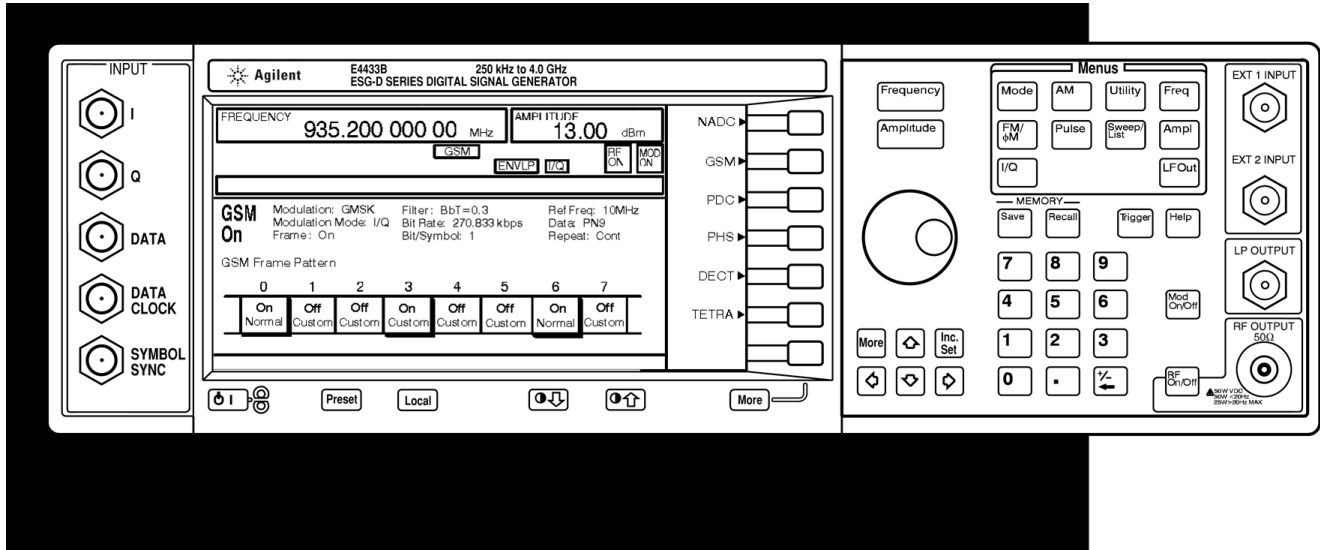# Generating and Downloading Data to the Agilent ESG-D RF Signal Generator for Digital Modulation

Product Note

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

Agilent Technologies

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Introduction

Many testing applications for wireless digital communications systems require specific data patterns modulated on an RF carrier. The following examples are only a few of the possible applications, and how those are implemented with the Agilent Technologies ESG-D signal generator with baseband I/Q generator Options 1EH, UN3, UN4, UN8, or UN9.

- **Proprietary data sequences.** Testing proprietary communications protocols or newly developing communications standards requires free manipulation of data, including the ability to correctly frame the data in bursts. The ESG-D with Option 1EH supplies NADC, GSM, PDC, and PHS formats. Options UN3 and UN4 (UN3/4) and UN8 and UN9 (UN8/9) include those standards as well as DECT, TETRA, and the flexibility of other protocols that can be simulated. For other communications schemes, data can be downloaded to the signal generator for continuous modulation, or when supplied with burst information, the ESG-D with Option UN3/4 and UN8/9 will simulate a non-standard framed protocol.

- **Add intentional errors for bit-error-rate (BER) testing.** The designer of a receiver or error-correction algorithm may want to transmit a pseudorandom noise (PN) sequence with intentional bit errors to verify the effect of errors on the receive chain or receiver DSP. Since internally generated PN sequences in the ESG-D meet ITU specifications and cannot be edited, a User File can be used to download the desired PN sequence for transmission.

- **Generating a variety of PN sequences.** The designer of a communications system may want to transmit a pseudorandom noise sequence not internally supplied in the ESG-D, such as PN7 or PN13. Any PN sequence can be generated externally on a computer and saved to the ESG-D file system.

- **Generating a multiple frame transmission to simulate communications protocol.** Several communications standards call for a protocol structure that requires multiple frames of information to be transmitted in specific sequence. The User File feature provides the required versatility to simulate multiple frame transmissions, such as a Global System for Mobile (GSM) control channel multiframe.

- **Generating a test sequence with error coding.** Some communications systems use forward error correcting codes to protect data traffic against corruption in transmission. The ESG-D may be loaded with coded patterns to measure the performance of error-correcting receivers.

This Product Note describes how to generate and download data to the ESG-D for digital modulation. This note is written for test engineers, programmers, application developers, and others familiar with the principles of digital modulation. (For an excellent background on the subject, ask your local representative for Application Note 1298, "Digital Modulation in Communication Systems—An Introduction," 5965-7160E.)

The ESG-D series of digital signal generators with UN3/4 or UN8/9 internal baseband I/Q generator option offer great flexibility and control of digitally modulated data. The ESG-D enables many types of data sequences to be generated, including internally generated ITU-compliant PN9 and PN15 data sequences, as well as many fixed bit patterns.

To expand upon built-in data flexibility, externally generated data patterns can be downloaded into the memory of the ESG-D for modulation. Data can also be inserted into internally supplied TDMA framing, including communications protocol. The downloaded data can be applied to either continuous modulation or with framing applied.

Digital data processing by the Agilent ESG-D with baseband generator option

There are three data sources available for digitally modulating the RF carrier in the Agilent ESG-D that can be applied either to continuous or framed transmissions (refer to Figure 1).

1. **Internally generated.** The ESG-D supplies PN9, PN15, and many fixed data patterns (user-defined repeating 4-bit sequence, or five different patterns of ones and zeros).

2. **Externally generated real-time data.** Real-time data and timing can be supplied by an external data source to the front-panel Data, Data Clock, and Symbol Sync connectors. This data can be continuously transmitted, or can be framed by supplying a data-synchronous burst pulse to the EXT1 input connector. Additionally, the external data can be multiplexed into the internally generated framing.

Note: This Product Note does not cover externally generated, real-time data. See the Agilent ESG-D Series Signal Generator User's Guide for details and timing diagrams.

3. **External data load through GPIB.**
   · **Direct pattern RAM (PRAM) block load.** For complete control over data and protocol, the user can directly write a block of data and control bits into PRAM. This is useful for generating nonstandard framing for proprietary communications protocols and for testing the limits of existing communications standards. This method completely bypasses all internal firmware-generated framing, and gives the user the ability to control all time-domain framing parameters. However, PRAM is kept in volatile memory, and all data is lost when the instrument is preset, overwritten by selection of internally generated data, or powered off.

Note: The ESG-D with Option 1EH does not allow downloaded framing. Options UN3/4 with firmware release A.01.10 contains a bug that does not correctly turn off the burst. This bug is partially fixed in A.01.12 (burst turns on/off correctly), but burst rise/ fall time is set to zero, and does not adjust even when commanded to non-zero values. These are corrected with firmware release B.01.01 or with Options UN8/9. ESG firmware may be downloaded from the ESG web page, www.agilent.com/find/esg or from your local Agilent sales offices.
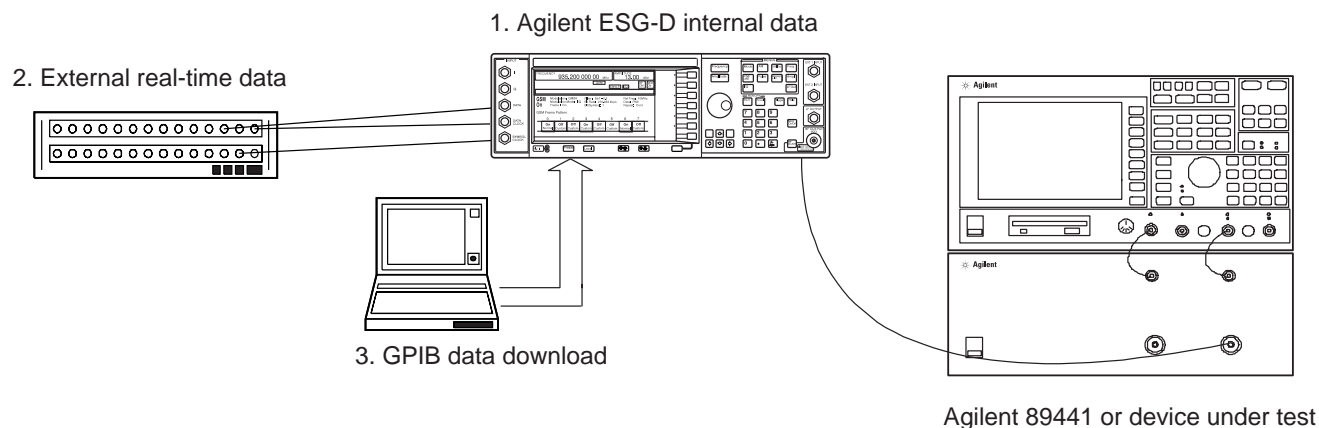

1. Agilent ESG-D internal data

2. External real-time data

3. GPIB data download

Agilent 89441 or device under test

Figure 1. Sources of digital data

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- **User File.** User Files provide a mechanism to download and store any data pattern to the ESG-D microprocessor file system. Subsequently, a User File can be selected as the data source for continuous modulation, or for any of the internally generated TDMA standards. Since the data is stored as a file in non-volatile memory, it is retained when the instrument is powered off or unplugged, and can be recalled later.

Modulating the RF carrier with digital data

The basic modulation of digital data, from memory to RF output, occurs through the following path, as shown in Figure 2:

- Internally generated or downloaded external data is loaded into PRAM memory by firmware.

- On each data clock, the baseband data generator reads data and framing information from PRAM, PN generator, or external connectors (depending on instrument settings) and supplies formatted symbols to the symbol builder/filtering hardware.[1] Note that the PRAM address counter is incremented with every data clock, so each data clock cycles the address to the next data byte. Since PRAM data is clocked into the baseband generator by the data clock, and the PRAM address counter increments with the data clock, each address in PRAM can be thought of as an increment in time.

- The symbol builder hardware generates the I/Q analog voltages corresponding to the selected modulation type and filtering.

- The I/Q modulator supplies RF modulation.

Note: For continuous PN9 or PN15 using Option UN3/4 with no TDMA framing, a dedicated hardware PN generator supplies data to the baseband generator, bypassing PRAM altogether. Option UN8/9 supplies PN9, PN11, PN20, and PN23 data sequences for continuous modulation.
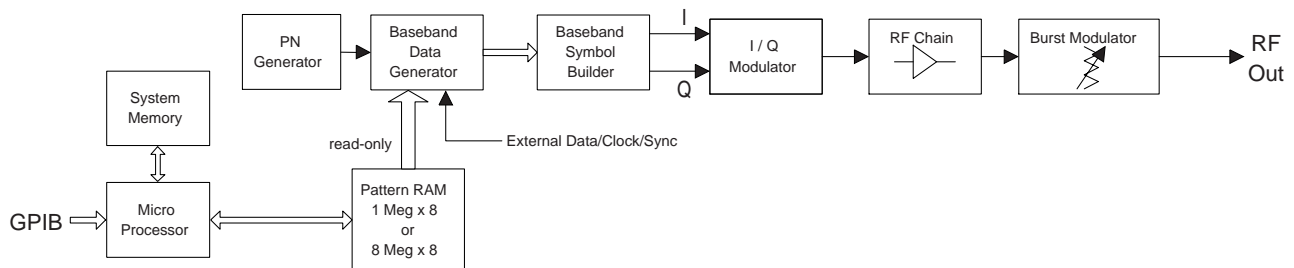

Figure 2. Agilent ESG-D digital modulation block diagram

PN generator, or external connectors (depending on instrument settings) and supplies formatted

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1. For 1-bit/symbol modulation formats such as GMSK, one data value is read for each symbol clock period, while for 2-bit/symbol modulation formats such as p/4-DQPSK, two data values are read for each symbol clock period.

Data and control bit definitions

PRAM not only contains the data bits to be modulated, but also consists of control bits for digitally modulating the carrier with burst. Firmware adds seven control bits to each bit of data to be modulated, so each bit of user data is contained within a 1-byte (8 bit) address in PRAM. Each PRAM byte is organized as shown in the table below.

Controlling data and protocol with direct write to memory

For complete control of data and protocol, the user can directly write a block of data and control bits into PRAM. This is useful for generating nonstandard framing for proprietary communications protocols and for testing the limits of existing communications standards. This method completely bypasses all internal firmware-generated framing, and gives the user the ability to control all time-domain framing parameters.

Note: See the Agilent ESG-D Signal Generator Programming Guide for more information.

For long patterns, it is advantageous to download in block format. The SCPI (Standard Commands for Programmable Instruments) command for loading a block of data directly into PRAM is

:MEMory:DATA:PRAM:BLOCK <datablock>.

Alternatively, the SCPI command for loading a list of data values (bytes) is

:MEMory:DATA:PRAM:LIST <value> [,<value>, < . . . >] where **<value>** is any of the valid values between 0 to 255, as specified by the PRAM data and control bit definitions table above. Note that each value corresponds to a unique byte in PRAM.

Bit	Function	Value	Comments
0	Data	0 / 1	This bit is the data to be modulated. This bit is a "don't care" when burst (bit 2) is set to 0.
1	Reserved	0	Always 0.
2	Burst	0 / 1	To turn RF on = 1. To blank RF = 0. For non-bursted, non-TDMA systems, this bit is set to 1 for all memory locations, leaving RF output on continuously. For framed data, this bit is set to 1 for "on" timeslots, and set to 0 for "off" timeslots.
3	Reserved	0	Always 0
4	Reserved	1	Always 1
5	Reserved	0	Always 0
6	Event 1 Output	0 / 1	Setting this to 1 causes a level transition on Event 1 BNC connector output. This can be used for any function, for example, as marker out put to trigger external hardware that the data pattern has restarted or to create a data-synchronous pulse train by toggling this bit in alternate addresses.
7	Pattern	0 / 1	Continue to next sequential memory address = 0. Indicate the end of memory and restart memory "playback" = 1. This bit is set to 0 for all but the last byte (address) of PRAM. For the last byte (address) of PRAM, it is set to 1 to restart the pattern.

For example, to burst a FIX4 data pattern of "1100" five times, then turn burst off for 32 data periods (assuming 1-bit/symbol modulation format), the command may look like this:

:MEM:DATA:PRAM:LIST 21,21,20,20,21,21,20,20,21,21,20,20,21,21,20,20,21,21,20,20, 16,16,16,16,16,16,16,16,16,16,16,16,16,16,16,16,16,16,16, 16,16,16,16,16,16,16,16,16,16,16,144

"21" signifies Data = 1, Burst = On (1).
"20" signifies Data = 0, Burst = On.
"16" signifies Data = Don't Care, Burst = Off (0).
"144" signifies Data = Don't Care, Burst = Off, Pattern Repeat =On (1)

To modulate the downloaded PRAM sequence in the ESG-D, the user must select and activate a communications standard (to define a modulation format, filter, and data clock). The communications standard is found under the MODE hardkey using the front panel keys or equivalent SCPI commands. The front panel will specify "Downloaded Data" under the Data softkey. Be aware that firmware cannot automatically verify or validate the downloaded data.

User Files
The key strength of User Files is that they are saved in the instrument's file storage system, and are thus non-volatile. The Agilent ESG-D file system (memory catalog) stores Binary, State, and List file types. Binary User Files store bit sequences to be used as data in a transmission. State files contain instrument configurations (frequency, power level, mode, etc.) that are saved in storage registers for later recall. List files store sweep information as defined under the Sweep/List hardkey.

When a User File is selected as the data source, firmware loads PRAM with the data specified in the User File, and sets the other seven PRAM bits depending upon the operating mode selected (regardless of whether a continuous or framed transmission is selected). In other words, User Files are mapped into PRAM such that 1 data bit equals 1 PRAM byte.

The size of User File that can be saved depends on the available memory in the ESG-D's microprocessor file system. The maximum amount of space available in the file system is about 128 kbytes (1 Mbits) of data, but available memory for User Files will be reduced if memory is also in use for saved instrument state files or sweep list files.

Downloading data

Data must be downloaded in multiples of 8 bits, since SCPI specifies the data in ASCII bytes. Therefore, if the original data pattern is not a multiple of 8 bits long, the programmer may need to: (1) add additional bits to complete an ASCII character, (2) replicate the data pattern to generate a continuously repeating pattern with no discontinuity, or (3) truncate and discard bits to reach a string that is a multiple of 8 bits in length.

For example:

• **For a continuously repeating transmission** of the 11-bit data pattern, the pattern should be repeated 8 times, so that 88 bits are downloaded, comprising 11 ASCII characters with no extraneous or missing bits.

• **For a single transmission** of an 11-bit data pattern, additional bits should be appended so that 16 bits (2 ASCII characters) are downloaded. Download 16 bits and select Pattern Repeat = "Continuous" on the ESG-D front panel. The result is five unwanted bits along with the 11 desired bits each time the pattern is repeated.

The SCPI command (refer to the ESG-D Signal Generator Programming Guide) for downloading a User File is:

MMEM:DATA "filename", #ABC

filename   the file name
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 represented in ASCII format (8 bits per ASCII character)

For example, the following command downloads 9 bytes of data to the User File "NEWDATAFILE"

MMEM: DATA "NEWDATAFILE", #1912SA40789

A = "1"; specifies that B contains a single digit
B = "9"; specifies that C contains 9 bytes of data
C = "12SA40789"; the ASCII representation of the data that is downloaded to the ESG-D

Note: Not all ASCII characters can be printed. In fact, only ASCII characters corresponding to decimal values 33 to 126 are printable keyboard characters. The above example was carefully chosen for simplicity. More likely than not, the ASCII character corresponding to an 8-bit pattern is not printable. Thus, the program written to download and upload a User File must correctly convert between ASCII and the visible representation of the sequence.

User Files for framed transmission

Specifying a User File as the data source for a framed transmission provides the user with an easy method to multiplex real data into internally generated TDMA framing. The User File will fill the data field(s) of the active timeslot in the first frame and continue to fill the same timeslot of successive frames as long as there is more data in the file. This functionality allows a communications system designer to download and modulate proprietary data sequences, specific PN sequences, or simulate multiframe transmissions, such as are specified by some mobile communications protocols. As the example in Figure 3 shows, a GSM multiframe transmission requires 26 frames for speech.

In the Agilent ESG-D, when a User File is selected as the data source for a framed transmission, firmware loads PRAM with the framing protocol of the active TDMA standard. For all addresses corre-sponding to "ON" timeslots, burst bits are set to "1" and data bits are set with the contents of the User File for the data fields of the timeslot. Other bits are set according to the configuration selected. For "OFF" timeslots, burst control bits are set to 0, and data is "don't care." "Pattern Reset" is set to "1" for the last used byte in PRAM, so that the pattern will repeat after the last byte is read.

Note: The load of PRAM is "static." In other words, firmware writes to PRAM once for the configuration selected, and the hardware reads repeatedly. Firmware overwrites the volatile PRAM memory to reflect the desired configuration only when the data source or mode is changed.

As an example of a User File application, a user wants to transmit a 228-bit User File for timeslot #1 (TS1) in a Normal GSM transmission.[1] The seven other timeslots in the GSM frame are off. The User File will completely fill timeslot #1 in two successive frames, and then will repeat.
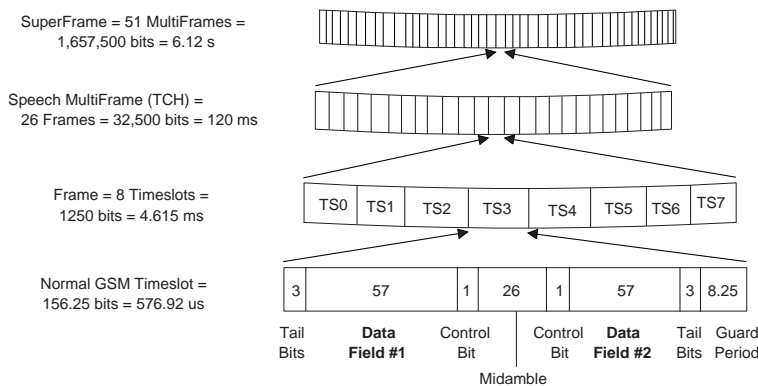

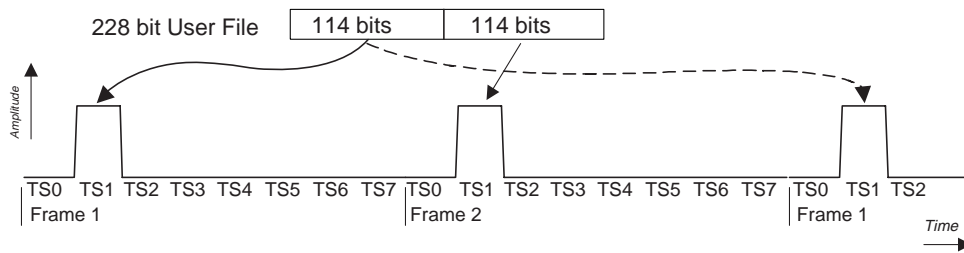**Figure 3. GSM multiframe transmission**

Figure 4. Mapping User File data to a single timeslot

1. Per the standard, a GSM Normal Channel is 156.25 bits long with two 57-bit data fields (114 bits total per timeslot), and 42 bits for control or signaling purposes. Compliant with the GSM standard, which specifies 156.25 bit timeslots, the ESG-D uses 156-bit timeslots and adds an extra guard bit every fourth timeslot.

For this protocol configuration, firmware loads PRAM with:

Frame	Timeslot	PRAM Address	Data Bits	Burst Bits	Pattern Reset
1	0	0 - 155	0/1 (don't care)	0 (off)	0 (off)
1	1 (on)	156 - 311	42 bits set by GSM Standard, first 114 bits of User File	1 (on)	0
1	2	312 - 467	0/1 (don't care)	0	0
1	3	468 - 624	0/1 (don't care)	0	0
1	4	625 - 780	0/1 (don't care)	0	0
1	5	781 - 936	0/1 (don't care)	0	0
1	6	937 - 1092	0/1 (don't care)	0	0
1	7	1093 - 1249	0/1 (don't care)	0	0
2	0	1250 - 1405	0/1 (don't care)	0	0
2	1 (on)	1406 - 1561	42 bits set by GSM standard, remaining 114 bits of User File	1 (on)	0
2	2 thru 6	1562- 2342	0/1 (don't care)	0	0 (off)
2	7	2343 - 2499	0/1 (don't care)	0	0 1 in addr 2499 only

Note: Event 1 output will be set to 0/1 depending on the "Sync Out" selection under the TDMA soft-key, which enables the Event 1 output at either the beginning of the frame, beginning of a specific timeslot, or at all timeslots.

Since timeslots are independently configured and enabled within the Agilent ESG-D, a User File can be individually assigned to one or more timeslots. A timeslot cannot have more than one data source (PN sequence or User File) specified for it. The amount of User File data that can be mapped into hardware memory depends on both the amount of PRAM available on the baseband generator, and the number and size of each frame. The amount of PRAM required for a framed transmission is:

PRAM size = size of timeslot x # of timeslots per frame x # of frames.

For example, to generate a superframe for GSM,

PRAM size =bits/timeslot x timeslots/frame x frames/multiframe x multiframes/superframe
=156.25 x 8 x 26 x 51
=1,657,500 bytes.

The 1 Mbyte memory available with Options 1EH, UN3, or UN8 is not enough for this application. Option UN4 or UN9 with 8 Mbytes is required.

Avoiding Problems

There are three conditions that must ALL be met to minimize problems:

- The User File selected must entirely fill the data field of each timeslot.

- The User File must be a multiple of 8 bits, so that it can be represented by ASCII characters.

- With large User Files, available pattern RAM must be large enough to support the data and framing. As described later in this product note, turning on a GSM Normal timeslot with a 511-bit modified PN9 sequence for the data source consumes 2,555,000 bytes in PRAM.

1. **Filling each timeslot**

    When creating a User File for a framed transmission, the data pattern should be long enough to completely fill the data fields of an integer number of timeslots. If a User File does not completely fill the data field in a timeslot, firmware will not load any data into the timeslot (if a User File would fill only ½ of the data field of a timeslot, no data is modulated). If the User File fills more than one timeslot in a continuously repeating framed transmission (Frame Repeat = "Continuous"), the User File will be restarted after the last timeslot that contains completely filled data fields. For example, if the User File has enough data to fill the data fields of 3.5 timeslots, firmware will load three timeslots with data, and restart the User File after the third timeslot. The last 0.5 timeslot amount of data is never modulated.

2. **Multiple of 8 bits**

    User File data must be downloaded in multiples of 8 bits, since SCPI specifies the data in ASCII bytes. Therefore, if the original data pattern is not a multiple of 8 bits long, the programmer may need to either add additional bits to complete an ASCII character, replicate the data pattern to generate a continuously repeating pattern with no discontinuity, or truncate the remaining bits.

Note: The "multiple of 8 bits" requirement is in addition to the above "Filling Each Timeslot" requirement. In other words,

$$\frac{\text{Data Pattern Length x repeat}}{8} = i,$$

where i (number of ASCII characters) MUST be an integer

AND

$$\frac{\text{Data Pattern Length x repeat}}{\text{Timeslot Data Field Size}} = k,$$

where k (number of frames in PRAM) MUST be an integer

The following method can be used to compute how many times the data pattern must be repeated in order to be continuous.

In this example, a modified PN9, 511-bit data pattern is to be applied as the data source for a 114-bit data field in a GSM Normal timeslot.
Set up a spreadsheet with:

A = number of repetitions of the original data pattern

B = User File length = number of repetitions x original data pattern length

C = number of ASCII characters = user file length /8 (8 bits per ASCII character)

D = number of frames = User File length / timeslot data field size (114 in this example)

E = total PRAM memory needed = # frames x # bits per frame (1250 in this example for GSM)

The first row where both columns C and D are integers (reading down) is the minimum number of repetitions required to transmit the User File without discontinuity. In this example, in order to correctly generate the modified PN9 and download it to a User File, the User File must contain 456 repetitions of the 511-bit pattern, and 233,016 total bits will be downloaded to the signal generator, comprising 29,127 ASCII characters.

A	B	C	D	E
Number of repetitions	Data pattern length x repetitions	Number of ASCII characters (B / 8)	Number of frames needed to end on a timeslot boundary (B / timeslot data field size)	Total PRAM memory needed (D x number of bits per frame)
1	511	63.88	4.48	5,603.07
2	1,022	127.75	8.96	11,206.14
3	1,533	191.63	13.45	16,809.21
4	2,044	255.5	17.93	22,412.28
5	2,555	319.38	22.41	28,015.35
6	3,066	383.25	26.89	33,618.42
7	3,577	447.13	31.38	39,221.49
8	4,088	511	35.86	44,824.56
9	4,599	574.88	40.34	50,427.63
. . .	. . .	. . .	. . .	. . .
455	232,505	29,063.13	2,039.52	2,549,396.92
456	233,016	29,127	2,044	2,555,000

3. **Available pattern RAM must be large enough to support the data and framing overhead.**
It is possible to run out of available PRAM with a large User File that must be continuous across a large number of frames. In the previous example, selecting the 233,016 bit User File as the data source for the Normal GSM timeslot will cause firmware to compute 2,044 frames of data, taking 2,555,000 bytes of PRAM space. Option UN4 or UN9 (8 Mbit data memory) is required for this configuration, and trying to load this on Option UN3 or UN8 data generator (1 Mbit) will cause an error since not enough PRAM is available. If PN11 was used instead of PN9, 456 repetitions of the data pattern would require a 933,432 bit User File, needing 8,188 frames and 10,235,000 bytes of PRAM. Since this is more than Option UN4 or UN9 can handle, the user needs to supply the data externally.

It is also possible to run into PRAM space limitations when selecting User Files for standards that specify a large number of bits per frame. For example, DECT protocol specifies 480-bit timeslots and 12 timeslots per frame, requiring 5,760 bytes of PRAM per frame. At most, UN4 or UN9 can handle 1,456 complete DECT frames.

4. **What if my data pattern exceeds available PRAM memory?**
If the data fields absolutely must be continuous data streams, and the data exceeds the PRAM available, real-time data can be provided externally through the Data input, with synchronization through the Data Clock and Symbol Sync connectors, and with internally generated TDMA framing. See the User's Guide for more detail on configuring this setup.

When multiple User Files are selected for different timeslots

If two or more User Files are selected for a framed transmission, the amount of PRAM required is determined by the User File that generates the largest number of frames. In order to generate continuously repeating data patterns, each User File must be long enough to completely fill an integer number of timeslots. In addition, all User Files must meet the "Multiple of 8 bits" and "Enough PRAM memory" requirements to be correctly modulated.

For example, DataPattern#1 contains 114 bits to fill the data fields of a Normal GSM timeslot, and DataPattern#2 contains 148 bits for a Custom GSM timeslot. In order to correctly transmit these data patterns as continuously repeating User Files without discontinuities, both data patterns must be repeated four times. Therefore, User File #1 contains 456 bits, and User File #2 contains 592 bits. Each User File will then create exactly four frames in PRAM.

When two or more User Files generate different numbers of complete frames, the User Files will repeat on different cycles. All User Files will restart when the User File that generates the largest number of frames repeats. For example, User File #1 needs four frames to completely transmit its data, and User File #2 only needs three. User File #2 will repeat after the third frame, and again when User File #1 repeats. If these were integer multiples of each other, both User Files would be continuous, and User File #2 would repeat after 2 frames.

When PN9 or PN15 are selected without User Files for framed transmission

If you select PN9 and/or PN15 to fill different time-slots, with no User Files involved, each PN sequence is hardware generated to fill its designated timeslot, and no discontinuity of the pseudorandom data occurs when the sequences are repeated.

PN sequences selected along with User Files for framed transmission

When a PN sequence is selected to fill a timeslot and a User File is selected for another timeslot, the PN sequence is firmware implemented.

Note: The PN sequence plays the role of a User File, and that PN9 is handled differently than PN15.

A firmware generated PN9 sequence always requires 511 frames to be continuous, regardless of the selected TDMA protocol. If the User File generates fewer than 511 frames, the User File will repeat as necessary to fill the data fields of 511 frames. If the User File fills more than 511 frames,

the PN9 will repeat after the 511th frame, and then again when the User File repeats. In these cases where the User File is not an integer multiple of 511 frames, either the User File or PN9 will be discontinuous.

Because of its length, a PN15 sequence will always be discontinuous regardless of whether a User File is selected for other timeslots, and regardless of the TDMA protocol selected. The PN15 sequence behaves just like a User File of equal length (32,767 bits).

Summary

With this Product Note, the user will be able to generate and download data to the Agilent Technologies ESG-D for digital modulation. User Files can be applied as the data source for TDMA protocols, or for specific repeating bit patterns modulated continuously. For the ultimate in protocol flexibility, the user can control PRAM download to generate user-defined protocols. Review the Agilent ESG-D Signal Generator User's and Programming Guides for more information.
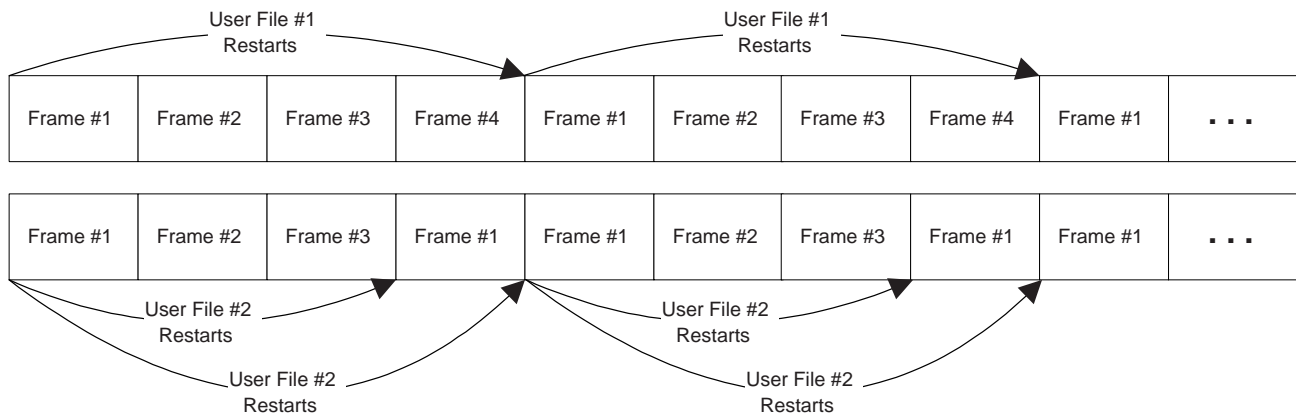

Figure 5. Repeating different length User Files

Appendix A: GPIB interface cards available for PCs and workstations

This information was current at the time of publication. For the most up-to-date information, visit www.agilent.com or your local Agilent sales office.

GPIB Interface Card

	82341C	82340B	82335B
Controller	PC-based	PC-based	PC-based
Operating System	Windows 3.1/ 95/NT®	Windows 3.1/ 95/NT	MS-DOS®, Windows 3.1
I/O Library	SICL/VISA	SICL/VISA	Command Library/SICL
Languages	C/C++, Visual BASIC, Agilent VEE	C/C++, Visual BASIC, Agilent VEE	C/C++, Pascal, BASIC for PC (including Visual BASIC), Agilent VEE
Backplane	ISA/EISA, 16 bit	ISA/EISA, 8 bit	ISA/EISA, 8 bit
Maximum I/O	750 KB/s	520 KB/s	355 KB/s
Buffering	Built-in	None	None

GPIB interface cards available for Agilent workstations:

GPIB Interface Card

	E2071C	E2070C
Operating System	HP-UX	HP-UX
Controller	HP Series 700 workstation	HP Series 700 workstation
I/O Library	SICL/VISA	SICL/VISA
Languages	ANSI C, Agilent VEE, HP BASIC	ANSI C, Agilent VEE, HP BASIC
Backplane	EISA	EISA
Maximum I/O	750 KB/s	230 KB/s
Buffering	built-in	none

The following GPIB cables are available:

- 10833A - 1 meter cable
- 10833B - 2 meter cable
- 10833C - 4 meter cable
- 10833D - 5 meter cable

Appendix B: SCPI commands for User File loads

SCPI (Standard Commands for Programmable Instruments) is a popular language used to communicate with the Agilent ESG signal generator. SCPI is not to be confused with SICL and VISA, which are I/O libraries of functions used by programs that communicate through GPIB. SCPI is the actual language used to communicate with the ESG-D instrument itself.

I/O libraries for GPIB

Standard Instrument Control Library (SICL) and Virtual Instrument Software Architecture (VISA) are I/O libraries used to develop I/O applications for the GPIB interface. SICL is a modular instrument-communications library that works with a variety of computer architectures, I/O interfaces, and operating systems. Applications written in C/C++ or Visual BASIC using this library can be ported at the source-code level from one system to another without, or with very few, changes. VISA is an I/O library that can be used to develop I/O applications and instrument drivers that comply with the VXI plug&play standards. Applications and instrument drivers developed with VISA can execute on VXI plug&play system frameworks that have the VISA I/O layer.

One or both of these libraries are included with the GPIB interface card. SICL/VISA for Series 700 Controllers (Model E2091D) and SICL/VISA for PC's (Model E2094E) may also be purchased. For further information on SICL and VISA, see the SICL User's Guide and VISA User's Guide included with the SICL/VISA software package.

SCPI commands

Use the following SCPI command line to download a User File for remote programming of the source's digital modulation:

MMEM:DATA "filename", #ABC

filename	the file name
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 represented in ASCII for mat (8 bits per ASCII character)

Example: The following command downloads 10 bytes of data to the User File "NEWDATAFILE2"

MMEM: DATA "NEWDATAFILE2", #21012&A%4D

A = "2"; specifies that B contains 2 digits, in this case 10

B = "10"; specifies that C contains 10 bytes of data

C = 12&A%4D789; the ASCII representation of the data that is downloaded to the ESG

Note: Not all ASCII characters can be printed. In fact, only ASCII characters corresponding to decimal values 33 to 126 are printable keyboard characters. The above example was carefully chosen for simplicity. More likely than not, the ASCII character corresponding to an 8-bit pattern is not printable. Thus, the program written to download and upload a User File must correctly convert between ASCII and the visible representation of the sequence.

Use the following SCPI command line to query a digital modulation User File and return the ASCII data bytes from the file:

MMEM:DATA? "filename"

Example: The following example returns the ASCII data bytes from "NEWDATAFILE"

MMEM:DATA? "NEWDATAFILE"

The data will be returned in the same #ABC format introduced earlier: #12SA40789.

Example: The following example returns the ASCII data bytes from "NEWDATAFILE2"

MMEM:DATA? "NEWDATAFILE2"

The data will be returned in the same #ABC format introduced earlier: #21012&A%4D789.

Appendix C: Accessing User Files in the Agilent ESG-D

How to view the memory catalog in the Agilent ESG-D

To determine the available memory and pre-existing files, follow these keypresses on the Agilent ESG-D front panel:
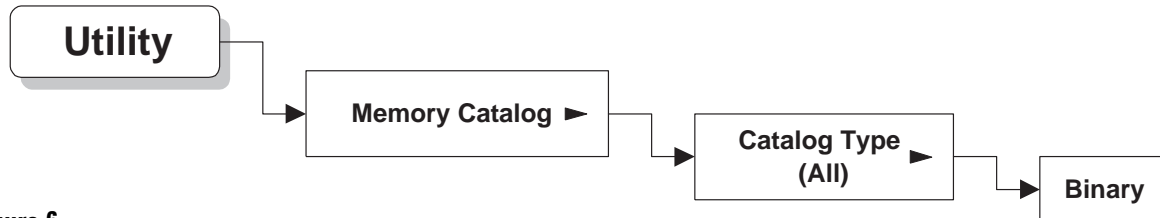

Figure 6.

How to select a User File for modulation

Note: Press the local button to place the instrument in the local mode after downloading a User File.

To select a User File as the data in a continuously modulated transmission:
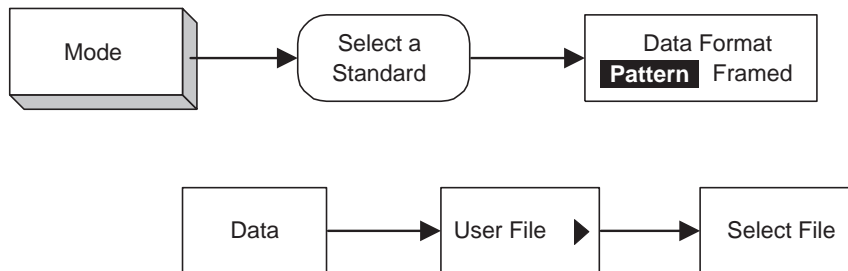

Figure 7.

If **Pattern Repeat Cont** is selected, the data pattern will be continuously repeated.

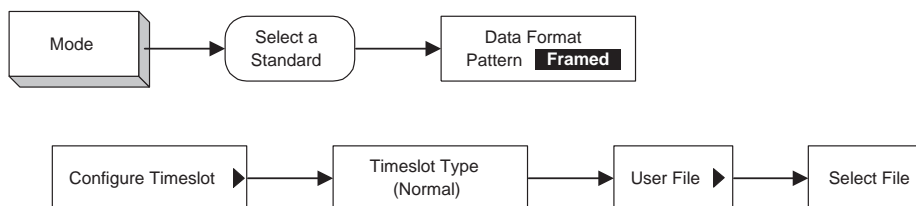To select a User File to fill the data field of a timeslot:

Figure 8.

If **Frame Repeat Cont** is selected, the resulting set of frames will be continuously repeated.

Appendix D: Sample programs

Refer to the User File Applications portion of the Agilent ESG-D User's Guide or Programming Guide for sample programs.

The following excerpt from a program written in Visual C++ demonstrates the use of the VISA I/O library and the SICL command language.

```
// Downloads a User File to the ESG

void CUserfileDialog::DownloadFile()

{
    ViSession defaultRM, vi;
    /* Open session to GPIB device at address 22 */
    viOpenDefaultRM(&defaultRM);
    viOpen(defaultRM, "GPIB0::22::INSTR", VI_NULL, VI_NULL, &vi);

    /* Generate the command to download a 32 bit (4 byte) sequence*/
    char* WriteString = "MMEM:DATA "Userfile1", #1412SA";
    int Length = strlen(WriteString);
    unsigned long BytesTransferred[1];

    /* Write the command to the ESG. Userfile1 is downloaded */
    viWrite(vi, WriteString, Length, BytesTransferred);

    /* Close session */
    viClose(vi);
    viClose(defaultRM);
}
```

Appendix E: Related literature

Agilent ESG Family of RF Signal Generators, Data Sheet, literature number 5965-3096E

IntuiLink Software, Data Sheet, literature number 5980-3115EN

Agilent ESG Family of RF Signal Generators, Configuration Guide, literature number 5965-4973E

Customize Digital Modulation with ESG-D Series Real-Time IQ Baseband Generator, Option UND, Product Note, literature number 5966-4096E

Multi-channel CDMA Personality for Component Test, Option UN5, Product Note, literature number 5968-2981E

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

Using the ESG-D Series of RF Signal Generators and the 8922 GSM Test Set for GSM Applications, Product Note, literature number 5965-7158E

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

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