



Products: CRTP02, CRTP02, SMIQ

## Mobile Tests for GSM 900 / 1800 / 1900 under Fading Conditions

### Application Note

This application note describes how the most important fading tests for mobile phones in all GSM frequency bands can be carried out cost-effectively using a combination of a CRTP/C02 Radiocommunication Tester and SMIQ Signal Generator.



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## **1 Overview**

GSM standard 11.10 prescribes a number of tests in which mobile phones are measured under multichannel conditions (fading).

This application note describes how the most important fading tests in all GSM frequency bands can be carried out cost-effectively by combination of a CRTP/C02 Radiocommunication Tester and a SMIQ Signal Generator.

Using the IEC/IEEE-bus control commands described and the enclosed program example you can generate and run your own fading tests.

## **2 Principle of Operation**

To test a mobile the CRTP/C02 Radiocommunication Tester establishes two independent bidirectional radio channels, the broadcast channel (BCCH) and the traffic channel (TCH). A transmitter/receiver is available in the CRTP/C02 for each channel.

The output paths of the two transmitters are taken to the front panel of the Tester via N jumpers. From the front panel each path can be connected to a RF fading simulator. However the fading simulators presently available on the market are very expensive and the number of manufacturers is limited.

For this reason, this application note proposes another approach in which the RF transmit signal is not postprocessed but it is generated as a multipath signal by a SMIQ Generator. The SMIQ replaces the transmit section in the CRTP/C02.

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In combination with the universal modulation coder (option SMIQB10) the SMIQ is ideal for generating high-quality digitally modulated signals.

In addition, the SMIQ delivers fading profiles from a list of programmed standards at a keystroke. TYPICAL URBAN, HILLY TERRAIN, RURAL AREA and EQUALIZER TEST are available for GSM each with the prescribed speeds. Options SMIQB14 (fading simulator for 6 paths) and, if necessary, SMIQB15 (second fading simulator for 12 paths) are required for this purpose. Of course, user's multipath profiles can be defined as required.

The SMIQ is modulated with the digital data bits from the CTRP/C02. This maintains excellent signal quality throughout the system and to avoid the summing of any unsymmetries and offsets which inevitably resulting from analog coupling.

An appropriate clock is to be generated in a simple circuit, to read the modulation data into the generator. While the CRTP/C02 delivers a clock TXOUTCLK to its DIGITAL I/O connector in addition to data bits TXOUTBIT. But this clock consists of 156 whole clocks with a quarter of a clock pause at the end: The SMIQ, however, needs a continuous data clock.

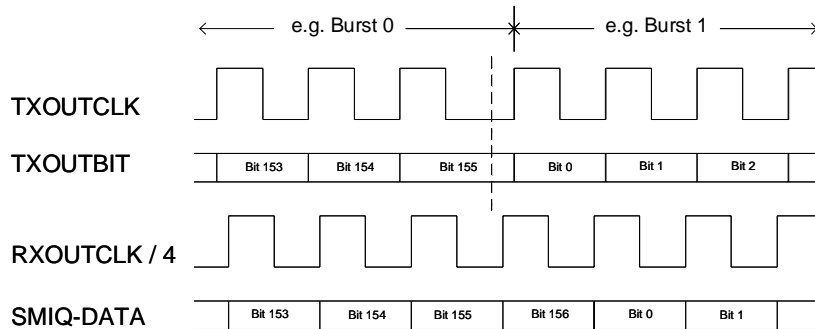


Fig. 1: Data and clocks

Generate a continuous data clock using a simple frequency divider from the four-fold bit clock RXOUTCLK which is also available at DIGITAL I/O connector. A circuit is shown in appendix A1.

As for application 1MA02, the SMIQ is controlled by the CRTP/C02 via the IEC/IEEE bus. Manual settings are therefore not required during a measurement. The extensions needed in the user program are described in Chapter 4 and can be copied from enclosed sample program **fademo.c**.

### 3 Test Setup

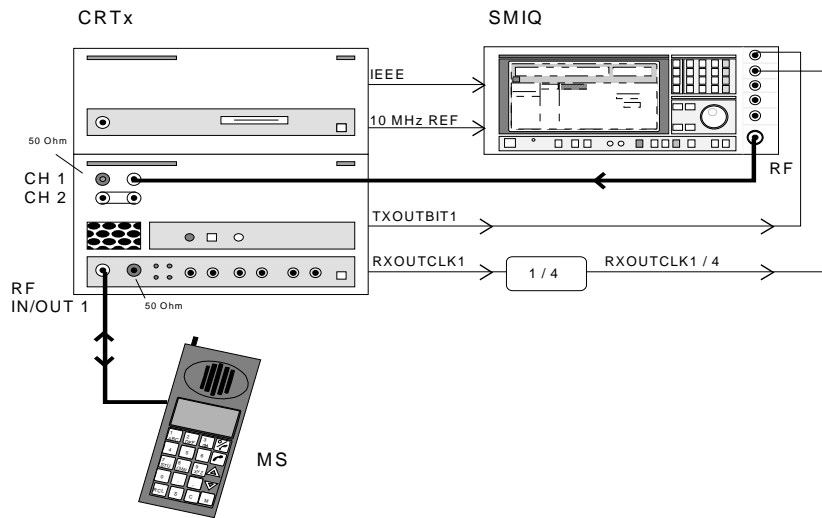


Fig. 2: How to connect the units

Fig. 2 shows the test setup for fading RF CH1. Proceed as follows:

- Remove the N jumper from transmit path RF CH1 on the CRTP/C02. Output stage TY CH1, which is not required is thus disconnected.
- Apply the SMIQ output signal to the unused right-hand connector. In the analog unit this signal is then combined with transmit signal TX CH2 and the receive channels at the RF IN/OUT 1 connector (see Fig. 3).

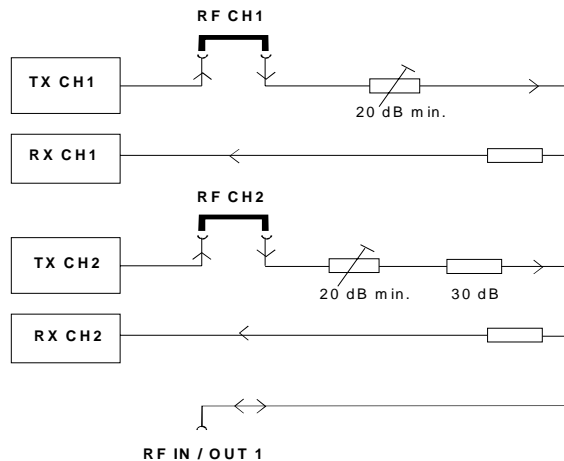


Fig. 3: RF paths in the CRTP/C02

- terminate the TX CH1 and the RF IN 2 connector with a 50-ohm termination, to avoid RF pickup.

Signals TXOUTBIT1 and RXOUTCLK1 can be taken from the DIGITAL I/O connector at the rear panel of the CTRP/C02 analog unit. The pin allocation of this connector is given in Annex A2.

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- Connect TXOUTBIT1 to the DATA input of the SMIQ. Connect RXOUTCLK1 to the frequency divider and the clock RXOUTCLK1/4 to the BIT CLOCK input of the SMIQ.
- To synchronize the frequencies of CRTP/C02 and SMIQ, connect the 10-MHz reference connectors of the units together. CRTP/C02 is the source; SMIQ is by the user program switched to an external reference. CRTP/C02 is the controller for the measurement combined system.
- Connect the SMIQ to the digital unit using an IEC/IEEE-bus cable.

**Note:** *RF CH2 can be faded in the same way as CH1. The minimum 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 (see Fig. 3). This value must be taken into account when programming the output level of the SMIQ.*

The two channels can be faded using two generators. Use a common BIT CLOCK, RXOUTCLK1 /4 or RXOUTCLK2 /4, for channels.

As a result of the regular clock one 157 bits and three 156 bits are allocated to a slot, instead of the four 156.25 bits. With this method it is coincidental in which part of the slot the 157 bits occur. For BCCH, the standard specifies that 157 bits occur in slot 0 or slot 4.

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

Only the experienced user should try to change the channels for an existing program. It should be noted that a great number of further modifications in the test program would then become necessary.

**Note:** *The suggested solution covers tests without frequency hopping.*

### 4 Modifying File `ieeconf.dat`

The digital unit of the CRTP/C02 is configured as an IEC/IEEE-bus controller. The SMIQ must be integrated into the system,

- append the following entries to 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
           Srq          yes
```

Through the declaration 'Device SMIQ' the IEC/IEEE-bus device is globally defined in the CRTP/C02 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.

**Note:** Do not use address 1. It is reserved for the CRTP/C02 analog unit.

With the exception of the first two entries, you can copy all other entries from the previous declaration for `Device CRTS_AU`

### 5 Extending the Test Program

To generate a multipath output signal with the described device configuration, extend a new or existing test program by adding setting commands. Two settings for CRTP/C02 hardware (the level programming in the CRTP/C02, and the delay compensation programming between CRTP/C02 and SMIQ) must at specific locations of the test program.

The other settings comprise SMIQ remote-control commands and are not position-dependent.

All settings are contained in the enclosed program example `fademo.c` and can be copied from there.

- First globally declare valid logic names (variable) for the IEC/IEEE-bus devices at a suitable location.

```
tpDevice SMIQ,CRTSAU; /* logical names */
```

They will be used later as parameters in the write routine `ieWriteToExtDev()`.

**Note:** The upper- and lower-case notation.

### Level Setting in CRTP/C02

Set the variable attenuator in the fading path shown in Fig. 3 is to be set to minimum.

- On calling the **SetLevelOfAnalogUnit()** routine, set the output level of the fading channel to  $-7$  dBm. (This call is available in each receiver test program.)

The CRTP/C02 output stage which is not required cannot be completely switched off. In order to reduce any interference picked up at RF IN / OUT 1, the level of the output stage is reduced by 60 dB.

- Insert the lines below after calling the **SetLevelOfAnalogUnit()** routine.

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

if (!ieWriteToExtDev (CrtsAU,
                      "OUTPUTSTAGE:DEVICE1:LEVEL -60")) {
    printf("ERROR: CrtsAU: set DEV1 to -60dB failed
\n");
    exit(1); }
```

**Note:** If CH2 is faded, use *DEVICE2*.

### Delay Compensation for CRTP/C02 – SMIQ

The SMIQ path (the modulation coder in particular) is approximately  $16 \mu\text{s}$  slower than the CRTP/C02 path. To compensate the signal generated by the CRTP/C02 must be delayed.

- And the call for the **SetSignallingRequest()** routine in your program. (This call is possibly contained in a subroutine.)
- Insert the following function call into the program code for the path which is not to be faded after **SetSignallingRequest()**.

```
if (!ModifyModemDelay((tByte) TxChannel2,
                      (tByte) 0,
                      (tWord) 17, /* quarter bits delay */
                      NULL)) {
    printf("ERROR - ModifyModemDelay failed\n");
    exit (1); }
```

**Note:** If CH2 is faded, the first parameter should be *TxChannel1*.

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### SMIQ Basic Settings

A suitable location in the program code for the following SMIQ commands is immediately after the call for **SetLevelOfAnalogUnit()**.

- First open the logic unit with

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

- Then send the IEEE-bus command:

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

- Repeat the code replace "XRST" check time with the following:

```
...":ROSC:SOUR EXT"...          /* 10 MHz ref
external */

...":DM:IQSWAP ON"...          /* to invert data bits */

...":DM:STAT ON"...           /* dig. modulation */

...":DM:SOUR SER"...          /* data extern serial */

...":DM:STAN GSM"...          /* GSM standard */

...":DM:COD OFF"...           /* no coding at all */

...":DM:CLOCK:SOUR EXT"...      /* clock external */

...":DM:CLOCK:MODE BIT"...     /* bit clock */

...":DM:CLOCK:POL NORM"...     /* clock pol. positive */
```

**Note:** As no external clock is applied yet, the fact that SMIQ is programmed to the external clock causes the following error message to be displayed:

*ERROR 225 MCODE: PLL unlocked*

*The ERROR message disappears after program start when CRTP/CRTC begins to generate clock pulses.*

### Test-Specific Settings on SMIQ

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

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

Use the **ieWriteToExtDev()** function for exemplar channel 110:

```
...":FREQ:CW 957MHz"...        /* ch 110 */
```



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With RF CH1, program an **SMIQ level** 20 dB higher (for RF CH2 50 dB higher). Programming for eg -50 dBm at RF IN / OUT 1 using CH1 is as follows:

```
...":POW:IMM -30dBm"... /* -50 dBm */
```

The following **fading profiles** are already programmed in the SMIQ: RA, HT, TU low, TU high, each at the appropriate speed. If different fading profiles are required, each of the maximum 12 paths must be programmed.

IEC/IEEE-bus commands for GSM900 high / 6 paths:

```
...":FSIM:CONF S6P"... /* 6 paths */
```

```
...":FSIM:STAN G6TU50"... /* URBAN 50 */
```

```
...":FSIM:SEQ RUN"... /* start sequence */
```

### Activating the SMIQ

Use again the **ieWriteToExtDev()** function:

```
...":FSIM ON"... /* fading on */
```

```
...":OUTP ON"... /* RF power on */
```

## 6 Burst Generation

The RF signal generated by the SMIQ is a continuous signal without burst ramps. To generate the burst shape, connect in addition the signal TX OUTAMPL1 (for CH 1) from DIGITAL I/O connector on the CRTP/C02 to the burst gate input of the PAR DATA connector on the SMIQ (see appendix A1 for pin allocation of connectors). Insert the following commands into your test program (use again the **ieWriteToExtDev()** function:

```
...":DM:PRAM:STAT ON"... /* ramping on */
```

```
...":DM:PRAM:SOUR DEXT"... /* extern control */
```

```
...":DM:PRAM:TIME 0.3"... /* rise time */
```

```
...":DM:PRAM:SHAP LIN"... /* edge shape */
```

```
...":DM:PRAM:DEL -2.5"... /* ramp delay */
```

**Note:** Forcing the burst ramps may impair the multipath profile. With some multipath profiles the signals of the slower paths can be cut off at the burst end.

### 7 Test Run

After completing use the test program code compile and link the c-file. Use 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:** *C RTP/C02 does not check the SMIQ command sequences for the SMIQ for correct syntax. Incorrectly written commands cause error messages on the SMIQ. The error message will however disappear once a command with correct syntax is subsequently received. During the first test run check therefore on the display of the SMIQ display carefully no check whether all settings are correct and no errors are displayed.*

Start a test by activating the message controller and calling up your exe file

### 8 Program Example

Enclosed you will find the program **fademo.c** for fading a traffic channel for CRTP/C02 phase 2. It comes with the required files in compressed form and a setup program.

Copy these files on to a disk, insert the latter into drive a: of the CRTP/C02 and enter:

```
a:install
```

The setup program creates the new directory **c:\user\fademo** and copies the application program and the associated data. The original **ieeconf.dat** file will be saved as **ieeconf.org** and replaced by the extended configuration file.

This program is the **demoproc.c** program supplied with each CRTP/C02 and contains the above additions for RF CH 1. It is suitable for the test setup shown in Fig. 1.

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

First activate the message controller of the CTRP/C02 (for call setups and bit error measurements). Enter:

```
i SPE
```

Then go to fademo directory and call fademo. Enter:

```
fademo
```

After the start, a location update is made, if necessary, with the first menu item offered. (This is made in the non-faded RF CH 2.) Then a call is set up with the menu items 2 or 3. The mobile station is assigned RF CH 1, 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 with the sixth menu item of the test program. By reducing the RF output power, a distinct increase in the 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*

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*by selecting the operating mode ATTENUATOR MODE FIXED for a specific variation range, see the SMIQ operating manual section 2.5.2.*

## **9 Literature**

GSM 11.10-1, GSM 05.05, Annex C, GSM 05.10

## **10 Ordering information**

<b>Radiocommunication Tester</b>		
C RTP02		1052.6506.02
C RTC02		1081.6000.02
I/Q Inputs / Outputs for C RTP	C RTP-B7	1052.9257.02
<b>Signal generator</b>		
SMIQ02		1084.8004.02
Modulations coder	SMIQB10	1085.5009.02
Fading Simulator 6 paths	SMIQB14	1085.4002.02
Second Fading Simulator 12 paths	SMIQB15	1085.4402.02

### 11 Annex A1

#### Outputs used at PAR DATA connector on the SMIQ:

(see SMIQ manual for the other pins)

Pin 1 GROUND

Pin 22 BURST GATE

#### Outputs used at DIGITAL I/O connector on the CRTP/C02:

(see CRTP manual for the other pins)

Pin 1 GROUND

Pin 11 TXOUTBIT1

Pin 13 TXOUTAMPL1

Pin 15 RXOUTCLOCK1

Pin 20 GROUND

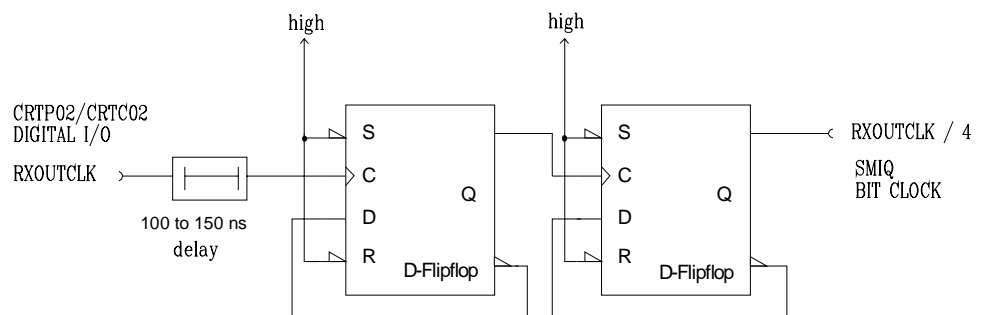
Pin 21 TXOUTBIT2

Pin 23 TXOUTAMPL2

Pin 25 RXOUTCLK2

### 12 Annex A2

#### Proposed clock generation circuit for SMIQ:



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