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# **GSM Mobile Tests under Conditions of Fading**

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Application Note 1MA02\_0E

Subject to change

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Products:

**Digital Radiocommunication Test Set CRTP02 /  
CRTC02**

**Signal Generator SMIQ**



**ROHDE & SCHWARZ**

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## 1. Overview

GSM standard 11.10 prescribes a number of tests requiring measurements on mobile stations under multichannel conditions (fading).

The combination of Radiocommunication Tester CRTP02 or CRTC02 and Signal Generator SMIQ allows cost-effective performance of the most important fading tests, in particular the tests according to sections 13.2, 14.2 and 14.3 of GSM 11.10.

The aim of this application note is to familiarize the user with all the capabilities offered by the above combination of measuring instruments. The user should then be able to quickly generate and run his own fading tests using the IEC/IEEE-bus control commands described in this application note.

To facilitate reading of the following, the testers CRTP02 and CRTC02 are referred to as CRTx.

## 2. Principle of Operation

The Radiocommunication Testers CRTx provide an independent transmit and receive section each for the broadcast (BCCH) and for the traffic channel (TCH).

The output paths of each transmit channel are taken via N jumpers to the front panel of the analog unit of the CRTx and can be opened to switch in an RF fading simulator. However the fading simulators presently available on the market are very expensive and the number of manufacturers is limited.

Therefore we propose the following alternative approach:

Instead of subsequently conditioning the RF transmit signal of a CRTx channel, processing of the faded channel is now completely handled by Signal Generator SMIQ. (The corresponding RF output stage of the CRTx is disconnected for this purpose). With the options SMIQ-B14 (6 fading channels) and, where required, SMIQ-B15 (another 6 fading channels) the SMIQ is able to generate preprogrammed fading profiles of the mobile radio standards in addition to the user-definable fading profiles.

The SMIQ is modulated by IQ vector signals which are made available by option CRTP-B7 on the Radiocommunication Tester.

The SMIQ is controlled by the CRTx via the IEC/IEEE bus. Manual settings are therefore not required during a measurement.

The extensions needed in the user program are described further below. Basic knowledge in programming the CRTx is required.

Note: Generation of one fading channel by the SMIQ is described in the following, since in most cases it is sufficient to condition the TCH signal only. It is of course also possible to interconnect and control two signal generators if BCCH and TCH have to be faded simultaneously.

The suggested solution covers tests without frequency hopping. The faded signal does not contain burst ramps.

### 3. Test Procedure

#### 3.1. Test Setup

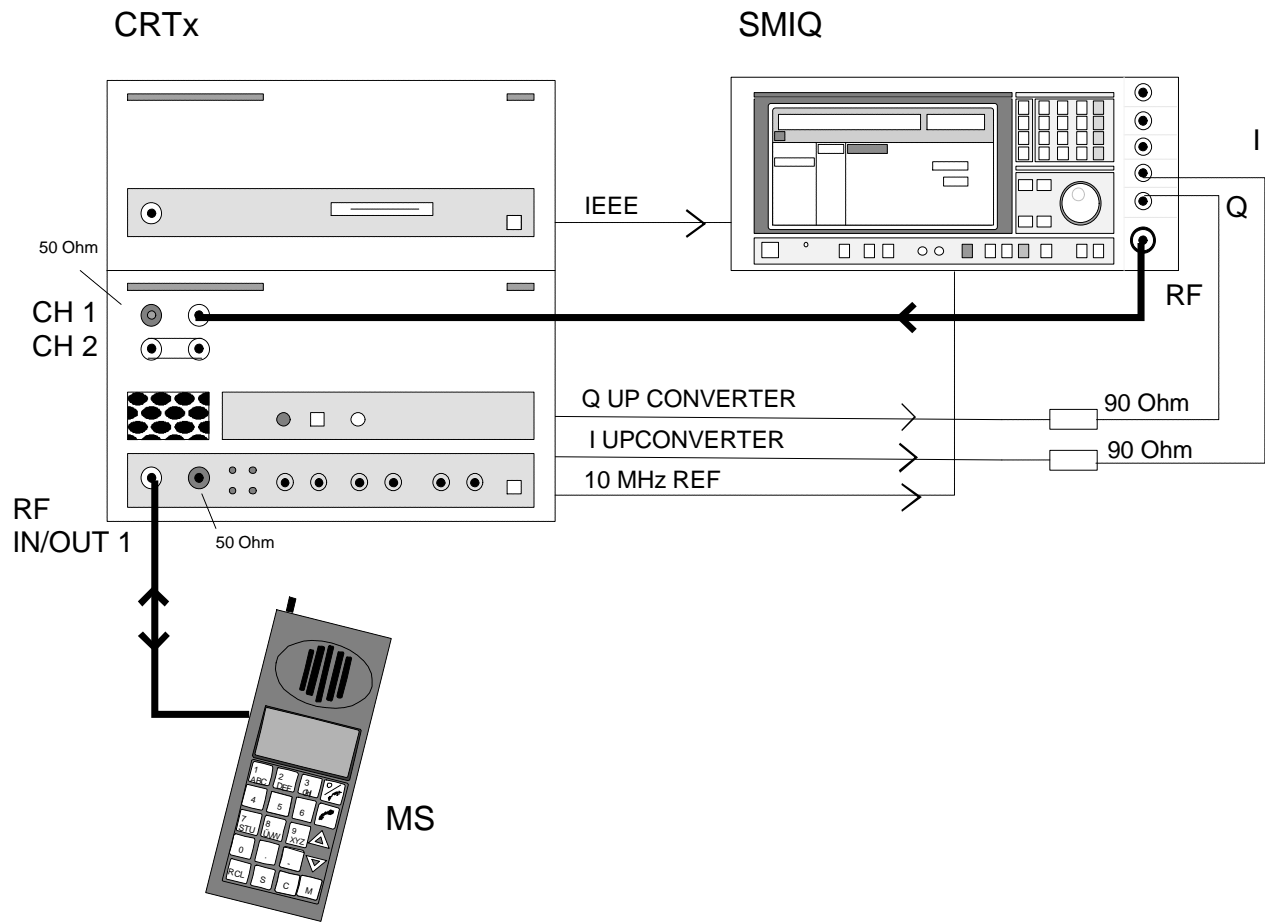


Fig. 1: Test setup for fading RF CH1 (RF CH2 not faded).

Remove the N jumper of transmit path RF CH1 on the CRTx. Apply the SMIQ output signal to the now free input socket. In the analog unit this signal is then combined with the second transmit signal and the receive channels at the RF IN/OUT 1 connector. The other connector that is now free (output stage RF CH1 of CRTx which is not required) must be terminated with a 50-ohm termination (R&S accessories).

In order to avoid RF pickup, the RF IN 2 connector must also be terminated.

The I/Q outputs of the CRTP-B7 are taken to the I/Q inputs of the SMIQ. Since the CRTx with +/- 1.5 V<sub>rms</sub> output level exceeds the permissible input voltage range of +/- 0.5 V on the SMIQ, series resistors of 90 ohm should be used.

For locking the frequencies of CRTx and SMIQ, the 10 MHz reference connectors of the two instruments must be connected. CRTx is the source; SMIQ is switched to an external reference.

An IEC/IEEE-bus cable is used to connect the SMIQ to the digital unit of the CRTx which is the controller of the measurement system.

Note: RF CH2 can be faded in the same way as CH1. Note that the insertion loss between the feed point of the SMIQ signal and connector RF IN/OUT 1 is 20 dB for CH1 but 50 dB for CH2 (with level programming as described below). The output level of the SMIQ must then exceed the desired traffic channel level by this amount.

To illustrate this, Fig. 2 shows the RF paths in the CRTx 'behind' the connector IN/OUT 1 with the corresponding attenuation values.

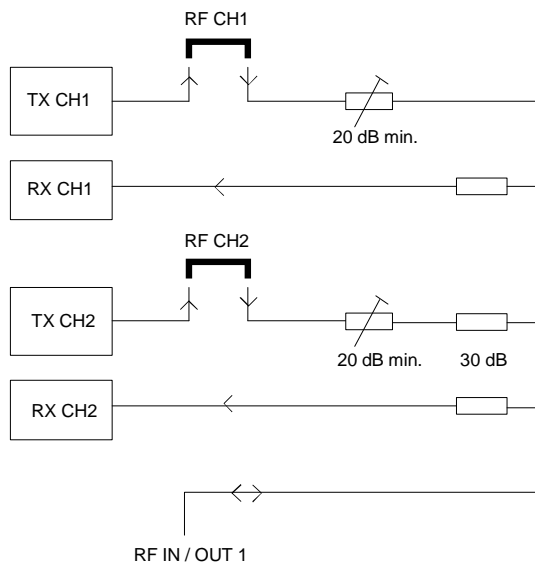


Fig. 2: RF paths for RF IN/OUT 1 in CRTx

With existing test programs it must be checked which of the RF channels is actually used. If the test program uses the `ConfigureDigitalUnit()` routine, the assignment can be found in the mc files: active TX SC 1 uses RF CH1, active TX SC 2 uses RF CH2. If, however, the test program uses `ConfigurePhysicalChannel()`, TxRxPair1 means RF CH1 and TxRxPair2 RF CH2.

With existing programs only the experienced user should try to change the channels. It should be noted however that a great number of further modifications in the test program would then become necessary.

### 3.2. Additional Entries in File `ieeconf.dat` on CRTx

The digital unit of the CRTx operates as an IEC/IEEE-bus controller. In order to integrate the SMIQ into the system, the following entries must be added at the end of file `c:\config\ieeconf.dat`:

```
Device SMIQ
Primary      28
eoi         no
eos         0xA
eot         yes
Timeout     15
Terminate   no
Compare     8
Listen     yes
Talk       yes
Srqr       yes
```

Through the declaration `Device SMIQ` the name for an IEC/IEEE-bus device is now globally declared in the CRTx software. The subsequent lines contain the remote-control capabilities of this device.

'28' designates the primary address (in this case the default address of SMIQ). For a different setting, another entry is required. (Address 1 is reserved for the CRTx analog unit.)

With the exception of the the first two entries, all other entries can be copied from the previous declaration for `Device CRTS_AU`.

### 3.3. Test Program Extensions

Depending on the requirements, an existing program can be supplemented or a new program written. The entries given below are to be inserted into the user's main program. A suitable position is after calling the routine `SetLevelOfAnalogUnit()` which is contained in each test program. At

this time the IEC/IEEE-bus hardware has already been initialized and level setting of the CRTx completed. This means that level programming of the non-required output stage as described under 3.3.2 will later not be changed by the test program.

Note: Observe the notation in upper- and lower-case letters for SMIQ/Smiq and CRTS\_AU/CrtsAU.

#### 3.3.1. General Settings:

##### Device communication:

```
tpDevice Smiq,CrtsAU;    /* logical name for the SMIQ and CRTS AU */

if (!ieOpenExternalDevice("SMIQ", &Smiq))
{
    printf("ERROR: ieOpenExternalDevice SMIQ failed\n");
    exit(1);
}
if (!ieOpenExternalDevice("CRTS_AU", &CrtsAU))
{
    printf("ERROR: ieOpenExternalDevice CRTS_AU failed\n");
    exit(1);
}
```

##### SMIQ basic settings:

```
if ( !ieWriteToExtDev(Smiq, "*RST" ) )                // PRESET
{
    printf("ERROR: SMIQ preset failed \n");
    exit(1);
}

if ( !ieWriteToExtDev(Smiq, ":ROSC:SOUR EXT" ) )      // REF EXT
{
    printf("ERROR: SMIQ set reference ext failed \n");
    exit(1);
}

if ( !ieWriteToExtDev(Smiq, ":DM:IQ:STAT ON" ) )     // IQ modulation
{
    printf("ERROR: SMIQ set IQ modulation on failed \n");
    exit(1);
}
```

```

}

if ( !ieWriteToExtDev(Smiq, ":FSIM:CONF S6P") )           // fading 6 paths
{
printf("ERROR: SMIQ set no of fading paths failed \n");
exit(1);
}

if ( !ieWriteToExtDev(Smiq, ":FSIM:SEQ RUN") )           // run fading
{
printf("ERROR: SMIQ start fading sequences failed \n");
exit(1);
}

```

### 3.3.2. Test-Specific Settings:

**Frequency:** The frequency of the SMIQ must be set in MHz. For GSM900 (downlink) for instance it is calculated using the formula

$935 \text{ MHz} + \text{channel number} * 0.2 \text{ MHz}$ .

For channel 110, for example, this yields 957 MHz.

```

if ( !ieWriteToExtDev(Smiq, ":FREQ:CW 957MHz") ) // frequency
{
printf("ERROR: SMIQ frequency programming failed \n");
exit(1);
}

```

**Level:** In order to minimize the attenuation between the feedpoint of the SMIQ and connector RF IN / OUT 1, the output level of the fading channel must be programmed to -7 dBm in the routine

SetLevelOfAnalogUnit ( )

of the user program. The variable attenuator shown in Fig. 2 is thus set to minimum. There is a residual insertion loss of 20 dB in total for RF CH1 and of 50 dB for RF CH2.

The SMIQ level to be programmed has to be increased by this amount. Programming for eg -50 dBm at RF IN / OUT 1 using CH 1 is as follows:

```

if ( !ieWriteToExtDev(Smiq, ":POW:IMM -30dBm") ) // power level
{
printf("ERROR: SMIQ level programming failed \n");
exit(1);
}

```

The output stage of the CRTx that is not required cannot be completely switched off. In order to reduce any interference that may be picked up at RF IN / OUT 1, the level of such output stage is reduced by 60 dB. This is done with the following command, in our example for RF CH1. For RF CH2, 'DEVICE2' would have to be entered.

```
if (!ieWriteToExtDev (CrtsAU, "OUTPUTSTAGE:DEVICE1:LEVEL -60"))
{
    printf("ERROR: CrtsAU: set DEVICE1 -60 failed \n");
    return(False);
}
```

Fading profile: The following fading profiles are already preprogrammed in the SMIQ:

RA, HT, TULow, TUhigh, each with the appropriate speed.

If different fading profiles are required, each of the up to 12 paths can be programmed by the user.

Programming eg for GSM900 TU high:

```
if ( !ieWriteToExtDev(Smiq, ":FSIM:STAN GTU50") ) // GSM900 URBAN 50
{
    printf("ERROR: SMIQ set fading standard failed \n");
    exit(1);
}
```

Activating the SMIQ:

```
if ( !ieWriteToExtDev(Smiq, ":FSIM ON") ) // fading on
{
    printf("ERROR: SMIQ set fading on failed \n");
    exit(1);
}

if ( !ieWriteToExtDev(Smiq, ":OUTP ON") ) // RF power on
{
    printf("ERROR: SMIQ set RF power on failed \n");
    exit(1);
}
```

### 3.4. Test Run

After completion of the test program code the c-file must be compiled and linked. This is done with BORLAND C as with all previous test cases. Since with the exception of the variables SMIQ and CrtsAU no further declarations or dependencies have occurred, there should not be any problems.

Note: CRTx does not check the command sequences for the SMIQ for correct syntax. Incorrectly written commands causes error messages on the SMIQ which disappear however if a sequence with correct syntax is subsequently received. During the first test run it should therefore be checked on the display of the SMIQ whether all settings are correct.

A test is started by activating the message controller (eg `i SPE`) and calling up the exe file.

## 4. Program Example

Enclosed you will find a program example for fading a traffic channel for CRTx phase 2. It comes with an installation program to expand the zip-file containing the program code and the configuration data. The two files shall be copied to a floppy disk which has to be inserted afterwards into the floppy drive of the CRTx. Entering

```
a:install
```

at the CRTx keyboard will create now the new directory `c:\fademo` and transfer the application program and data. The original `ieeconf.dat` will be saved as `ieeconf.org` and replaced by the extended configuration file.

This program example is the `demoproc.c` program supplied with each CRTx and contains the above supplements for RF CH1. It is suitable for the test setup shown above (Fig. 1).

Program operation has remained unchanged with regard to `demoproc`:

First the message controller of the CRTx is activated. This is done by entering

```
i SPE          for call setups and bit error
measurements. Then
```

```
fademo        is called up (from the fademo
directory) .
```

After the start, a location update is made, if necessary, with the first menu item offered. (This is

made in the non-faded RF CH2.) Then a call is set up with the menu items 2 or 3. The mobile station is assigned RF CH1, which has been conditioned by SMIQ with the fading profile GSM900 TU50. Due to the relatively high traffic channel level (-50 dBm) there is no noticeable interference in the transmission.

A continuous bit error measurement can now be carried out eg with sixth menu item of the test program. By continuously reducing the RF output power, a distinct increase in bit errors can be observed.

Note: The bit error rate increases briefly as the attenuator is switched during the variation of the SMIQ output level. This can be avoided by selecting the operating mode ATTENUATOR MODE FIXED for a specific variation range, see operating manual section 2.5.2.

## 5. References

- GSM 11.10-1, GSM 05.05, Annex C
- Operating Manual of Radiocommunication Test Set CRTP02
- Operating Manual of Vector Signal Generator SMIQ
- Steffen, R.: Universal tester for GSM and DCS mobile phones, News from Rohde & Schwarz, No. 149, p. 10
- Klier, J.: High-quality digital modulation, News from Rohde & Schwarz, No. 154, p. 4
- Körber, F.; Holzmann, G.: Baseband Signalling with Analog I/Q Inputs and Outputs, Application Note 1CPAN03E



## 6. Ordering Information

Radiocommunication Tester	CRTP02	1052.6506.02
	CRTC02	1081.6000.02
I/Q Inputs/Outputs for CRTP	CRTP-B7	1052.9257.02
Signal Generator	SMIQ02	1084.8004.02
Fading Simulator, 6 paths	SMIQB14	1085.4002.02
Second Fading Simulator for 12 paths	SMIQB15	1085.4402.02



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