Keysight VXT PXIe Vector Transceiver

This manual provides documentation for:

Keysight M9420A VXT Vector Transceiver

Keysight M9421A VXT Vector Transceiver

KEYSIGHT TECHNOLOGIES

Programmer's Guide

Notices

Trademark Acknowledgments

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Where to Find the Latest Information

Documentation is updated periodically. For the latest information about these products, including instrument software upgrades, application information, and product information, browse to one of the following URLs, according to the name of your product:

http://www.keysight.com/find/m9420a

http://www.keysight.com/find/m9421a

To receive the latest updates by email, subscribe to Keysight Email Updates at the following URL:

http://www.keysight.com/find/emailupdates

Information on preventing instrument damage can be found at:

http://www.keysight.com/find/PreventingInstrumentRepair

Is your product software up-to-date?

Periodically, Keysight releases software updates to fix known defects and incorporate product enhancements. To search for software updates for your product, go to the Keysight Technical Support website at:

http://www.keysight.com/find/techsupport

Contents

1 Start Programming with IVI Driver

This programmer's guide is intended for individuals who write and run programs to control test-and-measurement instruments. Specifically, in this programmer's guide, you will learn how to use Visual Studio 2010 with the .NET Framework to write IVICOM Console Applications in Visual C#. Knowledge of Visual Studio 2010 with the .NET Framework and knowledge of the programming syntax for Visual C# is required.

KEYSIGHT TECHNOLOGIES

What You Will Learn In This Guide

Our basic user programming model uses the IVI-COM driver directly and allows customer code to:

- Access the IVI-COM driver at the lowest level
- Access IQ Acquisition Mode, Power Acquisition Mode, and Spectrum Acquisition Mode
- Control the Keysight M9420A/M9421A VXT Vector Transceiver while performing measurements
- Generate waveforms created by Signal Studio software (licenses are required)

This guide provides the example programs below for your further use with the VXT transceiver:

- Example Program 1: CW Signal Power Test
- Example Program 2: Source - Play Waveform
- Example Program 3: CW Spectrum UI
- Example Program 4: Channel Power Acquisition
- Example Program 5: Spectrum Acquisition
- Example Program 6: FFT Acquisition
- Example Program 7: IQ Acquisition
- Example Program 8: Power Servo
- Example Program 9: Harmonics Test
- Example Program 10: ACPR Test
- Example Program 11: Combined Power Servo and ACPR Measurement

Related Website

- Keysight PXIe and AXIe Modular Products
- Keysight IVI Drivers & Components Downloads
- Keysight I/O Libraries Suite
- Keysight GPIB, USB, & Instrument Control Products
- Keysight VEE Pro
- Keysight Technical Support, Manuals, & Downloads
- Contact Keysight
- IVI Foundation
- MSDN Online

Related Documentation

To access documentation related to the Keysight M9420A/M9421A VXT Vector Transceiver Programmer's Guide, use one of the following methods:

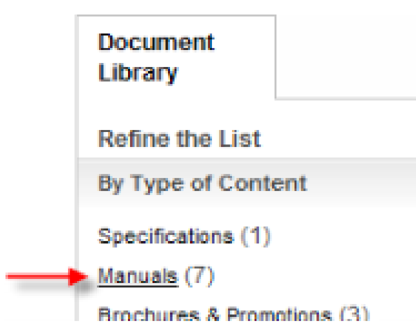
- If the product software is installed on your PC, the related documents are also available in the software installation directory.

Table 1-1 Related Documentation

Document	Description	Format
Getting Started Guide	Includes procedures to help you to unpack, inspect, install (software and hardware), perform instrument connections, and troubleshoot your product.	PDF
IVI Driver Reference (Help System)	Provides detailed documentation of the IVI-COM and IVI-C driver API functions, as well as information to help you get started with using the IVI drivers in your application development environment.	CHM (Microsoft Help Format)
X-series Applications Programmer’s Guide	Provides basic description about how to program VXT using SCPI commands, and explains how to use the programming documentation.	PDF
User’s and Programmer’s Reference	Describes the SCPI commands supported by the VXT	CHM (Microsoft Help Format)

- The documentation listed above is also available on the product DVD.
- To find the very latest versions of the user documentation, go to the product website (www.keysight.com/find/vxt) and download the files from the Manual support page (go to Resource Center > Document Library > Manuals):

Figure 1-1 Document Library Screenshootl



Overall Process Flow

Perform the following steps:

1. Write source code using Microsoft Visual Studio 2010 with .NET Visual C# running on Windows 7.
2. Compile source code using the .NET Framework Library.
3. Produce an Assembly.exe file – this file can run directly from Microsoft Windows without the need for any other programs.
   - When using the Visual Studio Integrated Development Environment (IDE), the Console Applications you write are stored in conceptual containers called Solutions and Projects.
   - You can view and access Solution and Projects using the Solution Explorer window (View > Solution Explorer).

Preparation Before Programming

If you want to program VXT module to perform measurement, you need to have the following hardwares and softwares:

1. VXT M9420A/M9421A modular
2. Chassis (such as Keysight M9018A)
3. Controller (such as Keysight M9037A)
4. Reference (such as Keysight M9300A)
5. VXT software
6. M9300A software
7. IO Libraries Suite (Keysight Connection Expert)
8. Visual Studio (C# or C++ etc) /Labview

Hardware Installation

You need install all the needed modulars into the chassis as first step of the whole configuration.

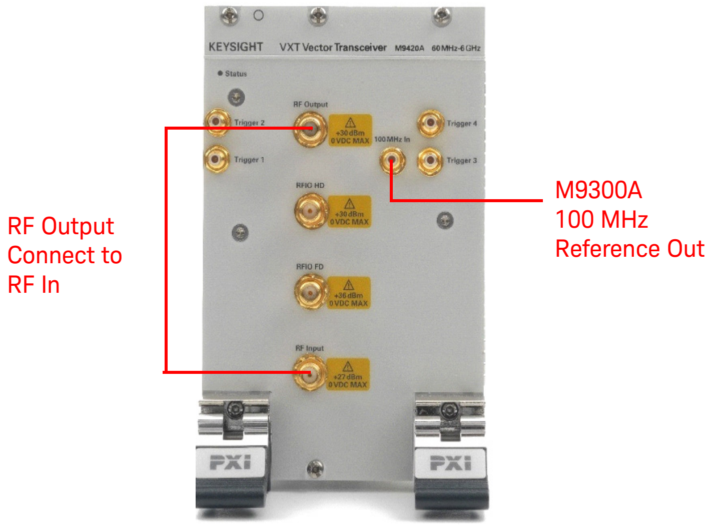
1. Unpack and inspect all hardware.
2. Verify the shipment contents.
3. Install the modules and make cable connections. For detailed procedures, please refer to VXT Getting Started Guide.

M9037A Controller

M9420A/M9421A VXT

M9300A Reference

4. Connect RF Output and RF Input port of VXT with a SMA cable.
5. Connect VXT 100M In port and M9300A 100M Out port.



Software Installation

You need install the following softwares before programming with VXT:

1. Install Microsoft Visual Studio with .NET Visual C# running on Windows 7.
2. Install Keysight IO Libraries Suite, this installation includes Keysight Connection Expert.
3. Install the VXT software, Version 16.57 or newer. Driver software includes all IVI-COM and IVI-C Drivers and documentation. All of these items may be downloaded from the Keysight VXT product website.
4. Install the VXT licenses, if you purchased. Please refer to VXT Getting Started Guide for further information.
5. Install the M9300A software. Please refer to M9300A Startup Guide for further information.

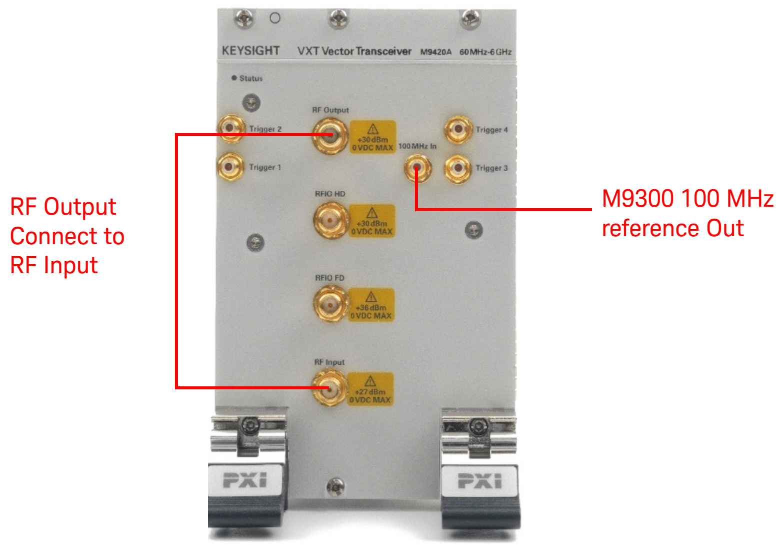
   The M9300A PXIe Reference must be included as part of the M9420A configurations. The M9300A PXIe Reference must be initialized first so that the other configurations that depend on the reference signal get the signal they are expecting. If the configuration of modules that is initialized first does not include the M9300A PXIe Reference, unlock errors will occur.

   Once the software and hardware are installed and Self-Test has been performed, they are ready to be programmatically controlled.

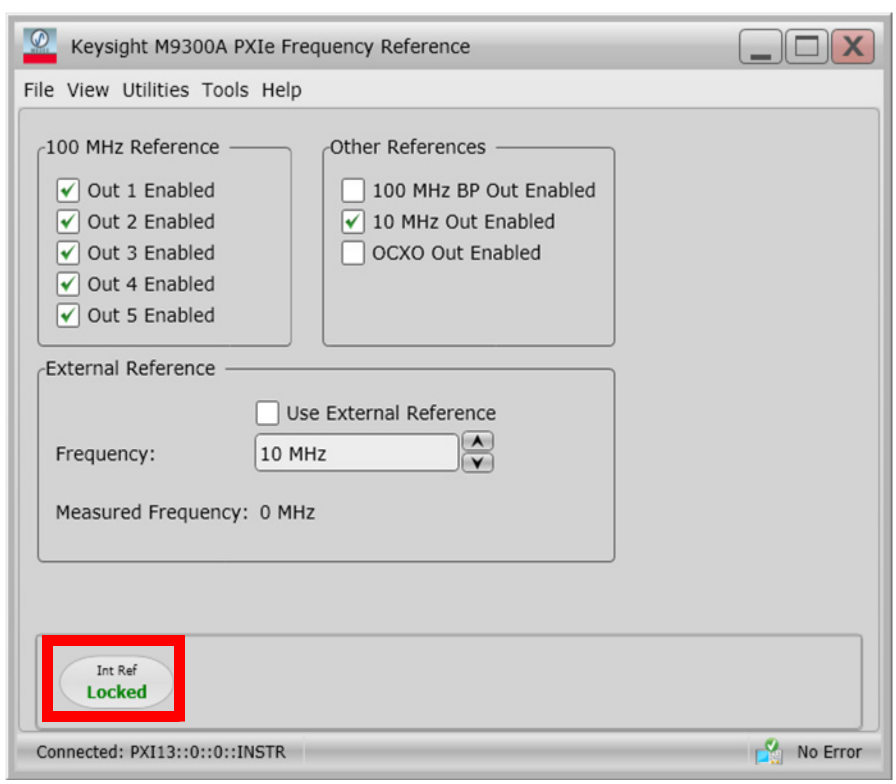
Function Verification

To make sure all the hardwares and softwares are ready for your programming, please perform the following steps to generate a CW signal with VXT:

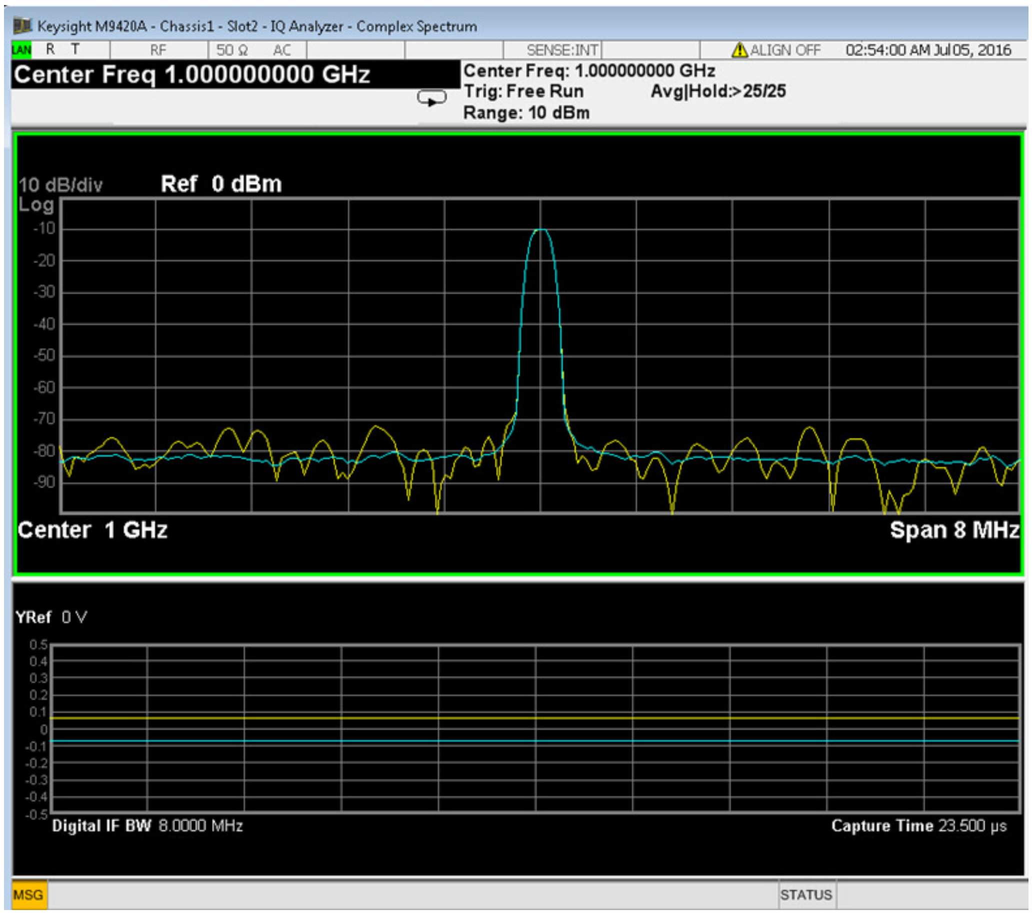
1. Connect VXT RF Output and RF Input with a SMA cable.



2. Power on the chassis and run M9300A software. The software window will be pop up as below. The icon "Int Ref Locked" on the lower left corner indicates the software runs properly.



3. Run VXT software by click *LaunchModularTRX.exe*. Please refer to *VXT Getting Started Guide* for the detailed procedure.
4. Set VXT source to generate a CW signal and use VXT receiver to observe this signal.
   1. Press Source > Amplitude > RF Power > - 20 dBm to set the signal amplitude to -20 dBm
   2. Press Return > Frequency > 1 GHz to set the signal frequency to 1 GHz.
   3. Press RF Output to turn on the source output
   4. Press FREQ Channel > Center Freq > 1 GHz to set the receiver center frequency to 1 GHz.



If you observe the CW signal as figure above, it indicates the VXT is ready for your programming, VXT supports multiple programming platform, such as Visual C#, Visual Basic .Net, Visual C++, Keysight VEE pro, Labview and MATLAB. In this guide, all the programming examples are programmed with Visual C#.

2 APIs Introduction

This chapter describes the Application Programming Interfaces (APIs) for the Keysight VXT vector transceiver.

The following IVI driver terminology may be used when describing the Application Programming Interfaces (APIs) for the VXT Vector Transceiver.

IVI[Interchangeable Virtual Instruments] - a standard instrument driver model defined by the IVI Foundation that enables engineers to exchange instruments made by different manufacturers without rewriting their code.

Currently, there are 13 IVI Instrument Classes defined by the IVI Foundation. The VXT Vector Transceiver do not belong to any of these 13 IVI Instrument Classes and are therefore described as "NoClass" modules.

- DC Power Supply
- AC Power Supply
- DMM
- Function Generator
- Oscilloscope
- Power Meter
- RF Signal Generator
- Spectrum Analyzer
- Upconverter
- Downconverter
- Digitizer
- Counter/Timer

IVI Compliant or IVI Class Compliant

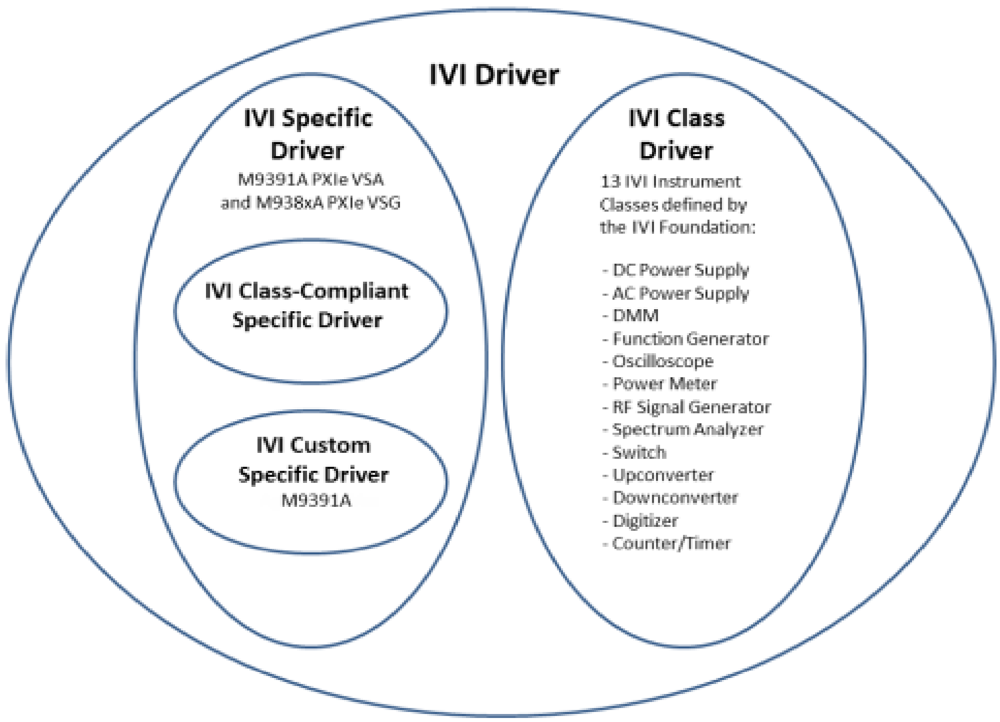
The VXT Vector Transceiver is IVI Compliant, but not IVI Class Compliant; none of these belongs to one of the 13 IVI Instrument Classes defined by the IVI Foundation.

- IVI Compliant - means that the IVI driver follows architectural specification for these categories:
  - If an instrument is IVI Class Compliant, it is also IVI compliant
  - Provides one of the 13 IVI Instrument Class APIs is in addtion to a Custom API
  - Custom API may be omitted (unusual)
  - Simplifies exchanging instruments
- IVI Compliant - means that the IVI driver follows architectural specification for these categories:
  - If an instrument is IVI Class Compliant, it is also IVI compliant
  - Provides one of the 13 IVI Instrument Class APIs is in addtion to a Custom API
  - Custom API may be omitted (unusual)
  - Simplifies exchanging instruments

IVI Driver Types

There are several types of IVI drivers as listed below:

Figure 2-1 *IVI Driver Types*



- IVI Driver
  - Implements the Inherent Capabilities Specification
  - Complies with all of the architecture specifications
  - May or may not comply with one of the 13 IVI Instrument Classes
  - Is either an IVI Specific Driver or an IVI Class Driver
- IVI Class Driver
  - Is an IVI Driver needed only for interchangeability in IVI-C environments
  - The IVI Class may be IVI-defined or customer-defined
- IVI Specific Driver
  - Is an IVI Driver needed only for interchangeability in IVI-C environments
  - The IVI Class may be IVI-defined or customer-defined
- IVI Class-Compliant Specific Driver
  - IVI Specific Driver that complies with one (or more) of the IVI defined class specifications
  - Used when hardware independence is desired

- IVI Custom Specific Driver
  - Is an IVI Specific Driver that is not compliant with any one of the 13 IVI defined class specifications
  - Used when hardware independence is desired

NOTE

This release is not binary compatible with prior releases of the IVI-Cdriver. Programs using the C/C++ IVI-C driver must be recompiled for this version of the driver. Similarly, programs compiled with this version of the driver will not be compatible with older versions of the IVI-C driver. This incompatibility is due to renumbering of attribute constants defined in the KtM9420.h include file.

IVI Driver Hierarchy

When writing programs, you will be using the interfaces (APIs) available to the IVICOM driver.

- The core of every IVI-COM driver is a single object with many interfaces.
- These interfaces are organized into two hierarchies: Class-Compliant Hierarchy and Instrument-Specific Hierarchy – and both include the IIviDriver interfaces.
  - Class-Compliant Hierarchy - Since the VXT Vector Transceiver does not belong to one of the 13 IVI Classes, there is noClass-Compliant Hierarchy in their IVI Driver.
  - Instrument-Specific Hierarchy
    - The VXT Vector Transceiver's instrument-specific hierarchy has IKtM9420 at the root (where KtM9420 is the driver name).
      - IKtM9420 is the root interface and contains references to child interface, which in turn contain references to other child interfaces. Collectively, these interfaces define the Instrument-Specific Hierarchy.
  - The IIviDriver interfaces are incorporated into both hierarchies: Class-Compliant Hierarchy and Instrument-Specific Hierarchy.

    The IIviDriver is the root interface for IVI Inherent Capabilities which are what the IVI Foundation has established ass a set of functions and attributes that all IVI drivers must include - irrespective of which IVI instrument class the driver supports. These common functions and attributes are called IVI inherent capabilities and they are documented in IVI-3.2 -Inherent Capabilities Specification. Drivers that do not support any IVI instrument class such as the VXT Vector Transceiver must still include these IVI inherent capabilities.

    Close

    DriverOperation

    Identity

    Initialize

    Initialized

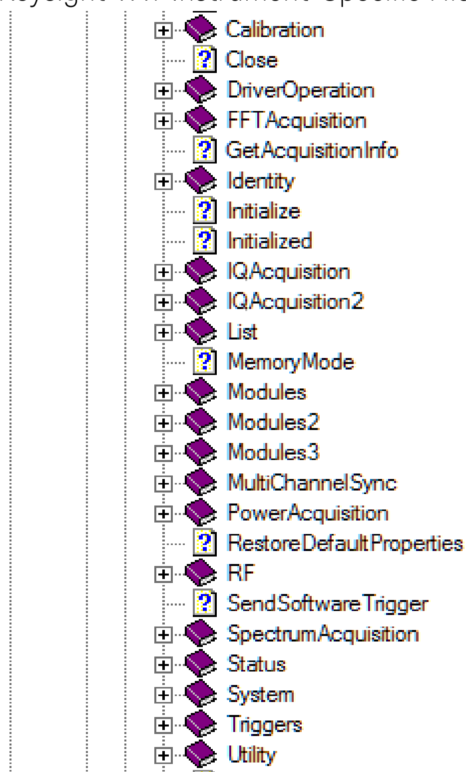
    Utility

Instrument-Specific Hierarchies for VXT

The following table lists the instrument-specific hierarchy interfaces for M9420A/M9421A VXT Vector Transceiver.

Keysight VXT Instrument-Specific Hierarchy
KtM9420 is the driver name
IKtM9420Ex is the root interface

Figure 2-2 Keysight VXT Instrument-Specific Hierarchy



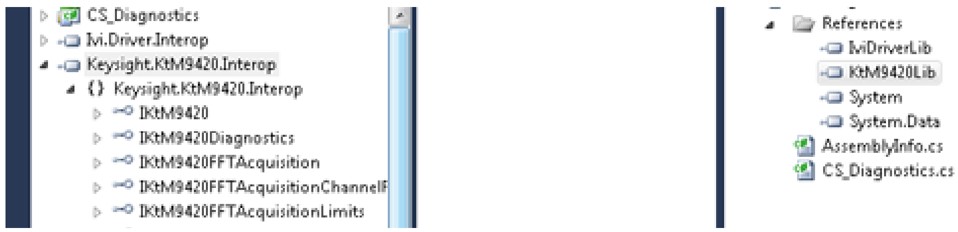
NOTE

All new code being created should use the IKtM9420Ex extended interfaces in place of the IKtM9420 interfaces. New functionalities have been added to the IKtM9420Ex extended interfaces. These new functionalities were not available in the original IKtM9420 interfaces, and have been left unchanged to support previously written code; this helps support backward code compatibility.

When Using Visual Studio

To view interfaces available in VXT, right-click KtM9420Lib library file, in the References folder, from the Solution Explorer window and select View in Object Browser.

Figure 2-3 Keysight VXT Instrument-Specific Hierarchy



Naming Conventions Used to Program IVI Drivers

General IVI Naming Conventions

- All instrument class names start with "IVi"

  Example: IviScope, IviDmm

- Function names

  One or more words use PascalCasing

  First word should be a verb

IVI-COM Naming Conventions

- Interface naming

  Class compliant: Starts with "IIvi"

  I<ClassNaming>

  Example:IIviScope, IIviDmm

- Sub-interfaces add words to the base name that match the C hierarchy as close as possible

  Example: IIviFgenArbitrary, IIviFgenArbitraryWaveform

- Defined values

  Enumerations and enum values are used to represent discrete values in IVI-COM

  <ClassName><descriptive words> Enum

  Example: IviScopeTriggerCouplingEnum

- Enum values don’t end in "Enum" but use the last word to differentiate

  Example: IviScopeTriggerCouplingAC AND IviScopeTriggercouplingDC

3 Creating a Project with IVI-COM Using C-Sharp

What you will learn in this chapter

This tutorial will walk through the various examples to create a console applications using Visual Studio and C#. It demonstrates how to instantiate driver instance, set the resource names and various initialization values, initialize the driver instance, print various driver properties to a console for each driver instance, check drivers for errors and report the errors if any occur, and close both drivers.

The project examples are listed below.

1. CW Signal Power Test
2. Source - Play Waveform
3. CW Spectrum UI
4. Channel Power Acquisition
5. Spectrum Acquisition
6. FFT Acquisition
7. IQ Acquisition
8. Power Servo
9. Harmonics Test
10. ACPR Test
11. Combined Power Servo and ACPR Measurement

All the example programs above are in the folder below after the VXT software is installed.

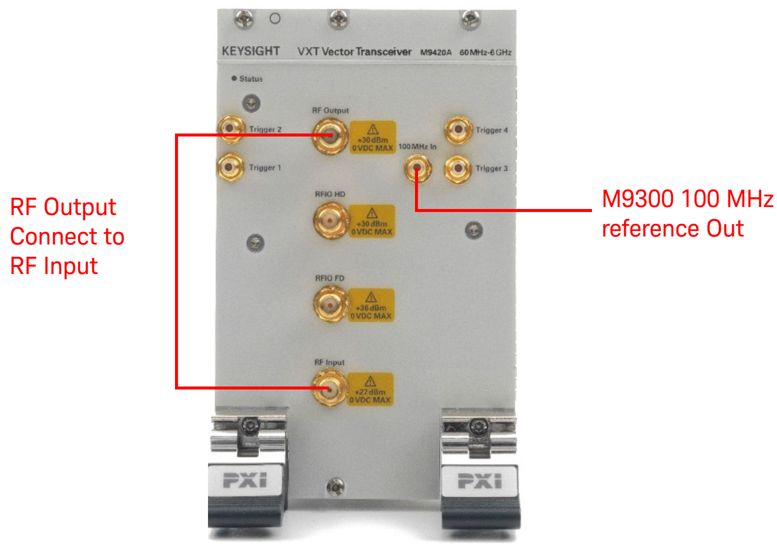
C:\Program Files (x86)\IVI Foundation\IVI\Drivers\KtM9420\Examples\VS.Net\Cpp

Example 1: CW Signal Power Test

This example introduces the programming procedure to perform a CW signal power test as below with VXT using Visual Studio and C#.

- VXT source outputs a 1 GHz CW signal
- VXT receiver measures this signal power

Figure 3-1 VXT CW Signal Power Test Cable Connection



NOTE Before programming, please connect VXT RF Output to RF Input port and VXT 100 MHz Ref In port to M9300A's 100 MHz Ref Out port.

The programming procedure are listed as 8 steps as below:

Step 1. - Create a "Console Application"

Step 2. - Add References

Step 3. - Add Using Statements

Step 4. - Create an Instance

Step 5. - Initialize the Instance

Step 6. - Write the Program (Create a Signal or Perform a Measurement)

Step 7. - Close the Instance

Step 8. - Build and Run the Program

After the VXT software is installed, you will find the source code as below:

C:\Program Files (x86)\IVI Foundation\IVI\Drivers\KtM9420\Examples\VS.Net\CSharp\CS_CWPowerTest.

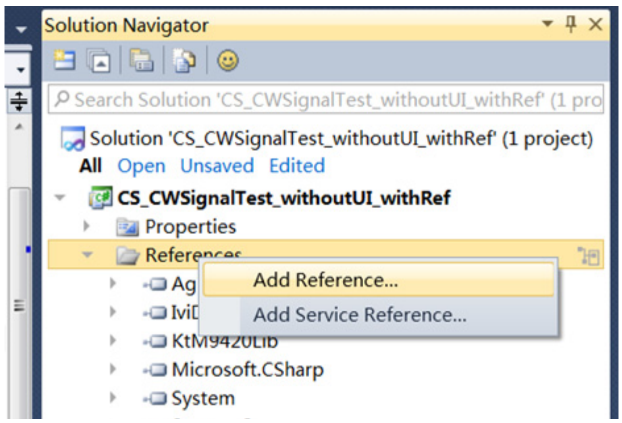
Step 1 – Create a Console Application

1. Launch Visual Studio and create a new Console Application in Visual C# by selecting: **File** > **New** > **Project** and select a Visual C# Console Application.
2. Enter **"CWPowerTest"** as the Name of the project and click OK.

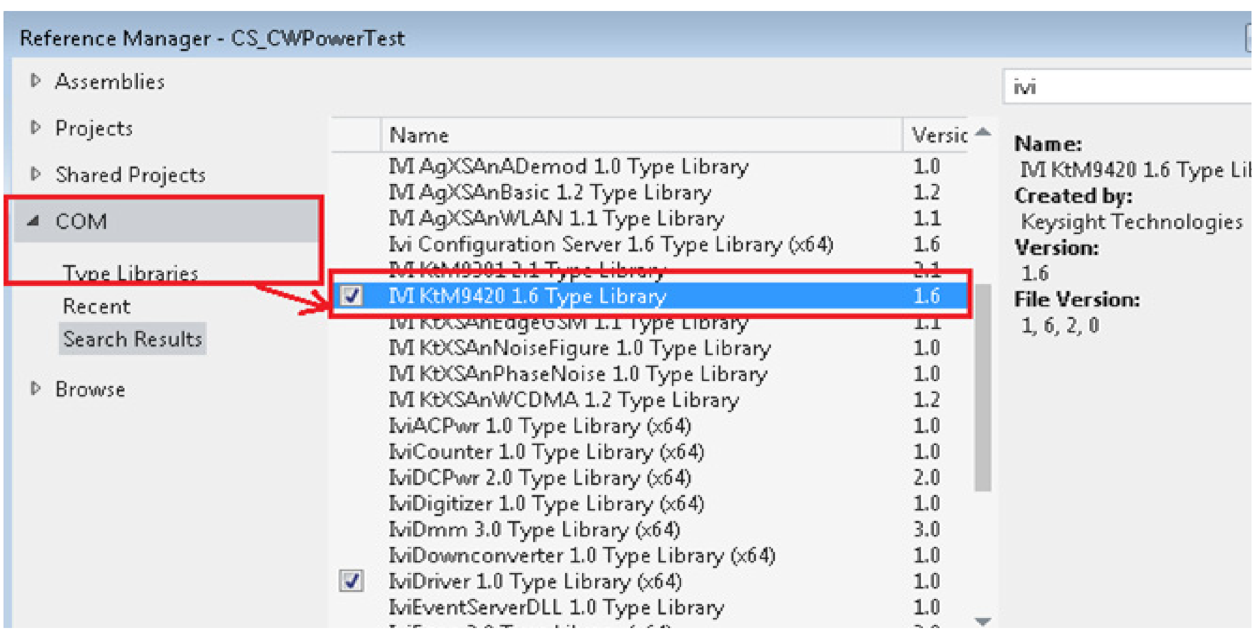
Step 2 – Add References

In order to access the VXT driver interfaces, references to their drivers (DLL) must be created.

1. In Solution Explorer, right-click on References and select Add Reference.



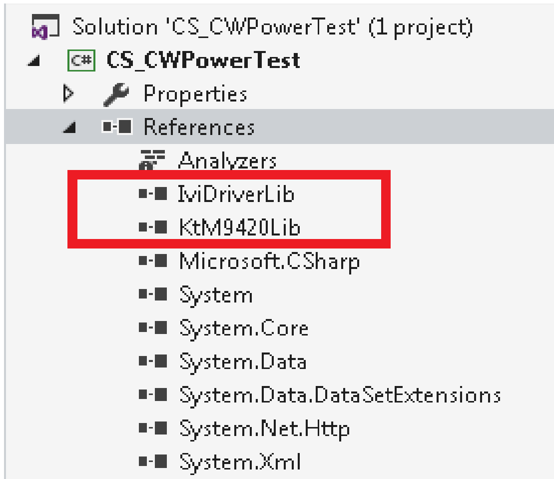
2. From the Add Reference dialog, select the COM tab to find VXT's library.



NOTE

If you have not installed the IVI driver for the VXT product (as listed in chapter 1, titled "Before Programming, Install Hardware, Software, and Software Licenses"), the IVI drivers will not appear in this list.

3. Select IVI KtM9420 1.6 Type Library and Click OK. The selected type libraries appear under the Reference node, in Solution Explorer, as:



NOTE

When any of the references for the KtM9420A are added, the IVIDriver 1.0 Type Library is also automatically added. This is visible as IviDriverLib under the project Reference; this reference houses the interface definitions for IVI inherent capabilities which are located in the file IviDriverTypeLib.dll (dynamically linked library).

Now the IVI drivers are referenced and available for your use.

Step 3 - Add Using Statements

To allow your program to access the IVI drivers without specifying full path names of each interface or enum, you need to add using statements to your program.

All data types (interfaces and enums) are contained within namespaces. (A namespace is a hierarchical naming scheme for grouping types into logical categories of related functionality. Design tools, such as Visual Studio, can use namespaces which makes it easier to browse and reference types in your code.)The C# using statement allows the type name to be used directly. Without the using statement, the complete namespace-qualified name must be used. To allow your program to access the IVI driver without having to type the full path of each interface or enum, type the following using statements immediately below the other using statements.

```
#region Specify using Directives
    using System;
    using Keysight.KtM9420.Interop;
#endregion
```

Step 4 - Create Instances of the IVI-COM Drivers

There are two ways to instantiate (create an instance of) the IVI-COM drivers:

- Direct Instantiation
- COM Session Factory

Since the VXT vector transceiver is considered NoClass module (because they do not belong to one of the 13 IVI Classes), the COM Session Factory is not used to create instances of their IVI-COM drivers. So, VXT vector transceiver IVI-COM driver uses direct instantiation. Because direct instantiation is used, their IVI-COM drivers may not be interchangeable with other modules.

To create driver instances, the new operator is used in C# as below.

```
IKtM9420 Driver = new KtM9420();
```

Step 5 - Initialize the Driver Instances

The `Initialize()` method is required when using any IVI driver. It establishes a communication link (an "I/O session") with an instrument and it must be called before the program can do anything with an instrument or work in simulation mode.

The `Initialize()` method has a number of options that can be defined. In this example, we prepare the `Initialize()` method by defining only a few of the parameters, then we call the `Initialize()` method with the parameters below.

To initialize the driver instances, the example code below is used in C#.

```
string options = "QueryInstrStatus=true, Simulate=false,
DriverSetup= AppStart = false";

driver.Initialize("PXI0::CHASSIS1::SLOT2::FUNC0::INSTR", true,
true, options);
```

Initialize() Parameters.

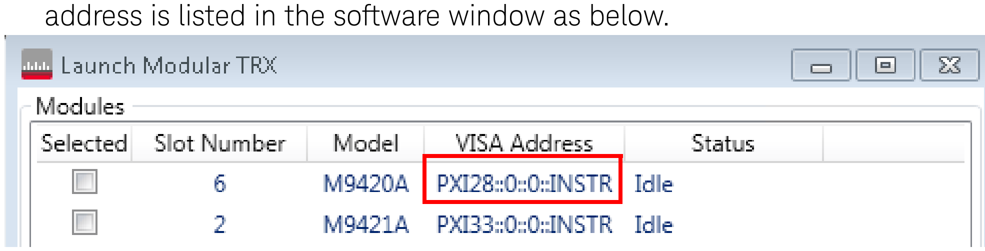
The following tables describes options that are most commonly used with the `Initialize(VXTResourceName, IdQuery, Reset, VXTOptionString)` method.

Property Type and Example Value	Description of Property
string ResourceName = "PXI13::0::0::INSTR";	VxtResourceName – The driver is typically initialized using a physical resource name descriptor, often a VISA resource descriptor. See the procedure in the Resource Names section in the next page.
bool IdQuery = true;	Setting the ID query to false prevents the driver from verifying that the connected instrument is the one the driver was written for because if IdQuery is set to true, this will query the instrument model and fail initialization if the model is not supported by the driver.
bool Reset = true;	Setting Reset to true instructs the driver to initially reset the instrument.
string OptionString = "QueryInstrStatus=true,	OptionString - Setup the following initialization options:
Simulate=true,	· QueryInstrStatus=true (Specifies whether the IVI specific driver queries the instrumetn status at the end of each user operation.) · Simulate=true (Setting Simulate to true instructs the driver to not to attempt to connect to a physical instrument, but use a simulation of the instrument instead.) · Cache=false (Specifies whether or not to cache the value of properties.) · InterchangeCheck=false (Specifies whether the IVI specific driver performs interchangeability checking.) · RangeCheck=false (Specifies whether the IVI specific driver validates attribute values and function parameters.) · RecordCoercions=false (Specifies whether the IVI specific driver keeps a list of the value coercions it makes for ViInt32 and ViReal64 attributes.)
DriverSetup=";	· DriverSetup= (This is used to specify settings that are supported by the driver, but not defined by IVI. If the Options String parameter (OptionString in this example) contains an assignment for the Driver Setup attribute, the Initialize function assumes that everything following 'DriverSetup=' is part of the assignment.)

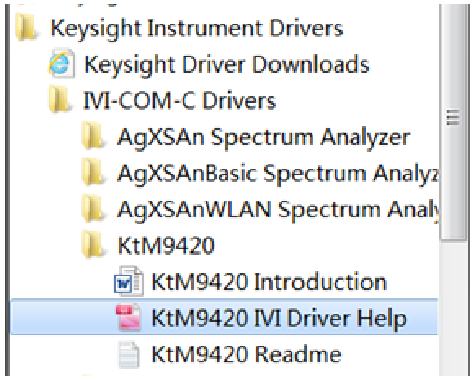
Resource Names

You need to determine the Resource Name address string (VISA address string) that is needed.

- Run VXT software (*LaunchModularTRX.exe*). The VXT modular' VISA address is listed in the software window as below.



Please refer to VXT IVI Driver *Help* (**Start** > **All programs** > **Keysight Instrument Drivers** > **IVI-COM-C Drivers** > **KtM9420** > **KtM9420x IVI Driver Help**) as below for further information.



Step 6 - Write the Program

At this point, you can add program steps that use the driver instances to perform tasks.In this example, perform the following steps:

1. Set VXT source to generate a -10 dBm CW signal at 1 GHz.
2. Set VXT receiver to measure the power of the CW signal.

Set the VXT Source

To set the VXT source to generate a -10 dBm CW signal at 1 GHz, please refer to the example code as below:

```
driver.Source.RF.Frequency = 1e9;
//Set the source's center frequency.
driver.Source.RF.Level = -10;
//Set the source's RF power level.
driver.Source.RF.OutputPort = KtM9420PortEnum.KtM9420PortRFOutput;
//Select the source output port
driver.Source.RF.OutputEnable = true;
//Enable output.
driver.Apply();
//Apply the above setting to VXT source's hardware.
```

For more APIs about VXT source frequency settings, please refer to the VXT IVI driver help as below.

Set the VXT Receiver

To measure the channel power in a bandwidth, please refer to the example code below:

```
driver.Receiver.RF.Frequency = 1e9; //Set Receiver's Center Freq
driver.Receiver.RF.Power = -5;
//the Receiver.RF.Power should be set equal to or little bigger than target
test value, to get exact test result
driver.Receiver.RF.PeakerToAverage = 3;
//Set Receiver's Peak to Average value. It's a important setting for digital
modulation signal test.

driver.AcquisitionMode =
KtM9420AcquisitionModeEnum.KtM9420AcquisitionModePower;//Choose Power
Acquisition Mode.
driver.PowerAcquisition.Bandwidth = 1e6;
driver.PowerAcquisition.Duration = 0.02;
driver.PowerAcquisition.ChannelFilter.Shape =
KtM9420ChannelFilterShapeEnum.KtM9420ChannelFilterShapeNone;
driver.PowerAcquisition.ChannelFilter.Alpha = 0.5;
driver.PowerAcquisition.ChannelFilter.Bandwidth = 1e5;//Set the channel
bandwidth.

driver.Apply();//Apply the above setting to VXT receiver's hardware.
driver.Arm();//Start the M9420A's receiver's measurement

driver.PowerAcquisition.ReadPower(CAPTURE_ID, ref power, ref overloaded);
//Read the power measurement result.
```

For more example codes of frequently used measurement cases, please refer to the other examples introduced in this chapter.

Step 7 - Close the Driver

Calling `Close()` at the end of the program is required by the IVI specification when using any IVI driver.

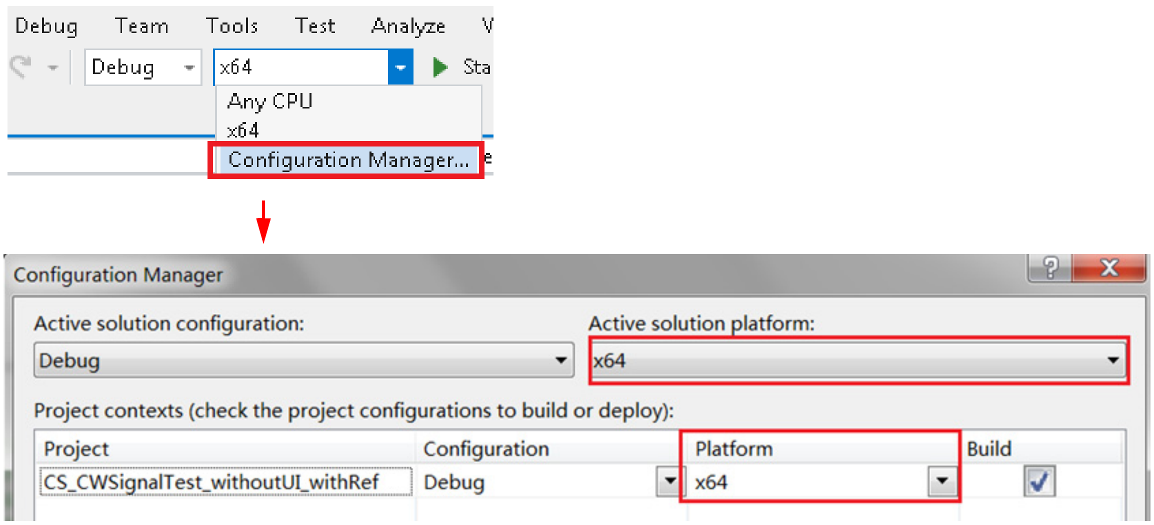
```
M9420Adriver.Close();
```

`Close()` may be the most commonly missed step when using an IVI driver. Failing to do this could mean that system resources are not freed up and your program may behave unexpectedly on subsequent executions.

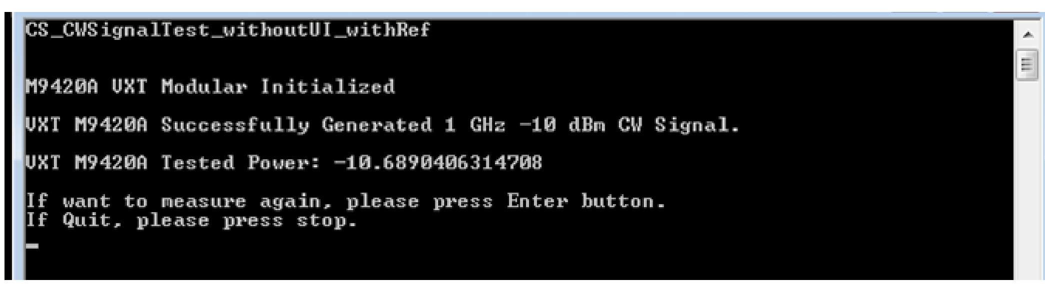
Step 8 – Build and Run a Complete Program

Build your console application and run it to verify it works properly.

1. Open the solution file CWSignalTest.sln in Visual Studio.
2. Set the appropriate platform target. If the installed VXT software is 64-bit, you need to set the active solution platform as X64 in configuration manager.



3. Choose Project > CWSignalTest Properties and select Build/Rebuild Solution. And the program file will be built out.
4. Run the program and you will get the test result as below.



Before running the program, please make sure the M9300A reference software is turned on.

It will take several minutes to run the program as the VXT vector transceiver need boot up before running this program.

For the most of the VXT programs, the step 1, 2, 3, 4, 7, 8 are same. The only difference is in step 5, 6, you need program your own code.

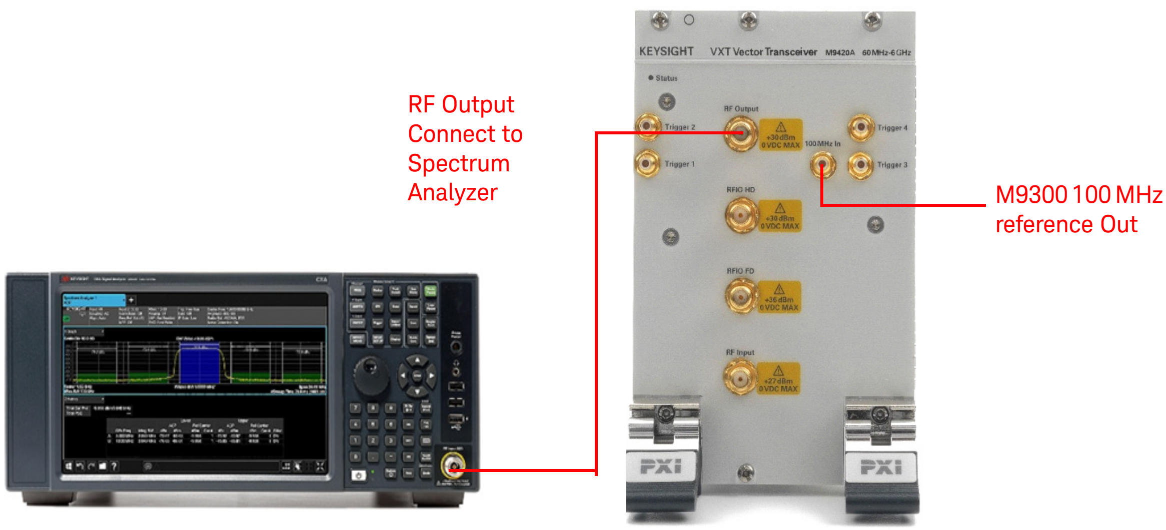
From the example 2 to 10, we will just focus on step 6 - **Write the Program**.

Example 2: Source - Generate LTE FDD Signal

This example introduces the programming procedure to output a LTE FDD signal with M9420A/M9421A source using Visual Studio and C#.

NOTE N7624B Signal Studio for LTE/LTE-FDD is needed to play a LTE FDD signal with VXT product.

Figure 3-2 VXT Source Play Waveform Cable Connection



NOTE Before programming, please connect VXT 100 MHz Ref In port to M9300A's 100 MHz Ref Out port.

The programming procedure are listed as 8 steps as below:

Step 1. - Create your project with Visual C#

Step 2. - Add References

Step 3. - Add Using Statements

Step 4. - Create an Instance

Step 5. - Initialize the Instance

Step 6. - Write the Program (Generate a LTE FDD signal with M9420A source)

Step 7. - Close the Instance

Step 8. - Build and Run the Program

For step 1, 2, 3, 4, 5, 7, 8, pleas refer to example 1 as those steps are similar. This section will only introduce the example code for step 6.

After the VXT software is installed, you will find the source code as below:

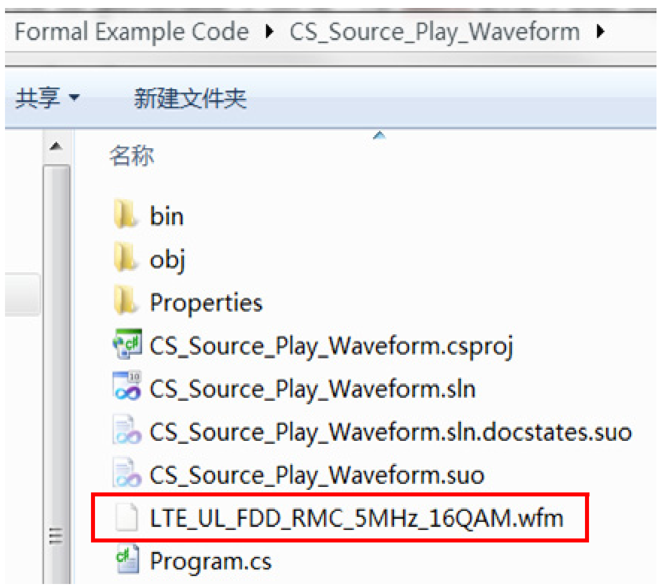
C:\Program Files (x86)\IVI Foundation\IVI\Drivers\KtM9420\Examples\VS.Net\CSharp\CS_Source_Play_Waveform.

Write the Measurement Program

To output a LTE FDD signal with M9420A source, please refer to the example code as below:

```
string filePath = "C:\\Waveform";
string fileName = "LTE_UL_FDD_RMC_5MHz_16QAM.wfm";
driver.Source.LoadWaveform(filePath, fileName); //load the wave form
driver.Source.Modulation.WaveformName = fileName; //choose the waveform to play

driver.Source.RF.Frequency = 1e9;//Set the source center frequency. In this
code it's set to 1e9Hz.
driver.Source.RF.Level = -5; //Set the source's RF power level.
driver.Source.RF.OutputPort = KtM9420PortEnum.KtM9420PortRFOutput;//Select
source output port
driver.Source.RF.OutputEnable = true; //Enable output.
driver.Apply(); //Apply the above setting to VXT source's hardware.
```

The waveform file “*LTE_UL_FDD_RMC_5MHz_16QAM.wfm*” used in this example code is attached in the project file. To play this waveform file, please copy it to the file path set in the code. In this example, you need to copy it to “C:\Waveform”.



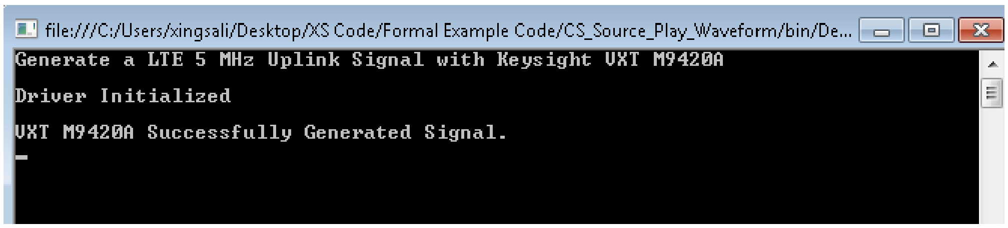
Commands Summary

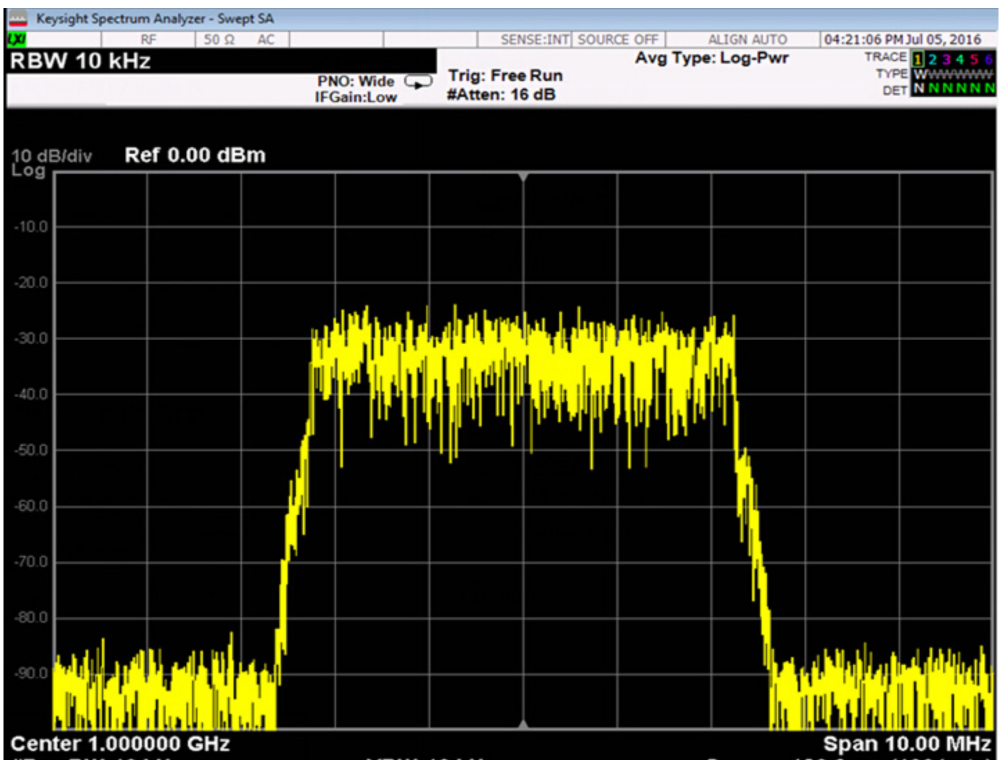
- `Driver.Apply()` method is used to update all the parameter setting, for VXT source and receiver. It is a frequently used method.
- The methods of `Driver.Source.RF` are used to set the basic RF parameters, such as output signal freq, level, output port. If you don’t play any waveform, it will generate a CW signal as example 1 does.

- `Driver.Source.LoadWaveform()` is used to load waveform to VXT memory, It allows you to load multiple waveform files into memory at the same time.
- `Driver.Source.Modulation.WaveformName` is used to choose the waveform.

Get the Measurement Result

Refer to the process of step 8 in example 1 to build and run your program to get the result as below.





Before running the program, please make sure the M9300A reference software is turned on.

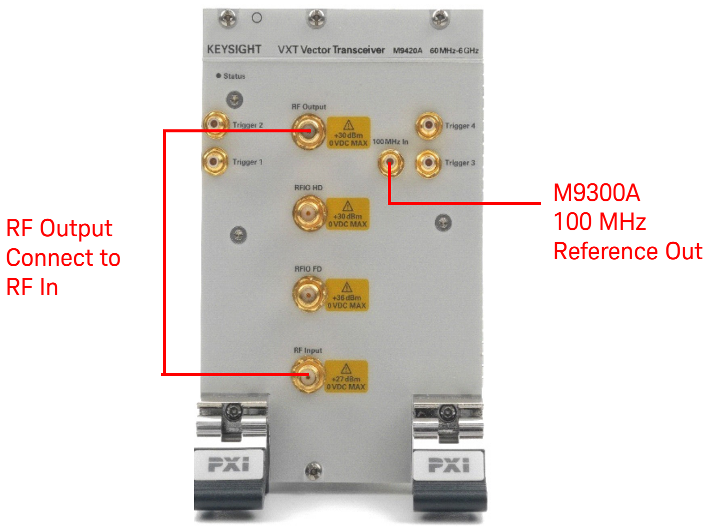
It will take several minutes to run the program as the VXT vector transceiver need boot up before running this program.

Example 3: CW Spectrum UI

This example introduces the programming procedure to display a spectrum in X series spectrum UI with M9420A/M9421A.

- VXT source outputs a 1 GHz CW signal
- Turn on the X series Spectrum UI and use SCPI command to set the receiver display the spectrum

Figure 3-3 Example 3 - Cable Connection



NOTE Before programming, please connect VXT RF Output to RF Input port and VXT 100 MHz Ref In port to M9300A's 100 MHz Ref Out port.

The programming procedure are listed as 8 steps as below:

Step 1. - Create your project with Visual C#

Step 2. - Add references

Step 3. - Add using statements

Step 4. - Create and initialize the Instance

Step 5. - Set source to generate CW signal

Step 6. - Setup SCPI programming environment

Step 7. - Set receiver to observe the CW signal with X-series spectrum UI

Step 8. - Close the Instance

Step 9. - Build and Run the Program

For step 1, 2, 3, 4,5, 8, 9, pleas refer to example 1 as those steps are similar. This section will only introduce the example code for step 6 and 7.

After the VXT software is installed, you will find the source code as below:

C:\Program Files (x86)\IVI Foundation\IVI\Drivers\KtM9420\Examples\VS.Net\CSharp\CS_CW_Spectrum_UI.

Initialize Instance and Turn on Spectrum UI

To initialize the driver instance and turn on spectrum UI, please refer to the example code as below:

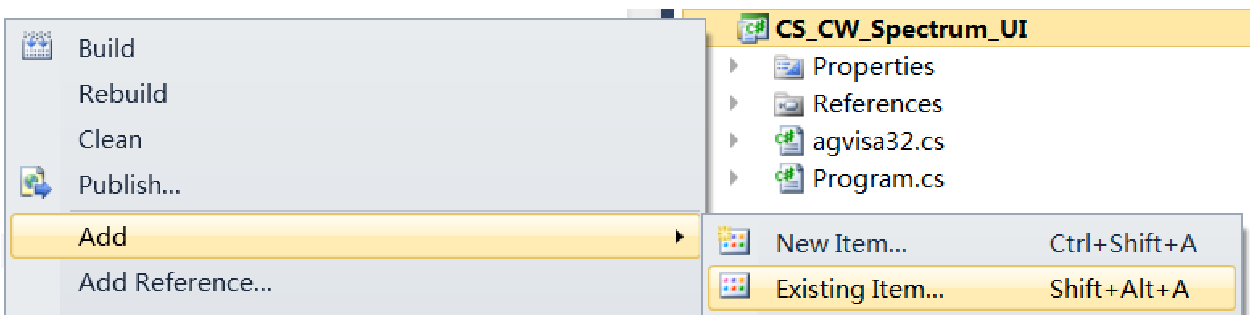
```
driver = new KtM9420();
string resource = "PXI0::CHASSIS1::SLOT2::FUNC0::INSTR";
String options = "QueryInstrStatus=true, Simulate=false, DriverSetup= ";
driver.Initialize(resource, true, true, options);
```

DriverSetup= " is used to turn on the UI display, if you do not need UI display, edit this setting as **DriverSetup=AppStart=false**".

Setup SCPI Programming Environment

To setup SCPI programming environment, please refer to the procedure below:

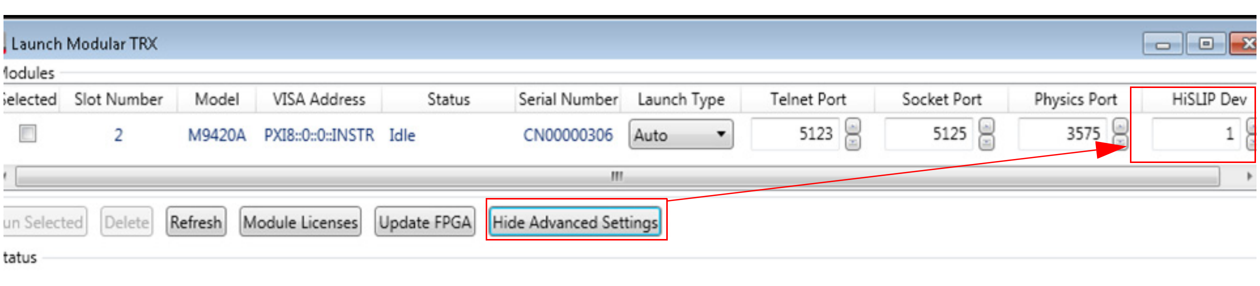
1. Install Keysight IO libraries suite.
2. Add file "agvisa32.cs" into your project. Select Add > Existing Item in Visual Studio as below. The file "agvisa32.cs" is located at C:\Program Files (x86)\IVI Foundation\VISA\WinNT\agvisa\include



3. Add the code below to your project to enable VISA connection with X series application.

```
int rm = 0; int xApp;
AgVisa32.viOpenDefaultRM(out rm);
AgVisa32.viOpen(rm, “TCPIP0::localhost::hislip1::INSTR”, 0, 0, out xApp);
AgVisa32.viSetAttribute(xApp, AgVisa32.VI_ATTR_TMO_VALUE, 10000);
AgVisa32.viPrintf(xApp, ":SYST:ERR:VERB ON;\n"); //clear the system error
information
```

The VISA connection need hislip LAN address. Please run *LaunchModularTRX.exe* to get the hislip address as below.



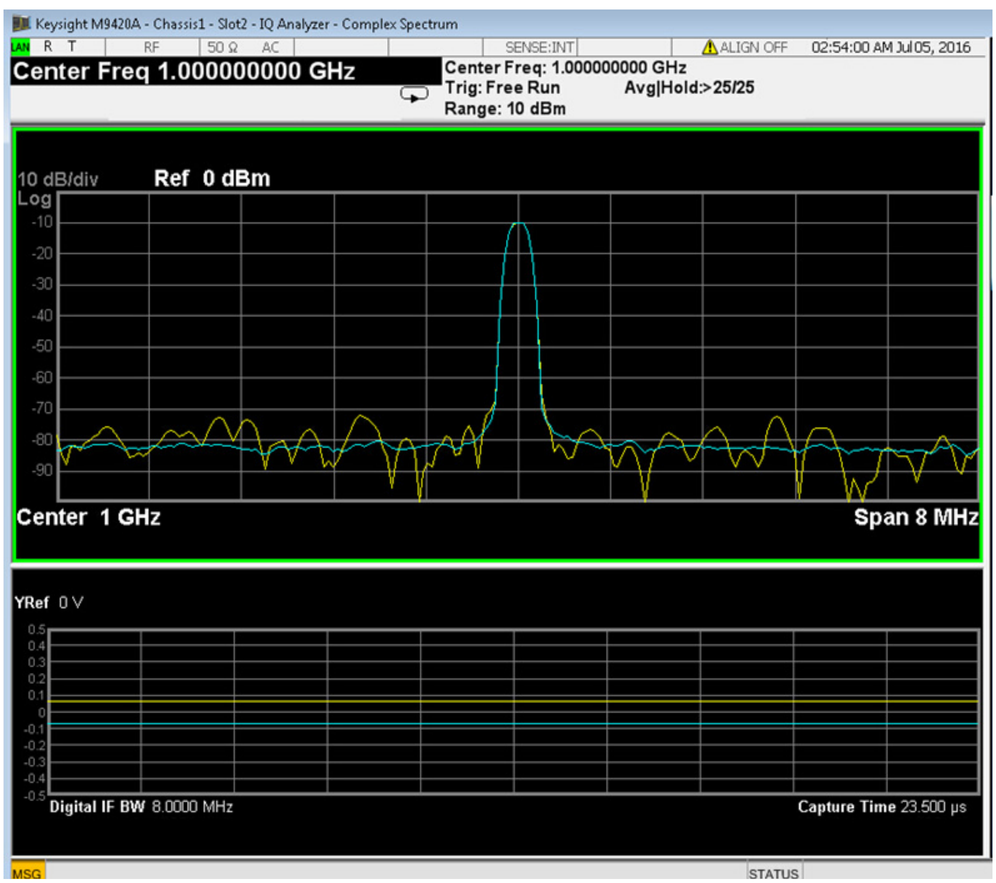
Set Receiver to Observe Signal

To set VXT receiver to observe the CW signal, please refer to the example code as below:

```
AgVisa32.viPrintf(xApp, ":INST:SEL BASIC;\n");//Enter basic mode (IQ Analyzer)

//It will take several seconds to load or switch mode, so this below code to wait and check.
int tryTimes = 0; string queryResult;
do
{
AgVisa32.viPrintf(xApp, ":INST:SEL? \n");
AgVisa32.viRead(xApp, out queryResult, 1024);
tryTimes++;
}
while ((queryResult != "BASIC\n") && (tryTimes < 100));

AgVisa32.viPrintf(xApp, ":FREQ:CENT 1e9 Hz \n");//Set Frequency
AgVisa32.viPrintf(xApp, "INIT:CONT 1 \n"); //Set continuous sweep mode
AgVisa32.viPrintf(xApp, ":POW:RANG 10.0 \n");//Set Attenuator
```

Get the Measurement Result

Refer to the process of step 8 in example 1 to build and run your program to get the result as below.



Before running the program, please make sure the M9300A reference software is turned on.

It will take several minutes to run the program as the VXT vector transceiver need boot up before running this program.

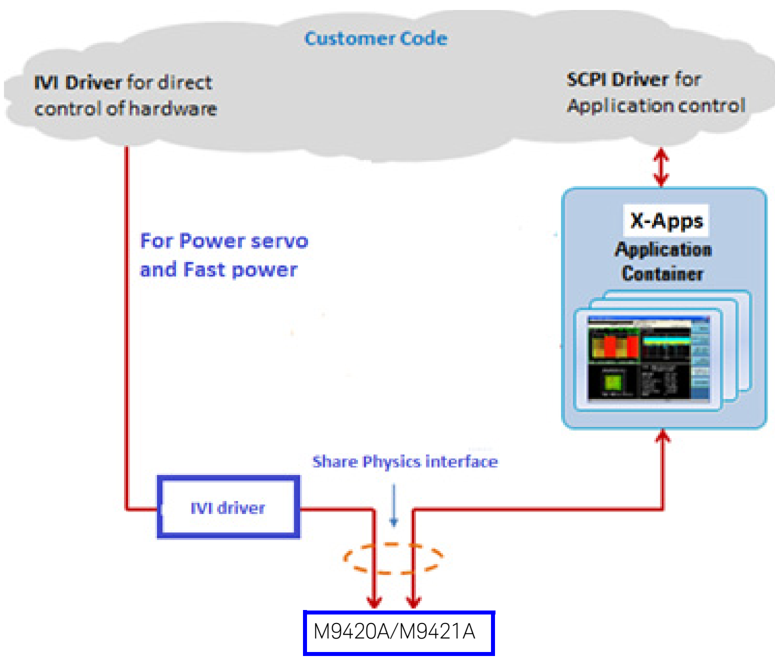
Basic Concepts: Two VXT Control Method

The VXT supports two method for remote control: by IVI driver and by SCPI command. The example 1 and 2 use IVI driver method and example 3 uses both methods.

IVI driver provides fast measurement speed and support power servo measurement with VXT.

SCPI command programming provides more features and Keysight classic UI display.

Figure 3-4 *IVI driver and SCPI driver in VXT*



The table below shows the supported measurement and features by IVI driver and SCPI.

Features	IVI Driver	SCPI
Spectrum Analysis	Supported	Supported
FFT Analysis	Supported	Supported
IQ Data Acquisition	Supported	Supported
Channel Power Test	Supported	Supported
Power Servo	Supported	Not supported
ACPR	Supported	Supported

Features	IVI Driver	SCPI
Harmonics	Supported	Supported
OBW	Not supported	Supported
Spectrum Emission Mask	Not supported	Supported
Marker	Not supported	Supported
Source (digital signal)*	Supported	Supported
Demod Digital Signal (EVM result)	Not supported	Supported
Keysight Classic Spectrum UI	Not supported	Supported

*. The VXT plays waveform file to produce digital signal.

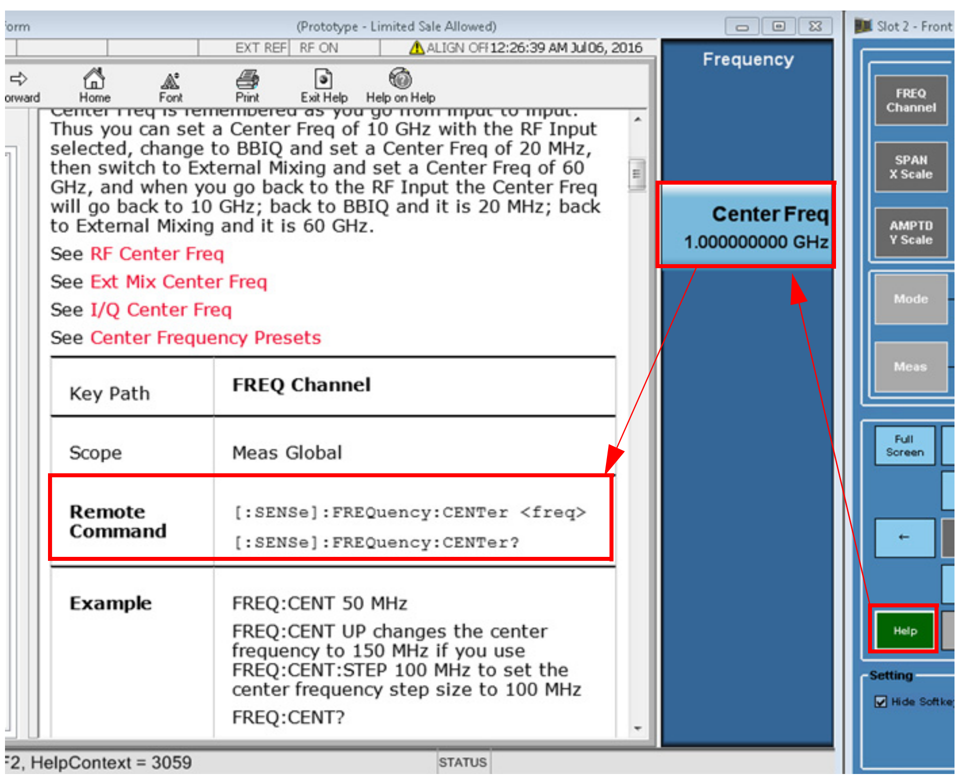
SCPI Commands Control Method

There are two steps to use SCPI control method:

1. Setup VISA connection between PC and instrument
2. Send instrument SCPI command.

For example, `AgVisa32.viPrintf(xApp, ":FREQ:CENT 1e9 Hz\n");//Set receiver's Center Freq` is a command used in example 3. `:FREQ:CENT 1e9 Hz` is a SCPI command.

To get a SCPI command, please refer to the online help system in VXT software



Or download the corresponding mode's *User's and Programmer's Reference* from http://keysight.com/find/vxt

IQ Analyzer Mode User's & Programmer's Reference for M9420A
User's and programmer's information for the IQ Analyzer mode whe

For further information about SCPI command programming, please refer to *X-Series Programmer's Guide*.

Example 4: Channel Power Acquisition

This example introduces the programming procedure to measure signal channel power with VXT.

- VXT source outputs a LTE FDD signal
- VXT receiver measures the signal channel power

NOTE N7624B Signal Studio for LTE/LTE-FDD is needed to play a LTE FDD signal with VXT product.

Before programming, please connect VXT RF Output to RF Input port and VXT 100 MHz Ref In port to M9300A's 100 MHz Ref Out port. Please refer to Figure 3-1 for details.

The programming procedure are listed as 8 steps as below:

Step 1. - Create your project with Visual C#

Step 2. - Add References

Step 3. - Add Using Statements

Step 4. - Create an Instance

Step 5. - Initialize the Instance

Step 6. - Write the Program

Step 7. - Close the Instance

Step 8. - Build and Run the Program

For step 1, 2, 3, 4, 5, 7, 8, pleas refer to example 1 as those steps are similar. This section will only introduce the example code for step 6 - Write the Program.

After the VXT software is installed, you will find the source code in the directory below:

C:\Program Files (x86)\IVI Foundation\IVI\Drivers\KtM9420\Examples\VS.Net\CSharp\CS_CHPowerAcquisition.

Write the Measurement Program

To output a LTE FDD signal with M9420A source, please refer to step 5 of example 2.

To set M9420A receiver to measure the channel power of the LTE signal, please refer to the example code as below:

```
driver.Receiver.RF.Frequency = 1e9; //Set receiver center freq
driver.Receiver.RF.Power = -5;
driver.Receiver.RF.InputPort = KtM9420PortEnum.KtM9420PortRFInput;
double rmsvalue = -20 * Math.Log10(driver.Source.Modulation.ArbRmsValue) + 3;
driver.Receiver.RF.PeakerToAverage = rmsvalue; //Please refer to the
explanation below.
driver.Apply(); //Apply the above setting to VXT receiver hardware

driver.AcquisitionMode =
KtM9420AcquisitionModeEnum.KtM9420AcquisitionModePower;
//choose power acquisition mode to test power
driver.PowerAcquisition.Bandwidth = 10e6;
// PowerAcquisition.Bandwidth set to a value > DUT signal bandwidth
driver.PowerAcquisition.Duration = 0.02;
driver.PowerAcquisition.ChannelFilter.Shape = KtM9420ChannelFilter
ShapeEnum.KtM9420ChannelFilterShapeNone;
driver.PowerAcquisition.ChannelFilter.Alpha = 0.1;
driver.PowerAcquisition.ChannelFilter.Bandwidth = 6e6;

driver.Arm(); // Start the M9420A's receiver measurement

if (!driver.WaitForData((6000))) // It will take some time to change receiver
setting, so use WaitForData() method to wait for a while.
{
  throw new ApplicationException("WaitForData failed.  No acquisition was
made.");
}

//Read the Channel Power Measurement Result from VXT memory
const int CAPTURE_ID = 0;
bool overloaded = false;
double power = 0;
driver.PowerAcquisition.ReadPower(CAPTURE_ID, ref power, ref overloaded);
//Read the channel power result
```

Commands Summary

- `Arm()` method is used to trigger the data capture of acquisition. In this example, after all the hardware parameters are set, use `Arm()` to enable the power measurement.

- After `Arm()`method to capture data, a time delay is set to wait for the measurement. `PowerAquisition.ReadPower()` is used to get the result from VXT memory.
- `Bandwidth, Duration, Offsetfreq` and `ChannelFilter` need to be set in power acquisition mode.
- `Receiver.RF` is used to set the basic RF parameters such as: `center freq`, `power (level)`, `input port`, and `peak to average`. In all the data acquisition modes, the commands to set those parameters are same. For example, use commands below to set the receiver's RF parameters:

```
driver.Receiver.RF.Frequency = 1e9; //Set receiver's center freq
driver.Receiver.RF.Power = -5; //Set receivers' power range
driver.Receiver.RF.InputPort = KtM9420PortEnum.KtM9420PortRFInput;
//Set the receiver's RF input port
```

- In benchtop spectrum analyzer, the reference, attenuator and pre-amplifier is set to avoid mixer overload, or to control DANL. In VXT, only one parameter `RF.Power` is used to set the power range of a receiver. Set `RF.Power` value ≥ DUT signal to avoid mixer overload. In example 4, DUT LTE signal is –5 dBm, `RF.Power` is set to -5 dBm. VXT will set attenuator and pre-amp accordingly.
- `Receiver.RF.PeakToAverage` is very important to test a signal with high peak to average value, such as some cellular digital modulation signal. To test a -10 dBm LTE signal, the average channel power of this signal will be -10 dBm, so set `Receiver.RF.Power` to -5 dBm. But this LTE signal may have 8 dB Peak to Average value, which means the peak signal power of this LTE signal should be -2 dBm. It exceeds -5 dBm `Receiver.RF.Power` setting, then the mixer will overload. The setting of `Receiver.RF.PeakToAverage` will help to optimize the attenuator and level setting in the mixer to get correct measurement result.

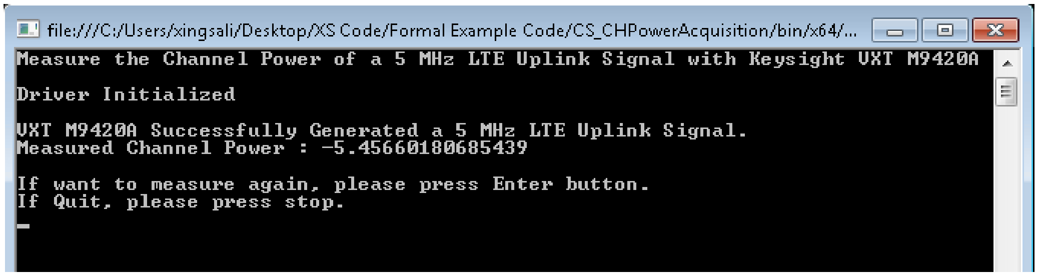
  In the source code below:

```
double rmsvalue = -20 * Math.Log10(driver.Source.Modulation.ArbRmsValue) + 3;
driver.Receiver.RF.PeakerToAverage = rmsvalue;
```

A waveform is played to generate this LTE signal, VXT provides a method to read an Arb Rms Value from the waveform, it is a peak to average volt ratio value. It could be used to calculate power peak to average value in dB unit. 3 dB buffer is added in the example.

Get the Measurement Result

Refer to the process of step 8 in example 1 to build and run your program to get the result as below.



Before running the program, please make sure the M9300A reference software is turned on.

It will take several minutes to run the program as the VXT vector transceiver need boot up before running this program.

Basic Concepts: 4 Receiver Acquisition Mode

Keysight VXT M9420A/M9421A provides 4 receiver acquisition mode as below.

Features	Use Case	Difference
Power Acquisition	Get the channel power directly	Fast power calculation
Spectrum Acquisition	Get the spectrum data based on span and RBW setting	More data points than FFT acquisition Lower DANL and better dynamic range
FFT Acquisition	FFT method to get the spectrum data	Faster SA data capture speed than spectrum acquisition Up to 512 data points Lower dynamic range
IQ Acquisition	IQ data output	Easy for post analysis

Keysight VXT M9420A/M9421A also provides 3 measurement mode: Power Servo, ACPR, Harmonics. Please refer example 8, 9, and 10 for details.

Example 5: Spectrum Acquisition

This example introduces the programming procedure to measure signal spectrum data and search the maximum power point with VXT.

- VXT source outputs a 1 GHz CW signal
- VXT receiver tests the signal spectrum data and search the maximum power point

Before programming, please connect VXT RF Output to RF Input port and VXT 100 MHz Ref In port to M9300A's 100 MHz Ref Out port. Please refer to Figure 3-1 for details.

The programming procedure are listed as 8 steps as below:

Step 1. – Create your project with Visual C#

Step 2. – Add References

Step 3. – Add Using Statements

Step 4. – Create and initialize the Instance

Step 5. – Set VXT source to generate 1 GHz CW signal

Step 6. – Set VXT receiver to test signal spectrum data and search the maximum power point.

Step 7. – Close the Instance

Step 8. – Build and Run the Program

For step 1, 2, 3, 4, 5, 7, 8, pleas refer to example 1 as those steps are similar. This section will only introduce the example code for step 6 - Set VXT receiver.

After the VXT software is installed, you will find the source code in the directory below:

C:\Program Files (x86)\IVI Foundation\IVI\Drivers\KtM9420\Examples\VS.Net\CSharp\CS_SpectrumAcquisition.

Set VXT Receiver to Test Spectrum Data

To set VXT receiver to test the signal spectrum data and search the maximum power point, please refer to the example code as below:

```
driver.Receiver.RF.Frequency = 1e9; //Set Receiver Center freq
driver.Receiver.RF.Power = -5; //Set power to -5 dBm
driver.Receiver.RF.InputPort = KtM9420PortEnum.KtM9420PortRFInput;
driver.Apply(); //Apply the changes to hardware.

driver.AcquisitionMode =
KtM9420AcquisitionModeEnum.KtM9420AcquisitionModeSpectrum;
//Switch to Spectrum Acquisition Mode
driver.SpectrumAcquisition.Span = 8e6; //Set Span of Spectrum
driver.SpectrumAcquisition.ResolutionBandwidth = 30000; //Set RBW
driver.SpectrumAcquisition.FFTWindowsShape =
KtM9420FFTWindowShapeEnum.KtM9420FFTWindowShapeFlatTop; //Set FFT Window Shape
driver.SpectrumAcquisition.Averaging.Mode =
KtM9420SpectrumAveragingEnum.KtM9420SpectrumAveragingTime;
//Set Average's Mode - choose time based average
driver.SpectrumAcquisition.Averaging.Duration = 0.01; //Set average based time
driver.SpectrumAcquisition.Averaging.Overlap = 0.5; // Set overlap value

driver.Arm(); //Arm the digitizer to start measurement or data capture

const int CAPTURE_ID = 0; double fstart = 0; double fdelta = 0;
double[] spectrum = new double[driver.SpectrumAcquisition.Bins];
//Read the Spectrum data from VXT memory
driver.SpectrumAcquisition.ReadPowerSpectrum(CAPTURE_ID, ref spectrum, ref
overloaded,ref fstart,ref fdelta);

Search maximum data point. Source code:
int maxBin = FindMaximumAmplitude(ref spectrum);
private static int FindMaximumAmplitude(ref double[] vector)
{
     Double maxValue = Double.MinValue;
     int bin = -1;
     for (int i = 0; i < vector.Length; i++)
        {
     if (vector[i] > maxValue)
             {
              bin = i;
              maxValue = vector[i];
              }
         }
            return bin;
        }
```

Commands Summary

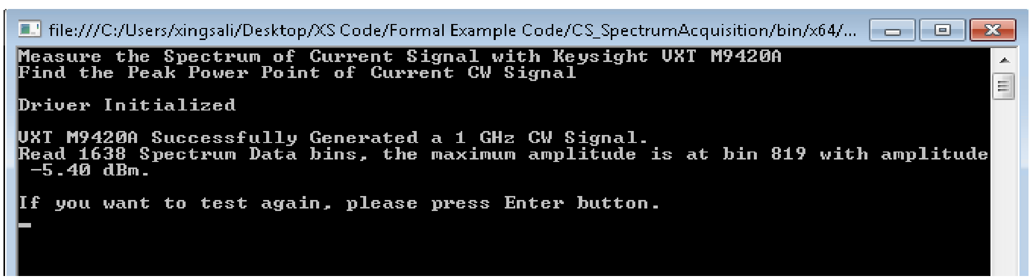
- `driver.SpectrumAcquisition.Bins` is used to get the number of frequency points captured by the spectrum acquisition mode. When you set the Span and RBW value, the VXT will set the frequency bins value automatically. Increase span and decrease RBW will result in a larger Bin value, which means more frequency points.

  you program will assign enough space to save the spectrum data, based on Bin's value.

- `driver.SpectrumAcquisition.ReadPowerSpectrum` is used to read spectrum acquisition. The default unit is dBm. The spectrum data captured by FFT acquisition mode is in mW unit.

Get the Measurement Result

Refer to the process of step 8 in example 1 to build and run your program to get the result as below.



Before running the program, please make sure the M9300A reference software is turned on.

It will take several minutes to run the program as the VXT vector transceiver need boot up before running this program.

Example 6: FFT Acquisition

This example introduces the programming procedure to measure signal spectrum data and search the maximum power point with VXT.

- VXT source outputs a 1 GHz CW signal
- VXT receiver tests the signal spectrum data in FFT mode and search the maximum power point

Before programming, please connect VXT RF Output to RF Input port and VXT 100 MHz Ref In port to M9300A's 100 MHz Ref Out port. Please refer to figure 3-1 for details.

The programming procedure are listed as 8 steps as below:

Step 1. - Create your project with Visual C#

Step 2. - Add References

Step 3. - Add Using Statements

Step 4. - Create and initialize the Instance

Step 5. - Set VXT source to generate 1 GHz CW signal

Step 6. - Set VXT receiver to test signal spectrum data in FFT mode and search the maximum power point.

Step 7. - Close the Instance

Step 8. - Build and Run the Program

For step 1, 2, 3, 4, 5, 7, 8, pleas refer to example 1 as those steps are similar. This section will only introduce the example code for step 6 - Set VXT receiver.

After the VXT software is installed, you will find the source code in the directory below:

C:\Program Files (x86)\IVI Foundation\IVI\Drivers\KtM9420\Examples\VS.Net\CSharp\CS_FFTAcquisition.

Set VXT Receiver

To set VXT receiver to test the signal spectrum data in FFT mode and search the maximum power point, please refer to the example code as below:

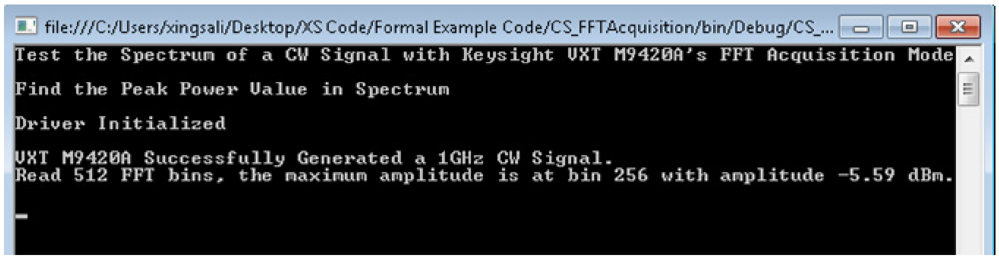
```
driver.Receiver.RF.Frequency = 1e9;
driver.Receiver.RF.Power = -5;
driver.Receiver.RF.InputPort = KtM9420PortEnum.KtM9420PortRFInput;
driver.Receiver.RF.PeakerToAverage = 3;
driver.Apply(); // Apply the changes to hardware

driver.AcquisitionMode = KtM9420AcquisitionModeEnum.KtM9420AcquisitionModeFFT;
driver.FFTAcquisition.Length =
KtM9420FFTAcquisitionLengthEnum.KtM9420FFTAcquisitionLength_512;
driver.FFTAcquisition.SampleRate = 5e6;
//Sample rate should be set to a value > 1.25 x Span.

driver.FFTAcquisition.WindowShape =
KtM9420FFTWindowShapeEnum.KtM9420FFTWindowShapeFlatTop;
driver.FFTAcquisition.Duration = 1e-4;

driver.FFTAcquisition.ChannelFilter.Shape =
KtM9420ChannelFilterShapeEnum.KtM9420ChannelFilterShapeNone;
driver.FFTAcquisition.ChannelFilter.Bandwidth = 4e6;
driver.FFTAcquisition.ChannelFilter.Alpha = 0.1;

driver.Arm(); //Arm the digitizer

Double[] fftData = new Double[driver.FFTAcquisition.Samples];

driver.FFTAcquisition.ReadMagnitudeData(0, ref fftData, ref overloaded);

TodBm(ref fftData); //this method switch the FFT result into dBm value.
int maxBin = FindMaximumAmplitude(ref fftData); //This method find the peak
power value.

private static void TodBm(ref double[] vector)
   {
    for (int i = 0; i < vector.Length; i++)
       {
          vector[i] = 10 * Math.Log10(vector[i]);
        }
   }
```

Commands Summary

- `driver.FFTAcquisition.Length` is limited up to 512 points to get fast test speed. To get more frequency points, please use spectrum acquisition mode.
- `FFTAcquisition.ReadMagnitudeData` is used to read spectrum acquisition. The default unit is dBm. The spectrum data captured by FFT acquisition mode is in mW unit.

Get the Measurement Result

Refer to the process of step 8 in example 1 to build and run your program to get the result as below.



Before running the program, please make sure the M9300A reference software is turned on.

It will take several minutes to run the program as the VXT vector transceiver need boot up before running this program.

Example 7: IQ Acquisition

This example introduces the programming procedure to measure signal channel power with M9420A/M9421A.

- VXT source outputs a LTE FDD signal
- VXT receiver captures signal's IQ data

NOTE The license key of N7624B Signal Studio is needed to play a LTE FDD signal with VXT product.

Before programming, please connect VXT RF Output to RF Input port and VXT 100 MHz Ref In port to M9300A's 100 MHz Ref Out port. Please refer to figure 3-1 for details.

The programming procedure are listed as 8 steps as below:

Step 1. - Create your project with Visual C#

Step 2. - Add References

Step 3. - Add Using Statements

Step 4. - Create and initialize the Instance

Step 5. - Set VXT source to generate 1 GHz LTE FDD signal

Step 6. - Set VXT receiver to capture signal's IQ data.

Step 7. - Close the Instance

Step 8. - Build and Run the Program

For step 1, 2, 3, 4, 5, 7, 8, pleas refer to example 1 as those steps are similar. This section will only introduce the example code for step 6 - Capture IQ Data.

After the VXT software is installed, you can find the source code as below:

C:\Program Files (x86)\IVI Foundation\IVI\Drivers\KtM9420\Examples\VS.Net\CSharp\CS_IQAcquisition.

Write the Measurement Program

To output a LTE FDD signal with M9420A source, please refer to Example 2.

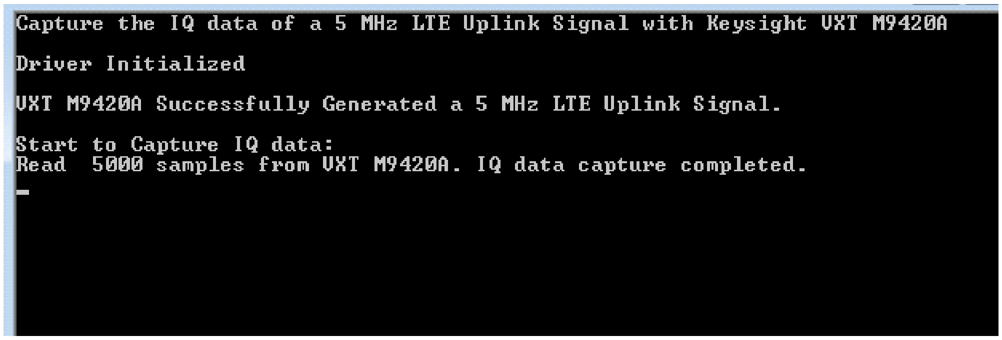
To capture the IQ data of the LTE signal, please refer to the example code as below:

```
driver.Receiver.RF.Frequency = 1e9; //Set the Receiver's Center Freq.
driver.Receiver.RF.Power = 0;
driver.Receiver.RF.InputPort = KtM9420PortEnum.KtM9420PortRFInput;
//set the Receiver to RF input port.
double rmsvalue = -20 * Math.Log10(driver.Source.Modulation.ArbRmsValue) + 3;
// read the RMS value from waveform file and transfer it into Peak to Avearge
Ratio Value(PAR). Add 3 dB buffer to PAR to avoid receiver overload.
driver.Receiver.RF.PeakerToAverage = rmsvalue;
//Set the Peak to Average Ratio.

driver.AcquisitionMode = KtM9420AcquisitionModeEnum.KtM9420AcquisitionModeIQ;
//choose IQ Acquisition Mode
driver.IQAcquisition.SampleRate = 5000000; //Set Sample Rate
double DURATION = 1e-3;
double SAMPLE_RATE = driver.IQAcquisition.SampleRate;
driver.IQAcquisition.Samples = (int)(DURATION * SAMPLE_RATE);
//Set the IQ data acquisition sample quantity, and it’s equal to Sample rate
multiple Duration.
int samples = driver.IQAcquisition.Samples;
driver.IQAcquisition.Units =
KtM9420IQUnitsEnum.KtM9420IQUnitsSquareRootMilliWatts; //Set the IQ data unit.
driver.IQAcquisition.ChannelFilter.Shape =
KtM9420ChannelFilterShapeEnum.KtM9420ChannelFilterShapeNone;
//Set the IQ Acquisition's channel filter shape

driver.Apply(); // Apply the changes to hardware.
driver.Arm(); //Arm the digitizer to start measurement or data capture.

double[] interleavedIqBlock = null; // Allocate enough room for 5,000 samples

Console.WriteLine("Start to Capture IQ data:");
driver.IQAcquisition.ReadIQData(0,0,samples,ref interleavedIqBlock,ref
overloaded);
//Read the captured IQ data from VXT.

//Add code to process this IQ data per your own requirement.
Console.WriteLine("Read {0,5} samples from VXT M9420A. IQ data capture
completed.", samples);
```

- `driver.IQAcquisition.Samples` is used to set the sample points you want to capture, so you can defined a number directly. Usually we can define it according to `IQAcquisition.SampleRate` and Duration Time you want to test. So in source code, it set as below,
  `driver.IQAcquisition.Samples = (int)(DURATION * SAMPLE_RATE);`
  //Set the IQ data acquisition sample number.

Get the Measurement Result

Refer to the process of step 8 in example 1 to build and run your program to get the result as below.



Before running the program, please make sure the M9300A reference software is turned on.

It will take several minutes to run the program as the VXT vector transceiver need boot up before running this program.

Example 8: Power Servo

This example introduces the programming procedure to perform power servo, and DUT is only a cable.

Power Servo Loop

One of the key measurements for a power amplifier or chip set, is performing a Servo Loop. Because when you measure a power amplifier or chip set, it is typically specified at a specific output power level. It needs to adjust the source input level until you measure the exact power level. To do this, you will continually adjust the source until you achieve the specified output power level.

NOTE In this example, need to generate a WCDMA uplink signal with VXT's source, so the license key of N7600B Signal Studio is needed with VXT product.

Before programming, please connect VXT RF Output to RF Input port and VXT 100 MHz Ref In port to M9300A's 100 MHz Ref Out port. Please refer to figure 3-1 for details.

The programming procedure are listed as 8 steps as below:

Step 1. - Create your project with Visual C#

Step 2. - Add References

Step 3. - Add Using Statements

Step 4. - Create and initialize the Instance

Step 5. - Set VXT source to generate 1 GHz WCDMA Uplink signal

Step 6. - Perform Power Servo operation.

Step 7. - Close the Instance

Step 8. - Build and Run the Program

For step 1, 2, 3, 4, 5, 7, 8, pleas refer to example 1 as those steps are similar. This section will only introduce the example code for step 6 - Write the Program.

After the VXT software is installed, you can find the source code as below:

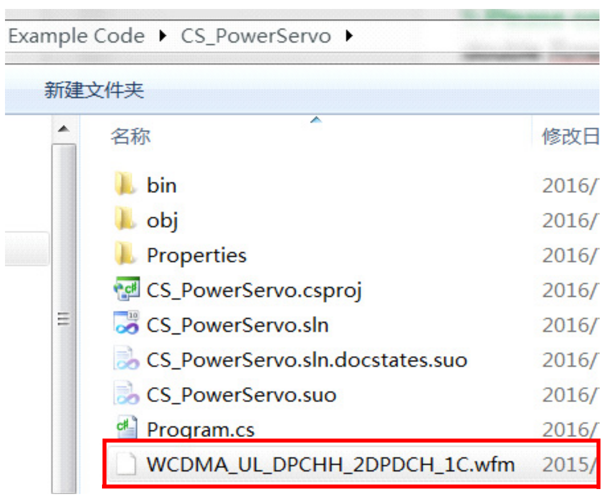
C:\Program Files (x86)\IVI Foundation\IVI\Drivers\KtM9420\Examples\VS.Net\CSharp\CS_PowerServo.

Write the Measurement Program

To output a WCDMA uplink signal with the M9420A source, please refer to below source codes:

```
driver.Source.RF.Frequency = 1e9; //set source center frequency
driver.Source.RF.Level = 3; //set source RF power level
driver.Source.RF.OutputPort = KtM9420PortEnum.KtM9420PortRFOutput;
driver.Source.RF.OutputEnable = true;
driver.Source.LoadWaveform("c:\\ARBdata", "WCDMA_UL_DPCHH_2DPDCH_1C.wfm");
\\ Please copy the waveform file ” WCDMA_UL_DPCHH_2DPDCH_1C.wfm” to “C:\ARBdata” of
your PC
double RmsValue = driver.Source.Modulation.ArbRmsValue;
driver.Source.Modulation.ArbPlayConfigure(WaveformName:
"WCDMA_UL_DPCHH_2DPDCH_1C.wfm", ArbPlayMode:
KtM9420ArbPlayModeEnum.KtM9420ArbPlayModePlayArb, ArbPlayDuration: 1e-4);
\\Play wave form to output WCDMA signal
driver.Apply();
```

The waveform file “*WCDMA_UL_DPCHH_2DPDCH_1C.wfm*” used in this example is attached in the project file. To play this waveform, please copy it to the file path set in the code. In this example you need to copy it to “C:\ARBdata”. You can set it to other address in Source.LoadWaveform().



To perform power servo operation, please refer to the example code as below:

```
//Setup Receiver
driver.Receiver.RF.Frequency = 1e9;
driver.Receiver.RF.Power = 5;
double RmsValue = -20 * Math.Log10(driver.Source.Modulation.ArbRmsValue) + 3;
driver.Receiver.RF.PeakerToAverage = RmsValue;
driver.Receiver.RF.InputPort = KtM9420PortEnum.KtM9420PortRFInput;

//Configure Power Servo
driver.Measurement.EnabledMeasurements =
(int)KtM9420MeasurementsEnum.KtM9420MeasurementsPowerServo;
driver.Measurement.PowerServo.AcqusitionMode =
KtM9420AcquisitionModeEnum.KtM9420AcquisitionModeFFT;
driver.FFTAcquisition.SampleRate = 30.72e6;
driver.FFTAcquisition.Length =
KtM9420FFTAcquisitionLengthEnum.KtM9420FFTAcquisitionLength_512;
driver.FFTAcquisition.Duration = 0.0001;
KtM9420ChannelFilterShapeEnum FilterType =
KtM9420ChannelFilterShapeEnum.KtM9420ChannelFilterShapeRaisedCosine;
double FilterAlpha = 0.22;
double FilterBw = 3840000.0;
driver.FFTAcquisition.ChannelFilter.Configure(FilterType, FilterAlpha,
FilterBw);
driver.FFTAcquisition.WindowShape =
KtM9420FFTWindowShapeEnum.KtM9420FFTWindowShapeGaussian;
double Level = 3;
double Gain = 0;  //Because the DUT used in this example is a cable, not a
amplifier, so we use 0 dB gain.
driver.Measurement.PowerServo.InputPower = Level + Gain;
driver.Measurement.PowerServo.OutputPower = Level;
driver.Measurement.PowerServo.OutputPowerMargin = 0.05;
driver.Measurement.PowerServo.OverheadTime = 600e-6;
driver.Measurement.PowerServo.MaximumOutputPower = 20;
driver.Apply();
//Power Servo Configuration Completed

driver.Measurement.Process(); //Active the measurement

double MeasuredPower = 0;
bool ServoPass = false; int ServoCount = 0; bool Overload = true;

//Read PowerServo Result
driver.Measurement.PowerServo.ReadPowerServo(ref MeasuredPower, ref ServoPass,
ref Overload, ref ServoCount);
```

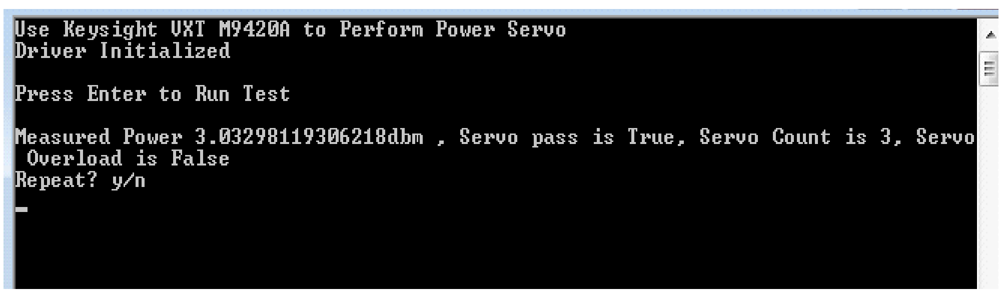
Commands Summary

- In this power servo example, the driver.Arm() method is not used to active the measurement. We used the driver.measurement.process() method.
- The driver.Arm() method is mainly used for the 4 basic acquisition modes, Power acquisition, FFT acquisition, spectrum acquisition and IQ acquisition. It will enable the test without any time delay or waiting.
- The driver.measurement.process() is mainly used to active the test of 3 measurements, Power Servo, Harmonics and ACPR. It will include internal waiting during the measurements.
- The 3 measurements items are tested based on 1 of 4 basic acquisition modes, so it requires to choose the Measurement.PowerServo.AcqusitionMode, and set related parameters in this mode.

Get the Measurement Result

Refer to the process of step 8 in example 1 to build and run your program to get the result as below.

The measured power is 3.03 dBm, and the servo count is 3.



Before running the program, please make sure the M9300A reference software is turned on.

It will take several minutes to run the program as the VXT vector transceiver need boot up before running this program.

Example 9: Harmonics Test

This example introduces the programming procedure to measure harmonics of a CW signal with M9420A/M9421A.

- VXT source outputs a 1 GHz CW signal
- VXT receiver test harmonics of this signal

Before programming, please connect VXT RF Output to RF Input port and VXT 100 MHz Ref In port to M9300A's 100 MHz Ref Out port. Please refer to figure 3-1 for details.

The programming procedure are listed as 8 steps as below:

Step 1. – Create your project with Visual C#

Step 2. – Add References

Step 3. – Add Using Statements

Step 4. – Create and initialize the Instance

Step 5. – Set VXT source to generate 1 GHz CW signal

Step 6. – Set VXT receiver to test the harmonics.

Step 7. – Close the Instance

Step 8. – Build and Run the Program

For step 1, 2, 3, 4, 5, 7, 8, pleas refer to example 1 as those steps are similar. This section will only introduce the example code for step 6 – Set VXT receiver to test harmonics.

After the VXT software is installed, you can find the source code as below:

C:\Program Files (x86)\IVI Foundation\IVI\Drivers\KtM9420\Examples\VS.Net\CSharp\CS_Measurement_Harmonics.

Write the Measurement Program

To output a CW signal with VXT source, please refer to Example 1.

To test the harmonics of this signal, please refer to below source codes:

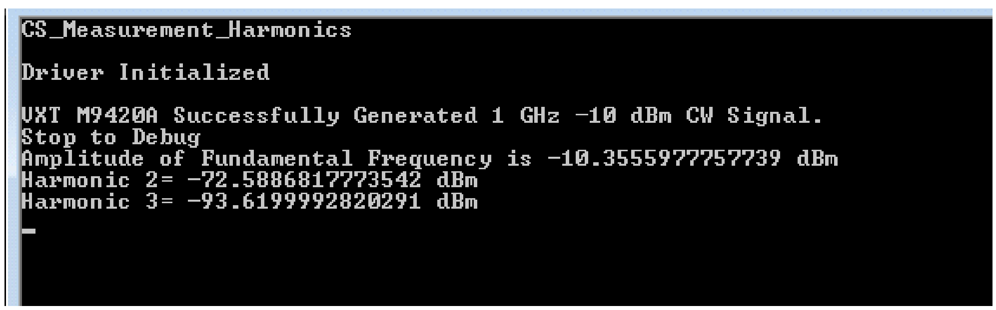
```
driver.Receiver.RF.Frequency = 1e9;
driver.Receiver.RF.Power = 10;
//Set the Receiver.RF.Power a little bigger than target test signal to avoid
overload
valuedriver.Receiver.RF.PeakerToAverage =3;
driver.Receiver.RF.InputPort = KtM9420PortEnum.KtM9420PortRFInput;

driver.Measurement.Harmonics.AcquisitionMode =
KtM9420AcquisitionModeEnum.KtM9420AcquisitionModeSpectrum;
//Choose the Spectrum Acquisition Mode
driver.SpectrumAcquisition.Span = 1e6;
driver.SpectrumAcquisition.ResolutionBandwidth = 1e3;
driver.SpectrumAcquisition.FFTWindowsShape =
KtM9420FFTWindowShapeEnum.KtM9420FFTWindowShapeHann;
driver.SpectrumAcquisition.OffsetFrequency = 0;
driver.Apply(); // Apply the above setting to VXT receiver's hardware.

driver.Measurement.Harmonics.Configure(FundamentalFrequency:
driver.Source.RF.Frequency, MaximumHarmonicsNumber: 3);
driver.Measurement.EnabledMeasurements |=
(int)KtM9420MeasurementsEnum.KtM9420MeasurementsHarmonics;
driver.Measurement.Process();  // Active the Harmonics measurement

bool overload = false;
double[] harmData = new double[5];
bool[] overloads = new bool[5];

driver.Measurement.Harmonics.ReadHarmonics(Harmonics: ref harmData, Overload:
ref overload);
//Read Harmonics test result. The output is the power of main signal and
harmonics in dBm unit.
```

Commands Summary

- Maximum Harmonics Number is to set the number of harmonics will be tested, default vaule is 1. Please take note it includes the fundamental frequency signal. For example, if you set the driver.Measurement.Harmonics.MaxmumHarmonicsNumber to 3 to test a 1 GHz CW signal, it will test the power level of 1 GHz(fundamental freq), 2 GHz and 3 GHz signal.
- Measurement.Harmonics.ReadHarmonics() is used to read the Harmonics test result, and the result is only in dBm unit. If you want to get the result in dBc unit, such as 2nd Harmonics is XX dBc related to fundamental signal, you need to calculate with your own code
- Because the Harmonics test usually requires high dynamic range, please carefully adjust driver.receiver.RF.power to achieve a better result.
- IQ Acquisition mode is not supported by Harmonics measurement mode.

Get the Measurement Result

Refer to the process of step 8 in example 1 to build and run your program to get the result as below.



```
CS_Measurement_Harmonics

Driver Initialized

VXT M9420A Successfully Generated 1 GHz -10 dBm CW Signal.
Stop to Debug
Amplitude of Fundamental Frequency is -10.3555977757739 dBm
Harmonic 2= -72.5886817773542 dBm
Harmonic 3= -93.6199992820291 dBm
_
```

Before running the program, please make sure the M9300A reference software is turned on.

It will take several minutes to run the program as the VXT vector transceiver need boot up before running this program.

Example 10: ACPR Test

This example introduces the programming procedure to measure ACPR of a LTE FDD signal with M9420A/M9421A.

- VXT source outputs a LTE FDD signal
- VXT receiver test ACPR of this signal

Before programming, please connect VXT RF Output to RF Input port and VXT 100 MHz Ref In port to M9300A's 100 MHz Ref Out port. Please refer to figure 3-1 for details.

The programming procedure are listed as 8 steps as below:

Step 1. - Create your project with Visual C#

Step 2. - Add References

Step 3. - Add Using Statements

Step 4. - Create an Instance

Step 5. - Initialize the Instance

Step 6. - Write the Program (Set VXT source to generate LTE FDD signal, and set VXT receiver to test the ACPR of this signal)

Step 7. - Close the Instance

Step 8. - Build and Run the Program

For step 1, 2, 3, 4, 5, 7, 8, pleas refer to example 1 as those steps are similar. This section will only introduce the example code for step 6 - Write the Program.

After the VXT software is installed, you can find the source code as below:

C:\Program Files (x86)\IVI Foundation\IVI\Drivers\KtM9420\Examples\VS.Net\CSharp\CS_Measurement_ACPR.

Write the Measurement Program

To output a CW signal with VXT source, please refer to Example 1.

To test the harmonics of this signal, please refer to below source codes:

```
driver.Receiver.RF.Frequency = 1e9;
driver.Receiver.RF.Power = 0; //set the Receiver.RF.Power a little larger the
target test value to avoid overload
double rmsvalue = -20 * Math.Log10(driver.Source.Modulation.ArbRmsValue) + 3;
//Read the RMS value from waveform file and transfer it into Peak to Avearge
Ratio Value(PAR). Add 3 dB buffer.
driver.Receiver.RF.PeakerToAverage = rmsvalue;//Set the Peak to Average Ratio
driver.Apply();

driver.Measurement.Acpr.UseChanPwrForRef = false; //Do not use Power Servo
result as carrier power to test ACPR result. Will introduce this in detail
later.
int numAcprMeas = 3;
//In this code, we will test 2 adjcent channels (1 lower and 1 upper), so 3
channel powers will be tested to get 2 ACPR results.
double[] AcprOffsetFreq = new double[] { 0, -5e6, 5e6 }; //Define the offset of
every channel. Carrier channel’s offset is 0.
double[] AcprSpan = new double[] { 4.5e6, 4.5e6, 4.5e6 }; //Define Span of every
channel
double[] AcprDuration = new double[] { 500e-6, 500e-6, 500e-6 };
KtM9420ChannelFilterShapeEnum[] AcprFilterType = new
KtM9420ChannelFilterShapeEnum[numAcprMeas];
AcprFilterType[0] =
KtM9420ChannelFilterShapeEnum.KtM9420ChannelFilterShapeRectangular;
AcprFilterType[1] =
KtM9420ChannelFilterShapeEnum.KtM9420ChannelFilterShapeRectangular;
AcprFilterType[2] =
KtM9420ChannelFilterShapeEnum.KtM9420ChannelFilterShapeRectangular;
double[] AcprAlpha = new double[] { 0.01, 0.01, 0.01 };
double[] AcprBandWidth = new double[] { 4.5e6, 4.5e6, 4.5e6 };

driver.Measurement.Acpr.AcquisitionMode =
KtM9420AcquisitionModeEnum.KtM9420AcquisitionModePower;
driver.Measurement.Acpr.SetAcprParameter(OffsetFrequency: AcprOffsetFreq,
Span: AcprSpan, Duration: AcprDuration);
driver.Measurement.Acpr.AveragingNumber = 10;
driver.Measurement.Acpr.ConfigureFilter(Shape: AcprFilterType, Alpha:
AcprAlpha, Bandwidth: AcprBandWidth);
```

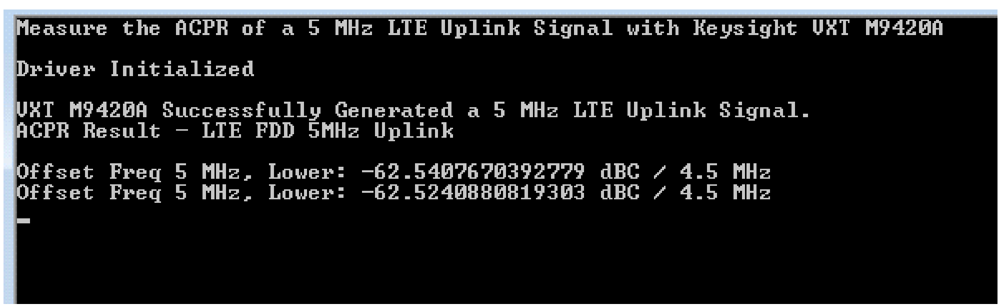
Commands Summary

- `driver.Measurement.Acpr.UseChanPwrForRef` is a special setting for VXT's ACPR measurement. If it set to `true`, VXT will use Power servo's power result as carrier channel's power to perform ACPR test. Because VXT is designed to perform high speed measurement. When customer test a amplifier, it requires to perform power servo and ACPR for same DUT. VXT support to use power servo's power result as carrier channel's power to perform ACPR, so it will help to decrease the total measurement time.
- If you don't need to perform Power Servo (such as transmitter or base station test) before ACPR test, should set the `driver.Measurement.Acpr.UseChanPwrForRef` to `false`. Current example is this case.
- No matter `UseChanPwrForRet` is set to true or false, the `Measurement.Acpr.ReadAcpr` result will NOT included the carrier chanel's channel power. Only the ACPR result – for example –xx dBc of 1st upper adjacent channel vs. carrier channel's power.
- `Measurement.Acpr.ReadAcpr` will get a `AcprResultOverload` value, and it will help to check whether you have received correct result. If the AcprResultOverload get **true,** the ACPR power result will be incorrect as the VXT has already overloaded.

Get the Measurement Result

Refer to the process of step 8 in example 1 to build and run your program to get the result as below.

VXT test the ACPR result as below:



Before running the program, please make sure the M9300A reference software is turned on.

It will take several minutes to run the program as the VXT vector transceiver need boot up before running this program.

Example 11: Combined WCDMA Power Servo and ACPR Measurement

When making a WCDMA Power Servo and ACPR measurement, Servo is performed using "Baseband Tuning" to adjust the source amplitude and then "Baseband Tuning" is used to digitally tune the center frequency in order to make channel power measurements, at multiple offsets, using the Power Servo interface of the VXT.

The following example code demonstrates how to instantiate driver instances, set the resource names and various initialization values, initialize the driver instances, and perform the other relevant tasks:

- Send source RF and LoadWaveform commands to the VXT driver
- Send receiver RF commands to the VXT driver
- Send measurement process command to run a Servo loop and ACPR measurement
- Read the measurement result and close the driver

Before programming, please connect VXT RF Output to RF Input port and VXT 100 MHz Ref In port to M9300A's 100 MHz Ref Out port. Please refer to figure 3-1 for details.

After the VXT software is installed, you can find the source code as below:

C:\Program Files (x86)\IVI Foundation\IVI\Drivers\KtM9420\Examples\VS.Net\CSharp\CS_PowerServo_ACPR.

Example Program 3 - Pseudo -code

Initialize drivers for VXT and check for errors

Configure Source RF Settings:

Frequency

RF Level

RF Output Port and Enable On

Configure ARBPLAY Settings:

Load WCDMA Signal Studio File

Get RMS Value

Play ARB File

Configure Receiver RF Settings:

Frequency

Level

Peak to Average Ratio

- Input Port
- Configure Power Servo Settings
  - Enable Power Servo Measurement
  - Acquisition Mode
  - Acquisition Settings
  - Power Servo Settings
- Configure ACPR Settings
  - Enable ACPR Measurement
  - ACPR Measurement Settings
- Enable VXT Settings:
  - Source Settings
  - Receiver Settings
- Apply All Above Settings and Measurements
- Read Power Servo Results
  - Measured Power
  - Pass/Fail
  - Overload
  - Servo Count
- Read ACPR Results
  - ACPR Values
  - Overload

Source Code

```
// Copy the following example code and compile it as a C# Console Application
#region Specify using Directives
using System;
using System.Collections.Generic;
using System.Linq;
using System.Text;
using Ivi.Driver.Interop;
using Keysight.KtM9420.Interop;
#endregion
```

```
namespace PaServoAcpr
{
    class Program
    {
        static void Main(string[] args)
        {
            // Create driver instances
            KtM9420 driver = new KtM9420();
            try
            {
                #region Initialize Driver Instances
                string ResourceName = "PXI0::23-0.0::INSTR";
                bool IdQuery = true;
                bool Reset = true;
                string OptionString = "QueryInstrStatus=true,
                Simulate=false,DriverSetup= ";
                driver.Initialize(ResourceName, IdQuery, Reset,OptionString);
                Console.WriteLine("Driver Initialized\n");

                #endregion

                #region Check Instrument Queue for Errors

                int errorcode = 0;
                string message = string.Empty;
                // Check instrument for errors
                do
                {
                    driver.Utility.ErrorQuery( ref errorcode, ref message );
                    if( errorcode != 0 )
                    {
                        Console.WriteLine( message );
                    }
                } while( errorcode != 0 );


                #endregion
                #region Create Default Settings for WCDMA Uplink Signal
                // Source Settings
                double Frequency = 1000000000.0;
                double Level = 3;
                double Gain = 0;
                double PowerOutMargin = 0.05;
                double ServoOverheadTime = 600e-6;
                // If a Signal Studio waveform file is used, it may require a
                software license.
                string ExamplesFolder = "C:\\Waveforms\\";
                string WaveformFile = "WCDMA_UL_DPCHH_2DPDCH_1C.wfm";
```

```
                // Receiver Settings
                double ChannelTime = 0.0001;
                double AdjacentTime = 0.0005;
                double IfBandwidth = 40000000.0;
                double MeasureBW = 5000000.0;
                KtM9420ChannelFilterShapeEnum FilterType =
KtM9420ChannelFilterShapeEnum.KtM9420ChannelFilterShapeRaisedCosine;
                double FilterAlpha = 0.22;
                double FilterBw = 3840000.0;
                double AcprFliterBw = 3840000.0;
                double AcprFilterAlpha = 0.22;
                KtM9420ChannelFilterShapeEnum AcprFilterType =
KtM9420ChannelFilterShapeEnum.KtM9420ChannelFilterShapeRaisedCosine;
                double[] FreqOffset = new double[] {-5000000.0, 5000000.0, -
10000000.0, 10000000.0};
                double[] acprFilterAlpha = new double[4] {AcprFilterAlpha,
AcprFilterAlpha, AcprFilterAlpha, AcprFilterAlpha};
                double[] acprFilterBw = new double[4] {AcprFliterBw,
AcprFliterBw, AcprFliterBw, AcprFliterBw};
                KtM9420ChannelFilterShapeEnum[] acprFilterType = new
                KtM9420ChannelFilterShapeEnum[4] {AcprFilterType,
AcprFilterType, AcprFilterType, AcprFilterType};
                double AcprSpan = 30.72e6 / 1.25;
                double AcprDuration = AdjacentTime;
                double[] acprSpan = new double[4]{AcprSpan, AcprSpan,
AcprSpan, AcprSpan};
                double[] acprDuration = new double[4]{AcprDuration,
AcprDuration, AcprDuration, AcprDuration};
                double MeasuredPower = 0;
                bool ServoPass = false;
                int ServoCount = 0;
                bool Overload = true;
                double[] MeasuredACPR = new double[4];
                bool[] MeasuredACPROverload = new bool[4];
                double RmsValue = 0;
                #endregion

                #region Run Commands
                //Setup Source
                driver.Source.RF.Frequency = Frequency;
                driver.Source.RF.Level = Level;
                driver.Source.RF.OutputPort =
KtM9420PortEnum.KtM9420PortRFOutput;
                driver.Source.RF.OutputEnable = true;
```

```
                driver.Source.LoadWaveform(ExamplesFolder, WaveformFile);
                RmsValue = driver.Source.Modulation.ArbRmsValue;
                driver.Source.Modulation.ArbPlayConfigure(
                        WaveformName: WaveformFile,
                        ArbPlayMode:
KtM9420ArbPlayModeEnum.KtM9420ArbPlayModePlayArb,
                        ArbPlayDuration: 1e-4
                    );
                // Setup Receiver
                driver.Receiver.RF.Frequency = Frequency;
                driver.Receiver.RF.Power = Level;
                driver.Receiver.RF.PeakerToAverage = RmsValue;
                driver.Receiver.RF.InputPort =
KtM9420PortEnum.KtM9420PortRFInput;
                // Configure PowerServo
                driver.Measurement.EnabledMeasurements = (int)
KtM9420MeasurementsEnum.KtM9420MeasurementsPowerServo;
                driver.Measurement.PowerServo.AcqusitionMode =
KtM9420AcquisitionModeEnum.KtM9420AcquisitionModeFFT;
                driver.FFTAcquisition.SampleRate = MeasureBW*1.25;
                driver.FFTAcquisition.Length =
KtM9420FFTAcquisitionLengthEnum.KtM9420FFTAcquisitionLength_512;
                driver.FFTAcquisition.Duration = ChannelTime;
                driver.FFTAcquisition.ChannelFilter.Configure
(FilterType,FilterAlpha, FilterBw);
                driver.Measurement.PowerServo.InputPower = Level + Gain;
                driver.Measurement.PowerServo.OutputPower = Level;
                driver.Measurement.PowerServo.OutputPowerMargin =
PowerOutMargin;
                driver.Measurement.PowerServo.OverheadTime = ServoOverheadTime;
                driver.Measurement.PowerServo.MaximumOutputPower = 20;
                // Configure Acpr
                driver.Measurement.EnabledMeasurements |= (int)
KtM9420MeasurementsEnum.KtM9420MeasurementsAcpr;
                driver.Measurement.Acpr.AcquisitionMode =
KtM9420AcquisitionModeEnum.KtM9420AcquisitionModeFFT;
                driver.Measurement.Acpr.UseChanPwrForRef = true;
                driver.Measurement.Acpr.ConfigureFilter
(acprFilterType,acprFilterAlpha,acprFilterBw);
                driver.Measurement.Acpr.SetAcprParameter
(FreqOffset,acprSpan,acprDuration);

                //Setup all hardware in one time.
                driver.Measurement.EnabledMeasurements |= (int)

KtM9420MeasurementsEnum.KtM9420MeasurementsSetupVsa;
```

```
                driver.Measurement.EnabledMeasurements |= (int)
KtM9420MeasurementsEnum.KtM9420MeasurementsSetupVsaFrequency;
                driver.Measurement.EnabledMeasurements |= (int)
KtM9420MeasurementsEnum.KtM9420MeasurementsSetupVsg;
                driver.Measurement.EnabledMeasurements |= (int)
KtM9420MeasurementsEnum.KtM9420MeasurementsSetupVsgFrequency;
                string response = "y";
                while (string.Compare(response, "y") == 0)
                {
                Console.WriteLine("Press Enter to Run Test");
                Console.ReadLine();

                //Process measurement
                driver.Measurement.Process();

                // Check instrument for errors
                do
                {
                    driver.Utility.ErrorQuery( ref errorcode, ref message );
                    if( errorcode != 0 )
                    {
                        Console.WriteLine( message );
                    }
                } while( errorcode != 0 );

                //Read PowerServo
                driver.Measurement.PowerServo.ReadPowerServo(ref
MeasuredPower,ref ServoPass, ref Overload, ref ServoCount);
                Console.WriteLine("Measured Power {0}dbm , Servo pass is {1},
Servo Count is {2}, Servo Overload is {3}",
                MeasuredPower, ServoPass, ServoCount, Overload);

                driver.Measurement.Acpr.ReadAcpr(ref MeasuredACPR, ref
MeasuredACPROverload);
                Console.WriteLine("ACPR1 L: {0} dBc, Overload is {1}",
MeasuredACPR[0], MeasuredACPROverload[0]);
                Console.WriteLine("ACPR1 U: {0} dBc, Overload is {1}",
MeasuredACPR[1], MeasuredACPROverload[1]);
                Console.WriteLine("ACPR2 L: {0} dBc, Overload is {1}",
MeasuredACPR[2], MeasuredACPROverload[2]);
                Console.WriteLine("ACPR2 U: {0} dBc, Overload is {1}",
MeasuredACPR[3], MeasuredACPROverload[3]);
                Console.WriteLine("Repeat? y/n");
                response = Console.ReadLine();
                }
                #endregion
            }
```

```
            catch (Exception ex)
            {
            Console.WriteLine("Exceptions for the drivers:\n");
            Console.WriteLine(ex.Message);
            }
            finally
            #region Close Driver Instances
            {
                if (driver != null && driver.Initialized)
                {
                    // Close the driver
                    driver.Close();
                    Console.WriteLine("Driver Closed");
                 }
            }
            #endregion

            Console.WriteLine("Done - Press Enter to Exit");
            Console.ReadLine();
            }
        }
    }
```

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