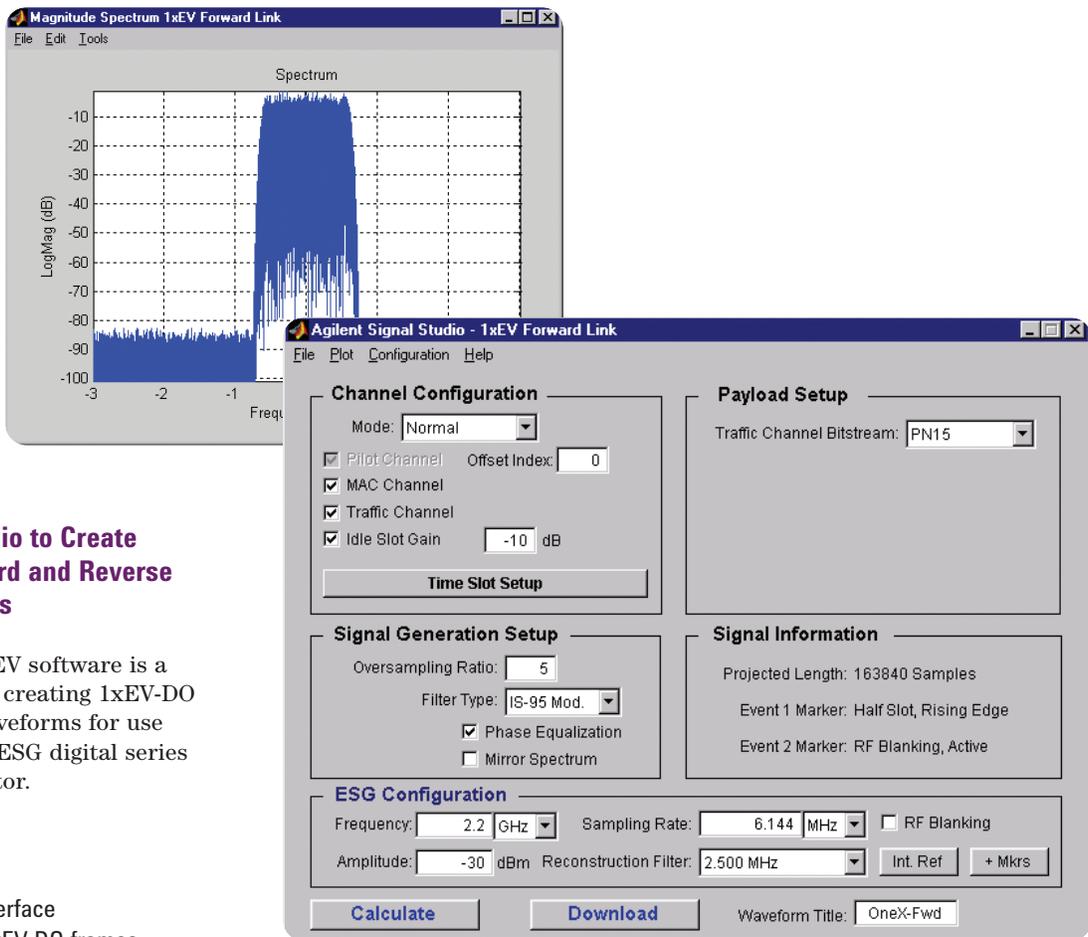


# Agilent Signal Studio 1xEV-DO Option 404

**For the ESG-D/DP Series Signal Generator**  
Product Note



## Use Signal Studio to Create 1xEV-DO Forward and Reverse Link Test Signals

Signal Studio-1xEV software is a powerful tool for creating 1xEV-DO baseband I/Q waveforms for use with the Agilent ESG digital series RF signal generator.

### Main features:

- Intuitive user interface
- Quickly create 1xEV-DO frames
- Configure channels in each timeslot
  - Forward Link Channels
    - Pilot, MAC, and Traffic
  - Reverse Link Channels
    - Pilot, MAC, ACK, and Data
- Selectable baseband filtering
- Plot I/Q signals, spectrum, and CCDF curve
- Remote configuration of ESG settings



**Agilent Technologies**

This Product Note is a self-guided tutorial describing the test signals that can be created with the Signal Studio-1xEV software. This document is not meant to be a 1xEV technology tutorial. Basic knowledge of the Forward and Reverse Link channel structure is required. For additional information on 1xEV technology, see to the References section at the end of this document.

## Table of contents

<b>Software overview</b>	<b>3</b>
<b>Benefits</b>	<b>3</b>
Component test	3
Receiver test	3
<b>Signal structure</b>	<b>4</b>
1xEV-DO frame structure	4
<b>Connecting to the ESG</b>	<b>4</b>
<b>Creating signals</b>	<b>4</b>
Forward link channel structure	5
Forward link frame configuration	6
Step 1 - Configure the forward channels	6
Step 2 - Setup the signal generation parameters	8
Step 3 - Configure the ESG	9
Step 4 - Calculate & download	10
Reverse link channel structure	12
Reverse link frame configuration	13
Step 1 - Configure the reverse channels	13
<b>Examples of basic measurements</b>	<b>15</b>
Channel power	15
Adjacent channel power (ACP)	17
<b>Signal Studio-1xEV data sheet</b>	<b>18</b>
Forward link	18
Reverse link	18
<b>Acronym list</b>	<b>18</b>
<b>Additional literature</b>	<b>19</b>
<b>References</b>	<b>19</b>
<b>Ordering information</b>	<b>19</b>

## Software overview

Signal Studio-1xEV software is an intuitive Windows-based tool for configuring Forward and Reverse Link 1xEV-DO frame structures. Unique physical channel configurations can be achieved in each time-slot. Based on the 1xEV-DO frame configuration parameters set by the user, the software calculates a custom baseband I/Q waveform file. Most waveforms take only a few seconds to build and are quickly downloaded to the ESG dual arbitrary waveform generator for playback.

A configuration menu for basic signal generator settings is provided as well, including frequency, amplitude, and marker polarity. Instrument settings and the waveform file are passed to the ESG digital series signal generator over the GPIB or RS-232 interface.

After downloading the waveform file and instrument settings to the signal generator, a 1xEV-DO RF signal is automatically generated. Local control of the signal generator is then re-enabled allowing modification of instrument settings, such as frequency and amplitude. Waveform files themselves cannot be modified once they have been downloaded to the instrument.

Waveform files can be saved in the ESG dual arbitrary waveform generator non-volatile memory and recalled for playback at any time.

## Benefits

Signal Studio-1xEV simplifies the user's role in creating 1xEV-DO Forward and Reverse link test signals for use with the ESG digital series RF signal generator. Instead of spending valuable time writing code to create a proprietary test signal, Signal Studio-1xEV provides the ability to quickly configure a standard-based test signal via an intuitive graphical user interface. Furthermore, the Signal Studio-1xEV frame configuration can easily be modified to create the desired test signal, without re-writing code.

### Component test

The performance characteristics of 1xEV components – including pre-amplifiers, combiners, filters, and amplifiers – is determined using a suitable stimulus. The Signal Studio-1xEV software meets this need by providing statistically correct signals in both the Forward and Reverse link directions. Signal parameters, including the number of active channels and modulation type, can be modified to properly exercise the components being tested.

### Receiver test

In order to thoroughly test a receiver's demodulation capabilities, a test signal with full channel coding is necessary. Full channel coding allows test engineers to determine if each functional stage of a receiver is operating correctly. In the Reverse link direction, the Signal Studio-1xEV software provides full channel coding. This level of channel coding enables FER and BER testing on the signal received by the Access Network to verify performance. As indicated in figure 2, full channel coding is not provided in the Forward link direction.

## Signal structure

### 1xEV-DO frame structure

In 1xEV-DO systems, information is transmitted in frames as shown figure 1. The total frame length is 26.67ms and each frame is divided equally into sixteen 1.666ms timeslots ( $1.2288 \text{ Mcps} \times 1.666 \text{ ms} = 2048$  chips per timeslot). The frame structure is identical in the Forward and Reverse Link. However, the basic channel structure within the timeslots is dependent upon the link direction.

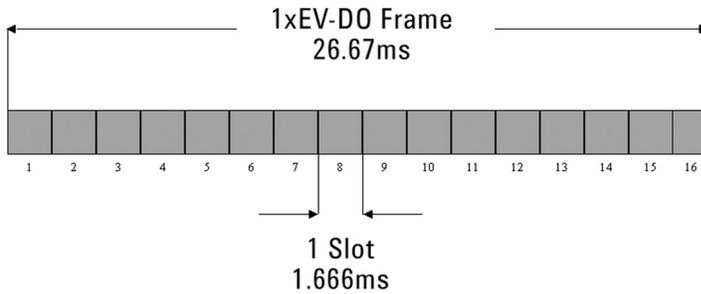


Figure 1. 1xEV-DO Frame Structure.

## Connecting to the ESG

Signal Studio software must be installed in a host computer prior to creating 1xEV-DO test signals. Before downloading waveforms to the instrument, verify that the host PC is communicating with the ESG digital series RF signal generator. Additional information on connecting to the signal generator is located in the Signal Studio Installation Guide [1].

## Creating signals

The Signal Studio software graphical user interface is divided into three configuration menus:

- Channel Configuration
- Signal Generation Setup
- ESG Configuration

The mechanics of menu configuration consists of selecting from pull-down menus and editing text fields. The point and click nature of this process is simple and intuitive and will not be discussed in detail. Help screens are provided when the mouse pointer is placed directly over the item of interest.

## Forward link channel structure

The 1xEV-DO Forward Channel Structure as implemented by Signal Studio is shown in figure 2. Green blocks indicate frame configuration parameters that can be modified by the user, whereas blue blocks indicate fixed parameters that are automatically implemented cannot be modified. Gray blocks are not implemented in the Signal Studio software. For example, convolutional encoding, scrambling, and interleaving are not implemented in the Forward Traffic Channel. Instead, the Forward Traffic Channel Bitstream is fed directly into the modulator block.

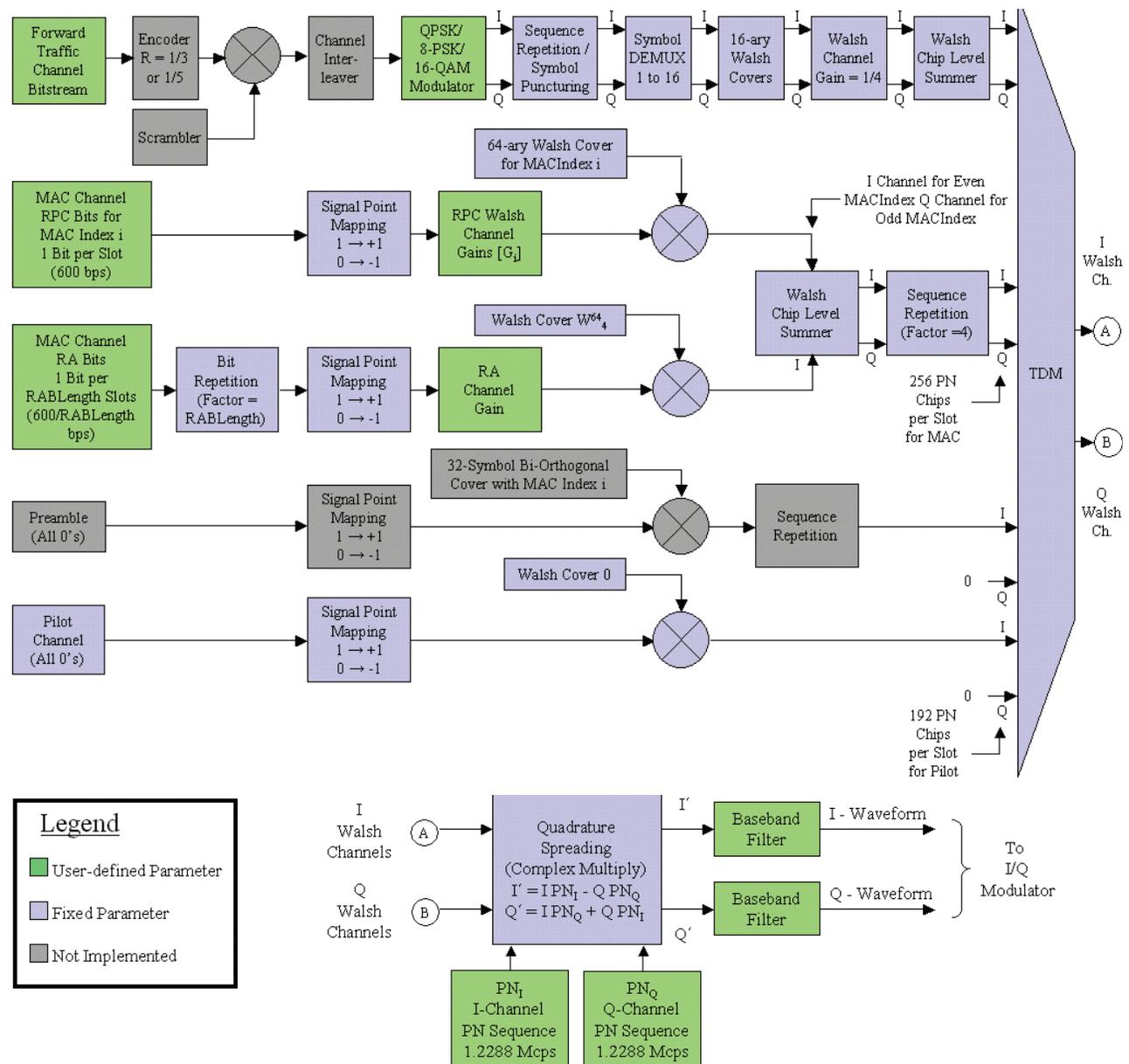


Figure 2. 1xEV-DO forward channel structure as implemented by Signal Studio .

## Forward link frame configuration

By following four easy steps, you can configure and download a 1xEV-DO Forward Link waveform:

- Step 1** - Configure the forward channels
- Step 2** - Setup the signal generation parameters
- Step 3** - Configure the ESG
- Step 4** - Calculate & download

### Step 1 - Configure the forward channels

The Channel Configuration menu boxed in figure 3 provides an intuitive graphical user interface for constructing 1xEV-DO frames. The Signal Studio-1xEV software provides two basic modes of operation: Normal and Continuous Pilot.

#### Normal operating mode

In Normal operating mode, a 1xEV-DO frame with custom channel configurations in each of the frame's sixteen timeslots can be configured. The following Forward Link channels are supported in Normal operating mode: Pilot Channel, MAC Channel, and Traffic Channel.

#### Pilot channel

The Pilot Channel is the default active channel in every frame and occurs as two distinct bursts in each timeslot of the frame. It cannot be de-activated. The Pilot Channel's PN Offset Index, ranging from 0 to 511, can be set in the Channel Configuration menu. The PN offset of the Pilot Channel indicates the cell or sector of the transmitting Access Network.

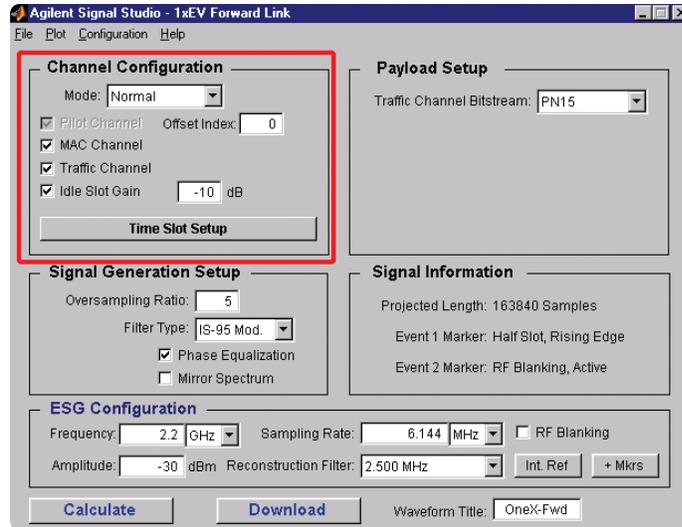


Figure 3. Signal Studio 1xEV forward link channel configuration menu.

#### MAC and traffic channels

The MAC Channel and Traffic Channel can each be activated or deactivated in the entire frame. Simply checking the box next to the MAC Channel and Traffic Channel in the Channel Configuration menu optionally activates the channel for use in frame configuration. Once a MAC Channel or Traffic Channel has been activated in the frame, further physical channel configuration can be implemented in each timeslot.

It is important to note that any channel configuration done at the timeslot level is not implemented unless the channel is activated for use in the entire frame, as discussed above.

#### Active slots vs. idle slots

In the Forward Link, physical channels are time division multiplexed in each of the frame's sixteen timeslots. If the Pilot Channel, MAC Channel, and Traffic Channel are all active in a timeslot, it is referred to as an Active Slot. When only the Pilot Channel and MAC Channel are active in a timeslot, it is referred to as an Idle Slot. The structure of both slot types is illustrated in figure 4.

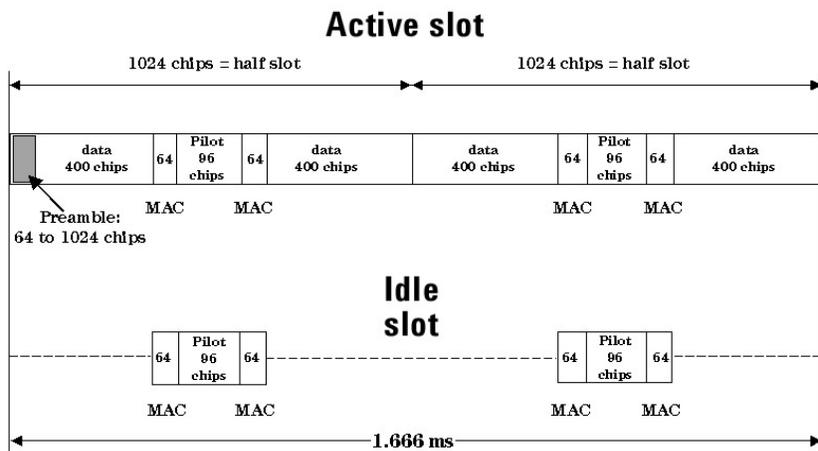


Figure 4. Forward link slot structures: active slot and idle slot.

### Idle slot gain

During Idle slot transmission, a large on/off power ratio requires that the access network power amplifier have extremely wide dynamic range. This is typically not the case. To address this issue, the software provides Idle Slot Gain capability in the Channel Configuration menu. This parameter allows the noise level during the off time of the idle slot to be varied relative to the Pilot Channel. By varying the Idle Slot Gain, the on/off power ratio can be set as needed to meet the transmission envelope mask requirements of the system. Optionally, the Idle Slot Gain parameter can be disabled. When disabled, RF Blanking is automatically enabled. This results in a very large on/off power ratio during idle slot transmission.

### Time slot setup

Selecting the Time Slot Setup button in the Channel Configuration menu brings up a configuration table, figure 5.

The Time Slot Setup configuration table is structured similar to a spreadsheet. Each row of the table represents one of the 16 timeslots in a 1xEV-DO frame. The columns of the table are labeled and grouped as to which parameter they represent and what physical channel is being configured.

To simplify channel configuration, the bottom row of pull down menus (highlighted in yellow) provide Fast Edit capabilities. The channel parameter selected in a Fast Edit field is set in all sixteen timeslots (the entire column). This provides a quick alternative for configuring a generic forward channel frame. To provide maximum flexibility, each timeslot channel parameter can still be configured individually.

### Traffic channel

The Traffic Channel can be activated or de-activated in each of the sixteen timeslots. Additionally, a pull-down menu is provided to uniquely configure the Traffic Channel modulation type (QPSK, 8-PSK, or 16-QAM) in each timeslot. The Traffic Channel modulation type is chosen based on the required rate of data transmission. The only Traffic Channel

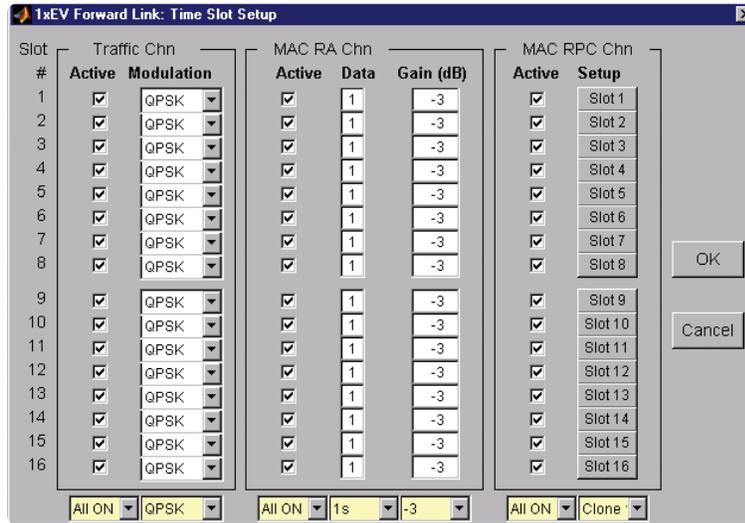


Figure 5. Signal Studio-1xEV forward link time slot setup table.

parameter not configured in the Time Slot Setup table is the Traffic Channel Bitstream. The bitstream can be set to all 0s, all 1s, alternating 01, alternating 10, PN9, or PN15 and is configured via a pull-down menu in the Payload Setup menu, figure 3. The Traffic Channel Bitstream is divided into each timeslot with an active Traffic Channel for the entire frame. In the case of PN sequences, a continuous PN sequence is distributed across the timeslots containing an active Traffic Channel. After the last timeslot with an active Traffic Channel has been filled with data, the PN sequence is truncated.

### MAC reverse activity channel

The MAC Channel in each timeslot consists of the summation of multiple sub channels: Reverse Activity (RA) Channel and up to 59 Reverse Power Control (RPC) Channels. The RA Channel and each RPC Channel are assigned a unique 64-ary Walsh cover. The RA Channel and RPC Channel 64-ary Walsh covers representing the information bit to be transmitted are Walsh summed.

The Signal Studio software allows the RA Channel to be activated or de-activated in each of the sixteen timeslots. The RA Channel information bit can be set to 0 or 1 in each of the 16 timeslots. In addition, the channel gain (relative to the Pilot Channel) can be specified via the pull-down menu in each of the 16 timeslots.

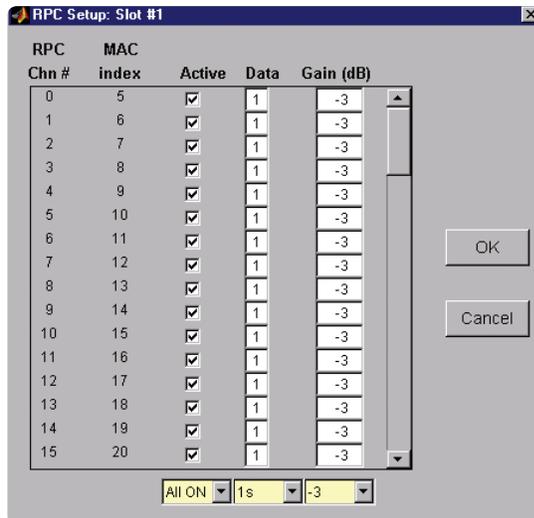


Figure 6. Signal Studio-1xEV forward link reverse power control setup table for slot #1.

## MAC reverse power control channel

The MAC RPC Channel can also be optionally activated in each timeslot. If the RPC Channel is activated in a timeslot, selecting the slot number button in the MAC RPC Channel Setup column produces a RPC Setup table, figure 6. The structure of the RPC Setup table is very similar to the Slot Setup table discussed previously, except that there are 59 possible entries for each timeslot.

These 59 RPC Channels can be individually configured for the selected timeslot. Each channel that is activated will eventually be Walsh summed with the RA Channel (if active) in the same timeslot to make up the MAC Channel. Each RPC Channel carries a single power control data bit per timeslot to a unique active access terminal. The access terminal will raise or lower power depending on whether a '0' or a '1' data bit is sent respectively. In the RPC Setup table, the data bit for each active RPC Channel can be individually defined. Additionally, the channel gain (relative to Pilot Channel) can be defined via the pull-down menu for each active RPC Channel.

### Continuous pilot operating mode

In Continuous Pilot operating mode, the Pilot Channel is continuously active over the entire 1xEV-DO frame. Instead of two Pilot Channel bursts occurring in each timeslot, the Pilot Channel is continuously active. In this mode of operation, the Pilot Channel is the only available channel type. The Continuous Pilot operating mode provides a fundamental test signal to be used as a troubleshooting tool to verify basic operation of the device under test.

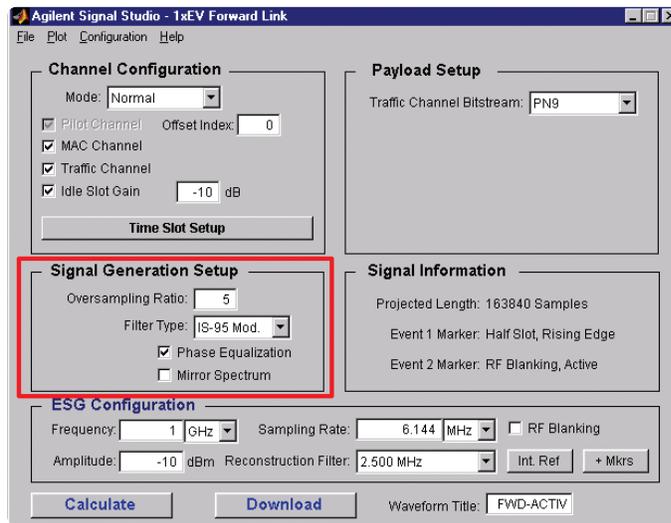


Figure 7. Signal Studio-1xEV forward link signal generation setup menu.

## Step 2 - Setup the signal generation parameters

The Signal Generation Setup menu shown in figure 7 provides a simple interface for defining the oversampling ratio, configuring the baseband filtering, and inverting the Q channel.

### Oversampling ratio

The oversampling ratio defines the number of samples calculated per I/Q symbol. Increasing the oversampling ratio of the constructed signal increases the separation of the sampling images from the desired signal. This allows for better image rejection by the baseband reconstruction filters. However, the improved image rejection comes with a price. Increasing the oversampling ratio increases the waveform calculation time and file size. Notice that the projected file length in the Signal Information section is updated as the oversampling ratio setting is increased.

For more information on reconstruction filters and oversampling ratio, refer to [4] or the ESG Family Signal Generator Option UND Dual Arbitrary Waveform Generator User's and Programming Guide.

### Baseband filtering

There are three selections available for baseband filtering in the Filter Type pull-down menu: None, IS-95 Standard, and IS-95 Modified. The IS-95 Modified filter provides

improved adjacent channel performance compared to the IS-95 Standard filter.

Phase Equalization filtering can also be optionally activated in the Forward Link. The phase equalization filter acts as a pre-distortion filter to correct for delay distortion across the frequency band of interest.

### Mirror spectrum

Enabling the Mirror Spectrum feature inverts the Q channel, resulting in a mirrored spectrum. As a signal propagates normally through the different functional blocks of a receiver, for example the mixer block, the signal spectrum may be inverted. Using this feature facilitates realistic testing of receiver functional blocks that would normally be presented with a mirrored spectrum signal. It should also be noted that when generating signals at IF frequencies below 250 MHz, the ESG swaps the I and Q channels, resulting in a mirrored spectrum. This occurs because carriers in the 250 kHz to 250 MHz band of the ESG are created by mixing down from higher synthesized frequencies. To compensate for this effect, the user can connect the I and Q out connectors on the rear panel of the ESG to the Q and I in connectors on the front panel, respectively. Alternatively, the user can enable the Signal Studio-1xEV Mirror Spectrum feature.

### Step 3 - Configure the ESG

Along with the configured 1xEV-DO waveform, the Signal Studio software passes instrument settings to the ESG digital series RF signal generator. These settings include frequency, amplitude, sampling rate, reconstruction filter, RF blanking, internal/external reference frequency, and marker polarity. Each setting is defined in the ESG Configuration menu shown in figure 8.

#### Frequency

This parameter defines the frequency at which the ESG will generate the signal.

#### Amplitude

This parameter defines the power at which the ESG will generate the signal.

#### Sampling rate

This parameter sets the rate at which the waveform I/Q samples are read from the dual arbitrary waveform generator memory during playback. It is automatically set when the oversampling ratio is defined in the Signal Generation Setup menu.

#### Reconstruction filter

The ESG provides three reconstruction filters (250 kHz, 2.5 MHz, 8 MHz) and a no filter option (through). The bandwidth of the baseband signal ( $1/2$  the RF bandwidth) dictates the minimum reconstruction filter bandwidth to be used (614.4 kHz for 1xEV-DO). Depending on the oversampling ratio and where the image frequencies appear, a wider bandwidth reconstruction filter may be selected. The default value (2.5 MHz) should not be modified unless there is a specific reason to do so. For more information on reconstruction filters refer to [4].

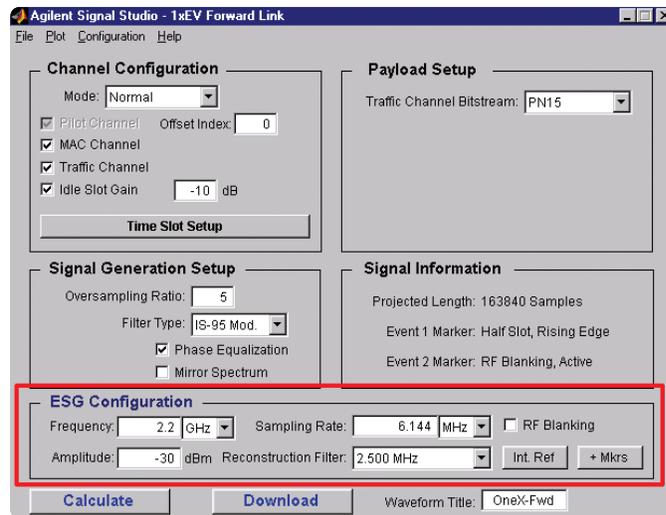


Figure 8. Signal Studio-1xEV forward link ESG configuration menu.

#### RF blanking

RF Blanking improves the signal quality when the MAC Channel and/or Traffic Channel are deactivated in a timeslot. It does so by increasing the on/off ratio of the Forward Link RF bursts. (Recall that the MAC Channel and Traffic Channel are time division multiplexed in each Forward Link frame timeslot.) The ESG Event 2 marker is internally routed to provide the RF Blanking signal.

Note: When RF Blanking is enabled, the Marker Polarity must be set to positive or the wanted RF signal will be blanked resulting in no RF output from the ESG.

#### Internal/external reference frequency

This field sets reference frequency for the ESG dual arbitrary baseband generator to internal or external. If an external reference is used, it should be connected to the ESG before the waveform and instrument settings are downloaded to the instrument.

#### Marker polarity

This field sets the polarity of the ESG Event 1 and Event 2 markers. As indicated in the Signal Information section of the Forward Link configuration window, the Event 1 marker rising edge occurs on each half-slot boundary. When RF Blanking is activated, the Event 2 marker is internally routed to provide access to the RF Blanking signal. Access to these signals is provided on the Event 1 and Event 2 ports on the rear panel of the ESG.

## Step 4 - Calculate & download

Once the waveform and ESG settings have been configured, the final step is to calculate the waveform and download it to the instrument, figure 9.

### Waveform naming

First name the waveform in the Waveform Title field. This is the name that will appear in the ESG dual arbitrary waveform generator user interface after the waveform is downloaded to the instrument. The ESG *only* recognizes waveforms that are named using the following alphanumeric characters:

- A thru Z
- 0 thru 9
- \$ & \_ # + - [ ]

If un-supported alphanumeric characters are used to name the waveform, the ESG will generate a File Name Not Found Error (Error: -256) when the waveform is downloaded to the instrument. There is a 20-character maximum name length for waveform files.

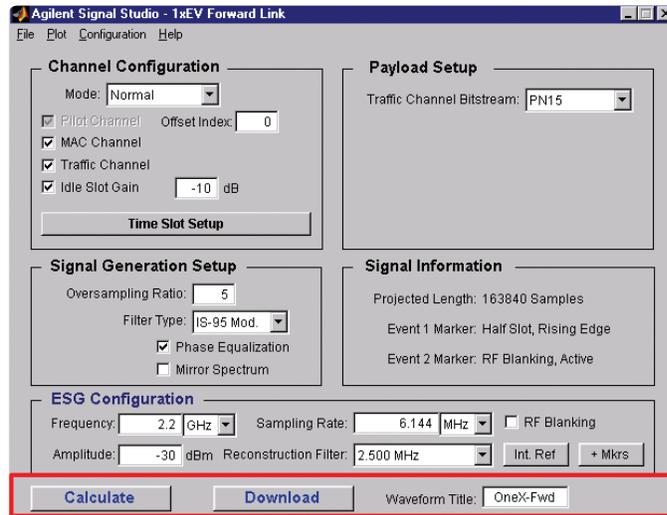


Figure 9. Signal Studio-1xEV forward link calculate and download menu.

### Waveform calculation

To initiate waveform calculation, select the Calculate button. The software will generate an I/Q waveform file in accordance with the current Channel Configuration and Signal Generation Setup. Waveform calculation typically takes only a few seconds.

## Plotting I/Q signals, spectrum, and CCDF curves

After the I/Q waveform has been calculated, the Signal Studio software can generate a plot of the base-band spectrum and the I/Q waveforms. To plot the spectrum, choose Plot → Spectrum from the menu keys at the top of the window, figure 10. The plot can be magnified using the zoom feature in the Tools pull-down menu at the top of the plot. Simply select the zoom feature and use the mouse pointer to select the section of the plot to be affected. Plots of the I/Q waveforms and CCDF curves can be generated in a similar manner.

### Downloading to the ESG

Select the Download button, figure 9, to send the calculated I/Q waveform file representing the Forward Link frame and the signal generator setting to the instrument. The signal generator automatically begins producing the 1xEV-DO RF signal. Local control of the instrument is then re-enabled and signal generator settings can be modified from the instrument's front panel. If the instrument is in its initial start-up state or in another personality prior to downloading a waveform from Signal Studio, it may be helpful (but not necessary) to set the ESG into Dual Arb Mode. This will reduce confusion because after the waveform has been downloaded to the signal generator, the waveform name and state of the instrument is clearly labeled in the Dual Arb user interface shown in figure 17. Only the instrument settings can be modified from the signal generator's front panel, the waveform files themselves cannot be modified once they have been downloaded to the instrument.

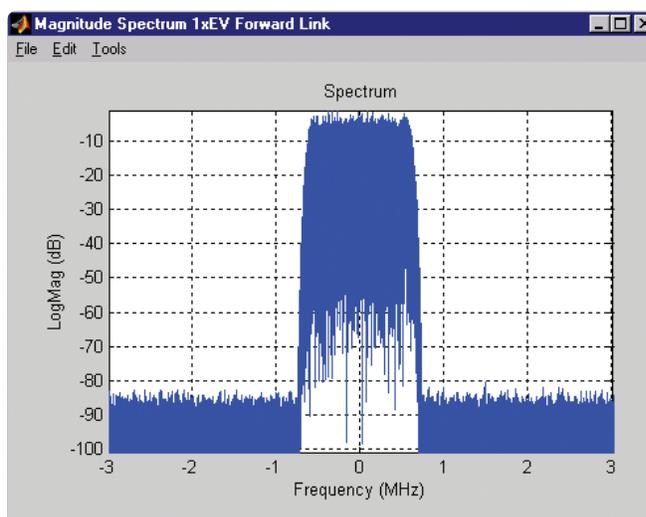


Figure 10. Spectrum plot of 1xEV-DO forward link I/Q waveform.

### Saving software configurations

The Signal Studio-1xEV software configuration can be saved to the host computer's local hard drive. The configuration can then be recalled at any time to re-calculate and download the waveform to the signal generator. This is especially useful when complex frame configurations have been created in the software. From the menu keys at the top of the window in figure 9, choose File → Save As, and then name the file and save it in the ESG-B/OneXFwd directory. The software configuration can be recalled anytime by choosing the following menu options: File → Open, then the file name.

### Saving waveforms in the ESG

After the calculated I/Q waveform has been downloaded to the signal generator for playback, it can be saved in the instrument's non-volatile memory for storage and recalled at anytime for playback. For more information on saving waveforms to the instrument, refer to the ESG Family Signal Generator Option UND Dual Arbitrary Waveform Generator Users and Programming Guide. The I/Q waveform files created by the Signal Studio software cannot be stored outside the instrument.

### Sequencing waveforms

The ESG dual arbitrary waveform generator is capable of sequencing several waveform segments. If multiple 1xEV-DO waveform files are configured and downloaded to the instrument, custom frame sequences can be created. Setting up waveform sequences is accomplished through the ESG dual arbitrary waveform generator user interface, not in the Signal Studio software. For more information on setting up waveform sequencing, refer to the ESG Family Signal Generator Option UND Dual Arbitrary Waveform Generator Users and Programming Guide.

### Reverse link channel structure

In the 1xEV-DO Reverse Link, physical channels are not time division multiplexed within each timeslot. Instead, each frame timeslot contains a complex summation of physical channels. The 1xEV-DO Reverse Channel Structure as imple-

mented by the Signal Studio software is shown in figure 11. The blocks highlighted in green indicate frame configuration parameters that can be modified by the user, whereas the blocks highlighted in blue indicate fixed parameters that are

automatically implemented and cannot be modified. The Reverse Link signals created using the Signal Studio-1xEV software are fully coded, meaning that all functional stages of the Reverse Channel Structure are implemented.

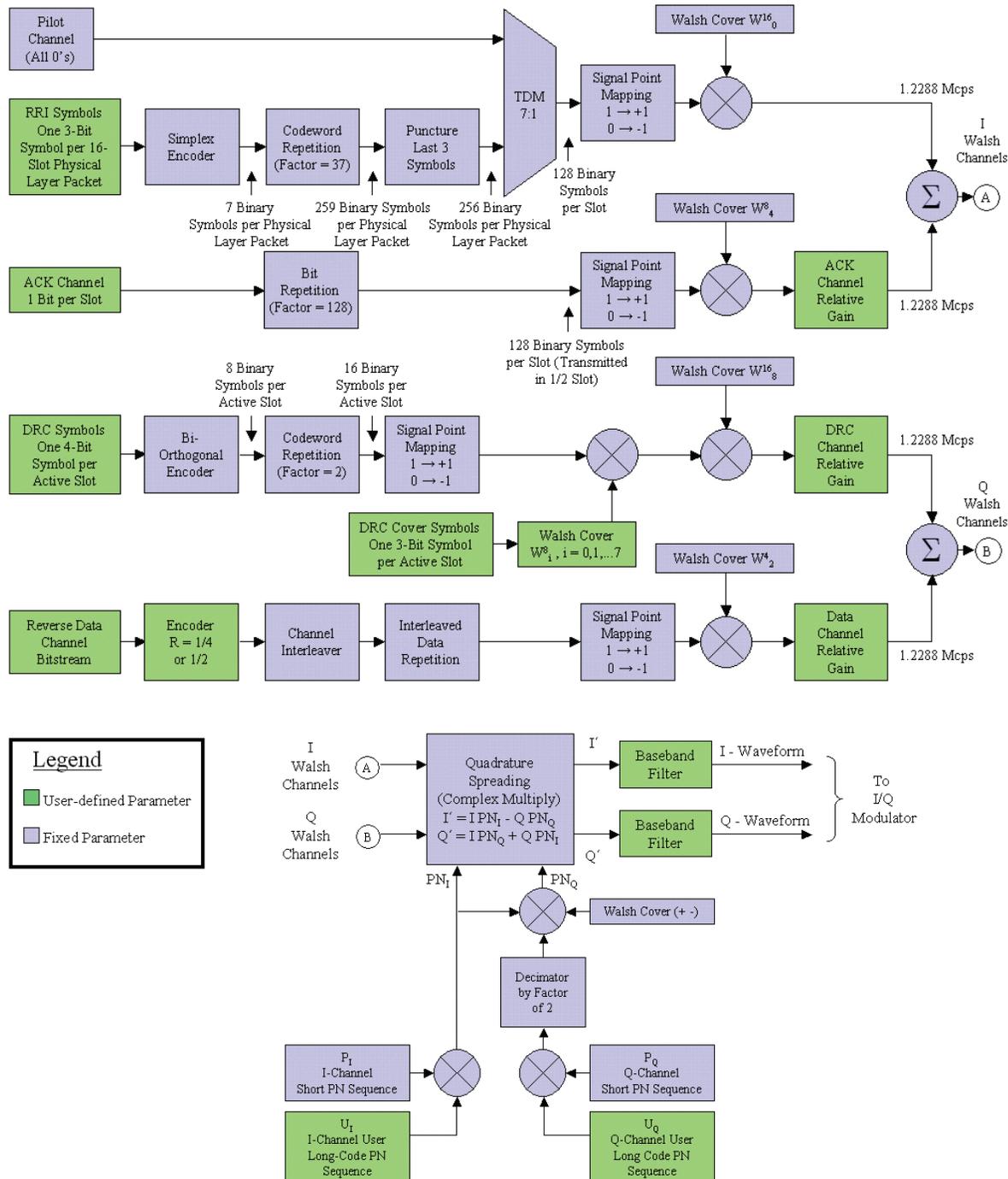


Figure 11. 1xEV-DO Reverse channel structure as implemented by Signal Studio.

### Reverse link frame configuration

Similar to the Forward Link, there are four basic steps to configuring a Reverse Link frame and generating the 1xEV-DO signal using the ESG series signal generator:

- Step 1** - Configure the reverse channels
- Step 2** - Setup the signal generation parameters
- Step 3** - Configure the ESG
- Step 4** - Calculate & download

Only Step 1 is significantly different from the four steps required to configure a forward link frame. As a result, Steps 2 – 4 will not be discussed; instead, refer to the Forward Link Frame Configuration section of this document.

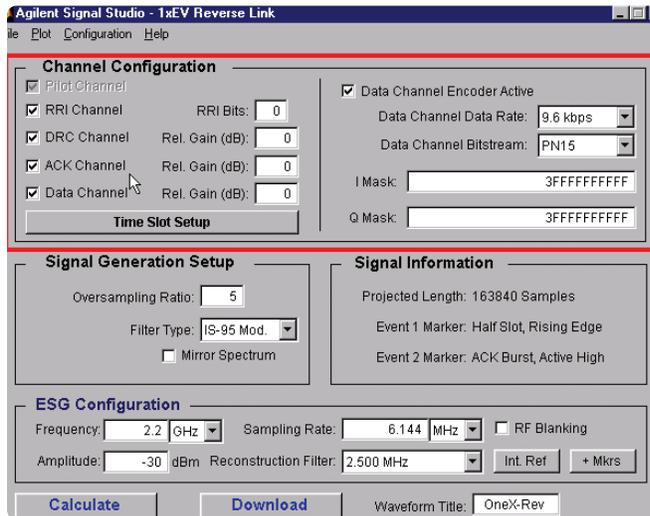


Figure 12. Signal Studio-1xEV reverse link channel configuration menu.

### Step 1 - Configure the reverse link channel

The Channel Configuration menu, boxed in figure 12, provides an easy-to-use graphical interface for constructing a 1xEV-DO frame with custom channel configurations in each of the frame's sixteen timeslots. The following Reverse Link channels are supported: Pilot Channel, Reverse Rate Indicator (RRI) Channel, Data Rate Control (DRC) Channel, Acknowledgement (ACK) Channel, and Data Channel.

#### Pilot channel and long-code mask

The Pilot Channel is the default active channel in every frame and appears in each timeslot. Its configuration cannot be changed. The user long-code mask, which identifies distinct Reverse Traffic Channels, is also set in the Channel Configuration menu.

#### Reverse rate indicator channel

The RRI Channel can be optionally activated by checking the box in the Channel Configuration menu. When activated, it is time division multiplexed with the Pilot Channel. The RRI 3-bit symbol, representing the rate at which the Data Channel is transmitted, is defined in the RRI Bits field. Valid entries are 0 through 7.

#### Data channel

The Data Channel can be optionally activated in the entire frame by checking the box in the Channel Configuration menu. When the Data Channel is activated, its relative gain with respect to the Pilot Channel can be specified. The Data Channel Bitstream is selected in the Channel Configuration menu. Turbo Encoding can also be optionally enabled. If encoding is enabled, the Data Channel Data Rate can be configured via the pull-down menu. The encoding rate ( $1/2$  or  $1/4$ ) and symbol repetition factor are automatically configured depending on the selected data rate. In addition, when a data rate is selected, the RRI Channel bits field in the Channel Configuration Menu is automatically updated to represent the selected data rate. When active, the Data Channel is present in each of the frame's timeslots.

### Data rate control and acknowledgement channels

The DRC and/or ACK Channel can each be optionally activated in the entire frame by checking the box in the Channel Configuration menu. If activated, the relative gain with respect to the Pilot Channel is specified in the Channel Configuration menu. Additional configuration can be accomplished by selecting the Time Slot Setup button. It brings up a configuration table in which each row represents one of the 16 time-slots in a 1xEV-DO frame. The columns of the table are labeled and grouped as to which parameter they represent and what physical channel is being configured, figure 13. The bottom row of pull down menus (highlighted in yellow) provides Fast Edit capabilities to simplify frame configuration. The channel parameter specified in a Fast Edit field is set in all sixteen timeslots (the entire column).

The ACK Channel can be activated (or de-activated) in each timeslot. In a 1xEV-DO system, a '0' bit (acknowledgement) is transmitted on the ACK Channel if a Forward Traffic Channel physical layer packet was successfully received from the access network. If the physical layer packet was not successfully received from the access network, a '1' bit (no acknowledgement) is transmitted. To simulate this, the information bit to be transmitted can be individually configured in each timeslot with an active ACK Channel.

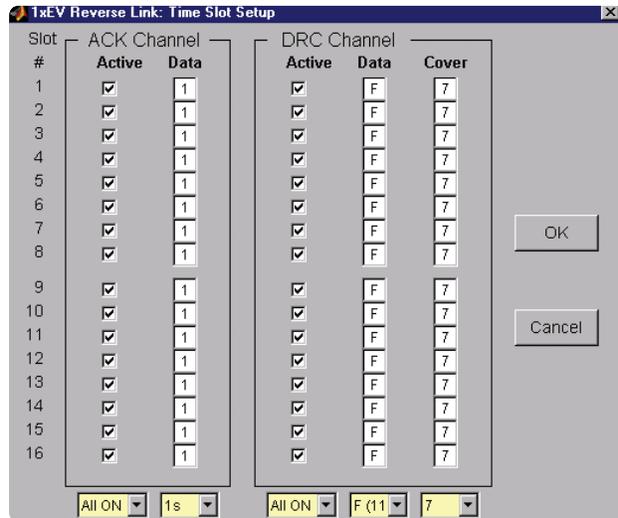


Figure 13. Signal studio-1xEV reverse link time slot setup table.

The DRC Channel is also optionally activated in each timeslot. The 4-bit DRC value indicating the selected serving sector and the requested data on the Forward Traffic Channel can be uniquely configured in each of the sixteen timeslots. Furthermore, the 8-ary Walsh Cover can be individually configured in each timeslot.

## Examples of basic measurements

The Signal Studio-1xEV software, ESG digital series signal generator and E4406A Vector Signal Analyzer (VSA) combine to provide a powerful test solution for the development and manufacturing of 1xEV products as shown figure 14. Although the VSA does not have a 1xEV test personality, it can perform many fundamental RF tests in basic operating mode, including: Channel Power, Adjacent Channel Power (ACP), Complementary Cumulative Distribution Function (CCDF), and Power vs. Time. To illustrate how these tests can be performed, two examples are shown: Channel Power and ACP. Instrument instructions for performing basic measurements are provided in Tables 1-4. Keystrokes surrounded by [ ] indicate hard keys located on the instrument front panel. Keystrokes surrounded by { } indicate soft keys located on the right side of the display.

### Channel power

The channel power measurement is the average power in the frequency bandwidth of the signal and is typically defined as power integrated over the frequency band. Table 1 defines the keystrokes for presetting the instrument.

1. Setup the Signal Studio-1xEV forward Link for active slot transmission as shown in figure 15.
  - a. Set the channel configuration menu:
    - Activate the MAC channel
    - Activate the traffic channel
    - Select PN9 for the forward traffic bitstream
  - b. Set the ESG configuration menu:
    - Set the frequency to 1 GHz
    - Set the amplitude to -10dBm
    - Enter “FWD-Active” in the waveform title field

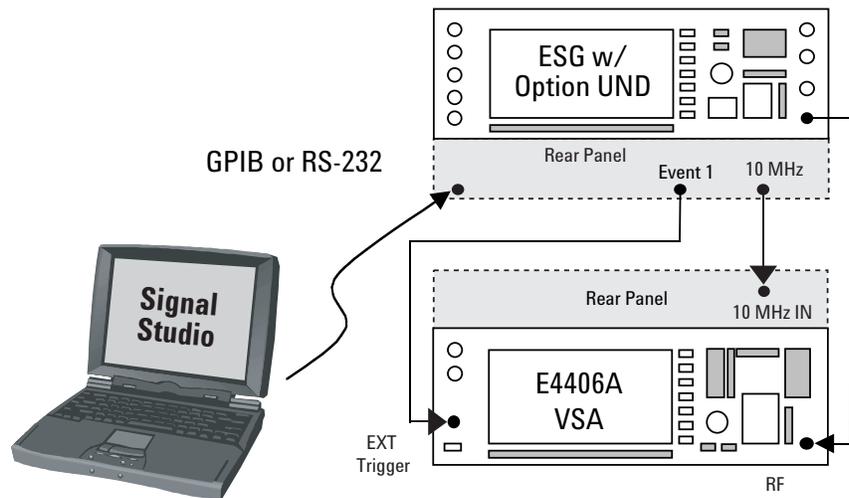


Figure 14. Connection diagram for downloading Signal Studio waveforms to the ESG digital series RF signal generator and performing measurements using the Agilent E4406A Vector Signal Analyzer.

Table 1. Instrument Preset.

Instructions: ESG-D series signal generator	Keystrokes: ESG-D series signal generator
Preset the instrument	[Preset]

To simplify the setup, the default Time Slot Setup and RPC Channel configuration table settings are used.

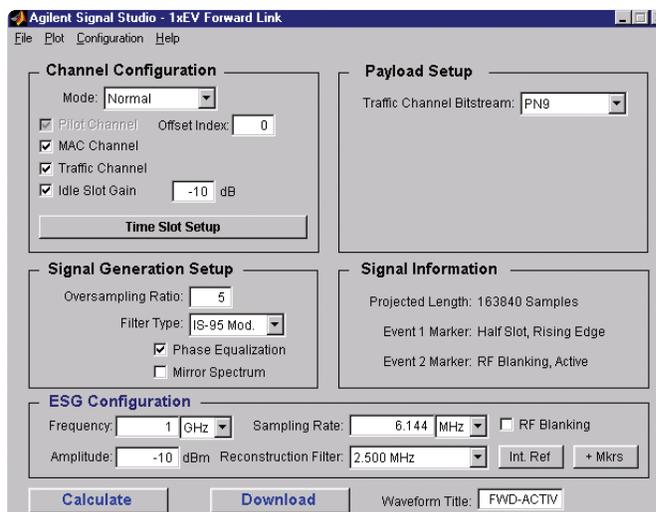


Figure 15. Signal studio setup for generic active slot transmission.

- Calculate and Download the 1xEV-DO Forward Link I/Q waveform to the ESG digital series signal generator. The window shown in figure 16 appears after a successful download.



Figure 16. Successful waveform download indicator.

The signal generator is now generating the 1xEV-DO modulated RF signal.

Table 2. Waveform download verification

Instructions: ESG-D series signal generator	Keystrokes: ESG-D series signal generator
Verify that active slot waveform is being generated, figure 17.	[Mode] {Arb Waveform Generator} {Dual Arb}

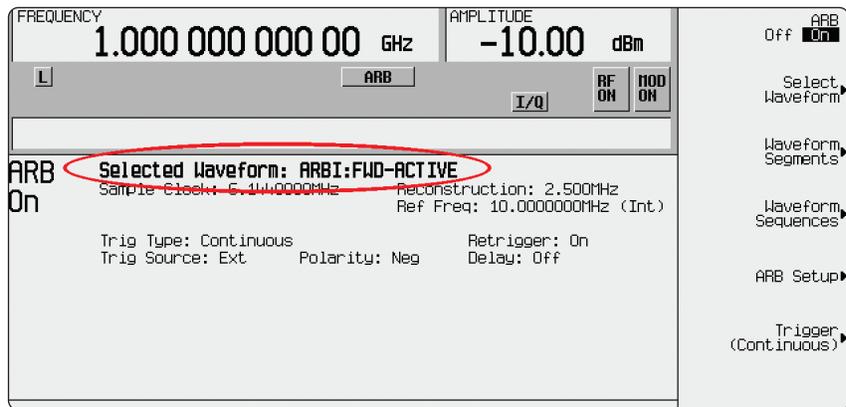


Figure 17. ESG dual arbitrary waveform generator user interface.

- Perform the channel power measurement using the vector signal analyzer.

Table 3. Instrument preset, channel power, and number averages.

Instructions: E4406A VSA	Keystrokes: E4406A VSA
Preset the instrument	[Preset]
Make the channel power measurement	[Measure] {Channel Power}
Set the number of averages to 100, figure 18	[Meas Setup] {Avg Number} [100] [Enter] {Avg Mode Exp/Repeat}

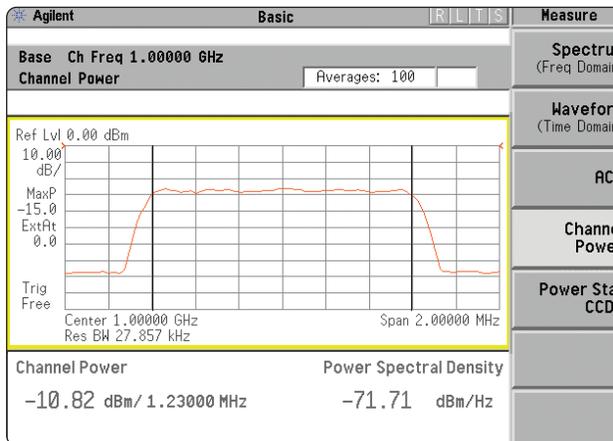


Figure 18. E4406A VSA channel power measurement.

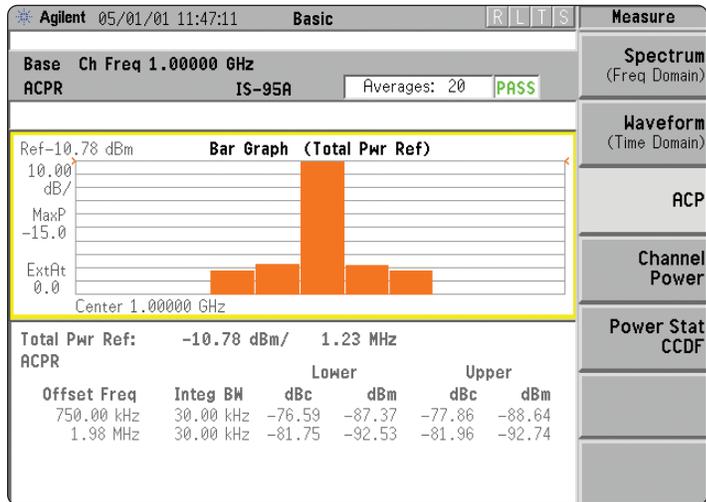
## Adjacent channel power (ACP)

Using the same Signal Studio waveform configured for the Channel Power measurement, ACP can be measured for active slot transmission.

The ACP measurement is typically defined as the ratio of the average power in the adjacent frequency channel to the average power in the transmitted frequency channel. ACP is usually measured at multiple offsets (adjacent and alternate channels).

**Table 4. Instrument preset and ACP measurement.**

Instructions: E4406A VSA	Keystrokes: E4406A VSA
Preset the instrument	[Preset]
Make the ACP Measurement, figure 19	[Measure] {ACP}



**Figure 19. ACP bar graph for 1xEV-DO active slot transmission.**

## Signal Studio-1xEV data sheet

### Forward link

Pilot channel	PN Offset Index: 0 to 511 Selectable Mode: Continuous or Bursted
MAC channel	
Reverse Activity	Data: 0 or 1 Gain relative to Pilot: -30 dB to -30 dB
Reverse Power Control (Up to 59 RPC Channels)	Data: 0 or 1 Gain relative to Pilot: -30 dB to +30 dB
Traffic channel	Data Bitstream: 0s, 1s, 01s, 10s, PN9, PN15 Modulation Type: QPSK, 8-PSK, 16-QAM
Idle slot gain	Noise Level relative to Pilot: 0 dB to -80 dB
Filter types	Rectangular, IS-95 Standard, IS-95 Modified (improved ACP), Phase Equalization
Oversampling ratio	Valid Range: 2 to 30

### Reverse link

Pilot Channel	
Reverse Rate Indicator channel	Data: 0 to 7 Octal
Data Rate Control channel	Data: 0 to F Hexadecimal Walsh Cover Index: 0 to 7 Gain relative to Pilot: -30 dB to +30 dB
ACK channel	Data: 0 or 1 Gain relative to Pilot: -30 dB to +30 dB
Traffic channel	Data Bitstream: 0s, 1s, 01s, 10s, PN9, PN15 Data Rate (kbps): 9.6, 19.2, 38.4, 76.8, 153.6 Encoding Rate: 1/4 Rate @ 9.6, 19.2, 38.4, 76.8 kbps 1/2 Rate @ 153.6 kbps Modulation Type: BPSK
I & Q Mask (42-bit)	Valid Range: 0000000000 to 3FFFFFFF
Filter types	Rectangular, IS-95 Standard, IS-95 Modified (improved ACP)
Oversampling ratio	Valid Range: 2 to 30

### Acronym list

<b>1xEV</b>	-	cdma2000 1x Evolution
<b>1xEV-DO</b>	-	cdma2000 1x Evolution for Data Only
<b>8-PSK</b>	-	8-ary Phase-Shift Keying
<b>16-QAM</b>	-	16-Level Quadrature Amplitude Modulation
<b>ACK</b>	-	Acknowledgement
<b>ACP</b>	-	Adjacent Channel Power
<b>BER</b>	-	Bit-Error-Rate
<b>CCDF</b>	-	Complementary Cumulative Distribution Function
<b>dBm</b>	-	Decibels relative to 1 milliwatt
<b>DRC</b>	-	Data Rate Control
<b>FER</b>	-	Frame-Error-Rate
<b>GHz</b>	-	Gigahertz
<b>GPIB</b>	-	General Purpose Interface Board
<b>IF</b>	-	Intermediate Frequency
<b>MAC</b>	-	Medium Access Control
<b>NAK</b>	-	No Acknowledgement
<b>PN</b>	-	Pseudorandom Noise
<b>PN9</b>	-	Pseudorandom Noise of period $2^9 - 1$
<b>PN15</b>	-	Pseudorandom Noise of period $2^{15} - 1$
<b>QPSK</b>	-	Quadrature Phase-Shift Keying
<b>RA</b>	-	Reverse Activity
<b>RF</b>	-	Radio Frequency
<b>RPC</b>	-	Reverse Power Control
<b>RRI</b>	-	Reverse Rate Indicator
<b>VSA</b>	-	Vector Signal Analyzer

## Additional Literature

- [1] *Signal Studio Installation Guide* Available at:  
[www.agilent.com/find/signalstudio](http://www.agilent.com/find/signalstudio)
- [2] *Agilent ESG Family of RF Signal Generators - Data Sheet*  
Literature Number 5965-3096E
- [3] *Agilent ESG Family/RF Signal Generators - Configuration Guide*  
Literature Number 5965-4973E
- [4] *Generating Digital Modulation with the Agilent ESG-D Series Dual Arbitrary Waveform Generator*  
Literature Number 5966-4097E

## References

TIA/EIA/IS-856 Standards

Recommended Minimum Performance Standards for cdma2000 High Rate Packet Data Access Network (Initial Revision)

Recommended Minimum Performance Standards for cdma2000 High Rate Packet Data Access Terminal (Initial Revision)

## Ordering Information

Signal Studio-1xEV is Option 404 for the Agilent ESG digital series signal generators.

### ESG-D: Standard Models

- E4430B** - ESG-D series RF signal generator, 1 GHz
- E4431B** - ESG-D series RF signal generator, 2 GHz
- E4432B** - ESG-D series RF signal generator, 3 GHz
- E4433B** - ESG-D series RF signal generator, 4 GHz

### ESG-DP: High spectral purity models

- E4434B** - ESG-DP series RF signal generator, 1 GHz
- E4435B** - ESG-DP series RF signal generator, 2 GHz
- E4436B** - ESG-DP series RF signal generator, 3 GHz
- E4437B** - ESG-DP series RF signal generator, 4 GHz

The Signal Studio software requires that the ESG is equipped with the optional dual arbitrary waveform generator (Option UND). Firmware Revision B.03.75 or greater is required to activate the License Key on the ESG signal generator.

### Try before you buy!

Go to [www.agilent.com/find/signalstudio](http://www.agilent.com/find/signalstudio) and download Signal Studio to your PC. Only the signal configuration and plotting capabilities of the software can be evaluated. A license key is required to load the waveforms created by the software into the ESG digital series signal generator. The license key can be ordered through your sales engineer or local sales office, which can be found at [www.agilent.com/find/assist](http://www.agilent.com/find/assist)

### Upgrade kits

If you currently own an ESG with Option UND (dual arbitrary waveform generator) and are interested in obtaining an upgrade kit only (license key), order E4430 BK Option 404 for the ESG digital series RF signal generator.

### **Agilent Technologies' Test and Measurement Support, Services, and Assistance**

Agilent Technologies aims to maximize the value you receive, while minimizing your risk and problems. We strive to ensure that you get the test and measurement capabilities you paid for and obtain the support you need. Our extensive support resources and services can help you choose the right Agilent products for your applications and apply them successfully. Every instrument and system we sell has a global warranty. Support is available for at least five years beyond the production life of the product. Two concepts underlie Agilent's overall support policy: "Our Promise" and "Your Advantage."

#### **Our Promise**

Our Promise means your Agilent test and measurement equipment will meet its advertised performance and functionality. When you are choosing new equipment, we will help you with product information, including realistic performance specifications and practical recommendations from experienced test engineers. When you use Agilent equipment, we can verify that it works properly, help with product operation, and provide basic measurement assistance for the use of specified capabilities, at no extra cost upon request. Many self-help tools are available.

#### **Your Advantage**

Your Advantage means that Agilent offers a wide range of additional expert test and measurement services, which you can purchase according to your unique technical and business needs. Solve problems efficiently and gain a competitive edge by contracting with us for calibration, extra-cost upgrades, out-of-warranty repairs, and on-site education and training, as well as design, system integration, project management, and other professional engineering services. Experienced Agilent engineers and technicians worldwide can help you maximize your productivity, optimize the return on investment of your Agilent instruments and systems, and obtain dependable measurement accuracy for the life of those products.

**By internet, phone, or fax, get assistance with all your test & measurement needs**

**Online assistance:**

[www.agilent.com/find/assist](http://www.agilent.com/find/assist)

**Phone or Fax**

**United States:**

(tel) 1 800 452 4844

**Canada:**

(tel) 1 877 894 4414

(fax) (905) 282 6495

**China:**

(tel) 800 810 0189

(fax) 1 0800 650 0121

**Europe:**

(tel) (31 20) 547 2323

(fax) (31 20) 547 2390

**Japan:**

(tel) (81) 426 56 7832

(fax) (81) 426 56 7840

**Korea:**

(tel) (82 2) 2004 5004

(fax) (82 2) 2004 5115

**Latin America:**

(tel) (305) 269 7500

(fax) (305) 269 7599

**Taiwan:**

(tel) 080 004 7866

(fax) (886 2) 2545 6723

**Other Asia Pacific Countries:**

(tel) (65) 375 8100

(fax) (65) 836 0252

Email: [tm\\_asia@agilent.com](mailto:tm_asia@agilent.com)

**Product specifications and descriptions in this document subject to change without notice.**

**© Agilent Technologies, Inc. 2002**

**Printed in USA January 31, 2002**

**5988-3636EN**



**Agilent Technologies**