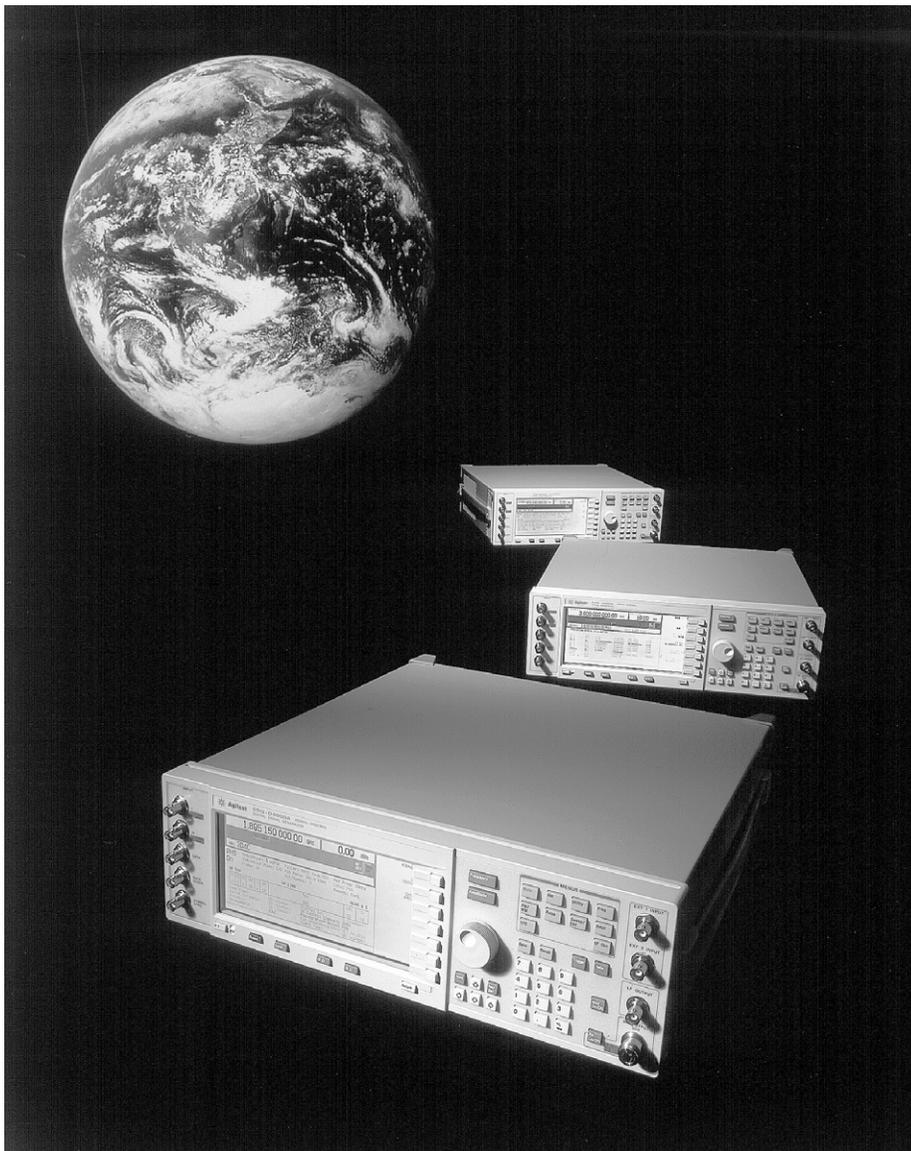# Agilent PN ESG-1

Using the Agilent ESG-D Series of RF Signal Generators and the Agilent 8922 GSM Test Set for GSM Applications

Product Note

Agilent Technologies

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1. Introduction

The ESG series RF signal generators from Agilent Technologies provides precise frequency and level control, modulation (AM, FM, phase modulation and pulse modulation), a choice of frequency coverage from 250 kHz to 1, 2, 3 or 4 GHz, and an easy-to-use interface. The digital family, the ESG-D series, adds versatile I/Q digital modulation capabilities and six built-in communications standards (GSM, DECT, TETRA, NADC, PHS and PDC) are provided with the optional IQ baseband generator (Options UN3 & UN4). Accessible at the touch of a button, these built-in communications personalities are easy to configure to meet user-defined test requirements. The ESG-D series provides operators measurement versatility by offering a choice of internal or external data generation, and flexible framing, timeslot and power burst profile configuration capabilities.

The purpose of this product note is to show how to use the ESG-D series signal generators to generate a digitally modulated signal for the Global System for Mobile Communications (GSM). Details will also be given on how the ESG-D series signal generators can be used with the Agilent 8922 GSM Test Set for GSM applications.

2. Introduction to GSM

The Global System for Mobile Communications (GSM) is the most successful digital cellular system in operation today. Although GSM originated in Europe, it is quickly gaining world-wide acceptance and is being adopted as a standard in many countries.

GSM uses 0.3 Gaussian Minimum Shift Keying (0.3 GMSK) modulation and a bit rate of 270.833 kbits/second. The "trellis" diagram, shown below, shows a representation of GMSK modulation. It shows time on the X-axis and phase on the Y-axis. This allows the examinations of the phase transitions with different symbols or bits.
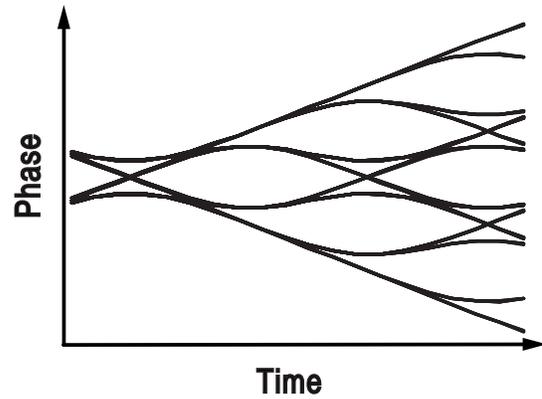

Figure 1a. Trellis diagram of GMSK.

GMSK is a special type of digital FM. Ones and zeros are represented by shifting the RF carrier by plus or minus 67.708kHz. This frequency shift has a corresponding shift in phase (relative to the unmodulated carrier) which conveys information.

3

If a long series of ones were sent, the result would be a series of positive phase transitions of 90 degrees per bit. If a long series of zeros were sent, there would be a constant declining phase of 90 degrees per bit. Typically, there would be intermediate transmissions with random data.

The modulation spectrum is reduced by applying a Gaussian pre-modulation filter. This slows down the rapid frequency transitions which would otherwise spread energy into adjacent channels. When Gaussian filtering is applied, the phase makes slower direction changes and this prevents the phase trajectory from meeting its 90 degree target points. The exact phase trajectory is very tightly controlled–the GSM specifications allow no more

than 5 degrees rms and 20 degrees peak deviation from the ideal trajectory. The 0.3 mentioned above describes the bandwidth of the Gaussian filter with relation to the bit rate, and is more commonly called the **filter alpha** or the **Bandwidth-by-Time product (BbT)**.

The GSM system consists of Mobile Stations (MS), both hand-held portables and mobiles mounted in a car, which communicate with the Base Station System (BSS) over the RF air interface. The BSS typically consists of a Base Transceiver System (BTS) and a Base Station Controller (BSC) which are connected by a link called the Abis interface. The Abis interface is often a microwave link, but can also be a cable or an optical fibre.
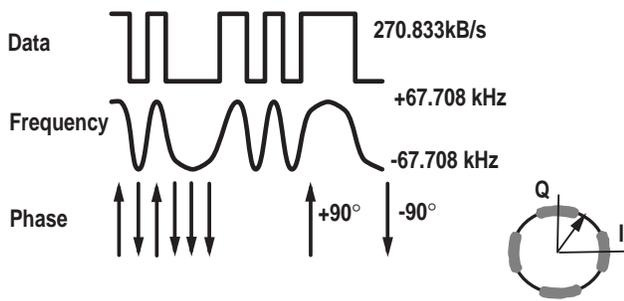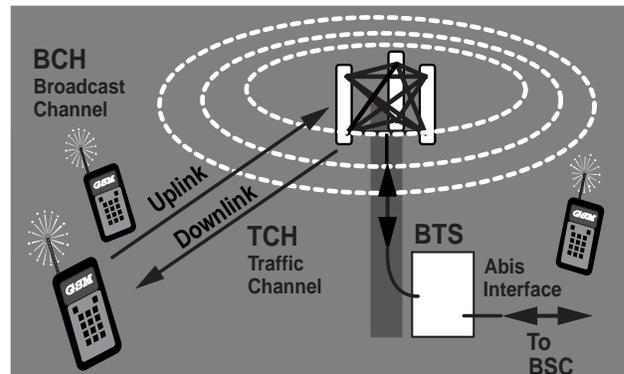

Figure 1b. 0.3 GMSK

Figure 2. Diagram of GSM cell

The BTS is fitted with a number of transmitter/receiver (or transceiver) modules, the number of which determines the number of frequency channels that can be used in the GSM cell. Its exact configuration varies depending on the number of users expected in the cell. All BTSs continually produce a Broadcast Channel (BCH). The BCH is like a beacon—it allows mobiles to find the GSM network. The BCH consists of various parts for frequency correction, synchronization, control and access. The BCH is received by all mobiles in the cell, whether they are on a call or not.

Mobiles on a call use a TCH (Traffic Channel). The TCH is a **two way** channel used to exchange speech information between the mobile and base-station. Using Frequency Division Multiple Access (FDMA), information is divided into the uplink and downlink, depending on its direction of flow. The uplink is for mobile transmission and the downlink is for base station transmission. Within each band the channel numbering scheme is the same, however, the uplink and downlink bands are 45 MHz apart.

Each band is then divided into 200 kHz channels called Absolute Radio Frequency Channel Numbers (ARFCN). In addition to frequency division, time is also divided into segments using Time Division Multiple Access (TDMA).

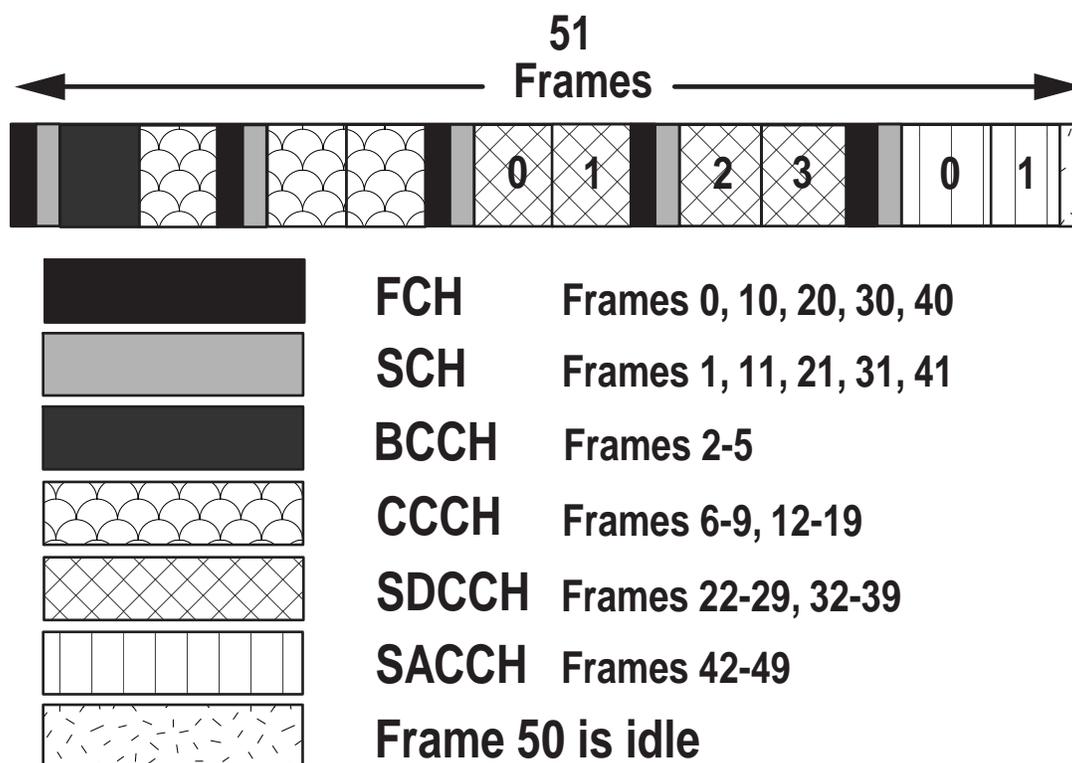|		
FCH	Frames 0, 10, 20, 30, 40	
SCH	Frames 1, 11, 21, 31, 41	
BCCH	Frames 2-5	
CCCH	Frames 6-9, 12-19	
SDCCH	Frames 22-29, 32-39	
SACCH	Frames 42-49	
Frame 50 is idle		

Figure 3. Diagram of BCH

Each ARFCN is shared between up to 8 mobiles. Since there are a maximum of eight users per frequency, there are eight timeslots (TS) per GSM frame. Each timeslot lasts 576.92μs and contains 156.25 bits of information, although only 148 of these bits are used for data. The remaining bits are used for "guard" time. The pattern repeats, giving the users another timeslot each frame. Therefore, each mobile (user) uses the ARFCN for one timeslot and then waits for its turn to come round again in the next frame.

The mobile transmitter turns on only during its active timeslot. The requirement to transmit in only one single timeslot and stay idle during the remaining seven timeslots results in very tight demands on the switching on and off of the RF power. If a mobile station does not perform according to the specifications, it will disturb other mobile stations in adjacent timeslots and on adjacent channels. The GSM specifications make sure a mobile's emissions remain in its assigned channel by specifying a power-versus-time template, shown in Figure 5. During the central, or "useful," part of the TDMA burst (corresponding to 147 bits) when data is being transmitted, the mobile has to control its output to within +/−1dB of the mean value. This pulsed transmission is not only defined for the mobile station but is also generally defined for base stations.

Figure 4. Diagram of ARFCNs

Figure 5. GSM TDMA burst

The ETSI GSM 05.05 specifications also define the Adjacent Channel Power (ACP) performance required by both mobile and base stations. The ACP specifications define the performance required by the mobile and base stations outside their assigned channels. The ACP is usually defined at 1 channel (200kHz), 2 channel (400kHz), 3 channel (600kHz), etc. offsets from the assigned channel. Both the modulation process and the power ramping up and down (switching transients) affect the output RF spectrum.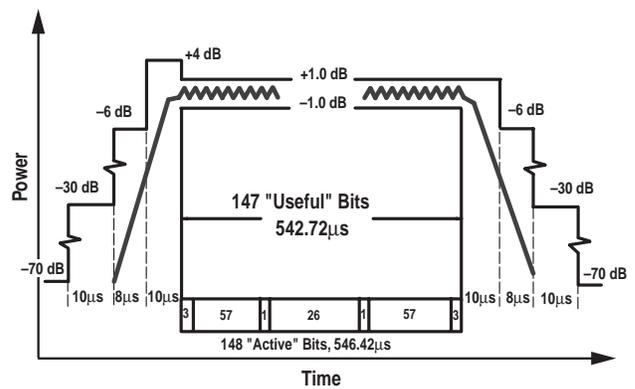 The required ACP performance due to these two effects is defined in the ETSI GSM 05.05 specifications. The diagram and table below illustrate the excellent ACP performance available with the ESG-D signal generator (configured with Option UN3 or Option UN4). It can clearly be seen from the table that the ESG-D complies with the ETSI specifications.
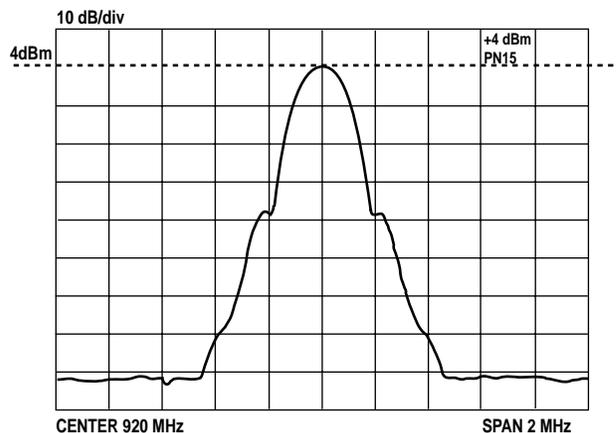
Figure 6. Agilent ESG-D GSM RF output profile (burst mode)

	Spectrum due to modulation				Spectrum due to switching			
Offset from carrier (kHz)	200	400	600	1,200	200	400	600	1,200
ETSI spec. (30 kHz measurement bandwidth)								
BS (at max power)	–30	–60	–70	–73	---	–57	–67	–74
MS (at max power)	–30	–60	–66	–66	---	–23 dBm	–26 dBm	–32 dBm
Agilent ESG-D spec. (30kHz measurement bandwidth)	**–37**	**–71**	**–81**	**<–83**	**–37**	**–69**	**–79**	**–81**

Table 1: Summary of Agilent ESG-D GSM ACP performance vs. ETSI GSM 05.05 recommendations
(ACP given in dBc, except where stated otherwise)

As mentioned earlier, eight time-slots make up a GSM frame. Frames are then grouped together to make multiframes. Speech multiframes (such as a TCH) consist of 26 frames, while signaling data multiframes (such as a BCH) are made up of 51 frames. A superframe consists of 26 or 51 multi-frames.

Figure 7. Diagrams of frames, multiframes, superframes

How are GSM, DCS1800 and PCS1900 different?
GSM is a family of digital cellular systems. The term GSM can be used collectively to describe the GSM900 and DCS1800 standards. GSM900 is the original GSM system, using frequencies in the 900 MHz band and is designed for wide area cellular operation. DCS1800 is an adaptation of GSM900. Creating DCS1800 involved widening the bands assigned to GSM and moving them up to 1.8 GHz. To avoid confusion, the chan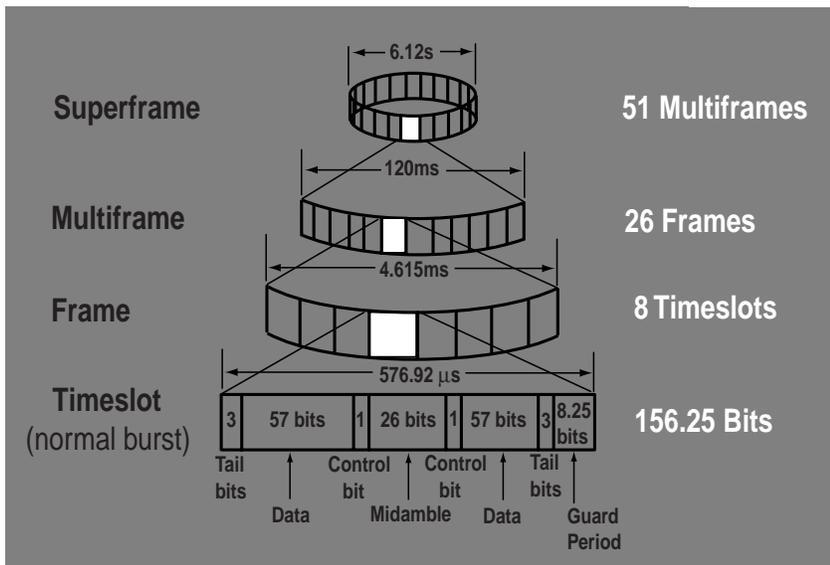nel numbers (ARFCN) used for GSM900 channels run from 1 to 124, and the ARFCNs for DCS1800 run from 512 to 885. With wider frequency allocation, leading to more channels, DCS1800 is able to cope with higher user densities. DCS1800 mobiles are also designed for lower output powers (up to 1W), so cell sizes have to be smaller, meaning even higher densities. In all other respects, GSM900 and DCS1800 are the

same. The GSM Phase II specifications (a revised and re-written standard) brings the two systems even closer. GSM900 gets additional bandwidth and channels, called E-GSM (Extended band GSM) and lower power control levels for mobiles, allow-ing micro-cell operation. These two features allow increased user densities in GSM systems. Phase II also makes provision for the addition of new serv-ices on GSM and DCS1800. The addition of specific services such as data, fax and dual mode operation is currently being defined in what is referred to as Phase II+. In the USA, bands have been released around 2 GHz for a PCS (Personal Communications System). The ready availability of GSM equipment and expertise has made GSM at 1.9GHz very attractive for many operators. In technical terms PCS1900 will be identical to DCS1800 except for frequency allocation and power levels.

The following table is a summary of the GSM specifics:

	Phase 1 GSM900	Phase 2 GSM900	Phase 1 DCS1800	Phase 2 DCS1800	PCS1900
Uplink Frequency Range	890 to 915 MHz	880 to 915 MHz	1710 to 1785 MHz	1710 to 1785 MHz	1850 to 1910 MHz
Downlink Frequency Range	935 to 960 MHz	925 to 960 MHz	1805 to 1880 MHz	1805 to 1880 MHz	1930 to 1990 MHz
ARFCN range	1 to 124	0 to 124 and 975 to 1023	512 to 885	512 to 885	512 to 810
TX/RX Spacing (Freq.)	45 MHz	45 MHz	95 MHz	95 MHz	80 MHz
Mobile Max Power	20W (8W used) 43 dBm/39 dBm	8W/39 dBm	1W/30 dBm	4W/36 dBm	2W/33 dBm
Mobile Min Power	20mW/13 dBm	3mW/5 dBm	1mW/30 dBm	1mW/0 dBm	1mW/0 dBm
Mobile Power Control Steps	0 - 15	2 - 19	0 - 13	0 - 15	0 - 15, 30, 31
Voice Coder Bit Rate	13 kBit/s	Full Rate 13 kBit/s, Half Rate 5.6 kBit/s	13 kBit/s	Full Rate 13 kBit/s, Half Rate 5.6 kBit/s	13 kBit/s

Table 2: Summary of GSM system parameters

Channel Spacing	200 kHz	**Bits per Burst**	156.25
Modulation Type	0.3 GMSK	**Useful Bits per Burst**	147
Modulation Data Rate	270.833 kHz	**Frame Period**	4.62µs
Tx/Rx Time Spacing	Three Timeslots	**Timeslot Period**	576.9µs
Slots per Frame	8	**Bit Period**	3.692µs

General GSM parameters

For more information on the GSM standard, see the list of related literature, given on the back page.

3. Generating a 0.3 GMSK Modulated Burst Signal for GSM (DCS 1800 & PCS 1900) Using the Agilent ESG-D Series Signal Generator

The ESG-D series signal generators are capable of generating 0.3 GMSK signals required for the development and testing of GSM communications systems and the components of these systems. 0.3 GMSK signal generation is achieved by using the ESG-D series signal generator with the internal I/Q baseband generator **(Options UN3** or **UN4)**. The baseband generator also provides signals that conform to other communications standards such as PHS, PDC, NADC, DECT and TETRA.

1. Turn the signal generator on or press **Preset** (the green button on the lower left corner of the instrument).

2. Set the desired RF output frequency. The current RF output frequency is always shown in the frequency area of the display. Press the **Frequency** front panel hardkey to change the RF output frequency. To enter a new value for frequency, rotate the front panel knob until the desired frequency is displayed, use the up and down arrow keys, or enter the value using the numeric keypad and press the **GHz, MHz, kHz,** or **Hz** terminator softkey.

For example, to set an output frequency of 880MHz:
> Press **Frequency**.
> Key in **880** using the numeric keypad.
> Press the **MHz** softkey.

Many GSM users are accustomed to thinking in terms of channel (ARFCN) numbers, rather than absolute frequency values. There are formulae which can be used to convert ARFCNs to the corre-

sponding absolute frequency values. These formulae are given in Section 9.

3. Set the desired RF output power level.
The current RF output power level is always shown in the amplitude area of the display. Press this front panel hardkey to change the RF output power. To enter a new value for amplitude, rotate the front panel knob until the desired amplitude is displayed, use the up and down arrow keys, or enter the value using the numeric keypad and press the **dBm, dBuV, dBuVemf, mV, uV, mVemf** or **uVemf** terminator softkey.

For example, to set up an output power level of 0 dBm:
> Press the **Amplitude** hardkey
> Press **0** on the numeric keypad
> Press the **dBm** softkey

4. Press the front panel **Mode** key.
Pressing the grey front panel **Mode** key reveals a menu of softkeys. These softkeys allow further menus to be accessed, for configuring the desired digital communications standards, in this case **GSM**.

5. Press the **GSM** softkey.
Pressing this softkey reveals a menu of softkeys for generating framed or unframed GSM transmissions.

6. **Data Format Pattern Framed**
Press this softkey to toggle between **Data Format Pattern**, to transmit a continuous stream or pattern of data, and **Data Format Framed**, to transmit a pulsed RF GMSK signal in a GSM TDMA format.
> Select **Data Format Framed**

The lower half of the signal generator's display will now show a graphic of the GSM timeslot pattern, as shown in the diagram below.
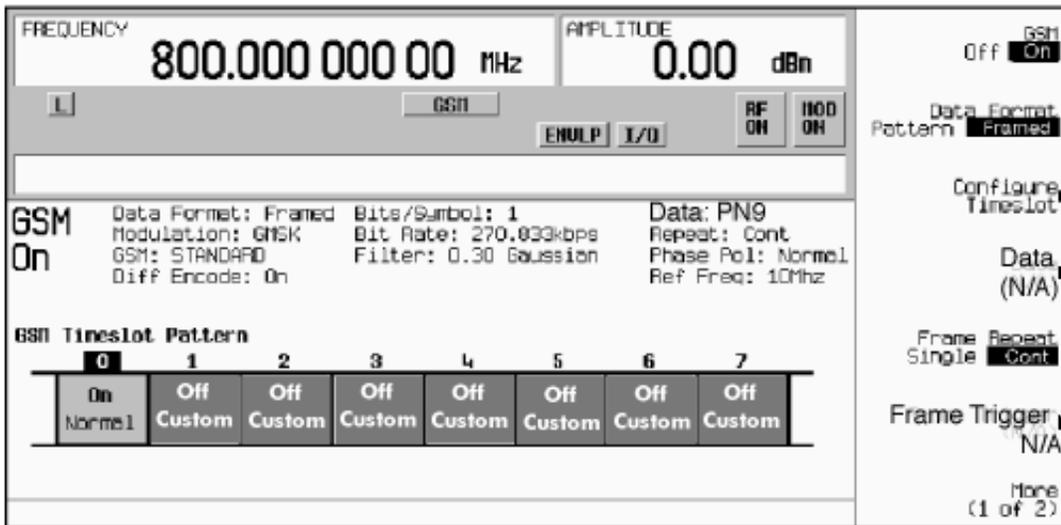

Figure 8. ESG-D GSM timeslot pattern

The default setting of the signal generator is that it transmits a single frame of data (**Frame Repeat Single** softkey). The Agilent ESG-D can also be set to transmit frames of data continuously (**Frame Repeat Cont** softkey). The data sequences that can be transmitted are described in Section 4 "Data Generation".

7. Manipulating the **timeslot**
The ESG-D series signal generator allows the contents of each timeslot to be defined.

Pressing the **Configure Timeslot** softkey reveals a menu of choices for configuring the timeslot. This softkey is inactive until **Data Format Framed** is selected.

In this menu, the user can select which timeslots to turn on and choose the type of RF power burst desired. The subsequent menus are then used to configure the data and training sequence fields.

As mentioned in the introduction, there are 156.25 bits in each timeslot. The ESG-D optional baseband generator (Option UN3/UN4) implements the GSM scheme by making every fourth timeslot (i.e. timeslot 0 & timeslot 4) 157 bit periods long, and the remaining timeslots in the frame (i.e. timeslots

1,2,3,5,6 & 7) 156 bit periods long. This implementation complies with the ETSI GSM standard (GSM 05.10, version 4.9.0, section 5.7).

A similar implementation applies to Guard Time and Extended Guard Time bits. Guard time (**G**) appears in the visual representation of the timeslot as a 8.25 bit field. In the actual implementation, the guard time in timeslots 0 & 4 are 9 bits long, and the remaining timeslots contain 8 bit fields. Extended Guard Time (**EG**) appears in the visual representation of Access timeslots as a 68.25 bit field. In the actual implementation, the guard time in timeslots 0&4 are 69 bits long, and the remaining timeslots contain 68 bit fields (also documented in the GSM standard "GSM 05.10, version 4.9.0, Section 5.7").

1. Turning timeslots off and on
After the **Configure Timeslot** softkey has been pressed, press the **Timeslot #** softkey. Any one of the eight timeslots can be selected by using the front panel knob, the up and down arrow keys, by entering the number using the numeric keypad, and pressing the **Enter** terminator softkey. The selected timeslot is activated by toggling **Timeslot Off On** to **On**. The visual

representation of the timeslot pattern should now show the selected timeslot turned on.

2. Setting the timeslot type
Having selected the active timeslots, the timeslot type can be set for the active timeslot. Any of the 8 timeslots can be set to one of the following types:

Normal
A **normal burst** is the most common burst in the GSM system and is transmitted in one timeslot either from the base station or the mobile station. This burst type configures the timeslot as a traffic channel. To select this burst type for the active timeslot:
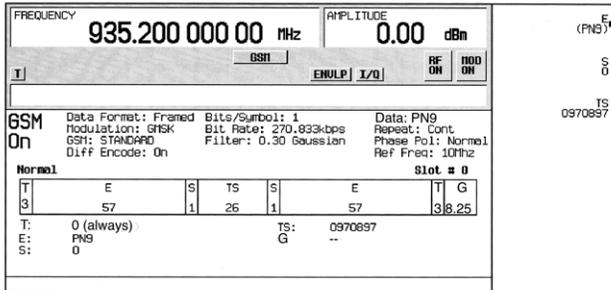   Press the **Normal** softkey.

Figure 9. ESG-D GSM normal timeslot
The above figure shows an example of display graphics for a normal timeslot. This shows each field of the timeslot as it is defined by the GSM standard.

Frequency Correction
Timing is a critical need in a GSM system. The base station has to provide the means for a mobile station to synchronize with the master frequency of the system. To achieve synchronization the base station transmits a frequency correction burst, during certain known intervals. This frequency correction burst is simply a fixed sequence of zeros for the duration of one timeslot. In a GSM network, frequency correction bursts occur every 10 frames (Frame 0, Frame 10, Frame 20 etc. of a BCH signaling data multiframe (see the FCH in Figure 3), and always occur in timeslot 0 (the base station always generates the BCH on timeslot 0). To maximize the flexibility of the ESG-D series signal generator, however, any timeslot may be set to the frequency correction type. Also note that the frequency correction burst will be repeated every frame, not every 10 frames, if the built-in data generator is used. To repeat every 10 frames, a long user-defined data sequence could be generated and loaded directly into the signal generator's pattern RAM (see Section 4.4, "Generating long data sequences").

To select this burst type for the active timeslot:
    Press the **FCorr** softkey.

Synchronization
The base station sends signals on the BCH, which contain some valuable system parameters, such as those which enable the mobile to synchronize to the BS. The mobile, however, needs a defined training sequence before it can demodulate and decode this information. The base station tells the mobile which training sequence to use with the **synchronization burst**. The synchronization burst has an extended midamble (or training sequence) with a fixed sequence in order to give the mobile the "key" it needs to decode the system parameters. Like frequency correction channels, synchronization channels occur every 10 frames (Frame 1, Frame 11, Frame 21 etc. of a signaling data multiframe - see the SCH in Figure 3), and the bursts always

occur in timeslot 0. To maximize the flexibility of the Agilent ESG-D series signal generator, however, any timeslot may be set to the synchronization type. The synchronization burst will be repeated every frame, not every 10 frames, if the built-in data generator is used. To repeat every 10 frames, a long data sequence could be generated and loaded directly into the signal generator's pattern RAM (see Section 4.4).

To select this burst type for the active timeslot:
    Press the **Sync** softkey.

Random Access
Mobiles use a **random access burst** when trying to gain initial access to the system. This burst type is shorter than a normal burst, and is used by the base station to measure the time delay a mobile's burst is experiencing.

To select this burst type for the active timeslot:
    Press the **Access** softkey.

Dummy
In the GSM system, the base station must transmit something in each timeslot of the base channel. Even if these timeslots are not allocated to communication with any mobiles, the base station has to transmit predefined **dummy bursts**, specially defined for this purpose, in the idle timeslots of the base channel.

To select this burst type for the active timeslot:
    Press the **Dummy** softkey.

Custom
The custom timeslot is provided for users' flexibility, but it is not a standard GSM timeslot type. A custom timeslot is configured using an internally-generated data pattern, a

downloaded sequence of bits stored in a user file, or by supplying external data.

To select this burst type for the active timeslot:
    Press the **Custom** softkey.

Once the desired timeslot type has been selected, the "Configure Timeslot" menu will be displayed.

3. Configuring selected timeslot
The data and training sequence fields within a certain timeslot type may be configured by the user. From within the **Configure Timeslot** menu, select the **Configure** ... softkey corresponding to the chosen timeslot type. For example, to configure a normal timeslot, the **Configure Normal** softkey should be selected. The visual representation of the timeslot shows each field of the timeslot as it is defined by the GSM standard. Note that if the text in a field is grey, the value in this field cannot be altered. However, if the text in a field is black, the values in this field can be changed. For example, in a Normal timeslot the **data** (**E** field - signifying encryption bits), **Stealing Flag** (**S**) bits and the **Training Sequence** (**TS**) values can be changed, but the **T** (**Tail**) bits, and the **Guard** (**G**) bits cannot be altered. The fields that can be changed depend on the type of timeslot chosen. Note that the **FCorr** timeslot values cannot be altered at all.

Selecting values for data
For **Normal**, **Sync** and **Access** Timeslots:
Pressing the **E** softkey from within the **Configure** ... menu reveals a menu of choices for internal **data generation** (**PN9, PN15, or a fixed sequence of data**) or the user can choose to supply his own data. The number of data bits in the E field depends on the timeslot type chosen.

For **Custom** Timeslots: The same choices as above are automatically displayed when the **Configure Custom** softkey is pressed.

The choices available for data are described in Section 4.

The data values will be shown on the signal generator's display, below the graphic of the current timeslot.

Setting values for the stealing bits
The stealing bits are set to indicate the difference between speech and control data on a TCH. The S bits can therefore only be set for **Normal** timeslots.

Press the **S** softkey, and enter a '0' or '1' using the front panel knob, up and down arrow keys, or the numeric keypad, and press the **Enter** terminator softkey.

Setting values for the training sequence
The training sequence can be changed for the following timeslot types only: **Normal**, **Sync** and **Dummy**.

Press the **TS** softkey to change the 26-bit (64-bit for Sync) training sequence. The preset hexadecimal value (when normal preset is selected) for TS represents a color code according to the GSM standard. A new value may be entered, to simulate different base station codes, by pressing this softkey.

The new value may be entered by using the front panel knob, up and down arrow keys, or the numeric keypad and the **A,B,C,D,E**, and **F** soft keys, and pressing the **Enter** terminator softkey. Note that other color code values used in GSM are specified in the **Help** text.

Setting values for the synchronization sequence
The synchronization sequence can be altered for Access timeslot types only. The synchronization sequence has a similar function to the training sequence in other timeslot types.

Press the **SS** softkey to change the 41-bit synchronization sequence.

The preset hexadecimal value (when normal preset is selected) for SS reflects the GSM standard, however a new value can be entered by pressing this softkey. A new value may be entered using the front panel knob, up and down arrow keys, or the numeric keypad and the **A,B,C,D,E**, and **F** softkeys, and pressing the **Enter** terminator softkey.

Setting values for extended tail bits
The extended tail bits can be changed for **Access** timeslot types only.

Press the **ET** softkey to change the 8-bit extended tail bit sequence.

The preset hexadecimal value (when normal preset is selected) for **ET** (extended tail bits) reflects the GSM standard, however a new value may be entered by pressing this softkey. A new value may be entered using the front panel knob, up and down arrow keys, or the numeric keypad and the A,B,C,D,E, and F softkeys, and pressing the **Enter** terminator softkey.

8. Return to the top level menu by pressing the **Return** front panel hardkey twice.

9. The RF carrier is modulated only when **Mod On/Off** is set to **On**. To turn GMSK modulation on, set **GSM Off On** to **On**.

10. Set **RF On Off** front panel hardkey to **On**. This makes the GSM signal available at the RF OUTPUT connector.

4. Data Generation

The Agilent ESG-D series signal generator offers a variety of internally generated data patterns, (PN9, PN15, fixed 4-bit repeating sequences, set patterns of ones and zeroes) or you can choose to supply your own data (download a binary file or input data using the DATA INPUT connector). It is also possible to continuously repeat the chosen data pattern.

With ESG-D series signal generators equipped with Options UN3 or UN4, the baseband generator's clock can be internally or externally supplied, and the external data clock can be set to a normal bit clock or a symbol clock for the NADC, PHS, PDC and TETRA formats. There are several data/clock combinations available to the user and the selections will affect the inputs required and the outputs available.

For more information on the input and output requirements for data and clock settings, see Tables 7-1 and 7-2 in Section 7, "Operation," of the Agilent ESG User Guide.

4.1 Choosing data patterns

The **Data** softkey is available in the GSM menu to select a data pattern for unframed transmission (**Data Format Pattern** is selected). The **Data** softkey is inactivated when **Data Format Framed** is selected for framed transmissions. If data generation for framed transmissions is required, the same choices are available by pressing the **E** softkey, within the **Configure Timeslot Normal**, **Configure Timeslot Sync**, **Configure Timeslot Access** menus, and from the **Configure Timeslot Custom** menu, as mentioned in the previous section.

PN9

Press the **PN9** softkey to select the PN9 pseudorandom bit sequence. The PN9 sequence consists of 511 bits ($2^9 - 1$ bits) and complies with the CCCIT Recommendation 0.153.

PN15

Press the **PN15** softkey to select the PN15 pseudorandom bit sequence. The PN15 sequence consists of 32767 bits (215 –1 bits) and complies with CCCIT Recommendation 0.151.

Fixed 4 bit

Press the **FIX4** softkey to select a 4-bit repeating sequence. Enter the desired 4-bit pattern using the front panel knob, up and down arrow keys, or enter the value using the numeric keypad and press the **Enter** terminator softkey.

Other Patterns

Press the **Other Patterns** softkey to select data patterns of 1's and 0's. Data patterns of 4 1's followed by 4 0's, 8 1's followed by 8 0's, and so on, may be chosen.

External data

Press the **Ext** softkey in the data selection menu (or in the E menu for framed transmissions) to select external data. With **Ext** selected, the data signal should be supplied to the DATA INPUT connector.

The DATA connector expects a TTL signal where a TTL high is a data 1 and a TTL low is equivalent to a data 0. The maximum data rate is 1.152 Mbit/s. The appropriate data and symbol clocks must also be supplied to the front panel inputs DATA CLOCK and SYMBOL SYNC.

User files

The Agilent ESG series signal generator allows user-specified data sequences to be loaded into the non-volatile memory of the signal generator.

These data sequences, accessible through the file catalog feature of the signal generator, are commonly used to:

- insert a specific set of data into the data field of a timeslot(s) of a built-in communications standard.

- simulate some type of transmission between a base station and a mobile by specifying the data of the entire frame.

Press the **User File** softkey to display the catalog of binary files stored in the signal generator's memory. A custom file may be selected from this catalog for the user-specified data pattern. Scroll through the listed files until the desired selection is highlighted, then press the **Select File** softkey.

If you elect to supply your own data file for framed transmissions, it should be created to exactly fill the data fields of an integer number of timeslots (n*148 bits for a GSM Custom timeslot and n*114 bits for a GSM Normal timeslot.

The following diagram illustrates that different user files may be selected to fill the data fields of different timeslots. In this example, UserFile #1 is selected to fill custom timeslot #0. The first 148 bits of data fill the data field of the timeslot in Frame 1. The next 148 bits go on to fill timeslot #0 in Frame 2, Frame 3, and so on. A second userfile, UserFile #2, is selected to fill timeslot #5, and is also sequentially loaded into timeslot #5 of every frame until the end of the file.

If the end of the file does not coincide with the end of a frame, data will be truncated in one of the following ways:

1. Enough frames will be generated to transmit as much of the data pattern as will fit into complete frames. The remaining bits of the data pattern (which are too few to completely fill a frame) are truncated.

2. If two files of unequal sizes are selected for different timeslots of the same framed transmission, enough frames will be generated to transmit as much of the data pattern of the largest file as will fit into complete frames.
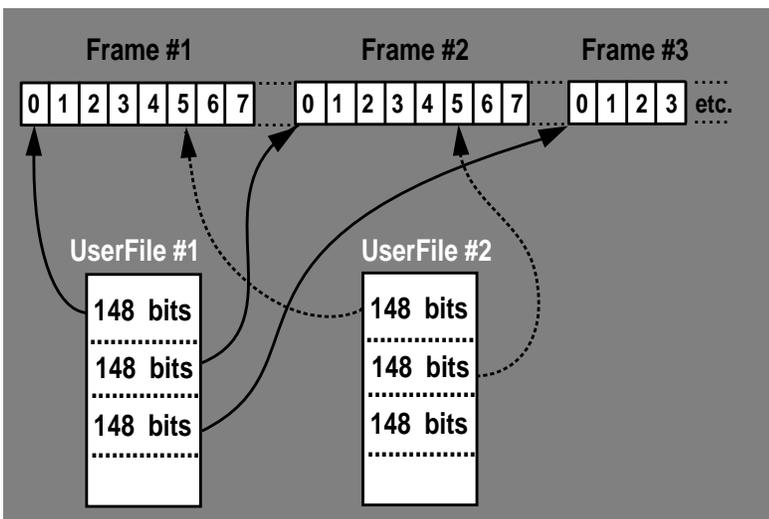

Figure 10

The remaining bits of the data pattern are truncated. The smaller file will be repeated as many times as necessary to completely fill these frames. Data will be truncated for the smaller file to coincide with the end of the last frame.

3. If a user's file and a PN9 file are selected for different timeslots of the same framed transmission and the user's file is shorter than the PN9, 511 frames will be generated to transmit the PN9 without truncation. The end of the PN9 data will coincide with the end of the 511th frame. The smaller user's file will be repeated as many times as necessary to completely fill these 511 frames. Data will be truncated for the smaller file to coincide with the end of the last frame.

4. If a user's file and a PN9 file are selected for the same framed transmission and the user's file is longer than the PN9, enough frames will be generated to transmit as much of the data pattern as will fit into complete frames.

The remaining bits of the data pattern (which are too few to completely fill a frame) are truncated. The PN9 data will be repeated as many times as necessary to completely fill these frames, but the PN9 sequence will be truncated if necessary.

The following SCPI command downloads a data sequence into the ESG series signal generator:

MMEM: DATA "FILENAME" , #ABC

where,
A = The number of numeric digits in B, which specifies the amount of data in C
B = The number of bytes of data in C
C = The data
For example, to download a file, called "NEW-DATAFILE", with data bytes in ASCII, the command :

MMEM: DATA "NEWDATAFILE" , #1912SA4D789

gives the A, B and C fields the following meanings:
A = the number **1** ; specifies that B contains a single digit.
B = the number **9** ; specifies that C contains 9 bytes of data.
C = **12SA4D789** ; the ASCII representation of the data that is downloaded to the ESG.

In the following example, the file "NEWDATAFILE1," contains 2 bytes of ASCII data:

MMEM: DATA "NEWDATAFILE1" , #21012&A%4D789

gives the A, B and C fields the following meanings:
A = the number **2** ; specifies that B contains a double digit - in this case **10**.
B = the number **10** ; specifies that C contains 10 bytes (in ASCII) of data
C = **12&A%4D789**; the ASCII representation of the digital demodulation data that is downloaded to the ESG.

If the data is downloaded using ASCII characters (which represent one byte of data per character), 19 bytes (152 bits) of data must be entered for Custom timeslots in order that the correct ASCII character is formed. Because the GSM custom timeslot only really needs 148 bits of data, when the ESG loads the user file into the timeslot, it will drop the four least-significant bits of the data sequence. A file of 18 bytes (representing 144 bits) of data is too small to completely fill the 148-bit data field. In this case the entire file would be truncated and nothing would be modulated. By the same logic, 15 bytes (120 bits) of data must be entered for a Normal timeslot to complete the final ASCII character.

The following SCPI command can be used to query a digital demodulation userfile from the file system:

MMEM:DATA? "filename"

For example, using the command

MMEM:DATA? "NEWDATAFILE"

will return the data **#1912SA4D789** in the same #ABC format as used in the earlier example.

The following example program demonstrates how to generate a program to send a file and data to the Agilent ESG-D signal generator's Userfile directory. This program example was created in Rocky Mountain Basic version 6.0.

```
10 Sig_gen=719
20 LOCAL Sig_gen
30 CLEAR Sig_gen
40 CLEAR SCREEN
50 OUTPUT Sig_gen;"*RST"
60 OUTPUT Sig_gen;"MMEM:DATA"
   "Newdatafile,"#1912SA4D789"
70 END
```

Example programs showing how to apply basic SCPI concepts, are given in Chapter 7 "Operation Userfile Applications" of the ESG User Guide.

Once the file has been transferred to the ESG series signal generator, existing and newly-transferred files can be reviewed using the signal generator's memory catalog.

1. Press the **Utility** button located under **MENUS**. **Note:** Press the **Local** button to place the instrument in the local mode.

2. Now press **Memory Catalog.**

3. Press (**All**) to review all the files in the system.

4. Now press Binary to review the binary files that exist.

To generate a GSM traffic multiframe, one would need to generate bit sequences for each timeslot of the multiframe, download them to user files, then select the custom burst mode in GSM and identify which user file to insert in each timeslot. The length of each timeslot file would have to be:
    148 bits x 26 frames = 3848 bits = 481 bytes
where,
148 = the number of data bits in a GSM Custom timeslot (the other bits are guard time and do not need to be loaded) and,
26 = the number of frames in a traffic multiframe.

The 3848 bits would be sequentially loaded in the selected timeslot through the 26 frames.

To simulate a control multiframe, such as a BCH, a user file containing:
    148 bits x 51 frames = 7548 bits = 944 bytes
where,
148 = the number of data bits in a GSM Custom timeslot (the other bits are guard time and do not need to be loaded) and,
51 = the number of frames in a signaling multiframe could be downloaded into timeslot #0 of the GSM frame. The actual data in the userfile would have to represent the appropriate information for a BCH (i.e. the data sequence corresponding to a FCH in frames 0, 10, 20 ; SCH in frames 1, 11, 21 ; and so on). Remember that the BCH transmits its useful

information always in timeslot #0. Dummy data or, for example, user files representing a TCH, could be selected for one or all of the other timeslots.

The size of userfile that may be downloaded depends on the available memory of the signal generator's file system. Currently, the maximum amount of space available in the file system is about 128 kbytes. The memory available for data files also shrinks if memory is also used for saved instrument states or sweep list files. There is enough memory in the file system to generate many multiframes using userfiles, but there are constraints on the number of userfiles than can be downloaded to Custom timeslots in order to generate a GSM superframe.

A GSM superframe contains 51 * 26 frames = 1326 frames. Therefore, for any particular timeslot, a GSM Custom file would require:
1326 * 148 bits = 196248 bits of information for that timeslot.

This requires a 25 kbtye user file. Remember that the maximum amount of memory available in the file system is 128 kbytes, so only a maximum of 5 of these userfiles could be stored in the file system.

Now, consider how much space 1326 GSM frames take up in data generator memory: 1326 * 156.25 bits/timeslot * 8 timeslots per frame = 1.6575 Mbits.

When data is written to RAM, 1 bit of data requires 1byte of pattern RAM, therefore a GSM superframe would require 1.6575 Mbytes of RAM.

Option UN3 contains 1MBytes of data generator memory (or pattern RAM) whereas Option UN4 offers 8MBytes. **Only** Option UN4 can therefore be used to generate the data pattern used to create a GSM superframe. This may be achieved by carrying out a "direct write" of data to the data generator memory. Details on how to carry out this direct write of data are given in Section 4.4.

4.2 Single/continuous data patterns

A choice of whether to output just one occurrence of the selected data, or to output a continuous stream of the data pattern is available.

From the first-level GSM menu, set the **Pattern Repeat Single Cont** to **Pattern Repeat Single** and the signal generator will output a single occurrence of the chosen data. Note that External data cannot be selected when **Pattern Repeat** is set to **Single**. Select the trigger event for the output using the **Pattern Trigger** softkey. This softkey reveals a menu of choices for triggering an *unframed* data pattern. The data can be triggered by the front panel **Trigger** key, by an external trigger supplied to the PATTERN TRIGGER rear panel connector, or by a command sent over GPIB.

The Pattern Trigger softkey is inactive when **Data Format Pattern Framed** is set to **Framed**. To trigger a one-shot pattern the trigger must make a transition from low to high, and is sampled by the rising edge of the data clock. The ESG-D also has the capability of transmitting framed data continuously or outputting a single frame. If only one timeslot is on, selecting a single framed transmission (Frame Repeat Single) will output the following sequences:

- **4-Bit patterns (FIX4)** - A single frame is generated. The 4-bit pattern repeats until the data fields are completely filled. Each trigger transmits the same frame.
- **PN9** - A single frame is generated. The data fields are filled with the leading bits of the PN9 sequence. A trigger causes the frame to be transmitted. The data fields of this frame are then filled sequentially with the next series of PN9 data bits. A trigger causes the frame to be transmitted. This process continues, transmitting the entire PN9 sequence frame by frame. The last bit of the PN9 sequence in a data field is immediately followed by the first bit of a second PN9 sequence.

- **PN15** - A single frame is generated. The data fields are filled with the leading bits of the PN15 sequence. A trigger causes the frame to be transmitted. The data fields of this frame are then filled sequentially with the next series of PN15 data bits. A trigger causes the frame to be transmitted. This process continues, transmitting the entire PN15 sequence frame by frame. The bit of the PN15 sequence in a data field is immediately followed by the first bit of a second PN15 sequence.

- **User file** - The user's file should have the appropriate data to fill an integer number of timeslots. If not, the remaining bits are truncated. Depending on the size of the file, more than one frame can possibly be generated.

- **External data** - External data is clocked into the data fields of the timeslot. A single frame is generated.

Triggering single frames of data is described in Section 5.

To output a continuous stream of data, **Frame Repeat Single** must be toggled to **Frame Repeat Cont.** Selecting **Cont** with framed data causes the frames to be transmitted continuously.

Note:
As with Section 1, the top level GSM softkey menu must be returned to, and GSM On must be turned set and RF turned on.

4.3 Data dependencies

There are some situations where certain combinations of data patterns will cause the data to be truncated or discontinuous. A discontinuous pattern will make BER testing invalid, therefore, it is very important to be aware of these situations.

- Any combination of external data and a PN15 data pattern will cause a discontinuous PN15 pattern.

- Any combination of user's files and a PN15 data pattern will cause a discontinuous PN15 pattern.

4.4 Generating long data patterns, such as a GSM superframe

The Agilent ESG-D signal generator (with Option UN3/UN4) offers the user the capability to generate long data patterns, and store them in the signal generator's pattern RAM.

The length of data sequence that can be stored in the pattern RAM depends on the installed optional baseband generator. Option UN3 provides 1MB of RAM and Option UN4 offers 8MB. This translates to maximum lengths of data sequences of 1Mbits and 8Mbits respectively, because each bit of data requires 1Byte of RAM. This is because there are other parameters, such as whether RF power is to be switched on, that must be set for each bit of data. This method of data generation results in a flexible means of controlling every single data bit in a user-defined sequence.

The SCPI command

    MEM:DATA:PRAM: BLOCK #0 < data_block >
    (or MEM:DATA:PRAM: LIST < unit8,...,...>)

allows a block of ASCII data or a string of decimal values to be written directly to the data generator memory (pattern RAM). This data takes over the burst control of the modulating signal. The entire data generator memory is controlled by this command. In other words, the user is in control of how the modulation is implemented. The features of the built-in communications formats, such as timeslots and timeslot types, can no longer be used. To carry out a direct load of data into the pattern RAM, the desired communications mode must be selected in order to set up the baseband generator and data generator clock rates for that mode. For example, if GSM transmission is required, press **Mode**, **GSM**, **GSM On**, to set the clock rate for GSM transmission. This will ensure the data is transmitted at the correct rate.

Note that when the front panel or SCPI user interface of a mode resumes its normal operation, the user interface is taking back the control of the data generator memory. This means that all previous user data written to the pattern RAM by the above command will be erased.

As mentioned earlier, one byte of data is used for every data bit produced. The purpose of these bits is as follows :

Bit Position	Bit Value (in decimal)	UN3/UN4 value
0	1	data value
1	2	0 always
2	4	burst control
3	8	0 always
4	16	**must always be set to 1**
5	32	0 always
6	64	Event 1 control
7	128	Pattern Reset

- Bit 0 ("data value") should be set to a 0 or 1 as required for a data bit.
- Bit 2 ("burst control") should be set to a 0 for burst off or 1 for burst on.
  All data values that require bursted RF power out must have this bit on.
- The "Event 1 control" bit (Bit 6) should be set to a 0 or 1, as desired, to be output at the EVENT 1 rear panel connector.
- "Pattern Reset" should be set to a 1 to reset the pattern generation to the start, after this entry is processed.

The user, therefore, has complete control over the value of data bits transmitted, whether RF power burst is on, how long the burst will be on for, and where to reset the pattern.

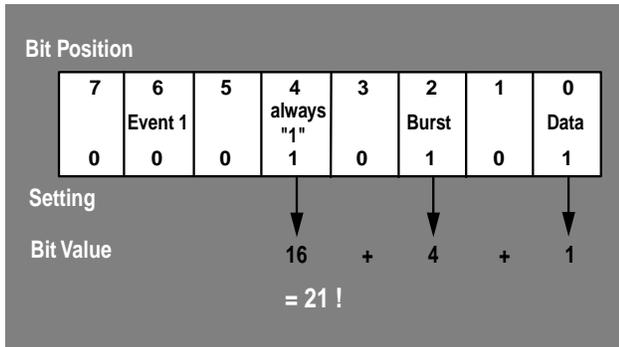For example, to store a data value of 1, with burst control on, the decimal value of the data would be 21.

Bit Position

7	6	5	4	3	2	1	0
	Event 1		always "1"		Burst		Data
0	0	0	1	0	1	0	1

Setting

Bit Value

16 + 4 + 1

= 21 !

Figure 11. Setting data values

To send a fixed 4 bit repeating sequence of 1100, with burst on, the command may look like this:
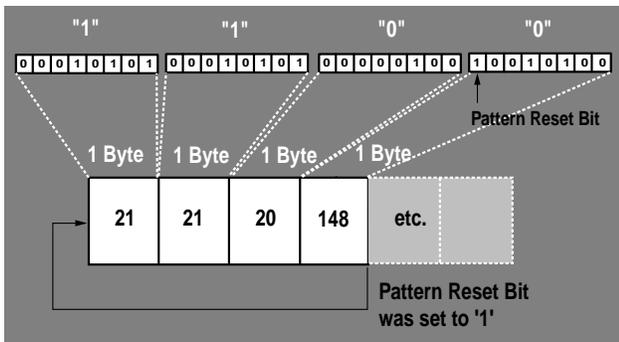
MEM:DATA:PRAM:LIST 21,21,20,148

"1" "1" "0" "0"

0 0 0 1 0 1 0 1 0 0 0 1 0 1 0 1 0 0 0 0 0 1 0 0 1 0 0 1 0 1 0 0

Pattern Reset Bit

1 Byte 1 Byte 1 Byte 1 Byte

| 21 | 21 | 20 | 148 | etc. | |

Pattern Reset Bit was set to '1'

Figure 12. Blocks of data

Each "block" represents the data bit and all it's parameters, and takes up 1Byte of RAM. Note that the last value in the sequence, 148, sets the Pattern Reset bit, so that the data counters for the memory will reset at the beginning of the 1100 sequence.

As mentioned in Section 4.2, the data bits corresponding to the 1326 frames in a superframe could be generated and loaded into the pattern RAM. There are 1250 bits in a GSM frame and therefore a superframe contains 1.6575 Mbits. This would require 1.6575MB of RAM, when using the direct load method. In order to have sufficient memory for generating a GSM superframe, Option UN4 (which has 8MB of pattern RAM) must be installed. Unlike the custom file method, all the bits in the superframe must be specified - this includes guard bits, control bits and data bits. To generate a continuous superframe the Pattern Reset bit should be set for the last bit in the sequence, so that the data generation will start again at the first bit of the superframe.

5. Triggering a GSM Frame

There are several options available to the user to trigger a single GSM frame. These are using the Trigger key, triggering over the bus, and triggering the frame externally.

From the GSM mode:
Select **Data Format Framed.**
Toggle **Frame Repeat Single Cont** to **Frame Repeat Single.**
Press the **Frame Trigger** softkey to display the range of options:

Trigger Key

Press the front panel Trigger hardkey to output one frame of data

Bus

Press this softkey to trigger the single frame over GPIB

External

Press this softkey to trigger a single frame from an external source. The frame triggerpulse must be sent to the PATTERN TRIG IN rear panel BNC input connector. The ESG-D is triggered when the CMOS input transitions from low to high, then one frame of data is generated. The minimum trigger input pulse width, high to low, is 100ns. The trigger edge is latched and sampled by falling edge of data bit clock to synchronize trigger with bit timing. At the end of the frame, guard bits are generated until a new trigger is received. If the trigger arrives too early (1.5 to 2.5 bit clock periods before the end of a frame), it will be ignored and the next frame is delayed until the next valid trigger occurs. If the trigger occurs too late (between N-1.5 to N-2.5 bit clocks after the frame ends), then the frame begins N bit clocks after the previous frame ends. For example, if the trigger occurs between 0.5 and 1.5 bit clock periods after the frame ends, i.e. N=1, then 1 additional bit is inserted in between frames (i.e. next frame begins 1 bit clock period after previous frame ends). For more information on frame and pattern trigger timing, see Section 7 of the ESG User Guide.

An application for the external frame trigger feature is in GSM Base Station manufacture. The BTS transmits its timing information on the downlink BCH, including details of the frame timing. The BCH is used to command the mobile and tell it when to respond and start communication with the BTS. In Base Station testing, the ESG-D signal generator (configured with the optional IQ baseband generator) can be used, simulate a mobile in order to send a signal to the BTS to verify correct BTS operation. The ESG-D must therefore be capable of starting its transmission at the correct time relative to the BTS transmission, as would a 'real' mobile station. To achieve this, the ESG-D can be configured to accept a frame trigger (setting **Frame Trigger External** and supplying BTS frame clock to PATTERN TRIG IN rear panel connector) from the BTS, as shown in the following diagram. This synchronizes the ESG-D to the BTS.
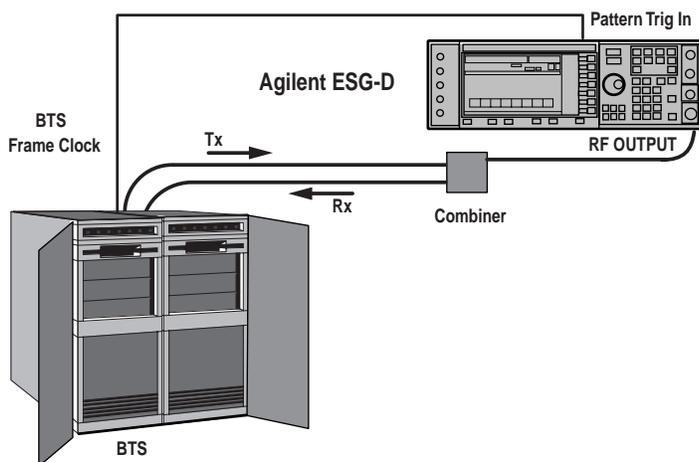

Figure 13. Application of external frame trigger

If the BTS sends a trigger at the start of every frame, and the ESG-D is set up with any of the internal data selections (PN9, PN15, FIX4, Other Patterns), the ESG-D will send a frame of the chosen data every time it receives the trigger. Some Base Station tests, however, may require a stream of frames from the ESG-D to synchronize to a single trigger from the BTS. In this case, a user file containing the appropriate number of bits for the number of frames needed in the stream could be used.

Setting a trigger delay

A programmable delay, in bits, may be set in order to trigger the ESG-D in a different timeslot. This feature is only available when triggering the signal generator externally. The Trigger Delay resolution is one data bit clock period.

To set the external trigger delay:
From the **Frame Trigger** menu, as described above, select external triggering:

> Select the **Ext** softkey.
> Set **Ext Delay Off On** to **On**
> Press the **Ext Delay Bits** softkey
> Enter the desired delay using the front panel knob, up and down arrow keys, or the numeric keypad, and press the **Enter** terminator softkey. The maximum programmable delay is 65,535 bits. Note that setting the trigger delay to the frame bit count minus two will allow the frame to start within +/- one half bit clock of trigger edge. For example, the GSM Frame bit count is 1250, therefore setting the delay to 1248 will allow the frame to start within half a bit clock of the trigger.

To trigger the Agilent ESG-D series signal generator to start producing frames continually.
From the GSM mode:
Select **Data Format Framed**.
Toggle **Frame Repeat Single Cont** to **Frame Repeat Cont.**
Press the **Frame Trigger** softkey to choose between triggering using the front panel **Trigger** key, or over GPIB (**Bus** softkey).

Synchronizing equipment to the Agilent ESG-D series signal generator

The ESG-D series signal generator may also be used to trigger other equipment.

From the first level GSM menu, press the **More (1 of 2)** softkey.
Press the **Sync Out** softkey to display the menu of choices for outputting a 1-bit synchronization signal to the EVENT 1 rear panel connector.

Begin Frame

Synchronization signal occurs at the beginning of the GSM frame.

Begin Timeslot

Synchronization signal occurs at the beginning of the selected GSM timeslot. Any one of the 8 timeslots may be selected.

Timeslot All

Synchronization signal occurs at the beginning of the each timeslot in the GSM frame.

It is also possible to move the synchronization signal forward or back from the beginning of the frame or timeslot.

From the GSM first level menu, press the **More (1 of 2)** softkey.

Press the **Sync Out Offset** to set the number of bits of offset.

Enter the desired value using the numeric keypad, the up and down arrow keys, or the front panel knob and press the **Enter** terminator softkey. The range of allowed values is –155 through +155 bits

6. Customizing the GSM Mode

The Agilent ESG-D series signal generator (with Option UN3 or UN4) provides the flexibility to modify the communications formats provided. For the GSM personality, the modulation data rate, the burst shape and the Gaussian Filter Factor can all be modified. Note that adjusting these factors means that the signal generated will no longer be a standard GSM signal. The display annunciator will change from **GSM:STANDARD** to **GSM:MODIFIED** when any of the aforementioned attributes are altered.

1. Press the **Mode** front panel hardkey.

2. Press the **GSM** softkey.

3. Press the **More (1 of 3)** softkey at the bottom of the display. A menu containing the softkey options and **Modify Standard** will be displayed.

4. To alter the data rate or the filter alpha, press **Modify Standard**.

4.1 To adjust the filter factor, press the **Filter** softkey. The choice of filter factor ranges from 0.2 to 0.7, in 0.05 increments. To enter a new value for filter alpha, rotate the front panel knob until the desired value is displayed, use the up and down arrow keys, or enter the value using the numeric keypad. The display should now include a symbol in the Filter field, to indicate that it differs from the GSM standard.

4.2 To adjust the modulation data rate, press the **Bit Rate** softkey. A data rate within the range 163 kbit/s to 300 kbit/s may be selected. To enter a new value for the modulation data rate, rotate the front panel knob until the desired value is displayed, use the up and down arrow keys, or enter the value using the numeric keypad and press the **kbs** softkey. The display should now include a symbol in the Bit Rate field, to indicate that it differs from the GSM standard.

The **Restore Default Filter BbT** and the **Restore Default Bit Rate** softkeys set the filter factor and modulation data rate to the GSM standard values of 0.3 and 270.833 kbit/s respectively.

5. To alter the GSM Burst Shape, press **Burst Shape**. Within this menu, the rise and fall times of the GSM burst may be modified. The rise and fall of the burst can also be delayed from the default values. This is useful for doing margin testing and adding impairments to existing systems, and for the development of new systems.

5.1 To adjust the rise and fall times, press the **Rise Time** and **Fall Time** softkeys respectively.

To enter a new value for the rise/fall time, rotate the front panel knob until the desired value is displayed, use the up and down arrow keys, or enter the value using the numeric keypad and press the **Enter** softkey. Rise and fall times can be set in bit periods, within the limits 0.2 to 30 bits.
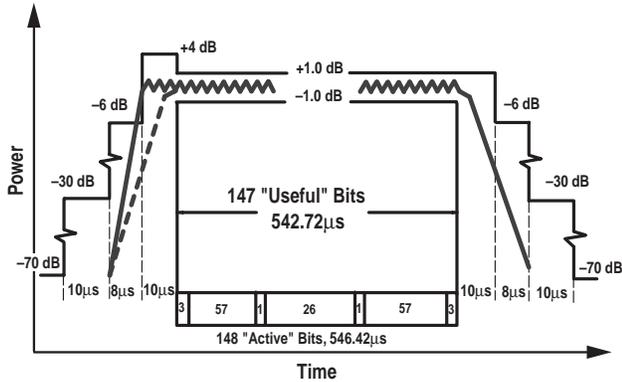
Figure 14. Adjusting the rise time of a GSM TDMA power burst

Figure 15. Adding rise delay to a GSM TDMA power burst

Here, the rise time has been decreased from the standard value, meaning that the power level is ramped up too quickly, and the burst profile does not fit within the desired mask. This could cause interference with other mobiles in the cell.

5.2 To delay the rise or fall of the GSM burst, press the **Rise Delay** and **Fall Delay** softkeys respectively. Delay times of up to 10 bit clock periods can be set. To enter a new value for the delay time, rotate the front panel knob until the desired value is displayed, use the up and down arrow keys, or enter the value using the numeric keypad and press the **Enter** softkey.

Here, a rise delay has been added to the burst. As can be seen, the burst profile is now right at the lower limit of the mask. Any further delay would result in the output power level being reached too late, and useful bits of information could be lost.

The **Restore Default Burst Shape** softkey restores the burst shape values to the rise/fall times of 4.22 and 3.44 bit clock periods and rise/fall delays of zero and 4.38 clock periods.

7. Adjacent Broadcast Channel Generation Using the Agilent ESG-D Series Signal Generator and the Agilent 8922 GSM Test Set

The purpose of this section is to demonstrate how the ESG-D series signal generator can be used with the 8922M GSM Mobile Test Set to generate an Adjacent Broadcast Channel.

The 8922 family of GSM MS Test Sets are integrated test solutions for the production and servicing of GSM radios. The 8922 used in this product note is designed for manufacturing, providing accurate and repeatable measurements for consistent test results. The 8922M test set generally follows the procedures as outlined in the associated GSM recommendations, but does not necessarily meet the exact requirements or cover all ranges, limits or conditions required for type approval testing.

As mentioned in Section 2, all Base Station Transceivers (BTSs) continually transmit a Broadcast Channel (BCH). The BCH is like a beacon—it allows mobiles to find the GSM network. The BCH consists of various parts for frequency correction, synchronization, control and access. Its exact configuration varies on the number of users expected in the cell. The ARFCN used by the BCH is different in each cell. The mobile has a list of these frequency channels in the Base Allocation (BA) table, in order to know which BCH frequencies to go out and measure. The BA table is coded onto the BCH. The BA table will differ for GSM 900, DCS 1800 and PCS1900 systems. The BCH is always received by all mobiles in a cell, whether they are on a call or not. Each mobile measures the power of the serving cell and the adjacent cell's BCH. Mobiles also measure the strength and quality of the signal being received on the Traffic Channel. Measurements of Received Level (RxLev) and Received Quality (RxQual) are reported back to the serving cell base station. RxQual reports can be mapped onto bit-error ratio. The RxLev numbers can be mapped directly onto signal levels in dBm. As a mobile roams around, it continually measures these power levels. If the mobile moves far from the serving BTS, i.e. if the RxLev becomes sufficiently low on the serving cell, the mobile will switch to an adjacent cell which is closer.

In this section, two broadcast channels will be generated on different ARFCNs, and sent to a mobile, using the 8922M GSM Test Set and the ESG-D series signal generator. The two BCHs will have different Broadcast Colour Codes (BCCs) to allow the mobile to differentiate between the 8922M BCH and the ESG-D BCH.

A BCH at RF, corresponding to a certain ARFCN, will be sent to a mobile using the 8922M. Then BCH information at baseband will be generated using the 8922M GSM Test Set. This data will be modulated up to a frequency corresponding to a different ARFCN using the ESG-D series signal generator and sent to the mobile. It will then be possible to verify that the mobile can find both signals (or both BTSs).

There are formulae given in Section 9 to convert ARFCNs into absolute frequency values. The details for cell selection and reselection are given in Chapter 20 of the GSM 11.10 Specifications.

Connect the 8922M MS test set, the ESG-D signal generator and the mobile under test

1. Connect the 8922M, ESG-D and the mobile to be tested, as shown in Figure 16.

2. Power on the 8922M, the ESG-D series signal generator and the mobile.

Set up the 8922M to send broadcast data to the ESG-D signal generator

The 8922M has default settings to broadcast on frequency channel ARFCN 20 with an amplitude of -85dBm. Different settings for these parameters may be chosen if desired, but this will not be covered in this note. Remember that the insertion loss through the power divider must be accounted for, as this will affect the amplitude of the signal.

3. From the front panel, press the **Cell Config** hardkey.

4. Go to the BA (Base Allocation) Table. This is a table that is sent to the mobile to let it know which BCH ARFCNs are active in its cell. First of all position the cursor on the "Activated"

field, push the knob and change to "Settable". There are 124 possible channels that can be set. Position the cursor to the top left "0" and push the cursor control knob.

A channel may be selected by going to the corresponding position in the table, and setting the value to "1".
For example, to set channel 10 for GSM, "Position" would be selected. The cursor control knob would then be used to go to the right hand column in the first row. This position (for channel 10) would be selected, and a "1" set to activate this ARFCN. When editing is complete, "Done" and then "Activated" are selected. This tells the mobile to look for a BCH on ARFCN 10.

5. Use the selection knob to go into the "Aux BCCH" menu. Select "Adjacent."

This turns the Modulation In/Out Data and Clock to OUT—the 8922M will send data to the ESG-D signal generator.
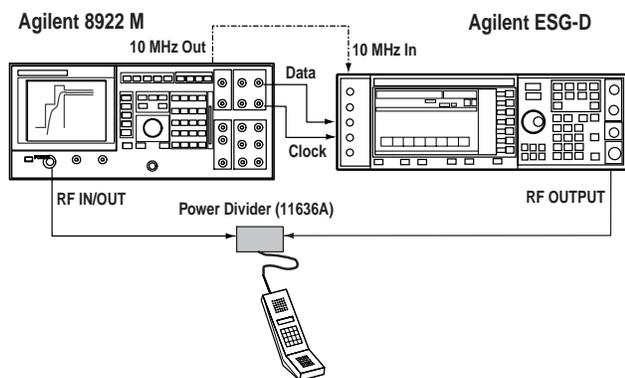

Figure 16. Diagram of set-up

Set up the Agilent ESG-D signal generator

6. Press **Frequency**. Enter "937MHz". This sets the adjacent signal to the frequency channel ARFCN 10. Any ARFCN may be chosen, provided it is different from that set on 8922M.

7. Press **Ampl**. Set to the power level to a value different from that on the 8922M broadcast channel (i.e. –85dBm in the default case). The amplitude of the signal should be larger than the sensitivity level of the mobile. For example, set the amplitude to **–100dBm**. In order to take into account the insertion loss through the power divider, enter an amplitude offset in the **Ampl** menu. The typical insertion loss for a power divider is 6.2dB, therefore the **Amplitude Offset** should be set to **6.2dBm.**

8. Press **Mode**.
   Select **GSM**
   Select **Data Format Pattern**
   Press the **Data** softkey
   Select the **Ext** softkey. This means that the data from the 8922M is the modulation provided.
   Turn **GSM On Off** to **GSM On**.

9. Turn **RF On Off** to **RF On**.

Check that the mobile can camp to both signals

10. Slowly decrease the amplitude of the signal of the 8922M, until it is much lower than that of the ESG-D signal generator. The mobile should camp onto the signal from the signal generator because its RxLev will be better. This can be verified by increasing the amplitude of signal from the ESG-D signal generator, and checking that the signal strength on the mobile's display increases. Lowering the amplitude of the signal generator should result in the displayed mobile signal level decreasing, until finally it will camp on to the signal from the 8992M again.

8. Using the Agilent ESG-D Series Signal Generator and the 8922 GSM Test Set to Carry Out GSM MS Receiver Tests

The receiver measurements for radios in the GSM system make use Bit Error Rate (BER) techniques. A known pseudorandom binary sequence (PRBS) is transmitted to the mobile station which loops the received bits, after channel decoding, back to the test equipment through its own transmitter. The BER is evaluated within the tester (such as the 8922 GSM Mobile Station Test Set).

In the following sections, some key GSM measurements will be made using the 8922M GSM Mobile Station Test Set and the ESG-D series signal generator. Note that this is **not** a comprehensive guide to the 8922M Test Set, **nor** an in-depth study of the GSM measurement specifications. For details of these areas, please refer to the 8922M documentation and the relevant sections of the ETSI GSM specifications.

There are formulae given in Section 14 to convert ARFCNs into absolute frequency values.

8.1 Receiver co-channel rejection

Co-channel rejection measures a receiver's ability to receive a wanted modulated signal in the presence of an unwanted modulated signal, both signals being at the same frequency. Bit error rate is then measured to ensure the receiver is rejecting the unwanted signal. The test is described in detail in the ETSI GSM Specifications 11.10 (Section 14.4)

The ESG-D series signal generator can be used as the unwanted source, as it provides precise 0.3GMSK modulation. The wanted signal can be generated using a test system such as the 8922M GSM MS Test Set.

Variations from the GSM 11.10 Section 11.4.4 Test Recommendations
The 8922M does not use the standard test signal "C1" for the in-channel source. The standard test signal is a 1-0 pattern with "dummy" bursts for all other timeslots of the frame. The 8922M uses a 1-0 data pattern but does not transmit "dummy" bursts in all other timeslots. The 8922M cannot generate a progress message to the mobile station. This is a signaling message instead of speech. The 8922M does not simulate fading. An external fader, e.g. 11759C, needs to be used with the 8922M to meet the GSM recommendation. The 8922M and ESG-D signal generator cannot test the mobile station in hopped mode, because the ESG-D signal generator cannot generate a hopping signal.
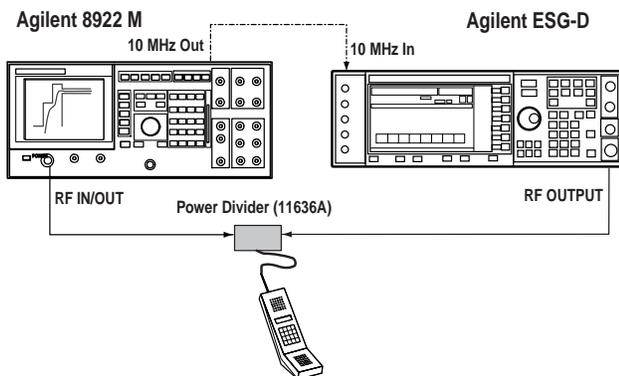

Figure 17a. Diagram of test set-up

Co-channel rejection measurement procedure
Connect the Agilent 8922M MS Test Set, the
Agilent ESG-D Signal generator and the mobile
under test as shown in Figure 17.

1. Power on all equipment BUT ensure the
ESG-D signal generator has **RF On Off** set to **RF Off**

Set up the Agilent 8922M MS test set

2. Preset the 8922M. Press the **Preset** front panel
hardkey.

3. From the Cell Status Screen, use the cursor
control to scroll to "To Screen, More".

4. Select "Cell Control 2".

5. From the Cell Control 2 screen:
- Under "TCH Parms" set the following:
  "TCH1"
  Mode "Single"
  ARFCN "60"
  Check that "FS" is selected (this
  should be as it is the default set-
  ting)
- Select "TCH Control"
- Select "TCH1 Asgn"
- Highlight "Execute"
- Scroll to Audio Cntl. Set "Loopback" to
  "FE" (This turns Frame Erasure on)
- Set "Speech" to "PRBS"
- Set "PRBS Pattrn" to "10"
- Set "RF Gen", "Amplitude" to "–85dBm" as
  defined in the GSM specification. (Take
  into account the insertion loss through the
  power divider. For example, if the insertion
  loss for your power divider is 6.2dB, the
  "Amplitude" should be set to 78.8 dBm to
  compensate for the loss. Alternatively, the

RF amplitude offset field in the 8922M I/O
configuration could be set to account for
the loss through the divider.)

6. Check that the mobile is camped onto the sig-
nal from the 8922M.

7. Scroll to the lower right hand corner menu,
and select the "BIT ERR 2" option. Under the Bit
Error Test screen "BIT ERR 2".
- Under "Meas Num 1","Type", select
  "ResTypeII".
- Under "Bits to Test", enter the desired
  number of bits according to the GSM speci-
  fications (see Table 14.14 on Specifications
  11.10). For example, enter "2,000,000".
- Under "Meas Num 2", "Type", select
  "ResTypeIb".
- Under "Bits to Test", enter the desired
  number of bits according to the GSM speci-
  fications (see Table 14.14 on Specifications
  11.10). For example, enter "3,300,000".
- Under "MS Loopback," "Loop Delay Speech
  Frms" set to "Auto".

Set up the Agilent ESG-D signal generator
8. Press **Frequency** front panel hardkey. Enter
"947MHz". This sets the interfering signal to the
same frequency channel as the in-channel signal
(ARFCN 60).

9. Press the **Ampl** front panel hardkey. Set to
"-94dBm" Compensate for the insertion loss
through the power divider by setting the
Amplitude Offset to 6.2dBm. This sets the inter-
ference signal to 9dB below the wanted signal,
as specified in the GSM recommendations.

10. Press **Mode**.
    Select **GSM**.
    Set **Data Format Pattern Framed** to **Data Format Pattern**
    Select random data e.g. set **Data** to **PN9**
    Turn **GSM On Off** to **GSM On**.

11. Turn **RF On Off** to **RF On**.

12. Set up a call from the mobile.

On the 8922M:
13. Under "MeasCntl" select "Single" and "Run". This will perform the bit error test.

Compare the results to those shown in the Test Limits Table in the GSM 11.10 Specifications.

To change channel numbers for additional measurements
14. From the 8922M Cell Control 2 screen:
    • Under "TCH Parms" set the following:
        "TCH1"
        Mode "Single"
        ARFCN - Enter the new channel number you want to test.
    • Select "TCH Control"
    • Select "TCH1 Asgn"
    • Highlight "Execute

15. Set the ESG-D signal generator **Frequency** to the frequency of the new channel.

16. Repeat steps 9 and 15 to measure bit-error rate.

8.2 Adjacent channel rejection
Adjacent Channel Rejection or Adjacent Channel Selectivity measures the GSM receiver's ability to reject an unwanted signal that is one or two chan-nel spacings from the receiver's nominal frequency. This is probably the most important out-of-channel test performed on radios. It determines how well the radio will perform when other radios are operated in the adjacent RF channels. The test is described in detail in the ETSI GSM Specifications 11.10 (Test 14.5).

Testing adjacent channel selectivity requires an in-channel signal generator set to the nominal center frequency of the receiver. This is achieved by using an 8922M Test Set to establish a call with the mobile on the channel under test. A second signal generator is used to simulate an unwanted or out-of-channel signal. Its frequency is set to +/– one or two channel spacings from the receiver's nominal center frequency, and is modulated with random data. The output level of the out-of-channel signal generator is set to a higher level (defined by the GSM standards) than the in-channel signal generator.

The ESG-D series signal generator can be used as the out-of-channel source, as it provides precise 0.3GMSK modulation. A feature of the ESG series signal generator is that there are two choices available for **optimizing phase noise** to suit your application. The phase-lock loop bandwidth may be set to optimize phase noise for offsets below (Mode 1) or above (Mode 2) 10kHz offsets. For out-of-channel measurements (as in this case), Mode 2 should be selected. This is the mode selected after normal preset, but the mode selection procedure will be described for future reference purposes.

Variations from the GSM 11.10 Section 11.4.5 Test Recommendations
As stated in Section 4.1, the 8922M does not generate the standard test signal "C1" or simulate fading.

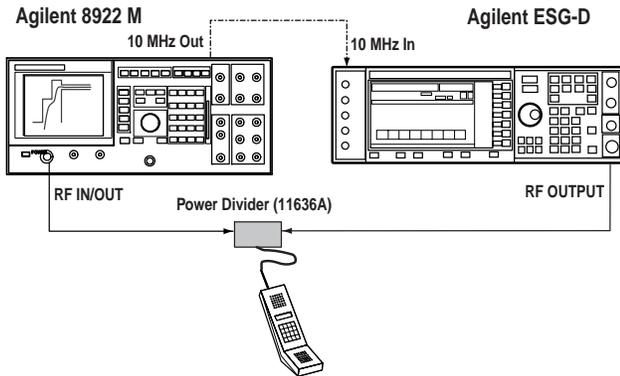*Adjacent channel rejection measurement procedure*

Fig 17b. Optional Diagram of set-up (same as Co-Channel Setup Figure 17a)

Connect the 8922M MS Test Set, the ESG-D Signal generator and the mobile under test as shown in Figure 17.

Power on all equipment BUT ensure the ESG-D signal generator has **RF On Off** set to **RF Off**

Set up the Agilent 8922M MS test set
1. Preset the 8922M. Press the Preset front panel hardkey.
2. From the Cell Status Screen, use the knob to scroll to "Screen More".
3. Select "Cell Control 2".

4. From the Cell Control 2 screen:
   • Under "TCH Parms" set the following:
      "TCH1"
      Mode "Single"
      ARFCN "60"
      Check that "FS" is selected
      (this should be as it is the default setting).
   • Select "TCH Control".
   • Select "TCH1 Asgn".
   • Highlight "Execute".
   • Scroll to Audio Cntl. Set "Loopback" to "FE" (This turns Frame Erasure on).
   • Set "Speech" to "PRBS".
   • Set "PRBS Pattrn" to "10".
   • Set "RF Gen", "Amplitude" to "−85dBm" as defined in the GSM specification. (Compensate for the insertion loss through the power divider).

5. Check that the mobile is camped onto the 8922M.

6. Under the Bit Error Test screen "BIT ERR 2"
   • Under "Meas Num 1","Type", select "ResTypeII".
   • Under "Bits to Test", enter the desired number of bits according to the GSM specifications (see Table 14.21 on Specifications 11.10). For example, enter "600,000".
   • Under "Meas Num 2","Type", select "ResTypeIb".
   • Under "Bits to Test", enter the desired number of bits according to the GSM specifications (see Table 14.21 on Specifications 11.10). For example, enter "1,000,000".
   • Under "MS Loopback","Loop Delay Speech Frms" set to "Auto".

Set up ESG-D signal generator

7. Press **Freq** front panel hardkey. Enter "947.2 MHz". This sets the interfering signal to the carrier frequency plus 200kHz (i.e. ARFCN 61). The procedure to select phase noise Mode 2, will now be described.

> Press the **Optimize ø Noise** softkey.
> Press the **Mode 2 Optimize > 10kHz Offset** softkey.

8. Press **Ampl** front panel hardkey. Set to "–76dBm". Take into account the insertion loss through the power divider by setting **Amplitude Offset** to, say, 6.2dBm. This sets the amplitude of the out-of-channel signal to 9dB above that of the in-channel signal, as specified in the GSM recommendations.

9. Press **Mode**.
> Select **GSM**.
> Set **Data Format Pattern Framed** to **Data Format Pattern**.
> Select a random data pattern. **Set Data, PN9**.
> Turn **GSM On Off** to **GSM On**.

10. Turn **RF On Off** to **RF On**.

11. Set up a call from the mobile.

On the 8922M:

12. Under "MeasCntl" select "Single" and "Run". This will perform the bit error test.

Compare the results to those shown in the Test Limits Table in the GSM 11.10 Specifications.

To change the frequency of the out-of-channel signal

13. Toggle to **RF Off**.

14. Set the ESG-D series signal generator **Frequency** to **946.8 MHz** (carrier frequency minus 200 kHz).

15. Repeat steps 9-12 to measure bit-error rate.

16. Set the ESG-D series signal generator **Frequency** to **947.4 MHz** (carrier frequency plus 400 kHz).

17. Set the ESG-D signal generator **Amplitude** to **–44dBm**. This sets the amplitude of the out-of-channel signal to 41dB above that of the in-channel signal, as stated in the GSM recommendations.

18. Repeat steps 9-12 to measure bit-error rate.

19. Set the ESG-D series signal generator **Frequency** to **946.6 MHz** (carrier frequency minus 400 kHz).

20. Repeat steps 9-12 to measure bit-error rate.

8.3 Receiver intermodulation rejection

Intermodulation rejection measures a receiver's ability to receive a wanted modulated signal in the presence of two or more unwanted signals that have a specific frequency relationship to the wanted signal's frequency. The primary source of intermodulation signals includes filters, mixers, and amplifiers in the RF front end of the GSM mobile phone. The test is described in detail in the ETSI GSM Specifications 11.10 (Section 14.6).

The two interfering signals are a GMSK-modulated signal carrying PRBS information and an unmodulated carrier. The modulated signal is operated at a frequency offset of eight channels and the unmodulated signal at an offset of four channels above the desired signal. The level of the desired signal is at 4dB above the reference sensitivity level. The levels of the interfering signals depend on the class of mobile station being tested.

The in-channel signal can be generated using a test system such as the 8922M GSM Test Station. The ESG-D series signal generator can be used as the modulated interference source, as it provides precise 0.3GMSK modulated random data. The second interference signal can also be provided by an ESG series signal generator without option UN3/UN4, as only an unmodulated signal is required.

Variations from the GSM 11.10 Section II.4.6 Test Recommendations
As in stated in Section 4.1, the 8922M does not use the standard test signal "C1" for the in-channel source.

Intermodulation rejection measurement procedure
Connect the 8922M MS Test Set, the ESG series signal generators and the mobile under test as shown in Figure 18.
1. Power on all equipment BUT ensure the ESG signal generators have **RF On Off** set to **RF Off**.

Set up the 8922M MS Test Set
2. Preset the 8922M. Press the **Preset** front panel hardkey.
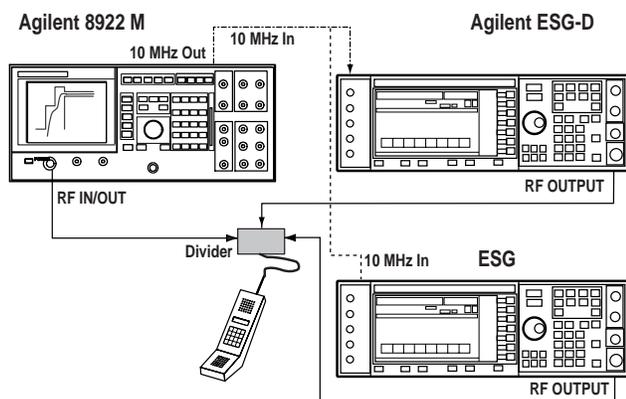
3. From the Cell Status Screen, use the knob to scroll to "Screen, More".
4. Select "Cell Control 2".
5. From the Cell Control 2 screen:
   • Under "TCH Parms" set the following:
      "TCH1"
      Mode "Single"
      ARFCN "60"
      Check that "FS" is selected (it should be as this is the default setting).
   • Select "TCH Control".
   • Select "TCH1 Asgn".
   • Highlight "Execute".
   • Scroll to Audio Cntl. Set "Loopback" to "FE" (This turns Frame Erasure on).
   • Set "Speech" to "PRBS".
   • Set "PRBS Pattrn" to "10".
   • Set "RF Gen", "Amplitude" to "–85dBm" as defined in the GSM specification. (Compensate for the insertion loss through the power divider, typically 6.2dB).

6. Make a call from the mobile to the 8922M.

Figure 18.

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7. Change "RF Gen", "Amplitude" to a level 4dB above the reference sensitivity as defined in the GSM specification. The reference sensitivity level will depend on the type of mobile used (–98dBm for small MS and –100dBm for other MS types). Remember to compensate for the insertion loss through the power divider.

8. Under the Bit Error Test screen "BIT ERR 2"
   • Under "Meas Num 1","Type", select "ResTypeII".
   • Under "Bits to Test", enter the desired number of bits according to the GSM specifications (see Table 14.14 on Specifications 11.10). For example, enter "8200".
   • Under "Meas Num 2," "Type", select "ResTypeIb".
   • Under "Bits to Test", enter the desired number of bits according to the GSM specifications (see Table 14.14 on Specifications 11.10). For example, enter "8200".
   • Under "MS Loopback," "Loop Delay Speech Frms" set to "Auto".

Set up the Agilent ESG signal generator for the first (unmodulated) interference source
9. Press **Frequency**. Enter "947.8 MHz". This sets the interfering signal to an ARFCN four frequency channels above the in-channel signal (ARFCN 64).

10. Press **Ampl**. Set according to GSM recommendations (–49dBm for a snall MS and –39dBm for other MS. DCS1800 mobiles require different power levels—refer to Table 14-23 in the GSM 11.10 specifications) Take into account the insertion loss through the power divider by setting **Amplitude Offset** to, say, 6.2dBm).

11. Turn **RF On Off** to **RF On**.

Set up the ESG-D signal generator for the second modulated interference source
12. Press **Frequency**. Enter "948.6 MHz". This sets the interfering signal to an ARFCN eight frequency channels above the in-channel signal (ARFCN 68).

13. Press **Ampl**. Set to according to GSM recommendations (–50 dBm for GSM900 mobiles. For DCS1800 mobiles, please refer to table 14-23 in the ETSI GSM 11.10 specifications). Again, compensate for the insertion loss through the power divider, by setting **Amplitude Offset**.

14. Press **Mode**.
    Select **GSM**.
    Set **Data Format Pattern Framed** to **Data Format Pattern.**
    Select a random data pattern. Set **Data, PN9**.
    Toggle **GSM On Off** to **GSM On**.

15. Turn **RF On Off** to **RF On**.

16. Make a call from the mobile.

On the 8922M:
17. Under "MeasCntl" select "Single" and "Run". This will perform the bit error test.

Compare the results to those shown in the Test Limits Table for Intermodulation Rejection in the GSM 11.10 Specifications.

To change frequencies of interfering signals

18. Repeat Steps 11-19 with the first interfering signal 4 ARFCNs below the wanted signal, and the second interfering signal 8 ARFCNs below the wanted signal. Do this using the Frequency softkey on both ESG signal generators.

To change channel numbers for additional measurements.

Follow steps 16-18 in Section 4.1 "Receiver Co-Channel Rejection".

ARFCN   Absolute Radio Frequency Channel Number

9. Translating ARFCN into Absolute Frequency Values for GSM Systems

Some GSM users prefer to work in terms of channel numbers (ARFCNs) rather than absolute frequencies. Here are some formulae to convert ARFCNs to the corresponding absolute frequencies.

Primary GSM:

Uplink: $F\mathrm{ul}(n)$ = 890.0 MHz + (0.2 MHz) . n

and

Downlink: $F\mathrm{dl}(n) = F\mathrm{ul}(n)$ + 45MHz

where

n = **ARFCN,** $1 \le n \le 124$

E-GSM:

Uplink: $F\mathrm{ul}(n)$ = 890.0 MHz + (0.2 MHz) . n

where

n = ARFCN, $0 \le n \le 124$

and

$F\mathrm{ul}(n)$ = 890.0 MHz + (0.2 MHz) . ($n\text{-}1024$)

where

$n = ARFCN,\ 975 \le n \le 1023$

and

Downlink: $F\mathrm{dl}(n) = F\mathrm{ul}(n)$ + 45MHz

DCS 1800:

Uplink: $F\mathrm{ul}(n)$ =1,710 MHz + (0.2 MHz) . (n -511)

and

Downlink: $F\mathrm{dl}(n) = F\mathrm{ul}(n)$ + 95MHz

where

n = **ARFCN,** $512 \le n \le 885$

PCS1900:

Uplink: $F\mathrm{ul}(n)$ =1850 MHz + (0.2 MHz) . (n -512)

and

Downlink: $F\mathrm{dl}(n) = F\mathrm{ul}(n)$ + 80MHz

where

n = **ARFCN,** $512 \le n \le 810$

10. Glossary of Terms

BA	Base Allocation
BCC	Broadcast Colour Code
BCCH	Broadcast Control Channel
BCH	Broadcast Channel
BER	Bit Error Rate
BSC	Base Station Controller
BSS	Base Station System
BTS	Base Transceiver Station
CCCH	Common Control Channel
CRC	Cyclic Redundancy Check
DECT	Digital Enhanced Cordless Telecommunications
ETSI	European Telecommunications Standards Institute
FCH	Frequency Channel
FDMA	Frequency Division Multiple Access
GSM	Global System for Mobile Communications
GMSK	Gaussian Minimum Shift Keying
I/Q	In phase/Quadrature
MS	Mobile Station
NADC	North American Dual Mode Cellular system

PCS	Personal Communications System
PHS	Personal Handyphone System
PDC	Personal Digital Cellular System
PRBS	Pseudo-random Binary Sequence
RF	Radio Frequency
RxLev	Received Signal Level
SACCH	Slow Associated Control Channel
SCH	Synchronization Channel
SDCCH	Standalone Dedicated Control Channel
TCH	Traffic Channel
TDMA	Time Division Multiple Access
TETRA	Trans European Trunked Radio
TS	Time Slot
TX/RX	Transmit/Receive Channels (uplink/downlink)
Type Ia	Error corrected and CRC protected bits
Type Ib	Error corrected bits
Type II	Non-error corrected bits

The following table shows a summary of the specifications for the digital communications standards provided with Options UN3 and UN4.

11. Specifications

	NADC	PDC	PHS	TETRA	DECT	GSM (DCS, PCS)
Modulation Format					GFSK	GMSK
Data Rate (default, kbits/sec)	48.6	42	384	36	1,152	270.83
Adjustment Range (kbits/sec)	40 to 75.5	40 to 75.5	320 to 605	31 to 37.8	922 to 1209.6	163 to 300
Filter						
Default Value	$\alpha = 0.35$	$\alpha = 0.5$	$\alpha = 0.5$	$\alpha = 0.35$	BbT = 0.5	BbT = 0.3
Range (a or BbT)		0.3, 0.35,	0.4, 0.5, 0.6		0.2 to 0.7 in	.05 dB steps
Error Vector Magnitude[2] (% rms)	Cont. / Burst	Cont. / Burst	Cont. / Burst	Cont. / Burst	N/A	N/A
Low EVM Mode	1.25 1.75	1.25 1.75	1.5 1.75	1.25 2.0		
Low EVM Mode (typical)	0.8 1.25	0.8 1.25	0.9 0.9	0.8 1.25		
Low ACP Mode (typical)	1.5 1.75	1.25 1.25	1.25 1.25	3.25 3.25		
Global Phase Error[1] (rms/pk)	N/A	N/A	N/A	N/A	N/A	1˚/4˚0.5˚/ 1.75˚ (typ.)
Deviation Accuracy[1] (kHz)	N/A	N/A	N/A	N/A	6 (1.5, typical)	N/A
Channel Spacing (kHz)	30	50	300	25	1728	200
Adjacent Channel Power[1] (ACP) (Low ACP Mode,dBc, typical)	Cont./Burst	Cont./Burst	Cont./Burst	Cont./Burst[3]	N/A	Cont. / Burst
at Adjacent Channel[4]	–34 –34	---	---	–68 –65		–37 –37
at 1st Alternate Channel[3]	–75 –72	–72 –70	–76 –76	–77 –76		–71 –69
at 2nd Alternate Channel[3]	–77 –76	---	–78 –78	–79 –78		–81 –79
at 3rd Alternate Channel[3]	–79 –78	–78 –78	---	–79 –79		–83 –81
Supported Burst Types	Custom, Up/Down TCH	Custom, Up/Down TCH Up Vox	Custom, TCH, Sync	Custom, Up Contrl 1&2, Up Normal, Down Normal, Down Sync	Custom, Dummy B 1&2, Traffic B, Low Capacity	Custom, Normal, FCorr, Sync, Dummy, Access
Scramble Capabilities			Yes	Yes		

1 PDC ACP measurements reflect performance in the 1400 to 1500 frequency band, at offset or 50 and 100 kHz.
2 Specifications apply for the frequency range, data rates and filter factors (a or BbT) specified for each standard and at power levels ≤+ 7 dBm (≤+ 4 dBm for TETRA).
3 ACP for TETRA is measured over a 25 kHz bandwidth, with an 18 kHz root raised cosine filter applied.
4 The 'channel spacing' determines the offset size of the adjacent and alternate channels: Adjacent Chan. offset = 1 x channel spacing, 1st Alt. Chan.= 2 x channel spacing, 2nd Alt. Chan. = 3 x channel spacing, etc.

Related Literature

	Pub. Number
ETSI GSM/DCS Technical Specifications, ETSI Secretariat, 06921, Sophia Antipolis Cedex, Valbonne, France.	
An Introduction to GSM, Siegmund M Redl, Matthias K Weber, Malcolm W Oliphant, 1995, Artech House Publishers ISBN 0-89006-785-6	
Agilent ESG Series RF Signal Generators, Data Sheet	5965-3096E
Agilent ESG Series Synthesized Signal Generators, Configuration Guide	5965-4973E
Flexibility and Performance - Agilent ESG Series Digital and Analog RF Signal Generators	5965-3095E
Evolving with your measurements needs - the enhanced Agilent ESG series RF signal generators provide additional performance, PhotoCard	5965-7158E
GSM Mobile Test Solutions, Data Sheet for the Agilent 8922S, 8922M and 8320E GSM/DCS/PCS mobile test sets	5964-6586E

	Pub. Number
GSM900 & DCS1800 Transmitter Testing, White Paper	5962-9942E
An introduction to digital modulation as used in communications systems	5965-7160E
Signal Generator Selection Guide	5965-3094E
IntuiLink Software, Data Sheet	5980-3115EN
Generating and Downloading Data to the ESG-D RF Signal Generator for Digital Modulation, Product Note	5966-1010E
Customize Digital Modulation with ESG-D Series Real-Time IQ Baseband Generator, Option UND, Product Note	5966-4096E
Multi-channel CDMA Personality for Component Test, Option UN5, Product Note	5968-2981E
Generating Digital Modulation with the ESG-D Series Dual Arbitrary Waveform Generator, Option UND, Product Note	5966-4097E

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