User
Guide

Keysight
Radio Test
Demo Program
Y1299A-007

KEYSIGHT
TECHNOLOGIES

Notices

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This product has been designed and tested in accordance with accepted industry standards, and has been supplied in a safe condition. To review the Declaration of Conformity, go to http://www.keysight.com/go/conformity.

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CAUTION

A CAUTION notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in damage to the product or loss of important data. Do not proceed beyond a CAUTION notice until the indicated conditions are fully understood and met.

WARNING

A WARNING notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in personal injury or death. Do not proceed beyond a WARNING notice until the indicated conditions are fully understood and met.

The following safety precautions should be observed before using this product and any associated instrumentation.

This product is intended for use by qualified personnel who recognize

shock hazards and are familiar with the safety precautions required to avoid possible injury. Read and follow all installation, operation, and maintenance information carefully before using the product.

WARNING

If this product is not used as specified, the protection provided by the equipment could be impaired. This product must be used in a normal condition (in which all means for protection are intact) only.

The types of product users are:

- Responsible body is the individual or group responsible for the use and maintenance of equipment, for ensuring that the equipment is operated within its specifications and operating limits, and for ensuring operators are adequately trained.

- Operators use the product for its intended function. They must be trained in electrical safety procedures and proper use of the instrument. They must be protected from electric shock and contact with hazardous live circuits.

- Maintenance personnel perform routine procedures on the product to keep it operating properly (for example, setting the line voltage or replacing consumable materials). Maintenance procedures are described in the user documentation. The procedures explicitly state if the operator may perform them. Otherwise, they should be performed only by service personnel.

- Service personnel are trained to work on live circuits, perform safe installations, and repair products. Only properly trained service personnel may perform installation and service procedures.

WARNING

Operator is responsible to maintain safe operating conditions. To ensure safe operating conditions, modules should not be operated beyond the full temperature range specified in the Environmental and physical specification. Exceeding safe operating conditions can result in shorter lifespans, improper module

performance and user safety issues. When the modules are in use and operation within the specified full temperature range is not maintained, module surface temperatures may exceed safe handling conditions which can cause discomfort or burns if touched. In the event of a module exceeding the full temperature range, always allow the module to cool before touching or removing modules from chassis.

Keysight products are designed for use with electrical signals that are rated Measurement Category I and Measurement Category II, as described in the International Electrotechnical Commission (IEC) Standard IEC 60664. Most measurement, control, and data I/O signals are Measurement Category I and must not be directly connected to mains voltage or to voltage sources with high transient over-voltages. Measurement Category II connections require protection for high transient over-voltages often associated with local AC mains connections. Assume all measurement, control, and data I/O connections are for connection to Category I sources unless otherwise marked or described in the user documentation.

Exercise extreme caution when a shock hazard is present. Lethal voltage may be present on cable connector jacks or test fixtures. The American National Standards Institute (ANSI) states that a shock hazard exists when voltage levels greater than 30V RMS, 42.4V peak, or 60VDC are present. A good safety practice is to expect that hazardous voltage is present in any unknown circuit before measuring.

Operators of this product must be protected from electric shock at all times. The responsible body must ensure that operators are prevented access and/or insulated from every connection point. In some cases, connections must be exposed to potential human contact. Product operators in these circumstances must be trained to protect themselves from the risk of electric shock. If the circuit is capable of operating at or above 1000V,

no conductive part of the circuit may be exposed.

Do not connect switching cards directly to unlimited power circuits. They are intended to be used with impedance-limited sources. NEVER connect switching cards directly to AC mains. When connecting sources to switching cards, install protective devices to limit fault current and voltage to the card.

Before operating an instrument, ensure that the line cord is connected to a properly-grounded power receptacle. Inspect the connecting cables, test leads, and jumpers for possible wear, cracks, or breaks before each use.

When installing equipment where access to the main power cord is restricted, such as rack mounting, a separate main input power disconnect device must be provided in close proximity to the equipment and within easy reach of the operator.

For maximum safety, do not touch the product, test cables, or any other instruments while power is applied to the circuit under test. ALWAYS remove power from the entire test system and discharge any capacitors before: connecting or disconnecting cables or jumpers, installing or removing switching cards, or making internal changes, such as installing or removing jumpers.

Do not touch any object that could provide a current path to the common side of the circuit under test or power line (earth) ground. Always make measurements with dry hands while standing on a dry, insulated surface capable of withstanding the voltage being measured.

The instrument and accessories must be used in accordance with its specifications and operating instructions, or the safety of the equipment may be impaired.

Do not exceed the maximum signal levels of the instruments and accessories, as defined in the specifications and operating information, and as shown on the instrument or test fixture panels, or switching card.

When fuses are used in a product, replace with the same type and rating for continued protection against fire hazard.

Chassis connections must only be used as shield connections for measuring circuits, NOT as safety earth ground connections.

If you are using a test fixture, keep the lid closed while power is applied to the device under test. Safe operation requires the use of a lid interlock.

Instrumentation and accessories shall not be connected to humans.

Before performing any maintenance, disconnect the line cord and all test cables.

To maintain protection from electric shock and fire, replacement components in mains circuits – including the power transformer, test leads, and input jacks – must be purchased from Keysight. Standard fuses with applicable national safety approvals may be used if the rating and type are the same. Other components that are not safety-related may be purchased from other suppliers as long as they are equivalent to the original component (note that selected parts should be purchased only through Keysight to maintain accuracy and functionality of the product). If you are unsure about the applicability of a replacement component, call an Keysight office for information.

WARNING

No operator serviceable parts inside. Refer servicing to qualified personnel. To prevent electrical shock do not remove covers. For continued protection against fire hazard, replace fuse with same type and rating.

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This symbol indicates product compliance with the Canadian Interference-Causing Equipment Standard (ICES-001). It also identifies the product is an Industrial Scientific and Medical Group 1 Class A product (CISPR 11, Clause 4).

KCC-REM-KST-
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South Korean Class A EMC Declaration. This equipment is Class A suitable for professional use and is for use in electromagnetic environments outside of the home. A 급 기 기 (업 무 용 방 송 통 신 기 자 재) 이 기 기 는 업 무 용 (A 급) 전 자 파 적 합 기 기 로 서 판 매 자 또 는 사 용 자 는 이 점 을 주 의 하 시 기 바 라 며 , 가 정 외 의 지 역 에 서 사 용 하 는 것 을 목 적 으 로 합 니 다 .

This product complies with the WEEE Directive marketing requirement. The affixed product label (above) indicates that you must not discard this electrical/electronic product in domestic household waste. **Product Category**: With reference to the equipment types in the WEEE directive Annex 1, this product is classified as "Monitoring and Control instrumentation" product. Do not dispose in domestic household waste. To return unwanted products, contact your local Keysight office, or for more information see http://about.keysight.com/en/companyinfo/environment/takeback.shtml.

This symbol indicates the instrument is sensitive to electrostatic discharge (ESD). ESD can damage the highly sensitive components in your instrument. ESD damage is most likely to occur as the module is being installed or when cables are connected or disconnected. Protect the circuits from ESD damage by wearing a grounding strap that provides a high resistance path to ground. Alternatively, ground yourself to discharge any built-up static charge by touching the outer shell of any grounded instrument chassis before touching the port connectors.

This symbol on an instrument means caution, risk of danger. You should refer to the operating instructions located in the user documentation in all cases where the symbol is marked on the instrument.

This symbol indicates the time period during which no hazardous or toxic substance elements are expected to leak or deteriorate during normal use. Forty years is the expected useful life of the product.

Contents

Introduction

The Keysight Radio Test Demo program ("RT Demo program") uses the Keysight M9381A PXIe VSG, M9391A PXIe VSA, M9393A PXIe Performance VSA, or M9290A CXA-m signal analyzer, ADLINK PXI-9527 dynamic signal analyzer (for audio measurements), along with the M90xA X-Series measurement application software, M9099 Waveform Creator (WFC) software, and the M9560A Radio Test Audio Library to perform two-way radio measurements commonly used in the production test of these devices. The RT Demo program supports multiple measurements for analog and digital. It can be used to demonstrate the measurement speed, repeatability and ranges of measurements for the Keysight PXI instruments used in the program. The measurements can be performed on a wide range of radios or on a through RF cable by configuring the settings in the user interface.

The following optional instruments and measurements are supported in addition to the basic RF and audio measurements:

- Keysight power meter or USB power sensor is supported to perform a system calibration.

The RT Demo program is C# Windows form application. Source code for the program can be provided. Contact your local Keysight representative to obtain the source code for the program.

Program Installation

The RT Demo program installer will be provided in a zip file. Copy the installation zip file to the target machine and unzip the file. Browse into the unzipped folder RT_ Demo_1.x.x/Volume and run the program setup.exe:
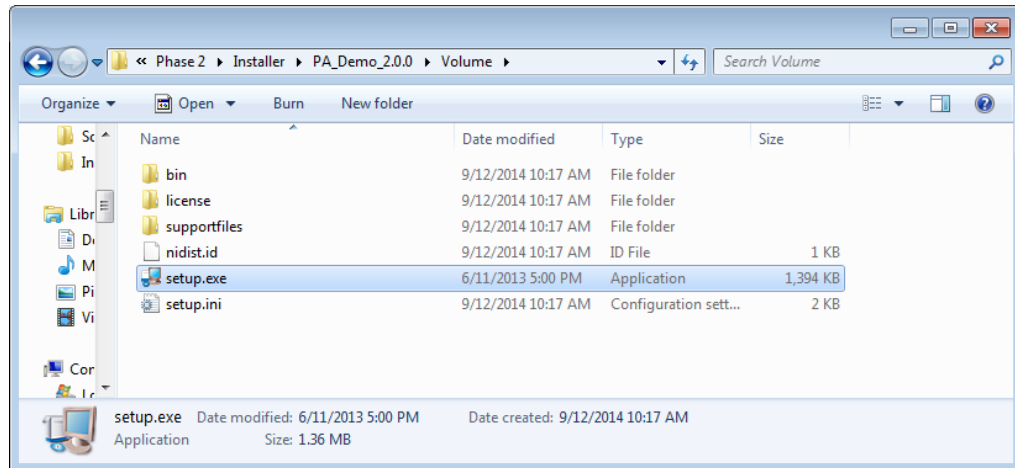
By default, the program will be installed at C:\Keysight\RT Demo Program. The installation can be run with all of the default vaues for each prompt. The Keysight software EULA must be accepted to install the software. The program will install and add shortcuts to the desktop and the start menu at Keysight/RT Demo Program. The start menu short cuts will include a short cut to run the program, one to show the users guide and one to show the list of required drivers.

Licenses are required to run the M90xA X-Series measurement applications ("X-Series apps"), M9099 Waveform Creator software, and M9560A Radio Test Audio Library. The RT Demo systems from Keysight will include the required licenses. To obtain a temporary license to run the program on a non-Keysight owned computer, please contact your local Keysight representative or obtain trial licenses from Keysight.com.

Driver Installation

Several instrument drivers and software packages must be installed before the RT Demo program can be run. The following are required:

- Keysight Connection Expert/IO Libraries
- M938x VSG IVI Driver
- M9391A VSA IVI Driver
- M9393A VSA IVI Driver
- M9290A X-Applications Software (optional, if M9290A is used)
- M90xA Modular X-Applications Software and IVI Driver
- M9099 Waveform Creator (WFC) Software (optional, for digital modulation generation)
- M9000 Keysight Measurement Library Software (for M9560A Radio Test Audio Library)
- ADLINK PXI-9527 driver
- Switch drivers for Keysight PXI switch (optional)
- License metadata file for M9560A Radio Test Audio Library
- M9099A Waveform Creator config.ini file

The required versions for each program are described in the Read Me File Versions.txt file included with the RT Demo program. All of the software packages except the M9560A license metadata file and M9099A config.ini file are in .exe files that will install the software in the required locations. Run each of these programs to install the drivers and software packages.

The M9099A Waveform Creator (WFC) config.ini file is needed to optimize automation speed when using the WFC to control the M9381A source automatically via the RT Ref Solution demo program. This file should be copied into the WFC install directory (usually C:\Program Files (x86)\Keysight\M9099). In addition, when WFC is installed, only the critical plugins should be installed for optimum speed. A readme file will be provided with the Config.ini file and delivered as part of the RT Ref Solution demo program install package.

The License metadata file for M9560A Radio Test Audio Library needs to be copied to the Keysight License Manager program directories prior to installing the M9560A license. This file "LicenseMetadata_M9560A.xml" will be delivered with the RT Ref Solution demo program installer, and should be copied to C:\Program Files (x86)\Agilent\ACCL\Licensing\bin. Then the Agilent License Service should be restarted (this can be accomplished by rebooting) prior to installing the M9560A license.

Running the Radio Test Demo Program

The RT Demo program provides a user interface to run the tests and display the results. The following is a screen capture of the GUI after the program is launched. Tool tip help is available for each control in the demo program by hovering the mouse over that control.

The View Users Guide button will show this document. The program saves test result and time data to a .CSV file. The most recent data file can be opened by pressing the Open Data Log button.

The Save State, Recall State and Reset to Default buttons will allow the user to save the current configuration of the user interface controls to a file, reload previous setting from a file or reset all of the values to a default condition. When the program is started, the GUI will be restored to the last state used. If there is an error, press the Reset to Defaults button to reset the UI.
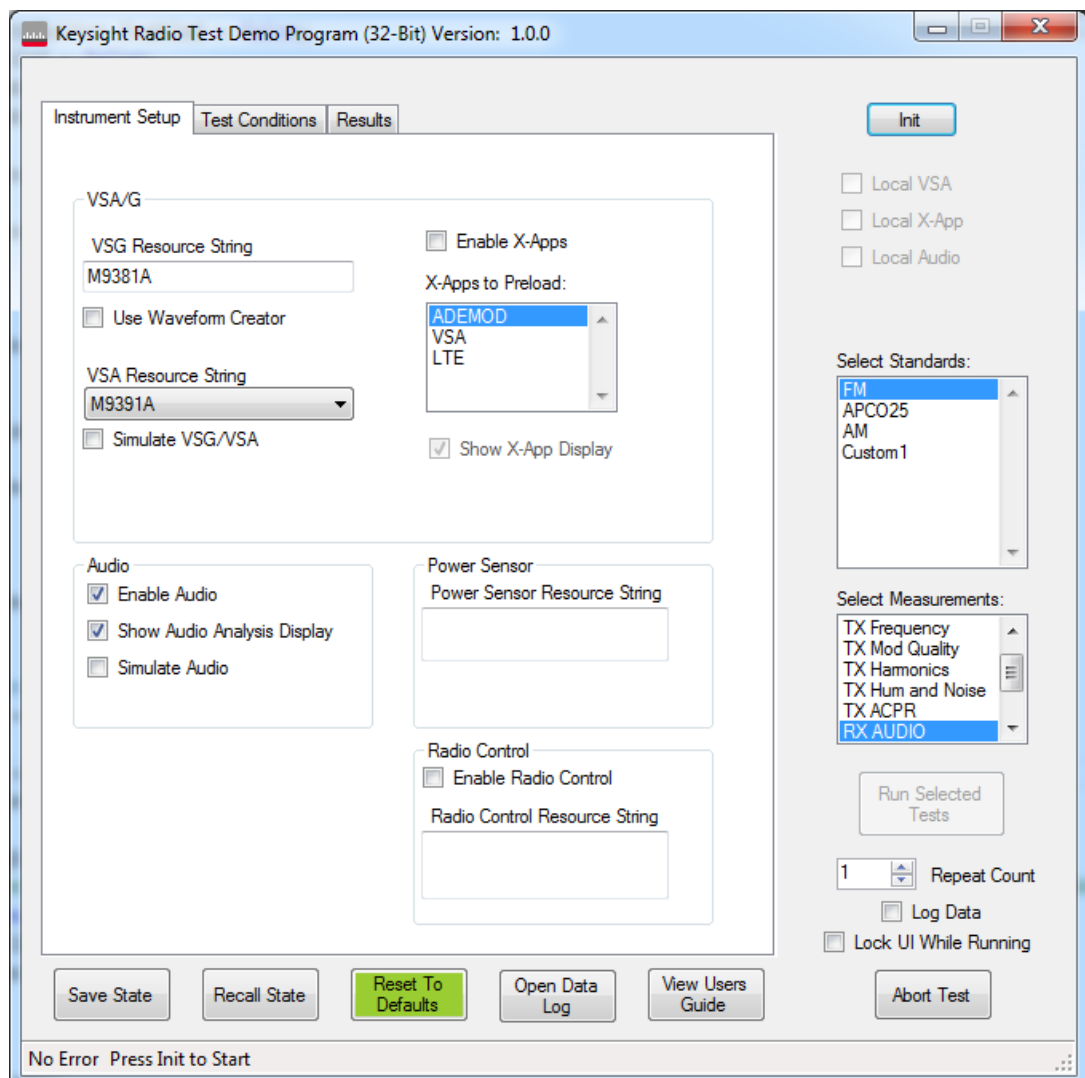
Configuring the Instruments

The Instrument Setup tab includes fields to enter the VISA resource address for each instrument and controls to configure the use of the M90xA X-App software.

The PXI VSG resource string can be either a list of the individual module addresses or the name of a saved configuration that was created with the M9381A PXIe VSG SFP. The VSG will be controlled using the M938x IVI driver. If the "Use Waveform Creator" checkbox is checked, the M9099 Waveform Creator software will be used to generate waveforms and control the M9381A PXIe VSG. The M9099 software is controlled via its SCPI interface. The M9099 software will be automatically started if it is not already running when the "Init" button is pressed.

The PXI VSA resource string will be selected from a list of saved configurations created with the M9391A PXIe VSA and M9393A PXIe Performance VSA Soft Front Panels (SFPs). Additionally, if an M9290A CXA-m signal analyzer is detected in the chassis, this option will be presented in the VSA Resource dropdown list. If there are no saved configurations defined, and no M9290A detected, an error message will be shown directing you to use the SFP to create a saved configuration.

The X-Series App software will be loaded if the Enable X-Apps check box is checked. In this case, the M9000 resource manager will be used to allow the PXI VSA to be accessed both by the VSA IVI driver and by the X-Series App software. If the X-Series App software is not selected, the PXI VSA will only be controlled by the IVI driver. If the X-Series App software is loaded, one or more X-Series Apps can be selected from the list of applications to preload. The X-Series Apps in this list will be loaded as part of the initialization process. Other X-Series Apps can be used later in the program, but there will be a delay while they load. For best results, select the X-Series Apps to be preloaded. Note that if the M9290A CXA-m analyzer is used, it operates only via its X-Series App software, and does not have an IVI driver. In this case, the selections for Enable X-apps and X-apps to preload are ignored. You can configure which X-apps are preloaded from the M9290A X-apps software.

The resource strings for all other instruments can be determined using Keysight Connection Expert. Enter these values into the appropriate fields in the RT Demo Program GUI, if any of these instruments will be used. The resource strings can be the actual VISA resource string or an alias created in Connection Expert. For the ADLINK audio card, it automatically uses the first channel present, so no entry is needed. For the audio and radio control instruments, the "Enable Instrument" checkbox for each instrument that will be used also needs to be checked.

After the controls in the instrument setup have been set to the desired values, press the "Init" button to open the sessions to the instrument drivers and start the X-Series App software.

For the power sensor, enter the VISA resource string if the calibration procedure will be run. The resource string for the power sensor can be entered any time before starting the PXI VSG/VSA Calibration procedure.

At the completion of using the demo program, the instruments will be closed by pressing the red X in the upper right corner of the user interface.

Connection Expert Showing the Power Sensor
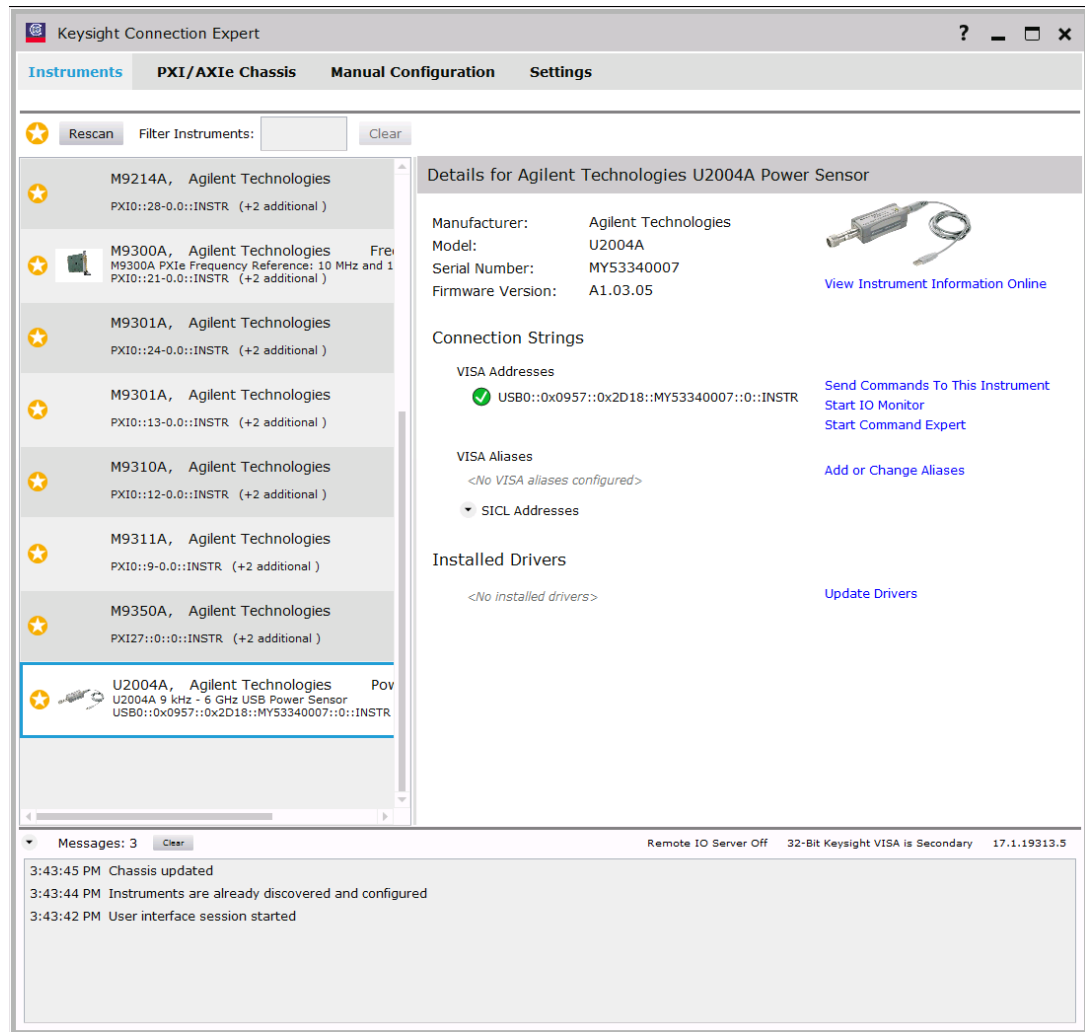
Radio Control can be used to control a switch to key the radio's push to talk switch (PTT) and for other settings if a complete radio interface is available. The RT Ref Solution currently supports Keysight PXI switches, and any switch that can be controlled via a COM port. For Keysight PXI switches, enter the VISA resource string. For serial-port switches, simply enter the COM port, such as COM3. If you leave the resource field blank, but check the Enable Radio Control box, dialogs will appear prompting you every time you need to key the PTT or release the PTT. If you leave the box unchecked, no dialogs will appear, and the solution will automatically advance from one test to the next without prompts. You should make sure to only

select a group of tests that don't require changing any radio settings when operating in this mode.

Configuring the Test Conditions

After the instruments are initialized, the program will switch to the Test Conditions tab as shown in the following screen shot:
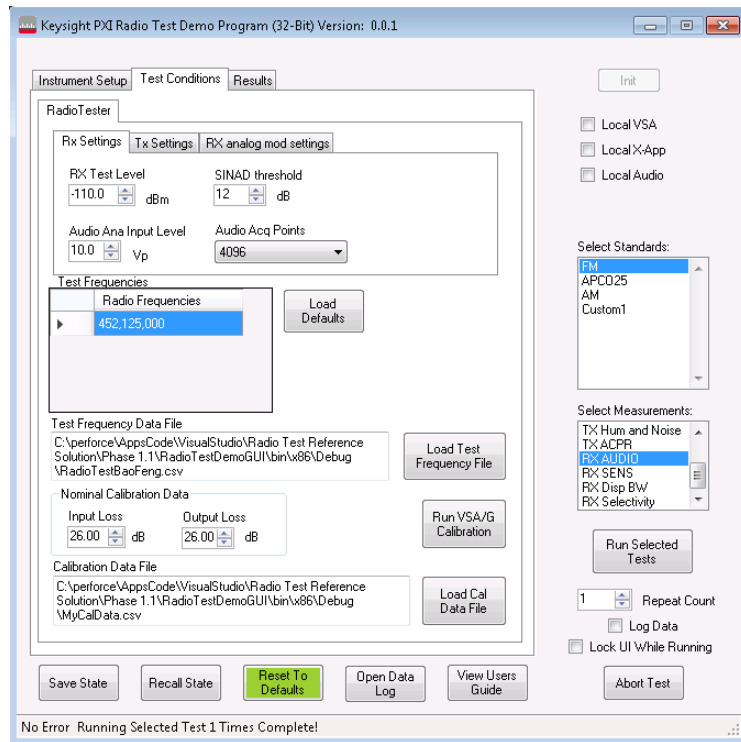
There are Rx and Tx test parameters to be set up for your DUT. The Rx Settings tab contains the general settings for the receiver test:

- RX Test Level – The power level at which to measure audio distortion, and a guide for where to begin making sensitivity-related measurements.
- Audio Ana Input Level – The max peak input voltage expected from the radio's audio output.
- SINAD threshold – The target SINAD for a sensitivity measurement.
- Audio Acq Points – Number of samples to acquire when making audio distortion measurements. More points will increase repeatability, but decrease speed.
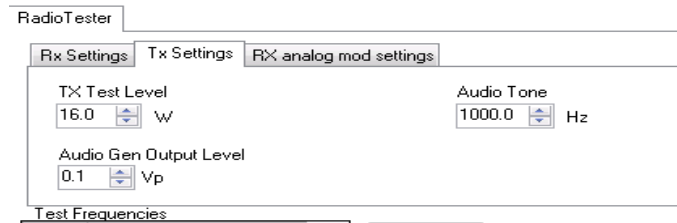
The Tx Settings tab contains the general settings for transmit test:
- TX Test Level – The expected radio output power in Watts.
- Audio Gen Output Level – The audio input drive level in Volts Peak.
- Audio Tone – The audio test frequency to apply to the mic input of the radio.
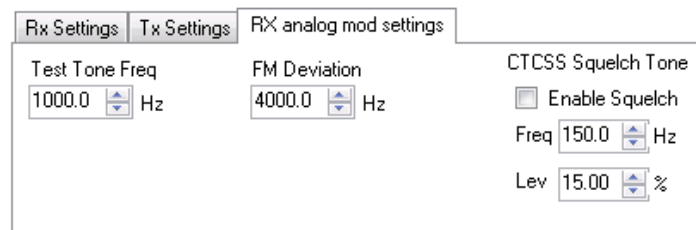
The RX analog mod settings tab contains the settings for FM or AM modulation:
- Test Tone Freq – The FM or AM Rate, which translates to audio test tone freq.
- FM Deviation – self explanatory. AM Depth is currently hard-coded to 50%.
- CTCSS Squelch tone settings. – Whether to enable a sub-audible second tone, its center frequency, and level as a percentage of the main tone level.

The program supports testing one or multiple test frequencies. The frequencies can be loaded from a CSV data file. The user can add any number of frequencies to a file. A sample frequency file is included in the program directory.

Input and output loss data can be specified in two manners. The Nominal Calibration Data values are used at all frequencies. To change these values, change the input and/or output loss. Calibration data can also be read from a CSV file, allowing different calibration values by frequency. When a calibration data file is used, the values will be interpolated so it is not necessary to supply calibration data for each test frequency. A sample calibration data file is also included in demo program directory. The Calibration data can also be calculated with an automated calibration routine that uses a Keysight power meter or USB power sensor. Press the "Run Calibration" button to begin the calibration procedure. There will be prompts during the calibration procedure to connect the power sensor and the input and output cables. When the calibration procedure is complete a CSV data file described above will be generated and loaded, allowing the calibration to be used again at a later time.

Note: The current calibration routine makes two assumptions: 1) The loss from VSG to DUT is identical to the loss from VSA to DUT and 2) The VSA has no amplitude inaccuracy. If these assumptions don't achieve the desired accuracy, the algorithm can be enhanced.

Running Tests

The tests to be run are selected from the "Select Standards" and "Select Measurements" lists. Both lists allow selection of multiple items. The items do not need to be consecutive in the lists. For example, FM and AM can be selected from the standards list and Tx Frequency and TX Harmonics can be selected from the measurement lists.

The program uses both the IVI drivers and the M90xA X-Series App software for measurements with the M9391A and M9393A PXI VSAs. Power, ACPR and Harmonics measurements are performed using the IVI driver. Mod quality measurements for all standards are performed using the X-App software. For M9290A CXA-m analyzer, the X-Series App software is used for all measurements.

When using X-Series App software, the X-Series App display can optionally be shown. If shown, the display will be visible in a separate window. To obtain the best throughput the display should not be visible. The option to select the visibility can be changed at any time that tests are not running.

After selecting the desired values from these lists, the tests are performed by running the "Run Selected Tests" button. After running the tests, the user interface will switch to the test results tab as shown in the following screen shot:

Keysight Y1299A-007 Radio Test Demo Program User Guide
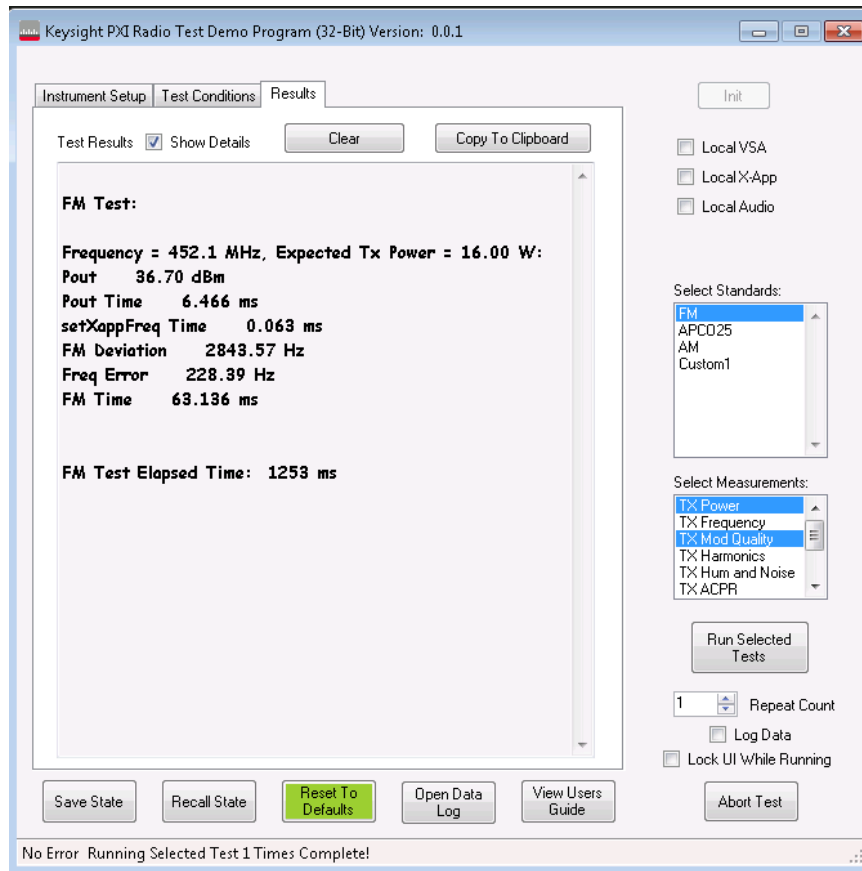
For each test, the test conditions, measured values and test times will be shown in the results display. The total test time for each standard is shown at the end of the results for that standard. Showing the results in the GUI can be omitted by unchecking the Show Details box. This will improve the test time by omitting the occasional test time increases when the GUI thread is writing the results. To further reduce any GUI event handling, check the "Lock GUI While Running" check box.

The Abort Button can be used to terminate the tests. The tests will be terminated at the completion of the current repetition, not immediately after the Abort Button is pressed. The Abort button will not operate when the "Lock GUI While Running" option is selected.

The Repeat Count field and Log Data option can be used to record measurement results and statistical variations of measured values.

To collect measurement repeatability data, set the repeat count to the desired value, and check the Log Data box. The program will generate a CSV file that includes headers, all test results and formulas for statistics. The data files will be C:\Temp. A new file is generated each time the "Run Selected Tests" button is pressed if the log data box is checked. The file names will be logFile[TimeStamp].csv. The most recent data file can be loaded by pressing the "Open Data Log" button. This will launch the default program for .CSV files on the PC. The following screen shot shows the file loaded into Libre Office:


Each column will include the measured values for one measurement at one test condition. Rows 1-3 include the test name, frequency and parameter name. Rows 4-8 include statistics. Each row below row 8 will include the data for one repetition of the measurements. This is useful when comparing measurement and test time results with multiple different setup conditions.

Local Control of Instruments

The RT Demo program allows interactive use of the VSG, VSA, X-Series App software, and audio generator/analyzer. After the selected tests are run, the program will maintain the conditions of the last measurement. To go into local mode, select the Local X-App, Local VSA or Local Audio check box.

When the Local VSA box is checked two windows will be shown. The first window will show the state of the M9381A and allow the displayed settings to be modified. This allows RF parameter settings such as center frequency, ALC state, and amplitude to be changed. It can also be used to generate AM and FM modulation. To load a waveform file from either Signal Studio or Waveform Creator, press the "Load Waveform" button, and navigate to the desired waveform file.

The second window will show the state of the VSA IVI driver, allow settings to be changed and allow measurements to be performed in the each of the acquisition modes. Note: If the M9290A analyzer is used, there is no IVI driver, and only the Local X-app can be used for local control. The tabbed area of the PXI VSA software front panel (SFP) will automatically change to the selected acquisition mode. The following screen shots show the two windows:
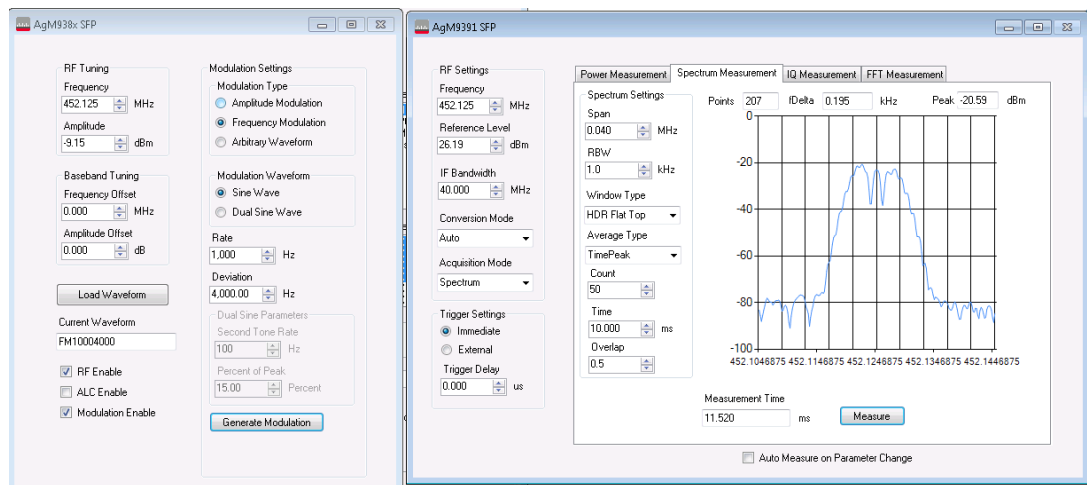

While local mode is enabled, the Run Selected Tests button is disabled. To end local control, uncheck the Local VSA box.

When the Local X-App box is checked, the PXI VSG display will be shown as above and the X-App display will be shown and the X-Series App will be put in continuous sweep mode, as shown in the following screen shot.
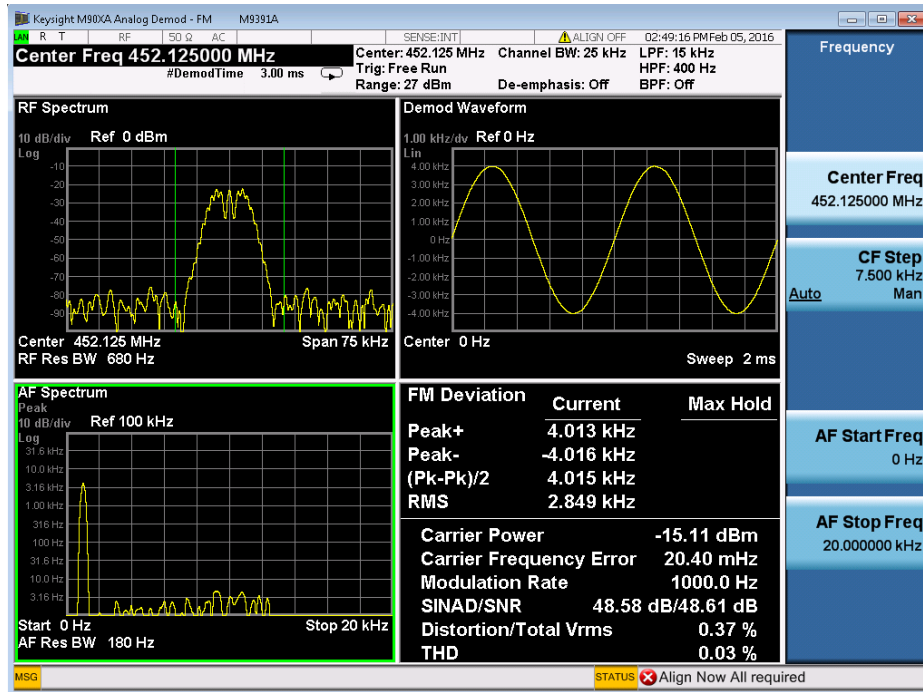
While local mode is enabled, the Run Selected Tests button is disabled. To end local control, uncheck the Local X-App box.

When the Local Audio box is checked, the Audio generator/analyzer can be controlled via the Audio Display. Again, while local mode is enabled, the Run Selected Tests button will be disabled. To end local control, uncheck the Local Audio box.
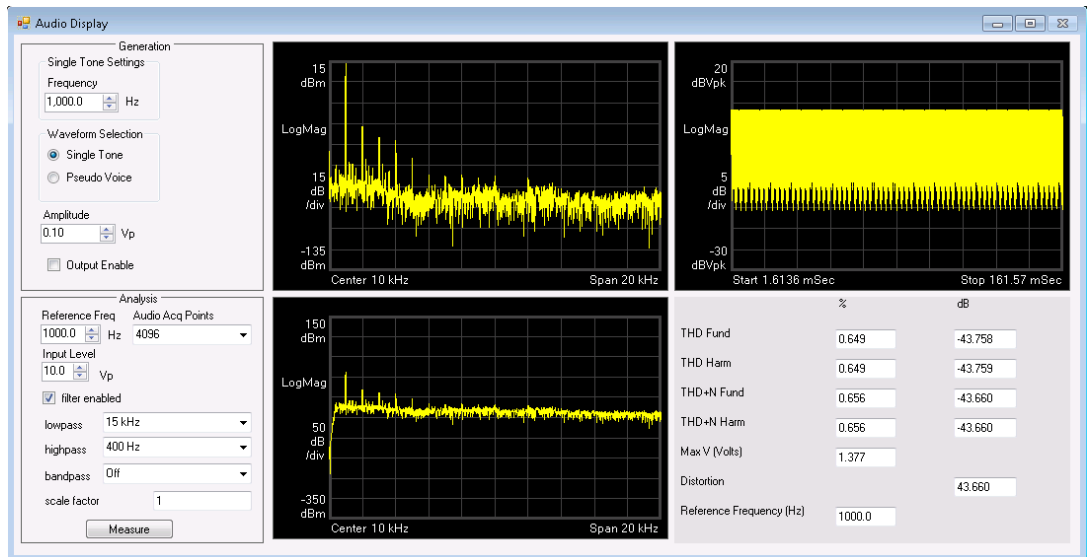
Appendix 1: M9290A CXA-m VSA

Introduction

The Phase 1 Radio Test Reference Solution supports M9381A VSG, ADLINK PXI-9527 Audio card, and 3 different PXI VSAs: M9391A, M9393A, and M9290A (CXA-m). This document will describe how to set up the system for use with the M9290A.

The M9391A and M9393A share a similar programming API. The IVI driver is used for fast power and harmonics measurements, and the X-Apps are used for demodulation, with a Resource Manager to switch between the Xapps and IVI driver. The Xapps are launched programmatically via the demo program. An IVI Configuration Store entry is created for the M9391A or M9393A using the soft front panel (SFP), and this is automatically detected by the demo program and displayed on the Instrument Setup tab in the VSA Resource String dropdown box. It is not necessary to have the M9391A or M9393A running prior to pressing the Init button.
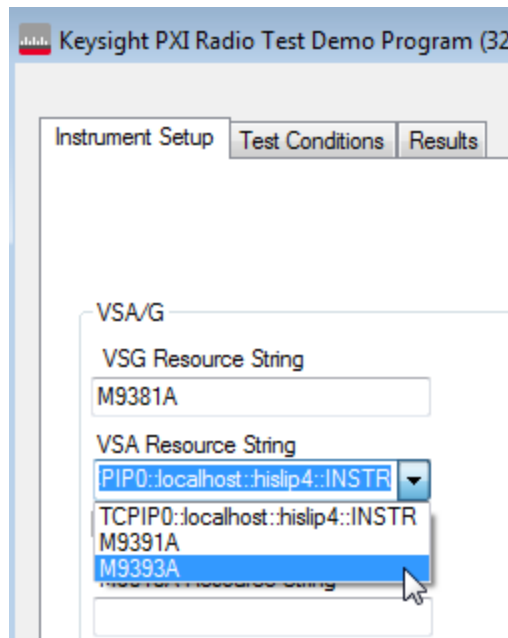
The M9290A does not have an IVI driver, and is used entirely via the X-series measurement applications. The application software must be launched first, prior to initializing the hardware. When the Radio Test Demo program is launched, it looks for a HiSLIP port connected to X-series measurement software for an M9290A, and automatically includes this in the list of VSA Resource strings. When the Init button is pressed, the software connects to the already running M9290A software.
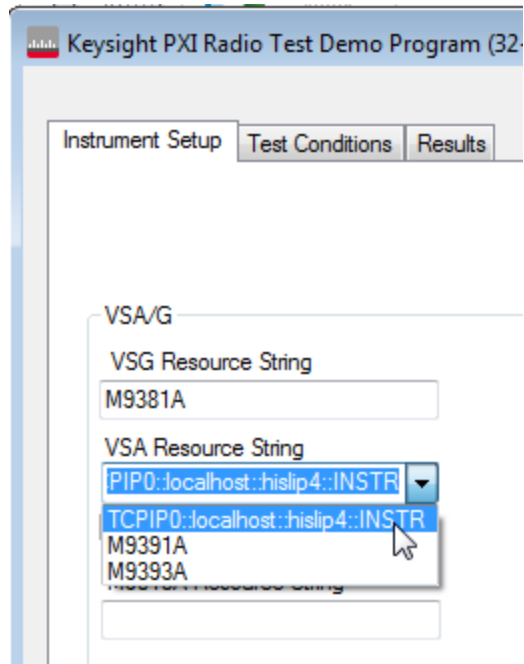
Setting up the M9290A

After installing the M9290A hardware and software, it is recommended to perform several steps to make it easier and faster to launch the software:

1. Run the Keysight Modular Transceiver "Configure Applications" program to choose the applications that load when the M9290A is started. Choose only the ones that are needed, as it will speed startup:
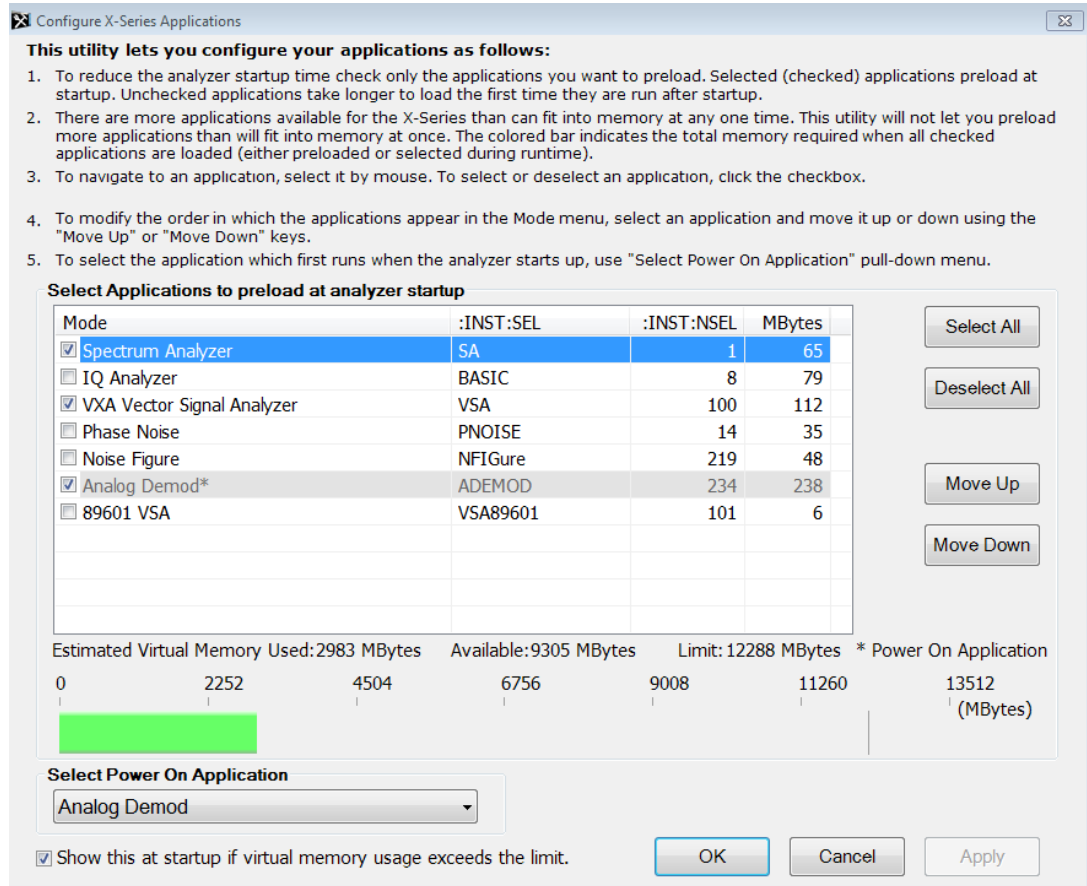
2. By default, an application called "LaunchModularTRX" is added to the Programs menu. This application will let you choose from installed M9290A modules, but requires manual interaction. You should run this the first time, and click on the "Show Advanced Settings" button. Then change the launch type to "Auto" for your M9290A. You can also set the hislip port number here.
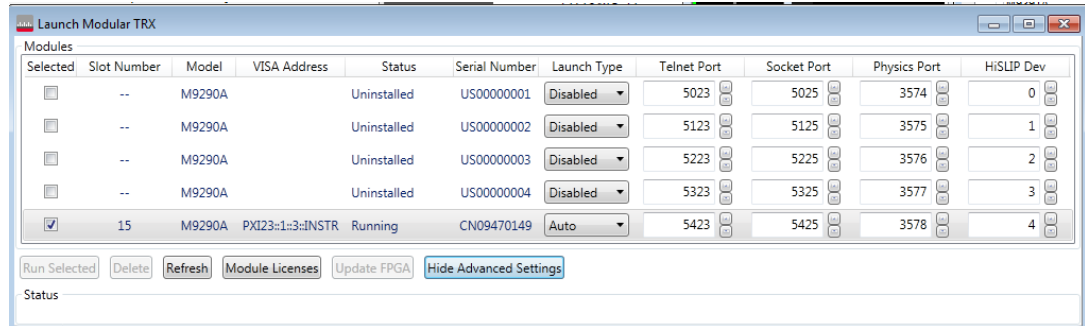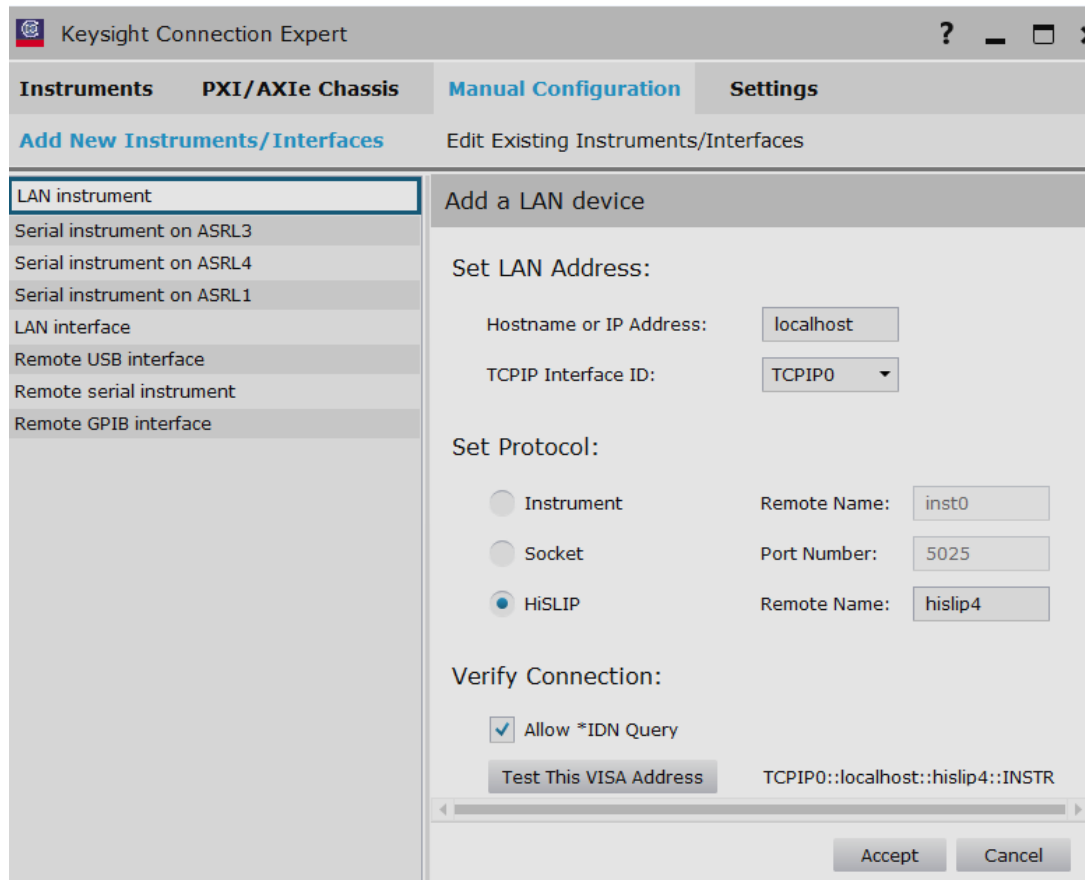
3. Now, create a shortcut to this program, which is not included in the Programs/Start menu:

C:\Program Files\Agilent\SignalAnalysis\Infrastructure\LaunchXSA.exe

This will automatically start the M9290A set to Auto in the previous step.

4. Before running the Radio Test Demo program, run this Launch XSA program to start the M9290A software.

5. Add the CXAm HiSlip address to IOLibs. This will enable the demo program to discover it.

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