Two devices communicate via NFC using an electromagnetic field with a frequency of 13.56 MHz.

The transmission from listener to poller takes place by means of load modulation: The listener does not draw a constant amount of energy from the field; instead, it can change the amount of drawn energy over time (by changing the impedance). Feedback changes the amplitude of the alternating electromagnetic field, which the poller can register.

NFC-A, NFC-B and NFC-F

For this type of transmission in the near field, various transmission standards – driven by various companies – have gained acceptance over time. The NFC Forum has incorporated the most important of these standards into the common NFC standard. The fact that the new standard from the NFC Forum is based on different existing standards is reflected in the division of the new standard into substandards NFC-A, NFC-B and NFC-F. All three of these substandards use a 13.56 MHz field. They differ only in how this field is amplitude-modulated, how the transmitted symbols are coded and in the bit rate.

NFC-B load modulation is sometimes also referred to as BPSK. However, it is not the field that undergoes phase modulation, but a subcarrier, which in turn modulates the amplitude of the 13.56 MHz field.

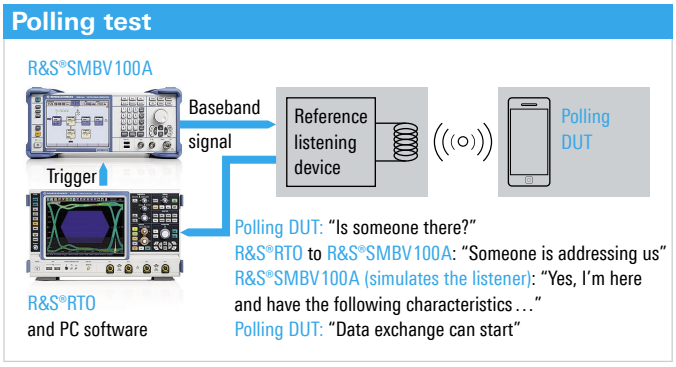

Fig. 4 Typical setup for polling device tests.

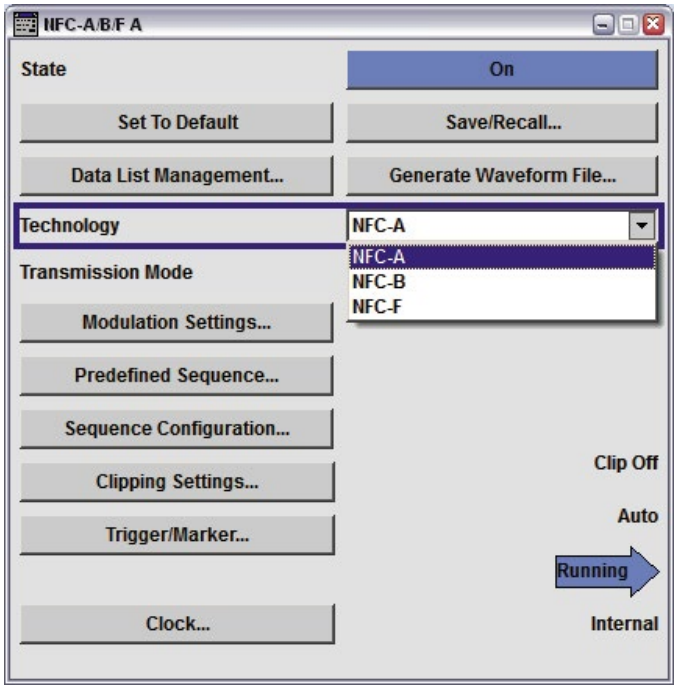

Fig. 5 The main menu for the R&S®SMx-K89 option. All three NFC Forum substandards are supported: NFC-A, NFC-B and NFC-F.

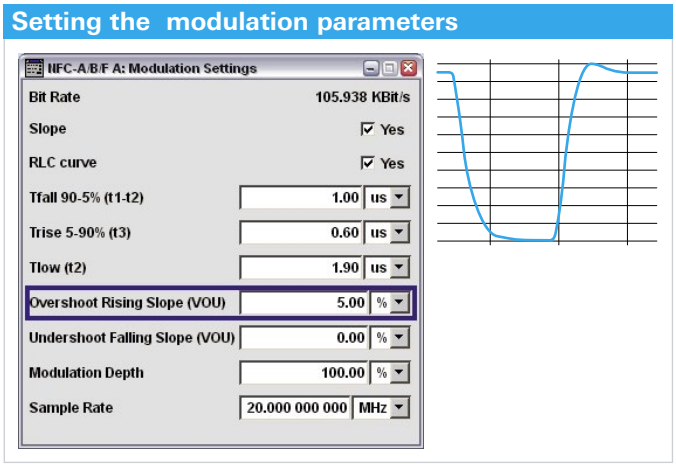

Fig. 6 Modulation parameters are used to modify the signal edges as needed. The artificial overshoot of 5 % after the rising edge is clearly visible.

Tests on polling devices

In the case of polling tests, the DUT generates the 13.56 MHz field for NFC transmission and modulates it with a poller signal. This test setup also requires an NFC reference antenna that is positioned in the poller field. The envelope for the received poller signal is output at a connector and checked by the NFC analysis system. For some poller tests, this is sufficient to determine whether the device passes or fails.

For other polling device tests, a signal generator must generate a listener response that prompts the poller to send additional signals (Fig. 4). The generator is triggered by the analysis system and then sends a suitable response to the reference antenna in the form of a baseband signal. The electronics in the reference antenna then perform the load modulation of the electromagnetic poller field. If the polling DUT behaves in line with the standard, it will output an additional poller signal that can then be analyzed.

The Rohde&Schwarz family of signal generators generates all NFC signals

When retrofitted with the new R&S®SMx-K89 option, the Rohde&Schwarz family of signal generators can conveniently generate the described poller and listener signals. This option is available for the R&S®SMU200A and R&S®SMBV100A vector signal generators, as well as for the R&S®AMU200A, R&S®SMJ100A and R&S®SMATE200A. The signals generated by this option are compliant with the NFC standard and support the three substandards NFC-A, NFC-B and NFC-F (Fig. 5).

The signals can be precisely parameterized. As a result, the edge shape can be changed, or the signals can be artificially degraded with overshoot in order to test whether the DUT still functions under adverse conditions (Fig. 6). All parameters can be defined manually via the graphical user interface, or when automated test sequences are available, the generator can also be remotely controlled in realtime by using SCPI commands via a GPIB or Ethernet connection.

If the standard-compliant base tests are to be supplemented with more in-depth, user-defined tests, the R&S®SMx-K89 option can be used to flexibly combine individual NFC commands into extensive sequences (Fig. 7). This option provides the basic commands for device search and conflict prevention as well as the NFC-A / -B / -F protocol commands used for data transmission (type 1 to 4 tag platform, ISO DEP, NFC-DEP).

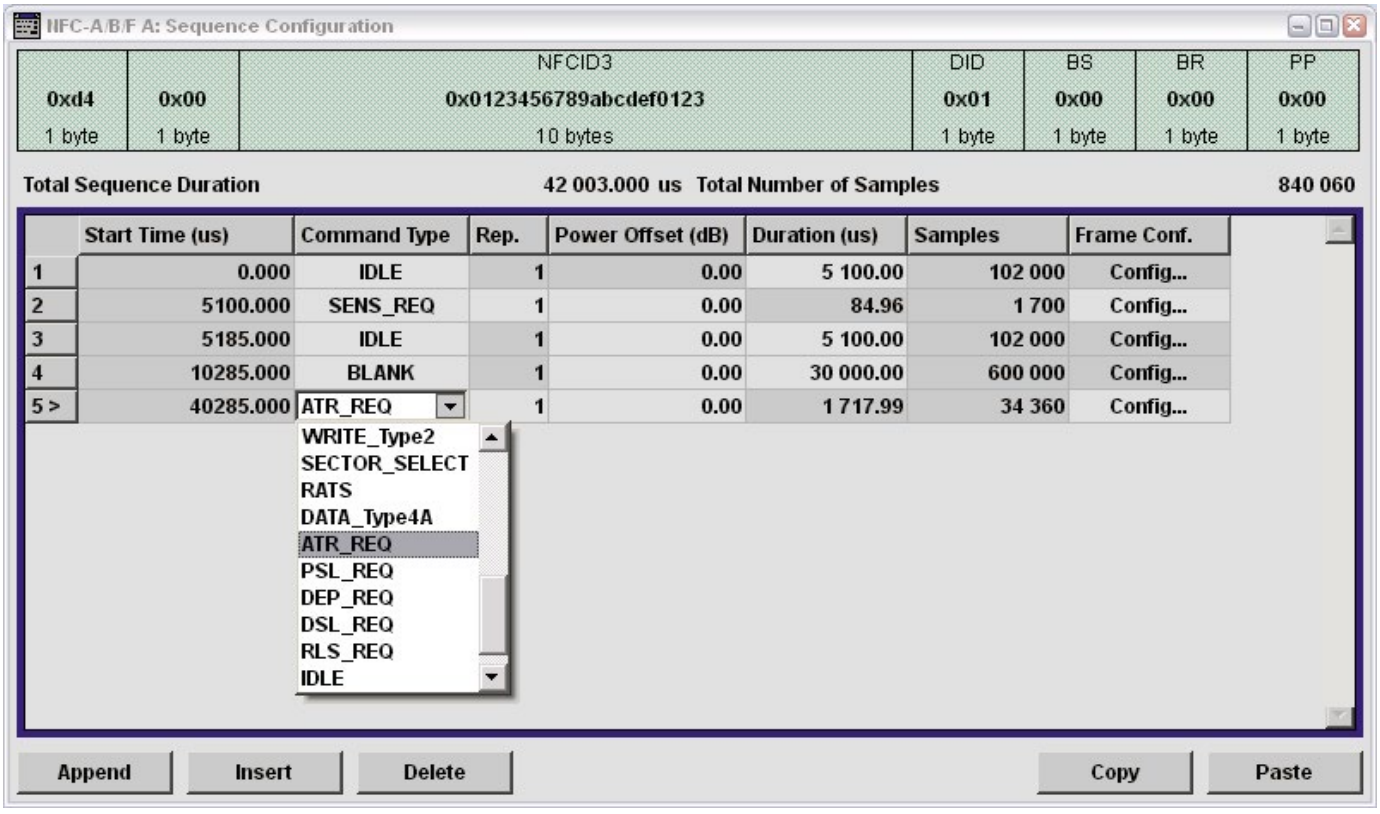

Fig. 7 NFC commands can be flexibly combined into longer sequences. The commands for the protocols based on NFC-A / -B / -F are supported (type 1 to 4 tag platform, ISO DEP and NFC-DEP).

NFC tests – one source

The Rohde&Schwarz NFC test portfolio includes everything needed to perform the tests described above. A complete set of reference antennas is available as an interface to the NFC field (R&S®CSNFC-B8 NFC Forum reference equipment) [1].

Existing Rohde&Schwarz equipment for mobile radio measurements can be expanded to include NFC functionality; additional instruments are not necessary. The R&S®FS-K112PC NFC measurement software, for example, can be used to test NFC signals captured using the R&S®RTO oscilloscope or the R&S®FSV signal and spectrum analyzer.

The new R&S®SMx-K89 option is available for all current Rohde&Schwarz vector signal generators and rounds out the offering of NFC test and measurement equipment [2].

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More information

[1] Rohde&Schwarz NFC / RFID technology page: http://www.rohde-schwarz.com/technology/nfc
[2] R&S®SMBV-K89 NFC A / B / F product page: http://www.rohde-schwarz.com/product/smbvk89

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