Tip/Ring Signal Simulator

PSTN Emulation

User Guide & Reference Manual

(Applies to AI-7280 & AI-80)

Advent Instruments Inc.

Release 2.00a – August 2009

Printed in Canada

Advent Instruments Inc.
111 - 1515 Broadway Street
Port Coquitlam, BC, V3C6M2
Canada

Internet: techsupport@adventinst.com
sales@adventinst.com

Web Site: http://www.adventinstruments.com

Telephone: (604) 944-4298
Fax: (604) 944-7488

Contents

1. Introduction

The TRsSim software is designed to provide a wide range of telephony testing capabilities. Working in conjunction with either the AI-7280 Central Office Line Simulator or the AI-80 Caller ID Signal Generator, its features include:

- Multi-country Type I and Type II Caller ID signal generation
- SM-SC (Short Message - Service Center) emulation
- DTMF & pulse dialing detection and analysis
- Network tone, DTMF, and MF tone generation
- Programmable ringing generator

This document contains information on the installation, setup, and usage of the TRsSim software. Consult the following sections for more detailed information on the various program aspects.

- **Installation & Setup** on page 4 provides instructions for installing the software as well as minimum PC requirements and setting up the hardware.
- **Basic Operation** on page 10 gives a basic overview of the software and its operation. It describes how the main control panel operates along with how to access the various program functions.
- **Program Settings** on page 32 explains in detail the effect of various settings, how to define tones and ringing patterns, along with DTMF and pulse dialing limits.
- **Caller ID Signal Generation** on page 41 contains a detailed description of the different Caller ID types supported, how messages are created, how signaling types work, and the effect of the signal settings.
- **SMS Service Center Emulation** on page 57 provides information on how to configure the software in order to test and emulate a SM-SC. This includes information on the supported SMS types, general SC settings, TL messages, and the message flow setups.
- **Signal Analysis & Generation** on page 84 explains how to make measurements and generate various signals. These include simple tones, patterned tones, DTMF, FSK and ringing.
- **Additional Information** on page 93 contains various topics describing hardware setup details, enabling optional components, and device specific features.

2. Installation & Setup

This section provides information on how to install the software and configure it for use with either the AI-7280 or AI-80 devices. If any problems are encountered please see the Technical Support section on how we can be contacted to provide assistance.

2.1 System Requirements

Computer/Processor:	PC with Pentium 4 (2 GHz) or greater
Memory:	512 MB of RAM
Display:	SVGA or greater
Operating System:	Microsoft Windows 2000, XP, Vista

It may be possible to use the TRsSim software with different PC configurations containing less RAM, lower resolution display, and different operating systems. Under most conditions it is likely that the software will operate correctly; however being outside our testing environment we can not ensure system resource limitations will not occur.

2.2 Software Installation

To start using the AI-7280 the TRsSim application software must first be installed followed by the installation fo the USB driver to allow communication to the PC. During the installation of the software the AI-7280 should not be connected to the PC.

When installing the software from the supplied CD, insert the CD in your PC's CD-ROM drive. Automatically your default browser software should display a screen showing the various products from Advent Instruments. Click the mouse on the applicable hardware device ie AI-7280. This displays a new screen listing product specific software applications and documents. Click the mouse on the **TRsSim - PSTN Emulation** item. This executes the software's setup program. Follow the instructions displayed on the screen to complete the installation.

If the CD does not auto start, click the **Start** button on the Windows Task Bar. Choose **Run**, then type D:\index.htm in the **Open** textbox and click **OK**. If the PC's CD-ROM is not mapped to driver letter 'D', then substitute the appropriate drive letter.

Alternatively, the software can be downloaded from our web site at

http://www.adventinstruments.com

as a single file executable. To install the software simply run the single file executable and follow the instructions presented.

At this point the TRsSim application is installed but in order to connect via USB the installation of the USB driver described in the following section must be completed.

Software updates are made available on our web site for download. The TRsSim software can be configured to periodically check for a newer version. If one is available, a message is displayed and you may download the latest files. When executing the TRsSim software for the first time, you will be asked if periodic update checks should be enabled.

2.3 USB Driver Installation

The proper drivers must be installed before a USB connection can be established with the AI-7280. If a serial RS-232 connection is used with the AI-7280 then the USB driver installation is not required.

Note: For detailed, step-by-step, instructions on installing the driver, see: Appendix D: USB Driver Installation on page 109.

In summary, the installation of the AI-7280 USB driver requires the following steps:

1. Ensure sufficient operating system rights are available to install device drivers. This normally requires using the **administrator** account.
2. Power up the AI-7280.
3. Connect the AI-7280 to the PC using a USB cable.
4. The windows operating system will indicate that it has found a new device and is requesting the location for the proper driver. Specify that the driver is located in the **\drivers** subdirectory of the TRsSim software. If the default directory was used during the software installation, this will be:

   C:\Program Files\Advent\TRsSim\Drivers

5. A message should be displayed indicating the successful installation of the driver.

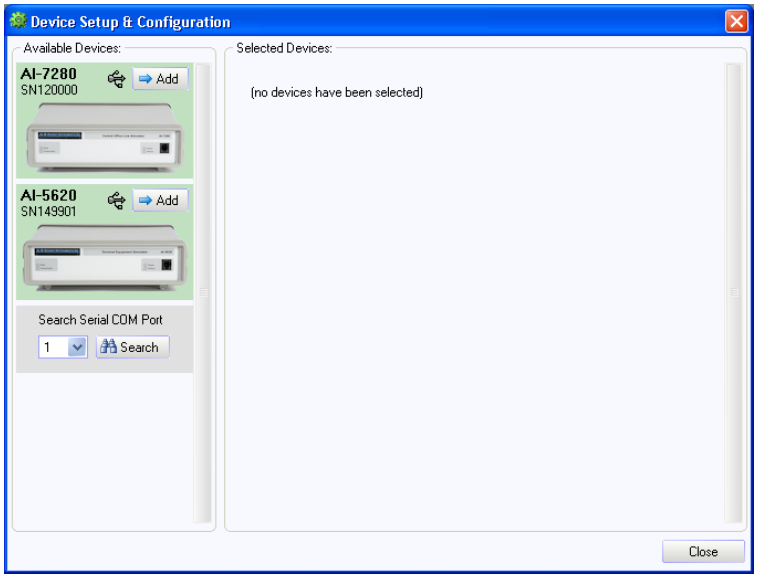
2.4 First Time Setup

After completing the software installation you can execute the TRsSim program. By default the installation process adds an entry to the Programs menu under the folder **Advent Instruments**. Selecting the **Tip-Ring Signal Simulator** entry in this folder starts the program.

As the TRsSim software functions with various hardware devices (AI-5120, AI-5620, AI-80), it needs to be told to search for an AI-7280 Central Office Simulator . Shortly after starting the program, the following window is shown.

Click the **Demonstration Mode** button if you do not have any hardware connected to the PC and would like to evaluate the software. This bypasses the hardware setup and continues the process of loading the remainder of the software. By running in demonstration mode the software is unable to control any connected hardware; however the various software features and general user interface can be explored.

If an AI-7280 is connected to the PC, click the **Configure and Setup Hardware** button. TRsSim will then display the device setup window. This window is divided into two columns. The left column lists all devices that are currently connected to the PC and are available for use. The right column lists all the devices that TRsSim is currently connected to. Initially the right column will be empty.



The above figure shows that two devices, an AI-5620 and AI-7280 are available to TRsSim. Select the desired device and add it to the list of selected devices, by clicking the **Add** button

Note that the TRsSim software supports up to four devices simultaneously. Only devices connected via USB are automatically displayed in the left column. To find devices connected on a serial COM port, click the **Search** button.

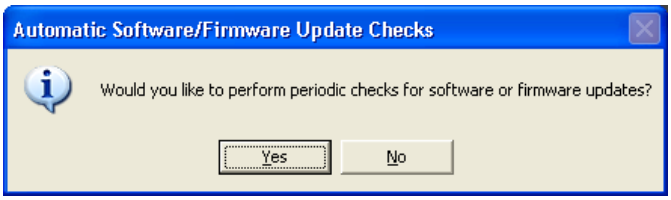
Once the **Add** button is clicked, the TRsSim software attempts to establish communications with the AI-7280. A software license key will have to be entered the first time it connects to the selected device. The key is included with the documentation

provided with the AI-7280. It is composed of the numbers 0 to 9, and the capital letters A to Z (with the exception of the letter 'O'). The letter 'O' is not used in the key so to avoid confusion with the number zero. The software key is linked to the serial number of the AI-7280. This allows the installation of the TRsSim software on multiple PC's, however only when the hardware device with the matching serial number is connected are the software features available. After entering the software key, click the **OK** button.

The TRsSim software remembers the software key for each device connected, so this is the only time it will have to be entered.

Once a connection is established, the TRsSim software will ask if you wish to enable periodic checks for newer versions of both the TRsSim software and the AI-7280 firmware. If you do not wish to enable this feature, click **No**. If **Yes** is clicked, an immediate check is made for updates and additional checks will be made once every 30 days upon program startup. This update feature and the interval of the update checks can also be changed from the **Preferences** window.

Note, the TRsSim software can only check for updates if it is permitted access to the internet by the PC and firewall software if installed.

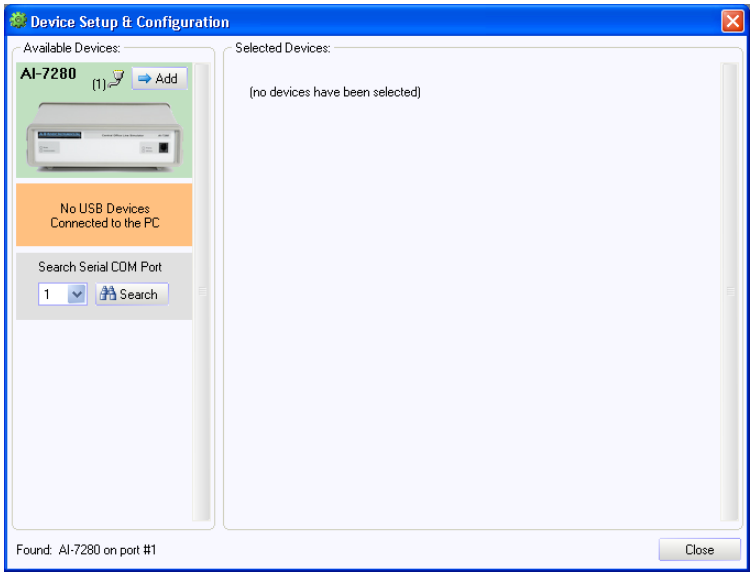


At this point the AI-7280 is ready to perform actions or monitor the telephone line. See Section 3. Basic Operation for an overview of the TRsSim software and using it with the AI-7280.

2.5 Using a RS-232 Connection

The preferred interface to the PC from the AI-7280 is USB but if that is not available then the unit may also use the older RS-232 serial bus. In order to find the AI-7280 or

AI-80 the COM port must be specified from the pull down menu and then the search button pressed. The following window is displayed.



A software key will have to be entered the first time it connects to the selected device. The key is included in the documentation provided with either the AI-7280 or AI-80. It is composed of the numbers 0 to 9, and letters A to Z (with the exception of the letter 'O'). The letter 'O' is not used in the key so as to avoid confusion with the number zero. The software key is linked to the serial number of the device. This allows the installation of the TRsSim software on multiple PC's, however only when the hardware device with the matching serial number is connected are the software features available.

After entering the software key, click **OK** . The TRsSim software remembers the software key for each device connected. As such, it will not have to be entered again.

2.6 Technical Support

For assistance in program installation, hardware setup, or general technical questions, please contact us in any of the following methods.

- **Email**:

  techsupport@adventinst.com

- **In North America**:

  Tel (604) 944-4298
  Fax (604) 944-7488
  Mail Advent Instruments Inc.
  111 - 1515 Broadway St.
  Port Coquitlam, BC, V3C6M2
  Canada

- **In Asia**:

  Tel (852) 8108-1338
  Fax (852) 2900 9338
  Mail Advent Instruments (Asia) Ltd.
  Unit 42, 18/F., Block D,
  Wah Lok Industrial Centre, Phase II,
  31 / 35 Shan Mei Street,
  Fotan, Shatin, New Territories, Hong Kong

Product updates providing new features and bug fixes are made available on our web site at:

http://www.adventinstruments.com

If unexpected results or any program errors are detected, please contact us in any of the above manners. In order to help us resolve encountered problems, it is recommended that all of the TRsSim settings and collected data are saved to a file. This is accomplished by selecting the **File** menu followed by the **Save as Configuration File** command. If you can email us this file as well as a description of the problem, it greatly helps our ability re-create similar operating conditions.

3. Basic Operation

This section provides a brief description of the common and basic features of the TRsSim software. It is a good starting point for understanding how the user interface works along with performing the basic operations.

For more detailed information on the various program capabilities and settings, see one of the following sections:

- **Program Settings** on page 32.
- **Caller ID Signal Generation** on page 41.
- **SMS Service Center Emulation** on page 57.
- **Signal Analysis & Generation** on page 84.
- **Additional Information** on page 93.

3.1 Features and Capabilities

The TRsSim software provides a large number of features and testing capabilities; however not all of them may be available. Some features may not be available due to hardware constraints while others are only available as an optional software component to TRsSim. The following table lists the various features of the TRsSim software, including device limitations and which features are only available as a software option.

The basic PSTN functions are available to all versions of the TRsSim software. Some capabilities present when using the AI-7280 may be restricted when using the AI-80 due to hardware limitations.

Basic PSTN Features:

Description	AI-80 Restrictions	AI-7280 Restrictions
Generate programmable tones adjustable frequency, level, pattern, up to 4 tones pre-defined: dial, busy, ring back, stutter dial	only 2 tones available, no simultaneous noise	-
DTMF Measurement Low and high group level Low and high group frequency Total and twist level Duration and inter-digit time	timing measurement not available	-
Pulse Dialing Measurement Make time (min, max, average) Break time (min, max, average) Ratio and PPS (pulses per second)	-	-
Measure line flash timing	-	-
Adjustable DTMF digit limits	-	-

Adjustable pulse dialing & flash timing limits	-	-
Generate Telecordia based FSK Caller ID Type I (on-hook) signaling Send data after 1st ring Send data after OSI Type II (off-hook) signaling Send CAS, wait for ACK, send data Message types supported Single/Multiple Message Single/Multiple Visual Message Waiting Parameter types supported Date/time, calling number, number absence, calling name, name absence, visual waiting	-	-
Generate ETSI based FSK Caller ID Type I (on-hook) signaling Send data after 1st ring RP-AS before data (with and without ringing) DT-AS before data (with and without ringing) Line reversal, DT-AS before data (with and without ring) Type II (off-hook) signaling Send CAS, wait for ACK, send data Message types supported Call Setup, Visual Message Waiting Parameter types supported Date/time, calling number, number absence, calling name, name absence, visual waiting	-	-
Generate DTMF based Caller ID Type I (on-hook signaling) Send data before ringing RP-AS before data with subsequent ringing Line reversal before data with subsequent ringing Line reversal, wait off-hook, send data Type II (off-hook signaling) Send data Message structure Up to 4 fields with programmable start code programmable stop code maximum of 64 DTMF digits	-	-
Measure Type II (off-hook) Caller ID ACK digit ACK Digit code Low and high group level Low and high group frequency Total and twist level	-	-
Telephone Interface: Line Voltage & Loop Current	48V fixed line voltage, loop current either 26 or 45 mA. Fixed constant current mode.	Voltage from 0 to 72 V, Current from 15 to 72 mA. Either constant voltage or constant current mode.
Telephone Interface: Adjustable Off-Hook Threshold Current	not available	5 to 15 mA
Telephone Interface: Impedance	600/900 ohm, and optional complex	600/900 ohm, TBR-21, and optional complex
Telephone Interface: Balance Impedance	not available	600/900 ohm, TBR-21, and optional complex
Programmable ringing generator adjustable frequency, level, pattern, wave shape, and DC offset voltage	wave shape always sine, fixed DC offset voltage	-
Generate DTMF tones adjustable level, twist, freq. offset, on/off time	-	-
Generate MF tones adjustable level, freq. offset, on/off time ITU Q.320, Q.441, and user define tone tables	-	-

Generate FSK signals (separate from Caller ID) adjustable mark/space level and frequency, baud rate	-	-
Generate metering pulses Adjustable frequency, level, duration, rate	not available.	-.
Generate broadband white noise adjustable level	-	-
Measure wide band signal level & frequency Level units of either dBm (600 ohms), dBV, or mVrms	frequency measurement not available	-
Selectable AC Filters LPF, HPF, LFP+HPF, Band pass, notch , dual notch DTMF LPF, DTMF HPF, C-message weighted	not available	-
Measure signal THD+N and DTMF THD+N	not available	-
Measure DC line voltage and loop current	not available	-
Monitor telephone line signals on BNC output connector	only if I/O module is installed	-
Inject signals onto the telephone line with the BNC input	only if I/O module is installed	-
Monitor telephone line signals with the built-in speaker	-	not available

Support for the SM Service Center Emulation (AI-ET001) is an optional component to the TRsSim software. Unless ordered when the TRsSim software was purchased, the features will not be available. This option can be added to the TRsSim software at any future date. It allows for testing of a SMS capable TE to either the ETSI ES 201 912 protocol 1 or protocol 2 standard.

SM Service Center Emulation Features:

Description	AI-80 Restrictions	AI-7280 Restrictions
Supports ETSI ES 201 912 standard Protocol 1 DLL and TL layers Protocol 2 DLL and TL layers	-	-
Supports the following protocol 1 PDU types SMS-DELIVER SMS-DELIVER-REPORT SMS-SUBMIT SMS-SUBMIT-REPORT SMS-STATUS-REPORT	-	-
Supports the following protocol 2 TL messages SMS-SUBMIT SMS-DELIVER SMS-STATUS-REP SMS-SUBMIT-REP SMS-DELIVER-REP SMS-TE-STATUS SMS-TE-CAPABILITY	-	-
Adjustable sending FSK parameters Mark/space tone level Mark/space tone frequency Baud rate	-	-
Programmable PSTN connection delay and network tone	-	-
Programmable FSK reception limits, frame timing	-	-
Separate SM-SC numbers for TE submit or TE delivery	-	-
Pre-programmed setups for ETSI ES 201 912 Protocol 1, Annex A 1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7, 1.8, 1.10 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8, 2.9, 2.10 Protocol 2, Annex B 1.3.1, 1.3.2, 1.3.3, 1.3.4, 1.3.5, 1.3.6, 1.3.7, 1.3.9	-	-
Create stand alone AI-80 test program using current setup for production environment	-	-

Support for the Advanced Caller ID functions (AI-ET002) is an optional component to the TRsSim software. Unless ordered when the TRsSim software was purchased, it will not be available. This option can be added to the TRsSim software at any future date. It expands the basic Caller ID capabilities in the manner described below.

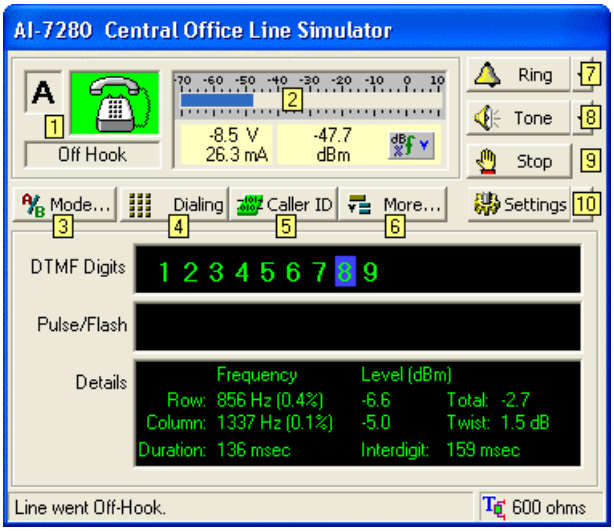
Advanced Caller ID Features:

Description	AI-80 Restrictions	AI-7280 Restrictions
Supports Japanese NTT Caller ID type Type I (on-hook) Caller ID Signaling Type II (off-hook) Calling ID Signaling Message Parameters: Calling Number (02h), Number Absence (04h), Calling Name (07h), Name Absence (08h), DDI Number (09h), Original Number (0Bh), Calling Number Ext. (21h), Public Message (24h)	Type II Signaling not available	-
Programmable FSK parameters Mark/space tone level Mark/space tone frequency Baud rate, bit timing skew Starting phase	-	-
Programmable DTMF parameters Level and twist Frequency offset On/off time Arbitrary tone mapping for non-DTMF standards	-	-
Programmable SAS and DT-AS/CAS setting Level, frequency, duration	-	-
Programmable ACK digit limits Digit type, low and high group minimum level, frequency error	-	-
Expanded ETSI message types Advice of Charge Short Message Service	-	-
Expanded Telecodia parameter types DDN, Call Qualifier	-	-
Expanded ETSI parameter types Called Line, Call Type, Number of Messages Comp. Calling Line, First Called Line Type of Forward, Type of User, Redirecting Number Extension for Network Use Message Identity, Last Message CLI Comp. Date/Time, Call Duration Provider Identify, Carrier Identify, Terminal Function Service Information, Display Information Charge, Additional Charge	-	-
Auto field increment for message parameters		
Programmable signaling types Modify existing signaling types Create new signaling types	-	-
Programmable Caller ID impairments Interfering tone (up to two tones) Interfering noise FSK carrier drop-outs (up to two) Echo noise	not available	-
Expanded FSK message capabilities Programmable channel seizure bits Programmable mark bits Programmable stop bits Programmable mark out bits Programmable data encoding (parity type) Programmable checksum type Scripted messages - allows for arbitrary message contents	-	-
Measure Type II (off-hook) Caller ID ACK digit timing	not available	-
Measure Type II (off-hook) Caller ID parallel set detect	not available	-

3.2 The Main Control Panel

The main control panel is at the heart of the TRsSim software. It provides both a summary view of the current telephone line status as well as a central location from where various actions are issued.

Each hardware device the TRsSim software is connected to is represented as a separate control panel. The AI-7280 or AI-80 control panel as displayed at program startup is shown below. The top half of the window is fixed for displaying status information and control buttons, while the bottom half is more flexible. It can show dialing information, Caller ID setup, SMS setup, and signal analysis & generation information.



The numbers 1 to 10 shown above denote the following aspects of the control panel.

1. **Line Status:** The graphical icon and the text field beneath it represent the current state of the telephone line. The various states shown are: on-hook, off-hook, ringing, tones active, and FSK data transmission.
2. **Level Meter:** The wide band level meter shows the AC RMS signal level present on the telephone line. Clicking the button to the right of marker 2 presents a list of units to choose from. These can be either dBm (600 ohms), dBV, or mVrms. The sliding scale graphically represents the level in the selected units, except when mVrms is selected. In that case, the scale defaults to dBV. In addition to the AC signal level, the AI-7280 displays line voltage and loop current measurements. These two measurements are not available on the AI-80.
3. **Mode Button:** The TRsSim software always operates in one of two exclusive modes. The modes are **PSTN Emulation** or **Signal Analysis & Generation**. Clicking this button displays a drop-down list from which one of the two modes can be selected.
   - **PSTN Emulation:** This mode is used to perform various PSTN related functions. This includes generating ringing, tones, sending Caller ID transmissions, and sending or receiving SMS messages.
   - **Signal Analysis & Generation:** In this mode, a number of different signal measurements can be made. These includes RMS level,

THD+N, DTMF frequency and level, and THD+N for DTMF tones. In addition, various signal filters can be inserted in the signal measurement path. A flexible signal generator can be used for creating various tones such as DTMF, FSK, noise, or ringing. Note that not all of the above features are supported with the AI-80 hardware.

4. **Show Dialing Button:** Clicking the mouse on this button causes the bottom half of the window to show the dialing panel (as shown above). This panel shows the last 16 DTMF digits detected and the last 16 pulse digits detected. In addition, the duration of any line flash is shown.
5. **Show Caller ID Button:** Clicking this button displays the current Caller ID settings in the bottom half of the window. From this display, the Caller ID type, signaling, and message are chosen.
6. **Show More Button:** Clicking this button causes a drop-down list to appear, giving additional selections for the bottom half of the window. The selections available are either **Short Message Service**, **Metering Pulse Generator** or **None** which hides the bottom half of the window.
7. **Start Ringing Button:** Starts the ringing generator with the last selected ringing pattern. To select a ringing pattern, click the mouse on the down arrow at the right side of the button. A drop-down list appears with all of the currently defined ringing patterns. Additional ringing patterns are created in the **Ringing Pattern** settings window. Note that ringing can only be started if the line status shows on-hook.
8. **Start Tone Button:** Starts the tone generator with the last selected tone definition. To select a tone, click the mouse on the down arrow at the right side of the button. A drop-down list appears with all of the currently defined tones. Additional tones are created in the **Tone Definitions** settings window.
9. **Stop Button:** Clicking this button stops any ringing, tones, Caller ID transmissions, or SMS sessions that may be active.
10. **Show Settings Panel Button:** Displays the last selected settings window. To display a specific settings window, click the mouse on the down arrow at the right side of the button. Shown is a drop-down list with all of the various settings windows. To display any of the settings window, select it from the list.

3.3 Tones, Ringing, and Dialing

3.3.1 Controlling the Tone Generator

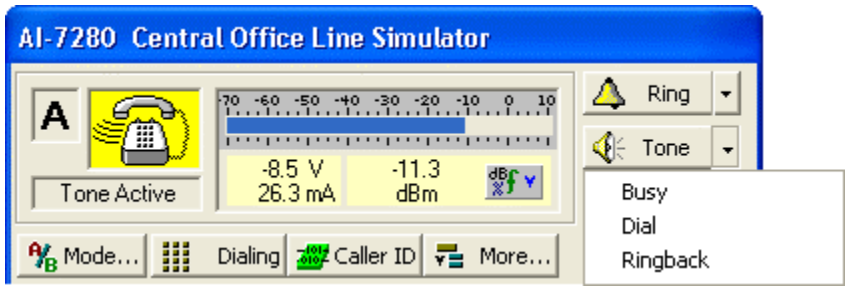
Generating a tone is accomplished by simply clicking the mouse on the **Tone** down arrow button and making the desired selection. Upon program startup, five tones are pre-defined. They are busy, dial, ring-back, double ring-back, and stutter dial. The characteristics of these five tones can be changed, or new tones can be defined. These characteristics include frequencies, level, patterns, events to turn off the tone, and events that can turn on the tone. All of these can be modified by viewing the **Tone Definition** settings window.

For more information on how to modify the tone definitions, see the section: Tone Definitions on page 34.

The AI-7280 has the capability to playback short waveform files. They are selected by choosing the Play Waveform command shown at the bottom of the tone list. For more information on importing and playing back waveforms, see the section: Playing Waveforms on page 29.

To turn off a tone, click the **Stop** button. Note that starting the ring generator, a Caller ID transmission, or an SMS session also terminates any active tone.

Clicking the mouse on the **Tone** button (not the down arrow to the right of it) starts the last used tone definition. This provides a shortcut if the same tone needs to be activated multiple times.



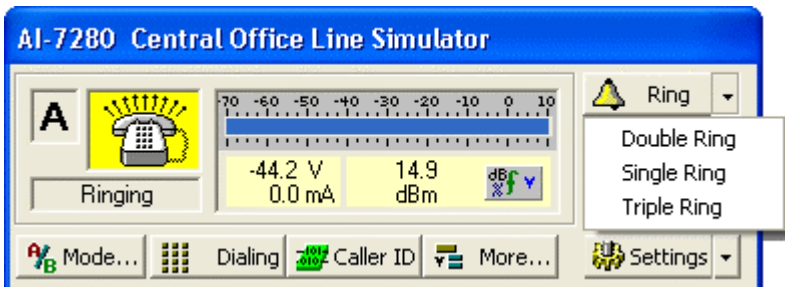
3.3.2 Controlling the Ring Generator

Operating in an almost identical manner to the tones, is the ringing generator. To start the ring generator, the down arrow to the right of the **Ring** button is clicked. This displays a list of all the defined ringing patterns. Select one with the mouse and the ringing begins. Three basic ringing types are defined upon program start; however, more can be defined or the existing ring patterns can be changed. This is done by viewing the **Ring Patterns** settings window.

For more information on how to modify the ringing parameters (frequency, level, pattern, wave shape), see the section: Ringing Patterns on page 33.

As with the tones, clicking the Ring button (not the down arrow to the right of it) starts the last ringing pattern again. It should be noted that if the TE is off-hook, ringing can not be initiated.

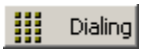
Ringing will be stopped if the TE goes off-hook, a tone is started, a Caller ID transmission is started, a SMS session is started, or when the **Stop** button is pressed.



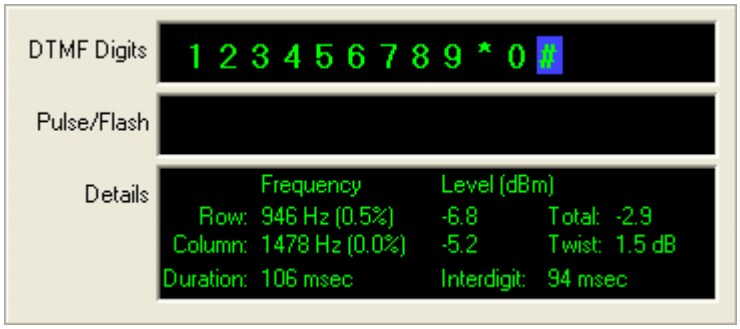
The AI-7280 ringing generator supports multiple wave shapes. The basic shapes are sine, triangle, and square. A user defined wave shape can also be selected. To view and modify the user defined wave shape, see the section: Custom Ringing Wave Shape on page 39.

3.3.3 DTMF Dialing Capture

Anytime the TE is off-hook, the TRsSim software monitors the line for DTMF digits. The last 16 digits are displayed in the dialing panel on the lower half of the control panel. By default, the dialing panel is visible upon program startup. To view it at any time simply click the mouse on the **Dialing** button.



An example of captured DTMF dialing follows below. The window shows the last 12 digits dialed with the first being '1' and the last being '#'. The lower portion of the window contains various details for the last digit dialed. In this case the '#' digit. Shown is the row and column frequency, frequency error (in percentage), and level, in addition to the total level and twist level.



The blue shading behind the DTMF digit is used to indicate for which digit the detailed data represents. Normally this is always the last digit. However clicking the mouse on any of the digits highlights it with the blue background and displays the measurement details.

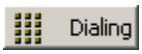
Limits for all of the DTMF digit measurements can be viewed and modified in the **DTMF Dialing Limits** settings window. If any characteristic is outside the corresponding limit the digit is displayed in a red color (with a bar overhead). Additionally the level or frequency that is outside the limit is displayed in red as well.

The default units for level are dBm. However this can be changed to either dBV or mVrms by changing the setting in the **DTMF Dialing Limits** window.

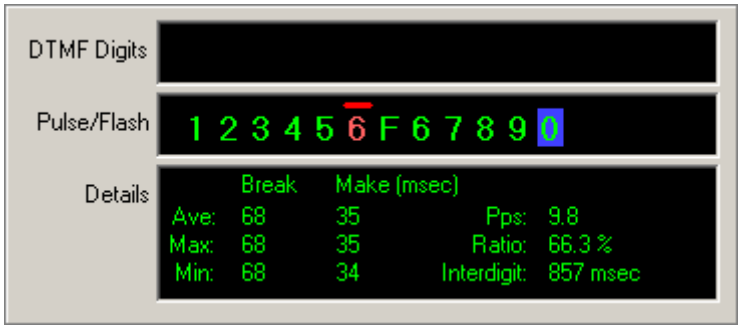
Note, the DTMF digit duration and interdigit time is only available when using the AI-7280. The AI-80 is unable to make timing measurements.

3.3.4 Pulse Dialing and Line Flash Capture

Operating in a similar manner to the DTMF dialing, the TRsSim software detects any pulse dialing digits or line flashes when the TE is off-hook. The last 16 digits or line flashes are displayed in the dialing panel on the lower half of the control panel. By default, the dialing panel is visible upon program startup. To view it at any time simply click the mouse on the **Dialing** button.

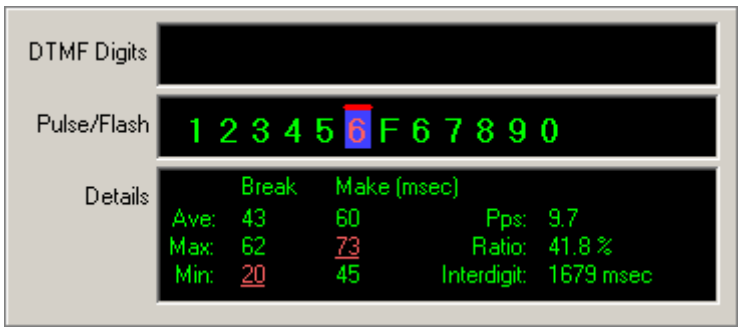


In the following example, a number of pulse dialed digits and a single line flash were detected. The first five digits 1 to 5 are detected without error, while the 6th digit is shown in red with a bar overhead. This signifies that one or more characteristics of the dialed digit is outside the set limits. The line flash, shown as an 'F' follows the 6th digit, which itself is followed by the digits 6, 7, 8, 9, and 0.



The lower portion of the window shows the details of the pulse dialed digit or line flash with the blue background. For pulse dialing, it shows the break times, make times, pulses-per-second rate, break ratio, and inter-digit time. For line flashes, it simply shows the flash duration.

Clicking the mouse on the failed 6th digit, displays its characteristics. From the red underlined readings, this pulse dialing digit is rejected because the minimum break time was too short and the maximum make time too long. Limits for all of the pulse digit characteristics and line flash duration can be viewed and modified in the **Pulse Dialing Limits** settings window.



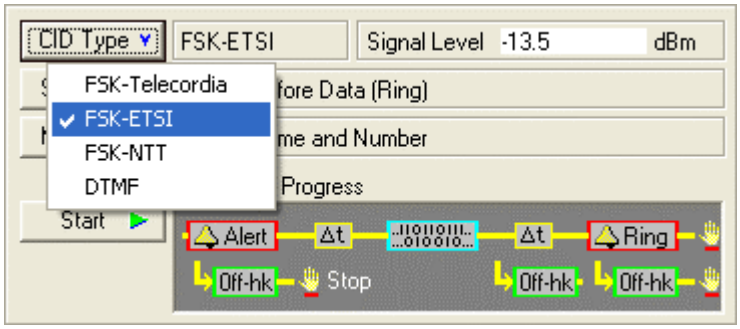
3.4 Sending Caller ID

3.4.1 Setting the Caller ID Type

Sending Caller ID messages is done via the Caller ID panel. From this panel the primary Caller ID settings are controlled and a transmission can be started.

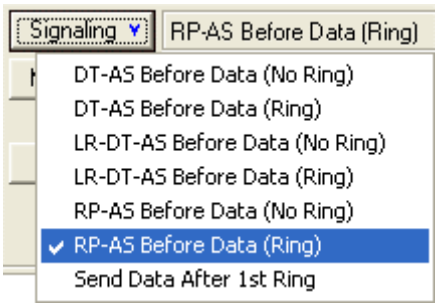
Clicking the mouse on the **Caller ID** button displays a panel similar to that shown below. The three buttons in the top left corner are used to specify the Caller ID type, signaling method, and message to send. A mouse click on any of the three buttons displays a list of selections to choose from.

The **CID Type** selection determines if the data is sent as FSK data or DTMF data along with the applicable standard in the FSK case. This setting effects which signaling types and messages are available as the signaling types and messages are linked to the Caller ID type. The Japanese NTT FSK selection is not available unless the Advanced Caller ID option is enabled.



3.4.2 Setting the Caller ID Signaling

In the case of the ETSI Caller ID type, clicking the mouse on the **Signaling** button presents the following list of selections.



The signaling type specifies how the data is sent to the TE. The basic varieties for the ETSI Caller ID type are described as follows:

- **DT-AS Before Data** (Ring and No Ring): In this signaling type, a DT-AS (Dual Tone Alerting Signal) is generated prior to sending the FSK data. Then following the FSK, ringing may or may not be generated depending on the selected signaling type.
- **LR-DT-AS Before Data** (Ring and No Ring): Similar to the previous signaling type, this method reverses the line polarity before sending the DT-AS. Once the Caller ID transmission ends, the line polarity is returned to its previous state.
- **RP-AS Before Data** (Ring and No Ring): In this type, a short ringing pulse alerting signal (RP-AS) precedes the FSK data. Then following the data, ringing may or may not be generated depending on the selected signaling type. The RP-AS can have a different frequency and level from the normal ringing that follows it.
- **Send Data After 1st Ring**: A initial ringing cadence is generated prior to sending the FSK data, which is then following by subsequent ringing cadences. Both ringing before and after the FSK data is of the same frequency and level .

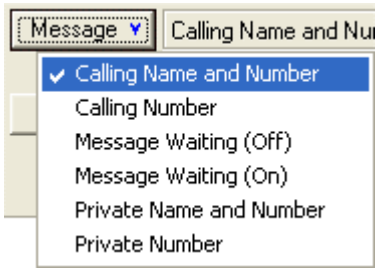
It is important to note that the signaling types are defined for either Type I (on-hook) Caller ID or Type II (off-hook) Caller ID. So if the TE goes off-hook, the signaling type automatically changes to one defined for Type II. In the case for the ETSI standard, only one signaling type is defined.

- **DT-AS Wait for ACK**: After an initial DT-AS is generated, the software waits for the TE to respond with an ACK tone. If accepted then the FSK data is sent.

All of the signaling types can be viewed in the **Caller ID Signaling** settings window. For more information on this topic, see Caller ID Signaling on page 51.

3.4.3 Setting the Caller ID Message

Using the ETSI Caller ID type as an example, clicking the mouse on the **Message** button presents the following list of selections.



The message defines what information is being sent to the TE. It is important to note that the signaling type has no effect on what information is sent. Rather only on how the information is sent.

By default, six different messages are defined upon program startup. The message contents may be viewed or modified from within the **Caller ID Messages** settings window. In addition, new messages may be created.

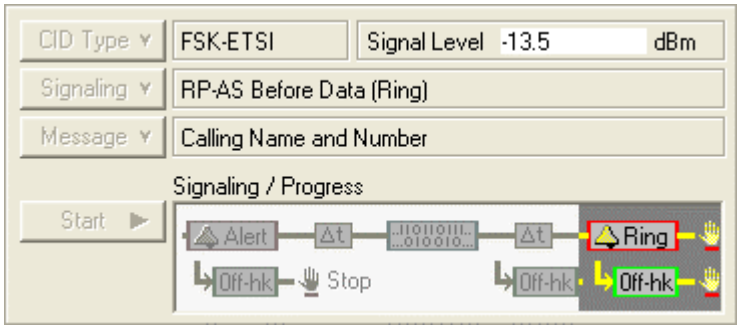
See the section: Caller ID Messages to Send on page 42 for more information on how messages can be modified or created.

3.4.4 Starting a Caller ID Transmission

Only after the Caller ID type, signaling, and message are all defined, will the **Start** button become enabled and a Caller ID transmission can be initiated.

Before starting a Caller ID transmission, the level of either the FSK or DTMF signal can be changed in the upper right corner text box. By default, dBm is used for the signal level unit. Either dBV or mVrms can be used instead by making the appropriate selection in the **General Settings** window.

Clicking the mouse on the **Start** button freezes all of the settings and disables all of the buttons while the Caller ID transmission is active. The following figure shows an example of this.



The graphical signaling flow is highlighted as the Caller ID transmission progresses. In the example above, the FSK data has been sent and ringing is about to begin following a short delay. Various graphical icons are used to represent alert ringing (RP-AS), time delays, FSK/DTMF data transmission, line reversals, OSI (open switching intervals), and normal ringing.

Some of the graphical signaling elements can cause a split in the flow. In the example above, if the TE goes off-hook during the alert ringing (RP-AS), time delay after FSK data, or during the normal ringing, the Caller ID transmission is halted. This is indicated by the stop icon.

For more details on these signaling icons, see the section: Caller ID Signaling on page 51.

Clicking the **Stop** button during a Caller ID transmission terminates its execution and re-enables all of the various controls.

3.5 Short Message Service

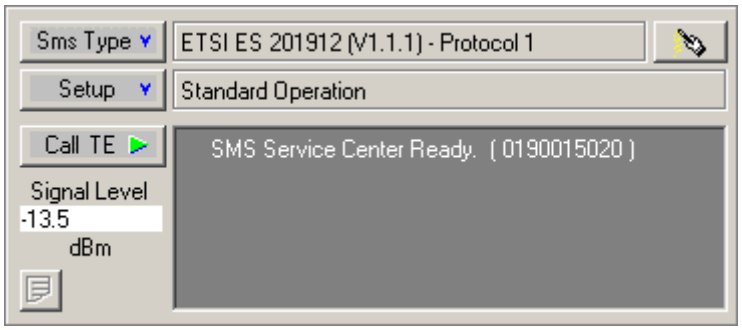
3.5.1 SMS Introduction

As an optional component, the TRsSim software supports the emulation of a Short Message Service Center (SM-SC) according to the ETSI ES 201912 standard. As part of the SM-SC emulation, short messages can be either sent to or received from a connected TE.

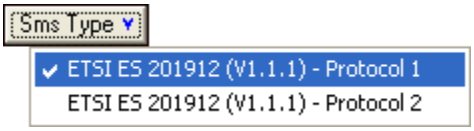
The current SMS settings are shown by clicking the mouse on the **More** button, followed by the **Short Message Service** selection.

The SMS control panel shows the key settings as well as summary information on the last short message session (if any). The following figure shows an example of the SMS control panel.

The SMS Type selection defines what standard the service center will emulate. In the example below, it is set to the ETSI ES 201912 - Protocol 1 standard.



To change this setting, click the mouse on the **SMS Type** button. A drop-down list appears just below the button, from which a different type is selected.



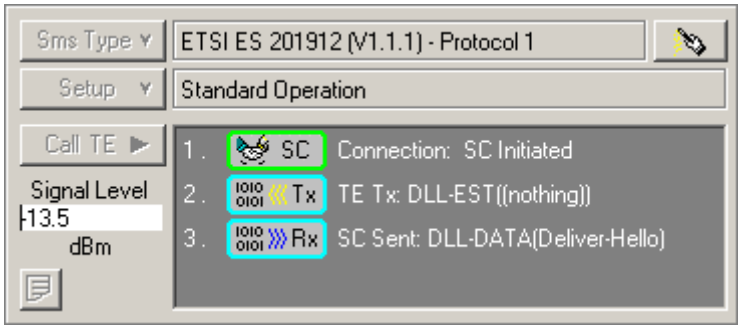
Once a SMS Type is chosen, a SMS Setup must be selected before any messages can be sent or received. The SMS Setup is a pre-defined set of rules that govern how the SM-SC operates. This includes both the transfer layer (TL) and data link layer (DLL) characteristics. By default, a number of setups are pre-defined for both protocol 1 and protocol 2. These setups follow (where possible) the sequence charts provided in Annex A and B of the ETSI ES 201912 standard. In addition, a setup called "Standard Operation" emulates the nominal message transfer for both protocol 1 and protocol 2. These setups may be modified, or new ones created in order to test various exception conditions. See the section: SMS Service Center Emulation on page 57 for more details on how the TL messages and the SMS setups are created.

The level of the SM-SC's FSK generator is shown just below the **Call TE** button. To change the setting, simply click the mouse inside the text box and enter a new value. The default units are shown as dBm, however they may be changed to either dBV or mVrms from within the "General Settings" window.

3.5.2 Sending a SMS Message

Choosing both a SMS Type and SMS Setup enables the **Call TE** button. Clicking the mouse on this button starts the process of sending a message to the TE. The contents of the message and how the message is sent is defined by the setup type. Using the "Standard Operation" setup, as selected in the figure above, sends the message "Hello World!" to the TE.

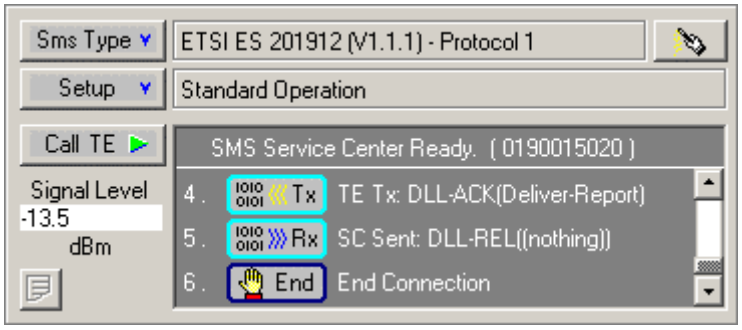
The process of sending a short message to a TE entails a number of steps. The first is the TRsSim software generating a Caller ID signal with the SM-SC's telephone number. Once the TE detects the Caller ID and matches the calling SC number with its internally stored SC number, it should go off-hook.



The figure above shows the progress of a message being sent to the TE. Once the TE has gone off-hook, a connection between the TE and SM-SC is established. Following this the TE sends a DLL-EST message according to the ETSI protocol 1 standard. In response, the SC sends a DLL-DATA message containing the short message data. For each event detected, the TRsSim software captures any applicable data that can be viewed in more detail once the SMS session has completed.

While a SMS session is in progress, the various buttons on the SMS control panel are disabled. This prevents changing any settings during the message transfer. If the SMS sessions must be terminated, simply press the **Stop** button. This immediately halts any message transfer and resets the SM-SC.

Once the SMS sessions finishes, the SC is reset and is ready to send or receive another short message. In addition, all of the events detected can be viewed as shown in the following figure.



The last three events indicate the TE sending a DLL-ACK message, which is in response to the previous DLL-DATA message sent by the SC. The ACK message indicates to the SC that the message has been received by the TE. As such the SC sends the DLL-REL message, meaning that the TE should release the line. This concludes the SMS session, as marked by the "End Connection" event. The scroll bar on the right side of the window can be used to view all the events detected. The events shown only provide basic summary information. Additional data for each event can be examined by viewing the Data Record window. For more information see the following section: Viewing Captured Data on page 25.

It is important to note that the SC's reaction to any message sent by the TE is completely defined by the SMS setup. A setup may not support sending messages to a TE, or on purpose send invalid messages in order to test a TE's error handling response.

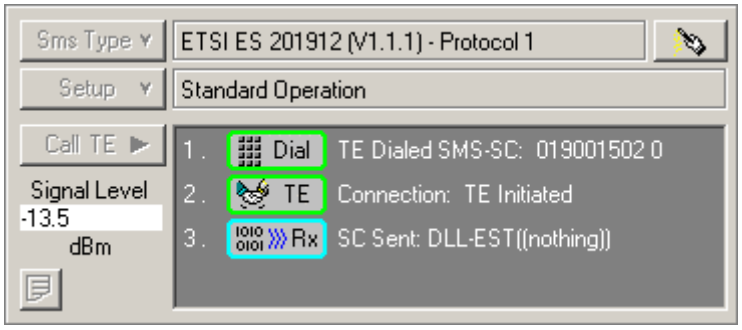
For information on how to create SMS messages for transmission to a TE, see the section: Creating SMS Messages on page 24.

3.5.3 Receiving a SMS Message

Once a SMS type and setup are chosen, the SC is ready to receive (or send) short messages. It is important to note that the SC's reaction to any message sent by the TE is completely defined by the SMS setup. A setup may not support the reception of messages from a TE, or on purpose simulate the reception of an invalid message in order to test a TE's error handling response.

The TRsSim software monitors the TE to check if it has DTMF dialed the SM-SC's telephone number. If so, a ring back tone is generated for a few seconds. This tone simulates the PSTN while it rings the SM-SC. The type of tone and its duration can be changed from the SMS General Settings window. Following the ring back tone a connection is established between the TE and SM-SC.

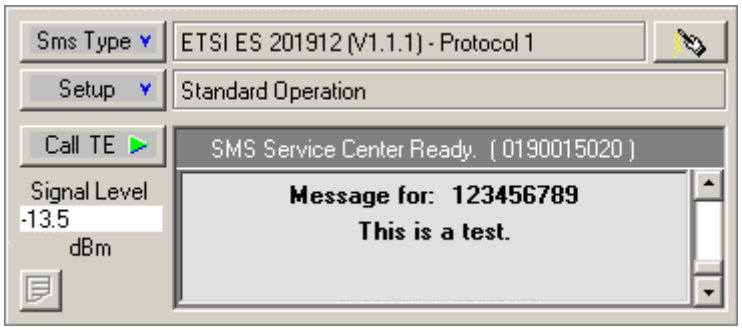
As in the case of sending short messages to a TE, the SMS control panel displays summary information of the SMS session. In the figure below, the first three events are displayed during the reception of a short message by the SC.



The first event simply signifies that the TE has dialed the telephone number of the SM-SC. Following the optional PSTN ring back tone, a connection to the SM-SC is established. As part of the "Standard Operation" setup, the SM-SC sends a DLL-EST message to the TE. This informs the TE that it has correctly dialed the SC and it may send the contents of a short message.

Though not shown in the above figure, four more events are captured before the SMS session is complete. They signify the TE sending the short message data, the SM-SC responding with an acknowledgment message, the TE sending a release message, and finally the "End Connection" event.

Once the SMS session ends, the TRsSim software displays the contents of the message sent by the TE. In this example, the TE had sent the message "This is a test." with a destination address of "123456789". Once the connection ends, the SM-SC resets itself and becomes ready to send or receive another short message.



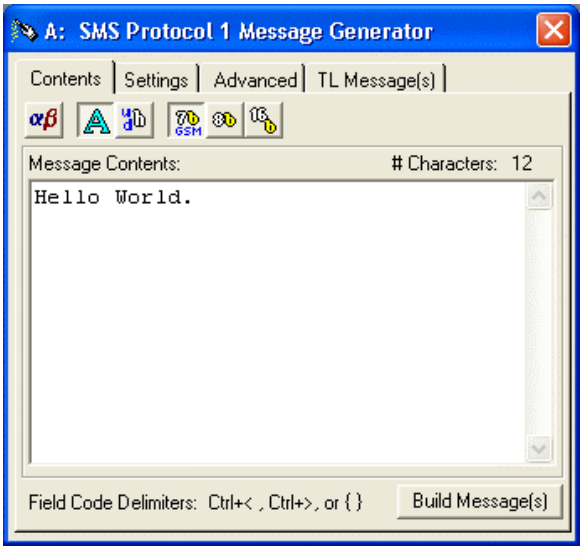
To clear the displayed message, simply click the mouse inside the message window. This returns to the previous display. The events shown here only provide basic information. Additional data on each event can be examined by viewing the Data Recorder window. For more information see the following section: Viewing Captured Data on page 25.

3.5.4 Creating SMS Messages

Creating SMS messages can become a complex task. This is especially true when sending a long message that must be broken up into multiple TL messages. In order to simplify this process, the TRsSim software can automatically create all of the TL messages required to send long messages.

The SMS Message Generator window is viewed by clicking the mouse on the button displayed to the far right of the **Sms Type** selection.

Clicking this button displays the Message Generator window, as shown in the following figure. The Message Generator window can be used to create SMS TL messages for short messages or long messages which require concatenation.



To create a message, simply click the mouse anywhere inside the large text box area and type the contents. Once complete, click the **Build Message(s)** button. This causes the TRsSim software to generate all of the TL messages needed to send the entered text. Once completed, click the **Call TE** button on the main control panel to send the message created. The **Settings** and **Advanced** tabs shown at the top of the Message Generator window are used to control various aspects of the TL messages. In addition, the **TL Message(s)** tab displays each byte value for any messages created. For more detailed information on this topic see the section: Simplified Message Generation on page 66.

3.6 Viewing Captured Data

3.6.1 Data Recorder Window

The TRsSim software records various events while operating in the PSTN emulation mode. These include any DTMF or pulse dialing digits, line flashes, Caller ID transmissions sent, and SMS data sent or received. All of the data collected can be viewed and examined in the Data Recorder window.

To open a Data Recorder window, click the **View** menu followed by the **Data Recorder** selection. Up to four windows may be displayed at the same time showing different data. The contents of the Data Recorder window can be printed at any time, by selecting the **File** then **Print** (or **Print Preview**) menu commands.

The following sections provide more detailed information on viewing any captured dialing, Caller ID, and SMS data.

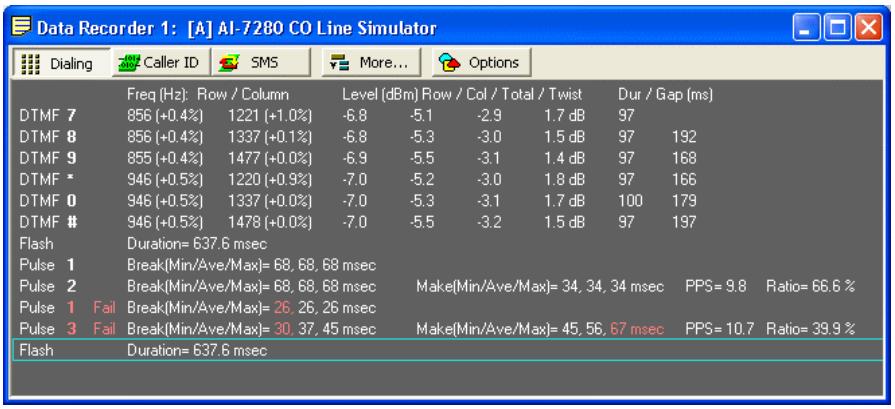
3.6.2 Dialing Captured Data

Once a Data Recorder window is open, clicking the Dialing button shows all of the DTMF or pulse dialing digits captured. Included in the same listing is the duration of any line flashes detected.

The following figure shows an example of captured dialing. The connected TE had generated 6 DTMF digits, followed by a line flash, three pulse dialed digits, and a second

line flash. Each dialing or line flash event is displayed on a separate line with the last event displayed at the end of the list.

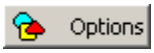
In the case of DTMF digits, the TRsSim software records the row and column frequencies as well as the levels. The listing includes additional columns showing the total DTMF level, level twist, digit duration, and inter-digit delay. The DTMF level units can be changed to either dBm, dBV, or mVrms. This selection is made in the **DTMF Dialing Settings** window.



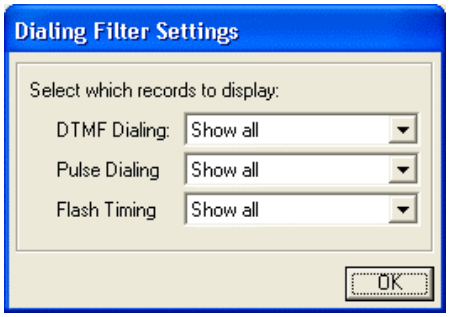
Note that DTMF digit duration and inter-digit timing information is not available when using the AI-80.

For the pulse dialed digits, the display shows the break time, make time, pulses-per-second (pps), and break ratio. If any of the measurements are outside specified limits, the digit is shown in red with the text "Fail" to the right of it. In the above figure, the last two pulse dialed digits fell outside the timing limits. The break time was below the minimum limit for both pulses, and the make time exceeded the maximum limit for the second failed digit.

In the same manner as pulse dialed digits, if any of the DTMF digit measurements fall outside the specified limits, it too is shown in the color red with the text "Fail". These limits are contained in the **DTMF Dialing Limits** settings window. For pulse dialing they are contained in the **Pulse & Flash Limits** settings window.



Clicking the mouse on the **Options** button displays a list of two choices. They either clear the dialing data or display the filter settings. Selecting the **Clear Data** option discards all of the dialing data and clears the Data Recorder window. Choosing the **Filter Settings** option displays the current filter selections as shown in the following figure.



To change the filter settings, simply select a different option from the drop-down box. The possible filter selections are either:

- Show all the records

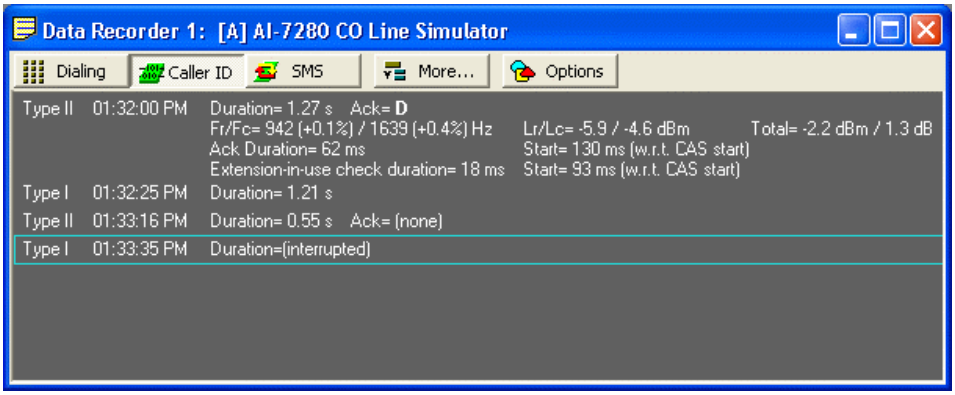
- Show none of the records
- Show only the data that passed the limits
- Show only the data that failed the limits

Pressing the OK button closes the window and updates the Data Recorder window with only those records matching the filter settings.

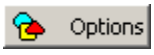
3.6.3 Caller ID Captured Data

Selecting the Caller ID button on the Data Recorder window updates the display with all of the Caller ID records captured.

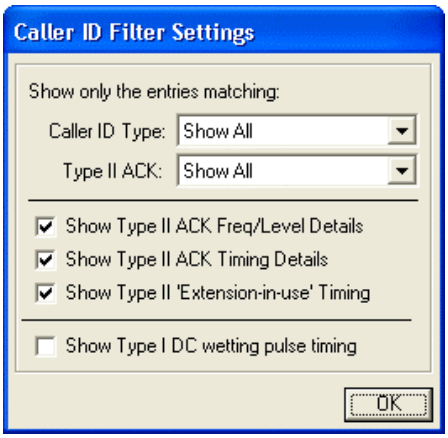
The following figure shows four separate Caller ID transmissions. Its type, start time, and duration are listed in the first three columns. For Type II (off-hook) Caller ID transmissions the ACK digit measurements may be shown as well.



The last line shown in the above figure does not show a value for the duration. It is displayed as interrupted, which indicates the **Stop** button was pressed during the Caller ID transmission.



Clicking the mouse on the **Options** button display a list of two choices. They either clear the Caller ID data or display the filter settings. Selecting the **Clear Data** option discards all of the data and clears the Data Recorder window. Choosing the **Filter Settings** option displays various settings as shown below.



The first filter selection is used to display only Type I FSK Caller ID, Type II FSK Caller ID, or DTMF based Caller ID records. The second selection only refers to Type II FSK

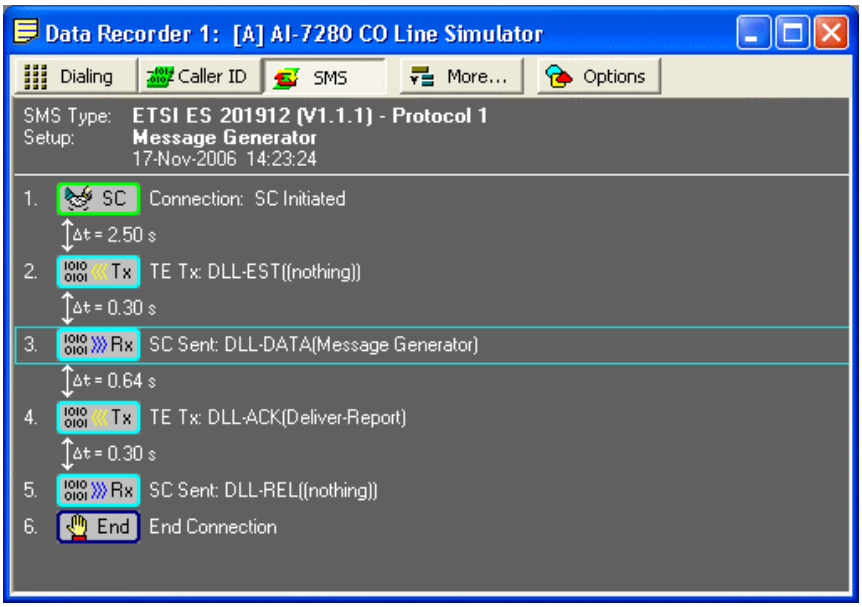
Caller ID and can be used to select only those entries with a valid ACK digit, or a missing ACK digit.

Finally, the following check boxes are used to enable or disable the display of measurements made during either Type II or Type I Caller ID.

3.6.4 SMS Captured Data

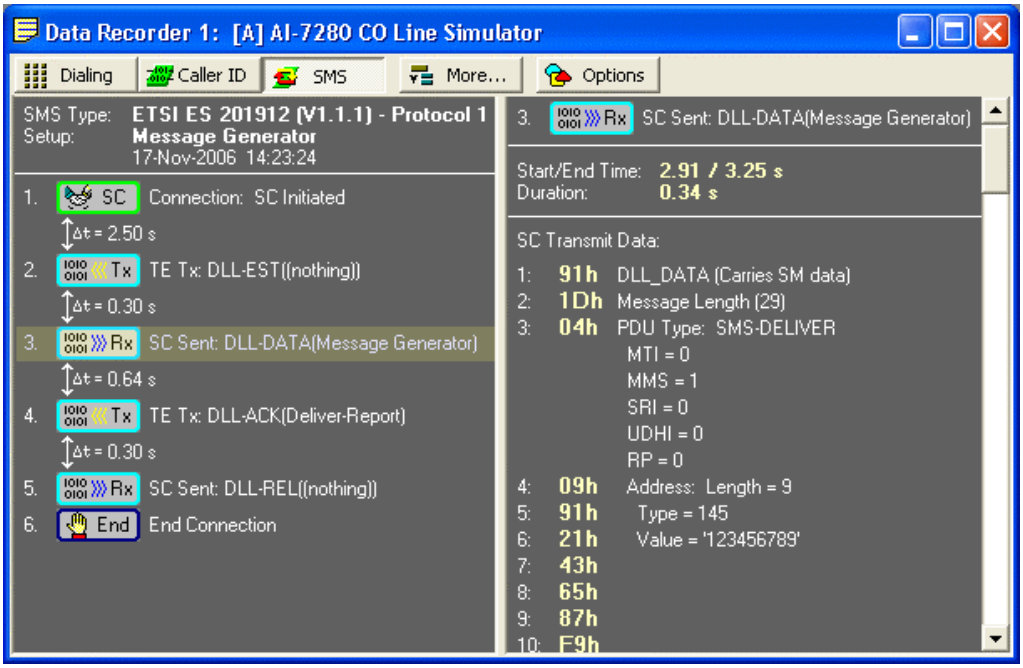
Clicking the SMS button on the Data Recorder window changes its display to show captured SMS data. The Data Recorder stores the last SMS session information for both of the SMS types (ETSI Protocol 1 and ETSI Protocol 2). The SMS type displayed is always the same type as currently selected in the SMS control panel.

The figure below is an example of sending a short message to a TE using the ETSI Protocol 1 SMS type.



Each event detected is represented by a graphical icon and a text description. Where applicable, the time delay between events is displayed as well. In the above example, the SMS session starts when the TE answers the call from the SC. This establishes a voice path connection between the SC and the TE and is represented by the first icon. Following a time delay of 2.50 seconds, the TE sends a DLL-EST message to the SC. In response, the SC sends a DLL-DATA message to the TE. It is this message that contains the contents of the short message. The fourth event is the TE sending back an acknowledgment message (DLL-ACK) indicating that the short message was received. Finally, the SC sends a DLL-REL message informing the TE that it should release the line. This ends the SMS sessions as marked by the sixth, and final, event.

To show more detailed information on each event, click the mouse on the event icons. In the above example, clicking the mouse on the third event toggles the display to a split screen. The right side pane of the window now shows the details of the third event.



In this case, the contents of the message sent to the TE is displayed in the right side pane. To the right of the message byte values is additional information describing its meaning, where applicable. Any data below the visible portion of the Data Recorder window can be brought into view by using the scroll bar on the right side.

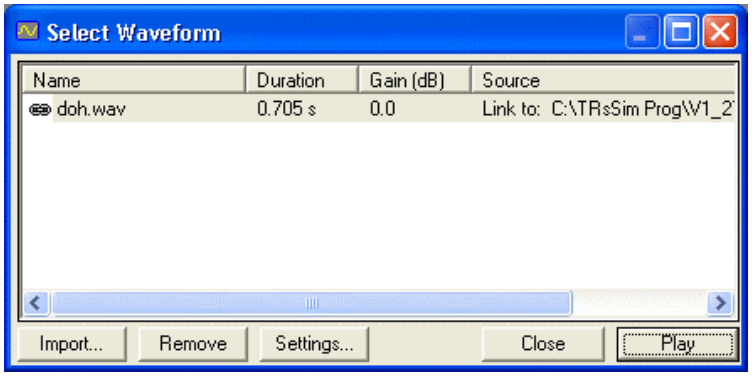
To change the detailed information in the right side pane, simply click the mouse on a different event icon on the left side pane. Clicking on the same icon twice hides the detailed information.

3.7 Playing Waveforms

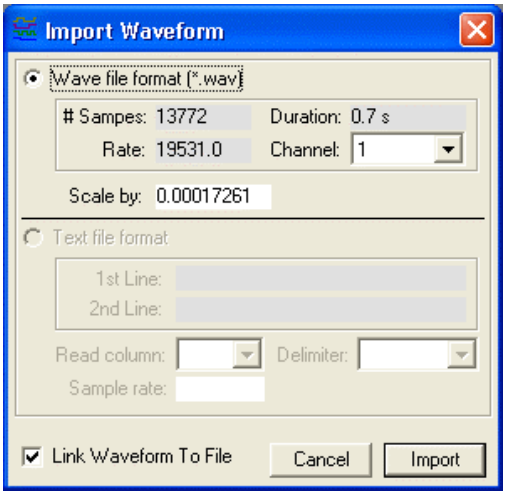
In addition to generating various tones, the AI-7280 can be used to play back wave files. Clicking the down arrow to the right side of the **Tone** button displays a list of all the defined tones as well as an option to play waveform files.

Selecting the **Play Waveform** command displays a window listing all of the waveforms that have been imported into TRsSim. The window, as shown in the following figure, lists each waveform name as well as its duration, gain adjustment setting, and source.

To play a specific waveform, simply selected it with the mouse and click the **Play** button. This transfers the waveform to the AI-7280 and starts the playback.



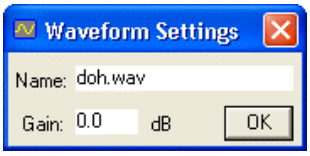
To add a waveform to the list, click the **Import** button. Waveforms can be imported from either a '.wav' file, or a text file that lists all of the sample points. After the **Import** button is clicked, the waveform file must be selected. The selected file is then scanned to see if it can be read as a wave file or a text file. In the example figure below, a wave file containing 13772 samples is being imported.



The **Scale by** field is used to specify the conversion factor from the wave file integer sample values to volts. The default scale factor accommodates a voltage range of approximately 10 volts peak-to-peak for a 16 bit wave file.

When importing a waveform, it can be either loaded into the TRsSim software, or only linked via the file name. If the **Link Waveform To File** option is checked, then the TRsSim software monitors the file for changes to its date/time stamp. If the file changes, then before the next time the waveform is played, the TRsSim software automatically re-loads the waveform data from the updated file.

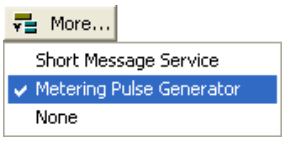
The name used to reference the waveform or its playback level can be changed by clicking the **Settings** button from the Select Waveform window. This shows a window similar to the following figure. To change the name or gain, enter a new value in the appropriate field and click the **OK** button.



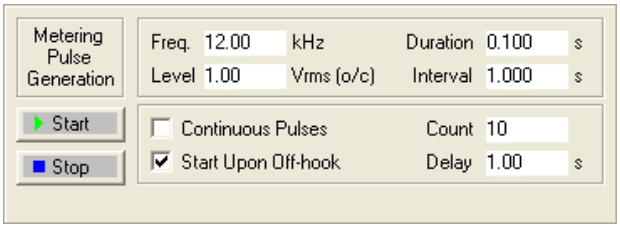
Note that the AI-80 is not capable of waveform playback. Only the AI-7280 supports this feature.

3.8 Generating Metering Pulses

The AI-7280 is able to generate metering pulses over a wide frequency, level, and timing range. To view the metering pulse settings, click the **More** button and then select the **Metering Pulse Generator** option.



The following figure shows the controls used to configure the metering pulse generator. The top four fields set the tone pulse frequency (5 to 18 kHz), open circuit RMS output level (0 to 4 Vrms), tone pulse duration (0.001 to 1000 seconds), and interval between tone pulse starts (0.001 to 1000 seconds). Note that if the interval is greater than the tone pulse duration, the tone will be continuous.

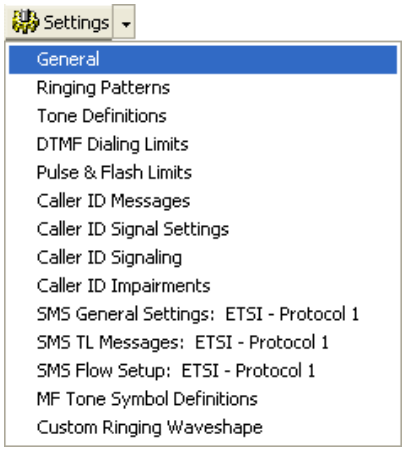


Metering pulses may be continuously generated if the **Continuous Pulses** box is checked. If not, then the value in the **Count** field determines how many pulses are generated.

The metering pulse generator is started and stopped by clicking the **Start** and **Stop** buttons respectively. If the **Start Upon Off-hook** box is checked, then the tone pulses will automatically start when an off-hook condition is detected. The **Delay** field sets the time delay from when the off-hook occurs to when the metering pulses begin.

4. Program Settings

Most of the settings used in the TRsSim software are accessed by the **Settings** button on the main control panel. Clicking the down arrow on the right side of the button displays a list of categories similar to the following. Selecting any of the categories displays a window where the applicable settings can be viewed and/or modified. Clicking the large portion of the **Settings** button toggles between showing the last window displayed or hiding the current window displayed.



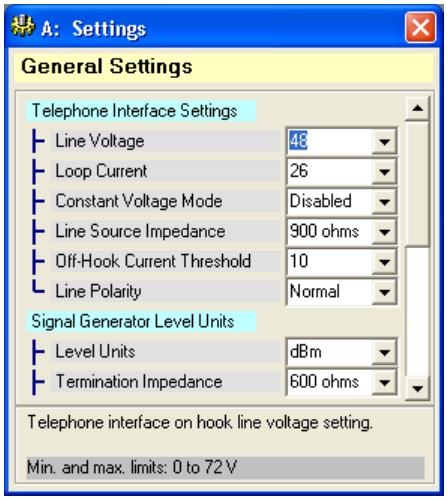
The following sections provide more information on the general program settings, ringing patterns, tone definitions, dialing limits, and MF tone definitions.

For more information on the Caller ID and SMS settings, see the sections: Caller ID Signal Generation on page 41 and SMS Service Center Emulation on page 57 respectively.

4.1 General Settings

The General Settings window shows the current value of the telephone interface parameters as well as signal generation level units and termination options.

Settings that can not be modified due to hardware limitations are disabled and shown with an orange background color. When using the AI-80, this is the case with the Line Voltage, Constant Voltage Mode, and Off-Hook Current Threshold settings. The following figure shows the general settings when using the AI-7280, which does not have these limitations.



To change any of the various settings, simple click the mouse on the current setting value. Then either type a new value or click on the drop-down list arrow to display the possible choices.

The various signals generated by the TRsSim software can be specified using the units of either dBm, dBV, or mVrms. Network tones, DTMF, MF signals, and FSK for Caller ID and SMS all have their level specified in the system of units selected here.

In addition, signal levels can be specified with a termination impedance of either 200 ohms, 600 ohms, 900 ohms, open circuit, or source Z. The signal generator then adjusts its output level such that the specified level is present at the tip/ring interface when the termination impedance is applied. The 'Source Z' setting means that the termination impedance is assumed to be exactly the same as the telephone interface source impedance. The 'Termination Impedance' setting has no effect on the telephone line source impedance, it only adjusts the generator output level to compensate for the loading effect of the termination impedance.

Note, if selecting a complex line source impedance, the signal generator termination impedance is forced to the open circuit setting if the current setting is either 200, 600, or 900 ohms. This is because the TRsSim software is unable to calculate the level correction factors needed since it becomes dependent on the signal's frequency components.

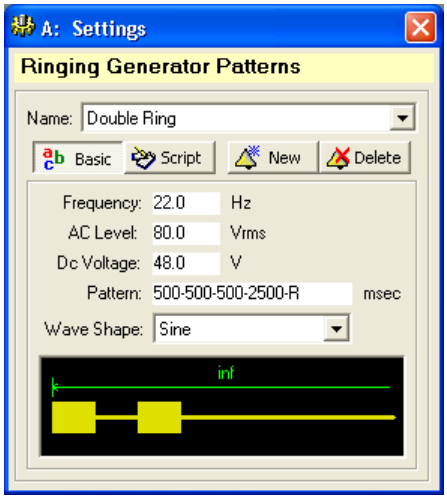
For the AI-7280, the final setting in the list controls the reference bandwidth for the noise generator. The output of the noise generator has a bandwidth of approximately 18 kHz. By default, noise output signal levels are referenced to this bandwidth. By changing this setting, the bandwidth used to specify noise levels can be changed to various values between the range of 1000 Hz to 10 kHz.

4.2 Ringing Patterns

The Ringing Generator Patterns window is used to view, modify, or create ringing patterns. By default the TRsSim software is pre-defined with three patterns called "Single Ring", "Double Ring", and "Triple Ring". Any of the ringing patterns defined can be viewed by choosing its name from the drop-down list box marked **Name**.

The following figure shows the settings for the "Double Ring" pattern. Its key parameters consist of a 20 Hz ringing frequency at 80 Vrms. The text field marked Pattern is used to defined the cadence of the ringing. The default pattern is set to 500 ms

on, 500 ms off, followed by another 500 ms on and then 2500 ms off. This cadence is then repeated indefinitely.



For more information on the structure and format of the pattern definition, see: Appendix A: Pattern Definitions on page 101.

When using the AI-80, the Wave Shape selection is fixed at Sine. Only the AI-7280 supports alternate wave shapes. To define alternate wave shapes, see: Custom Ringing Wave Shape on page 39.

All ringing patterns can be defined in one of two different modes. These are **Basic** and **Script**. The selection of the mode is made by the clicking one of the two buttons just underneath the name of the ringing pattern. In the previous figure the basic mode is used to define the "Double Ring". The scripting mode, while more complex, allows for a much wider range of settings and capabilities.

To create a new ringing pattern, simply click the mouse on the **New** button. This displays a small window where the name of the pattern must be specified. Each ringing pattern must have a unique name to identify it. Once a new name is entered, and OK is pressed, a new ringing pattern added to the list and its settings may be edited.

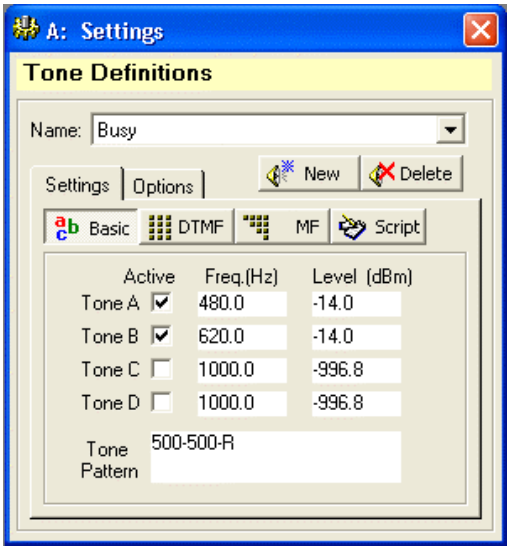
To delete any of the ringing patterns, simply click the mouse on the **Delete** button. Following a confirmation, the ringing pattern is deleted.

4.3 Tone Definitions

Tone definitions are used when generating PSTN related signals such as dial tone, busy tone, ring back tone, along with others. All of the tones defined in the TRsSim software can be viewed or modified in the Tone Definition settings window. In addition new tones can be created or existing tones deleted.

Each tone must have a unique name by which it is identified. Five tones are pre-defined in the TRsSim software with the names of "Busy", "Dial", "Ringback", "Ringback (double)", and "Stutter Dial". To view a specific tone, select its name from the drop-down list near the top of the settings window.

The next figure shows the settings for the Busy tone. This tone is the combination of two different frequencies (480 Hz and 620 Hz) with a pattern of 500 ms on followed by 500 ms off.

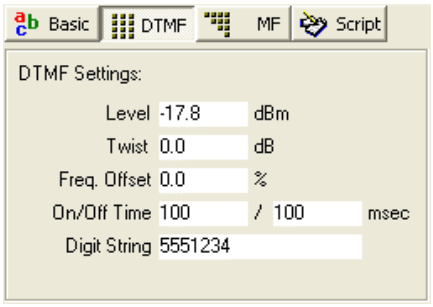


Though up to four single frequency signals can be used (A to D) with the AI-7280, the AI-80 only supports two frequencies. As such, tones C and D will be disabled. To change the frequency of any tone, simply click the mouse in the frequency text box and enter a new value. Likewise for changing the level.

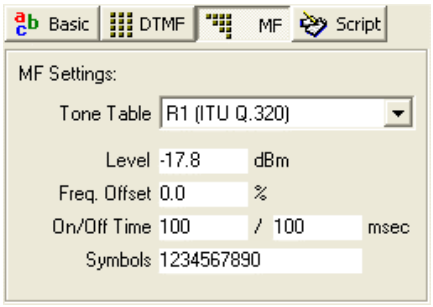
For more information on the structure and format of the pattern definition, see: Appendix A: Pattern Definitions on page 101.

Four different modes can be used to define tones. They are Basic, DTMF, MF, and Script. All of the pre-defined tones use the Basic mode as this is the simplest mode for tones that have constant frequency. Changing modes is accomplished by simply clicking one of the mode buttons.

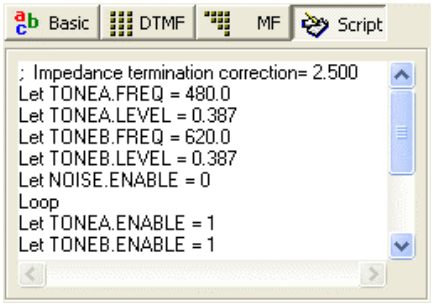
Using the **DTMF** mode, the tone can be specified as a single or series of DTMF digits. The level, twist, frequency offset, tone on time, and tone off time (pause time) can be modified by selecting the corresponding text box and entering a new value.



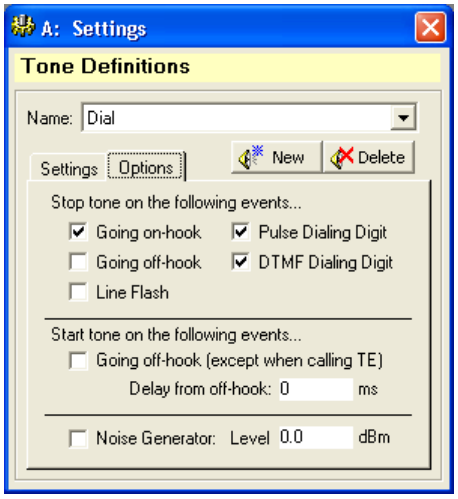
The **MF** mode is very similar to the DTMF mode. However instead of using the standard DTMF frequencies, the MF mode can use one of four different tone tables. Three of the tone tables follow the ITU Q.320 and Q.441 standard, while the forth may be user defined. See the section: Multi-Frequency (MF) Tone Tables on page 38 for information on how to view or modify the tone tables. As with the DTMF mode, the MF mode supports adjustable signal level, frequency offset, tone on time, and tone off time (pause time).



The last mode is **Script**. While more complex, this mode allows for a much wider range of settings and capabilities.



In addition to the various modes used to define the tones, each tone can be linked to a number of options governing its behavior. Clicking the mouse on the **Options** tab, displays the state of the these settings. As the following figure shows, a tone may be configured to terminate on events such as on-hook transition, off-hook transition, line flash, pulse dialing, or DTMF dialing. In the example below, the Dial tone is turned off automatically when the TE goes on-hook, or any DTMF/pulse dialing is detected.



A tone may also be automatically started if the TE goes off-hook. If the corresponding check box is checked in the figure above, the tone starts once the TE transitions from an on-hook state to an off-hook state. Note that only one tone may have this option enabled. Also, if the TE goes off-hook in response to ringing or Caller ID, the tone will not turn on.

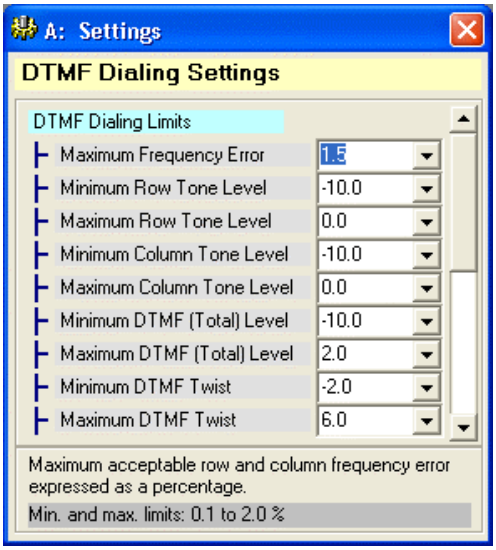
The last option allows for a broad band white noise to be present while the tone is generated. This is only supported when using the AI-7280, as the AI-80 lacks this capability.

To create a new tone definition, simply click the mouse on the **New** button. This displays a small window where the name of the new tone must be specified. Each tone definition must have a unique name to identify it. Once a new name is supplied it is added to the list of tones and its settings may be edited.

To delete any of the tone definitions, simply click the mouse on the **Delete** button. Following a confirmation, the tone is deleted.

4.4 DTMF Dialing Limits

The DTMF Dialing settings window contains all the limits used to qualify any detected digits. If a detected digits does not meet these limits, it is displayed in a red color and marked as a failed digit in the Data Recorder window.

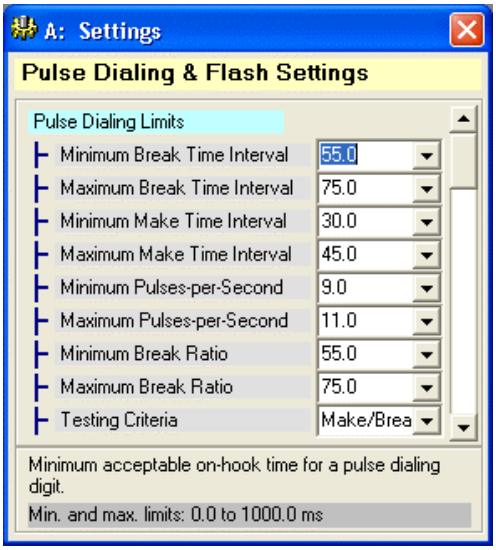


To change a setting, simply click the mouse in the applicable text box and enter a new value. The range of acceptable values for any limit is shown at the bottom of the window. If any value entered is outside the valid range the minimum and maximum values shown change to a background color of orange.

The units for the row, column, total, and twist levels can be either dBm, dBV, or mVrms. The last setting in the list determines the unit system to use. To change the units, click the mouse on the down arrow beside the unit and select a new one from the list. The same unit setting is used for displaying the levels of any detected DTMF digits in the main control panel and in the Data Recorder window.

4.5 Pulse Dialing & Line Flash Limits

All of the timing limits for pulse dialing and line flashes are stored in the Pulse Dialing & Flash Limits settings window. Every pulse dialed digit must meet the timing ranges specified. If not, they are considered invalid and displayed in a red color. Likewise for all line flashes. If the duration of the line flash is not between the specified range, it is displayed in a red color.



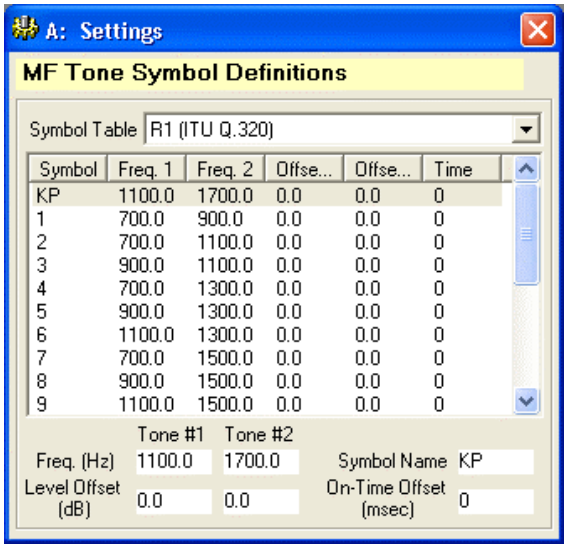
To change a setting, simply click the mouse in the applicable text box and enter a new value. The range of acceptable values for any limit is shown at the bottom of the window. If the value entered is outside this valid range the minimum and maximum values shown change to a background color of orange.

For the pulse dialed digits one of three different testing criteria can be selected. They are **Make/Break**, **Pps/Ratio**, or **Both**. In the case of Make/Break, all the digits must meet the minimum and maximum break and make durations. However they do not need to pass the pulses-per-second or break ratio limits. In the second case of Pps/Ratio, the digit is only required to meet the pulses-per-second and break ratio limits, but not the break and make duration limits. Finally, in the last case, both the break and make duration and the pulses-per-second and break ratio limits must be met.

4.6 Multi-Frequency (MF) Tone Tables

The TRsSim software supports multi-frequency (MF) tone generation using one of four different tone tables. Each tone table defines the frequency, level offset, and duration offset for up to twenty individual symbols. The MF Tone Table Definitions settings window is used to view or edit any of the table data.

By default the first three tone tables are pre-defined with the ITU Q.320 and Q.441 (forward and backward) MF tones. The figure below shows the tone table settings for the ITU Q.320 tones.



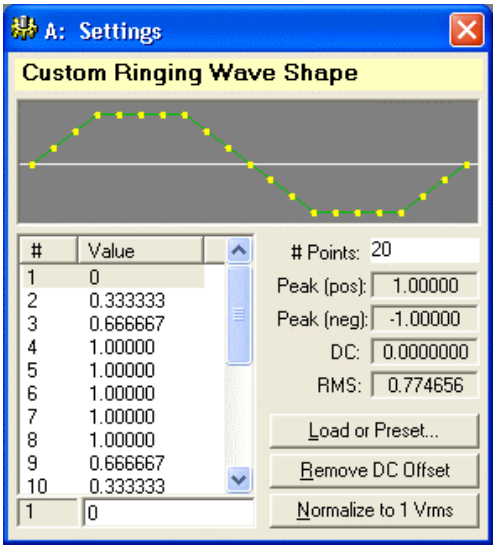
Six different columns make up the tone table. From left to right they are the symbol name, first frequency, second frequency, first level offset, second level offset, and tone duration offset. Clicking the mouse on any row in the tone table copies the data to the text boxes at the bottom of the window. To make changes, simply edit the appropriate text box.

Using this tone table data MF tones can be defined from within the Tone Definition settings window, or used with DTMF Caller ID.

4.7 Custom Ringing Wave Shape

In addition to sine, triangle, and square wave ringing, the AI-7280 supports user definable wave shapes. Up to 255 points can be used to define a ringing wave shape.

To view or modify a wave shape, select the **Custom Ringing Wave shape** command from the **Settings** menu. This shows a window similar to the following figure.



The custom wave shape can be modified in three different manners. They are:

- Loaded from a text file. Clicking the **Load or Preset** button displays a list of options of which the first item allows loading the wave shape data points from a text file. The text file must contain the value of each data point on a separate line.
- Load preset wave shape. Clicking the **Load or Preset** button displays a list of seven different wave shapes. These include various trapezoidal shapes, sine, and square. These predefined wave shapes can serve as starting points before being manually modified.
- Manually entered data points. The value of a wave shape data point can be manually changed by clicking its entry in the displayed list and then entering a new value. The number of points in the wave shape is set by the text field in the upper right corner of the window.

The top portion of the window shows graphically the custom wave shape. Note that a wave shape must always begin and end at the same value. As such, the number of data points shown is always one more than the number of data points in the wave shape. The last point shown (right most side) always matches the value of the first data point (left most side). In the example above, the wave shape consists of 20 points, but the displayed wave shape shows 21 points. This extra point is only shown for display purposes.

Various statistics on the wave shape are displayed on the right side of the window and are updated anytime a change is made. They indicate peak values (positive and negative), along with the DC offset value and RMS level. Note that these statistics are not important when the AI-7280 generates the ringing wave shape. The ringing RMS level and DC offset will always match the setting of the defined ringing pattern, or for Caller ID applications, the specified ringing level.

It is important to note that the AI-7280 can generate a ringing level of 80 Vrms for the sine wave shape (crest factor of 1.41). If a custom wave shape contains a crest factor of more than 1.41, the AI-7280 many not be able to reproduce the wave shape without clipping at the highest ringing level (80 Vrms).

5. Caller ID Signal Generation

The TRsSim software provides a wide range of Caller ID signal generation functions. These include supporting both FSK based and DTMF/MF based Caller ID, Type I (on-hook) and Type II (off-hook) transmissions, variable physical layer parameters, and flexible message layer settings.

Some of the more advanced Caller ID features are part of an optional module. Unless the software key purchased includes the advanced Caller ID option, those features are not accessible. However basic Caller ID functionality is always available. The basic functions include the following:

- FSK data transmission (Telecordia and ETSI)
- DTMF data transmission
- Type I (on-hook) and Type II (off-hook) transmission
- Wide range of basic signaling types
- User definable messages

The advanced Caller ID option adds the following capabilities:

- NTT (Japan) FSK data transmission
- MF tone data transmission
- User definable signaling types
- More flexibility in creating messages
- Programmable FSK, CAS, SAS settings

Details on generating Caller ID signals is provided in the following sections.

5.1 Caller ID Types

The TRsSim software classifies the different forms of Caller ID into "Types". Four different types have been defined to encapsulate the various systems in use today. They are:

- FSK - Telecordia
- FSK - ETSI
- FSK - NTT
- DTMF

The **FSK - Telecordia** Caller ID type supports the signaling and message types defined by the Telecordia (formally Bellcore) and Telecommunication Industry Association (TIA) standards. Using Bell 202 FSK modulation, this type supports both Type I (on-hook) and Type II (off-hook) Caller ID with four different message types.

Similar to the Telecordia type, the **FSK - ETSI** Caller ID type supports the signaling types and message types defined in the ETSI EN 300659-1/2/3 documents. The data is sent using V.23 FSK modulation with a wide range of possible signaling types. A short ring burst or alerting signal may precede the data, or it may be sent between the first and second rings. Both on-hook and off-hook Caller ID is supported.

The **FSK - NTT** Caller ID type conforms to the NTT (Japan) Caller ID standard. Though using V.23 FSK modulation to send the data, the message structure is significantly different than that of the Telecordia or ETSI types. In addition the signaling is more complex requiring the TE to go off-hook just before the transmission of data.

The last Caller ID type is **DTMF**. Instead of using a FSK signal to transmit the Caller ID data, this type uses DTMF or MF tones. As such the message structure is also quite different than that of FSK based Caller ID.

Changing the Caller ID type is accomplished by simply clicking the mouse on the **CID Type** button and choosing the desired selection.

Once the Caller ID type is changed, the signaling method and message name are reset. They must be chosen from the available selections for the new Caller ID type.

5.2 Caller ID Messages to Send

For a Caller ID transmission, the message defines what information is being sent, while the signaling method defines how it is sent. The TRsSim software pre-defines a few messages at program start. These messages may be modified, or new ones created at any time. Choosing a message to send is done by clicking the mouse on the **Message** button as shown below. This displays a list of all the messages defined for the current type to choose from.

To modify, create, or delete messages, open the **Caller ID Messages** settings window. This window displays the contents of all the messages defined for any of the Caller ID types.

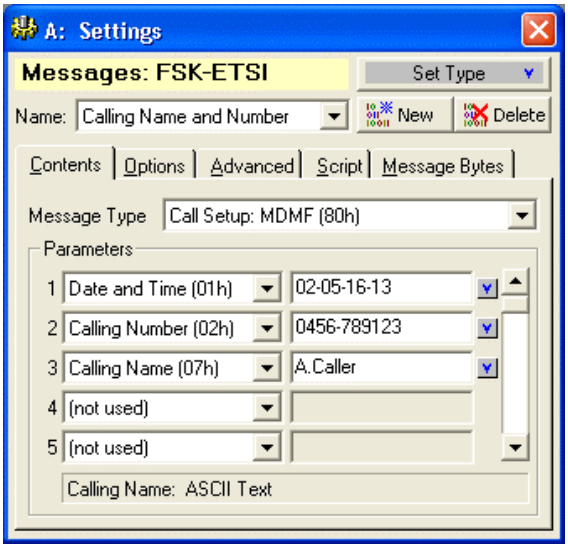
5.2.1 Telecordia & ETSI & NTT Caller ID Messages

As the FSK based Telecordia, ETSI, and NTT messages are somewhat similar, the same controls are used to view and edit the message contents. It is important to note that the messages are linked to a specific Caller ID type. This prevents using an ETSI message when the Telecordia Caller ID type is selected. Likewise, Telecordia messages can not be used with the ETSI Caller ID type.

To change the Caller ID type for the messages, click the **Set Type** button in the top right corner of the Caller ID Messages window. A list appears from which the Caller ID type is selected from. Normally the window will always default to the currently selected Caller ID type.

New messages are created by clicking the **New** button and then supplying the name of the new message. To delete a message, select it from the **Name** drop-down list and the click the **Delete** button.

The figure below shows the pre-defined "Calling Name and Number" message for the ETSI Caller ID type. Each message name must be unique as it is used to identify the different messages. By clicking the down arrow on the right side of the Name drop-down list, any message defined for the ETSI Caller ID type can be viewed.



Five tabs are used to control and view the message contents. They are Contents, Options, Advanced, Script, and Message Bytes.

Contents:

The **Contents** tab is the primary means for specifying what the message contents will be. A message is comprised of a message type and a variable number of message parameters. The message type is selected by the drop-down list box at the top of the contents tab. The supported message types are as follows:

- ETSI Caller ID Type
  - Call Setup: MDMF (80h)
  - Visual Waiting: MDMF (82h)
  - Advice of Charge: MDMF (86h) *1
  - Short Message Service: MDMF (89h) *1
- Telecordia Caller ID Type

- Call Setup: SDMF (04h)
- Visual Waiting: SDMF (06h)
- Call Setup: MDMF (80h)
- Visual Waiting: MDMF (82h)

- NTT Caller ID Type *1
  - CLIP (40h) *1
  - CIDCW (41h) *1
  - Auto Select (40h/41h) *1

***1: Only available with the advanced Caller ID option**

The NTT Caller ID message type is normally 40h for Type I (on-hook), and 41h for Type II (off-hook). Using the **Auto Select** message type causes TRsSim to automatically adjust the message type depending on if the line state is on-hook or off-hook. When on-hook, the 40h message type is used. Likewise, if off-hook, the 41h message type is used.

Below the message type are the message parameter controls. While only five parameters are shown at a time, a message can contain up to thirty parameters. Use the scroll bar at the right side of the window to view all the possible parameters. Each parameter is composed of a type and value. The different parameters types are used to convey different information to the TE. This can include the calling number, calling name, and date/time among others. The left side drop-down lists are used to select the different parameter types while the right side controls are used to hold the parameter value.

The supported parameter types for the ETSI, Telecordia, and NTT messages are as follows:

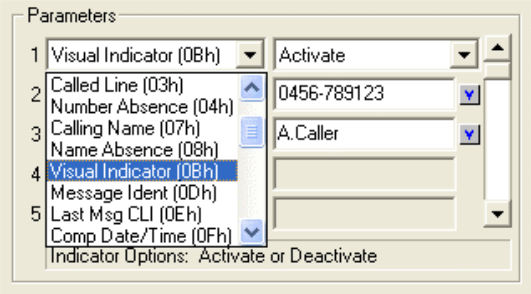
- ETSI Caller ID Type
  - Date and Time (01h)
  - Calling Number (02h)
  - Number Absence (04h)
  - Calling Name (07h)
  - Name Absence (08h)
  - Visual Indicator (0Bh)
  - Called Line (03h) *1
  - Message Identity (0Dh) *1
  - Last Message CLI (0Eh) *1
  - Comp. Date and Time (0Fh) *1
  - Comp. Calling Line (10h) *1
  - Call Type (11h) *1
  - First Called Line (12h) *1
  - Number of Messages (13h) *1
  - Type of Forwarded Call (15h) *1
  - Type of Calling User (16h) *1

  - Redirecting Number (1Ah) *1
  - Charge (20h) *1
  - Additional Charge (21h) *1
  - Call Duration (23h) *1
  - Network Provider Identity (30h) *1
  - Carrier Identity (31h) *1
  - Terminal Function (40h) *1
  - Display Information (50h) *1
  - Service Information (55h) *1
  - Extension for Network Use (E0h) *1
- Telecordia Caller ID Type
  - Date and Time (01h)
  - Calling Number (02h)
  - Number Absence (04h)
  - Calling Name (07h)
  - Name Absence (08h)
  - Visual Indicator (0Bh)
  - DDN (03h) *1
  - Call Qualifier (06h) *1
- NTT Caller ID Type *1
  - Calling Number (02h) *1
  - Number Absence (04h) *1
  - Calling Name (07h) *1
  - Name Absence (08h) *1
  - DDI Number (09h) *1
  - Original Number (0Bh) *1
  - Calling Number Extension (21h) *1
  - Public Message (24h) *1

***1: Only available with the advanced Caller ID option**

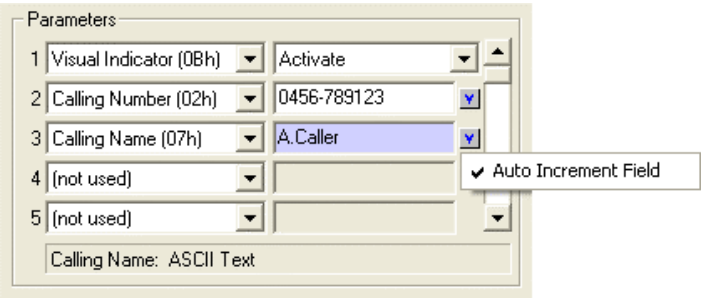
Depending on the message type selected, not all of the parameter types may be available. Also for the Telecordia Single Message Data Format (SMDF) message types, some of the parameter types are fixed and can not be changed. This is due to the structure of the SMDF.

To change a parameter type, simply click on the left side drop-down list boxes. All of the available types are displayed in order of ascending type value.



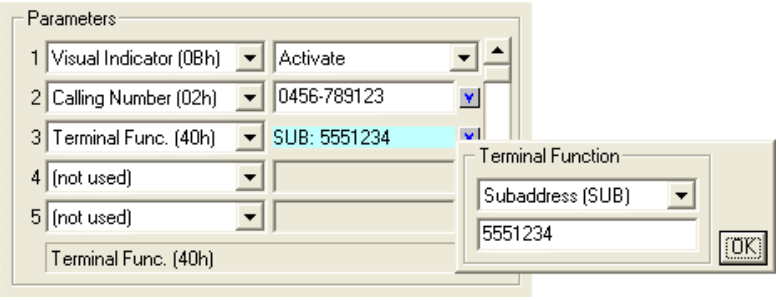
Note that an additional parameter type named "Custom" can be selected in order to create new or undefined parameters.

The "value" of each parameter is shown to the right of the "type" drop-down list. Some parameter types only have a limited possibility of selections. For these parameters, another drop-down list is used to select the value from the list. As shown in the figure above, the Visual Indicator (0Bh) parameter value can be set to either "Activate" or "Deactivate". Other parameter types may use a text string to define their contents. This is the case with the Calling Number (02h) and Calling Name (07h) parameters. With these parameter types, the value can be entered directly into the text field. For all parameters that use a text field for their value, an auto increment feature can be enabled.



By clicking on the small down arrow to the right of the text field, a popup menu allows enabling or disabling the auto increment mode. If enabled, once the Caller ID message has been sent, the TRsSim software increments the text field from the right most character to the left most character. Letters are incremented from A to Z, while numbers are incremented from 0 to 9. Once a letter or number rolls over, the character to the left increments. This feature ensures that every message sent can have a unique parameter value.

Some parameter types have complex structures. For these types, clicking the small down arrow at the right side of the parameter opens a new window containing the parameter value settings. The figure below shows the controls used to access the Terminal Function (40h) parameter.

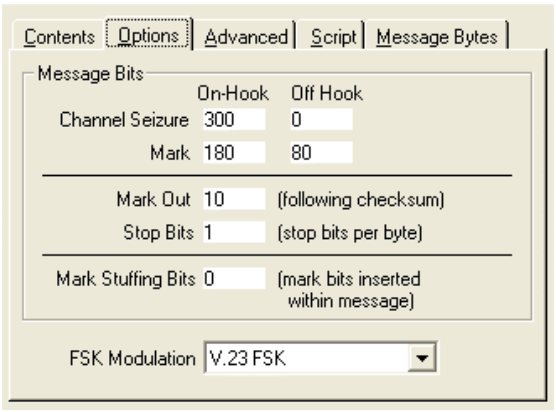


Note that the parameter data is contained inside the message in order of top to bottom. As such the top parameter in the list is transmitted first and the bottom parameter is

transmitted last. Any parameters marked as "not used" are ignored and adds no data to the message.

Options:

The **Options** tab contains various fields used to specify the bits sent in conjunction with the message contents. This includes the number of channel seizure, mark, mark out, stop bits, and mark stuffing bits. **Channel Seizure** is an alternating mark/space pattern usually sent at the start of a Type I (on-hook) message. The first channel seizure bit sent is always a space (0) bit. Following any channel seizure, the specified number of **Mark** bits are sent, which precedes the FSK message. The number of mark bits can be different depending if Type I (on-hook) or Type II (off-hook) Caller ID is sent. Once the entire message contents have been sent, the **Mark Out** interval begins. This is the number of mark bits generated following the last stop bit of the last byte in the message.



The **Stop Bits** setting determines the number of mark bits sent after each data byte. At minimum one stop bit must be sent for each data byte. The Mark Stuffing Bits setting controls the insertion of additional mark bits. If set to a non-zero value, additional mark bits are inserted after the message type byte, message length byte, every parameter type byte, every parameter length byte, and at the end of the parameter value bytes.

The last setting on the Options tab controls the FSK modulation. Though normally the ETSI and NTT messages use V.23 FSK and the Telecordia messages use Bell 202, this can be changed on a message by message basis using the drop-down list at the bottom of the panel.

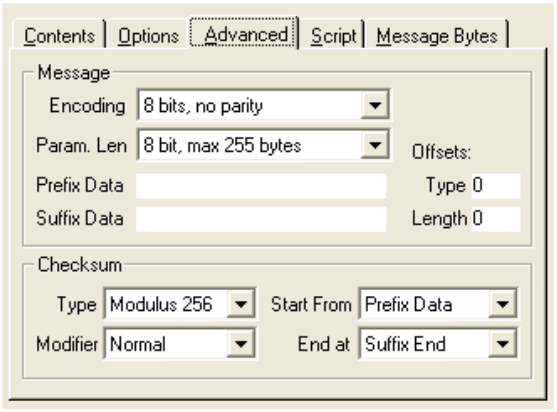
Note that the settings in the Options tab are only available with the advanced Caller ID option. If this option is not enabled the controls are shown in an orange background.

Advanced:

The **Advanced** tab provides a number of controls used for modifying the message contents and the function of the checksum. By changing the **Encoding** selection, the entire message or only text characters can be encoded in 7 data bits with even or odd parity, or all data bytes can be set to 8 data bits with no parity. The **Parameter Length** field can be selected as either the nominal 8 bit value or a 16 bit value.

The two fields marked **Prefix Data** and **Suffix Data** are used to add bytes in front of the message type byte or after the last parameter value byte. These fields are normally used with the NTT Caller ID type and may be used with the ETSI and Telecordia Caller ID type for exception testing. Data bytes can be entered in either decimal or hexadecimal form. Note that hexadecimal values are suffixed with the 'h' character.

Two **Offset** fields are used to adjust either the message **Type** byte or message **Length** byte. While normally set to zero, a non-zero value usually creates an invalid message which can be used for exception testing. Enter positive values to increase the byte values or negative values to decrease the byte values.



The checksum value added at the end of the message can be modified by the controls shown at the bottom of the Advanced settings tab. Its method of calculation is defaulted to Modules 256 for ETSI and Telecordia messages, but can be changed to CRC-16 (as used for NTT type Caller ID messages) with the **Type** drop-down list. In addition the **Modifier** drop-down list is used to manipulate the checksum value. Its value can be incremented by 1, decremented by 1, set all bits to zero, or set all bits to one. Lastly, the **Start From** and **End At** fields are used to specify the range of data bytes used to calculate the checksum.

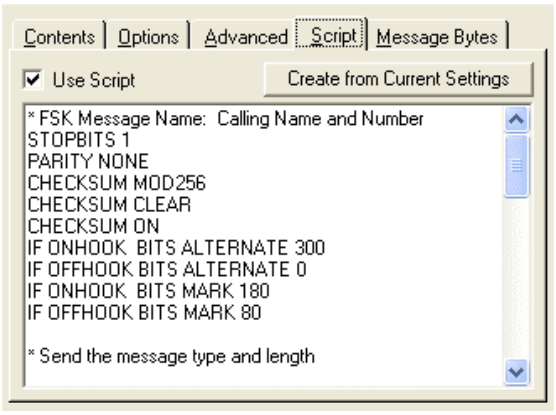
Note that the settings in the Advanced tab are only available with the advanced Caller ID option. If this option is not enabled the controls are shown in an orange background.

Script:

A more flexible and alternate method to define the Caller ID message is provided by the **Script** tab. The FSK message script can be used to specify the exact bit pattern to transmit. This can be useful in testing exception conditions where the message has been corrupted on purpose in order to test the TE's response.

By checking the **Use Script** box, the settings of the **Contents**, **Options** (except FSK Modulation), and **Advanced** tabs are ignored and the FSK message is determined solely by the script.

In performing exception testing, it is usually simpler to start with a valid message and then modify it to create the exception or error condition. This can be accomplished by clicking the **Create from Current Settings** button. This creates a script using all of the current settings. From this script any number of modifications can be made manually by editing the script in the text box shown.

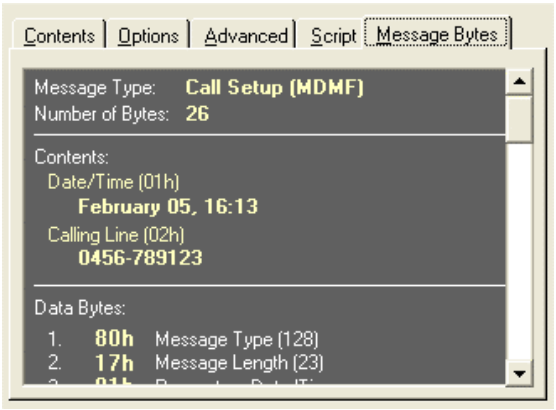


For information on the syntax of the message script, see: Appendix B: FSK Message Script on page 104.

Note that the functions of the Script tab are only available with the advanced Caller ID option. If this option is not enabled the controls are shown in an orange background.

Message Bytes:

The Message Bytes tab shows a listing of all the byte values that form the FSK message. All known Caller ID message types, and parameters are decoded with their contents displayed. If any error conditions such as invalid checksum have been enabled, warning messages are displayed indicating that the FSK message bytes do not follow a valid structure.



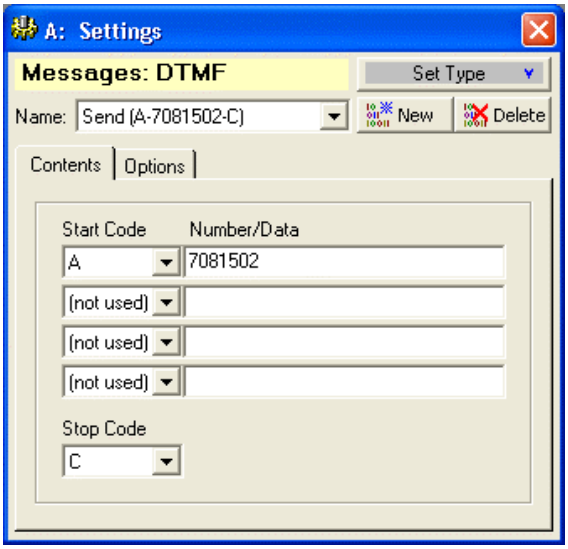
5.2.2 DTMF/MF Caller ID Messages

The DTMF Caller ID type can use either DTMF or MF tones to convey the Caller ID information. To change the Caller ID type for the messages to DTMF, click the **Set Type** button in the top right corner of the window and then select **DTMF**.

New messages are created by clicking the **New** button and then supplying a name for the new message. To delete a message, select it from the **Name** drop-down list and then click the **Delete** button.

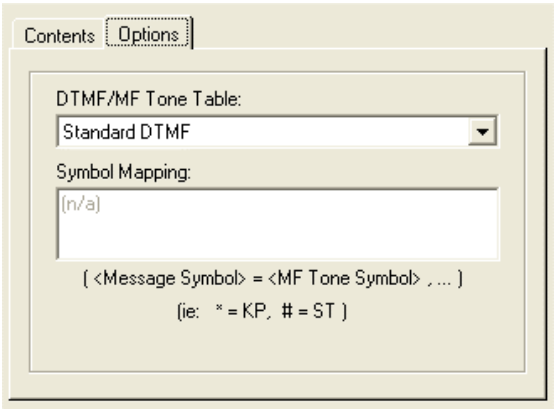
The next figure shows a message for the DTMF Caller ID type. Each message name must be unique as it is used to identify the different messages. By clicking the down

arrow on the right side of the Name drop-down list, any message defined for the DTMF Caller ID type can be viewed.



The messages are composed simply as a series of DTMF digits. Within the message, up to four different number or data fields can be specified. Each number/data field requires a start code (normally A or D). Following the last number/data field an optional stop code can be defined. In the example above, the message is composed of 9 digits. They are "A" (start code), "7081502" (number), and "C" (stop code).

The **Options** tab allows the use of MF tones instead of the standard DTMF tones. In order to use MF tones, a tone table must be specified in the drop-down list box. In addition, a symbol mapping list linking each DTMF digit to a MF tone symbol is required.

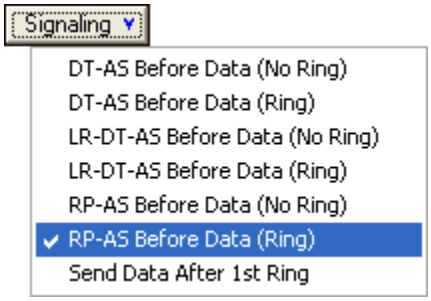


The MF frequencies, level offsets, duration offsets, and symbol names may be modified for any of the tone tables by viewing the **MF Tone Symbol Definition** settings window.

Note that the functions in the Options tab are only available with the advanced Caller ID option. If this option is not enabled the controls are shown in an orange background.

5.3 Caller ID Signaling

The Caller ID signaling defines the sequence of events required to send the message to the TE. For each of the four Caller ID types, a number of basic signaling sequences are pre-defined. Changing the signaling sequence is accomplished by clicking the **Signaling** button on the Caller ID panel and then choosing the desired selection. For the ETSI Caller ID type, the following figure shows the pre-defined signaling sequences.

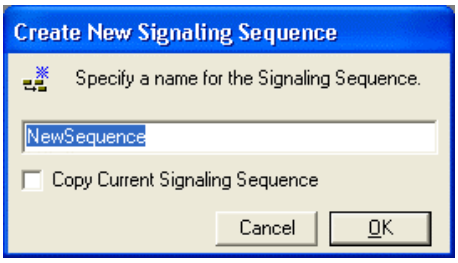


For the Telecordia, NTT, or DTMF Caller ID types, the list of pre-defined signaling sequences is different.

Editing or viewing of the sequences is performed from within the **Caller ID Signaling** settings window. From this window, new sequences can be created or existing ones modified. It is important to note that the signaling sequences are linked to a specific Caller ID type. As such, sequences defined for the ETSI type can not be used with any other Caller ID type.

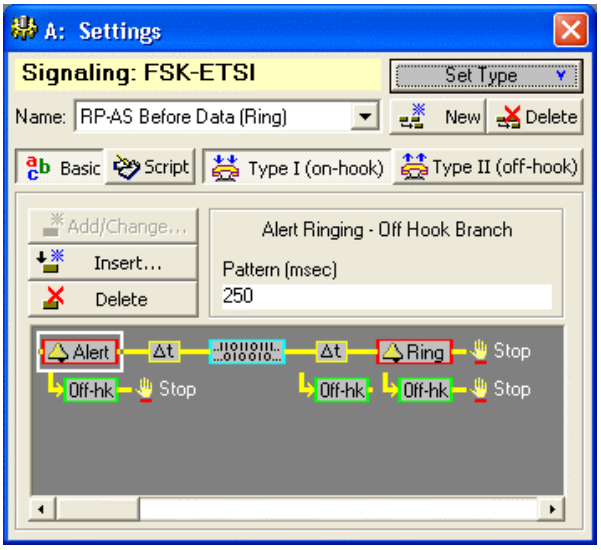
To change the Caller ID type for the signaling sequences, click the **Set Type** button in the top right corner of the Caller ID Signaling window and select it from the list displayed.

New sequences are created by clicking the **New** button and then supplying the name of the new sequence. The name of each sequence must be unique. If the **Copy Current Signaling Sequence** box is checked, then the new sequence will be a copy of the currently selected sequence.



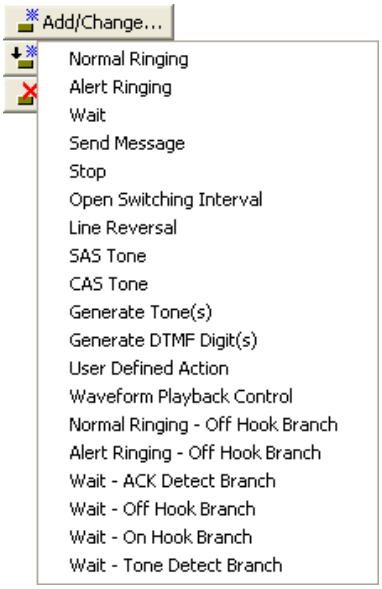
To delete a sequence, select it from the **Name** drop-down list and then click the **Delete** button.

The figure below shows the pre-defined "RP-AS Before Data (Ring)" sequence for the ETSI Caller ID type. By clicking the down arrow on the right side of the Name drop-down list, all the sequences defined for the ETSI Caller ID type are displayed.



The signaling sequences are represented by a series of graphical blocks. Each block symbolizes a specific function such as ringing, time delay, or sending data. The figure above shows a sequence that starts with an alerting ring, followed by a time delay, transmission of Caller ID data, another time delay, and finally ends with normal ringing. Some of blocks allow for a split in the sequence if a certain event is detected. For example, the first block in the above figure generates an alert ringing pattern. If during this ringing the TE goes off-hook, the sequence flow shifts to the next line down. In this case the next block is a Stop symbol which halts the Caller ID transmission. Likewise for the time delay block shown just after sending the data and then the normal ringing block. If the TE goes off-hook during these two blocks, the sequence changes to the line underneath which leads to a Stop symbol.

Using the **Add/Change**, **Insert**, and **Delete** buttons, these graphical blocks can be manipulated to create a wide array of signaling sequence. At most a sequence can consist of 25 blocks on a single flow path (horizontal row) and up to four different flow paths. Most of the blocks have one or more parameters that affect its operation. For example, the ringing block parameter sets the pattern of the ringing, while the wait block parameter specifies the duration of the delay.

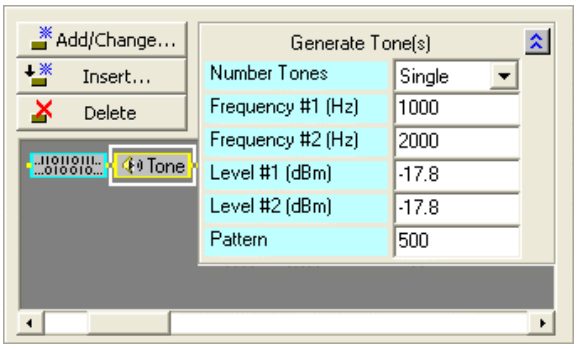


In total there are 19 different graphical blocks. However five of them are only available with the AI-7280, due to hardware limitations with the AI-80. The function and operation of the graphical blocks are as follows:

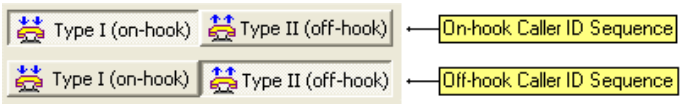
- **Normal Ringing**: Generates a ringing pattern using the "normal" ring frequency, level, and wave shape setting. These settings are located in the "Caller ID Signal Settings" window.
- **Normal Ringing - Off Hook Branch**: Similar to normal ringing, except that if the TE goes off-hook anytime during the ringing pattern, the sequence drops down to the next flow path (horizontal row).
- **Alert Ringing**: Generates a ringing pattern using the "alert" ring frequency, level, and wave shape setting. These settings are located in the "Caller ID Signal Settings" window.
- **Alert Ringing - Off Hook Branch**: Similar to alert ringing, except that if the TE goes off-hook anytime during the ringing pattern, the sequence drops down to the next flow path (horizontal row).
- **Wait**: Delays a sequence by a specified number of milliseconds.
- **Wait - Off Hook Branch**: Similar to the normal Wait, except if the TE goes off-hook anytime during the delay the sequence drops down to the next flow path (horizontal row).
- **Wait - On Hook Branch**: Similar to the normal Wait, except if the TE goes on-hook anytime during the waiting time the sequence drops down to the next flow path (horizontal row).
- **Wait - ACK Detect Branch**: Similar to the normal Wait, except if an ACK DTMF digit is detected during the delay the sequence drops down to the next flow path. The ACK digit code(s), minimum level, and maximum frequency tolerance settings are located in the "Caller ID Signal Settings" window.
- **Wait – Tone Detect Branch (AI-7280 only)**: Similar to the normal Wait, except if a tone of a specific frequency is detected the sequence drops down to the next flow path.
- **Send Message**: Generates either the FSK message or the DTMF message based on the selected Caller ID type.
- **Open Switching Interval**: Removes the DC feeding voltage for a specified duration.
- **Line Reversal**: Reverses the line polarity. If it was normal, this block sets it to the reverse state. Likewise if in the reverse state, this block sets it to the normal state.
- **SAS Tone**: Generates a Subscriber Alerting Signal (SAS) using the specified pattern. The frequency and level settings are located in the "Caller ID Signal Settings" window.
- **CAS Tone**: Generates a CPE Alerting Signal (CAS) using the specified pattern. Note that the CAS tone is the same as the Dual Tone Alerting Signal (DT-AS). The frequency and level settings are located in the "Caller ID Signal Settings" window.
- **Generate Tone(s) (AI-7280 only)**: Generates one or two tones at any arbitrary frequency and level.

- **Generate DTMF Digit(s) (AI-7280 only)**: Generates one or more DTMF digits with an arbitrary frequency, level, on time, and pause time.
- **Waveform Playback Control (AI-7280 only)**: Starts, stops, or resumes the playback of a wave file.
- **User Defined Action (AI-7280 only)**: Executes a user define AI-7280 device script.

Some of the graphical sequence blocks have multiple parameters. An example is the **Generate Tone(s)** block. When selecting this block by clicking the mouse on it, the list of parameters can be expanded or compressed by clicking the small blue arrows shown in the upper right corner of the window.



All of the signaling sequences must be specified for either Type I (on-hook) or Type II (off-hook) operation. This is determined by the state of the **Type I** and **Type II** buttons shown on the settings window. Only Type I sequences are available if the TE is on-hook prior to starting a Caller ID transmission. Likewise only Type II sequences can be used if the TE is off-hook prior to starting a Caller ID transmission.

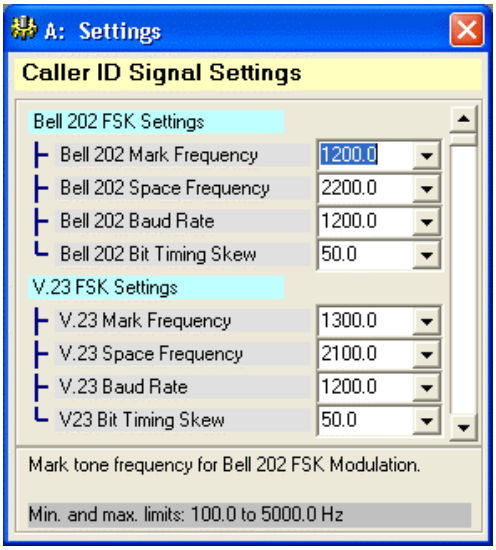


Note that new signaling sequences can only be created or the pre-defined sequences modified if the advanced Caller ID option is enabled. If not enabled, then only the ringing/alert pattern of existing sequences can be changed.

5.4 Caller ID Signal Parameters

All of the various physical layer parameters used in Caller ID transmissions are accessed in the **Caller ID Signal Settings** window. These include the FSK characteristics, DTMF parameters, ringing, alert tones, and ACK detection limits.

To change a setting, simply click the mouse in the applicable text box and enter a new value. The range of acceptable values for any parameter is shown at the bottom of the window. If a value entered is outside the valid range the min/max values shown changes to a background color of orange.



There are nine different categories for all of the physical layer parameters displayed in this window. They are:

- **Bell 202 FSK Settings**: These define the mark tone frequency, space tone frequency, baud rate, and timing skew for the Bell 202 FSK modulator. The timing skew setting represents the ratio of mark bit time to the sum of both mark and space bit time. Accordingly, the default setting of 50% represents equal mark and space bit times. Higher values increases the mark time at the expense of space bit time. Likewise lower values decrease mark time and increase space bit time. Note that the FSK level is specified on the main Caller ID control panel.
- **V.23 FSK Settings**: Similar to the Bell202 settings, these define the mark and space tone frequency, baud rate, and timing skew. Note that the FSK level is specified on the main Caller ID control panel.
- **General FSK Settings**: The Level Specification Mode parameter in this category determines how the FSK level is specified. It can be either as a total level, total level with twist, or independent mark and space tone levels. The Starting Phase parameter controls the initial phase angle of the FSK modulator. By default it is zero degrees. This can be changed to any value between 0 and 360 degrees in 15 degree increments. An alternate setting 'Random' causes a random initial phase angle every time a Caller ID transmission is started.
- **General DTMF Settings**: These parameters control the DTMF/MF generator by setting the digit's tone on duration, tone off or pause duration, frequency offset, and level mode. The DTMF/MF signal level is specified as either a total level, total level with twist, or independent row and column tone levels.
- **SAS Tone Settings**: Defines the frequency and level for up to two independent tones. By default, only a single tone is used for the SAS tone.
- **CAS/DTAS Tone Settings**: Defines the frequency and level for two independent tones.
- **Normal Ringing Settings**: These parameters set the normal ringing level, frequency, and wave shape. Note that the wave shape setting is not available with the AI-80.

- **Ring Burst Alert Settings**: Similar to the normal ringing settings, but for the alert ringing signal. Note that the wave shape setting is not available with the AI-80.
- **ACK Tone Settings**: Defines the acceptable ACK digit code, minimum ACK level, maximum ACK frequency error, and FSK timing mode. The minimum ACK level refers to both the row and column tone. Both tones must exceed this level in order for the ACK to be detected. The FSK Delay Time w.r.t. ACK setting determines when the **Wait – ACK Detect Branch** sequence block has ended and the next block is executed (usually a wait followed by Send Message). If set to "Detected", then the ACK detect block ends when the ACK tone is detected. This usually occurs 25 to 35 ms after the ACK tone has started. The alternate setting "End of ACK" waits until the ACK tone ends. Once it ends the next block is executed. This setting is not available with the AI-80.

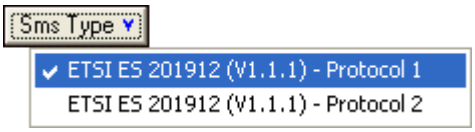
Note that most of these parameters can only be modified if the advanced Caller ID option is enabled. If not, only the normal ringing and alert ringing parameters can be changed. All of the unavailable parameters are shown in an orange background color.

6. SMS Service Center Emulation

Short Message Service (SMS) is the ability to send and receive text messages between various devices. Terminal equipment supporting SMS use the PSTN to establish a voice path with a Short Message Service Center (SM-SC). Once a connection between the TE and SM-SC is made, text messages can be sent or received. The TRsSim software supports the emulation of a SM-SC for TE testing purposes. It can either receive calls from the TE and accept text messages, or dial the TE for delivery of text messages.

Two different methods of text message transfers are supported. Both are defined in the ETSI ES 201912 standard and are referred to as Protocol 1 or Protocol 2.

Selecting which SMS type to use is done by clicking the mouse on the **Sms Type** button and choosing one of the two methods, as shown below.



See the section: Short Message Service on page 21 for more information on how to change the SMS type and setup selections along with how to send and receive messages.

The following sections describe in more detail all of the settings used to control the SMS data exchanges as well as how the Transfer Layer (TL) messages and SMS setups are modified or created.

Note that the SM-SC functionality of the TRsSim software is an optional component. Unless ordered when the software was purchased, it is not available. This option can be added to the TRsSim software at any future date.

6.1 ETSI SMS Protocol 1

Details on the operation of protocol 1 can be found in the ETSI ES 201912 standard. It describes how the DLL (Data Link Layer) is used to transfer the TL (Transfer Layer) messages back and forth between the SM-TE and SM-SC. In addition it references ETSI ES 300659-2 and ETSI ES 300778-2 for details on the physical layer requirements for FSK transmission and reception. As the TL messages follow the GSM short message service structure, protocol 1 references ETSI TS 100901 for information on the structure.

Within the TRsSim software, three different settings windows are used to define how the SM-SC operates under protocol 1. They are:

- **General Settings**: A collection of various SM-SC parameters that define the physical layer characteristics such as timing, FSK limits, telephone number, sub-address values along with some PSTN related settings.

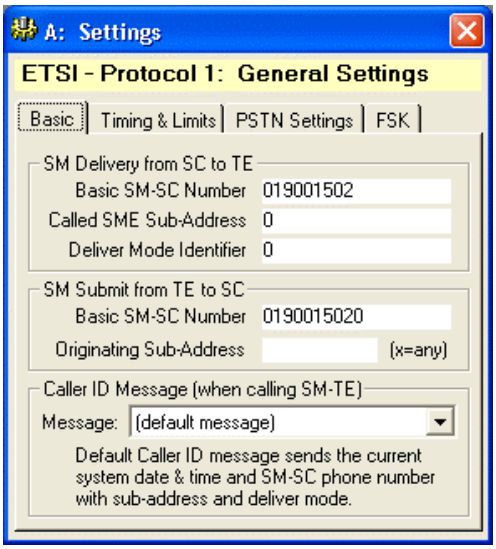
- **Transfer Layer Messages**: Used to view, modify, or create all of the TL messages sent by the SM-SC.
- **Message Flow Setup**: Used to view, modify, or create SMS setups. A setup is defined as a set of rules governing the transfer of DLL/TL messages to and from the TE.

6.1.1 General Settings

The ETSI Protocol 1 General Settings window stores a number of parameters controlling the operation of the SM-SC. As shown below, it is divided into four different tabs.

The **Basic** tab sets the telephone numbers used when calling the TE or receiving a call from the TE. If the SM-SC calls the TE, the TE will receive Caller ID information containing the calling number of the SM-SC. By default, the calling number is composed of three parts. These are the basic number, sub-address, and deliver mode identifier. All three values are sent together in the calling number parameter of the Caller ID transmission.

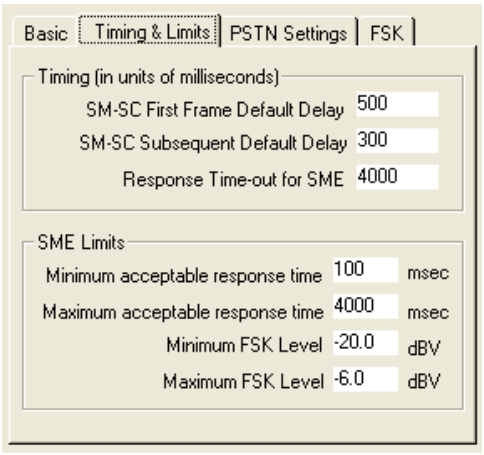
In the case where the TE calls the SM-SC (to submit a message), the TRsSim software compares the number dialed by the TE to the combined SM-SC Number and Originating Sub-Address fields. If a match, the TRsSim software begins the process of connecting the TE to the SM-SC. The Sub-Address field is optional and may contain "don't care" digits. By using the character 'x', the TRsSim software requires a dialed digit, but does not care what the digit is.



Near the bottom of the Basic tab is a drop-down list used to select the Caller ID message to send to the TE when the SM-SC is calling. The default message contains the current date & time, basic SM-SC number with sub-address and deliver mode. If required it is possible to choose other Caller ID messages from the drop-down list.

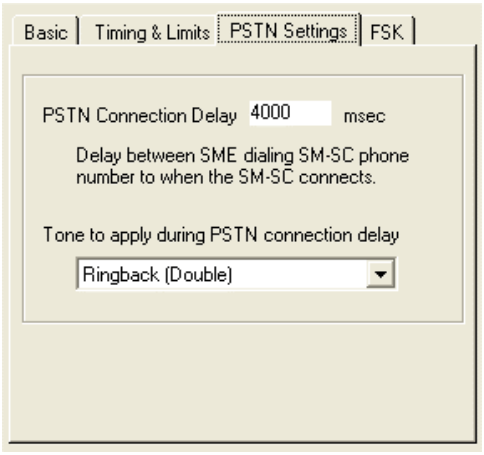
The **Timing & Limits** tab sets the timing of the SM-SC FSK frames as well as timing and FSK level limits for the TE. The SM-SC First Frame Default Delay field determines the amount of time the SM-SC waits after establishing a voice path connection to the SM-TE and then sending the first FSK frame. The field just below it determines how long the SM-SC waits after receiving a FSK frame from the TE. Note that these delays may be increased or decreased on an individual frame basis by the settings in the Message Flow Setup window.

The Response Time-Out for a SME represents the maximum amount of time to wait for the complete reception of a DLL message sent by the TE. This time starts when the SM-SC has finished sending a DLL message to the TE.

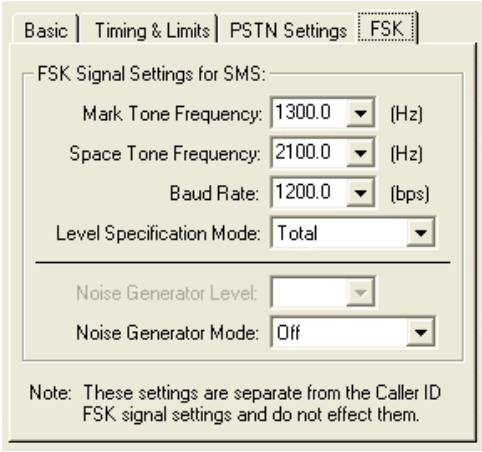


The four SME Limits settings define the valid range for the TE's DLL message response time and FSK level. If any of these limits are violated, the offending DLL message is flagged in the Data Recorder window with a warning message.

The third tab, **PSTN Settings**, controls the PSTN's reaction to the TE dialing the SM-SC telephone number. The connection delay represents the time required for the PSTN to "ring" the SM-SC and then the SM-SC to answer the call and establish a voice path connection. During this delay the TRsSim software can apply any of the defined network tones. By default, the double ring back tone is selected.



The **FSK** tab sets the physical layer characteristics of the FSK modulator. To change either of the mark frequency, space frequency, or baud rate click the mouse in the field and enter a new value. The next field controls how the FSK level is specified, which can be either as total level, total level with twist, or independent mark and space levels. Note that the FSK level is specified on the SMS control panel and not within the General Settings window.



For the AI-7280 only, a broad band white noise generator may be enabled during FSK transmissions. The noise generator level can be specified as either absolute or relative to the FSK level.

6.1.2 Transfer Layer Messages

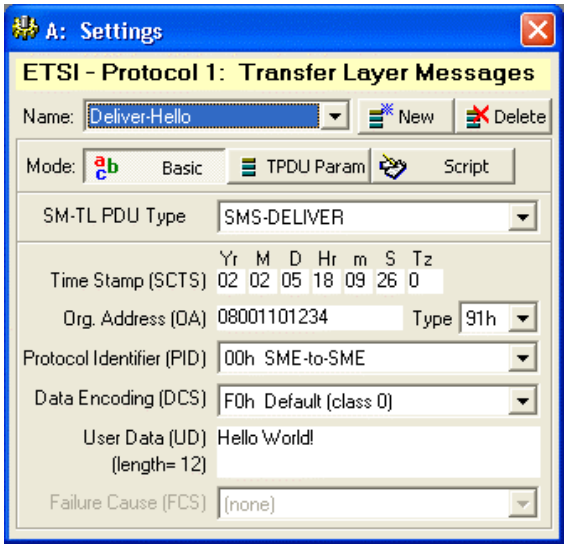
In the ETSI SMS protocol stack, the Data Link Layer (DLL) is used to transport Transfer Layer (TL) messages. These TL messages are then used to convey the text messages or report status information.

All of the TL messages sent by the SM-SC can be viewed or modified using the Transfer Layer Messages settings window. In addition new messages can be created or existing ones deleted.

Note, while the Transfer Layer Message settings window provides a large degree of flexibility in composing messages, it is much easier to use the Message Generator window to create messages. While not as flexible, it simplifies many complex tasks especially when concatenated messages are to be sent. For more information see the section: 6.1.4 Simplified Message Generation on page 66.

Each TL message must have a unique name by which it is identified. A number of messages are pre-defined in the TRsSim software and used in the pre-defined setups to transfer short test messages or submission reports. To view a specific message, select its name from the drop-down list near the top of the settings window.

New messages are created by clicking the **New** button and then supplying the name of the new message. To delete a message, select it from the **Name** drop-down list and then click the **Delete** button.



The previous figure shows the settings for the "Deliver-Hello" message. It is used to send the text "Hello World!" to a SM capable TE. For details on the structure of the TL messages consult the ETSI TS 100901 standard.

The TRsSim program supports three different methods to define a TL message. They are represented by the three buttons labeled **Basic**, **TPDU Param**, and **Script**. Each successive mode allows more flexibility in defining the TL message's contents. However they also require a more detailed knowledge of the message structure.

The **Basic** mode is the simplest to use and the least flexible. As the previous figure shows, the "Deliver-Hello" message uses this mode. All TL message must use one of six possible PDU types. The basic mode supports five of these types. They are:

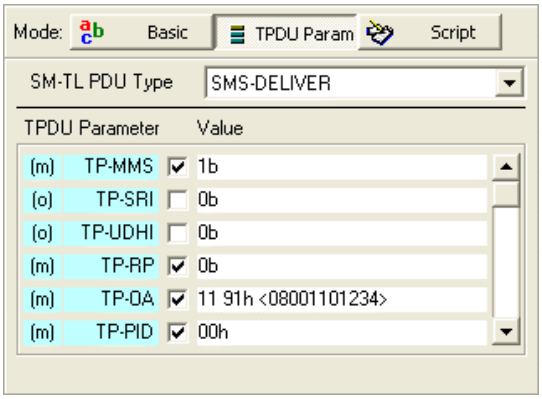
- SMS-DELIVER: contains a short message being sent from the SC to the TE.
- SMS-DELIVER-REPORT: contains information regarding the success or failure of a SMS-DELIVER or SMS-STATUS-REPORT message.
- SMS-SUBMIT: contains a short message being sent from the TE to the SC.
- SMS-SUBMIT-REPORT: contains information regarding the success or failure to a SMS-SUBMIT or SMS-COMMAND message.
- SMS-STATUS-REPORT: contains status information being sent from the SC to the TE.

Depending on which PDU type is selected, the fields underneath the drop-down list may change. Each PDU type has a different structure using different TPDU parameters. The fields shown underneath the PDU type does not represent all of the TPDU parameters, but rather the ones most commonly modified.

In the case of the SMS-DELIVER message, the TPDU parameters shown are the SC time stamp (SCTS), originating address (OA) for the message, protocol identifier field (PID), data encoding field (DCS), and the user data field (UD). It is the user data field that contains the text message. The failure cause field (FCS) is disabled, since it is not applicable to SMS-DELIVER messages.

The **TPDU Param** mode offers more flexibility than the basic mode. It allows modification of all the TPDU parameters and also allows illegal data to be contained within them. This is very useful for creating error conditions within the TL message and

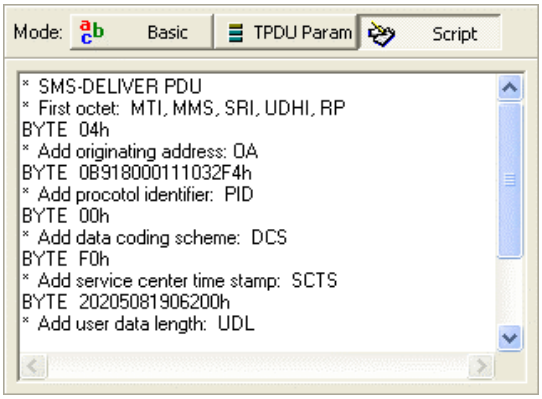
testing the TE's response. To change to this mode, click the mouse on the TPDU Param button.



The displayed window shows a list of all the TPDU parameter used with the specified PDU type. The left side of the list indicates the short hand abbreviation for the TPDU along with either the letter 'm' or 'o'. The letter 'm' indicates that the TPDU parameter is mandatory for the selected PDU type, while the letter 'o' indicates that it is optional. If a check mark is visible beside the TPDU name, then that parameter is included in the TL message. If the box is blank the parameter is not included. The contents or value of each TPDU parameter is shown on the right side of the list. There are many different methods available to specify the value of the parameter. It may be done as individual bits, an integer number, hexadecimal bytes, 7-bit GSM characters, or 8-bit ASCII characters. For information on the data formats allowed, see the section: Appendix C: Specifying Binary Data on page 107.

Note that if a change is made to a TPDU parameter setting, the mode can not be changed back to basic mode without undoing any changes made.

The third mode is the **Script** mode. It allows the most flexibility in determining the contents of a TL message. In this mode the message is created from a series of instructions that define every bit or byte. There is no requirement to follow the structure of the standard PDU types.



For information on the structure and commands of the FSK message script, see the section: Appendix B: FSK Message Script on page 104.

The three modes work in a hierarchical fashion. Changing the mode from basic to TPDU updates all the TPDU parameters to match the settings used in the basic mode. Likewise, changing the mode to script from TPDU, updates the script with the current TPDU parameter settings.

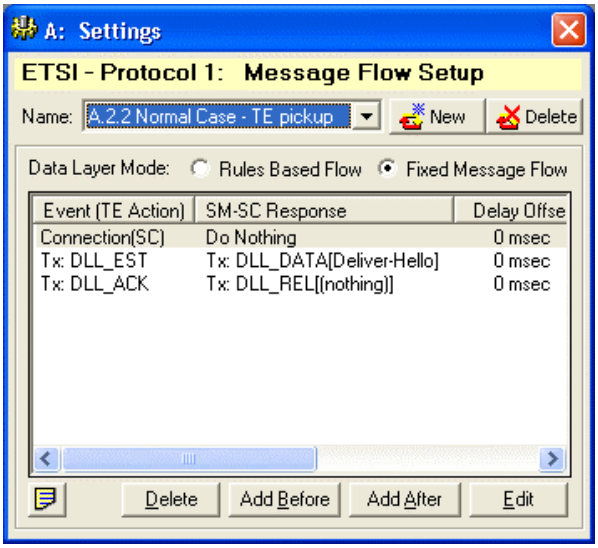
Note that if a change is made to a message script, the mode can not be changed back to basic or TPDU parameter without undoing any edits performed.

6.1.3 Flow Setup

The rules that govern the flow of messages is defined in the Flow Setup window. This window allows for examining the details of an existing setup or creating new setups. A SMS setup is simply a list of events detected by the SM-SC and its corresponding action in response to the event. Each setup must have a unique name by which it is identified. Many different setups are pre-defined in the TRsSim software. They follow many of the sequence flow charts contained in Annex A of the ETSI ES 201912 document. To view a specific setup, select its name from the drop-down list near the top of the window.

New setups are created by clicking the **New** button and then supplying the name of the new setup. To delete a setup, select it from the **Name** drop-down list and then click the **Delete** button.

The following figure shows the setup "A.2.2 Normal Case - TE pickup". It represents the nominal situation of sending a SMS message from the SC to TE.



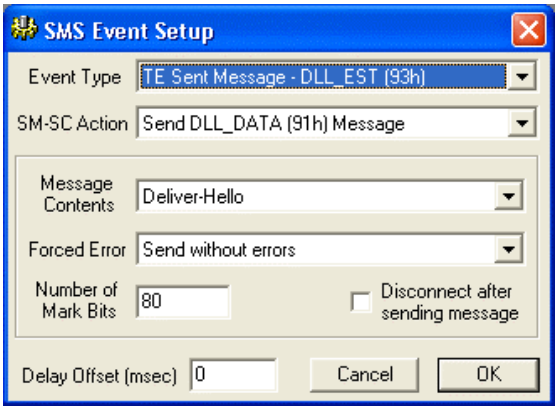
There are only three event/action pairs listed for this setup. Each one is represented by a separate line in the window. They function as follows:

- **Event: Connection(SC)**: This event indicates that the TE has received the Caller ID message and has gone off-hook in order to establish a voice path connection to the SC. The SC does not take any action to this event.
- **Event: TE Sent DLL-EST**: This event is triggered when the TE sends a DLL-EST message. This message does not contain a TL message, but rather is used to inform the SC that the TE has answered the call and is ready to receive messages. In response to this event the SC sends a DLL-DATA message. This DLL message contains the contents of the "Deliver-Hello" TL message. It is the TL message that conveys the text information.
- **Event: TE Sent DLL-ACK**: If the TE correctly receives the DLL-DATA message it should respond with a DLL-ACK message. This tells the SC the message was received correctly. If an error had occurred the TE would send a DLL-NACK message instead. In response to the DLL-ACK message, the SC sends the DLL-REL message. This informs the TE that it should release the connection.

These three actions and the associated events represent the A.2.2 message sequence chart in ETSI ES 201 912 Annex A document.

All of the event/action pairs can operate in one of two different modes. They are either **Rules Based Flow** or **Fixed Message Flow**. When using the rules based flow, the order of events listed does not matter. Once an event is detected, its corresponding action is taken regardless of where the event is positioned in the list. For fixed message flow, the events must be detected in the order they are listed. This is much more restrictive, but allows for verification that the TE under test follows an exact message flow. If any event detected is not in the list, or the events occur in a different order then a fixed flow violation is issued which stops the SMS session. In the example above, the fixed message flow is used. The two buttons above the list of event/action pairs are used to change the mode setting.

The **Delete**, **Add Before**, **Add After**, and **Edit** buttons at the bottom of the window are used to modify the event/action pairs. For example, selecting the second event with the mouse and clicking the **Edit** button displays the following window. This window is used to change any of the event action settings.



The top selection in the window selects the type of event to detect. This can be any one of the following event types:

- **Connection TE Initiate**: This event is triggered when the TE has dialed the SC and the SC answers the call, creating a voice path connection.
- **Connection SC Initiate**: This event is triggered when the TE answers a call from the SC by going off-hook, thus creating a voice path connection.
- **TE Sent Complete Message**: Indicates that the TE has completed sending a DLL message to the SC that matches one of the following message types (DLL-DATA, DLL-ERROR, DLL-EST, DLL-REL, DLL-ACK, DLL-NACK).
- **TE Sent Segmented Message**: Indicates that the TE has completed sending a segmented DLL message to the SC that matches one of the following message types (DLL-DATA, DLL-ERROR, DLL-EST, DLL-REL, DLL-ACK, DLL-NACK).
- **TE Sent Message with DLL Error**: A message was sent by the TE, but it contains a DLL error in which the received checksum does not match the calculated checksum.
- **Timeout in Waiting for Message**: This event is triggered if a timeout occurs in waiting for the TE to send a message.

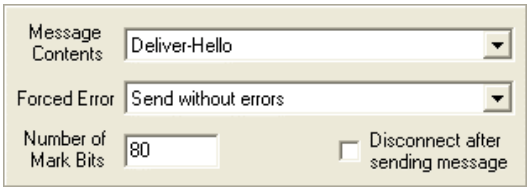
- **DLL Error Counter Exceeded**: Each time a message is received from the TE with a DLL error, an error counter is incremented. If this counter exceeds a specified value, this event is triggered.

A special condition exists for the "TE Sent Message - DLL-ACK" events (both segmented and non-segmented). These events can be further qualified by a counter that increments every time a DLL-ACK message is received. This allows for different actions to occur for every reception of the DLL-ACK message.

Just below the event type selection is a drop-down list box containing all of the possible SC actions in response to the event. The SC actions to an event are summarized as follows:

- **Do Nothing**: The SC does nothing in response to the event.
- **Disconnect**: This action causes the SC to disconnect from the TE and end the SMS session.
- **Send Last Message Again**: The last message sent by the SC is re-transmitted.
- **Send Complete Message**: The SC will transmit one of the following message types: DLL-DATA, DLL-ERROR, DLL-EST, DLL-REL, DLL-ACK, DLL-NACK.
- **Send Segmented Message**: The SC will transmit one of the following segmented message types: DLL-DATA, DLL-ERROR, DLL-EST, DLL-REL, DLL-ACK, DLL-NACK.
- **Send Custom Message**: The SC will transmit a message to the TE using a custom FSK message script. This allows for any type of message to be sent. See Appendix B: FSK Message Script on page 104 for details on the message script syntax.

If the action selected is to send a complete or segmented DLL message, four additional controls are used to determine the payload of the DLL message along with other options.



The first is used to select the contents of the DLL message. The drop-down list includes all of the TL messages that have been previously defined as well as predefined messages that contain a single byte of either 01h, 02h, 03h, 04h, or FFH. The single byte values are normally used to return an error code to the TE using the DLL-ERROR message type.

The second control is used to force an error upon the message being sent. The options are either to send without error or add 1 to the message length, subtract one from the message length, add 1 to the checksum value, or subtract one from the checksum value.

Normally preceding the message data bytes are 80 mark bits. The field in the lower left corner can be used to modify this value on a message by message basis.

Finally, the last option is to end the voice path connection with the TE after sending the message. This is normally enabled if the SC sends the DLL-REL message indicating that the TE should release the line.

In addition, the **Delay Offset** field is used to apply a positive or negative time offset to when the message is sent by the SC. The offset value is added to the default frame delay

value specified in the General Settings window. The resulting value is used as the frame delay, which allows for adjustment on a message by message basis.

6.1.4 Simplified Message Generation

The structure of TL messages for ETSI ES 201912 - Protocol 1 can become complex in certain situations. This includes the case of sending long messages, as the contents must be broken up into multiple TL messages. Each TL message must then include information that allows the receiving SME to correctly combine the contents of each TL message together.

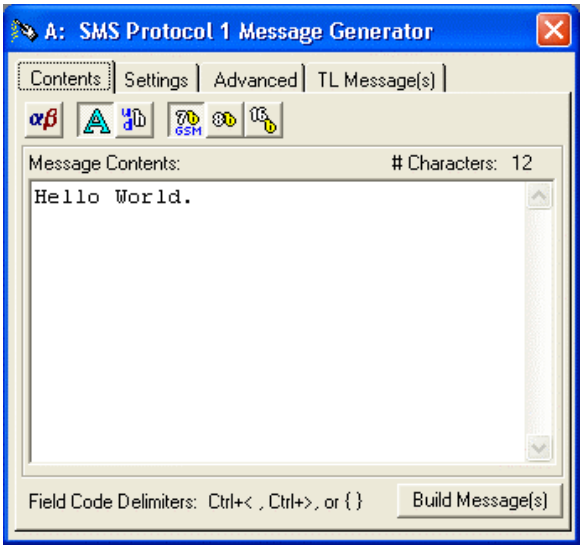
In order to assist in the process of creating the TL messages, the TRsSim software can display a "Message Generator" window. If the **Sms Type** selection is set to the ETSI Protocol 1 setting, the following button is shown at the far right of the control panel window.

Clicking this button displays the "Message Generator" window. The window, as shown below, has four tabs from which various controls are accessed.

Contents Tab:

The "Contents" tab holds a large text box used to enter the contents of the TL message(s). To send a message to a SMS capable TE, click the mouse anywhere inside the text box and enter the message contents. If the number of characters entered exceeds the maximum for a TL message, it is automatically broken up into multiple TL messages. The maximum number of TL messages is determine by the connected hardware device. If using the AI-80, it can support up to four TL messages each containing up to 153 characters. The AI-7280 can send up to 10 TL messages for a maximum of 1530 characters.

Once the text box contains the characters to send, click the **Build Message(s)** button. This starts the process of generating the TL message(s) and optionally, the SMS Setup as well. When complete, the total number of characters contained in the User Data (UD) field of the TL messages is displayed in the upper right corner. In the example below, the text "Hello World." requires 12 characters to send.



Depending on the PC's keyboard and regional settings, not all of the GSM character set may be accessible via the keyboard. To enter characters not available from the keyboard, click the mouse on the GSM Character Map button as shown below.

This displays a window showing the GSM characters. As the mouse is moved over any of the characters, its decimal and hexadecimal code is shown in the bottom left corner of the window. Clicking on the button marked **Extension**, toggles the character map from its default table setting to the extension table setting.

To enter any of the displayed characters into the Message Generator contents text box, simply click the mouse on the character. For example, clicking on the highlighted character in the above window adds the text:

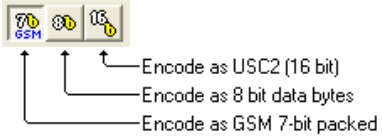
«22»

The number 22 is the decimal value for the selected character. The « and » characters are used as delimiters for field codes. These delimiter characters can be manually entered by pressing the **CTRL <** and **CTRL >** keys on the keyboard. Any character code from 0 to 127 can be entered into the text message by either clicking on the character in the GSM character map, or manually entering the field code. To enter multiple characters in a field code, separate each one with a comma. For example, the € character is represented by the following field code:

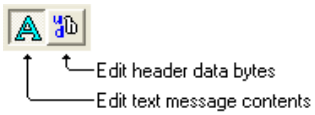
«27,101»

The first value of 27 is used to specify that the next character is using the GSM extension table. The second value of 101 is the code for the € character within the extension table. Character values must range from 0 to 127 and can be specified either as a decimal number or as a hex value (0h to 7Fh). Append the letter 'h' to hex values.

The message contents may be encoded in one of three different formats. They are either using the standard GSM packed 7 bit character map, 8 bit character encoding, or USC2 (16 bit) encoding. The following three buttons are used to select the encoding mode.



The text box used to enter the message contents can also be used to specify the contents of the UDH (user data header) field. The following two buttons are used to alternate between the modes.



When editing the UDH contents, the byte values can be specified in either decimal or hexadecimal format. For example, the following text string:

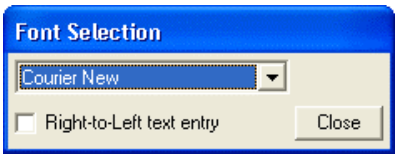
23 FFh 2A6C9Eh 123

Sets the UDH field to the following six bytes:

17h, FFh, 2Ah, 6Ch, 9Eh, 7Bh

The UDL (user data length) field is automatically calculated as the number of octets needed to hold both the UDH and UD fields.

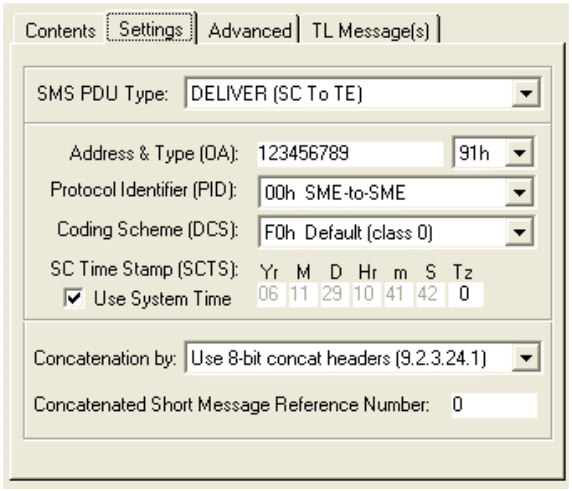
As not all character fonts support all of the various international characters in use today, the font used to enter the message text can be changed. Double clicking the mouse anywhere inside the message contents text box displays the font selection window.



By default the Courier font is used to display the text characters. However this may be changed to any font installed on the PC. Alternate fonts may support certain characters that can not be displayed with the Courier font. The font selection is remembered by the TRsSim software the next time it is executed.

Settings Tab:

The "Settings" tab contains a number of controls which are used in specifying details for the TL messages created. At the top of the window is the PDU type selection. The Message Generator window creates one of two different types of PDU's. The default setting is the DELIVER PDU. This is used for sending messages from the SC to the TE. This may be changed to SUBMIT for sending messages from the TE to the SC. As the AI-80 or the AI-7280 emulates the SC, the SUBMIT PDU is not normally used.



As part of the DELIVER PDU, the user can specify four additional fields. These are the Originating Address (OA), Protocol Identifier (PID), Coding Scheme (DCS), and SC Time Stamp (SCTS). By default, when a message is created the SC time stamp is taken from the PC's current system time. To specify a different time, click the mouse on the **Use System Time** check box. For more information on the usage of each of these fields, consult the ETSI document TS 100 901.

The bottom two controls determine how the Message Generator window splits up long messages. Three methods are available.

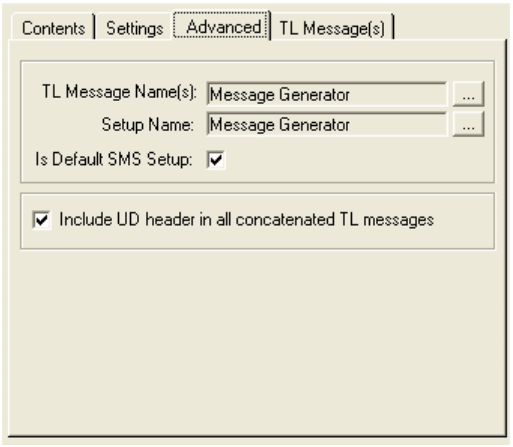
The default selection is to use the 8 bit concatenation headers described in section 9.2.3.24.1 of TS 100 901. This method adds header data bytes to the User Data (UD) field specifying that the TL messages should be concatenated to form the complete message. When using this method, the user may specify a 8 bit reference number from 0 to 255. This reference number forms part of the header and remains constant for all of the TL messages generated.

Similar to the above concatenation method, the second method uses 16 bit concatenation headers as defined in section 9.2.3.24.8 of TS 100 901.

The third method is to use the "+" character within the User Data (UD) field. If multiple TL messages are required, the subsequent message(s) start with the "+" character. All of the TL messages (except the last one) end with the "+" character in the UD field.

Advanced Tab:

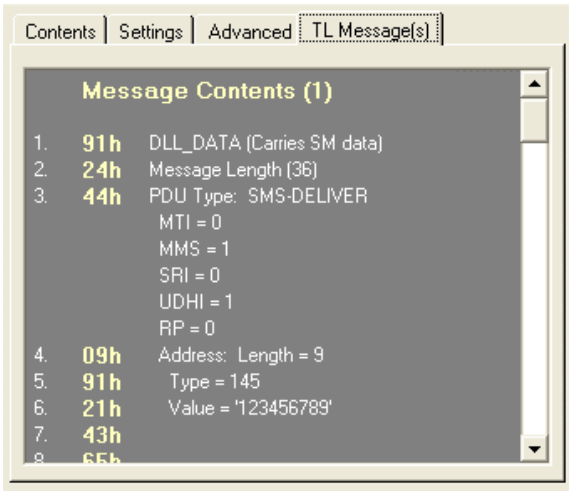
When the Message Generator window builds the TL message(s) and SMS setup, it uses the names defined in the "Advanced" tab. The default name used is "Message Generator". To change this setting, click the button to the right of the displayed name. This displays a dialog window from which a new name is entered.



If the **Is Default SMS Setup** setting is checked, then the AI-80 or AI-7280 device is automatically updated with the new message contents or settings. Otherwise, the created SMS setup must be selected by clicking the **Setup** button on the main control panel.

TL Message(s) Tab:

The forth tab within the Message Generator window displays each byte of the TL messages created. If more than one message is created, they are shown in order starting from the first message. The following figure shows an example of the first few bytes of a TL message.



6.2 ETSI SMS Protocol 2

Operational details on protocol 2 can be found in the ETSI ES 201912 standard. It describes how the DLL (Data Link Layer) is used to transfer the TL (Transfer Layer) messages back and forth between the SM-TE and SM-SC. In addition it references ETSI ES 300659-2 and ETSI ES 300778-2 for details on the physical layer requirements for FSK transmission and reception.

Within the TRsSim software, three different settings windows are used to define how the SM-SC operates under protocol 2. They are:

- **General Settings**: A collection of various SM-SC parameters defining the physical layer characteristics such as timing, FSK limits, telephone number, sub-address values along with some PSTN settings.
- **Transfer Layer Messages**: Used to view, modify, or create all of the TL messages sent by the SM-SC.
- **Message Flow Setup**: Used to view, modify, or create SMS setups. A setup is defined as a set of rules governing the transfer of DLL messages to and from the TE.

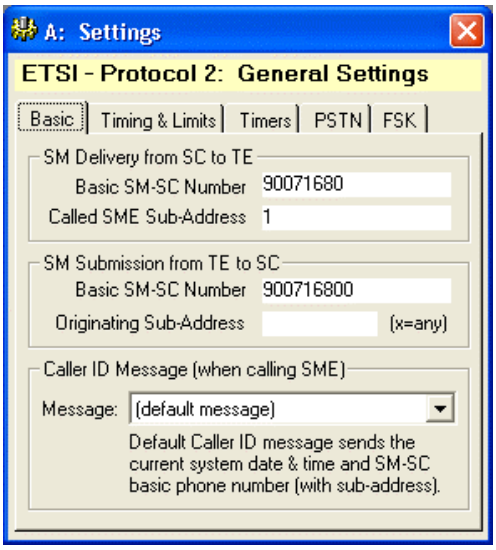
Note that protocol 2 operates in a master and slave relationship between the two SME's. The initiating party is always considered the master. As such if the SC calls the TE, the SC is the protocol master. Likewise if the TE calls the SC, the TE is the protocol master.

6.2.1 General Settings

The ETSI Protocol 2 General Settings window stores a number of parameters controlling the operation of the SM-SC. As shown below, it is divided into five different tabs.

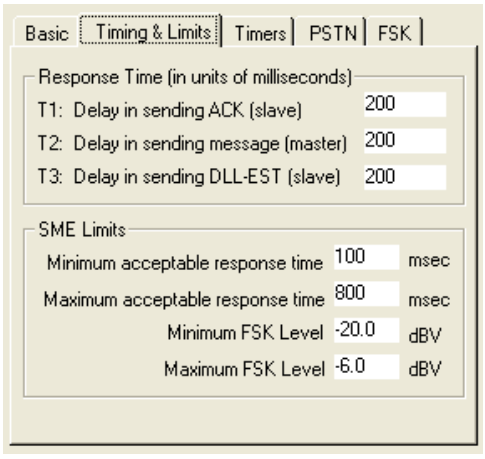
The **Basic** tab sets the telephone numbers used when calling the TE or receiving a call from the TE. If the SM-SC calls the TE, the TE will receive Caller ID information containing the calling number of the SM-SC. By default, the calling number is composed of two parts. These are the basic number and sub-address. Both values are sent together in the calling number parameter of the Caller ID transmission.

In the case where the TE calls the SM-SC (to submit a message), the TRsSim software compares the number dialed by the TE to the combined SM-SC Number and Originating Sub-Address fields. If a match, the TRsSim software begins the process of connecting the TE to the SM-SC. The Sub-Address field is optional and may contain "don't care" digits. By using the character 'x', the TRsSim software requires a dialed digit, but does not care what the digit is.



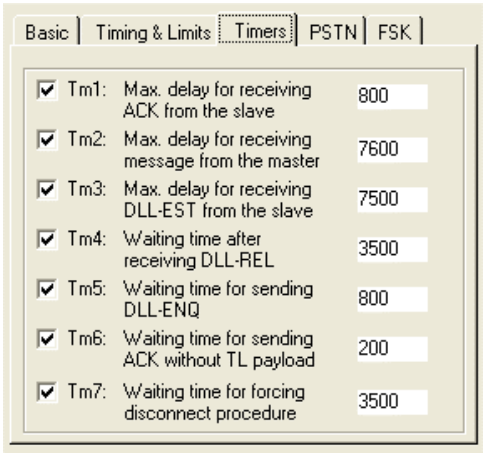
Near the bottom of the Basic tab is the drop-down list used to select the Caller ID message sent to the TE when the SM-SC is calling. The default message contains the current date & time and basic SM-SC number with sub-address. If required it is possible to choose other Caller ID messages from the drop-down list.

The **Timing & Limits** tab sets the timing of the SM-SC FSK frames as well as timing and FSK level limits for the TE. Three different delay values (T1 to T3) are used to control the SM-SC frame delays. T1 is only applicable if the SM-SC is the slave. It sets the delay used when sending DLL-ACK messages. The second time delay (T2) applies only to the master and determines the delay used sending messages following a DLL-EST or DLL-ACK message. Finally the third delay (T3) applies only to the slave and represents the delay from when establishing a voice connection to when the first DLL-EST message is sent. Note that these delays may be increased or decreased on an individual frame basis by the settings in the Message Flow Setup window.

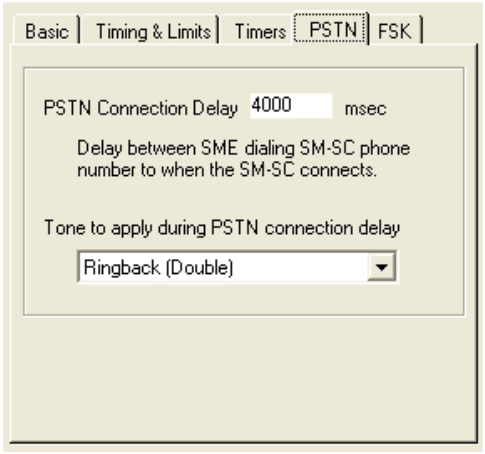


The four SME Limits settings define the valid range for the TE's DLL message response time and FSK level. If any of these limits are violated, the offending DLL message is flagged in the Data Recorder window with a warning message.

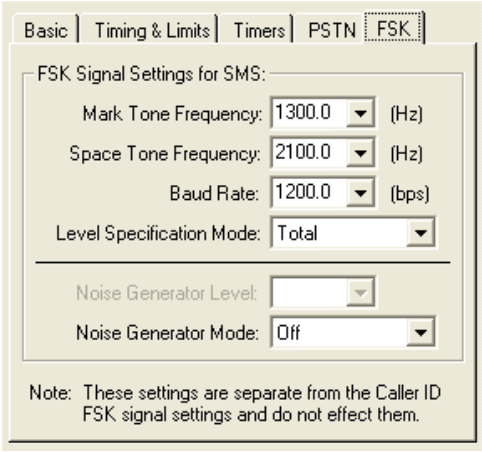
The **Timer** tab sets the time-out values used by the protocol. Some of the timers are only applicable to the protocol master (Tm1, Tm3, Tm5, Tm7), while the rest apply only to the protocol slave (Tm2, Tm4, Tm6). As such the SC only uses the timers appropriate, depending on whether or not it is the protocol master. All of the time-out values are specified in units of milliseconds.



The forth tab, **PSTN Settings**, controls the PSTN's reaction to the TE dialing the SM-SC telephone number. The connection delay represents the time required for the PSTN to "ring" the SM-SC and then the SM-SC to answer the call and establish a voice path connection. During this delay the TRsSim software can apply any of the defined network tones. By default, the double ring back tone is selected.



The **FSK** tab sets the physical layer characteristics of the FSK modulator. To change either of the mark frequency, space frequency, or baud rate click the mouse in the field and enter a new value. The next field controls how the FSK level is specified. It can be either as total level, total level with twist, or independent mark and space levels. Note that the FSK level is specified on the SMS control panel and not within the General Settings window.



For the AI-7280, a broad band white noise generator may be enabled during FSK transmissions. The noise generator level can be specified as either absolute or relative to the FSK level.

6.2.2 Transfer Layer Messages

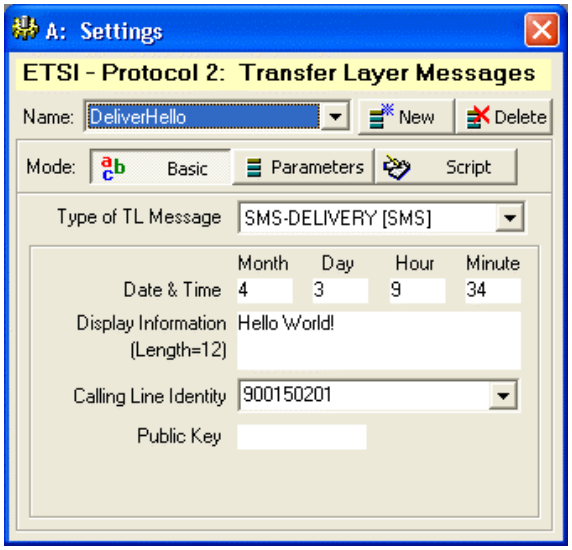
In the ETSI SMS protocol stack, the Data Link Layer (DLL) is used to transport Transfer Layer (TL) messages. These TL messages are then used to convey the text messages or report status information.

All of the TL messages sent by the SM-SC can be viewed or modified using the Transfer Layer Messages settings window. In addition new messages can be created or existing ones deleted.

Note, while the Transfer Layer Message settings window provides a large degree of flexibility in composing messages, it is much easier to use the Message Generator window to create messages. While not as flexible, it simplifies many complex tasks especially when concatenated messages are to be sent. For more information see the section: 6.2.4 Simplified Message Generation on page 79.

Each TL message must have a unique name by which it is identified. A number of messages are pre-defined in the TRsSim software and used in the pre-defined setups to transfer short test messages or submission reports. To view a specific message, select its name from the drop-down list near the top of the settings window.

New messages are created by clicking the **New** button and then supplying the name of the new message. To delete a message, select it from the **Name** drop-down list and then click the **Delete** button.



The previous figure shows the settings for the "DeliverHello" message. It is used to send the text "Hello World!" to a SM capable TE. For details on the structure of the TL messages consult the ETSI ES 201912 standard.

The TRsSim program supports three different methods to define a TL message. They are represented by the three buttons labeled **Basic**, **Parameters**, and **Script**. Each successive mode allows more flexibility in defining the TL message's contents. However they also require a more detailed knowledge of the message structure.

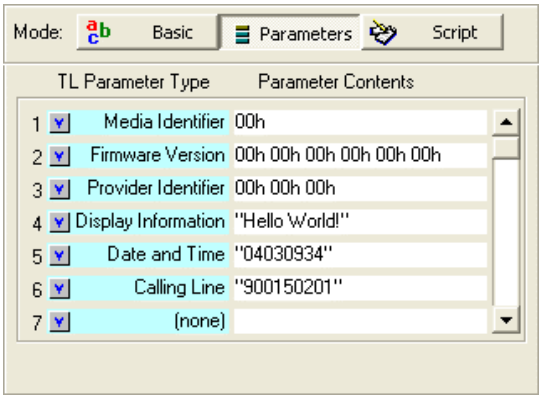
The **Basic** mode is the simplest to use and the least flexible. As the previous figure shows, the "DeliverHello" message uses this mode. For protocol 2 there are seven basic TL message types. These TL message types define which parameters are mandatory and which are optional. The seven message types are:

- SMS-SUBMIT: contains a short message being sent from the TE to the SC. Based on the Media Identifier parameter, this TL message type has six sub-types.
- SMS-DELIVERY: contains a short message being sent from the SC to the TE. Based on the Media Identifier parameter, this TL message type as three sub-types
- SMS-STATUS-REP: contains information sent form the SC to the TE.
- SMS-SUBMIT-REP: contains information regarding the success or failure to a SMS-SUBMIT message.
- SMS-DELIVERY-REP: contains information regarding the success or failure to a SMS-DELIVERY message.
- SM-TE-STATUS: provides status information about the TE.
- SM-TE-CAPABILITY: provides information on the capabilities of the TE.

Depending on which TL message type is selected, the fields underneath the drop-down list may change. This is due to the different message types requiring different parameters. The fields underneath the TL message type may not represent all of the parameters contained in the message, but rather the ones most commonly modified.

In the case of the SMS-DELIVERY[SMS] message shown above, the parameters displayed are the date & time, information to display, calling line identity, and public key field.

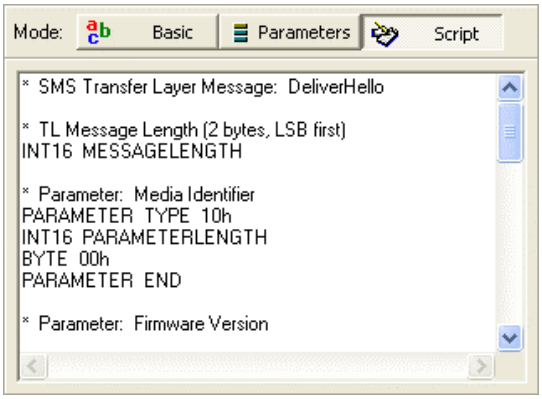
The **Parameter** mode offers more flexibility that the basic mode. This mode allows modification of all the parameters and also allows their contents to take on illegal values. This is very useful for creating error conditions within the TL message and testing the TE's response. To change to this mode, click the mouse on the Parameters button.



Up to twenty parameters can be included in a single TL message. Each parameter and its contents is shown on a single line. To change a parameter type, click the mouse on the down arrow beside the parameter number. This displays a list of all the possible parameter types (including none) from which one can be selected. Parameters marked as "(none)" are not included in the TL message. The contents or value of each parameter is shown on the right side of the list. There are many different methods available to specify the value of the parameter. It may be done as individual bits, integer numbers, hexadecimal bytes, 7-bit GSM characters, or 8-bit ASCII characters. For information on the data formats allowed see the section: Appendix C: Specifying Binary Data on page 107.

Note if a change is made to a parameter setting the mode can not be changed to basic mode without undoing any changes made.

The third method to define a TL message is the **Script** mode. It allows the most flexibility in determining the message contents. In this mode the message is created from a series of commands that define every bit or byte. There is no requirement to follow the structure of the standard TL message types.



For information on the structure and commands of the FSK message script, see: Appendix B: FSK Message Script on page 104.

The three modes work in a hierarchical fashion. Changing the mode from basic to parameters updates all the parameters to match the settings used in the basic mode. Likewise, if changing the mode to script from parameters, the script displayed is created from the parameter settings.

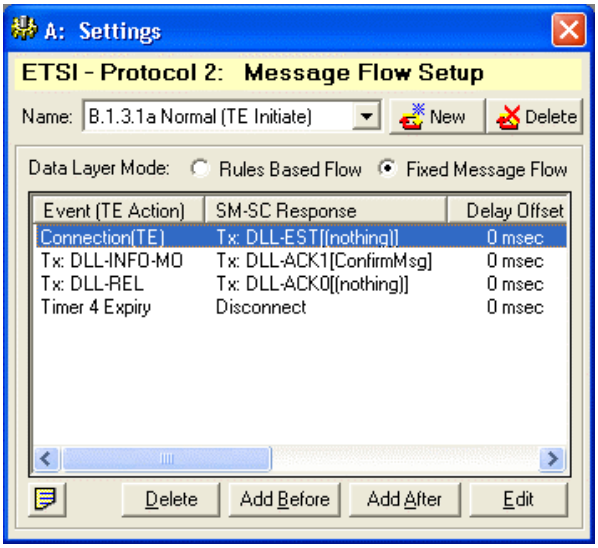
Note if a change is made to a message script the mode can not be changed back to either basic or parameters without undoing any changes made.

6.2.3 Flow Setup

The rules that govern the flow of messages is defined in the Flow Setup window. This window allows for examining the details of an existing setup or creating new setups. A SMS setup is simply a list of events detected by the SM-SC and its corresponding action in response to the event. Each setup must have a unique name by which it is identified. Many different setups are pre-defined in the TRsSim software. They follow many of the sequence flow charts contained in Annex B of the ETSI ES 201912 document. To view a specific setup, select its name from the drop-down list near the top of the window.

New setups are created by clicking the **New** button and then supplying the name of the new setup. To delete a setup, select it from the **Name** drop-down list and then click the **Delete** button.

The following figure shows the setup "B.1.3.1a Normal (TE Initiate)". It represents the nominal situation of receiving a SMS message from the TE.



There are four event/action pairs listed for this setup. Each one is represented by a separate line in the window. They function as follows:

- **Event: Connection(TE)**: This event indicates that the TE has called the SC and a voice path connection is established between the TE and the SC. As the TE initiated the session, the SC assumes the role of protocol slave. The corresponding action for the SC is to send the DLL-EST message.
- **Event: TE Sent DLL-INFO-MO**: Following the TE reception of the DLL-EST message, it would normally send a DLL-INFO-MO message. This DLL message contains a TL message with the contents of the short message. In response to this event the SC sends a DLL-ACK1 message. The DLL message contains the "ConfirmMsg" TL message, which confirms the reception of the SM.
- **Event: TE Sent DLL-REL**: Once the TE receives the SC's acknowledgment message, it starts the process of ending the connection by sending a DLL-REL message. The SC, in response to receiving this

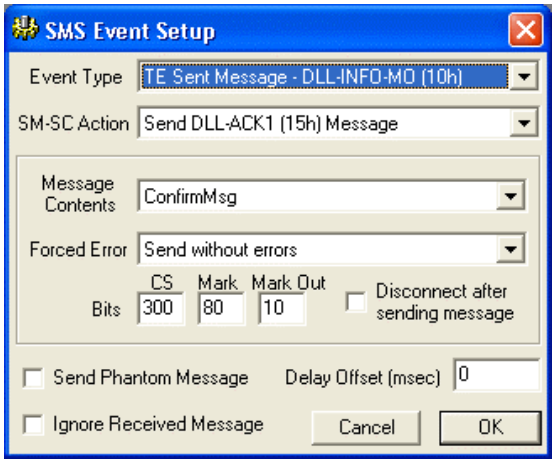
message sends an acknowledgement in the form of a DLL_ACK0 message. In this case, no TL message is contained within the DLL message.

- **Event: Timer 4 Expiry**: This timer starts when the SC finishes transmitting a DLL-ACK message in response to the TE sending the DLL-REL. Its expiry is used to signal the end of the SMS connection and disconnect.

These four actions and the associated events represent the B.1.2 Connection establishment, B.1.3 SM transfer, and B.1.4 Connection release sequence chart in the ETSI ES 201 912 Annex B document.

All of the event/action pairs can operate in one of two different modes. They are either **Rules Based Flow** or **Fixed Message Flow**. When using the rules based flow, the order of events listed does not matter. Once an event is detected, its corresponding action is taken regardless of where the event is in the list. For fixed message flow, the events must be detected in the order they are listed. This is much more restrictive, but allows for verification that the TE under test follows an exact message flow. If any event detected is not in the list, or the events occur in a different order then a fixed flow violation is issued which stops the SMS session. In the example above, the fixed message flow is used. The two buttons above the list of event/action pairs are used to change the mode setting.

The **Delete**, **Add Before**, **Add After**, and **Edit** buttons at the bottom of the window are used to modify the event/action list. For example, selecting the second event with the mouse and clicking the **Edit** button displays the following window. This window is used to change any of the event/action settings.



The top selection in the window sets the type of event to detect. It can be any one of the following event types:

- **Connection TE Initiate**: This event is triggered when the TE has dialed the SC and the SC answers the call, creating a voice path connection.
- **Connection SC Initiate**: This event is triggered when the TE answers a call from the SC by going off-hook, thus creating a voice path connection.
- **TE Sent Complete Message**: Indicates that the TE has completed sending a DLL message to the SC that matches one of the following message types (DLL-EST, DLL-INFO-MO, DLL-INFO-MT, DLL-INFO-STA, DLL-NACK, DLL-ACK0, DLL-ACK1, DLL-ENQ, DLL-REL).
- **TE Sent Segmented Message**: Indicates that the TE has completed sending a segmented DLL message to the SC that matches one of the

following message types (DLL-INFO-MO, DLL-INFO-MT, DLL-INFO-STA, DLL-ACK0, DLL-ACK1).

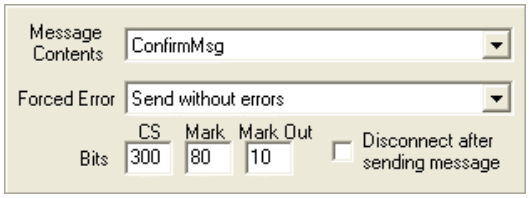
- **TE Sent Message with DLL Error**: A message was sent by the TE, but it contains a DLL error in which the checksum received does not match the calculated checksum.
- **Timer 1 to 7 Expiry**: This event is triggered if one of the seven timers is triggered. Note that some of the timers are only applicable to the protocol slave, while the rest are only applicable to the protocol master.
- **Nretry Counter Limit Exceeded**: The retry counter is incremented under two conditions. The first occurs when a DLL-INFO type message is followed by a DLL-NACK message. The second occurs when a DLL-ENQ message is sent without receiving a DLL-ACK. Once the counter exceeds a specified limit it triggers this event.
- **Nwait Counter Limit Exceeded**: The wait counter increments every time an DLL-ENQ message is sent in order to maintain an active link. Once the counter exceeds a specified limit this event is triggered.
- **DLL Error Counter Exceeded**: Each time a message is received from the TE with a DLL error, an error counter is incremented. If the counter exceeds a specified value this event is triggered.

Just below the event type selection is a drop-down list box containing all of the possible SC actions in response to the event. The SC actions to an event are summarized as follows:

- **Do Nothing**: The SC does nothing in response to the event.
- **Disconnect**: This action causes the SC to disconnect from the TE and end the SMS session.
- **Send Last Message Again**: The last message sent by the SC is re-transmitted.
- **Send Complete Message**: The SC will transmit one of the following message types: DLL-EST, DLL-INFO-MO, DLL-INFO-MT, DLL-INFO-STA, DLL-NACK, DLL-ACK0, DLL-ACK1, DLL_ACKx, DLL-ENQ, DLL-REL.
- **Send Segemented Message**: The SC will transmit one of the following segmented message types: DLL-INFO-MO, DLL-INFO-MT, DLL-INFO-STA, DLL-ACK0, DLL-ACK1, DLL_ACKx.
- **Send Custom Message**: The SC will transmit a message to the TE using a custom FSK message script. This allows for any type of message to be sent. See Appendix B: FSK Message Script on page 104 for details on the message script syntax.

Note that the protocol 2 slave normally sends DLL-ACK0 messages for even frame counts and DLL-ACK1 messages for odd frame counts. In some circumstances it is not possible to know at setup time which ACK message to use. In this case specify the DLL-ACKx message type. Sending this message type uses the proper ACK0 or ACK1 message based on the frame count.

If the action selected is to send a complete or segmented DLL message, additional settings determine the payload of the DLL message along with other options.



The first setting is used to select the contents of the DLL message. The drop-down list includes the names of all the TL messages currently defined along with the entry "(nothing)". The "(nothing)" selection is used in cases not requiring a TL message.

The second setting is used to force an error with the message being sent. The options are either to send without error, or add 1 to the message length, subtract one from the message length, add 1 to the checksum value, or subtract one from the checksum value.

Normally preceding the message data bytes are 300 channel seizure bits and 80 mark bits. Also, following the message are 10 mark out bits. The three fields in the lower left corner can be used to modify these values on a message by message basis.

The last option ends the connection with the TE after sending the message. Clicking the mouse on the check box toggles this feature on and off.

Anytime a message is sent, the **Delay Offset** field is used to apply a positive or negative time offset to the start of message transmission. The offset value is added to the default frame delay value specified in the General Settings window. The resulting value is used as the frame delay, which allows for adjustment on a message by message basis.

Finally, the **Send Phantom Message** and **Ignore Received Message** check boxes are used in testing exception conditions.

If the specified action is to send a message, but the Send Phantom Message check box is marked, then no message is sent. However all applicable timers will be reset as if the message was sent. This option is used to simulate the situation where the TE does not receive the SC's message.

In order to simulate the loss of a TE's message, click the Ignore Received Message check box. If the event represents the reception of a message then the SC will act as if the message was never received. None of the timers associated with message reception will be reset.

6.2.4 Simplified Message Generation

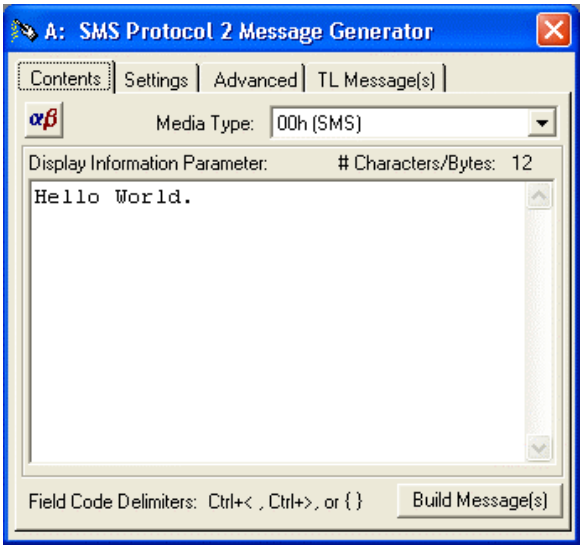
In order to assist in the process of creating the TL messages, the TRsSim software can display a "Message Generator" window. If the **Sms Type** selection is set to the ETSI Protocol 2 setting, the following button is shown at the far right of the control panel window.

Clicking this button displays the "Message Generator" window. The window, as shown below, has four tabs from which various controls are accessed.

Contents Tab:

The "Contents" tab holds a large text box used to enter the contents of the TL message(s). To send a message to an SMS capable TE, click the mouse anywhere inside the text box and enter the message contents.

Once the text box contains the characters to send, click the **Build Message(s)** button. This starts the process of generating the TL message and optionally, the SMS Setup as well. When complete, the total number of characters contained in the message is displayed in the upper right corner. In the example below, the text "Hello World." requires 12 characters to send.



Depending on the PC's keyboard and regional settings, not all of the GSM character set may be accessible via the keyboard. To enter characters not available from the keyboard, click the mouse on the GSM Character Map button as shown below.

This displays a window showing the GSM characters. As the mouse is moved over any of the characters, its decimal and hexadecimal code is shown in the bottom left corner of the window. Clicking on the button marked **Extension**, toggles the character map from its default table setting to the extension table setting.

To enter any of the displayed characters into the Message Generator contents text box, simply click the mouse on the character. For example, clicking on the highlighted character in the above window adds the text:

«22»

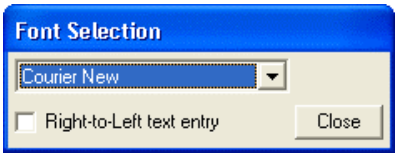
The number 22 is the decimal value for the selected character. The « and » characters are used as delimiters for field codes. These delimiter characters can be manually entered by pressing the **CTRL <** and **CTRL >** keys on the keyboard. Any character code from 0 to 127 can be entered into the text message by either clicking on the character in the GSM character map, or manually entering the field code. To enter multiple characters in a field code, separate each one with a comma. For example, the € character is represented by the following field code:

«27,101»

The first value of 27 is used to specify that the next character is using the GSM extension table. The second value of 101 is the code for the € character within the extension table. Character values must range from 0 to 127 and can be specified either as a decimal number or as a hex value (0h to 7Fh). Append the letter 'h' to hex values.

The **Media Type** drop down list determines the contents of the Media Identifier parameter. By default it is set to '00h (SMS)'; however, it may be changed to either '02h (E-mail)' or '06h (Data)'.

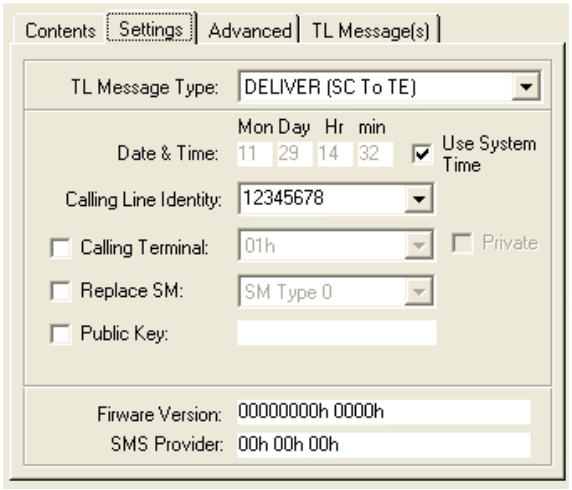
As not all character fonts support all of the various international characters in use today, the font used to enter the message text can be changed. Double clicking the mouse anywhere inside the message contents text box displays the font selection window.



By default the Courier font is used to display the text characters. However this may be changed to any font installed on the PC. Alternate fonts may support certain characters that can not be displayed with the Courier font. The font selection is remembered by the TRsSim software the next time it is executed.

Settings Tab:

The "Settings" tab contains a number of controls used in specifying various details of the TL message created. At the top of the window is the TL Message Type selection. The Message Generator window creates one of two different message types. The default setting is the DELIVER. This is used for sending messages from the SC to the TE. This may be changed to SUBMIT for sending messages from the TE to the SC. As the AI-80 or the AI-7280 emulates the SC, the SUBMIT PDU is not normally used.



The remainder of the settings determine if additional parameters are contained within the TL message and what their contents are.

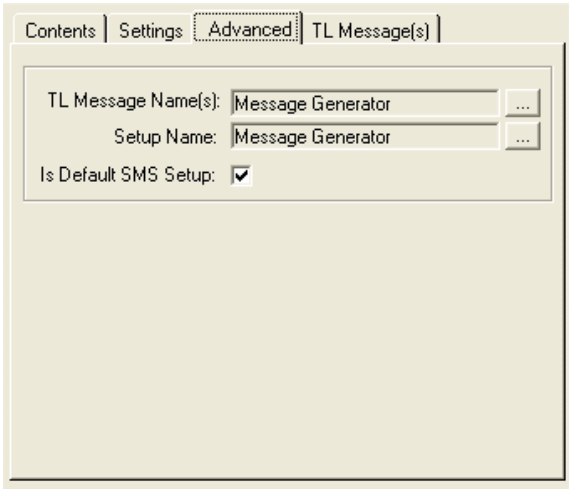
The Date/Time parameter is always included in the TL message. By default its value is the same as the PC's system time. The Calling Line Identity parameter can be set to any text string, or by selecting 'Not Available' or 'Private' from the drop-down list, the Absence of CLI parameter is sent.

Optionally, the Calling Terminal, Replace SM, and Public Key parameters are included in the TL message if the corresponding check box is marked.

The last two fields are used to specify the contents of the Firmware Version and SMS Provider parameters. Both of these parameters are always included in the TL message.

Advanced Tab:

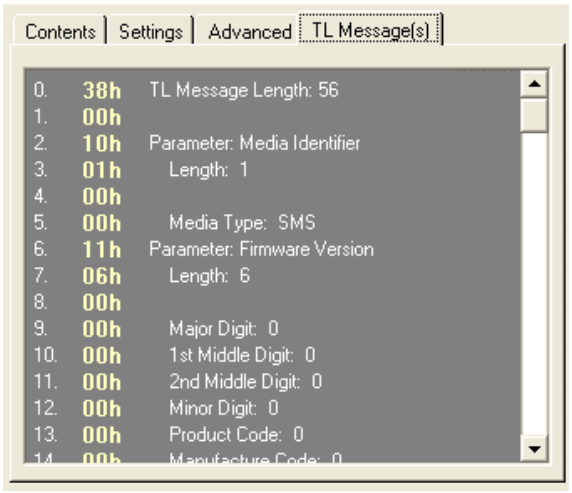
When the Message Generator window builds the TL message and SMS setup, it uses the names defined in the "Advanced" tab. The default name used is "Message Generator". To change this setting, click the button to the right of the displayed name. This displays a dialog window from which a new name is entered.



If the **Is Default SMS Setup** setting is checked, then the AI-80 or AI-7280 is automatically updated with the new message contents or settings. Otherwise, the created SMS setup must be selected by clicking the **Setup** button on the main control panel.

TL Message(s) Tab:

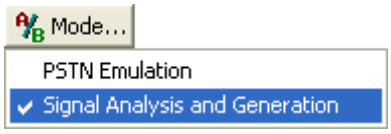
The forth tab within the Message Generator window displays each byte of the TL messages created. The following figure shows an example of the first few bytes of a TL message.


Contents
Settings
Advanced
TL Message(s)
0. 38h TL Message Length: 56
1. 00h
2. 10h Parameter: Media Identifier
3. 01h Length: 1
4. 00h
5. 00h Media Type: SMS
6. 11h Parameter: Firmware Version
7. 06h Length: 6
8. 00h
9. 00h Major Digit: 0
10. 00h 1st Middle Digit: 0
11. 00h 2nd Middle Digit: 0
12. 00h Minor Digit: 0
13. 00h Product Code: 0

7. Signal Analysis & Generation

The TRsSim software operates in one of two mutually exclusive modes. The first is the PSTN Emulation mode which provides the dialing, ringing, Caller ID, and SMS functionality. The second is the Signal Analysis & Generation mode. This mode presents a flexible method of generating various signals and performing different types of measurements.

Changing modes is accomplished by clicking the **Mode** button on the main control panel. The two modes are displayed on the list below the button, from which a selection is made.

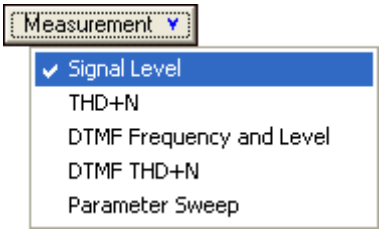


Selecting the Signal Analysis and Generation mode causes two new buttons to appear to the right of the Mode button. Called **Measure Signals** and **Generate Tones**, they change the displayed controls according to the selected function.

The following sections provide more information on how the signal analysis and signal generation functions operate.

7.1 Signal Measurements

Clicking the mouse on the **Measure Signals** button displays the measurement panel. The AI-7280 supports five different measurement types. The AI-80 supports two. They are either the wide band signal level measurement or DTMF frequency and level measurement. To change the current measurement type, click the **Measurement** button followed by the measurement selection.

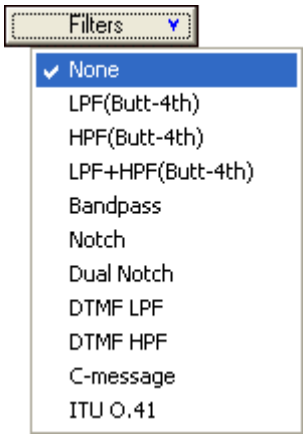


For all of the measurement types other than "DTMF Frequency and Level", various filters may be applied to the readings. One of nine different filter shapes can be selected by clicking the mouse on the **Filters** button. They are:

- Low Pass Filter: Butterworth 4th Order (*)
- High Pass Filter: Butterworth 4th Order (*)

- Low and High Pass Filter: Each Butterworth 4th Order (*)
- Band pass Filter (*)
- Notch Filter (*)
- Dual Notch Filter (*)
- DTMF Low Pass Filter
- DTMF High Pass Filter
- C-Message Weighted Filter
- ITU O.41 Psophometric Filter

Filter types marked with (*) have adjustable corner or center frequencies. If these filters are selected, a text box appears to the right of the filter selection with the corner or center frequency. To change the frequency, simple enter a new value and press Enter.



Note that the measurement filters are only available with the AI-7280 Central Office Line Simulator. The AI-80 is unable to support any pre-measurement filters.

7.1.1 Signal Level Measurement

The wide band signal level measurement simply displays the current RMS signal level present on the tip and ring interface. Five different units can be chosen by clicking the units button. These are either dBm, dBV, mVrms, dBr, and %. The last two units display readings are relative to a reference level. The reference level can be set to the current level by clicking the **Ref** button.

In addition to signal level, the AI-7280 displays the signal frequency if sufficient level is present. In the above example, a 1000 Hz tone of -6.7 dBm is being detected by the AI-7280. If the AI-80 is used, no frequency measurement is displayed, as the AI-80 is unable to support this reading.

7.1.2 Signal Distortion Measurement

This measurement mode displays the Total Harmonic Distortion plus Noise (THD+N) reading. The value displayed can be expressed in one of three different units. They are percentage, dB, or mVrms. If percentage or dB units are chosen, the reading is a ratio of the harmonic distortion level plus noise level to the total signal level measured. Selecting the mVrms units, returns the level of the harmonic distortion products plus noise level.

In addition to the THD+N reading, the frequency of the signal is displayed.

By default, the **Auto Notch Tune** check box is enabled. This causes the meter's notch filter to automatically adjust itself to the measured frequency. If the signal frequency changes, the notch filter position also changes to match. In situations with large amounts of noise or distortions the frequency reading may become erratic or unstable. This may cause the notch filter to continually change settings and effect the stability of the THD+N measurement. For these cases, it is best to turn off the **Auto Notch Tune** setting and manually enter the notch filter frequency.

Note, the AI-80 does not support this measurement mode.

7.1.3 DTMF Level & Frequency Measurement

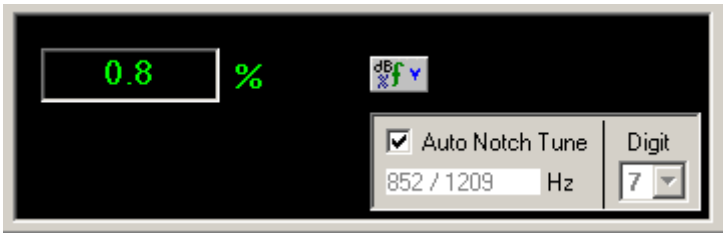
The DTMF measurement type displays the row and column frequency and level of any DTMF tones present at the tip/ring interface. The level readings are always continuously updated; however the frequency measurement is only displayed if sufficient level is present. A minimum of -26 dBV is required (per tone) for the frequency reading. If the row and column frequencies correspond to a valid DTMF digit, the digit code is shown in addition to the frequency error (as a percentage).

As with the wide band signal level measurement, five different units can be chosen by clicking the units button. For use with the relative dBr and % units, the reference level is set to the current level by clicking the **Ref** button.

7.1.4 DTMF Distortion Measurement

This measurement mode displays the Total Harmonic Distortion plus Noise (THD+N) reading for a DTMF digit. Unlike the Signal Distortion Measurement, this reading uses two notch filters instead of one. They remove the fundamental frequency component of both the row and column tones for the DTMF digit. The value displayed can be expressed in one of three different units. They are percentage, dB, or mVrms. If percentage or dB units are chosen, the reading is a ratio of the harmonic distortion level

plus noise level to the total signal level measured. Selecting the mVrms units, returns the level of the harmonic distortion products plus noise level.

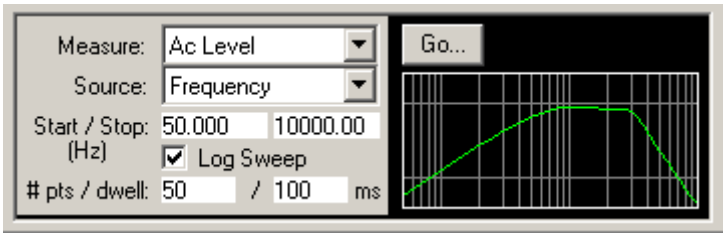


If the **Auto Notch Tune** check box is enabled, the two notch filters are automatically adjusted to match the proper DTMF row and column frequency. In the above example, the DTMF digit 7 is detected. This causes the notch filter to adjust to 852 Hz and 1209 Hz for the row and column frequencies respectively. If the check box is disabled, then the notch filters can be manually adjusted by selecting the DTMF digit from the drop down list box at the right. The first selection in the drop down list is a blank entry. If it is chosen then the row and column frequencies can be directly modified by clicking the mouse on the text box and typing the new notch filter values followed by pressing Enter.

Note, the AI-80 does not support this measurement mode.

7.1.5 Parameter Sweep Measurement

This measurement mode provides a simple means of sweeping a source parameter and measuring its effect. The measurement panel consists of a number of controls used to define the parameter sweep. In the example below, the AC signal level is measured while a tone starts at 50 Hz and proceeds to 10 kHz using logarithmic steps. Fifty measurement readings are taken with a dwell time of at least 100 ms for each point. The small graph to the right shows the results of the parameter sweep.



Since the C-message filter was selected for the above example figure, the measurement graph displays the filter shape.

The controls used to configure the parameter sweep are as follows:

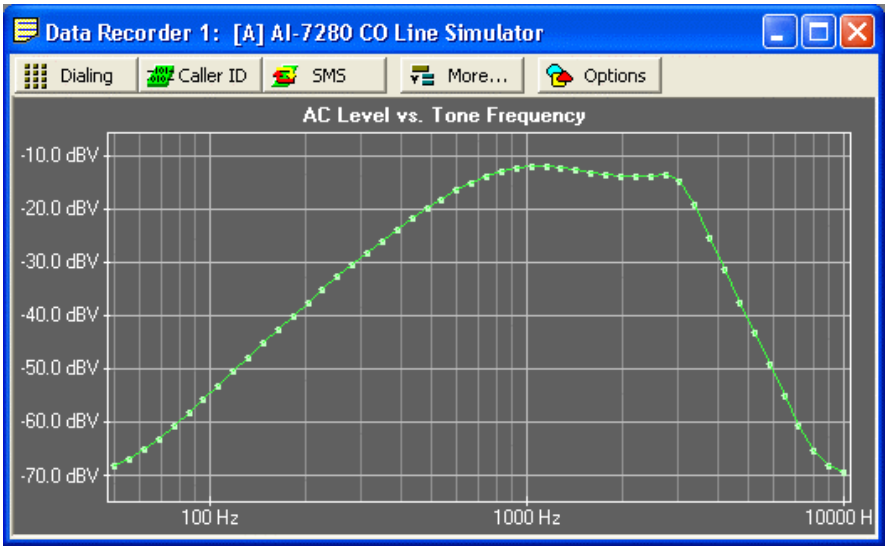
- **Measure**: This drop down list selects what measurement is made for each data point. They are as follows:
  - **AC Level**: Measures the AC signal level in units of dBV. Any of the nine available filters may be enabled for this measurement.
  - **AC Level with Tracking Filter**: Measures the AC signal level in units of dBV. In addition, the band pass filter is enabled and tracks the frequency of the source tone.
  - **DC Voltage & Current**: Measures both the telephone interface line voltage and loop current.
- **Source**: This drop down list selects what parameter is swept over the specified start to stop range. They are as follows:

- **Frequency**: Adjusts the frequency of a tone. The start and stop values are specified in units of Hz within the range of 20 to 18000 Hz. The level of the tone is specified by the level setting for Tone A in the **Generator** panel.
- **AC Level**: Adjusts the AC signal level of a tone. The start and stop values are specified in units of Vrms within the range of 0 to 4 Vrms. The frequency of the tone is specified by the frequency setting for Tone A in the **Generator** panel.
- **Line Voltage**: Adjusts the telephone interface line voltage. The start and stop values are specified in units of volts within the range of 15 to 55 Volts.
- **Loop Current**: Adjusts the telephone interface loop current. The start and stop values are specified in units of mA within the range of 15 to 55 mA.

- **Log Sweep**: If this control is checked then the source parameter is adjusted in equal logarithmic steps. Otherwise the source parameter is adjusted in equal linear steps.
- **Start Value**: Sets the initial source parameter value. The units for this value depend on the **Source** setting.
- **Stop Value**: Sets the final source parameter value. The units for this value depend on the **Source** setting.
- **Number of Points**: Sets the number of measurements to perform. This value must range from a minimum of 1 to a maximum of 1000.
- **Dwell Time**: This parameter sets the minimum amount of time to wait between changing the source parameter to performing the selected measurement. If the **Measure** setting is AC Level the TRsSim software will automatically check to ensure the reading has settled before changing the source parameter to the next value.

To start a parameter sweep, click the **Go** button. As the sweep if progressing, clicking the displayed cancel button terminates the sweep.

The data collected after a parameter sweep can be viewed by the Data Recorder window. To display the window, select the **View** menu followed by the **Data Recorder** command. Sweep data is displayed in either a graphical or tabular form by clicking the **More** button followed by the desired output format. This can be either as a graph or a listing of measurement values.



Following every parameter sweep, all of the measurement values are written to a text file. This file is stored in **\trssim\log** directory under the name of **ParamSweep.txt**.

Note, the AI-80 does not support parameter sweeping.

7.2 Signal Generation

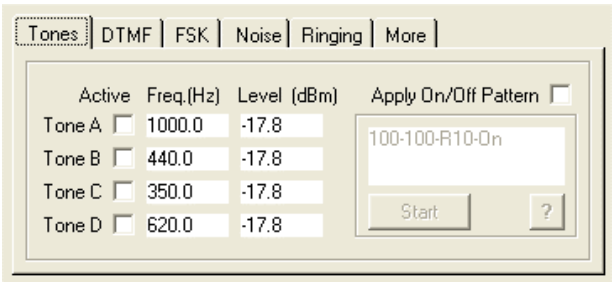
To generate tones, DTMF, FSK, or other signals, click the **Signal Generation** button. This changes the bottom half of the control panel, showing various controls used to generate signals. The control panel has six tabs which are used to select the signal type or action to perform.

To immediately terminate any of the signals generated (tones, DTMF, FSK, noise, ringing) press the **Stop** button.

It is important to note that for all signals generated, except ringing, the TRsSim software applies a correction factor as determined by the Line Impedance setting and the Termination Impedance setting. Both of these parameters can be changed in the General Settings window. In addition, the unit system used for signal levels is also controlled by the General Settings window. The default units are 'dBm'; however, they can be changed to either 'dBV' or 'mVrms'.

7.2.1 Generating Tones

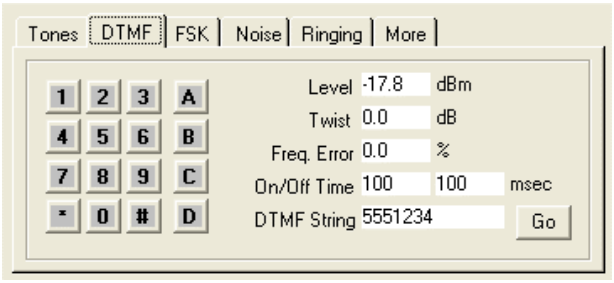
The **Tones** tab provides a means to generate various signals using up to four single frequency tones for the AI-7280 and two tones for the AI-80. The frequency and level for tones A, B, C, and D are independently specified in the appropriate fields shown below. Clicking the **Active** check box enables or disables the tones. Optionally, a pattern can be applied to the tones. If the **Apply On/Off Pattern** check box is selected, then clicking the **Start** button enables the tone generator(s) using the specified pattern.



For information on how to specify patterns, see: Appendix A: Pattern Definitions on page 101.

7.2.2 Generating DTMF

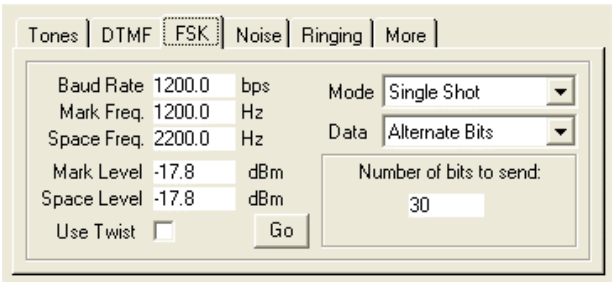
The **DTMF** tab provides a simple way to generate standard DTMF tones. Clicking the mouse on the DTMF keypad starts or stops the selected digit. The total signal level and twist of the generated tone is set by the **Level** and **Twist** text fields. In addition, a frequency error can be applied to both the row and column tones. Its setting must range from between -10% to +10%. An alternate method to generating DTMF digits is to use the **DTMF String** field. Up to 60 DTMF digits can be generated at once by clicking the **Go** button. The duration and pause time of each digit is determined by the value contained in the On/Off Time field.



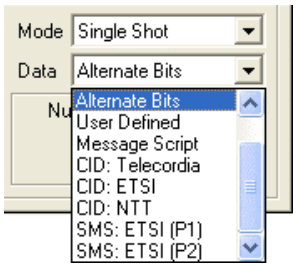
7.2.3 Generating FSK

The **FSK** tab allows access to the AI-7280 or AI-80 FSK generator. All of the key signal parameters such as baud rate, mark/space frequency and level can be specified. Selecting the **Use Twist** check box provides an alternative means to specifying the FSK level by using total and twist instead of mark/space level.

The generator operates in one of three different modes as set by the **Mode** selection. They are either single shot, continuous, and hold last bit. In single shot mode, all of the data specified is sent once and then the FSK generator turns off. In continuous mode, the FSK generator repeats sending the data until the **Stop** button is pressed. If the hold last bit mode is selected, the FSK data is sent once but the last data bit is stretched indefinitely. So if the last bit is a mark bit, a continuous mark tone is generated after the last bit. Likewise if the last data bit is a space bit a continuous space tone is generated.



The data sent by the FSK generator is determined by the **Data** drop-down list selection. This can be either all mark bits, all space bits, an alternating pattern of space and mark bits, a user definable pattern, and FSK message script, or any of the currently defined Caller ID or SMS messages.



If **User Defined** is selected, the FSK data stream can be made up of ASCII text, decimal numbers, hexadecimal numbers, or binary bits. An example of a data stream is:

```
6Ch "abcd" 255 101b
```

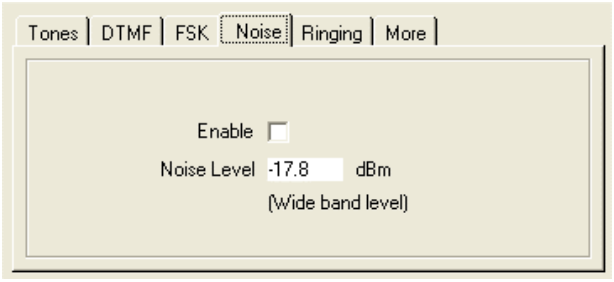
This generates a FSK bit stream starting with a byte value of 6Ch (or 108 decimal), the next four bytes representing the ASCII characters "a" to "d", then another byte of value 255 (or FFh), and finally the bit 1 followed by 0 followed by 1. All of the bytes sent are preceded with a single start bit and end with a single stop bit. Byte values are also sent with the least significant bit first.

Selecting **Message Script** shows a small text box which is used to enter a message script. See Appendix B: FSK Message Script on page 104 for information on the message script format.

The **CID** and **SMS** selections allows the generation of any Caller ID message or SMS message currently defined.

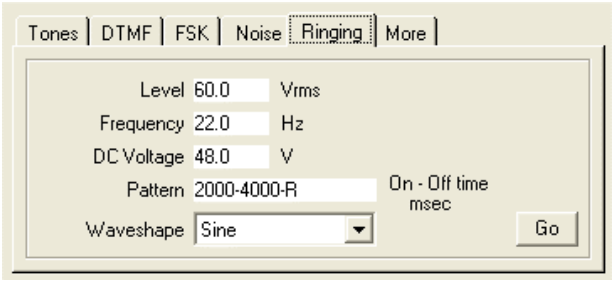
7.2.4 Generating Noise

The forth tab **Noise**, provides a simple means to control a wide band white noise generator. By clicking the **Enable** check box the noise generator is toggled on and off using the specified level.



7.2.5 Generating Ringing

The fifth tab **Ringing** is used to control the ringing generator. To create a ringing pattern, simply enter the desired level, frequency, and pattern followed by clicking the **Go** button. The ring generator is stopped if the line state changes to off-hook or the **Stop** button is pressed. For information on how to specify the ringing pattern, see: Appendix A: Pattern Definitions on page 101. For continues ringing, enter '**ON**' as the pattern.

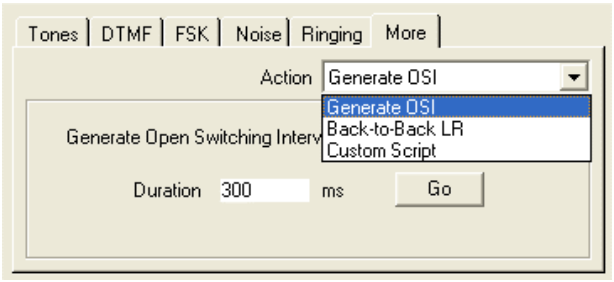


Note that the AI-80 does not support an adjustable DC voltage or wave shape for ringing. As such these controls are disabled when using an AI-80.

7.2.6 Additional Operations

The last tab **More** can be used to perform a few additional operations. These are:

- Generate an OSI (open switching interval) for a specified duration.
- Generate back-to-back line reversals with a specified time interval.
- Execute a custom script.

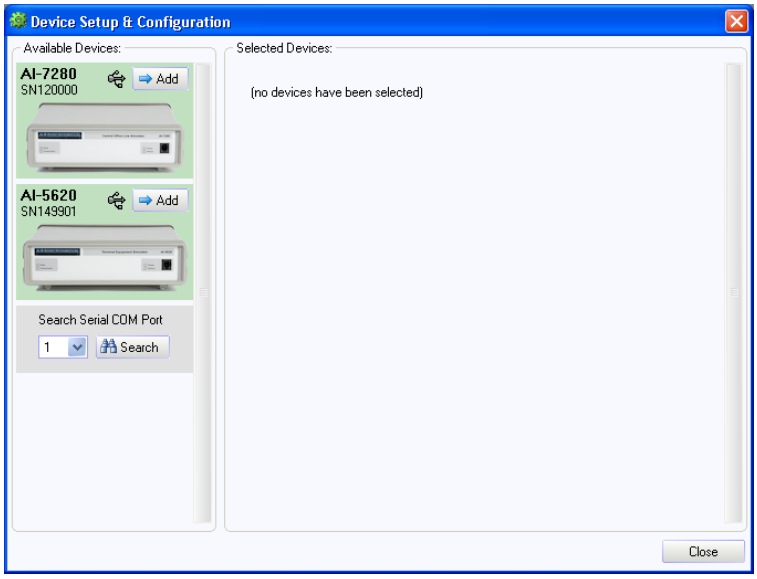


8. Additional Information

8.1 Hardware Setup

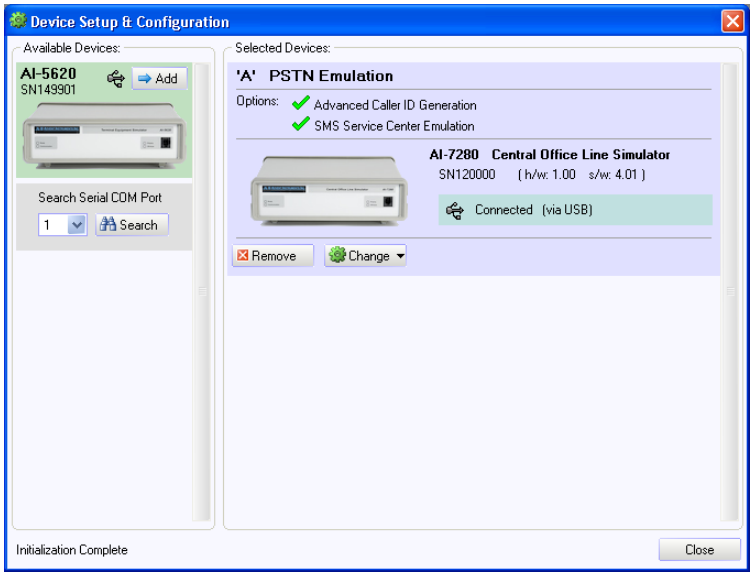
The Device Setup & Configuration window displays the current state of the AI-7280's or other Advent products connection to the PC. Selecting the **Configuration** menu followed by **Device Setup** command opens this window..

As shown below, the window is divided vertically into a listing of available devices (left side) and selected devices (right side).



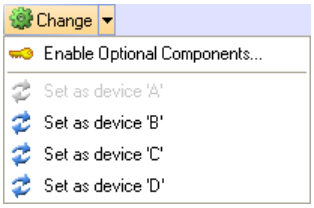
Available devices connected via USB are automatically displayed. However for devices connected via a RS-232 serial port, they must be discovered manually by clicking the **Search** button.

The TRsSim software supports up to four simultaneously selected devices. To add available devices, simply click the **Add** button for the desired device. As devices are added, each is assigned a device letter from A to D. This letter is used to identify each device for scripting purposes.



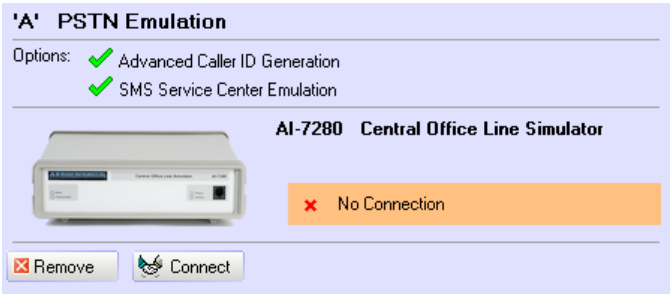
To remove a selected device, simply click the device's **Remove** button.

Clicking the **Change** button displays a menu of options for enabling optional components or changing the letter assigned to the device.



For each selected device, the window displays the device model & name, serial number, firmware and hardware versions, connection status, and what options (if any) are enabled.

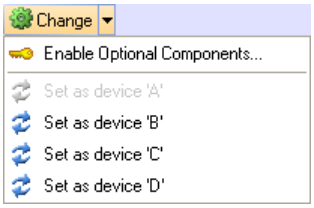
When exiting the TRsSim software, it remembers which devices it was connected to. Thus when re-starting the program it attempts to connect with the same devices. If a device is missing or can not be found the Device Setup & Configuration window indicates that no connection was established with the device. Clicking on the **Connect** button attempts to find the unit again, while clicking on the button with the information icon displays why the attempt to find and connect to the unit failed.



8.2 Enabling Optional Features

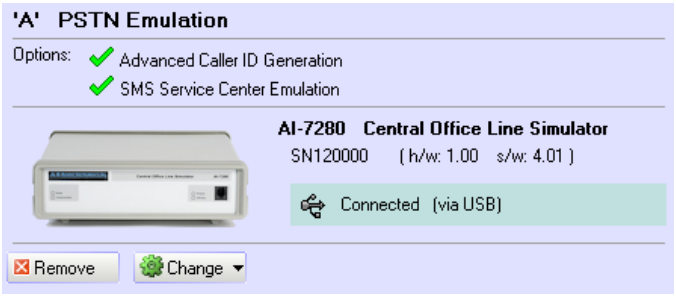
Depending on the connected device, various optional components may be available. The TRsSim software uses license keys for enabling these functions. Each key is linked to a specific device (ie. AI-5620, AI-7280) and may not be available if a different device is connected to TRsSim.

To enable optional components for a device, open the Device Setup & Configuration window by clicking on the **Configuration** menu followed by **Device Setup** command. Then click the **Change** button which displays the following menu.



Selecting the **Enable Optional Components** menu item then shows the following window. Enter the license key provided in this window to enable the optional components.

Once the new key has been entered the window closes and the Device Setup & Configuration window displays any changes to the optional components.



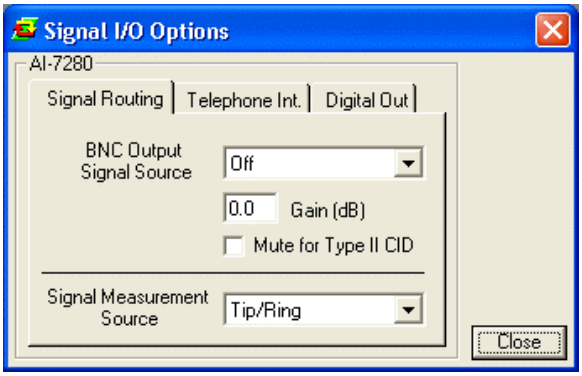
Options that are enabled are listed with a green check mark, while options not enabled are shown with a red 'X'.

8.3 Signal I/O Options: AI-7280

The Signal I/O window controls the AI-7280's signal flow settings. Selecting the **Configuration** menu followed by the **Signal I/O Options** command shows a window similar to the following figure.

The various controls are grouped into three tabs. They are "Signal Routing", "Telephone Interface", or "Digital Out".

The **Signal Routing** tab is used to selected what if any signals are routed to the rear panel BNC output connector, and the source of all signal measurements.

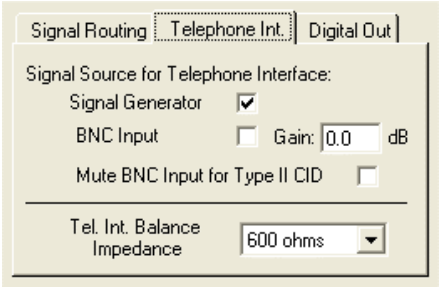


The BNC output connector can be used to monitor signals from various points. They are: Tip/Ring, Telephone Interface Receive, BNC Input Connector, Internal Tone/DTMF/FSK generator, Telephone Interface Transmit, Output from signal meter (following any enabled filters), and THD+N meter output following notch filters. A gain (or loss) can be applied to the BNC output signal by entering a value in the **Gain** field. Additionally, the signal routed to the BNC output can be muted during a Type II (off-hook) Caller ID transmission.

The Signal Measurement Source drop-down list selects the source point for measurements as one of the following: Tip/Ring, Telephone Interface Receive, BNC Input Connector, Internal Tone/DTMF/FSK generator, and Telephone Interface Transmit.

The **Telephone Interface** tab is used to change the signal source for the telephone interface along with specifying its balance impedance.

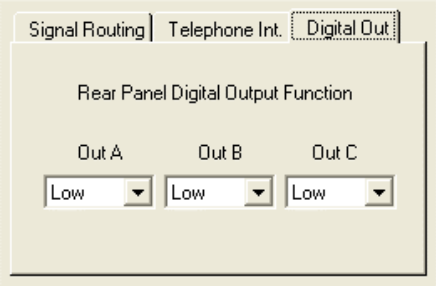
The source of the telephone interface transmit signals are normally the AI-7280's internal Tone/DTMF/FSK signal generators. Optionally the signals present at the BNC input connector can be routed to the telephone interface as well. This provides a means of adding impairment signals or specialized tones. As with the BNC output, the BNC input may be muted during a Type II (off-hook) Caller ID transmission.



The Balance Impedance setting is used by the AI-7280 only when routing the telephone interface receive signals to the BNC output connector or to the measurement meter. In order for the AI-7280 to separate the receive signals (sent from the TE), from the signals

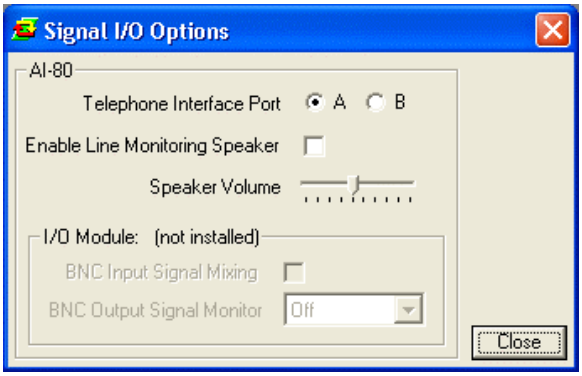
transmitted by the AI-7280 the balance impedance setting must match the load impedance of the connected TE.

The last tab, **Digital Out** specifies the function of the three digital outputs present at the rear panel terminal block. All of the outputs A, B, and C can be set either to a logic low or high state. Additionally, output A can be set to mirror the hook state of the TE. In this mode, when the TE goes off-hook, output A changes to a high state. Accordingly when the TE goes back on-hook, output A changes to a low state. Output B can be set to mirror the output of the FSK decoder. When detecting mark signal (or no signal at all), output B is high. If a space signal is detected, output B changes to a low state.



8.4 Signal I/O Options: AI-80

The Signal I/O window controls the AI-80's signal flow settings. Selecting the **Configuration** followed by **Signal I/O Options** menu command shows a window similar to the following figure.

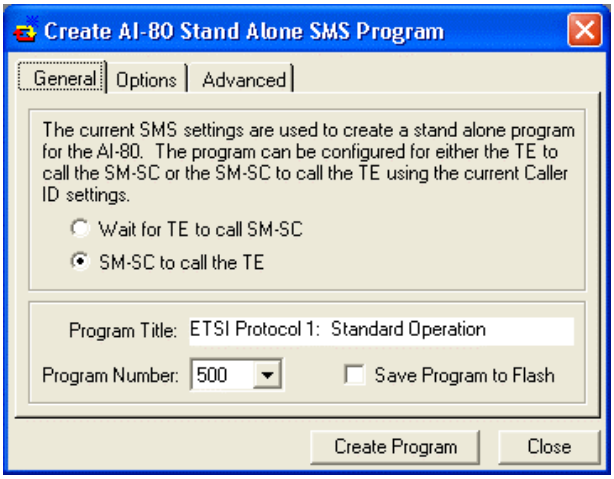


The two top buttons allow either the telephone interface port A or B to be used while the check box just below enables the built-in speaker for monitoring the telephone line. If the AI-80 is equipped with an I/O module, the BNC input connector can be used to inject signals onto the telephone line. In addition the BNC output connector can be used to monitor various signals by the selection of the drop-down list box.

8.5 Stand Alone AI-80 SMS Programs

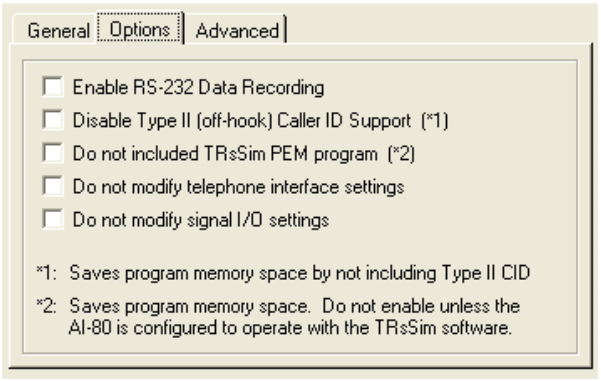
The TRsSim software can create a stand alone program for the AI-80 using the current SMS settings. This is useful if the AI-80 needs to operate without a PC for SMS testing. Before a program can be created, a SMS type and setup must be selected. Then by

choosing the **Configuration** and **Create AI-80 SMS Program** the following window is displayed.



The AI-80 program created either sends a SMS message by calling the TE, or waits for the TE to send a SMS to it. This is determined by selecting one of the two buttons shown above. The controls near the bottom of the window are used to set the program name along with the program number. If the Save Program to Flash checkbox is selected, the standalone program is transferred to the AI-80's flash memory. In either case it is stored as the file "TRs_SMS.apf" in the same directory as the TRsSim software. The file can be loaded into the AI-80's flash memory at any time using the A.I.WorkBench software.

The **Options** tab displays a few controls used for modifying the program created.



If the Data Recording option is enabled, the AI-80 outputs data from its RS-232 port during a SMS session. A special program called SmsMonitor is freely available from the TRsSim installation CD or our web site that decodes the data output. It shows the contents of any SMS messages sent by the TE.

The second check box, if enabled, eliminates the Type II Caller ID program script if the SM-SC is calling the TE. This reduces the program size and saves memory in the AI-80's flash memory. The third option also reduces the program size by sharing a file in the AI-80's flash memory with that used by the TRsSim software. However this option should only be selected if the AI-80 is enabled to use the TRsSim software.

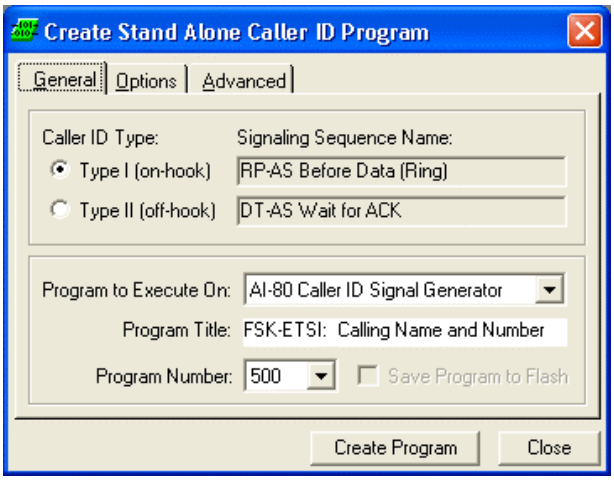
Normally the program created will configure the AI-80's telephone interface settings and signal I/O settings to match the current TRsSim settings. However, by enabling the forth and/or fifth check boxes, the SMS program created will not change the AI-80's telephone interface or signal I/O settings respectively.

Note, in order for the AI-80 stand alone program to function correctly, the AI-80 must be equipped with the FSK decoder option. This option allows the AI-80 to decode FSK data when not connected to the PC and running the TRsSim software. If this option is present within the AI-80, it briefly displays "SO 1" during power up. If the option is not present then running the SMS program causes the display to show "n/a".

8.6 Stand Alone Caller ID Programs

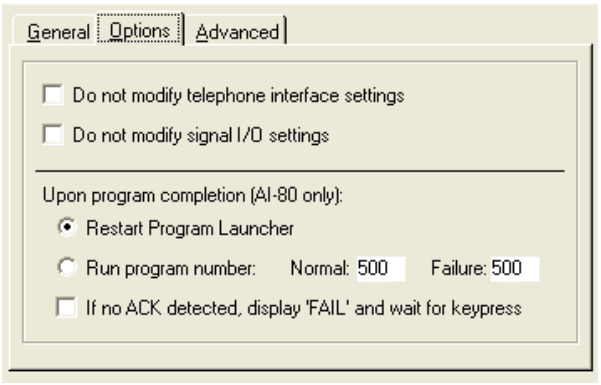
The TRsSim software can create stand alone programs for either the AI-7280 or AI-80 using the current Caller ID settings. These programs can be executed on either the AI-7280 or AI-80 without the TRsSim software. For the AI-80, the Caller ID programs are accessible from the front panel controls, while for the AI-7280, the DLL can be used to load and execute the program. Before creating a program, ensure that the Caller ID type, signaling, and message settings match the desired configuration.

By selecting the **Configuration** menu, followed by the device (AI-80 or AI-7280) and then the **Create Caller ID Program** command, the following window is displayed.



From the **General** tab, the Caller ID type must be selected from either Type I (on-hook) or Type II (off-hook). By then clicking the **Create Program** button, the current Caller ID settings are converted into a program file. The program file "TRs_CID.apf" is located in the same directory as the TRsSim software. It can be loaded into the AI-7280's or AI-80's flash memory by using the A.I.WorkBench software. Alternatively, by enabling the **Save Program to Flash** check box the TRsSim software automatically writes the program into the target device's flash memory.

The **Options** tab displays additional settings used to modify the Caller ID program characteristics.



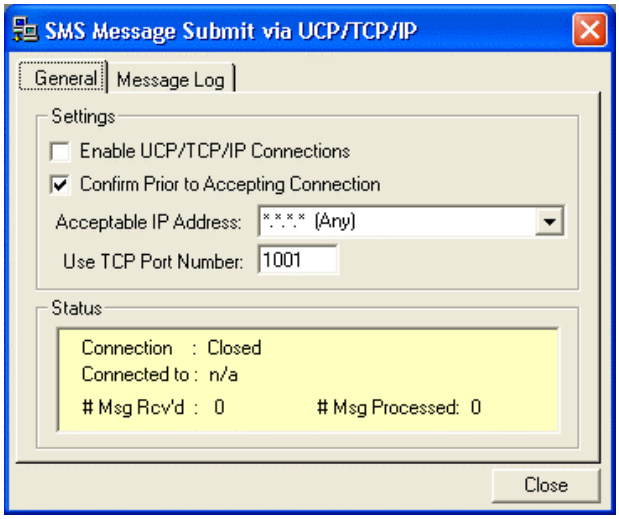
Normally the program created will configure the AI-80's or AI-7280's telephone interface settings and signal I/O settings to match the current TRsSim settings. However, by enabling the top two check boxes, the Caller ID program created does not change the device's telephone interface or signal I/O settings respectively.

Only for AI-80 targeted programs, the remaining settings determine what action to take at the end of the Caller ID program. If the program does not detect the TE's ACK tone for Type II (off-hook), it can display 'FAIL' on the front panel and wait for a key press. In addition, different programs can be executed once the Caller ID program finishes depending on if the ACK tone was detected or not.

8.7 SMS Message Submit via UCP/TCP/IP

The TRsSim software can be configured to accept UCP messages via a TCP/IP connection. These UCP messages are then converted into the SMS DELIVERY messages and sent to the connected TE via the current SMS settings.

In order to enable this operation, select the **Configuration** menu, followed by the connected device, and then the SMS **Message Submit via UCP/TCP/IP** command. This displays the following window:



By enabling the TCP/IP connections and setting the desired IP address and port number, the TRsSim software begins listening for UCP messages. The **Message Log** tab records changes in the TCP/IP connection status and the contents of any UCP messages received.

Appendix A: Pattern Definitions

The TRsSim software uses a special notation for defining signal patterns. These patterns are used to control the ringing and tone generators for various applications.

The TRsSim software uses a special notation for defining signal patterns. These patterns can be used when generating tones or broadband noise.

A pattern is simply defined as a series of one or more commands. If more than one command is used in a pattern it must be separated by a dash ("-") character. The following list describes all of the commands supported.

<duration>: Tone On or Off Duration:

Where <duration> is an integer value between 1 and 1000000 in units of milliseconds. The first occurrence of <duration> turns on the tone for the stated duration, while the second occurrence turns off the tone for the stated duration. Subsequent commands repeat this on/off sequence.

R[<label>][<loop>]: Repeat Block:

This command repeats a block of commands. The number of times to loop is set by the optional integer value <loop>. If <loop> is present, it must be in the range of 1 to 1000000. If not specified, then the command block is repeated indefinitely. Optionally a <label>, composed of only letters, may be included in the command. If a <label> is specified, the repeat block starts at the marker command with a matching M[<label>]. If no <label> field is supplied, then all the commands from the last R[<loop>] or M command are repeated.

M[<label>]: Block Marker:

This command delimits a block of commands. It is used in conjunction with the R[<label.][<loop>] command to set the repeat range. The optional [<label>] field is used to link this marker with a repeat command using the same label

ON: Forces the tones/noise on.

OFF: Forces the tones/noise off.

STOP: Stops the pattern execution.

F[<tone>]<operator><value>: Adjust Tone Frequency

L[<tone>]<operator><value>: Adjust Tone or Noise Level

The above two commands are used to modify either the frequency or level of a tone. For the noise generator, only the level may be modified.

The optional <tone> field determines which tone(s) is modified. For example, if 'AB' is specified, then tones 'A' and 'B' will be modified. If no <tone> field is specified, then all tones associated with the pattern will be modified. For the noise generator, this field is not used.

The <operator> field determines how the frequency or level is to be changed. The valid operators are:

=	Set new frequency/level to <value> (units of Hz or Vrms)
+=	Increment frequency/level by <value> (units of Hz or Vrms)
-=	Decrement frequency/level by <value> (units of Hz or Vrms)
*=	Multiply frequency/level by <value> (units of Hz or Vrms)
/=	Divide frequency/level by <value> (units of Hz or Vrms)
+dB=	Increase frequency/level by <value> dB
-dB=	Decrease frequency/level by <value> dB

Examples of patterns:

500-700-500-3000

Turn signal on for 500 ms, then off for 700 ms, then on for 500 ms, and finally off for 3 seconds.

100-100-R9-ON

Turn signal on for 100 ms and then off for 100 ms. Repeat this 9 additional times and then turn the signal on indefinitely. This pattern is commonly used for stutter dial tone.

2000-4000-R

Turn signal on for 2 seconds, then turn signal off for 4 seconds. Repeat indefinitely.

100-150-R5-2000-1000-M-50-25-R10-ON

Generate 6 cycles of 100 ms signal on followed by 150 ms signal off. The turn on signal for 2 seconds and then off for 1 second. Then generate 11 cycles of 50 ms signal on and 25 ms signal off. Finally turn the signals on and stop the pattern.

1000-500-L+dB=1.5-R9

Turn signal on and wait 1000 ms, turn signal off and wait 500 ms, increase tone level by 1.5 dB, repeat 9 more times.

F=500-M-1000-F+=500-R9

Set tone frequency to 500 Hz, turn signal on and wait 1000 ms, increase frequency by 500 Hz, repeat the delay and frequency increment 9 more times.

FA=1000-MA-LA=1-LB=1-MB-100-LB-DB=3-RB19-FA*=1.2-RA9

This complex pattern has two nested loops. The inner loop 'MB' to 'RB19', Sweeps the level of tone generator B down in twenty 3 dB steps, once every 100 ms. The outer loop 'MA' to 'RA9', Sweeps the

frequency of tone 'A' by increasing it by 20% through each of the 10 loops.

The pattern can be read as follows: Set tone A frequency to 1000 Hz, mark start of loop 'A', set level of tone A to 1 Vrms, set level of tone B to 1 Vrms, mark start of loop 'B', turn on tones and wait 100 ms, decrement tone B level by 3 dB, repeat from marker 'B' 19 more times, increase tone A frequency by 20%, repeat from marker 'A' 9 more times.

Appendix B: FSK Message Script

A form of scripting language is used by the TRsSim software to create FSK messages. Though its use is not required, any Caller ID or SMS TL message can be specified with this scripting language. It gives a large degree of control regarding the exact bit pattern generated by the FSK modulator. This is very useful for testing a TE's exception condition handling, as the messages can contain non-standard data formats.

Each line of the message script must either contain a command, comment, or be blank. The FSK message script commands are not case sensitive and comment lines must start with the "*" character.

The supported commands within a message script are as follows:

STOPBITS (n)

Sets the number of stop bits added after each data byte sent. The value (n) must range between 1 and 100.

PARITY NONE | ODD | EVEN [ALL]

Sets the parity mode for transmitted data bytes. By default the parity setting is 'NONE' which transmits all eight data bits without any parity bit. A setting of 'ODD' or 'EVEN' transmits 7 data bits, with the 8th data bit representing either odd or even parity. Normally the parity setting only effects data bytes added to the message with the CHAR command. However, if the optional 'ALL' keyword is specified, then all data bytes in the message (except the checksum) is encoded with parity.

CHECKSUM CLEAR | ADD | ON | OFF | CRC16 | MOD256 | (n) | INC (n) | DEC (n)

This command is used to control the message checksum. The CLEAR keyword zeros the calculated checksum value to zero. The ADD keyword adds the checksum value to the message. The ON keyword enables the checksum calculator so any bytes added to the message will modify the checksum value. The OFF keyword disables the checksum calculation. The CRC16 keyword sets the checksum calculator to use a 16 CRC method. The MOD256 keyword sets the checksum calculator to use a modulus 256 calculation. If an integer value (n) is specified, then the current checksum calculator value is set to (n). The INC (n) and DEC (n) will increment or decrement the current checksum value by the specified integer (n).

MESSAGE TYPE (n|h) | END

Used to mark the beginning and end of a message. By knowing the start and end points of a message, the message length can be automatically calculated. The TYPE (n|h) keyword marks the start of the message and inserts single byte specified by either the 8 bit integer (n) or the hexadecimal byte (h). The END keyword is used to mark the end of the message.

PARAMETER TYPE (n|h) | END

Used to mark the beginning and end of a parameter. By knowing the start and end points of a parameter, the parameter length can be automatically calculated. The TYPE (n|h) keyword marks the start of the parameter and inserts single byte specified by either the 8 bit integer (n) or the hexadecimal byte (h). The END keyword is used to mark the end of the parameter.

BYTE (n) | (h) | MESSAGELENGTH [offset] | PARAMETERLENGTH [offset]

The BYTE command adds one or more byte values. This value can be either an 8 bit integer (n), or a hexadecimal byte (h). If specified as a integer, only a single byte is added to the message. Using the hexadecimal notation allows for sending multiple bytes. For example, 1234h adds two bytes to the message. The first is 12h which is then followed by 34h. Alternatively, the keywords MESSAGELENGTH and PARAMETERLENGTH are used to add a single byte value representing the message length or parameter length respectively. Optionally, an offset can be added to the length values. This is specified as an integer value.

INT16 (n) | (h) | MESSAGELENGTH [offset] | PARAMETERLENGTH [offset]

The **INT16** command adds a 16 bit value. This value can be specified as either a 16 bit integer (n), or two hexadecimal bytes (h). Alternatively, the keywords MESSAGELENGTH and PARAMETERLENGTH are used to add a 16 bit value representing the message length or parameter length respectively. Optionally, an offset can be added to the length values, and is specified as an integer value. The 16 bit values added are sent as two separate bytes with the LSB sent before the MSB.

CHAR "abc"

Adds from 1 to 64 characters to the message. Each character is translated to its ASCII character code and then processed with the current parity setting.

BITS MARK (n) | SPACE (n) | ALTERNATE (n)

Adds individual bits to the message. If the MARK keyword is used, then (n) mark bits are added. Likewise the SPACE keyword adds (n) space bits. The ALTERNATE keyword adds an alternating pattern of zero and one bits. The pattern starts with a zero bit and the number of bits added is specified by (n). The value (n) must be an integer in the range of 0 to 4096

IF ONHOOK (command)

This statement allows conditional commands execution. Any of the above commands can be specified following the ONHOOK keyword. The command is executed if the tip/ring line state is on-hook at the time the message script is executed.

IF OFFHOOK (command)

Same functionality as the IF ONHOOK statement, except the command is executed if the tip/ring line state is off-hook.

DUPLICATE (n)|OFF

Duplicates the specified byte value if it has been added to the message. This is normally used for NTT Caller ID when the DLE code is used within the message.

Note that checksum byte(s) are never duplicated and the check for duplicate values is made prior to encoding the byte parity (if any).

The following example uses the message script to create a basic Caller ID message. The message uses the MDMF structure and contains date/time, calling number, and calling name information.

```
* Set the number of stopbits,
* parity mode, and checksum mode
STOPBITS  1
PARITY  NONE
CHECKSUM  MOD256
CHECKSUM  CLEAR
CHECKSUM  ON
* If on-hook add 300 channel seizure
* bits followed by 180 mark bits.
IF ONHOOK  BITS ALTERNATE 300
IF ONHOOK  BITS MARK 180
* If off-hook only add 80 mark bits.
IF OFFHOOK BITS MARK 80
* Use the Call Setup message type (80h)
MESSAGE TYPE 80h
BYTE MESSAGELENGTH
* Add the data/time parameter:  Oct. 25, 14:23
PARAMETER TYPE 01h
BYTE PARAMETERLENGTH
CHAR "10251423"
PARAMETER END
* Add the calling number parameter
PARAMETER TYPE 02h
BYTE PARAMETERLENGTH
CHAR "01900150200"
PARAMETER END
* Add the calling name parameter
PARAMETER TYPE 07h
BYTE PARAMETERLENGTH
CHAR "John Smith"
PARAMETER END
* End of the message, so add the
* checksum and some mark out bits
MESSAGE END
CHECKSUM ADD
BITS MARK 10
```

Appendix C: Specifying Binary Data

The Transfer Layer (TL) messages sent during a SMS session can be created using a special notation. This notation allows for specifying the binary data included in the TL message in a number of different formats. This becomes useful for testing various exception conditions if the binary data contained in the message does not conform to the applicable standards. For the ETSI protocol 1 SMS type, this notation is used when the TL message is created in the **TPDU Parameter** mode. Likewise for the ETSI protocol 2 SMS type, this notation is used if the TL message is created in **Parameter** mode.

The structure for this notation is a series of one or more data elements. If more than one element is used it must be separated by at least one space character. The different data elements are defined as follows:

- **Bits: xb** Where x is one or more one or zero bits represented by the symbols 0 and 1. For example 0101b specifies 4 bits starting with 0 and ending with 1.
- **Integer (8 bit): n** Where n is an integer number between and including the value of 0 to 255.
- **Hexadecimal Byte(s): xh** Where x is an even number of hexadecimal symbols (0-9,A,B,C,D,E,F). Each pair of symbols is converted to a single byte.
- **Characters (8 bit): {abc}** Where abc represent any number of characters. Each character is converted to a single byte using its ASCII representation.
- **Characters (8 bit): "abc"** Where abc represents any number of characters. Each character is converted to one or more bytes using the GSM default alphabet as defined in ETSI TS 100900 with the 8th bit fixed at zero. If the character is located in the GSM extension table, it is preceded by a byte value of 27.
- **Characters (7 bit): 'abc'** Where abc represents any number of characters. Each character is converted into a 7 bit code using the GSM default alphabet, unless the character is contained in the extension table. In this case it is represented by two 7 bits values with 27 as the first value. The resulting 7 bit codes are packed into bytes starting from the least significant bit.
- **Integer (7 bit): nc** Where n is an integer in the range of 0 to 127. The 7 bit value is packed into bytes.
- **Semi-octet: <x>** Where x is one or more of the following symbols: 0 to 9, *, #, a, b, c. Each symbol is converted to a nibble value (*=10, #=11, a=12, b=13, c=14) and then packed into bytes starting at the low nibble. If the number of symbols is odd, the last byte is padded with ones in its high nibble.

When using the Integer (8-bit), Hexadecimal, Characters (8 bit), or Semi-octet types, the data always starts on a byte boundary. Any unused bits from a previous byte will be padded with zeros.

The Bits, Characters(7 bit), and Integer(7 bits) types start at filling data bytes bit-by-bit at the location the last element ended. The filling is done from LSB to MSB.

For example:

```
11101b  C5h

      Translates into two bytes.  The first is 00011101(1D)
      and the second is 11000101(C5).
```

Note that the character data types support embedded delimiting characters by doubling up the delimiting character. For example to specify the string:

```
He Said, "Today is Friday".
```

as 7 bit GSM characters is done as follows

```
'He Said, ''Today is Friday''.'
```

Appendix D: USB Driver Installation

The following figures show the step by step procedure for installing the AI-7280 USB drivers. These drivers are required in order to use the USB connection to the AI-7280. The figures are taken from the Windows XP operating system.

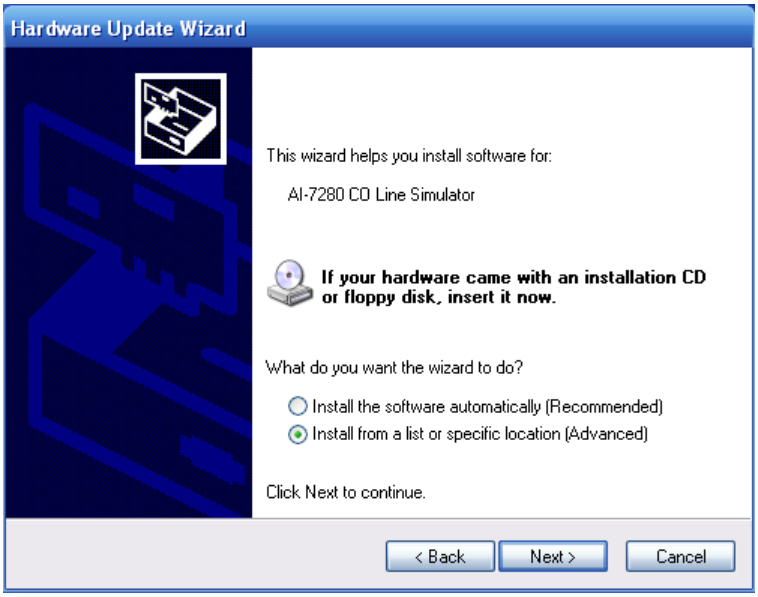
1. Connect the AI-7280 to the PC with USB cable

With the AI-7280 powered on, connect a USB cable from the PC to the AI-7280. The windows operating system will detect the presence of the AI-7280 and display a message as follows:

As the USB drivers are not installed, Windows starts the new hardware wizard to guide you through the installation process.

2. Select "No, not at this time", and click "Next"

The Windows operating system needs to be told how it should locate the driver files for the AI-7280. The correct selection is to specify the location for the driver files.



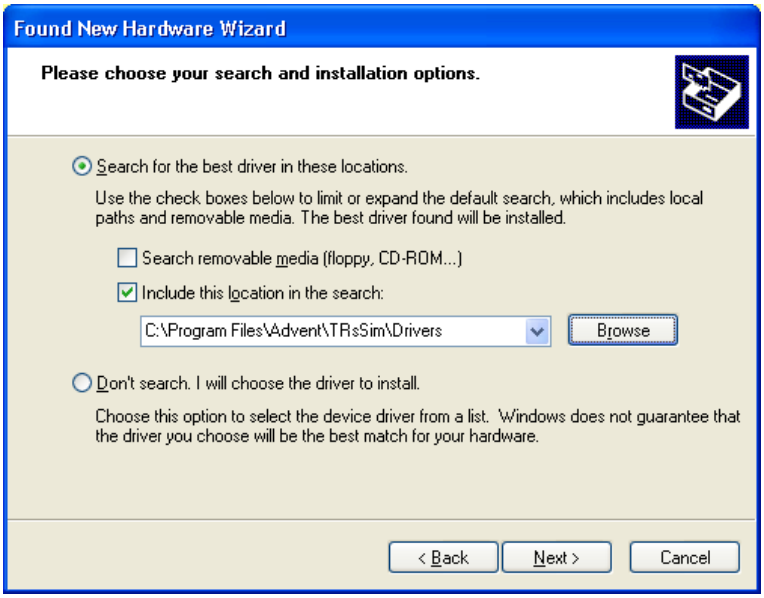
3. Select "Install from a list or specific location" and click "Next"

The path to the driver files is supplied in the following window. Click the **Browse** button, which opens a window for selecting directories. The directory to select is the \drivers\ subdirectory within the TRsSim software program files. By default the drivers will be copied to the following folder when TRsSim is installed:

C:\Program Files\Advent\TRsSim\Drivers

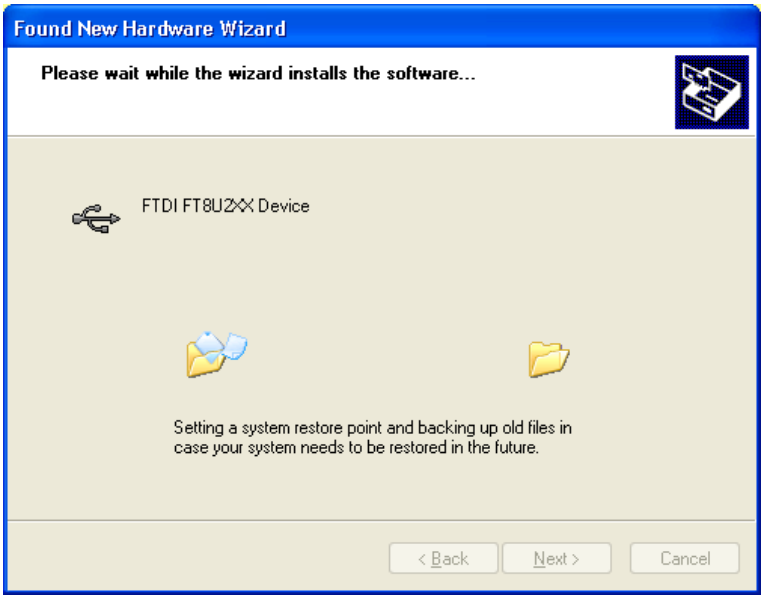
As an alternative, the drivers are also located on the supplied CD under the following folder:

<CD Drive>:\UsbDriver

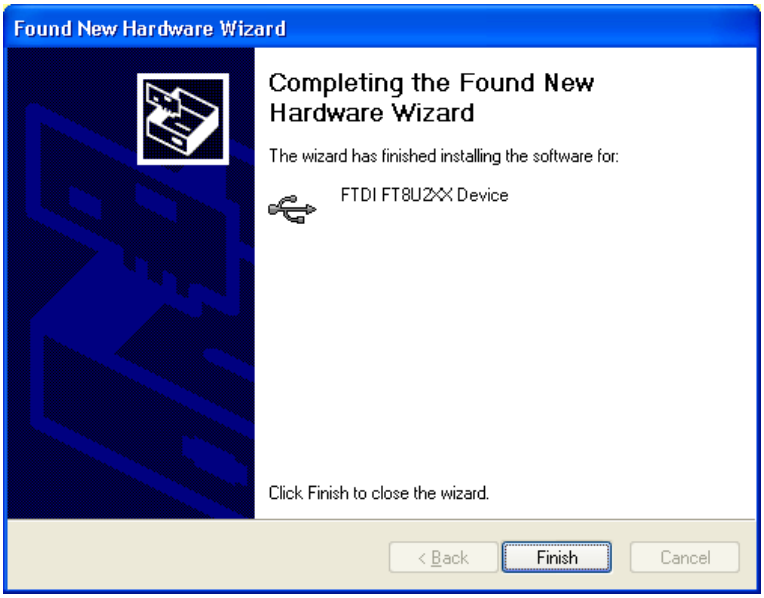


4. Specify the folder containing the drivers and click "Next"

The installation process may take a few moments. During this time, a window similar to the following will be shown.

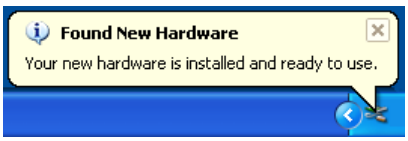


Once the installation is complete, the AI-7280 will be ready for use. The name for the USB driver is "FTDI FT8U2XX Device" so that when viewing the Control Panel's 'Device Manager' window, the AI-7280 is indicated by the "FTDI FT8U2XX Device" driver name.



5. Click "Finish"

A brief popup bubble, as shown below, indicates that the USB driver has been correctly installed and the AI-7280 is ready for use.



Appendix E: Glossary of Terms

ACK Tone

Acknowledgement signal sent by the TE in response to detecting a DT-AS or CAS tone. The signal is usually a DTMF digit 'D' or 'A'.

Bell 202

An FSK modulation standard that uses 1200 Hz for the mark tone frequency and 2200 Hz for the space tone frequency. The baud rate used is 1200 bits per second.

CAS Tone

CPE Alerting Signal. See DT-AS.

Channel Seizure

A FSK modulated alternating zero/one bit pattern that may be sent prior to any data bytes.

Checksum

For the purposes of Caller ID or SMS DLL, the checksum is a byte value sent after the message data. It represents the two's complement sum of all the message byte values. The checksum is used for error detection.

dBm

Unit of signal power level. Calculated as 10 times the base 10 logarithm of the ratio of the signals power relative to 0.001 Watt. For example, 1 mW = 0 dBm, 100 mW = 20 dBm. For most telephone applications, signal levels expressed in dBm are expressed with a 600 ohm terminating impedance. This fixes the relationship between dBm and dBV as 0 dBm = -2.218 dBV, or 0 dBV = 2.218 dBm.

dBV

Unit of signal voltage level. Calculated as 20 times the base 10 logarithm of the signal's voltage. For example, 1 Vrms = 0 dBV, 0.1 Vrms = -20 dBV.

DLL

Data Link Layer: A layer in the SMS protocol stack above the physical layer, but below the TL layer. Used to transport TL messages between SME's.

DT-AS

Dual Tone Alerting Signal: A signal composed of two tones (2130 Hz & 2750 Hz) used to alert the TE of an incoming Caller ID data transmission. Also refered to a CAS tone.

DTMF

Dual Tone Multi-Frequency: A signal comprised of two tones used for dialing or other signaling purposes. Eight different frequencies represented by a 4x4 matix are used for the two tones.

Flash

Telephone Line Flash: An action by a TE in which it momentarily goes on-hook, then returns to the off-hook state. The on-hook duration is usually in the range of 100 ms to 1000 ms.

FSK

Frequency Shift Keying: A method of signal modulation for data transmission. For Caller ID and SMS applications, a tone's frequency is shifted between two values representing either a mark or space bit.

MDMF

Multiple Data Message Format: A structure used to convey FSK modulated data of up to 255 bytes in length. Most commonly used for Caller ID applications or for sending SMS DLL messages.

MF

Multi-Frequency: A method used to convey signaling information over telephone networks. Uses signals comprised of two, or possible more, tones from a standardized list of frequencies.

Off-Hook

A state in which a TE draws loop current from the tip/ring interface. Denotes that the device is in use or active.

On-Hook

A state in which a TE does not draw any loop current from the tip/ring interface. Denotes that the device is idle or in-active.

OSI

Open Switching Interval: An interval of time in which the central office disconnects the DC feed voltage from the TE. Can be used as a method of informing a TE of an

incoming Caller ID message, or simply generated as an artifact by the central office when various resources are being connected/disconnected from the telephone line.

PDU

Protocol Data Unit: For the purposes the ETSI Protocol 1 SMS, the PDU is a data structure used to convey information. These PDU's are the Transfer Layer (TL) messages and take the form of one of six different types. They are: SMS-DELIVER, SMS-DELIVER-REPORT, SMS-SUBMIT, SMS-SUBMIT-REPORT, SMS-STATUS-REPORT, and SMS-COMMAND.

pps

Pulses per Second: A measurement of pulse dialing which expresses the rate of dialing pulses. A dialing pulse is a short interval of time in which the TE goes on-hook and then returns to the off-hook state. The most common pulse rate in use is 10 pps; however various PSTN's may require faster or slower rates for dialing.

PSTN

Public Switched Telephone Network: A network of devices allowing a TE to establish a connection to another device for the purposes of passing voice band signals.

RP-AS

Ring Pulse Alerting Signal: A short ringing burst that is used to alert the TE of an incoming Caller ID data transmission.

SAS

Subscriber Alerting Signal: A signal used as part of the call waiting service alerting the subscriber of an incoming call. Also may be used during a Type II Caller ID transmission by preceding the CAS signal.

SDMF

Single Data Message Format: A data structure that may be used to send Type I Caller ID data consisting of date/time and calling number information. See also MDMF.

SM

Short Message: Information sent between SME's using the Short Message Service (SMS)

SME

Short Message Entity: A device having the capability to send or receive short messages (SM). Can be either a SM-TE or SM-SC.

SMS

Short Message Service: A service used to send short messages (SM) to and from SME's.

SM-SC

Short Message Service Center: A functional unit that receives or sends short messages to a SM-TE.

SM-TE

Short Message Terminal Equipment: A terminal equipment device that is capabile of sending or receiving short messages to or from a SM-SC.

Start Bit

For Caller ID and SMS applications, every 8 bit data byte transmitted via a FSK modulated signal is preceeded with a single start bit. The start bit is always represented with the space tone.

Stop Bit

For Caller ID and SMS applications, every 8 bit data byte transmitted via a FSK modulated signal is followed with at least one stop bit. The stop bit is always represented with the mark tone.

TE

Terminal Equipment: A device connected to the telephone network. Also commonly referred to as a CPE (Customer Premise Equipment).

THD+N

Total Harmonic Distortion plus Noise: A measurement normally expressed as a ratio of the signal's harmonic distortion level plus noise to the total signal level.

TL

Transfer Layer: A layer in the SMS protocol stack providing a service to the SMS application layer. The transfer layer messages convey short message data or status information between SME's.

TPDU

Transfer Protocol Data Unit. See ETSI TS 100 901 section 9 for PDU structure as it relates to SMS applications.

Twist

Commonly refers to the ratio in signal level between the row and column tones of DTMF, or the mark and space tones of FSK. The ratio is normally expressed in decibels (dB). In the case of DTMF, positive twist indicates that the column signal level is greater than the row signal level. For FSK the most common convention is that positive twist indicates that the mark signal level is higher than the space level.

Type I

Caller ID data transmission occuring while the TE is in the on-hook state.

Type II

Caller ID data transmission occuring while the TE is in the off-hook state.

V.23

An FSK modulation standard that uses 1300 Hz for the mark tone frequency and 2100 Hz for the space tone frequency. The baud rate used is 1200 bits per second.