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User Guide

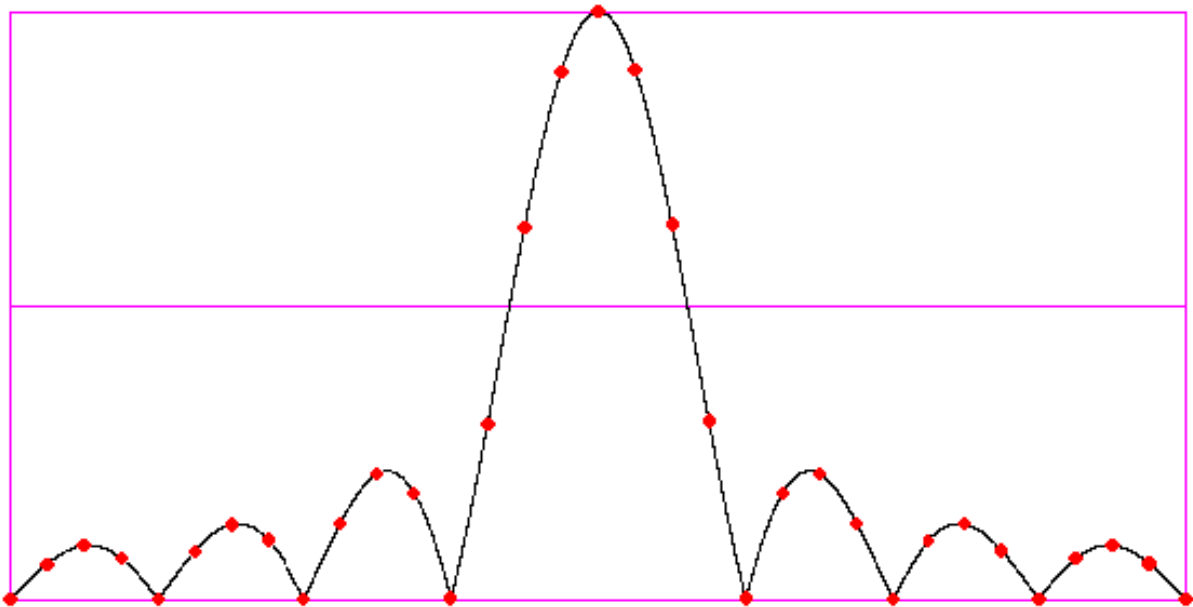
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# Option 10

## Complex Modulation

Waveform Download Software for the MG3690A/B/C Series  
Synthesized Signal Generator



**Anritsu**

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# Table of Contents

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## Chapter 1—General Information and Setup

|     |   |     |
|-----|---|-----|
| 1-1 | Introduction . . . . .                            | 1-1 |
| 1-2 | Description . . . . .                             | 1-1 |
| 1-3 | Related Manuals . . . . .                         | 1-1 |
| 1-4 | Required Equipment . . . . .                      | 1-2 |
|     | GPIB Communication . . . . .                      | 1-2 |
|     | Serial Communication . . . . .                    | 1-2 |
| 1-5 | Program Installation . . . . .                    | 1-3 |
| 1-6 | Complex Modulation Interface . . . . .            | 1-4 |
| 1-7 | Communications Setup . . . . .                    | 1-5 |
|     | Instrument Setup . . . . .                        | 1-5 |
|     | Serial Communications Setup . . . . .             | 1-6 |
|     | GPIB Communications Setup . . . . .               | 1-7 |
|     | Saving/Canceling a Communications Setup . . . . . | 1-7 |

## Chapter 2—Operation

|      |   |      |
|------|---|------|
| 2-1  | Introduction . . . . .                          | 2-1  |
| 2-2  | Complex Modulation Interface . . . . .          | 2-1  |
|      | Opening the Program . . . . .                   | 2-1  |
|      | Additional Modulation Mode Options . . . . .    | 2-3  |
| 2-3  | SCAN Modes . . . . .                            | 2-3  |
| 2-4  | FM/PM Modes . . . . .                           | 2-3  |
|      | Internal Frequency Modulation Options . . . . . | 2-3  |
|      | External Frequency Modulation Options . . . . . | 2-5  |
|      | Internal Phase Modulation Options . . . . .     | 2-6  |
|      | External Phase Modulation Options . . . . .     | 2-7  |
| 2-5  | AM Modes . . . . .                              | 2-8  |
|      | Internal Amplitude Modulation Options . . . . . | 2-8  |
|      | External Amplitude Modulation Options . . . . . | 2-9  |
| 2-6  | Pulse Modes . . . . .                           | 2-9  |
|      | Internal Pulse Options . . . . .                | 2-9  |
|      | External Pulse Options . . . . .                | 2-12 |
| 2-7  | Waveform Information Menu . . . . .             | 2-12 |
| 2-8  | Synchronization . . . . .                       | 2-13 |
|      | Synchronize Function Generators . . . . .       | 2-13 |
|      | Synchronize Randomizers . . . . .               | 2-14 |
| 2-9  | Sending the Configuration . . . . .             | 2-14 |
| 2-10 | Saving/Recalling a Configuration . . . . .      | 2-14 |
| 2-11 | Signal Generator Reset . . . . .                | 2-14 |

## Table of Contents (Continued)

---

|      |   |      |
|------|---|------|
| 2-12 | Complex Modulation Waveform Editor . . . . .      | 2-15 |
|      | Opening the Program . . . . .                     | 2-15 |
|      | Waveform Information . . . . .                    | 2-15 |
|      | Drawing or Editing a Waveform . . . . .           | 2-17 |
|      | Saving/Recalling a Waveform . . . . .             | 2-18 |
|      | Sample Waveforms . . . . .                        | 2-19 |
| 2-13 | Creating Waveforms with Microsoft Excel . . . . . | 2-20 |
|      | Excel Hints . . . . .                             | 2-20 |
|      | Sample Spreadsheets . . . . .                     | 2-20 |
| 2-14 | Complex Modulation Clean-up Utility . . . . .     | 2-22 |
|      | Opening the Program . . . . .                     | 2-22 |
|      | Cleaning up a File . . . . .                      | 2-22 |

### Chapter 3—Programming

|     |                                  |     |
|-----|----------------------------------|-----|
| 3-1 | Introduction . . . . .           | 3-1 |
| 3-2 | Communications . . . . .         | 3-1 |
|     | GPIB . . . . .                   | 3-1 |
|     | Serial . . . . .                 | 3-1 |
|     | Waveform Data Transfer . . . . . | 3-1 |
| 3-3 | Programming Commands . . . . .   | 3-2 |
| 3-4 | Program Example . . . . .        | 3-6 |
|     | Description . . . . .            | 3-6 |
|     | Example Code . . . . .           | 3-7 |

# Chapter 1 — General Information and Setup

## 1-1 Introduction

This manual provides general information, a description of required equipment, setup procedures, operating instructions, and programming commands for Option 10–Complex Modulation capability for the MG369xA/B/C Series Synthesized Signal Generators. Throughout this manual, the terms signal generator and synthesizer are used interchangeably to refer to the instrument.

## 1-2 Description

The Option 10–Complex Modulation capability combines the use of an external computer/controller, running the software program, with the modulation capabilities of the synthesized signal generators to enable users to generate complex modulation of the RF output.

The computer/controller, running the Windows-based software program, directly controls all of the signal generator's modulation capabilities. The program supports communications with the signal generator using either the IEEE-488 General Purpose Interface Bus (GPIB) or the serial communications port.

The software comprises three separate programs:

- Anritsu Complex Modulation Interface
- Anritsu Complex Modulation Waveform Editor
- Anritsu Complex Modulation Clean-up Utility

The software provides the user with the capability to create modulation waveforms and waveform data that can be sent to the signal generator to be used as the modulating waveform for AM and/or FM/ΦM. With the waveform data loaded, the user can select which modulation type is enabled. Any combination of AM, FM/ΦM, Pulse modulation, or SCAN modulation can be selected.

## 1-3 Related Manuals

More detailed information and instructions for operating and programming the signal generators can be found in the following manuals:

**Table 1-1.** Related Manuals

| Instrument Model Number | Manual Part Number | Manual Description             |
|-------------------------|--------------------|--------------------------------|
| <b>MG369xA</b>          | 10370-10353        | Operation Manual               |
|                         | 10370-10354        | Native GPIB Programming Manual |
|                         | 10370-10359        | SCPI Programming Manual        |
|                         | 10370-10355        | Maintenance Manual             |
| <b>MG369xB</b>          | 10370-10365        | Operation Manual               |
|                         | 10370-10366        | Native GPIB Programming Manual |
|                         | 10370-10368        | SCPI Programming Manual        |
|                         | 10370-10367        | Maintenance Manual             |
| <b>MG369xC</b>          | 10370-10353        | Operation Manual               |
|                         | 10370-10354        | Native GPIB Programming Manual |
|                         | 10370-10354        | SCPI Programming Manual        |
|                         | 10370-10355        | Maintenance Manual             |

## 1-4 Required Equipment

An MG369xA/B/C series synthesized signal generator is required. The signal generator must have Option 10—Complex Modulation capability installed and enabled.

A computer running the Windows XP SP2 operating system is required with the following:

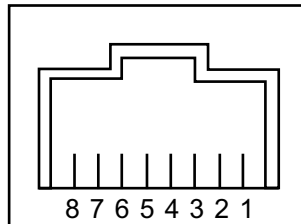
- 8 MBytes of memory, minimum
- 10 MBytes free on the primary Hard Disk Drive
- Serial or GPIB Interface

### GPIB Communication

To communicate with the signal generator via GPIB, the computer/controller must have a National Instruments GPIB interface card or GPIB adapter installed running the appropriate Windows driver software. Ensure that your GPIB interface is set up to the default configuration as per National Instruments' instructions. In addition, a standard GPIB cable must be connected between the computer/controller and the signal generator's GPIB port.

### Serial Communication

If serial communications with the signal generator is desired, the computer/controller must have a standard serial port installed and available for use by the software program. Additionally, a serial cable must be connected between the computer/controller and the signal generator serial ports. Anritsu provides a serial interface cable (part number T1678) with the installed option or a serial cable can be built using the synthesizer pinout diagram and connecting the appropriate communication lines.



1. **RXb**: Serial Data input to the Processor
2. **RXa**: Serial Data input to the Processor (for Anritsu test only—must remain open)
3. **GND**: Chassis Ground
4. Not Used
5. Not Used
6. **GND**: Chassis Ground
7. **TXa**: Serial Data output from the Processor (for Anritsu test only—must remain open)
8. **TXb**: Serial Data output from the Processor

**Figure 1-1.** Synthesizer Serial I/O Connector Pinout Diagram

## 1-5 Program Installation

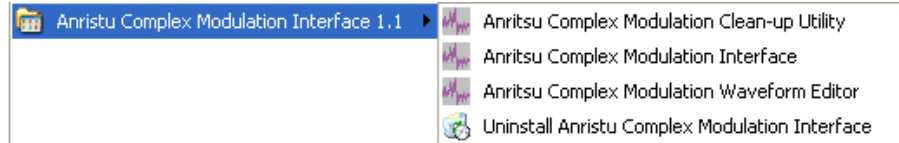
The Anritsu Complex Modulation software program is a conventional Microsoft Windows program. Installation is similar to all other such programs. Install the program as follows:

1. Download the Anritsu Complex Modulation program from the Anritsu Website Download Center:  
<https://www.anritsu.com/en-US/test-measurement/support/downloads>
2. Follow the on-screen installation instructions.

**Note** The Setup routine creates a new Program group named “Anritsu Complex Modulation Interface.” This group, [Figure 1-2](#), contains three file icons:

- Anritsu Complex Modulation Clean-up Utility (Cleanup.exe)
- Anritsu Complex Modulation Interface (Compmod.exe)
- Anritsu Complex Modulation Waveform Editor (Wave.exe).

3. Click the **Anritsu Complex Modulation Interface** program group to open the Complex Modulation Interface program options.

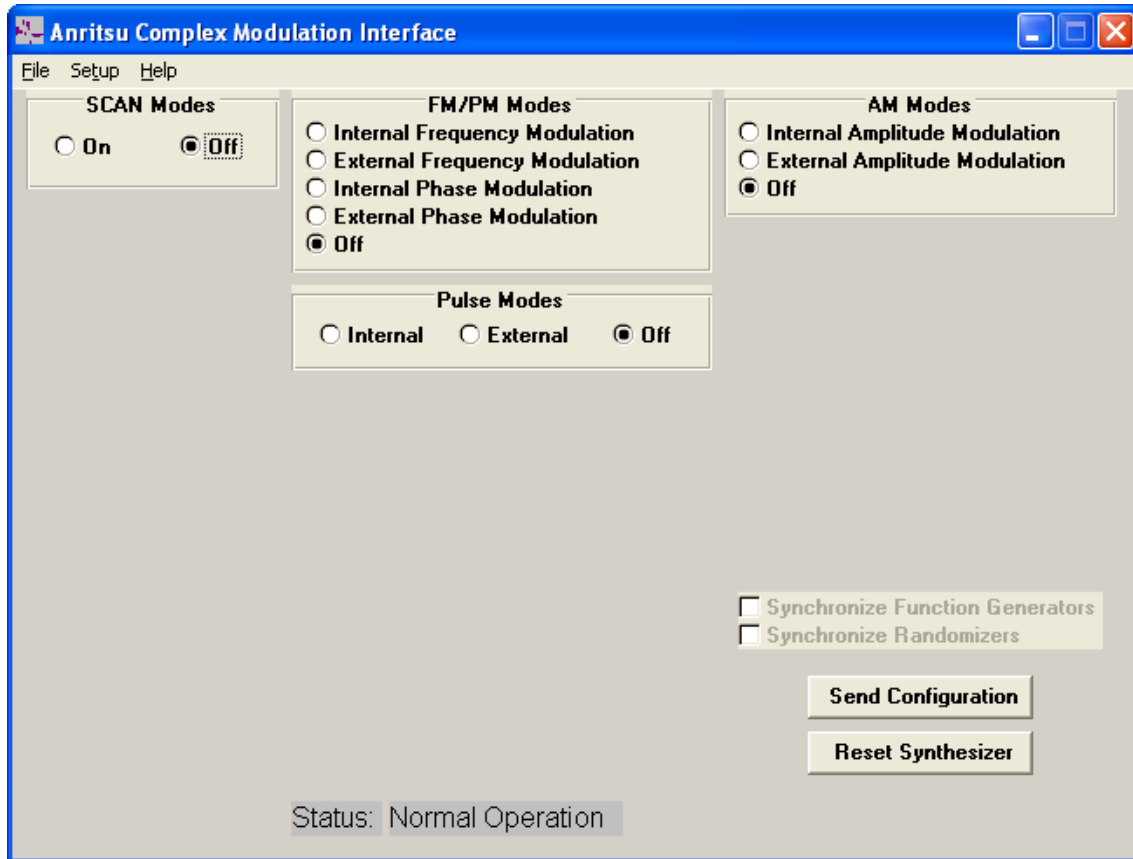


**Figure 1-2.** Anritsu Complex Modulation Interface Program Group

## 1-6 Complex Modulation Interface

The Complex Modulation Interface program controls all of the modulation capabilities of the signal generator. The program lets you perform the following:

- Set up communications with the signal generator
- Establish the synthesizer's modulation configuration
- Send the configuration to the signal generator
- Save and recall modulation configurations



**Figure 1-3.** Complex Modulation Interface Window (Default Settings)

Before beginning communications setup or modulation selections, review the program **Help** or [Chapter 2, “Complex Modulation Interface”](#) and take a few moments to acquaint yourself with the Complex Modulation Interface program. This manual provides information and instructions for operating the various program features, controls, and options.



## 1-7 Communications Setup

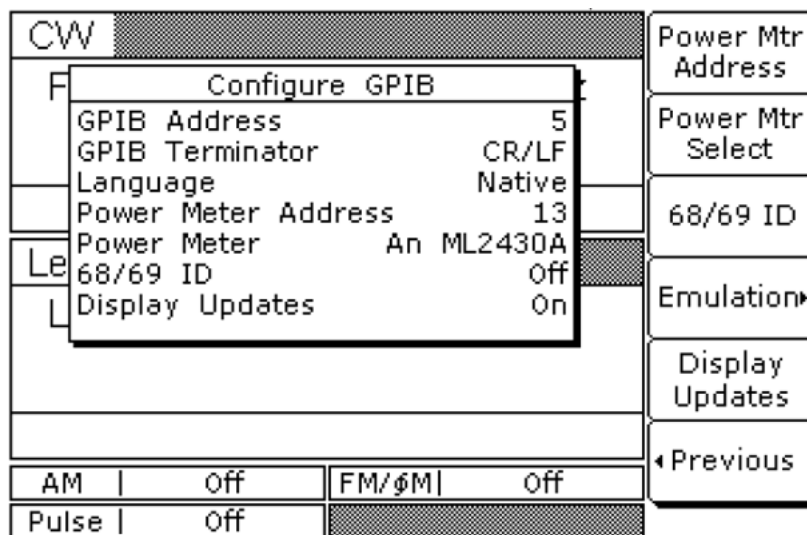
The software program supports communications with the signal generator using either GPIB or serial communications. The following procedures provide setup instructions for each communications type.

### Instrument Setup

For MG3690C users and MG3690B users with SCPI option (SM5821), the native setting must be set before using Option 10 with both, Serial or GPIB communication.

To set the Native remote communication protocol:

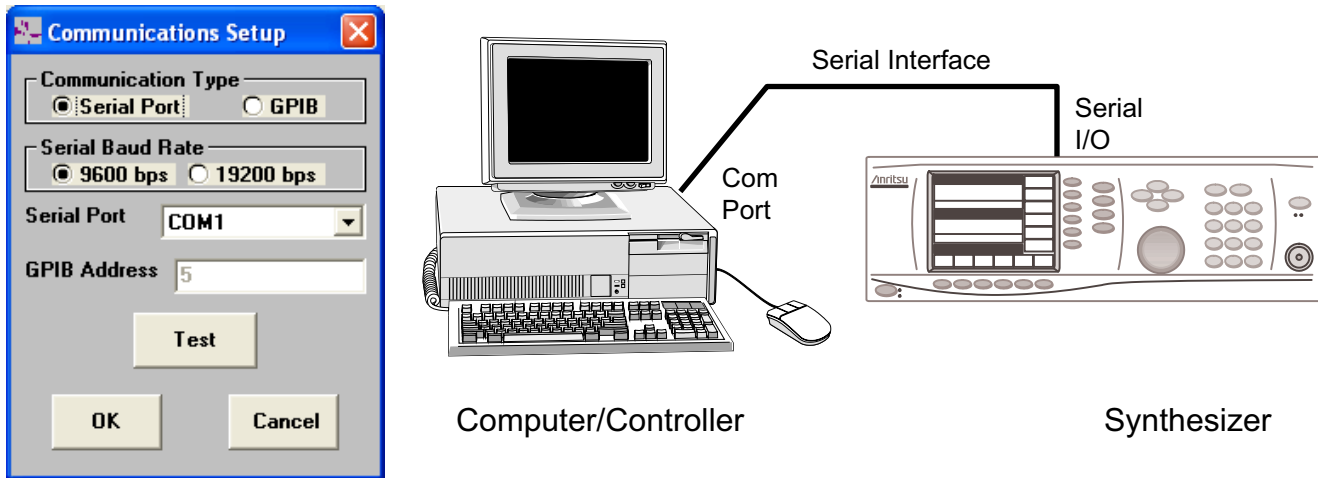
1. Press System.
2. Press Config.
3. Press GPIB.
4. Press the Native/SCPI button to toggle the Language displayed to Native as shown in [Figure 1-4](#).



**Figure 1-4.** Configure GPIB With Native Language

## Serial Communications Setup

Use the following procedure to establish serial communications with the signal generator.



**Figure 1-5.** Serial Communications Setup

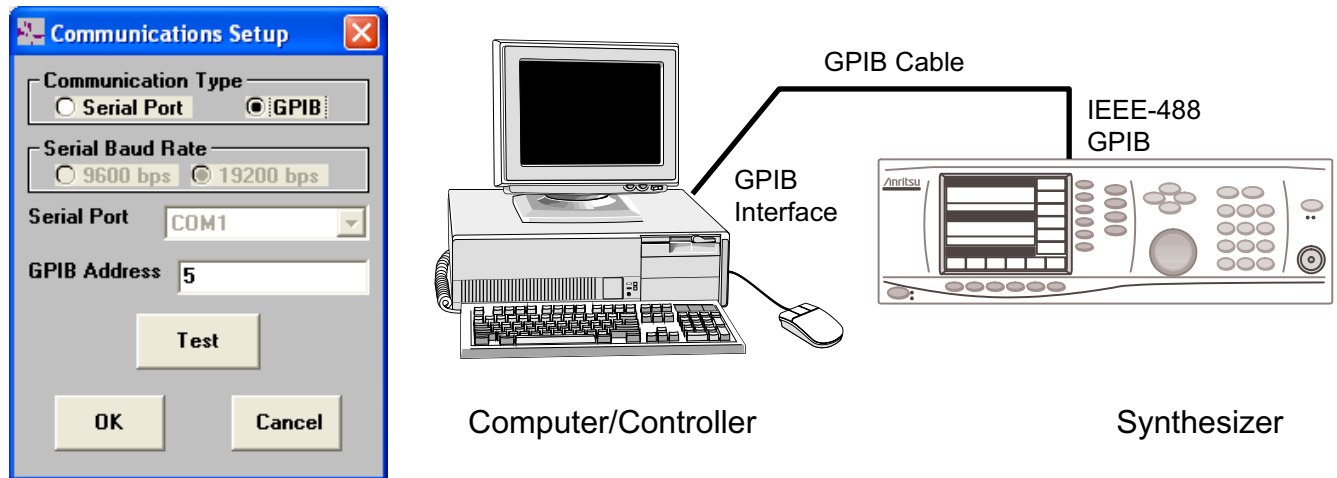
1. Connect the supplied serial interface cable between the Com Port on the computer/controller and the Serial I/O connector on the signal generator.
2. Click **Setup** in the top menu bar to open the Communication Setup window.
3. In the Communication Type area, select **Serial Port**.
4. In the Serial Baud Rate area, select either 9600 bps or 19200 bps to set the speed at which the waveform is transferred to the sweep generator.

**Note** All standard commands are sent at 9600 bps, but the waveform can be sent at either 9600 or 19200 bps. The only limitation is the speed of the serial communications of the computer/controller.

5. The Serial Port parameter provides a list of serial ports. Select the **Serial Port** that the serial interface cable is connected to on the computer/controller (**COM1** in this example).
6. Click the **Test** button to configure the computer/controller with the setup selected and attempt communications with the signal generator.
  - If the connection and setup are correct, the signal generator will display **Remote Mode** and a Windows message will state that the test passed.
  - If the test failed, recheck the settings and the physical cable connections. If 19200 bps is selected and the test still fails, retry at 9600 bps.

## GPIB Communications Setup

Use the following procedure to establish GPIB communications with the signal generator.



**Figure 1-6.** GPIB Communications Setup

1. Connect a GPIB cable between the GPIB Interface Card connector on the computer/controller and the IEEE-488 GPIB connector on the signal generator.
2. Click **Setup** in the top menu bar to open the Communication Setup window.
3. In the Communication Type area, select **GPIB**.
4. Enter the GPIB Address of the synthesizer or scroll through the available addresses by using the keyboard up and down arrow keys.

**Note** The default GPIB address for the synthesizer is 5.

5. Click the **Test** button to configure the computer/controller with the setup selected and attempt communications with the signal generator.
  - If the connection and setup are correct, the signal generator will display **Remote Mode** and a Windows message will state that the test passed.
  - If the test failed, recheck the GPIB settings and the physical cable connections. Ensure that no other devices are connected to the GPIB that might be causing a conflict.

### Saving/Canceling a Communications Setup

Clicking the **Cancel** button returns all settings to the values they had before the Communication Setup window was opened. All setting changes since the window was opened will be lost.

Clicking the **OK** button stores the communication settings in memory and use them for the current Complex Modulation Interface program session. When the program is closed, the communication settings are saved to the SETUP.INI file. This file is loaded when the Complex Modulation Interface program is started to restore the previous communication settings.

**Note** Whenever the communications setup is changed, the configuration should be tested by clicking the **Test** button.



# Chapter 2 — Operation

## 2-1 Introduction

This chapter provides information and instructions on operating the Complex Modulation software program. It contains instructions on the following:

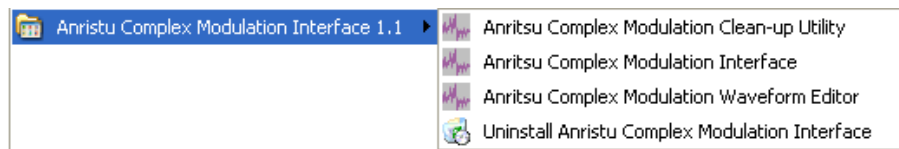
- [Complex Modulation Interface](#)
  - [SCAN Modes](#)
  - [FM/PM Modes](#)
  - [AM Modes](#)
  - [Pulse Modes](#)
  - [Waveform Information Menu](#)
  - [Synchronization](#)
  - [Sending the Configuration](#)
  - [Saving/Recalling a Configuration](#)
  - [Signal Generator Reset](#)
- [Complex Modulation Waveform Editor](#)
- [Creating Waveforms with Microsoft Excel](#)
- [Complex Modulation Clean-up Utility](#)

## 2-2 Complex Modulation Interface

The Complex Modulation Interface program lets you set the modulation configuration for the signal generator by selecting which modulation modes are enabled and setting the options for each mode selected. Any combination of AM, FM or  $\Phi$ M, Pulse modulation, and SCAN modulation can be selected for the configuration.

### Opening the Program

To open the program, click the **Anritsu Complex Modulation Interface** icon in the Anritsu Complex Modulation Interface program group.



**Figure 2-1.** Anritsu Complex Modulation Interface Program Group

Figure 2-2 shows the Complex Modulation Interface window and all of its available options.

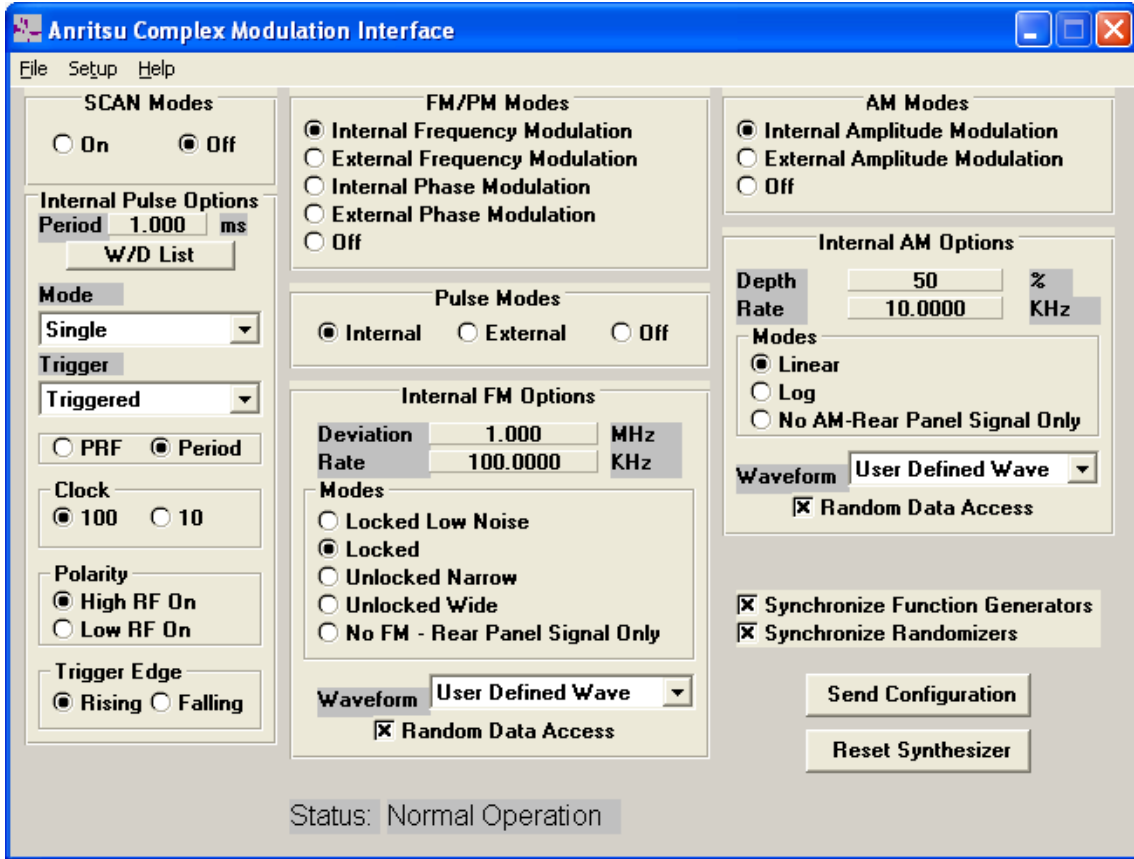


Figure 2-2. Complex Modulation Interface Window (with Modulation Modes Selected)

Click a modulation mode to select it. A list of options for that modulation mode will appear. (SCAN modulation mode does not have any additional parameters; therefore, no additional options are display when it is selected.)

The modulation mode options default to the same values as the signal generator. Change the options by clicking the desired option.

Change numerical values by clicking the number to be changed. A window will open, prompting for a new value. Enter the number in the units specified, and then either press **<ENTER>** or click the **OK** button to update the parameter and close the window. Figure 2-3 shows an example of the numeric entry window.

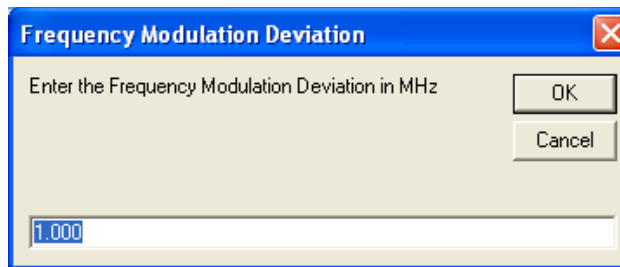


Figure 2-3. Numeric Entry Window

**Note**

If the Phase Modulation option is not installed in the signal generator, the Phase Modulation mode selections have no effect.

If the SCAN Modulator option is not installed in the signal generator, the SCAN modulation mode settings have no effect.

In general, any mode selections that are not available in the instrument will have no effect. Refer to the synthesizer's operation manual for more details about operation modes.

## Additional Modulation Mode Options

The Complex Modulation Interface program provides additional modulation mode options that are not available on the standard signal generator. These options are briefly described in the following paragraphs.

### Rear Panel Signal Only

When Internal AM, FM, or  $\Phi$ M modes are selected, this option becomes available. Clicking this button in a modulation mode disables the connection from the internal function generator to the modulation circuitry. It causes the internal function generator output to only go to a rear panel BNC connector. (In AM mode, it goes to the AM OUT connector; in FM or  $\Phi$ M mode, it goes to the FM/ $\Phi$ M OUT connector.)

### User Defined Wave

This option is one of the eight selections available for the Waveform parameter in Internal AM, FM, or  $\Phi$ M mode. Selecting **User Defined Wave** allows loading of a user-created waveform into the signal generator.

**Note**

Selecting the Send Configuration button will not resend the waveform to the signal generator unless the waveform was changed since it was last sent.

## 2-3 SCAN Modes

Selecting the On button turns the SCAN modulation function on.

Selecting the Off button turns the SCAN modulation function off.

**Note**

If the SCAN Modulator (Option 20) is not installed, these settings do nothing.

## 2-4 FM/PM Modes

Selecting the Internal Frequency Modulation button turns the Internal Frequency Modulation function on and turns off all other FM/PM functions. Selecting this button also enables the Internal FM Option menu.

Selecting the External Frequency Modulation button turns the External Frequency Modulation function on and turns off all other FM/PM functions. Selecting this button also enables the External FM Option menu.

Selecting the Internal Phase Modulation button turns the Internal Phase Modulation function on and turns off all other FM/PM functions. Selecting this button also enables the Internal PM Option menu.

Selecting the External Phase Modulation button turns the External Phase Modulation function on and turns off all other FM/PM functions. Selecting this button also enables the External PM Option menu.

Selecting the Off button turns off all FM/PM functions.

### Internal Frequency Modulation Options

This menu allows setting of all parameters related to the Internal Frequency Modulation circuitry per the following definitions.

### Internal Frequency Modulation Deviation

This parameter sets the modulation deviation of a frequency modulated signal. The deviation is measured in MHz. The deviation value must be within the following ranges for the specified mode:

- 1.00 kHz to 20.0 MHz for Locked Narrow Low Noise Mode, Locked Narrow Mode, and Unlocked Narrow Mode
- 100 kHz to 100 MHz for Unlocked Wide Mode

This parameter cannot be edited if the “[No FM - Rear Panel Signal Only](#)” mode is selected.

### Internal Frequency Modulation Rate

This parameter sets the rate of the FM/ΦM internal function generator. The rate is measured in kHz. The rate value must be within the following ranges for the specified mode:

- 0.0001 kHz to 10000.0000 kHz for Sine Wave generation (actual maximum depends on instrument specification)
- 0.0001 kHz to 1000.0000 kHz for all other wave generation (actual maximum depends on instrument specification)

If **Random Data Access** is selected for a user defined wave, the rate parameter controls the rate at which the signal changes value.

### Internal Locked Narrow Low Noise Frequency Modulation

This button selects the Locked Narrow Low Noise mode of operation for the Frequency Modulation circuit. In this mode, the RF output signal is locked at the set frequency. Also in this mode, more accurate modulation is available by limiting the deviation. See “[Internal Frequency Modulation Deviation](#)” for the deviation limits. Also, this mode enables the modulated output to have much lower noise than in Locked Narrow FM. As a result, the amount of deviation per rate is less.

### Internal Locked Narrow Frequency Modulation

This button selects the Locked Narrow mode of operation for the Frequency Modulation circuit. In this mode, the RF output signal is locked at the set frequency. Also in this mode, more accurate modulation is available by limiting the deviation. See “[Internal Frequency Modulation Deviation](#)” for the deviation limits. Also, this mode has a greater amount of deviation per rate than the Locked Narrow Low Noise FM. As a result, the amount of noise is greater.

### Internal Unlocked Narrow Frequency Modulation

This button selects the Unlocked Narrow mode of operation for the Frequency Modulation circuit. In this mode, the RF output signal is not locked at the set frequency. Also in this mode, more accurate modulation is available by limiting the deviation. See “[Internal Frequency Modulation Deviation](#)” for the deviation limits. The amount of deviation is not limited by the rate of modulation in this mode.

### Internal Unlocked Wide Frequency Modulation

This button selects the Unlocked Wide mode of operation for the Frequency Modulation circuit. In this mode, the output signal is not locked at the set frequency. Also in this mode, broader deviation is possible by limiting the accuracy of the modulation. See “[Internal Frequency Modulation Deviation](#)” for the deviation limits. The amount of deviation is not limited by the rate of modulation in this mode.

### No FM - Rear Panel Signal Only

This button disables the connection from the internal function generator to the Frequency Modulation circuitry. It causes the internal function generator output to only go to the rear panel FM/ΦM Out connector. This signal can be routed for any use via a standard BNC cable. The RF signal out is locked and not Frequency Modulated.



### Internal Frequency Modulation Waveform

This Selects the waveform to load into the internal FM/ΦM function generator. There are seven waveforms defined in the synthesizer that can be chosen from. These waveforms are: **Sine Wave, Square Wave, Ramp Up, Ramp Down, Gaussian Noise, Uniform Noise, and Triangle Wave.**

The eighth option, **User Defined Wave** allows a user-created waveform to be loaded into the synthesizer. If a User Defined Wave has already been selected, the option will contain the text:

```
User - <filename>
```

The <filename> will be replaced by the file name of the user-created waveform.

When the **User Defined Wave** option is selected, a new window will open. This window will allow a new user-created waveform to be loaded, viewed, or sent directly to the synthesizer. See [Section 2-7 “Waveform Information Menu”](#) and [Section 2-12 “Complex Modulation Waveform Editor”](#) for more information.

### Internal Frequency Modulation Waveform Random Data Access

This option is only available when the **User Defined Wave** option is selected from the Waveform parameter. This option, when selected, causes the synthesizer to randomly access the waveform data at the specified Rate.

## External Frequency Modulation Options

This menu allows setting of all parameters related to the External Frequency Modulation circuitry per the following definitions.

### External Frequency Modulation Sensitivity

This parameter sets the sensitivity of the internal Frequency Modulation circuitry to the external signal. The sensitivity is measured in MHz per volt. The sensitivity value must be within the following ranges for the specified mode:

- –20.0 MHz to 20.0 MHz for Locked Narrow Low Noise Mode, Locked Narrow Mode, and Unlocked Narrow Mode
- –100 MHz to 100 MHz for Unlocked Wide Mode

The modulation deviation is computed by measuring the peak and valley of the input signal and multiplying these by the sensitivity. Maximum input voltage is 2.00 volts peak-to-peak.

### External Locked Narrow Low Noise Frequency Modulation

This button selects the Locked Narrow Low Noise mode of operation for the Frequency Modulation circuit. In this mode, the RF output signal is locked at the set frequency. Also in this mode, more accurate modulation is available by limiting the deviation. See [“External Frequency Modulation Sensitivity”](#) for the sensitivity/deviation limits. Also, this mode enables the modulated output to have much lower noise than in Locked Narrow FM. As a result, the amount of deviation per rate is less.

### External Locked Narrow Frequency Modulation

This button selects the Locked Narrow mode of operation for the Frequency Modulation circuit. In this mode, the RF output signal is locked at the set frequency. Also in this mode, more accurate modulation is available by limiting the deviation. See [“External Frequency Modulation Sensitivity”](#) for the sensitivity/deviation limits. Also, this mode has a greater amount of deviation per rate than the Locked Narrow Low Noise FM. As a result, the amount of noise is greater.

### External Unlocked Narrow Frequency Modulation

This button selects the Unlocked Narrow mode of operation for the Frequency Modulation circuit. In this mode, the RF output signal is not locked at the set frequency. Also in this mode, more accurate modulation is available by limiting the deviation. See “[External Frequency Modulation Sensitivity](#)” for the sensitivity/deviation limits. The amount of deviation is not limited by the rate of modulation in this mode.

### External Unlocked Wide Frequency Modulation

This button selects the Unlocked Wide mode of operation for the Frequency Modulation circuit. In this mode, the output signal is not locked at the set frequency. Also in this mode, broader deviation is possible by limiting the accuracy of the modulation. See “[External Frequency Modulation Sensitivity](#)” for the sensitivity/deviation limits. The amount of deviation is not limited by the rate of modulation in this mode.

## Internal Phase Modulation Options

This menu allows setting of all parameters related to the Internal Phase Modulation circuitry per the following definitions.

### Internal Phase Modulation Deviation

This parameter sets the modulation deviation of a phase modulated signal. The deviation is measured in radians. The deviation value must be within the following ranges for the specified mode:

- 500  $\mu$ rad to 5.00 rad for Narrow Mode
- 50.0 mrad to 500 rad for Wide Mode

This parameter cannot be edited if the “[No PM - Rear Panel Signal Only](#)” mode is selected.

### Internal Phase Modulation Rate

This parameter sets the rate of the FM/PM internal function generator. The rate is measured in kHz. The rate value must be within the following ranges for the specified mode:

- 0.0001 kHz to 10000.0000 kHz (actual maximum depends on instrument specification) for Sine Wave generation
- 0.0001 kHz to 1000.0000 kHz (actual maximum depends on instrument specification) for all other wave generation

If **Random Data Access** is selected for a user defined wave, the rate parameter controls the rate at which the signal changes value.

### Internal Locked Narrow Phase Modulation

This button selects the Locked Narrow mode of operation for the Phase Modulation circuit. In this mode, the RF output signal is locked at the set frequency. Also in this mode, more accurate modulation across a broader rate is possible by limiting the deviation. See “[Internal Phase Modulation Deviation](#)” for the deviation limits.

### Internal Locked Wide Phase Modulation

This button selects the Locked Wide mode of operation for the Phase Modulation circuit. In this mode, the RF output signal is locked at the set frequency. Also in this mode, broader deviation is possible by limiting the accuracy and reducing the bandwidth of the signal. See “[Internal Phase Modulation Deviation](#)” for the deviation limits.

### No PM - Rear Panel Signal Only

This button disables the connection from the internal function generator to the Phase Modulation circuitry. It causes the internal function generator output to only go to the rear panel FM/ $\Phi$ M Out connector. This signal can be routed for any use via a standard BNC cable. The RF signal out is locked and not Phase Modulated.

### Internal Phase Modulation Waveform

This selects the waveform to load into the internal FM/ $\Phi$ M function generator. There are seven waveforms defined in the synthesizer that can be chosen from. These waveforms are: **Sine Wave, Square Wave, Ramp Up, Ramp Down, Gaussian Noise, Uniform Noise, and Triangle Wave.**

The eighth option, **User Defined Wave** allows a user-created waveform to be loaded into the synthesizer. If a **User Defined Wave** has already been selected, the option will contain the text:

```
User - <filename>
```

The <filename> will be replaced by the file name of the user-created waveform.

When the **User Defined Wave** option is selected, a new window will open. This window will allow a new user-created waveform to be loaded, viewed, or sent directly to the synthesizer. See [Section 2-7 “Waveform Information Menu”](#) and [Section 2-12 “Complex Modulation Waveform Editor”](#) for more information.

### Internal Phase Modulation Waveform Random Data Access

This option is only available when the **User Defined Wave** option is selected from the Waveform parameter. This option, when selected, causes the synthesizer to randomly access the waveform data at the specified Rate.

## External Phase Modulation Options

This menu allows setting of all parameters related to the External Phase Modulation circuitry per the following definitions.

### External Phase Modulation Sensitivity

This parameter sets the sensitivity of the internal Phase Modulation circuitry to the external signal. The sensitivity is measured in radians per volt. The sensitivity value must be within the following ranges for the specified mode:

- $-5.00$  rad/V to  $5.00$  rad/V for Narrow Mode
- $-500$  rad/V to  $500$  rad/V for Wide Mode

The modulation deviation is computed by measuring the peak and valley of the input signal and multiplying these by the sensitivity. Maximum input voltage is 2.00 volts peak to peak.

### External Locked Narrow Phase Modulation

This button selects the Locked Narrow mode of operation for the Phase Modulation circuit. In this mode, the RF output signal is locked at the set frequency. Also in this mode, more accurate modulation across a broader rate is possible by limiting the deviation. See [“External Phase Modulation Sensitivity”](#) for the sensitivity/deviation limits.

### External Locked Wide Phase Modulation

This button selects the Locked Wide mode of operation for the Phase Modulation circuit. In this mode, the RF output signal is locked at the set frequency. Also in this mode, broader deviation is possible by limiting the accuracy and reducing the bandwidth of the signal. See [“External Phase Modulation Sensitivity”](#) for the sensitivity/deviation limits.

## 2-5 AM Modes

Selecting the Internal Amplitude Modulation button turns the Internal Amplitude Modulation function on and turns off External AM. Selecting this button also enables the Internal AM Option menu.

Selecting the External Amplitude Modulation button turns the External Amplitude Modulation function on and turns off Internal AM. Selecting this button also enables the External AM Option menu.

Selecting the Off button turns off all AM functions.

### Internal Amplitude Modulation Options

This menu allows setting of all parameters related to the Internal Amplitude Modulation circuitry per the following definitions.

#### Internal Amplitude Modulation Depth

This parameter sets the modulation depth of an amplitude modulated signal. The depth is measured either in Percent (%) or Decibels (dB). The depth value must be within the following ranges for the specified mode:

- 0 % to 100 % for Linear Mode
- 0 dB to 25.0 dB for Log Mode

This parameter cannot be edited if the “[No AM - Rear Panel Signal Only](#)” mode is selected.

#### Internal Amplitude Modulation Rate

This parameter sets the rate of the AM internal function generator. The rate is measured in kHz. The rate value must be within the following ranges for the specified mode:

- 0.0001 kHz to 10000.0000 kHz for Sine Wave generation (actual maximum depends on instrument specification)
- 0.0001 kHz to 1000.0000 kHz for all other wave generation (actual maximum depends on instrument specification)

If Random Data Access is selected for a user defined wave, the rate parameter controls the rate at which the signal changes value.

#### Internal Linear Amplitude Modulation

This button selects the Linear mode of operation for the Amplitude Modulation circuit. In this mode, the amount of amplitude modulation is measured on a linear percentage scale. See “[Internal Amplitude Modulation Depth](#)” for the deviation limits.

#### Internal Log Amplitude Modulation

This button selects the Log mode of operation for the Amplitude Modulation circuit. In this mode, the amount of amplitude modulation is measured on a logarithmic decibel scale. See “[Internal Amplitude Modulation Depth](#)” for the deviation limits.

#### No AM - Rear Panel Signal Only

This button disables the connection from the internal function generator to the Amplitude Modulation circuitry. It causes the internal function generator output to only go to the rear panel AM Out connector. This signal can be routed for any use via a standard BNC cable. The RF signal out is locked and not Amplitude Modulated.

#### Internal Amplitude Modulation Waveform

This Selects the waveform to load into the internal AM function generator. There are seven waveforms defined in the synthesizer that can be chosen from. These waveforms are: **Sine Wave, Square Wave, Ramp Up, Ramp Down, Gaussian Noise, Uniform Noise, and Triangle Wave.**

The eighth option, **User Defined Wave** allows a user-created waveform to be loaded into the synthesizer. If a User Defined Wave has already been selected, the option will contain the text:

```
User - <filename>
```

The <filename> will be replaced by the file name of the user-created waveform.

When the **User Defined Wave** option is selected, a new window will open. This window will allow a new user-created waveform to be loaded, viewed, or sent directly to the synthesizer. See [Section 2-7 “Waveform Information Menu”](#) and [Section 2-12 “Complex Modulation Waveform Editor”](#) for more information.

### Internal Amplitude Modulation Waveform Random Data Access

This option is only available when the **User Defined Wave** option is selected from the Waveform parameter. This option, when selected, causes the synthesizer to randomly access the waveform data at the specified Rate.

## External Amplitude Modulation Options

This menu allows setting of all parameters related to the External Amplitude Modulation circuitry per the following definitions.

### External Amplitude Modulation Sensitivity

This parameter sets the sensitivity of the internal Amplitude Modulation circuitry to the external signal. The sensitivity is measured either in Percent per Volt (%/V) or Decibels per Volt (dB/V). The sensitivity value must be within the following ranges for the specified mode:

- 0 %/V to 100 %/V for Linear Mode
- 0 dB/V to 25.0 dB/V for Log Mode

The modulation deviation is computed by measuring the peak and valley of the input signal and multiplying these by the sensitivity. Maximum input voltage is 2.00 Volts peak to peak.

### External Linear Amplitude Modulation

This button selects the Linear mode of operation for the Amplitude Modulation circuit. In this mode, the amount of amplitude modulation is measured on a linear percentage scale. See [“External Amplitude Modulation Sensitivity”](#) for the deviation limits.

### External Log Amplitude Modulation

This button selects the Log mode of operation for the Amplitude Modulation circuit. In this mode, the amount of amplitude modulation is measured on a logarithmic decibel scale. See [“External Amplitude Modulation Sensitivity”](#) for the deviation limits.

## 2-6 Pulse Modes

Selecting the **Internal Pulse** button turns the Internal Pulse function on and turns off External Pulse. Selecting this button also enables the Internal Pulse Option menu.

Selecting the **External Pulse** button turns the External Pulse function on and turns off Internal Pulse. Selecting this button also enables the External Pulse Option menu.

Selecting the **Off** button turns off all Pulse functions.

### Internal Pulse Options

This menu allows setting of all parameters related to the Internal Pulse circuitry per the following definitions.

### Internal Pulse Period/PRF Parameter

This parameter sets either the Pulse Period or the Pulse PRF. The value for this parameter is measured in seconds (s) for the Period mode and frequency (Hz) for the PRF mode. The value must be within the following ranges for the specified mode:

- 100 MHz Clock:
  - 40 ns to 167.77215 ms for Period Mode
  - 5.961 Hz to 25 MHz for PRF Mode
- 40 MHz Clock:
  - 250 ns to 419.2872 ms for Period Mode
  - 2.385 Hz to 4 MHz for PRF Mode
- 10 MHz Clock:
  - 400 ns to 1.667 s for Period Mode
  - 600 MHz to 2.5 MHz for PRF Mode

### Internal Pulse Width/Delay List

The W/D List button opens the Pulse Width/Delay List edit window. This window allows editing of the Pulse Modulation Width and Delay parameters (W1, W2, W3, W4, D1, D2, D3, and D4). Based on the selected Pulse Mode and Pulse Trigger, some or all of the Width and Delay parameters will be available for editing. At least, W1 will be available for editing, as shown below.

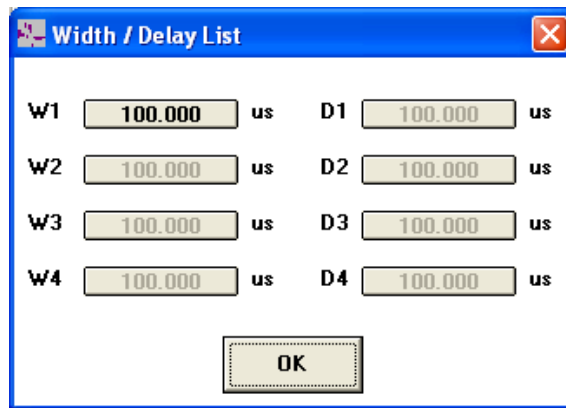


Figure 2-4. Width/Delay List Menu

These parameters are bound by the same limits as the Pulse Period/PRF parameter. To see the limits, see the “[Internal Pulse Period/PRF Parameter](#)”.

### Internal Pulse Mode Selection List

This selection list contains the four Pulse modes for selection. The four modes are: **Single, Doublet, Triplet, and Quadruplet**.

### Internal Pulse Trigger Selection List

This selection list contains the six Pulse triggers for selection. The six triggers are:

- **Free Run:** The pulse generator produces Single, Doublet, Triplet, or Quadruplet pulse modulation waveforms at the internal pulse repetition rate. Pulse delay (D1) is not available in this trigger mode.
- **Gated:** An external pulse gates the internal pulse generator on and off. When gated on, the pulse generator produces a Single pulse modulation waveform at the internal pulse repetition rate. Doublet, Triplet, and Quadruplet pulse modes are not available in the trigger mode.

- **Delayed:** The pulse generator produces Single, Doublet, Triplet, or Quadruplet pulse modulation waveforms delayed by pulse delay (D1) at the internal pulse repetition rate.
- **Triggered:** The pulse generator is triggered by an external trigger to produce Single, Doublet, Triplet, or Quadruplet pulse modulation waveforms. Pulse delay (D1) is not available in the trigger mode.
- **Triggered with Delay:** The pulse generator is triggered by an external trigger to produce Single, Doublet, Triplet, or Quadruplet pulse modulation waveforms delayed by pulse delay (D1).
- **Composite:** In this mode, an external pulse triggers the internal pulse generator and also pulse modulates the RF output signal. The internal pulse generator produces a Single pulse (W1) delayed by pulse delay (D1) which also pulse modulates the RF output signal. This effectively sums the external and internal pulses to pulse modulate the output signal. Doublet, Triplet, and Quadruplet pulse modes are not available in this trigger mode.

### Internal Pulse PRF Mode

This button sets the Period/PRF parameter to Pulse Repetition Frequency (PRF) mode. See the [“Internal Pulse Period/PRF Parameter”](#) for limits and unit information.

### Internal Pulse Period Mode

This button sets the Period/PRF parameter to Period mode. See the [“Internal Pulse Period/PRF Parameter”](#) for limits and unit information.

### Internal Pulse 100 MHz Clock

This button sets the Internal Pulse Clock to 100 MHz, if the instrument supports a 100 MHz clock. If the instrument supports a 40 MHz clock then it will be activated. This effects the minimum and maximum settings for the Period/PRF parameter. See the [“Internal Pulse Period/PRF Parameter”](#) for the effect on the Period/PRF limits.

### Internal Pulse 40 MHz Clock

Use the 100 MHz clock setting for instruments that have a 40 MHz clock maximum. The instrument will activate the 40 MHz clock. This effects the minimum and maximum settings for the Period/PRF parameter. See the [“Internal Pulse Period/PRF Parameter”](#) for the effect on the Period/PRF limits.

### Internal Pulse 10 MHz Clock

This button sets the Internal Pulse Clock to 10 MHz. This effects the minimum and maximum settings for the Period/PRF parameter. See the [“Internal Pulse Period/PRF Parameter”](#) for the effect on the Period/PRF limits.

### Internal Pulse High RF On

This button causes the RF output to be pulse modulated when the external pulse signal is a TTL-High. When the external pulse signal is a TTL-Low, the RF output is turned off. This only has an effect on Gated and Composite triggering.

### Internal Pulse Low RF On

This button causes the RF output to be pulse modulated when the external pulse signal is a TTL-Low. When the external pulse signal is a TTL-High, the RF output is turned off. This only has an effect on Gated and Composite triggering.

### Internal Pulse Rising Trigger Edge

This button sets the pulse generator to be triggered by the rising edge of the external trigger pulse. This option is only enabled when in Gated, Triggered, or Triggered with Delay mode.



### Internal Pulse Falling Trigger Edge

This button sets the pulse generator to be triggered by the falling edge of the external trigger pulse. This option is only enabled when in Gated, Triggered, or Triggered with Delay mode.

## External Pulse Options

This menu allows setting of all parameters related to the External Pulse circuitry per the following definitions.

### External Pulse High RF On

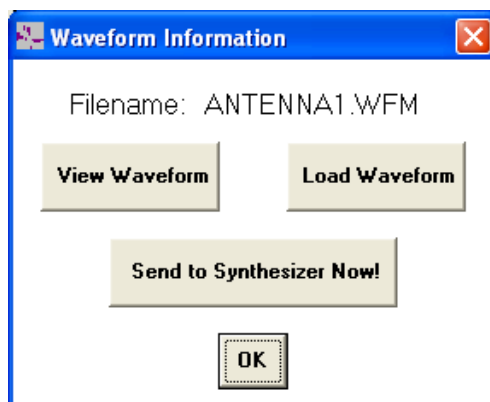
This button causes the RF output to be on when the external pulse signal is a TTL-High. When the external pulse signal is a TTL-Low, the RF output is turned off.

### External Pulse Low RF On

This button causes the RF output to be on when the external pulse signal is a TTL-Low. When the external pulse signal is a TTL-High, the RF output is turned off.

## 2-7 Waveform Information Menu

Selecting the **User Defined Wave** option causes the Waveform Information window to open. This window lets a new user-created waveform be loaded, viewed, or sent directly to the signal generator.

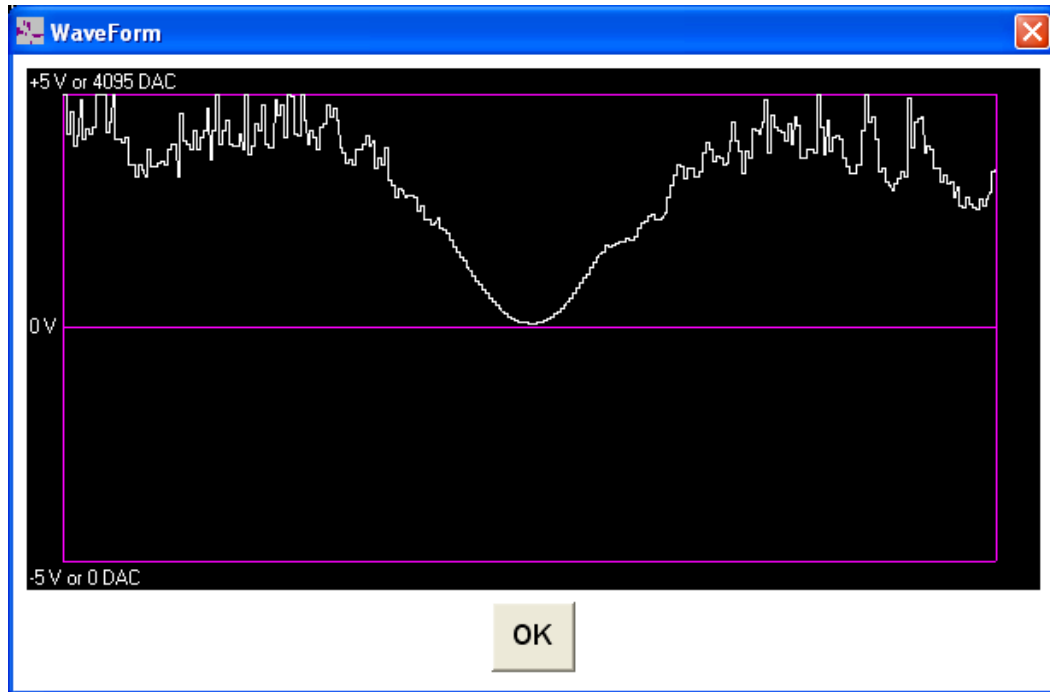


**Figure 2-5.** Waveform Information Menu

Clicking the **Load Waveform** button causes the dialog box to default to the Waveform (.WFM) file directory. Select the waveform file to be loaded into the signal generator from this directory.



Click the **View Waveform** button to draw the current user-created waveform into the Waveform View window. If no user-created waveform has been loaded, then a line across the center of the grid is drawn. [Figure 2-6](#) shows a user-created waveform as drawn into the Waveform View window.



**Figure 2-6.** Waveform View Window

Because of screen resolution limits, only one out of every eight values from the waveform are displayed on the screen. If a waveform changes drastically in any eight consecutive points, it may not be displayed correctly in this window. To edit the waveform, use the Complex Modulation Wave Editor program (described in [Section 2-12 “Complex Modulation Waveform Editor”](#)).

Click the **Send to the Synthesizer Now!** button to send the currently selected user-created waveform to the signal generator. The waveform is sent using the current settings in the Communications Setup. No information other than the waveform is sent to the signal generator.

## 2-8 Synchronization

The synchronization selections allow the signals from the two function generators (AM and FM/ΦM) in the signal generator to become synchronized.

### Synchronize Function Generators

This function only becomes enabled when the Internal AM mode is selected and either the Internal FM mode or the Internal ΦM mode is also selected. Selecting this check box causes the modulating waveforms, selected in the Waveform parameter, to begin at the same point in the function generators' waveform lookup tables.

If a **User Defined Wave** is being used, resend the waveform to the signal generator after the Synchronize Function Generators option is selected. This ensures that the waveform is loaded properly into the signal generator's RAM. If the rates specified in the **Rate** parameter for the two modulation modes are the same, the signals from the two function generators will remain synchronized until taken out of synchronization. If the rates for the two modulation modes are different, the signals will lose synchronization immediately. If the function generators are randomly accessing the waveform data (both modulation modes have **User Defined Wave** and **Random Data Access** selected), selecting the **Synchronize Function Generators** function alone will cause the signals from the function generators to be synchronized in frequency only.

## Synchronize Randomizers

This function only becomes enabled when the **Synchronize Function Generators** function is enabled and both function generators are randomly accessing the waveform data (both modulation modes have **User Defined Wave** and **Random Data Access** selected). Selecting this check box causes the **Synchronize Function Generators** check box to become selected, if not already. Deselecting the **Synchronize Function Generators** check box causes the **Synchronize Randomizers** check box to become deselected, if it is selected.

Selecting the **Synchronize Randomizers** check box causes the randomizing circuits in the function generators to access the same waveform data locations.

## 2-9 Sending the Configuration

This synchronizes the signals from the two function generators in both frequency and level. If the same waveform pattern is loaded into both function generators, the two generators will operate exactly the same. If different waveform patterns are loaded into the two function generators, the generators will access the same data locations at the same time.

Once the modulation configuration for the signal generator is set, click the **Send Configuration** button to send it to the signal generator. After the configuration has been sent, this button is disabled and remains disabled until a change is made in the configuration setup on the interface.

Each time the **Send Configuration** button is clicked, all configuration information is sent to the signal generator except for the user defined waveform (unless it has changed). If the user defined waveform has not changed, but does need to be sent to the signal generator, send it by clicking the **Send to Synthesizer Now!** button in the Waveform Information window.

## 2-10 Saving/Recalling a Configuration

The configuration setup on the interface can be saved to a configuration file (.CFG). This will save all modulation parameters for recall at a later time. To save a configuration setup as a file, click **File**, in the top menu bar, and select **Save Configuration** from the drop down menu or press **Ctrl+S**.

To recall a configuration setup, click **File** and select **Open Configuration** from the drop down menu or press **Ctrl+O**. The dialog box defaults to the Configuration (.CFG) file sub-directory. Select the configuration file to be loaded into the interface from this directory.

To set all modulation parameters to their default values, click **File** and select **New Configuration** from the drop down menu or press **Ctrl+N**.

## 2-11 Signal Generator Reset

To reset the signal generator to the default values, click the **Reset Synthesizer** button. This causes a reset command to be sent to the signal generator.

## 2-12 Complex Modulation Waveform Editor

The Complex Modulation Waveform Editor program provides the tools necessary to create modulation waveforms. The following paragraphs provide general waveform information and instructions for drawing and editing modulation waveforms.

### Opening the Program

To open the program, click the **Anritsu Complex Modulation Waveform Editor** icon in the Anritsu Complex Modulation Interface program group. [Figure 2-7](#) shows the Complex Modulation Waveform Editor window at startup.



**Figure 2-7.** Anritsu Complex Modulation Waveform Editor

The window has three available drop down menus—**File**, **Waveform**, and **Help**. The **File** menu lets you save and recall waveforms, the **Waveform** menu provides waveform editing tools, and the **Help** menu provides descriptions of the program features and general waveform information.

The window contains a grid area for drawing new waveforms and viewing previously created wave forms. At startup and whenever there is no previously created waveform loaded, a line is drawn across the center of the grid area. Because of limits in screen resolution, only one out of every eight values from the waveform are displayed on the screen. If a waveform changes drastically in any eight consecutive points, it may not be displayed correctly on the screen.

### Waveform Information

To create and modify complex modulation waveforms, an understanding of the waveform (.wfm) file, its content, and how it is processed by the function generator is necessary.

### The Waveform File

The waveform file is a space-delimited text file of up to 65,536 numbers. The signal generator accepts either the **<space>** character or **<Enter>** character as a delimiter. (A delimiter is a special character that separates the data; it tells the instrument when one data entry ends and the next entry begins.) Multiple **<space>** characters are ignored. The instrument interprets multiple **<space>** characters to be a single delimiter. Multiple **<Enter>** characters are not ignored. Two **<Enter>** characters in a row are interpreted as two delimiters with a data entry of zero between them.

This configuration is particularly useful for formatting waveform files so that they can be easily read or manipulated with a text editor or spreadsheet program. A typical arrangement is 8 columns and up to 8192 rows as shown:

|       |       |       |       |       |       |       |       |
|-------|-------|-------|-------|-------|-------|-------|-------|
| 1     | 2     | 3     | 4     | 5     | 6     | 7     | 8     |
| 9     | 10    | 11    | 12    | 13    | 14    | 15    | 16    |
| 17    | 18    | 19    | 20    | 21    | 22    | 23    | 24    |
| 25    | 26    | 27    | 28    | 29    | 30    | 31    | 32    |
| .     | .     | .     | .     | .     | .     | .     | .     |
| .     | .     | .     | .     | .     | .     | .     | .     |
| .     | .     | .     | .     | .     | .     | .     | .     |
| 65505 | 65506 | 65507 | 65508 | 65509 | 65510 | 65511 | 65512 |
| 65513 | 65514 | 65515 | 65516 | 65517 | 65518 | 65519 | 65520 |
| 65521 | 65522 | 65523 | 65524 | 65525 | 65526 | 65527 | 65528 |
| 65529 | 65530 | 65531 | 65532 | 65533 | 65534 | 65535 | 65536 |

**Figure 2-8.** Waveform Text File

The data is a series of numbers represented by ASCII text. These numbers are a digital representation of the waveform that the function generator will create. Each number is an integer between 0 and 4095. The number 0 corresponds to the minimum modulation level and a  $-5$  V output at the rear panel of the signal generator. The number 4095 corresponds to the maximum modulation level and a  $+5$  V rear panel output. The number 2048 corresponds to a 0 V rear panel output.

For example, if the signal generator's output power is set to  $-10$  dBm, AM Log mode is on, and AM depth is set to 3 dB, then a number of 0 would provide  $-3$  dB of AM, or  $-13$  dBm of output power. A number of 4095 would provide  $+3$  dB of AM, or  $-7$  dBm of output power.

**Note** The instrument will accept non-integer numbers, but this is not recommended as it increases download time.

The waveform file length can be any power of 2. It can consist of 2 numbers or 4 numbers or 8 numbers, etc., up to 65,536 numbers. When the file is downloaded to the signal generator, it expands the data to completely fill the 65,536 locations of the Direct Digital Synthesizer's (DDS) lookup table in the function generator. The data is expanded by duplicating each number the appropriate number of times. For example, if a waveform file with only 2 numbers is downloaded, the signal generator expands the data so that the first 32,768 locations in the DDS lookup table are set to the first number and last 32,768 locations are set to the second number.

### Waveform Data Processing

The process by which the function generator's DDS reads the data in its lookup table is not important for simple waveforms. However, for complex waveforms or waveforms that represent multiple cycles, the DDS read process can affect the shape and period of the waveform.

The DDS is, essentially, a 12-bit Digital-to-Analog Converter (DAC). It sequentially reads data from a table of numbers to create the waveform. If the table contains the numbers to create a sine wave, as the DDS cycles through the table, a sine wave is created.

The DDS is driven by a 3.3554432 MHz clock. If the DDS's slowest rate of 0.1 Hz is requested, the clock is divided by 512 so that the DDS steps through the table at a 6.5536 kHz rate. With the table size of 65,536, the DDS makes one cycle through the table in 10 seconds, corresponding to the requested rate of 0.1 Hz.

If the requested rate is increased, the clock divider is decreased, so that the DDS still cycles through the entire table. This continues until the divider is decreased to 1, corresponding to a rate of 51.2 Hz. At that point, if the requested rate continues to increase, the DDS begins skipping table locations.

As the rate increases, the DDS skips more and more locations in the table until, at the maximum rate of 1 MHz, the DDS is only reading 3 table locations per cycle. Note that the DDS does not read the same 3 table locations. (This would cause a rate of 3.3554432 MHz divided by 3 or 1.118481067 MHz. We want precisely 1 MHz.) Rather, as the DDS attempts to read 3.3554432 locations, it ends each cycle with a remainder. This remainder is carried over as the DDS wraps around, so that it starts the next cycle at a different location in the table.

The process of skipping locations works well for most waveforms. However, there are two mandatory considerations:

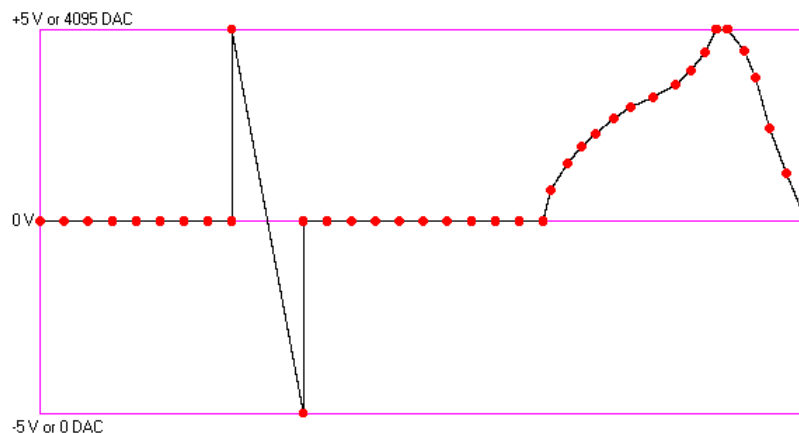
- If the waveform contains sharp transitions, such as square waves or pulse trains, there will be a small amount of cycle-to-cycle jitter on the transitions, caused by the wrap-around effect just described
- If the waveform contains many transitions, such as a 128-bit pseudo-random digital pattern, the fastest rates will lose some of the transitions as the DDS skips multiple table locations. Usually this is not a problem, because the analog bandwidth of the system limits the speed and number of transitions

## Drawing or Editing a Waveform

The Complex Modulation Waveform Editor program provides two methods of drawing or editing a waveform—the drag method and the discrete value method.

### The Drag Method

The red dots on the waveform, shown in the grid area of the program window, are drag points. When the mouse pointer moves over one of these drag points, the pointer changes to a cross hair. When the pointer is a cross hair, the drag point can be moved. By clicking and holding the left mouse button, the drag point can be moved from the top of the grid to the bottom of the grid, as shown below.



**Figure 2-9.** Drawing a Waveform

A drag point can only be moved as far left or right as the drag points next to it. The drag points at the two ends of the waveform can not be moved left or right, only up and down.

Smoothing a curve in a waveform may require that many drag points be moved very close together. As a result, there may not be sufficient drag points to draw the complete waveform. To add drag points to the waveform, click **Waveform**, in the top menu bar, and select the **Edit Point Addition** option from the drop down menu or press **Ctrl+P**. When this option is enabled, a drag point can be added by clicking two adjacent drag points with the right mouse button. A new drag point will be added between these drag points. The **Edit Point Addition** option can be enabled without any hindrance to program operation. Once enabled, the option remains on until turned off, or the program is terminated.

After extensive editing, the waveform display can become difficult to understand because the borders and drag points can be erased. Clicking the **Update Waveform** button will redraw all borders, all drag points, and the waveform for continued editing.

### Discrete Value Method

The discrete value method allows a specific value to be set to a range of waveform entries. Once the data is entered, the value is reflected in the waveform drawing.

To enter a discrete value for a waveform range, click **Waveform**, in the top menu bar, and select the **Set Discrete Value** option from the drop down menu or press **Ctrl+V**. The **Set Discrete Value** window opens for data entry.

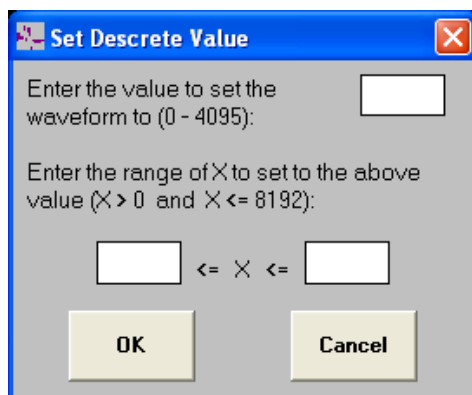


Figure 2-10. Set Discrete Value

### Saving/Recalling a Waveform

First, enter the numerical value that the waveform range will be set to. The value must be an integer number between 0 and 4095.

Next, set the range of waveform entries. These entries must be integer numbers between 1 and 8192. The entry in the left box is the start value and must be less than the entry in the right box, which is the stop value.

Click the **OK** button to accept the parameters, close the window, and update the waveform. If an entry is invalid, a message stating the error is displayed. The error must be corrected before the **OK** button will accept the parameters. The **Cancel** button can be clicked at any time and all changes will be aborted.

Upon completion of drawing and/or editing a modulation waveform, it can be saved to a waveform file (.WFM). To save a waveform as a file, first click the **Update Waveform** button to redraw the waveform. Then, click **File**, in the top menu bar, and select **Save Waveform** from the drop down menu or press **Ctrl+S**.

To save a waveform as a file and rename it, first click the **Update Waveform** button to redraw the waveform. Then, click **File** and select **Save Waveform As...** from the drop down menu or press **Ctrl+A**.

To recall a waveform, click **File** and select **Open Waveform...** from the drop down menu or press **Ctrl+O**. The dialog box defaults to the Waveform (.WFM) file sub-directory. Select the waveform file to be loaded into the wave editor from this directory.

## Sample Waveforms

Several sample waveforms are provided with your Complex Modulation software. These waveforms are located in the Waveform (.WFM) file sub-directory. The following is a brief description of each sample waveform.

**Note** For more information on how these waveforms were created, refer to [Section 2-13 “Creating Waveforms with Microsoft Excel”](#).

### **16QAMA.WFM and 16QAMP.WFM**

These are amplitude and phase waveforms to create a simple 16QAM pattern. The pattern simply steps through each of the 16 states in the 16QAM signal. A sample configuration file, 16QAM.CFG, is provided to properly configure the signal generator for this signal.

### **16QAMAR.WFM and 16QAMPR.WFM**

These are amplitude and phase waveforms to create a simple pseudo-random 16QAM pattern. The pattern steps through a 64-symbol random pattern. A sample configuration file, 16QAMR.CFG, is provided to properly configure the signal generator for this signal.

### **16QAMARN.WFM and 16QAMPRN.WFM**

These are amplitude and phase waveforms to create a pseudo-random 16QAM pattern with amplitude and phase noise. The pattern steps through a 64-symbol random pattern with noise on each symbol. A sample configuration file, 16QAMRN.CFG, is provided to properly configure the signal generator for this signal.

### **ANTENNA1.WFM and ANTENNA2.WFM**

These are waveforms duplicating an actual antenna scan measurement. ANTENNA1.WFM represents a 288-point measurement. ANTENNA2.WFM represents the same measurement with interpolation between points. The sample configuration files, ANTENNA1.CFG and ANTENNA2.CFG, are provided to properly configure the signal generator for these signals. Note that these signals are intended to drive the signal generator’s optional scan modulator, which is required to produce the desired modulation. The signal generator’s rear panel AM OUTPUT must be connected to the rear panel SCAN INPUT for these waveforms to properly modulate the RF output.

### **CHIRPFM.WFM and CHIRPPLS.WFM**

These are FM and pulse modulation waveforms to create a chirped radar pulse with a 10% duty cycle. A configuration file, CHIRP.CFG, is provided to properly configure the signal generator for these signals. The signal generator’s rear panel AM OUTPUT must be connected to the rear panel PULSE TRIGGER INPUT for these waveforms to properly modulate the RF output.

### **FSK.WFM**

This waveform represents one bit of FSK modulation. This is the simplest waveform possible, consisting of only two numbers.

### **IFF.WFM**

This waveform represents a complex pulse stream, loosely approximating an IFF waveform. Note that the signal generator’s rear panel AM OUTPUT must be connected to the rear panel PULSE TRIGGER INPUT for this waveform to properly modulate the RF output.

### **SINX\_X.WFM**

This waveform represents a sine X/X pattern. The waveform out to the fourth zero is represented.

### TRIGGER.WFM

This waveform represents a single pulse with a 1/8 (12.5%) duty cycle. If only one waveform is used, this waveform can be loaded into the other function generator to generate a synchronous trigger pulse.

## 2-13 Creating Waveforms with Microsoft Excel

The waveform file is simply a table of numbers. As such, many application programs can be used to create waveform files. The most common application programs for creating waveform files are spreadsheet programs, such as Microsoft Excel. This section deals specifically with Microsoft Excel, but the concepts presented are applicable to any spreadsheet program. A basic understanding of the operation of Excel is assumed.

### Excel Hints

Excel has some characteristics that are significant when generating waveforms. These characteristics are listed here as hints.

1. When saving data in a “delimited” format (space delimited, comma delimited, etc.), Excel saves only the current sheet and it saves the entire sheet. Therefore, the final waveform data must be on a sheet of its own and nothing else can be on that sheet. Also, Excel saves data sequentially, left to right on the first row, then left to right on the second row, etc. The data must be formatted to account for this.
2. When a spreadsheet is saved as a delimited file, only the values are saved. All calculations are not saved. When a spreadsheet is saved as a delimited file, it should also be saved as a spreadsheet file (.XLS) to avoid losing calculations.
3. When saving data as space delimited text, Excel has two quirks.
  - a. Excel will place as many spaces between numbers as are necessary to match the cell size specified on the sheet. For example, if the sheet’s cell size is 8, and the number in the cell is 4095 (4 characters), when Excel exports the data, it will add 4 spaces before the number. While the signal generator will accept waveform files with multiple spaces, they take up extra disk space and require longer download time. If the cell size is 4, and the number is 4095, then Excel will output no spaces between the number and the previous number. This will result in an unloadable waveform file.
  - b. If the spreadsheet is more than 30 columns wide, Excel will save the first 30 columns of all rows, then save the next 30 columns of all rows, etc. This will result in an invalid wave form file.
4. The best format to use when saving data from Excel is the CSV (comma delimited) format. Then, the Anritsu Complex Modulation Utility can be used to clean up the file and convert the comma delimiters to spaces.

### Sample Spreadsheets

Three example Excel spreadsheet files are supplied with the Complex Modulation software. They are located in the EXCEL (.XLS) file sub-directory and contain imbedded instructions. Detailed descriptions are included in these sample spreadsheets. To view the descriptions, open the spreadsheet in Microsoft Excel.

#### SINX\_X.XLS

The simplest, in concept, is SINX\_X.XLS. It creates a sine X/X waveform with the main lobe and 3 lobes on each side. This spreadsheet uses no macros or programs, it simply uses cell formulas. The waveform file size must be a power of 2, so the data is arranged as 8 columns by 512 rows or 8192 numbers. Note that the final values are duplicated on a sheet of their own, the values sheet, because of the Excel characteristic previously noted.

The sample waveform, SINX\_X.WFM, was created with this spreadsheet.



### 16QAM.XLS

This spreadsheet is an example of how detailed complex waveforms can be created with Excel. It contains a macro that uses a random number generator to create pseudo-random 16QAM waveforms with amplitude and phase noise. Note that no values exist in the values sheets. The macro must be run to create the values. Since the macro creates pseudorandom waveforms, each time it is run, a different pattern will be generated. This spreadsheet contains two values sheets for both amplitude and phase values because QAM involves both amplitude and phase modulation. QAM requires amplitude and phase to change synchronously so, when the waveforms are run by the signal generator, the modulation generators must be synchronized.

The waveforms, 16QAMARN.WFM (16QAM Amplitude Random with Noise) and 16QAMPRN.WFM (16QAM Phase Random with Noise), were created by setting the noise constants in the macro to values of 100 and running the macro. Note that this spreadsheet creates waveform files of the maximum size, 65536 numbers each.

A configuration file, 16QAMRN.CFG, has been created. It loads the waveforms, 16QAMARN.WFM and 16QAMPRN.WFM, and sets the signal generator to the correct settings to create the pseudorandom 16QAM signal with noise.

### ANTENNA.XLS

The ANTENNA.XLS spreadsheet is an example of how actual measured data can be manipulated to duplicate outputs from real devices. The data is an antenna scan pattern measured on a Anritsu Vector Network Analyzer. The spreadsheet expands the data to be in the proper format for the signal generator. Note that this spreadsheet has more than 30 columns, so Excel will not properly save the waveform as a space-delimited file. To save this waveform, it must be saved as a comma-delimited file, then run through the Complex Modulation Utility for clean up.

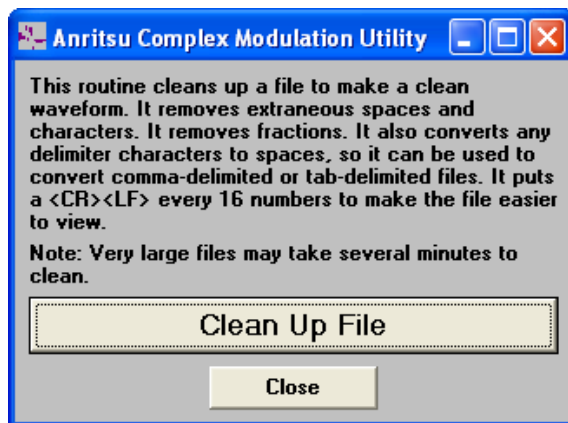
The ANTENNA1.WFM and ANTENNA2.WFM waveforms were created with this spreadsheet. The ANTENNA1.CFG and ANTENNA2.CFG configuration files will properly configure the signal generator for these waveforms. Note that these waveforms are intended to run the signal generator's optional scan modulator. If the signal generator is not equipped with a scan modulator, these waveforms will not produce the desired modulation.

## 2-14 Complex Modulation Clean-up Utility

The Complex Modulation Clean-up Utility program cleans up a file to make a clean waveform. It removes extraneous spaces, characters, and fractions. It converts any delimiter characters to spaces, so it can be used to convert comma-delimited and tab-delimited files. The program also places a <CR><LF> every 16 numbers to make the file easier to view.

### Opening the Program

To open the program, double-click the **Anritsu Complex Modulation Clean-up Utility** icon in the Anritsu Complex Modulation program group. The Complex Modulation Clean-up Utility window, shown below, is displayed on the screen.



**Figure 2-11.** Anritsu Complex Modulation Clean-up Utility

### Cleaning up a File

To clean up a file, click the **Clean Up File** button.

The dialog box defaults to the file directory where the software is installed. Select the file to be cleaned and click **OK**.

The program will prompt you for a name for the cleaned file. Enter a name and click **OK**. The program will then clean up the file and prompt you when finished. Click the **OK** button to return to the Complex Modulation Clean-up Utility window.

Click the **Clean Up File** button to clean another file or click the **Close** button to terminate the program.

# Chapter 3 — Programming

## 3-1 Introduction

The computer/controller, running the Complex Modulation Interface program, sends commands via the GPIB or serial interface to directly control all of the signal generator's modulation capabilities. This chapter provides information and programming commands for both interface modes.

## 3-2 Communications

### GPIB

The computer/controller sends GPIB commands to the signal generator via the GPIB bus using standard GPIB data transfer and control functions. In response, the signal generator executes these commands.

[Table 3-1](#) provides a listing of the GPIB commands used by the complex modulation interface program to control the signal generator's modulation capabilities. For more information on remote operation of the signal generator using commands sent via the GPIB, refer to the GPIB Programming manual for the specific series signal generator.

### Serial

The computer/controller controls the signal generator's modulation capabilities via the serial interface. It initializes the serial interface by sending the string "CompMod" to the signal generator at 9600 baud. Upon receipt of this string, the signal generator goes into remote mode and awaits commands on the serial interface. When commands are received, the signal generator executes the commanded operations.

Commands are 2-byte binary numbers sent most significant byte first. The serial commands used by the complex modulation program to control the signal generator's modulation capabilities are the exact equivalent of the GPIB commands used, with a few additional serial-only commands.

### Waveform Data Transfer

Data transfer for a complex modulation waveform occurs following the GPIB command to prepare the synthesizer for receipt of the data. Once the synthesizer has received the command, it stores the next 65,536 values as the waveform data. If the waveform data comprises less than 65,536 values, the data is uniformly expanded to fill all 65,536 values. Refer to ["Waveform Information" on page 2-15](#) for information about complex modulation waveforms, an understanding of the waveform (.wfm) file, and how waveform data is processed by the synthesizer.

## 3-3 Programming Commands

Table 3-1 provides an alphabetical listing of the GPIB commands used by the Complex Modulation Interface program to control the signal generator's modulation capabilities. The table lists the GPIB command mnemonic (and integer value for the equivalent serial command) and a brief description of the command function.

Table 3-1. Programming Commands (1 of 4)

| MNEMONIC CODE       | FUNCTION   |
|---------------------|--|
| <b>ADP1 (0x262)</b> | Opens the internal AM % depth parameter. Must be followed by a number (between 0 and 100) and terminated by PCT (0x14a).   |
| <b>ADP2 (0x263)</b> | Opens the internal AM dB depth parameter. Must be followed by a number (between 0 and 25) and terminated by DB (0x140).  |
| <b>ALW (0x04a9)</b> | Prepares the signal generator to receive an AM waveform. A 2-byte value indicating the size of the waveform (minus 1) and 2-byte values containing the waveform data must immediately follow the command. Each waveform value is a 16-bit, unsigned integer consisting of two bytes, the upper half of the value followed by the lower half of the value. The size of the waveform must be a power of 2. |
| <b>AM0 (0x10c)</b>  | Turn off AM mode and disconnect internal AM function generator.  |
| <b>AM1 (0x10d)</b>  | Turn on AM linear mode and connect external AM input to AM circuitry.  |
| <b>AM2 (0x37f)</b>  | Turn on AM log mode and connect external AM input to AM circuitry.   |
| <b>AM7 (0x260)</b>  | Turn on AM linear mode and connect internal AM function generator to AM circuitry.   |
| <b>AM8 (0x261)</b>  | Turn on AM log mode and connect internal AM function generator to AM circuitry.  |
| <b>AMR (0x264)</b>  | Opens the internal AM rate parameter. Must be followed by a number (between 0.1 Hz and 1 MHz for sine wave; between 0.1 Hz and 100 kHz for square, triangle, and ramp waveforms) and must be terminated by MH (0x145), KH (0x144), or HZ (0x143).  |
| <b>AMS (0x111)</b>  | Opens the external AM %/V sensitivity parameter. Must be followed by a number (between 0 and 100) and terminated by PCV (0x306).   |
| <b>AMW (0x265)</b>  | Select internal AM function generator waveform. Must be followed by a waveform number (1=sine wave, 2=square wave, 3= positive ramp, 4=negative ramp, 5=Gaussian noise, 6=uniform noise, 7=triangle wave, and 8=user defined waveform).  |
| <b>AR0 (0x04b2)</b> | Disable random waveform access of the AM waveform.   |
| <b>AR1 (0x04b3)</b> | Enable random waveform access of the AM waveform.  |
| <b>ASD (0x266)</b>  | Opens the external AM dB/V parameter. Must be followed by a number (between 0 and 25) and terminated by DV (0x140).  |
| <b>D1 (0x287)</b>   | Opens the internal pulse delay 1 parameter. Must be followed by a number (between 0 and 419 ms at 40 MHz or 100 MHz pulse clock rate; between 0 and 1.6 s at 10 MHz pulse clock rate) and terminated with SEC (0x146), MS (0x149), US (0x148), or NS (0x14b).  |
| <b>D2 (0x288)</b>   | Opens the internal pulse delay 2 parameter. Must be followed by a number (between 100 ns and 419 ms at 40 MHz or 100 MHz pulse clock rate; between 300 ns and 1.6 s at 10 MHz pulse clock rate) and terminated with SEC (0x146), MS (0x149), US (0x148), or NS (0x14b).  |
| <b>D3 (0x289)</b>   | Opens the internal pulse delay 3 parameter. Must be followed by a number (between 100 ns and 419 ms at 40 MHz or 100 MHz pulse clock rate; between 300 ns and 1.6 s at 10 MHz pulse clock rate) and terminated with SEC (0x146), MS (0x149), US (0x148), or NS (0x14b).  |

Table 3-1. Programming Commands (2 of 4)

| MNEMONIC CODE       | FUNCTION   |
|---------------------|--|
| <b>D4 (0x28a)</b>   | Opens the internal pulse delay 4 parameter. Must be followed by a number (between 100 ns and 419 ms at 40 MHz or 100 MHz pulse clock rate; between 300 ns and 1.6 s at 10 MHz pulse clock rate) and terminated with SEC (0x146), MS (0x149), US (0x148), or NS (0x14b).  |
| <b>FDV (0x273)</b>  | Opens the internal FM deviation parameter. Must be followed by a number (between 1 kHz and 20 MHz in Locked, Locked Low-Noise, and Unlocked Narrow FM mode; between 100 kHz and 100 MHz in Unlocked Wide FM mode) and terminated by MH (0x145) or KH (0x144).  |
| <b>FLW (0x04ab)</b> | Prepares the signal generator to receive an FM waveform. A 2-byte value indicating the size of the waveform (minus 1) and 2-byte values containing the waveform data must immediately follow the command. Each waveform value is a 16-bit, unsigned integer consisting of two bytes, the upper half of the value followed by the lower half of the value. The size of the waveform must be a power of 2. |
| <b>FM0 (0x194)</b>  | Turn off FM mode and disconnect internal FM/ΦM function generator.   |
| <b>FM1 (0x195)</b>  | Turn on FM Unlocked Narrow mode and connect external FM/ΦM input to FM circuitry.  |
| <b>FM2 (0x496)</b>  | Turn on FM Locked Low-Noise mode and connect external FM/ΦM input to FM circuitry.   |
| <b>FM7 (0x270)</b>  | Turn on FM Unlocked Narrow mode and connect internal FM/ΦM function generator to FM circuitry.   |
| <b>FM8 (0x271)</b>  | Turn on FM Unlocked Wide mode and connect internal FM/ΦM function generator to FM circuitry.   |
| <b>FM9 (0x272)</b>  | Turn on FM Locked mode and connect internal FM/ΦM function generator to FM circuitry.  |
| <b>FML (0x197)</b>  | Turn on FM Locked mode and connect external FM/ΦM input to FM circuitry.   |
| <b>FMN (0x497)</b>  | Turn on FM Locked Low-Noise mode and connect internal FM/ΦM function generator to FM circuitry.  |
| <b>FMO (0x04ac)</b> | Disconnect the internal FM/ΦM function generator from the FM circuitry (only connected to the rear panel).   |
| <b>FMR (0x274)</b>  | Opens the internal FM rate parameter. Must be followed by a number (between 0.1 Hz and 1 MHz for sine wave; between 0.1 Hz and 100 kHz for square, triangle, and ramp waveforms) and terminated by MH (0x145), KH (0x144), or HZ (0x143).  |
| <b>FMS (0x198)</b>  | Opens the external FM sensitivity parameter. Must be followed by a number (between ±1 kHz/V and ±20 MHz/V in Locked, Locked Low-Noise, and Unlocked Narrow FM modes; between ±100 kHz/V and ±100 MHz/V in Unlocked Wide mode) and terminated by KV (0x220) or MV (0x254).  |
| <b>FMW (0x19b)</b>  | Turn on FM Unlocked Wide mode and connect external FM/ΦM input to FM circuitry.  |
| <b>FR0 (0x04b4)</b> | Disable random waveform access of the FM waveform.   |
| <b>FR1 (0x04b5)</b> | Enable random waveform access of the FM waveform.  |
| <b>FWV (0x275)</b>  | Select internal FM function generator waveform. Must be followed by a waveform number (1=sine wave, 2=square wave, 3= positive ramp, 4=negative ramp, 5=Gaussian noise, 6=uniform noise, 7=triangle wave, and 8=user defined waveform).  |
| <b>IP (0x215)</b>   | Turn on internal pulse modulation mode.  |
| <b>P0 (0x280)</b>   | Turn off pulse modulation mode.  |
| <b>PC1 (0x28f)</b>  | Select the 10 MHz internal pulse generator clock rate.   |
| <b>PC4 (0x290)</b>  | Select the 40 MHz or 100 MHz internal pulse generator clock rate.  |

Table 3-1. Programming Commands (3 of 4)

| MNEMONIC CODE        | FUNCTION  |
|----------------------|---|
| <b>PDY (0x30a)</b>   | Opens the internal pulse delay 1 parameter. Must be followed by a number (between 0 and 419 ms at 40 MHz or 100 MHz pulse clock rate; between 0 and 1.6 s at 10 MHz pulse clock rate) and terminated with SEC (0x146), MS (0x149), US (0x148), or NS (0x14b).   |
| <b>PER (0x312)</b>   | Opens the internal pulse period parameter. Must be followed by a number (between 250 ns and 419 ms at 40 MHz or 100 MHz pulse clock rate; between 400 ns and 1.6 s at 10 MHz pulse clock rate) and terminated by SEC (0x146), MS(0x149), US (0x148), or NS (0x14b).   |
| <b>PH0 (0x498)</b>   | Turn off $\Phi$ M mode and disconnect internal FM/ $\Phi$ M function generator.   |
| <b>PH1 (0x499)</b>   | Turn on $\Phi$ M Narrow mode and connect external FM/ $\Phi$ M input to the $\Phi$ M circuitry.   |
| <b>PH2 (0x49a)</b>   | Turn on $\Phi$ M Wide mode and connect external FM/ $\Phi$ M input to the $\Phi$ M circuitry.   |
| <b>PH7 (0x49f)</b>   | Turn on $\Phi$ M Narrow mode and connect internal FM/ $\Phi$ M function generator to $\Phi$ M circuitry.  |
| <b>PH8 (0x4a0)</b>   | Turn on $\Phi$ M Wide mode and connect internal FM/ $\Phi$ M function generator to $\Phi$ M circuitry.  |
| <b>PHD (0x4a1)</b>   | Opens the internal $\Phi$ M deviation parameter. Must be followed by a number (between 0.0005 and 5 radians in $\Phi$ M Narrow mode; between 0.05 and 500 radians in $\Phi$ M Wide mode) and terminated by RD (0x4a7)   |
| <b>PHO (0x04ae)</b>  | Disconnect the internal FM/ $\Phi$ M function generator from the FM circuitry (only connected to the rear panel).   |
| <b>PHR (0x4a3)</b>   | Opens the internal $\Phi$ M rate parameter. Must be followed by a number (between 0.1 Hz and 1 MHz for sine wave; between 0.1 Hz and 100 kHz for square, triangle, and ramp waveforms) and terminated by MH (0x145), KH (0x144), or HZ (0x143).   |
| <b>PHS (0x4a4)</b>   | Opens the external $\Phi$ M sensitivity parameter. Must be followed by a number (between $\pm 0.0005$ radians/V and $\pm 5$ radians/V in $\Phi$ M Narrow mode; between $\pm 0.05$ radians/V and $\pm 500$ radians/V in $\Phi$ M Wide mode) and terminated by RV (0x4a8).  |
| <b>PHV (0x4a5)</b>   | Select internal $\Phi$ M function generator waveform. Must be followed by a waveform number (1=sine wave, 2=square wave, 3= positive ramp, 4=negative ramp, 5=Gaussian noise, 6=uniform noise, 7=triangle wave, and 8=user defined waveform).   |
| <b>PLW (0x04ad)</b>  | Prepares the signal generator to receive a $\Phi$ M waveform. A 2-byte value indicating the size of the waveform (minus 1) and 2-byte values containing the waveform data must immediately follow the command. Each waveform value is a 16-bit, unsigned integer consisting of two bytes, the upper half of the value followed by the lower half of the value. The size of the waveform must be a power of 2. |
| <b>PMD (0x28b)</b>   | Selects the internal pulse modulation mode. Must be followed by a number (1=single, 2=doublet, 3=triplet, and 4=quadruplet).  |
| <b>PMR0 (0x04b6)</b> | Disable random waveform access of the $\Phi$ M waveform.  |
| <b>PMR1(0x04b7)</b>  | Enable random waveform access of the $\Phi$ M waveform.   |
| <b>PR (0x320)</b>    | Opens the internal pulse frequency parameter. Must be followed by a number (between 2.385 Hz and 4 MHz at 40 MHz or 100 MHz pulse clock rate; between 0.597 Hz and 2.5 MHz at 10 MHz pulse clock rate) and terminated MH (0x145), KH (0x144), or HZ(0x143).   |
| <b>PTF (0x28e)</b>   | Select internal pulse triggering on the falling edge of an external input.  |
| <b>PTG (0x28c)</b>   | Select the internal pulse trigger. Must be followed by a number (1=free run, 2=gated, 3=delayed, 4=triggered, 5=triggered with delay, and 6=composite).   |
| <b>PTR (0x280)</b>   | Select internal pulse triggering on the rising edge of an external input.   |

Table 3-1. Programming Commands (4 of 4)

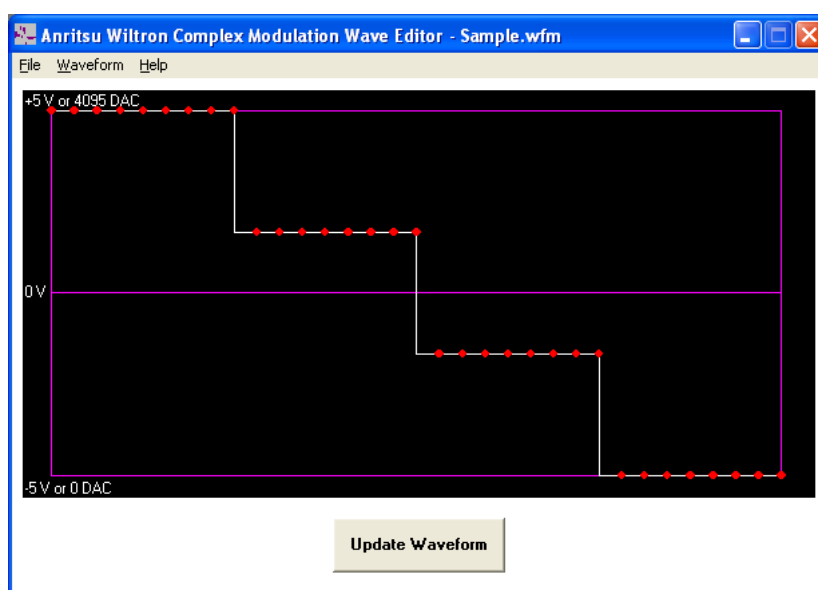
| MNEMONIC CODE       | FUNCTION  |
|---------------------|---|
| <b>PW (0x321)</b>   | Opens the internal pulse width 1 parameter. Must be followed by a number (between 25 ns and 419 ms at 40 MHz or 100 MHz pulse clock rate; between 100 ns and 1.6 s at 10 MHz pulse clock rate) and terminated by SEC (0x146), MS (0x149), US (0x148), or NS (0x14b).  |
| <b>SC0 (0x291)</b>  | Turn off SCAN mode.   |
| <b>SC1 (0x292)</b>  | Turn on SCAN mode.  |
| <b>SR0 (0x04b9)</b> | Disable synchronization of the AM and FM/ΦM randomizers.  |
| <b>SR1 (0x04ba)</b> | Enable synchronization of the AM and FM/ΦM randomizers. Note: The SR0 or SR1 commands should be sent before the WFS and waveform data are sent to the signal generator. The commands will not function properly if not sent in the correct order.   |
| <b>W1 (0x283)</b>   | Opens the internal pulse width 1 parameter. Must be followed by a number (between 25 ns and 419 ms at 40 MHz or 100 MHz pulse clock rate; between 100 ns and 1.6 s at 10 MHz pulse clock rate) and terminated by SEC (0x146), MS (0x149), US (0x148), or NS (0x14b).  |
| <b>W2 (0x284)</b>   | Opens the internal pulse width 2 parameter. Must be followed by a number (between 25 ns and 419 ms at 40 MHz or 100 MHz pulse clock rate; between 100 ns and 1.6 s at 10 MHz pulse clock rate) and terminated by SEC (0x146), MS (0x149), US (0x148), or NS (0x14b).  |
| <b>W3 (0x285)</b>   | Opens the internal pulse width 3 parameter. Must be followed by a number (between 25 ns and 419 ms at 40 MHz or 100 MHz pulse clock rate; between 100 ns and 1.6 s at 10 MHz pulse clock rate) and terminated by SEC (0x146), MS (0x149), US (0x148), or NS (0x14b).  |
| <b>W4 (0x286)</b>   | Opens the internal pulse width 4 parameter. Must be followed by a number (between 25 ns and 419 ms at 40 MHz or 100 MHz pulse clock rate; between 100 ns and 1.6 s at 10 MHz pulse clock rate) and terminated by SEC (0x146), MS (0x149), US (0x148), or NS (0x14b).  |
| <b>WFS (0x04b8)</b> | Enable synchronization of the internal AM and FM/ΦM function generators.<br>Note: The WFS command must be sent before and after any waveform as shown in the following example:<br><code>WFS ALW&lt;2-byte binary data for waveform size&gt;&lt;2-byte binary data for waveform data&gt; PLW&lt;2-byte binary data for waveform size&gt;&lt;2-byte binary data for waveform data&gt; WFS</code> |
| <b>XP (0x373)</b>   | Turn on external pulse modulation mode.   |
| <b>0x04af</b>       | Exit serial remote mode. Must be sent when serial communications are completed. This is a serial-only command.  |
| <b>0x04b0</b>       | Set signal generator serial port to 9600 baud. This is the default setting. This is a serial-only command.  |
| <b>0x04b1</b>       | Set signal generator serial port to 19200 baud. This is a serial-only command.  |

## 3-4 Program Example

### Description

The C code example in this section sends a user defined stepped saw tooth wave in AM mode. The following set of values define the waveform, which are illustrated in the Wave Editor in [Figure 3-1](#).

|      |      |      |      |      |      |      |      |
|------|------|------|------|------|------|------|------|
| 4095 | 4095 | 4095 | 4095 | 4095 | 4095 | 4095 | 4095 |
| 4095 | 4095 | 4095 | 4095 | 4095 | 4095 | 4095 | 4095 |
| 2730 | 2730 | 2730 | 2730 | 2730 | 2730 | 2730 | 2730 |
| 2730 | 2730 | 2730 | 2730 | 2730 | 2730 | 2730 | 2730 |
| 1365 | 1365 | 1365 | 1365 | 1365 | 1365 | 1365 | 1365 |
| 1365 | 1365 | 1365 | 1365 | 1365 | 1365 | 1365 | 1365 |
| 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |



**Figure 3-1.** Sample User Defined Waveform

The ALW command takes two arguments, the *number* of waveform values and the *list* of waveform values. Each waveform value consists of 2 bytes. The arguments specify 64 values by sending the first argument of 63, then sending the second argument of 64 pairs of bytes (128 bytes) that define the waveform value list. The values start off as 0x0FFF or 4095, then 0x0AAA or 2730, and so on. The C code initializes an unsigned char array, which must be initialized with byte values. Each value is broken up into its upper byte and its lower byte. For example, 0xFFF is broken into 0x0F and 0xFF.



## Example Code

```
// Complex Modulation Example.cpp
#define _WIN32_WINNT 0x0501 // Windows XP minimum required platform
#include "ni4882.h"
#include <stdio.h>
#include <tchar.h>
#include <string.h>

int _tmain(int argc, _TCHAR* argv[]) {
    int          sigGen;
    char         *cmd;
    // Define the ALW command and its arguments, one less than the number of values
    // and the stream of 2-byte values that define the waveform.
    unsigned char alwCmd[133] = {
        0x41, 0x4c, 0x57,    // 'A','L','W'
        0x00, 0x3f,        // 64 values minus 1 is 63
        0x0f, 0xff, 0x0f, 0xff, 0x0f, 0xff, 0x0f, 0xff, 0x0f, 0xff, 0x0f, 0xff, 0x0f, 0xff, 0x0f, 0xff,
        0x0f, 0xff, 0x0f, 0xff, 0x0f, 0xff, 0x0f, 0xff, 0x0f, 0xff, 0x0f, 0xff, 0x0f, 0xff, 0x0f, 0xff,
        0x0a, 0xaa, 0x0a, 0xaa, 0x0a, 0xaa, 0x0a, 0xaa, 0x0a, 0xaa, 0x0a, 0xaa, 0x0a, 0xaa, 0x0a, 0xaa,
        0x0a, 0xaa, 0x0a, 0xaa, 0x0a, 0xaa, 0x0a, 0xaa, 0x0a, 0xaa, 0x0a, 0xaa, 0x0a, 0xaa, 0x0a, 0xaa,
        0x05, 0x55, 0x05, 0x55, 0x05, 0x55, 0x05, 0x55, 0x05, 0x55, 0x05, 0x55, 0x05, 0x55, 0x05, 0x55,
        0x05, 0x55, 0x05, 0x55, 0x05, 0x55, 0x05, 0x55, 0x05, 0x55, 0x05, 0x55, 0x05, 0x55, 0x05, 0x55,
        0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00,
        0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00
    };

    sigGen = ibdev(0, 5, 0, T10s, 1, 0);
    cmd = "RST ADP1 80PCT AMR 1KH AM7 WFS";
    ibwrt(sigGen, cmd, strlen(cmd));

    // Send the ALW command to load the user-defined waveform into the signal generator.
    ibwrt(sigGen, alwCmd, sizeof(alwCmd));

    // Select the user-defined waveform.
    cmd = "WFS AMW8";
    ibwrt(sigGen, cmd, strlen(cmd));

    ibloc(sigGen);
    ibonl(sigGen, 0);

    return 0;
}


```





# Anritsu



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