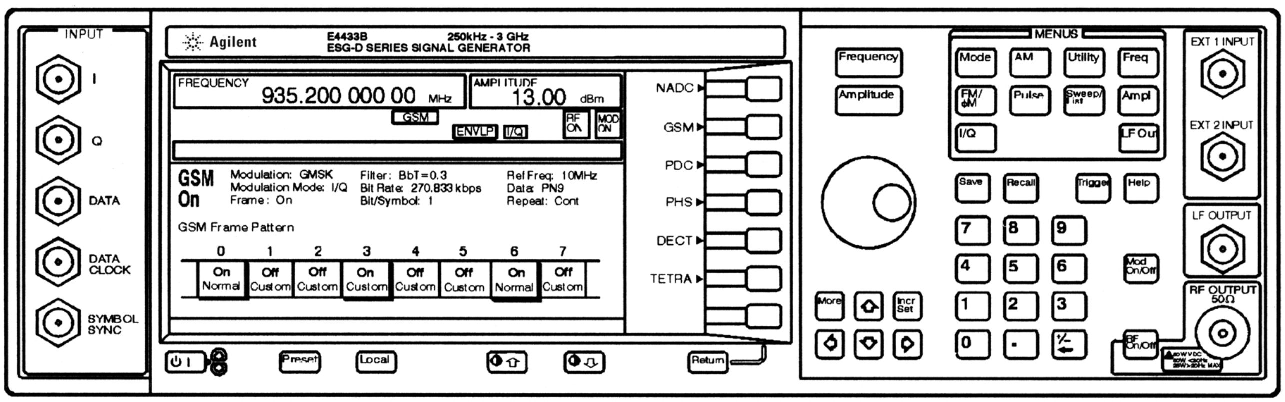
Controlling TDMA timeslot power levels using the Agilent ESG-D series RF signal generators

Product Note



Agilent E4430B 1 GHz
Agilent E4431B 2 GHz
Agilent E4432B 3 GHz
Agilent E4433B 4 GHz

Overview

Keep pace with the demanding changes in digital communications standards with the versatile Agilent Technologies ESG-D series of RF signal generators. The ESG-D series of RF signal generators offer flexible baseband architectures that provide unsurpassed and complementary features for generating complex digitally modulated signals. These flexible architectures provide the freedom to define or create digitally modulated signals, modify existing digital protocols, and simulate transmissions as specified by existing communications standards.

Use the alternate timeslot power level control (Option UNA) to vary the power levels of the transmitted digital data in timeslots of a TDMA frame. This provides realistic signals for the testing of TDMA communications systems.

This product note introduces alternate timeslot power level control using the ESG-D series of signal generators and covers the following areas:

- Example applications for alternate timeslot power level control
- Setting up alternate timeslot power levels
- ESG-D configuration for alternate timeslot power level control

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Example applications for alternate timeslot power level control

The example applications originate from the cellular standard GSM (Global System for Mobiles). The GSM family is comprised of GSM900, DCS1800, and PCS1900.

Receiver Testing

In GSM receiver testing, one must ensure that the receiver can work in the presence of interfering sources under the following conditions:

- on the same absolute radio frequency channel number (ARFCN)
- on an ARFCN one or two channels away, or
- at the same frequency but separated in time

Receiver sensitivity measurements are carried out on both mobiles and base stations. A receiver's sensitivity is examined to verify its ability to recover very weak signals and still be able to demodulate and decode the information modulating those signals within a certain margin of safety. Bit Error Rate (BER) techniques are used to quantify the sensitivity of a mobile or base station receiver.

The signal level used for test is set to the reference sensitivity level of the receiver. At this power level, the decoder or BER tester must decode only a certain number of error bits. Table 1 of the ETSI specifications GSM 05.05 (ETS 300 577) gives the maximum allowable BER and states the reference sensitivity levels for all classes of GSM mobile and base stations.

At the reference sensitivity level, the mobile or base station must not exceed the specified BER limits even when there are signals present in its two neighboring timeslots. For mobile stations, the neighboring timeslots must be 20 dB above the reference sensitivity, and for base stations the adjacent timeslots must be 50 dB above the sensitivity level. For handheld GSM900 mobiles the reference sensitivity is -102 dBm. The adjacent timeslots would therefore be 20 dB above this level, at -82 dBm, as Figure 1 illustrates.

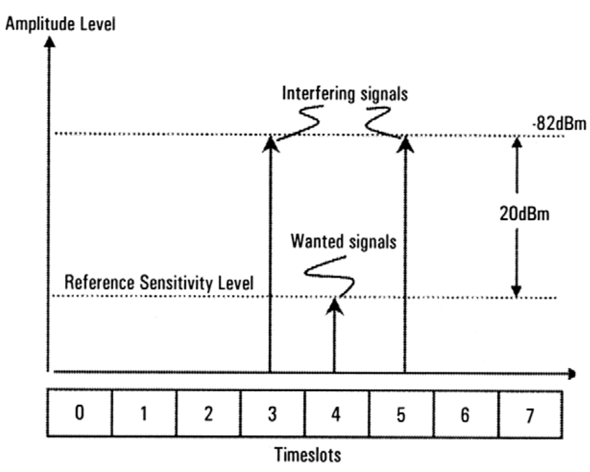


Figure 1. GSM900 receiver sensitivity test

To simulate a GSM mobile or base station for this measurement, the signal generator must be able to generate a GSM signal in a number of different timeslots and be able to vary the level of the signal in the chosen timeslot. The alternate timeslot power level control, Option UNA, of the Agilent ESG-D signal generator provides this capability.

Using the process described in the section "Setting up alternate timeslot power levels," the ESG-D signal generator can vary the amplitude in a chosen timeslot. A BER test would then be carried out to verify that the receiver works correctly.

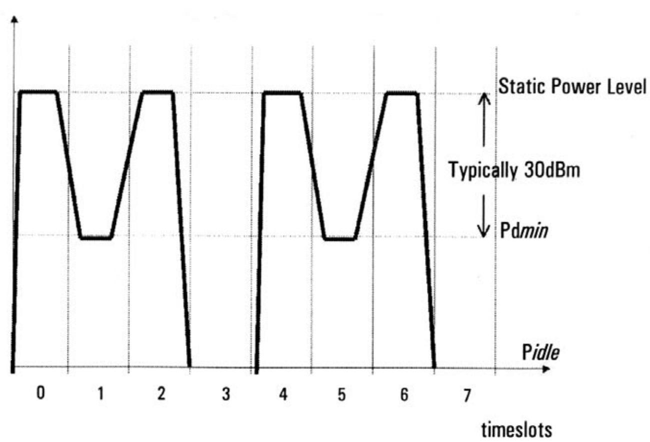
Transmitter component testing

Alternate timeslot power level control Option UNA can also be used in another GSM application; Switching Transients Spectrum for Base Station Transmitter Tests (GSM 11.21 Section 6.5.2, ETS 300 609).

The switching transients spectrum verifies that the output RF spectrum due to switching transients does not exceed the specified limits.

Switching transients, often called sidebands due to switching, is a very important measurement on a transmitter. During the design and manufacture of a transmitter, components of the transmitter chain, such as amplifiers, must be tested with a stimulus. The resulting output RF spectrum is then monitored on a spectrum analyzer. The ESG-D signal generator with Option UNA provides a suitable stimulus.

The switching transients test requires the base station transmitter to have its timeslots configured as shown in Figure 2.



Note: P*dmin* – Lowest dynamic power step measured in GSM 11.21 subsection 6.3
P*idle* – power in an idle timeslot

Figure 2. Power/timeslot configuration for switching transients

Again, the ESG-D signal generator and Option UNA can be configured to produce the power/timeslot configuration shown in Figure 2 and, in conjunction with a suitable analyzer, test devices in the transmitter chain.

Multislot data

Conventional GSM mobiles use a single timeslot on the uplink and downlink to convey a traffic channel (TCH) as shown in Figure 3.

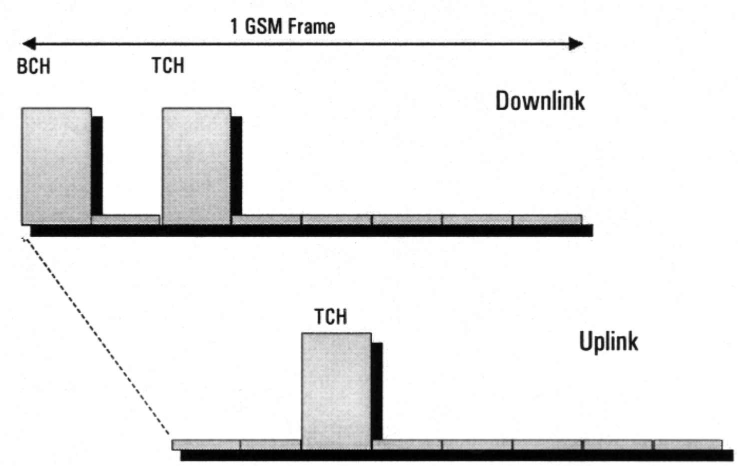


Figure 3. Uplink and downlink TCH in conventional GSM

The ability to transmit data as well as voice traffic is one of the features of GSM. Traditionally, data was transmitted in a single TCH timeslot, at rates of 2.4 kilobits per second (kbps), 4.8 kbps, 9.6 kbps, or 14.4 kbps. Advances in technology and the need for higher data rates are driving the demand for increased bandwidth. ETSI recently enhanced the GSM standards to allow higher data rates. High Speed Circuit Switched Data (HSCSD) improves the speed of regular circuit switched data connections by using multiple timeslots.

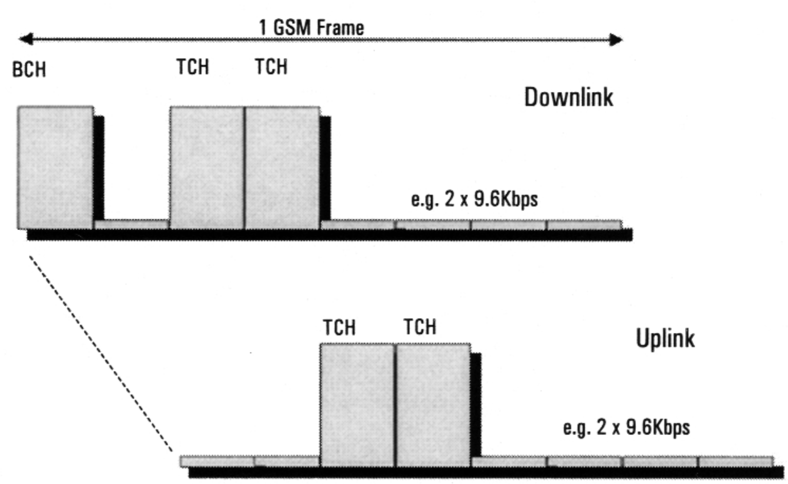


Figure 4. High-Speed Circuit Switched Data (HSCSD)

In Figure 4, the maximum data rate is 19.2 kbps, compared to 9.6 kbps in the original ETSI GSM standard. If a data rate of 14.4 kbps was used in each time-slot, a composite data rate of 28.8 kbps could be attained. Even higher data rates can be achieved by using more than two timeslots to transmit the data.

In addition to this, each uplink and downlink timeslot can be transmitted at different power levels, as shown in Figure 5. This is detailed in Section 6.2 of the ETSI Technical Specification GSM 05.05 (version 5.9 and version 6.2).

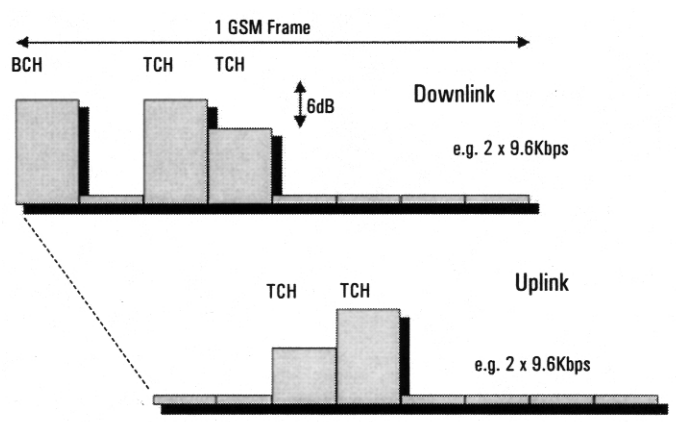


Figure 5. Different power levels in HCSCD

The ESG-D signal generator with Option UNA can produce GSM timeslots at varying power levels and can therefore be used to simulate such a GSM transmitter.

Setting up alternate timeslot power levels

Setting up alternate timeslot power levels with the Agilent ESG-D series RF signal generator is easy. Follow the steps below to configure the ESG-D signal generator and produce the signals required for a GSM900 mobile receiver reference sensitivity test. The reference sensitivity amplitude is -102 dBm and the adjacent timeslots are 20 dB higher. The required key presses are given in the left hand column. Hardkey commands are depicted by the button icons and the softkey commands are given as text.

1. Preset the ESG-D signal generator.

2. Set the Frequency to desired value, e.g., 900 MHz, using the numeric keyboard, up/down arrow keys, or rotary knob, and press the MHz softkey.

3. Set the RF power level. Press the dark grey Amplitude hardkey and enter desired value, e.g., 102, using the same method as in Step 2. Press the dBm softkey. This is the Main amplitude, and should now be present in the upper right-hand corner of the display.

4. Set the alternate timeslot power level. Press the light grey Ampl hardkey located in the Menus section of the front panel.

- Select the **Alternate Amplitude ▸** softkey.
- Set the alternate power level delta. Press **Alt Ampl Delta** softkey and enter the value desired. This delta value is added to the main RF output amplitude (set in Step 3). Enter **20** and press the **dB** softkey. The alternate amplitude will now be (-102 dBm + 20 dBm) = **-82 dBm.**
- Set the trigger source for the alternate timeslot power level using the **Alt Ampl Trigger** softkey. The choices are: manual, internal, and external. To allow the real-time IQ baseband generator to trigger the alternate timeslot power level, choose **Int**.
- Turn the alternate amplitude facility on. Toggle the **Alt Ampl** softkey to **Alt Ampl On**. The delta annunciator Δ= **20.00 dB** should now be showing above the main RF amplitude on the display.

Preset

Frequency

9 **0** **0**

Amplitude

+/– **1** **0** **2** **dBm**

Ampl

Alternative Amplitude ▶

Alt Ampl Delta

2 **0** **dB**

Alt Ampl Trigger

Int

Alt Ampl Off **On**

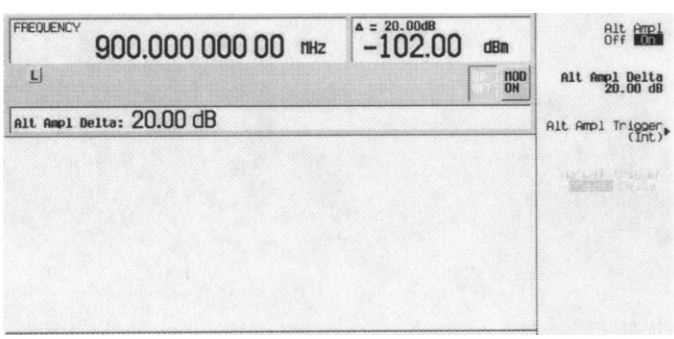


Figure 6. Screen capture of set-up so far

5. Press Mode.

6. If Options UN8 and UND and/or Option UN7 are installed, select **Real Time IQ Baseband.** If only Option UN8 is installed please bypass this step.

7. Choose the **TDMA** format you require–in this case, **GSM**.

8. Choose framed data. A graphic depicting 8 GSM timeslots should be present on the display.

9. Select **Configure Timeslots ▸**.

10. Choose the desired timeslot–in this case, **Timeslot #4**.

11. Choose the timeslot type (e.g. **Normal**) and select desired data (e.g. **PN9**). The default settings for timeslot #4 are Custom and PN9. Change the timeslot type to Normal.

12. Set the power level of the timeslot. Choose between the Main value entered in step 3 or the Alternate value entered in step 4. In this case, select **Main**.

13. Turn timeslot #4 On.

Now set up a neighboring timeslot to have the alternate power level.

14. Select Timeslot #3 using the keyboard, rotary knob, or up/down arrow keys.

15. Choose timeslot type and data. Again, the settings of Normal and PN9 will be used.

16. Toggle Timeslot Ampl from Main to Delta. The delta value (20 dB) should now appear in the Timeslot #3 graphic.

17. Turn the timeslot on.

18. Repeat this sequence for Timeslot #5, the other timeslot which is adjacent to Timeslot #4.

19. Press Return hardkey.

20. Enable the GSM standard.

21. Turn RF on. The modulated signal is now available at the RF OUTPUT connector.

Mode

Real Time IQ Baseband

TDMA ▶
GSM ▶
Data Format Framed

Configure Timeslots ▶

Timeslot#0 **4** **Enter**

Timeslot Type ▶ Normal

Timeslot Ampl Main Delta

Timeslot Off **On**

Timeslot#4 **3** **Enter**

Timeslot Type Normal

Timeslot Ampl Main **Delta**

Timeslot Off **On**

Timeslot#3 **5** **Enter**
Timeslot Type ▶ Normal
Timeslot Ampl Main **Delta**
Timeslot Off **On**

Return

GSM Off **On**

RF On/Off

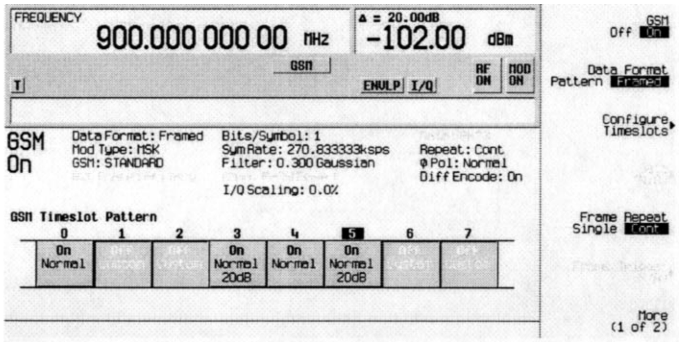


Figure 7. Screen capture of final set-up

The Agilent ESG-D signal generator is now producing a GSM signal with power levels of -102 dBm on timeslot #4 and –82 dBm on timeslots #3 and #5.

The ESG-D signal generator with Option UNA can be used to vary the power levels of:

- timeslots in any of the six built-in communications standards (GSM, NADC, PHS, PDC, DECT, and TETRA) provided with the real-time I/Q baseband generator (Option UN8), or;
- signals created using the flexible pattern RAM and real-time I/Q baseband generator (Option UN8)

Remember: the maximum and minimum limits for the alternate timeslot power level are bounded by the upper[1] and lower power levels of the ESG-D signal generator, given below:

- -136 dBm <= Main RF Level + Delta <= +13 dBm (250 kHz to 1000 MHz)
- -136 dBm <= Main RF Level + Delta <= +10 dBm (>1000 MHz to 3000 MHz)
- -136 dBm <= Main RF Level + Delta <= +7 dBm (>3000 MHz to 4000 MHz)

1. The Agilent ESG-D user interface allows amplitudes of up to +20 dBm to be set, however performance is unspecified at this level.

Agilent ESG-D configuration for alternate timeslot amplitude control

The ESG-D series signal generators (E4430B to E4433B) must be configured with the real-time I/Q baseband generator (Option UN8) before alternate timeslot power level control Option UNA can be installed.

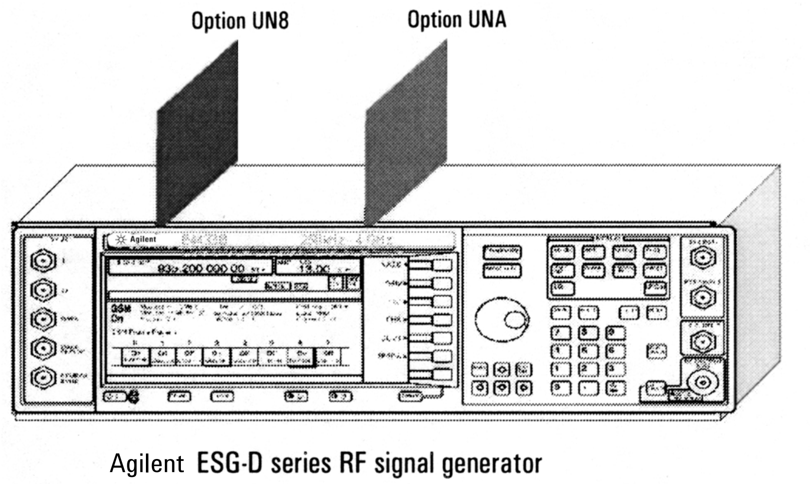


Figure 8. Required options for alternate timeslot power control

Please note that the high power with mechanical attenuator (Option UNB) and the alternate timeslot power level control (Option UNA) are mutually exclusive.

Summary

You should now understand the benefits that the ESG-D RF signal generator configured with alternate timeslot power level control Option UNA can provide.

For more information on the ESG series RF signal generators, please consult the following list of related literature or contact your local Agilent representative.

Related literature

Product information

Agilent ESG Series RF Signal Generators
Technical Specifications, literature number 5965-3096E

Agilent ESG Synthesized Signal Generators
Configuration Guide, literature number 5965-4973E

Signal Generator Selection Guide, literature number 5965- 3094E

Agilent ESG-D Series RF Signal Generators Options UN8 and UN6
Product Overview, literature number 5966-3680E

Agilent ESG-D Series RF Signal Generators Options UND and UN5
Product Overview, literature number 5966-3678E

Agilent ESG-D Series RF Signal Generators Option UN7
Product Overview, literature number 5966-3557E

Application information

Digital Modulation in Communications Systems–An Introduction,
literature number 5965-7160E

Using the ESG-D Series of RF signal generators and the 8922
GSM Test Set for GSM Applications, literature number 5965-7158E

Generating and Downloading Data to the ESG-D RF Signal Generator
for Digital Modulation, literature number 5966-1010E

Using Vector Modulation Analysis in the Integration,
Troubleshooting, and Design of Digital Communications Systems,
literature number 5091-8687E

Generate Digital Modulation with the ESG-D Series Dual Arbitrary
Waveform Generator, Option UND, Product Note, 5966-4097E

Customize Digital Modulation with the ESG-D Series Real-time I/Q
Baseband Generator, Option UN8, Product Note, 5966-4096E

Making Bit-error-rate Measurements with the ESG-D Series,
Option UN7, Product Note, 5966-4098E

ETSI GSM/DCS Technical Specifications, ETSI Secretariat, 06921,
Sophia Antipolis Cedex, Valbonne, France

"An Introduction to GSM," S.M. Redl, M.K. Weber, M.W. Oliphant, 1995,
Artech House Publishers, ISBM 0-89006-785-6

Web page

Access to news, product and support information, application literature
and more. Use this online service 24 hours a day to get the latest data on
the ESG Series.

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