
AI-5620 Terminal Equipment Simulator



User Guide

Advent Instruments Inc.

Release 1.0f

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Safety Symbols and Terms



When the  symbol is present on an instrument it indicates that the operators should refer to the User Guide for more information.



When the  symbol is present it indicates a terminal that is connected to the functional ground of the instrument.



When the  symbol is present it indicates that the surface may be hot. Avoid contact with the surface of the instrument to avoid burns.



When the  symbol is present near a screw it should be connected to a safety earth ground using a wire recommended in the User Guide.

Installation Categories

Advent Instruments products are designed for use and to measure electrical signals that are rated Measurement Category I as described in the International Electrotechnical Commission (IEC) Standard IEC 606064. The equipment measurement terminals are not designed to be directly connected to the mains voltage or a voltage source with high transient over-voltages.

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1. Getting Started

1.1 Introduction

The AI-5620 simulates a single port two wire analog TE (Terminal Equipment) or CPE (Customer Premise Equipment) device. It is designed to measure and analyze signals generated by a CO (central office) line card, VoIP terminal adapter's FXS port, or any device utilizing a SLIC (subscriber line interface circuit).

Common applications include:

- Verifying Caller ID signal generation from CO's, PBX's, and line simulation equipment.
- Measuring general telephony signals such as DTMF, ringing, pulse dialing, line flash duration, metering pulses, and line voltage.
- Testing SLIC characteristics using adjustable load resistances, ringing loads, and AC terminations.
- Monitoring telephone line signals including line voltage and loop current.



When used in conjunction with the TRsSim software, the AI-5620 performs a wide range of test functions, including:

Measurement & Signal Detection

- Line voltage, loop current, common mode voltage
- Ringing frequency, level, duration, DC offset voltage
- AC RMS level, frequency, THD+N

- DTMF digit level, twist, frequency error, duration
- CAS/DTAS level, frequency, duration
- Metering pulse level, frequency, duration
- V.23 and Bell 202 FSK based Caller ID
- Pulse dialing, line flash, polarity reversals

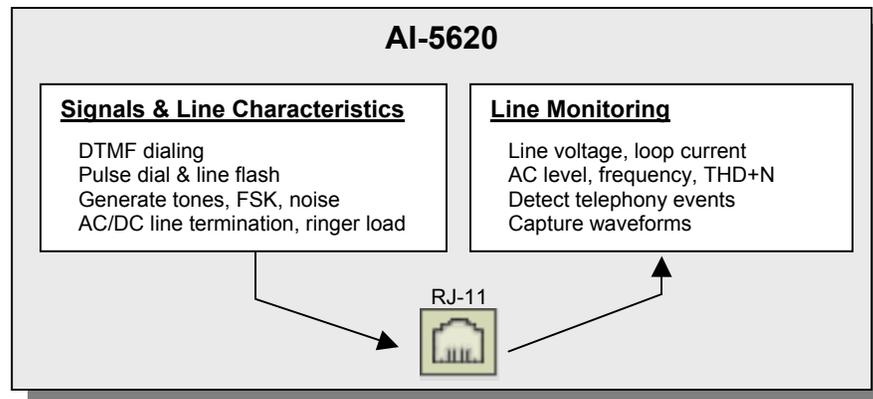
Signal Generation Capabilities

- DTMF tones with arbitrary frequency, level, and duration
- Programmable flash timing and pulse dialing
- V.23 and Bell 202 FSK modulated data
- One to four tones of arbitrary frequency, level, and duration
- Wave file playback
- Broadband noise generation
- Echo generation

Line Interface Capabilities

- Off hook programmable DC resistance from 50 to 1000 Ω
- Off hook fixed terminations of 600 Ω and short circuit
- Resistive AC impedance programmable from 200 to 1000 Ω
- Complex AC terminations for TBR-21, German ZR
- Programmable ringing loads

Logically the AI-5620 consists of two distinct functional blocks. The first provides the ability to change physical line characteristics and generate a wide range of signals, while the second provides all of the line monitoring and signal measurement capabilities.



The wide range of programmable line characteristics gives the AI-5620 the ability to present conditions that fall both inside and outside the conformance range of various standards. This helps to ensure that the equipment being tested can experience conditions outside the normally expected range.

Full support for Telecordia, TIA, ETSI, and Japan NTT Caller ID allows the AI-5620 to act like a TE for testing FSK and DTMF data transmission. Its response to off-hook

CAS/DTAS tones is fully programmable in order to verify correct operation of the signal generation equipment.

Unlike a traditional terminal equipment device, the AI-5620 can generate and measure signals in both the on and off-hook line states. This includes the ability to perform AC frequency and level sweeps with programmable filters, or perform sweeps of DC resistance for verification of the connected DC feeding bridge characteristics.

The second key element to the AI-5620 is its line monitoring capability. While operating independently from any signal generation, it continuously monitors the line interface making measurements and listening for telephony related events. These events include line state changes, ringing, dialing (pulse and DTMF), Caller ID FSK, and metering pulses. They may be sorted and filtered in a wide range of methods for discovering unexpected conditions.

In addition to event detection, a chart recorder feature stores a wide range of measurements for longer term testing. The measurements include line voltage, loop current, AC signal level, frequency, and distortion.

As an option to the AI-5620, the AI-ET004 Waveform Capture allows real time downloading and viewing of the line interface voltage and current waveforms. The waveform capture can be configured to record continuously, or just as telephony events are detected. In addition, the option provides support for viewing real time FFT's of the downloaded waveforms.

The included TRsSim software provides a high level graphical user interface for both controlling the AI-5620's actions, and for displaying the results of its line monitor functions. The software operates on a XP, Vista, or Win7 PC with a USB connection to the AI-5620. A brief introduction to the software is provided in a following section. For more complete information, see the included TRsSim – Terminal Equipment Simulator User Guide which provides more details on the operation of the software.

The rear panel of the AI-5620 provides various connectors for expanding its testing ability. A BNC audio input connector allows external signals to be routed to the line interface circuitry or the various signals detectors internal to the AI-5620. In addition, a BNC audio output connector allows monitoring signals present at the line interface, or from many of the AI-5620's internal signal generators. A digital I/O connector may be used to monitor conditions such as off-hook, ringing detection, FSK decoder outputs, or force the AI-5620 to an off-hook state.

1.2 Package Contents

Use care when unpacking the AI-5620 to avoid damage to the instrument and the packing materials. Retain the packing materials in case the unit is transported in the future.

Please inspect the shipping container and the contents for any damage. If visible damage is present, contact your local sales representative or Advent Instruments directly (see Appendix C: Technical Support). Keep the shipping materials for the carrier inspection.

The package should contain the following items:

- AI-5620 Terminal Equipment Simulator
- Full speed USB cable
- Telephone Cord with RJ-11 Connectors
- AC Power Mains Cable (plug type dependent on destination country)

- CD-ROM containing TRsSim software, USB drivers, and Setup software
- AI-5620 User Guide Manual
- TRsSim User Guide Manual
- Software License Key for TRsSim Application
- Calibration Certificate

If any of the above items are missing, contact your local sales representative or Advent Instruments directly for replacement.

1.3 Important Safeguards and Safety Precautions

Please read all instructions and save them for future use. Observe the following precautions to avoid injury and prevent damage to the AI-5620 or any products connected to it. The AI-5620 is intended for use by qualified personnel who recognize shock hazards and procedures to avoid possible electrical shock. The AI-5620 is designed for use with electrical signals that are rated Measurement Category I as described in IEC Standard 60664. All connectors and I/O are intended for connection to Category I sources unless otherwise described in the manual.

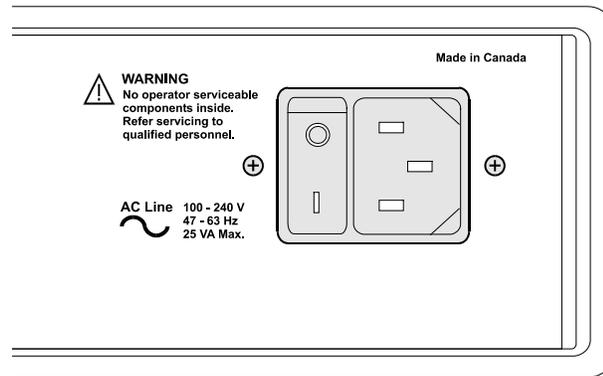
- Insure the AC power source is compatible with the voltage and frequency requirements stated on the label on the rear of the unit.
- Do not operate the instrument with the case opened.
- Do not allow any liquid to enter the interior of the instrument.
- Observe all terminal ratings to avoid fire or shock hazards.
- Avoid exposed terminals. Do not touch exposed connections when power is present.
- Do not operate with suspected failures. If damaged is suspected, do not continue to operate the instruments until inspected by qualified service personnel.
- Caution To reduce the risk of fire use only a No 26 AWG or larger telecommunications line cord
- The instrument is intended for use in an indoor laboratory environment with an altitude not to exceed 2000m. (Pollution Degree 2)
- To clean the instrument, disconnect it from the power supply, and then wipe down the exterior with a cloth dampened with a mixture of mild detergent and water. After the instrument is completely dry, the power supply may be re-connected.
- Refer servicing to a trained personal only.

1.4 Powering on the AI-5620

Before powering on the AI-5620 for the first time, disconnect any cables connected to the unit. The internal supply automatically adjusts to a wide range of input voltages and

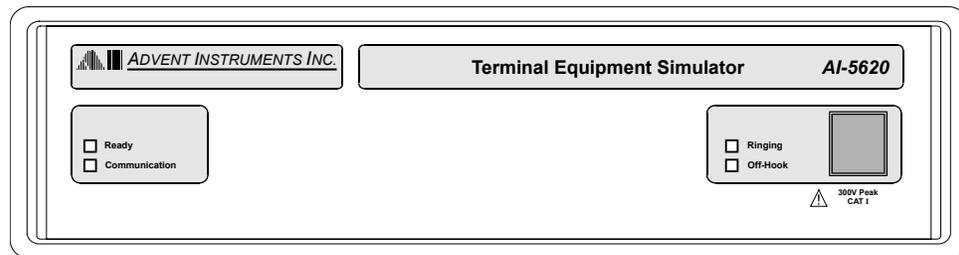
frequencies. However please ensure the AC voltage source is within the limits printed on the rear panel.

The power switch is integrated into the same connector that is used to connect the AC mains cable. Make sure that it is powered off prior to connecting the AC power cord and ensure the mains supply is properly earth grounded.



- Connect the AC power cord, ensuring a snug fit in the receptacle
- Turn on the power to the AI-5620 by rocking the power switch downward.

The Advent instrument logo illuminates along with the four front panel indicators when the power is first applied.



After a short duration all the indicators except for Ready will turn off. The AI-5620 then waits for the PC to recognize its connection via USB. While waiting, the Ready indicator flickers once every second.

A number of internal checks are performed during the power up cycle. If a fault is detected, the Ready indicator will either flash, or remain off. For information on the fault condition and corrective action, see Appendix B: Error Codes on page 25.

1.5 USB Driver Installation

The proper drivers must be installed before a USB connection can be established between the AI-5620 and the PC. The WHQL USB driver files are automatically installed with the TRsSim application and no further steps should be required.

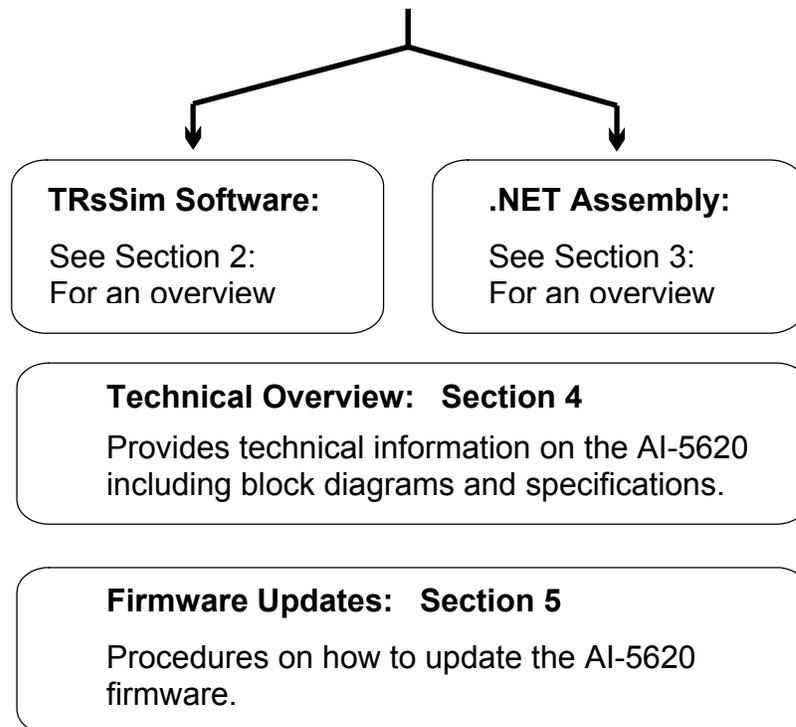
If the end use does not require the TRsSim application then it is also possible to install the driver manually.

For detailed step-by-step instructions on installing the driver, see Appendix A: USB Driver Installation on page 22. The following is a summary of the installation procedure.

1. Download the USB driver installation package from our website or from the CDrom.
2. Double click on the self extracting installer. This normally requires using the **administrator** privileges in Vista and Windows 7
3. The installer will decompress the files and prompt you through the steps to install the driver files.
5. A message should be displayed indicating the successful installation of the two driver files.

1.6 Where to go from Here

Once the AI-5620 has been powered up and connected to the PC, the next step is determined by the end user application. This is generally either using the TRsSim software to provide a graphical user interface for controlling the unit and performing tests, or developing custom control software with the Windows .NET Assembly.

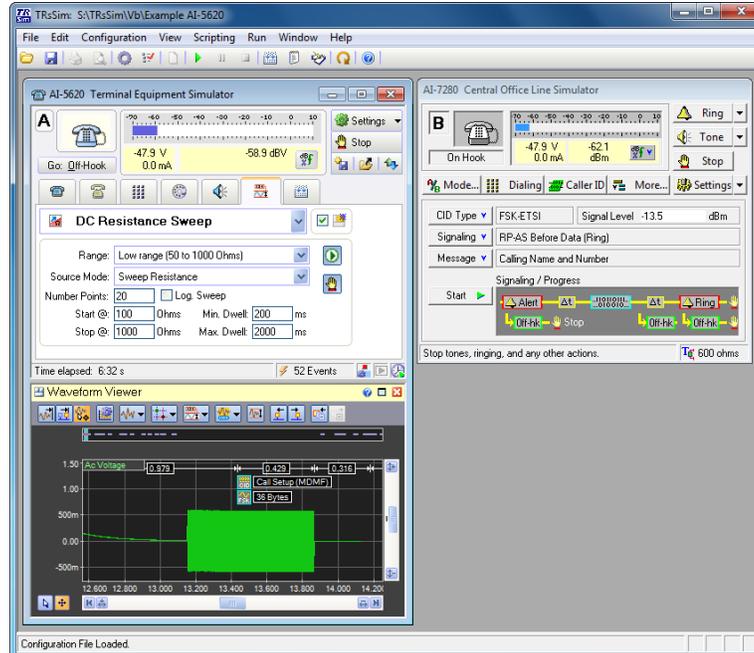


2. TRsSim Software

2.1 Introduction

Operating under the Windows OS (XP, Vista, Windows 7), the TRsSim software provides a high level graphical user interface for the AI-5620. While in most cases only a single AI-5620 is used at any given time, the TRsSim software can connect to and control multiple devices simultaneously. This includes another AI-5620 or other devices such as an AI-7280 Central Office Line Simulator, or an AI-5120 Telephone Line Monitor.

Each device controlled by the TRsSim software is represented by a separate 'control panel' window. In the example shown below, the TRsSim software controls two different devices. The left window represents the AI-5620 while the right window represents an AI-7280 Central Office Line Simulator. Each window has separate controls and displays specific to the type of device it is connected to.



While every connected device operates independently from one another, they can all be controlled via the built in scripting capabilities of TRsSim. Programs written in the scripting language may control either a single device, or all of the connected devices.

The scripting ability can be used to automate repetitive tasks or perform more complex tests.

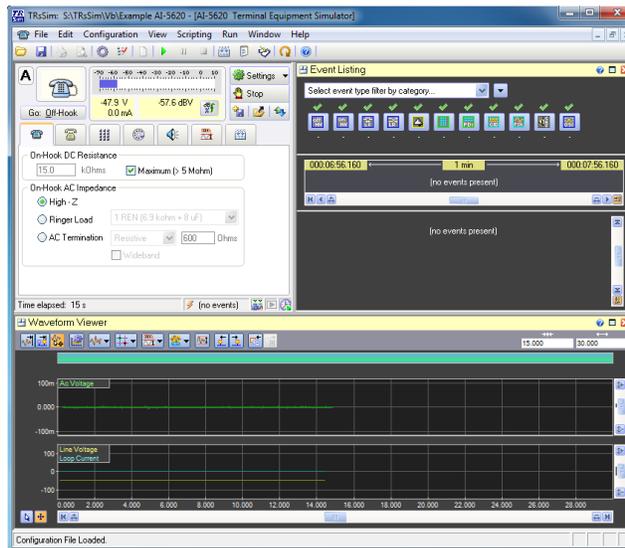
A remote control feature of TRsSim supports accepting commands from a remote application via a TCP/IP connection. This allows another application located on the same PC, or located on a different PC, to control the TRsSim software. By using this ability, a wide range of testing applications may be created that incorporates additional equipment not controlled from the TRsSim software.

To assist in development, a Windows DLL and a .NET assembly are available for abstracting the TCP/IP connection and low level commands. The .NET assembly allows applications to be developed from within Microsoft's Visual Studio IDE. The DLL, .NET assembly, and .NET example program are available for download from our web site:

<http://www.adventinstruments.com>

2.2 Controlling the AI-5620

When the TRsSim software connects to an AI-5620, it creates a window containing a wide range of controls for determining its operation and viewing collected data. The following figure shows an example of this window.



The window is itself divided into sub-regions, termed 'views'. In the example above three views are present. They are the 'Status & Action' view located in the top left corner, the 'Event Listing' shown in the top right corner, and the 'Waveform Viewer' located along the bottom of the window.

The 'Status & Action' view is always visible and always located at the top left corner of the window. It continually displays the AI-5620's line state, DC line voltage, DC loop current, and AC RMS level. This provides a quick means for identifying the current conditions on the telephone line. The remainder of the view contains a number of controls for adjusting the line characteristics and performing actions. For example, to take the AI-5620 off-hook, simply click the button labeled 'Go Off-Hook'. The various

tabs below this button display settings for the on-hook state, off-hook state, DTMF dialing, pulse dialing, tone generation, and measurement actions.

The event listing and waveform view shown in the above figure display information on the detected telephony events and captured waveforms respectively. These views can be modified in size, removed, or changed to show other data. Up to five different view types are available. They are:

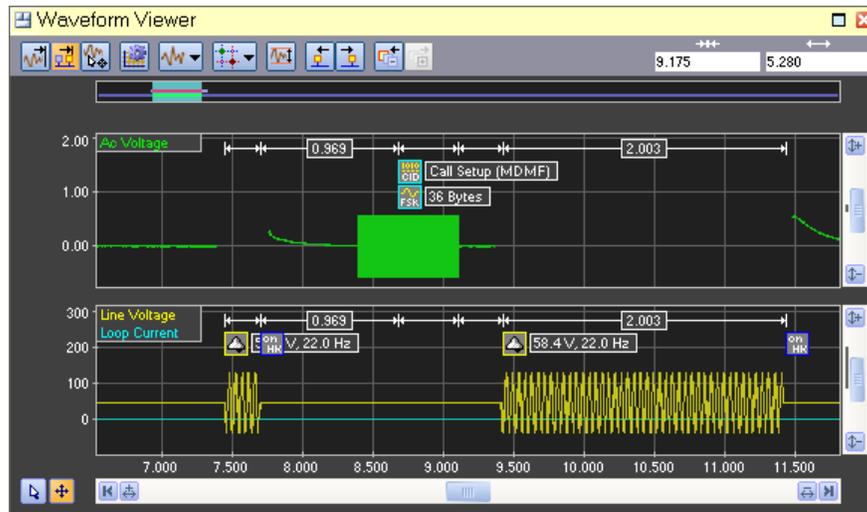
- **Measurements & Sweep Data:** Displays a wide range of measurement data including graphical level meters, results from AC signal or DC resistance sweeps, and detected metering pulse statistics and measurements.
- **Event Listing:** Shows details on the telephony related events detected by the AI-5620. Each event may be included on a graphical time line showing timing relationships and a listing of detailed measurements. The type of events displayed is controlled by various filtering options which help to isolate events of interest.
- **Chart Recorder:** Graphically displays any or all of the measurement channels collected by the chart recorder. Measurements of line voltage, loop current, AC signal level, frequency, THD+N, among others are made 5 times a second and can stored for up to one week.
- **Waveform (Added with AI-ET004 option):** Displays waveforms downloaded from the AI-5620. The waveforms represent the telephone interface line voltage, loop current, and common mode voltage. Captured waveforms may be played back through the telephone interface or exported to files.
- **FFT Display (Added with AI-ET004 option):** Shows a frequency domain graph of either live downloading waveforms, or waveforms previously captured. Averaging and peak hold settings may be used to smooth out or capture transient conditions.

2.3 Waveform Capture Option (AI-ET004)

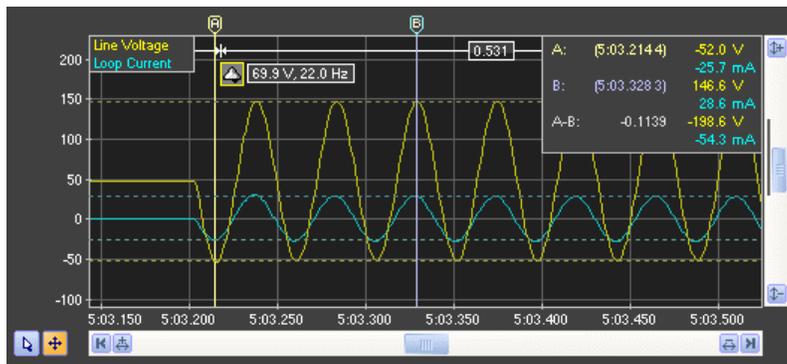
The optional waveform capture component provides the TRsSim software with the ability to download waveforms from the AI-5620 on a real time basis. The waveforms represent various signals measured from the front panel RJ-11 jack. The TRsSim software refers to these signals as channels and they are:

- **AC Coupled Line Voltage:** Sampled at an approximate rate of 40 kHz with a range of +/- 5V.
- **DC Coupled Line Voltage:** Sampled at a rate of 1000 Hz with a range of +/- 300 V.
- **DC Coupled Loop Current:** Sampled at a rate of 1000 Hz with a range of +/- 120 mA.
- **DC Coupled Common Mode Voltage:** Sampled at a rate of 1000 Hz with a range of +/- 300 V.
- **Digital Inputs 'A' & 'B':** Sampled at a rate of 1000 Hz.

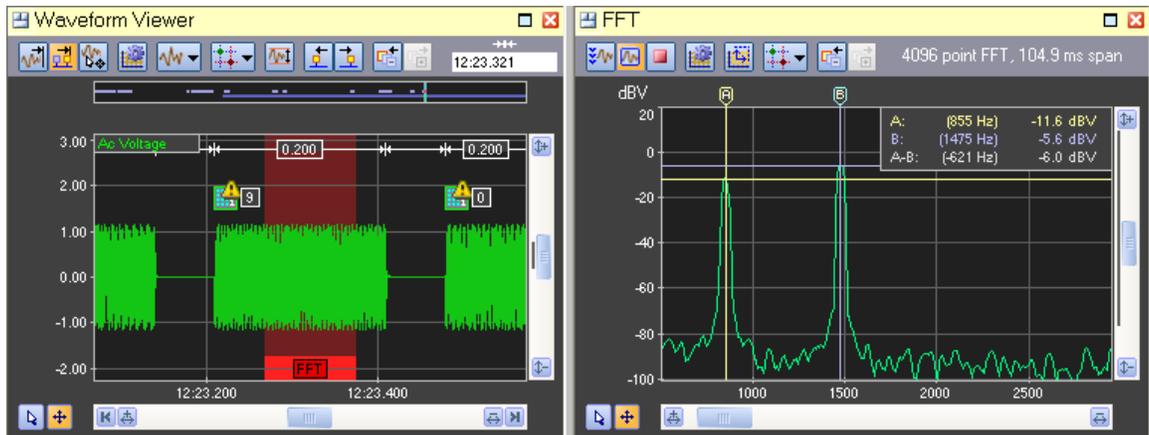
Example Figures:



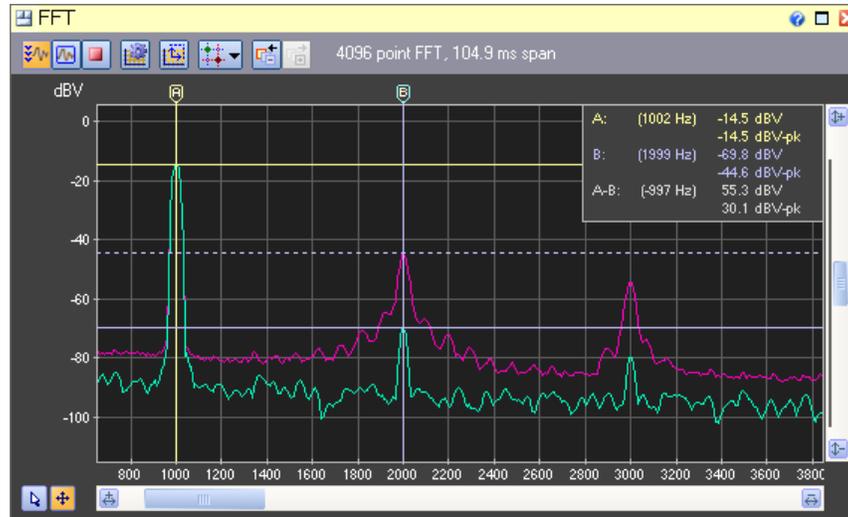
1. Capture of the waveforms present during an on-hook Caller ID transmission. The top green trace shows the AC coupled channel containing the FSK modulated data, while the bottom yellow and blue traces show the line voltage and loop current channels respectively.



2. Capture of ringing signal with a ringing load applied. Cursors are used to measure the positive and negative peaks for both the line voltage and loop current.



3. Viewing the FFT of a captured DTMF digit. The waveform view highlights in a red background color the time range used for the FFT calculation. Its position is always fixed to the center of the graph, while its width is determined by the number of sample points used to calculate the FFT.



4. Viewing a real time FFT of a 1 kHz tone. The purple trace represents the peak hold channel, which shows the effect of transient conditions. The two cursors are used to measure the second harmonic level of the 1 kHz tone. In this case, the second harmonic is normally 55 dB lower than the fundamental tone; however a transient event recorded by the peak hold dramatically increased the harmonic level by approximately 25 dB.

2.4 For More Information

Detailed information on the operation of the TRsSim software for the AI-5620 can be found in the **TRsSim - Terminal Equipment Simulator - User Guide** document. It shows how to install and setup the software along with more complete instructions on its use. This document is included with the AI-5620 package.

As newer versions of the TRsSim software are made available, they are posted on our web site at:

<http://www.adventinstruments.com>

Along with software updates, the web site provides the latest versions of any relevant documentation for download.

For technical support questions regarding the AI-5620 or the TRsSim software, please contact us in any of the manners listed in Appendix C: Technical Support on page 27.

3. User Programming

In situations where a graphical user interface is not required, or very specific test conditions are needed, using the .NET assembly for the AI-5620 may be a better approach than using the TRsSim software. The .NET assembly allows access to a wide range of objects abstracting the AI-5620 hardware capabilities. By using these objects, the AI-5620 can be integrated into custom test systems or used for custom applications.

Methods are available for controlling the line interface, performing dialing tasks and line flashes, generating tones, FSK, and noise, along with playing back waveforms. Additional methods abstract the line monitoring capabilities of reporting various measurements and detected telephony related events.

The .NET assembly is designed to be used from within Microsoft's Visual Studio development environment. The environment provides a rich set of development and debugging tools easing application development.

Technical documentation and examples are made available for download from our web site at:

<http://www.adventinstruments.com>

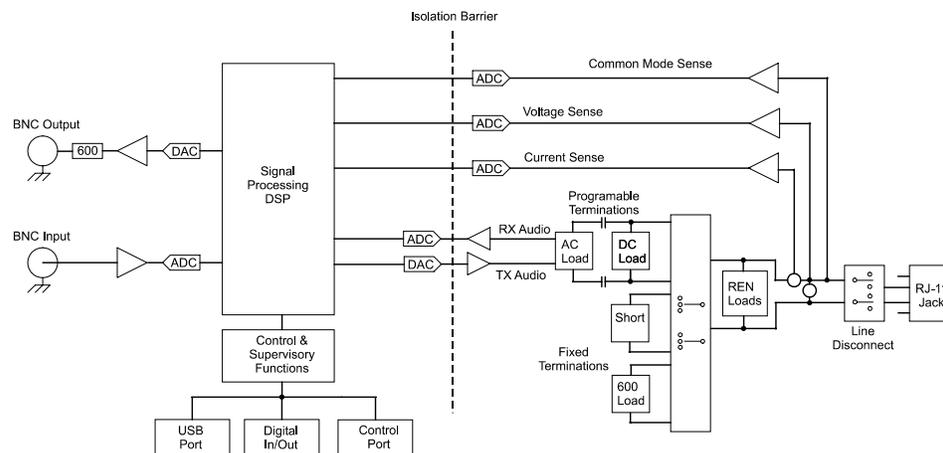
4. Technical Overview

4.1 Block Diagrams

The AI-5620 Terminal Equipment Simulator consists primarily of highly programmable AC and DC termination impedances coupled with circuits used in monitoring the telephone line voltage and current conditions.

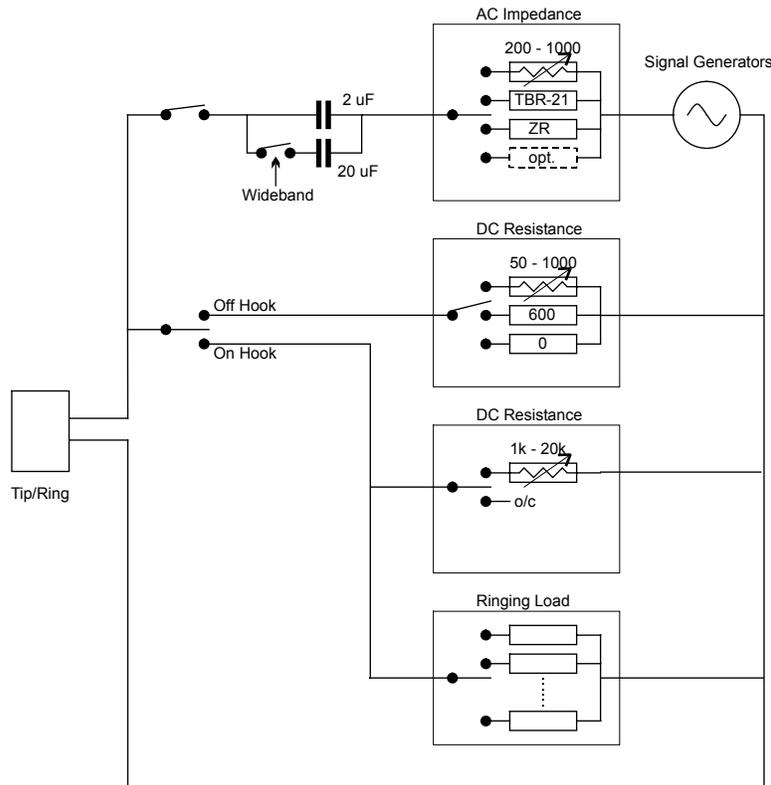
The following figure shows the major functional blocks of the AI-5620. At its center is the signal processing block responsible for controlling the line interface's DC and AC characteristics, generating signals, and monitoring the line conditions.

Five different terminations may be applied to the line in various combinations. The terminations are a programmable DC resistance, programmable AC impedance, fixed 600 ohm resistance, zero ohm resistance, and programmable ringing loads. By engaging the programmable AC impedance termination, a wide range of signals may be applied to the line. This includes DTMF dialing, Bell 202 or V.21 FSK, broadband white noise, or playback of arbitrary waveforms.



At all times, the AI-5620 monitors and records the metallic line voltage, common mode voltage, and loop current. Measured AC signals are processed for the detection of a wide range of telephony related events such as DTMF digits, Caller ID FSK messages, CAS/DTAS, or metering pulse tones.

The next diagram provides a more detailed view of the various AC and DC terminations that can be applied across the tip/ring leads. All of the terminations are categorized into four groups. They are AC impedance, off-hook resistance, on-hook resistance, on-hook ringing loads.



The AC impedance terminations are AC coupled to the tip/ring leads by a 2.2uF capacitor, with the option of adding an additional 20uF in parallel. This additional capacitance improves the level accuracy when generating low frequency signals. The termination impedance is selectable from either an adjustable value in range of 200 to 1000 Ω , the TBR-21 complex reference impedance, the German ZR complex reference impedance, or an optional third complex impedance (if installed).

The AC impedance terminations may be connected to the tip/ring leads in both the on-hook and off-hook state.

The off-hook resistance can be selected from a variable 50 to 1000 Ω settings, a fixed 600 Ω , or a short circuit setting.

Note that in the off-hook state, the AC impedance terminations are automatically disconnected if the fixed 600 Ω or short circuit settings are selected. It is not possible to generate any tones when then fixed 600 Ω or short circuit termination is selected.

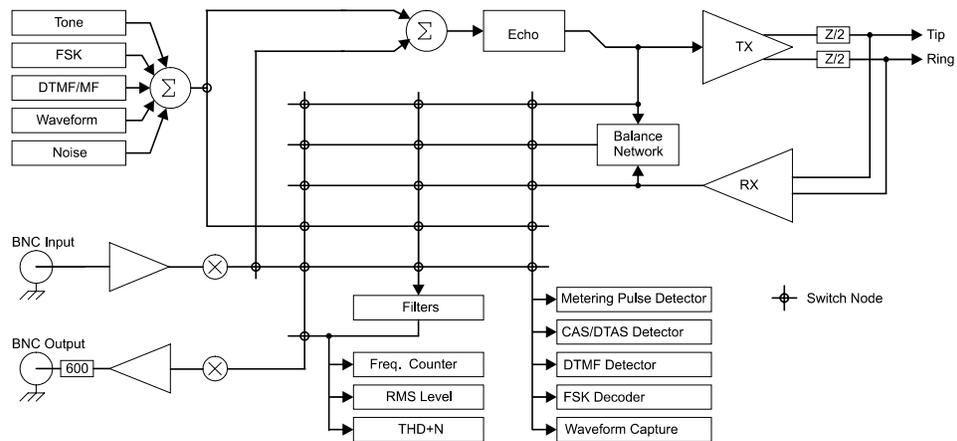
In the on-hook state, the DC resistance may be selected from a variable 1 k Ω to 20 k Ω setting, or an open circuit setting. In the open circuit setting the DC resistance across the tip/ring leads is slightly more than 5 M Ω .

Also in the on-hook state, various AC ringing loads may be applied. By default, six different ringing loads corresponding to REN1 through REN6 as defined by the TIA-1063 standard may be selected. Each ringing load is represented by a capacitor and resistor in series.

Note, if any of the ringing loads are enabled, the signal generator AC terminations are automatically disconnected.

From the stand point of AC signals, the following diagram shows the signal routing flow within the AI-5620.

All signals presented to the line interface are created by either the various internal signal generators or from the rear panel BNC input connector. The signal generators are capable of producing simple tones, FSK modulated data (Bell 202 or V.21), DTMF, MF (multi-frequency), broadband white noise, or arbitrary waveform playback. The sum of all the generators can be combined with the rear panel BNC input signal and routed to the line interface. Optionally, varying degrees of echo can be applied to the signal before it is sent to the line.



The AI-5620 has three primary signal sinks. They are a signal measurement meter, signal analyzer, and the rear panel BNC output connector.

The signal measurement meter provides continually updated readings of RMS level, frequency, and THD+N. Prior to making any measurements, it can apply any one of a number of filters. These include adjustable low pass, high pass, band pass, and notch filters.

The signal analyzer performs a number of different tasks. They are detecting DTMF digits, detecting CAS/DTAS tones, detecting metering pulses, decoding Bell 202 or V.23 FSK modulated data, and recording AC signal waveforms.

The BNC output connector provides a means of externally monitoring the signals present at either the line interface or other locations within the signal routing flow.

The signal source for the measurement meter, analyzer, and BNC output is selected from one of five different signal points. They are either the generator output, telephone interface TX signal, telephone interface RX signal, BNC input signal, and the telephone interface RX hybrid output signal.

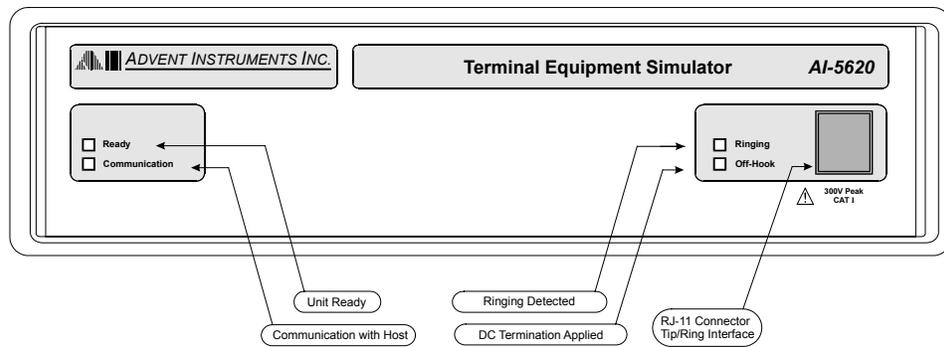
The RX hybrid output signal is generated from a balance network which attempts to cancel the TX signal by simulating the source impedance of AI-5620 and the expected load impedance of any device connected to the line interface. This provides a means of measuring or monitoring signals that are generated by only the connected equipment, and not the AI-5620.

4.2 Indicators & Connections

The AI-5620 front panel is quite simple and contains four LED indicators and one RJ-11 telephone line interface jack.

The two left side indicators Ready and Communication show the status of the unit and communication activity respectively.

Under normal operation the Ready indicator is constantly illuminated. However, if the AI-5620's USB port is not connected to an operating PC it briefly blinks once every one to two seconds. In situations where an internal fault is detected, the Ready indicator will start flashing. When flashing, the Ringing and Off-Hook indicators are used to signal the specific fault condition. See Appendix B: Error Codes on page 25 for more information on the fault conditions.

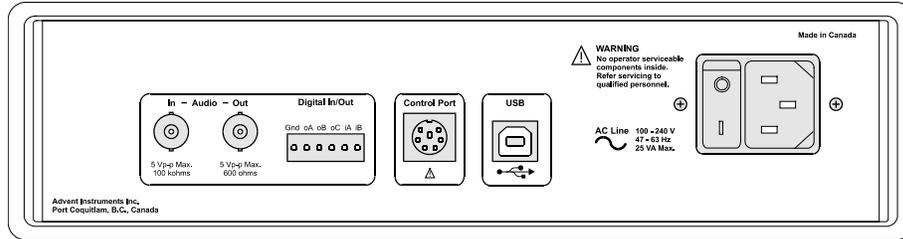


The communication LED briefly illuminates anytime data is either sent to the PC or received from the PC.

When the Ready indicator is illuminated (no fault condition), then the two right side LED's show when the AI-5620 has detected ringing or when the line interface is in the off-hook state. Ringing is detected if an AC voltage exceeding 40 Vrms with a frequency in the range of 10 to 100 Hz. is measured. The AI-5620 illuminates the Off-Hook LED when one of the following terminations is engaged:

- Programmable DC resistance (50 to 1000 Ω)
- Fixed 600 Ω termination resistor
- Short circuit termination

The next figure shows the configuration of the AI-5620 rear panel. The right most IEC power jack is used to power the unit and the switch beside it allows the unit to be turned on or off while connected to the AC mains. The connection to the PC (or any other host) is made via the USB type B connector.



The BNC output connector can be used to monitor signals from the telephone line as well as other internal signal points. Its output impedance is $600\ \Omega$ with a maximum output level of 5 Volts peak-to-peak. The BNC input connector is AC coupled and accepts a maximum peak-to-peak signal of 5 volts. Its input impedance is $100\ \text{k}\Omega$

To the right of the BNC output connector is a 6 pin terminal block. This connector provides 3 general purpose digital outputs and 2 digital inputs. The sixth pin provides a ground connection to the AI-5620. The outputs (A, B, C) are an open collector configuration. They can each sink up to 25 mA and are pulled high to +5 volts with a $5.1\ \text{k}\Omega$ resistor. All three digital outputs can be set either high, low, or to monitor the following internal signals:

- Output A: Mirror the bit pattern decoded by the FSK demodulator.
- Output B: Mirror the state of the ringing detector (high for ringing).
- Output C: Mirror the state of the front panel Off-Hook indicator

The two digital inputs (A, B) have an input impedance of $100\ \text{k}\Omega$. The maximum input level to detect a logic low is 0.8 volts, while the minimum level to detect a logic high is 2.0 volts. Input 'A' can be configured to force the AI-5620 into the off-hook state if a logic high voltage is applied.

The 6 pin Control Port connector is designed for control and communication with future peripherals, or other Advent Instrument devices. It uses a standard 6 pin mini-circular DIN connector.

4.3 Specifications

4.3.1 Telephone Interface

General:

DC Channel Measurements

Input Voltage Range	± 300 Volts peak Maximum
Voltage Measurement Accuracy	$\pm 2\%$ of reading, $\pm 100\ \text{mV}$
Input Current Range	$\pm 120\ \text{mA}$, Maximum.
Current Measurement Accuracy	$\pm 2\%$ of reading, $\pm 100\ \mu\text{A}$
Common mode input range	± 200 Volts Maximum

DC Resistance

Minimum applied Voltage	$>1.4\ \text{Vdc}$
On Hook DC impedance Max	$>5\text{M}\Omega$
On Hook DC impedance Range	$1\text{k}\Omega$ to $20\text{k}\Omega$, Programmable
On Hook DC impedance Accuracy	$1\% \pm 75.0\ \Omega$
Off Hook DC impedance Range	$50\ \Omega$ to $1000\ \Omega$, Programmable

Off Hook DC impedance Accuracy	1% ± 5.0 Ω
Maximum DC load Power dissipation	4.5W
AC Channel Measurements	
Max AC input	12. V p-p, (+12.4 dBV)
AC input accuracy	± 0.2 dB (50 Hz – 10 kHz)
AC input noise (low gain)	-55 dBV Full Bandwidth, -68 dBV ITU 0.41 psophometric weighted, 600 Ω
AC input noise (High gain)	-70 dBV Full Bandwidth, -86 dBV ITU 0.41 psophometric weighted, 600 Ω
Frequency Measurement Accuracy	0.1% ± 1 Hz (100 Hz to 10 kHz & > -45 dBv)
Common Mode Rejection	-70 dB at 60 Hz
AC Generator	
AC Level Max	8 V p-p Open Circuit
AC Level Accuracy	± 0.2 dB (50 Hz – 10 kHz), on hook
AC Frequency range	20 Hz – 18 kHz
AC Terminations	
Resistive AC termination Range	200 Ω to 1000 Ω
Resistive AC Termination Accuracy	± 2 % (100 Hz to 4000 Hz)
Reactive AC termination Setting	TBR-21, German Zr, Optional
Reactive AC termination	± 4.5 % (100 Hz to 4000 Hz)
Ringer Load	1-6 REN* ¹ programmable in 1 REN steps
Connector Style	RJ-11 (center two conductors used)

*1 or Ringer Equivalence Number REN ≡ 6.9k + 8uF

4.3.2 Input & Output

BNC Input:

Unbalanced AC Coupled	
Input Impedance	100 k Ω, ± 5%
Maximum Input Level	5 Vp-p Maximum
Level Accuracy	± 0.2 dB, 50 Hz to 10 kHz
Frequency Range	10 Hz to 18 kHz
Maximum DC input Voltage	± 55 Volts

BNC Output:

Unbalanced, Ground Referenced	
Output Impedance	600 Ω, ± 3%
Output Level	5 Vp-p Maximum
Level Accuracy	± 0.2 dB, 50 Hz to 10 kHz
Frequency Range	10 Hz to 18 kHz
Signal Source	Tip/Ring, Tip/Ring with user selectable filters, Tone Generator

Digital I/O:

Number of Output Pins	3 (can be set to mirror hook state, ring detect status, and FSK decoder output status)
Output Pin Configuration	Open Collector
Output Pin Maximum Sink Current	25 mA
Output Pin Pull-up Resistance	5.1 kΩ
Number of Input Pins	2
Input Pin Impedance	100 kΩ
Input Pin Low Level Input	0.8 Volts (for logic 0) Maximum
Input Pin High Level Input	2.0 Volts (for logic 1) Minimum

4.3.3 General

Host Communication:

USB Port
USB Connector

Version 2.0, Full Speed (12 Mbit/s)
Standard Type-B

AC Line:

Voltage
Frequency

100 to 240 Vrms, 25 VA Max.
47 to 63 Hz

Physical:

Dimensions

Width: 26 cm (10")
Height: 8.5 cm (3.3")
Depth: 27 cm (10.6")

Weight
Operating Temperature Range
Storage Temperature Range
Operating Altitude

≈ 2.7 Kg (6 lbs)
5 to 40 °C, 80%RH
-25 to 70 °C, 80%RH
≤ 2000 m

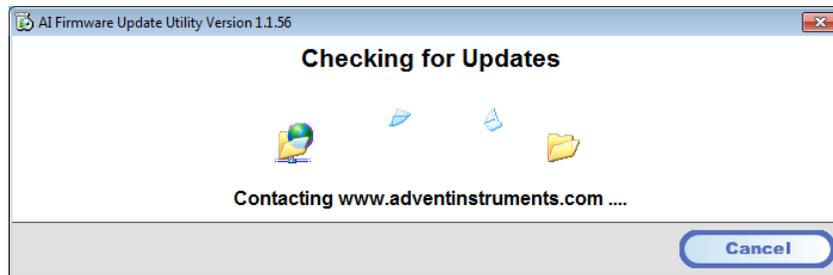
5. Firmware Updates

The AI Firmware Update program provides a simple means of updating all of the system files stored in the AI-5620's internal flash memory. The software can be used to upgrade the system files to the latest version and correct device specific problems if the AI-5620's flash memory becomes corrupted.

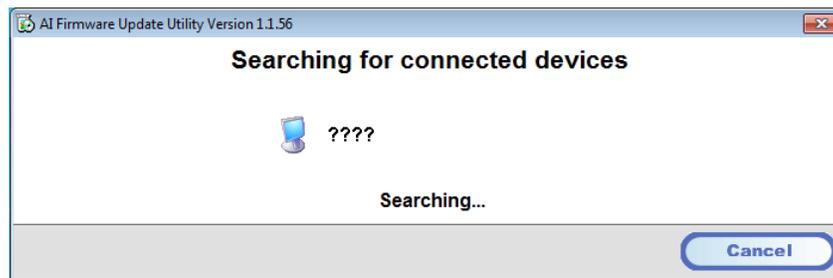
The program is available from the included CD or from our web site at:

<http://www.adventinstruments.com>

Once the AI Firmware Update software is installed on a PC, connect the AI-5620 to one of its USB ports. Power the AI-5620 on and start the firmware update software. The software will ask if it should query our website for latest updates. It is recommended to click yes to ensure the latest firmware is utilized.

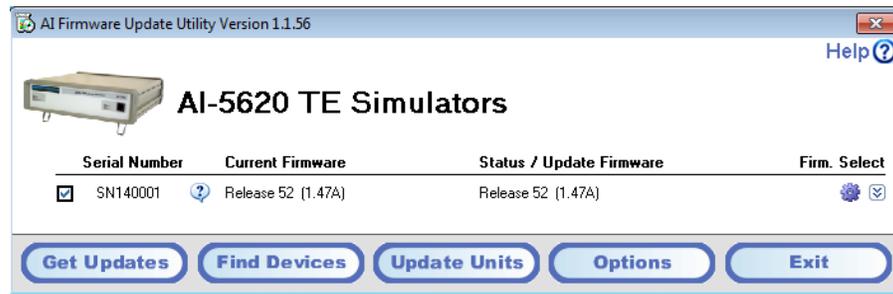


Once the update, if available, is downloaded the software checks for all compatible devices connected to the PC.



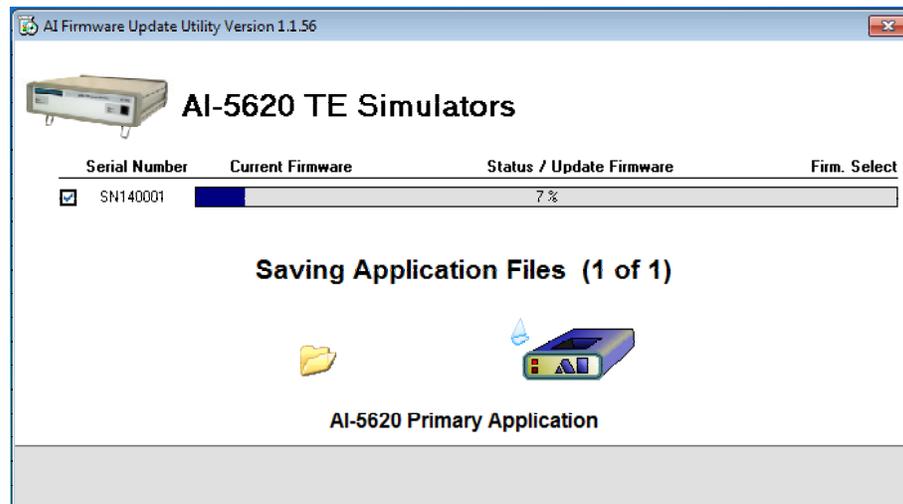
Once this is complete a window appears (as shown below) displaying all the connected devices. For each device, its current firmware revision is shown along with the newest

versions that may be installed. Older version of the firmware may be installed by clicking on the right most firmware selection icon.

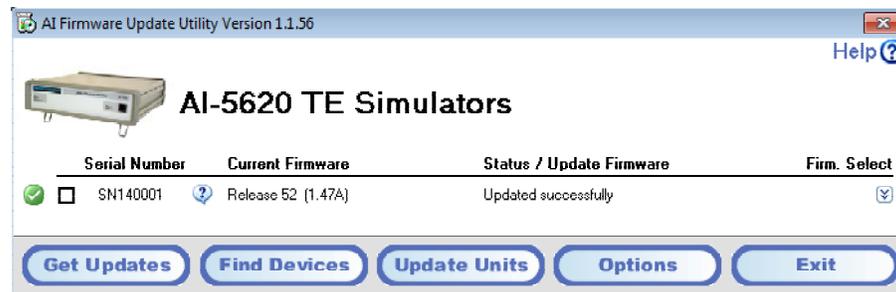


The check box to the left determine which devices are to be updated. By ensuring it is checked and clicking on the **Update Units** button, the process of installing the selected firmware begins.

Note: It is important not to shut off the power during the update process as this may permanently corrupt the memory of the device.



Once the update process is complete and no errors were detected, a green icon is shown to the left of the device information. If the update could not be completed due to errors, a message providing information on the error is displayed. Please contact us for assistance in resolving the error.



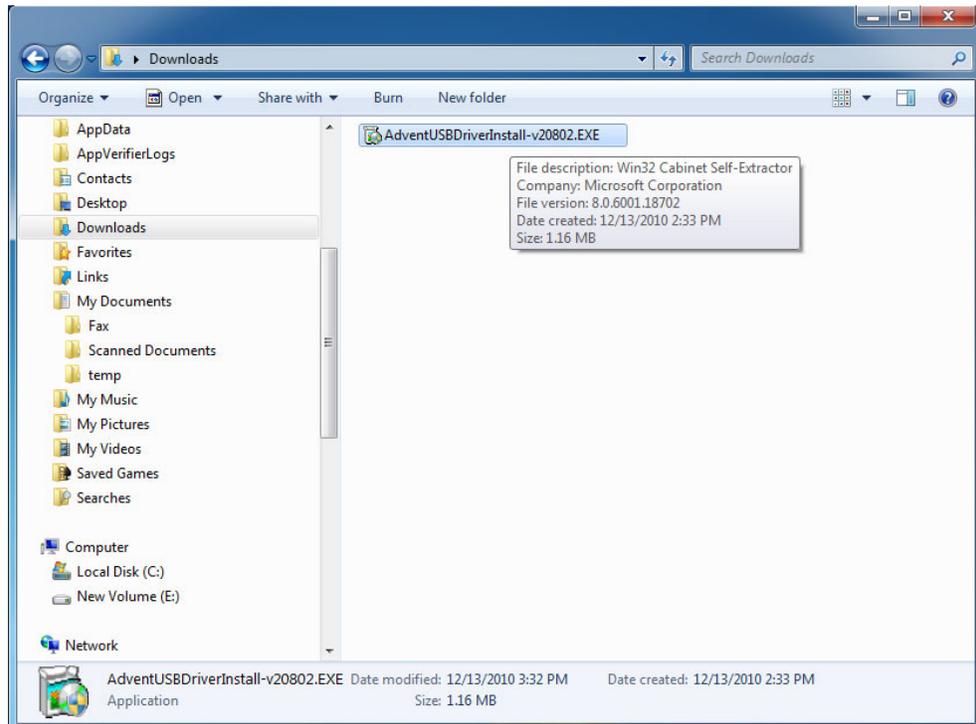
Appendix A: USB Driver Installation

The WHQL certified driver files are automatically installed along with the TRsSim application and the following procedure should only be required if the end application will not use the TRsSim software.

The drivers may be installed manually by using the add remove hardware wizard or via the self extracting installer package. The following figures show the step by step procedure for installing the USB drivers with this installer package.

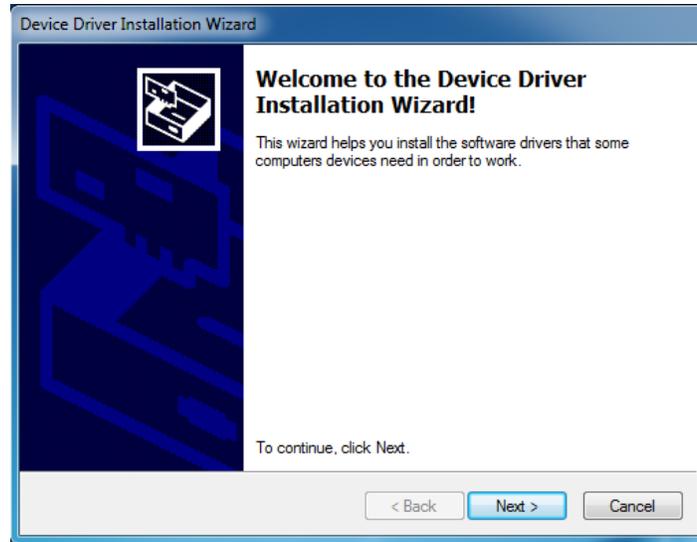
1. Download the USB installer Package

The USB installer package can be downloaded from our website at the following page <http://www.adventinstruments.com/Downloads/> or copied from the original CDrom provided with the instrument.



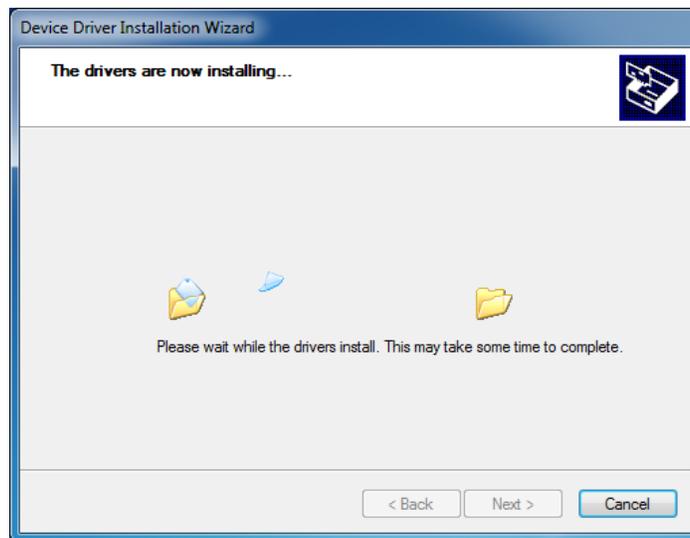
2. Run the USB installer Package

Once the file is located on the target computer double click on the file to start the self extraction and the following window will be displayed.



3. Click on the Next button to install the driver files

Windows will now copy the driver files from the installer package to the target computer.



4. Confirm the Driver installed correctly

Once Windows has completed the installation of the driver files the following window will display the results. Confirm that there are two ✓ marks beside both of the listed driver names.

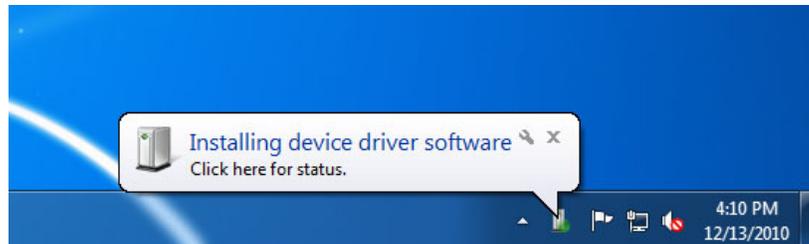


5. Click on the Finish button to exit the installer

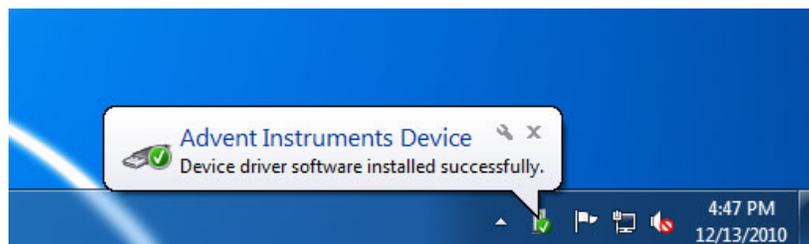
The driver is now installed and you may connect the instrument to the PC via a USB cable.

6. Connect the Instrument to the PC via the USB cable

The following brief popup bubble will appear indicating Windows has detected the new instrument.



Then a short time later the following popup will appear and the instrument is recognized by Windows and the PC.



Appendix B: Error Codes

Under normal operation, the front panel **Ready** indicator is illuminated continuously. However if an error condition is detected by the AI-5620, it starts to flash the **Ready** indicator. In this state, the **Ring** and **Off-Hook** front panel LEDs are used to indicate the fault condition.

The following table lists the various fault conditions along with possible corrective actions.

READY Indicator	RINGING Indicator	OFF-HOOK Indicator	Description / Corrective Measure
illuminated, but flickers off briefly once a second	any state	any state	<p>USB Interface Not Connected: The USB interface is either not connected to the PC, the PC is turned off, a failure within the PC's USB port, or Windows has failed to enumerate the AI-5620.</p> <p>Ensure the AI-5620 is connected to the PC and the PC is operating normally. If this condition persists try a different USB port, USB cable, or reboot the PC.</p>

READY Indicator	RINGING Indicator	OFF-HOOK Indicator	Description / Corrective Measure
Flashing	On	Flashing	<p>Line Interface Protection: The line interface circuit has been disconnected from the front panel RJ-11 jack due to the detection of excessive line voltage or loop current.</p> <p>From within the TRsSim software, open the Error Log & Telephone Interface Status window. The current state of the protection system is displayed in this window. Click the Restore Tel. Int. Settings button to restore the line interface connection.</p>

The following fault conditions may occur if the internal flash memory becomes corrupted. The corrective action for all these conditions is to restore the memory by using the **Firmware Update** program available from our web site. If the firmware update program does not correct the problem, please contact technical support for assistance.

READY Indicator	RINGING Indicator	OFF-HOOK Indicator	Description / Corrective Measure
Flashing	On	On	<p>Flash Memory Corruption Missing configuration information:</p>

			A unit configuration file stored in the flash memory is either missing or is corrupted.
Flashing	Flash	Off	Flash Memory Corruption Missing unit ID code: The unit ID code stored in the flash memory is either missing or is corrupted.
Flashing	Off	Flashing	Flash Memory Corruption Missing calibration item(s): One or more of the calibration factors is missing from the flash memory.
Flashing	Flashing	Flashing	Flash Memory Corruption No boot script file: The startup script file is either missing from the flash memory or is corrupted.
Flashing	Flashing	On	Flash Memory Corruption Missing system script files: One or more system script files is either missing from the flash memory or is corrupted.
Flashing	Off	Off	Flash Memory Corruption No program file: The primary DSP application program is missing from the flash memory or is corrupted.
Off	On	Off	Flash Memory Corruption Failure to boot primary application: This fault condition is a special case in which the Ready indicator does not flash, but is rather off. It occurs when the primary DSP application program fails to boot. It indicates a corrupted file within the flash memory, or a hardware fault.

The following fault condition indicates a serious error detected by the firmware. As the unit becomes unresponsive in this condition, the power must be cycled to restore normal operation.

READY Indicator	RINGING Indicator	OFF-HOOK Indicator	Description / Corrective Measure
Very Fast Flashing	Very Fast Flashing	Very Fast Flashing	Program Stack Fault The AI-5620 firmware has encountered a stack fault. This error prevents the AI-5620 from responding to any commands and effectively freezes the system. The power must be turned off and then back on in order to restore normal operation. Please contact technical support if this error occurs as it represents a serious firmware error.

Appendix C: Technical Support

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

- **Email:**
 - Technical Questions: techsupport@adventinst.com
 - Sales Inquires: sales@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) 3909-2338
 - 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