Keysight Technologies

Accelerate Program Development using Keysight Command Expert with MATLAB

Application Note

KEYSIGHT TECHNOLOGIES

Introduction

Keysight Command Expert for fast and easy instrument control!

Keysight Technlologies, Inc. Command Expert is a FREE software application that provides fast and easy instrument control in many PC application environments. Command Expert combines instrument command sets, command sequences, documentation, syntax checking, and command execution in one simple interface. Command Expert helps you to:

- Find instrument commands
- Access command documentation
- Verify command syntax
- Build instrument command sequences
- Execute instrument command sequences
- Integrate sequences into the MATLAB, Visual Studio, Excel, LabVIEW, Keysight VEE, or Keysight SystemVue PC application environment
- Generate code for command sequences in MATLAB, Visual C#, Visual Basic .NET, and Visual C/C++
- Profile command execution time
- Debug command sequences using breakpoints and single-stepping

Instrument command sets are available for instruments that use Standard Commands for Programmable Instrumentation (SCPI) or IVI-COM drivers.

This application note contains two main sections:

- **Command Expert Basics** Introduces you to the Command Expert user interface and shows an example sequence.
- **Command Expert in the MATLAB Environment** Describes how to how to run Command Expert sequences from MATLAB and automatically generate code for use with the MATLAB Instrument Control Toolbox.

Command Expert Basics

This section describes how to download, install, and start Command Expert, and uses an example sequence to show the features of the Command Expert user interface.

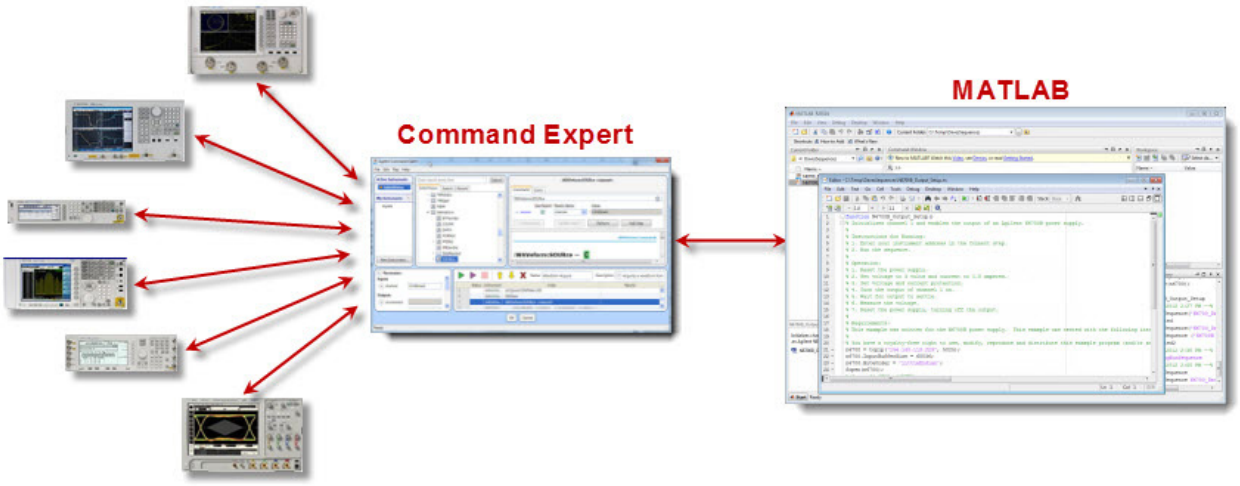

Figure 1. Command Expert and MATLAB Integration

Downloading and Installing the Software

1. Download and install the Keysight IO Libraries Suite (Version 15.0 or above). This software is required by Command Expert to find and communicate with instruments. You can download Keysight IO Libraries Suite from **www.keysight.com/find/iosuite**.
2. Install MATLAB and MATLAB Instrument Control Toolbox. Command Expert can be used with MATLAB R2009a (or above) with Instrument Control Toolbox.
3. Download and install Command Expert. If MATLAB is already installed, the Command Expert MATLAB Add-On will be installed automatically. You can download Command Expert from www.keysight.com/find/commandexpert.

Figure 2. Command Expert Icon

Starting Command Expert

Click **Start > All Programs > Keysight Command Expert > Keysight Command Expert**. The Command Expert opening window (Welcome Window) is shown below. Command Expert comes with a number of preconfigured examples for popular instruments. The installation software installs an example instrument named ***N6700*** that provides the commands for the Keysight N6700B Power Supply. We will use this instrument and the ***N6700_PowerSupply_OutputSetup*** example to introduce you to the Command Expert user interface.

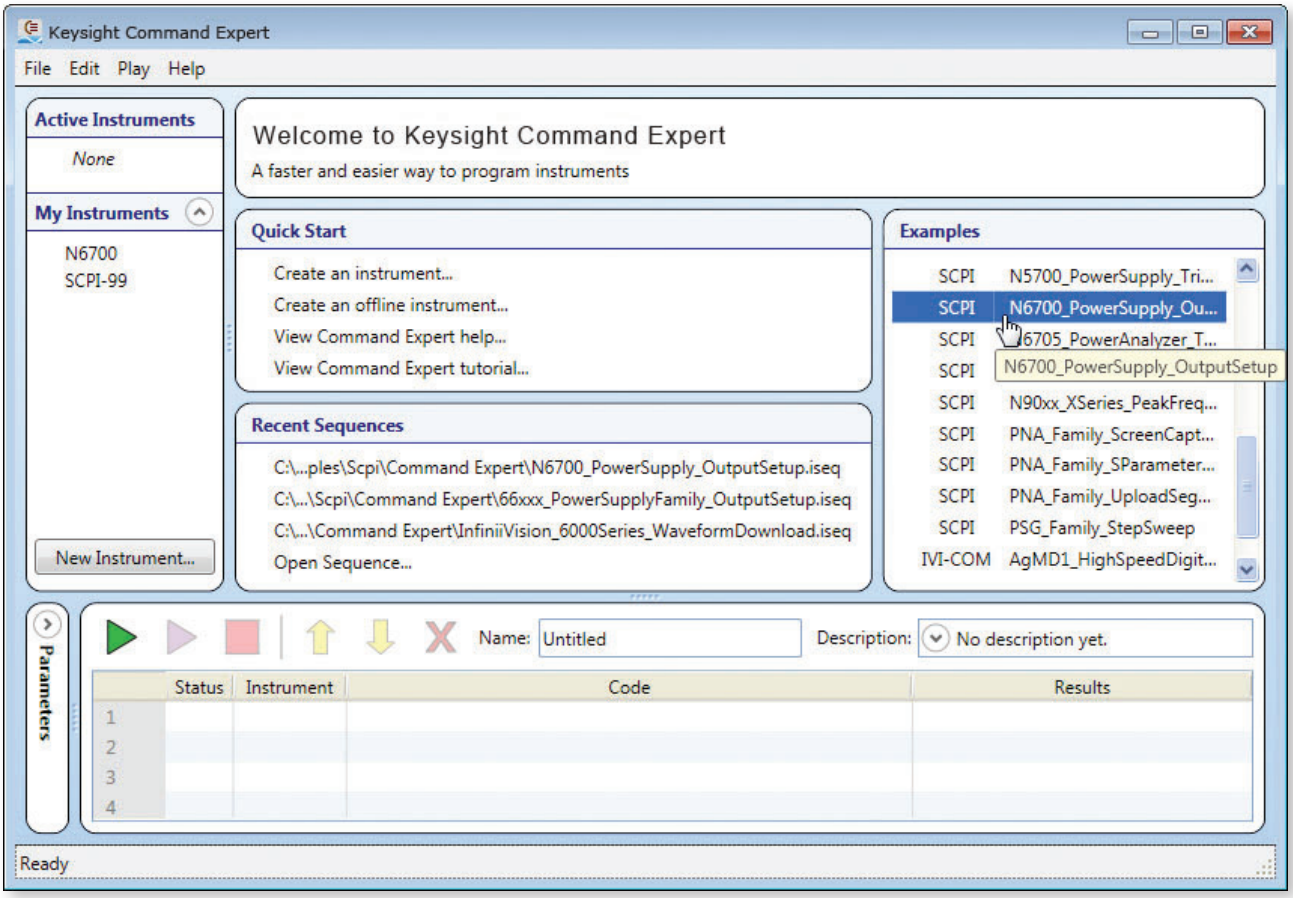

Figure 3. Command Expert Welcome Window

Internet access and command sets

The N6700 instrument and its SCPI command set are installed by default. For other instrument examples, you will be prompted to install the instrument's command set. After installing Command Expert, you will need Internet access to download SCPI command sets or IVI-COM instrument drivers for your instruments. If you work in a secure environment with limited Internet access, you can still use Command Expert. Simply download the SCPI command sets or IVI-COM instrument drivers using a computer with internet access. You can then transfer the command sets or drivers to the computer with no internet access (using a USB drive, for example).

The Command Sequence

The command sequence for the *N6700_PowerSupply_OutputSetup* example is shown in the Sequence Pane in the graphic below. A Command Expert sequence is a series of steps that are executed in order to connect to an instrument, configure an instrument, set outputs, and perform measurements.

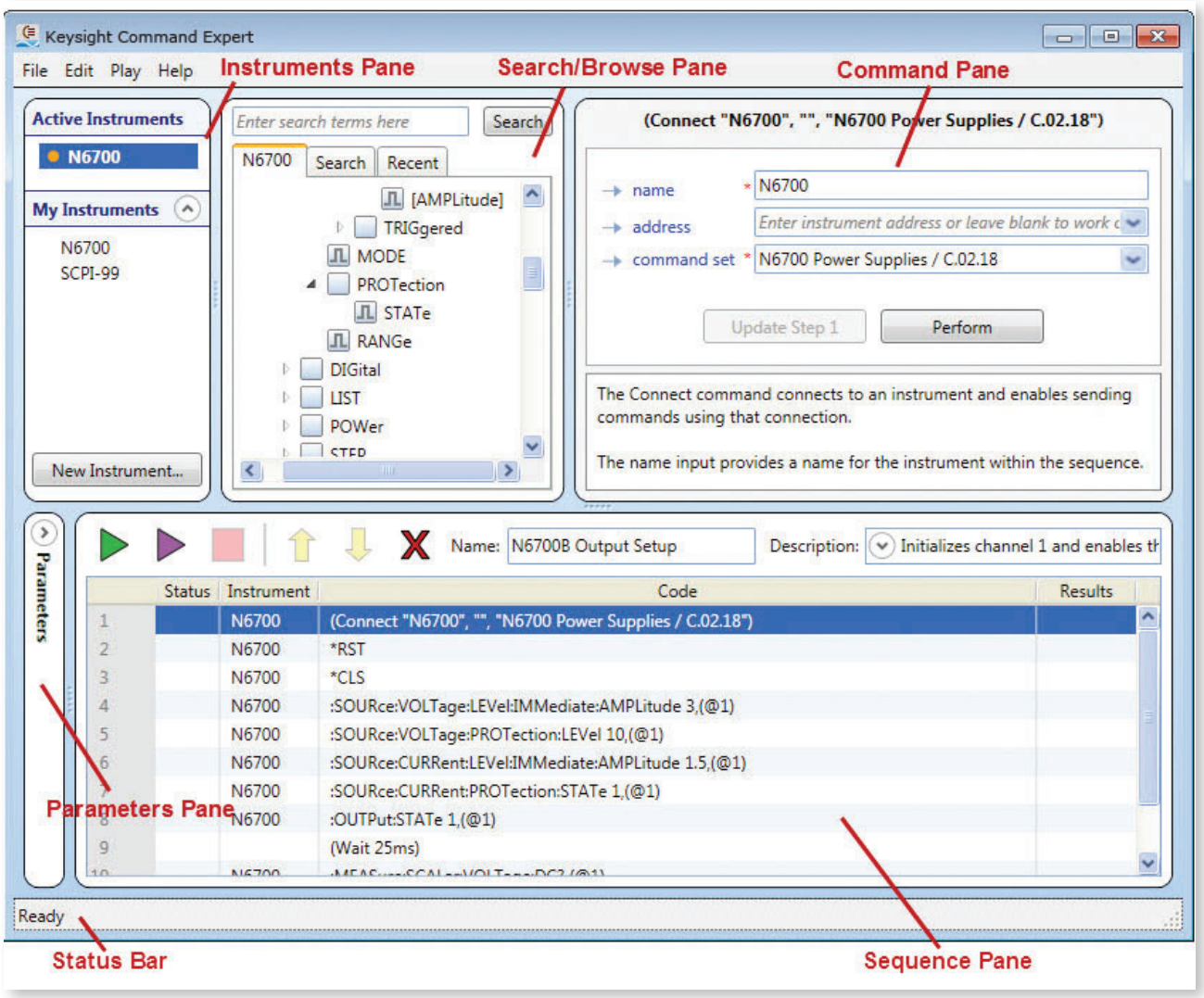

Figure 4. Command Expert User Interface Overview

- The **Instruments Pane** shows your instruments and lets you connect to them.
- The **Search/Browse Pane** shows you the commands for the selected instrument and lets you search for commands.
- The **Command Pane** shows the selected command and its documentation, and lets you execute the command.
- The **Status Bar** shows progress messages as Command Expert performs operations.
- The **Parameters Pane** expands to show sequence parameters and lets you view and edit their names and values.
- The **Sequence Pane** shows the various steps in the Command Expert sequence and lets you edit the sequence and replay commands. The Sequence Pane has the following features:

The Command Sequence *(continued)*

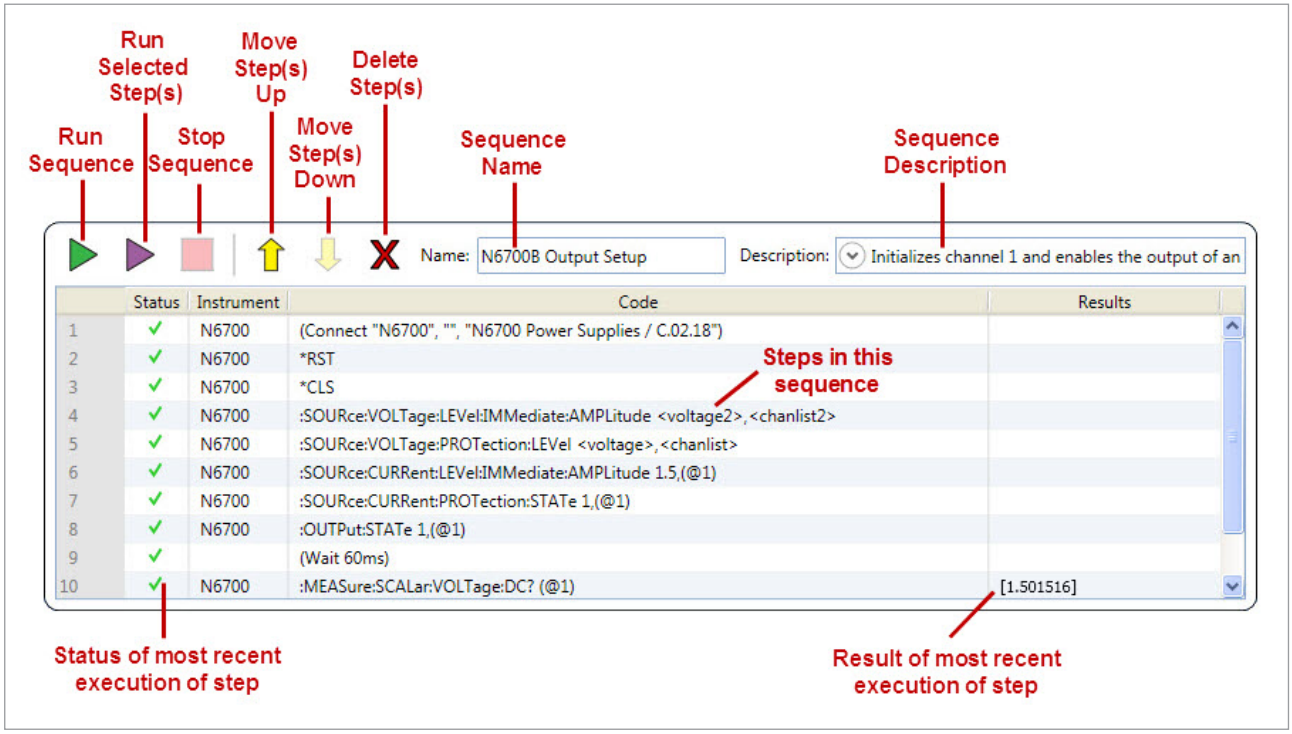

Figure 5. Sequence Pane Details

Working offline

The absence of a specific instrument address in step 1 of the sequence shown above indicates that we are working offline. To connect to an actual instrument, select step 1 in the Sequence Pane, and enter the instrument address in the address field in the Command Pane.

Working offline is a simulation mode where you can view and perform commands as usual, but the commands return default values. This is a good way to explore a command set, view documentation, and prototype sequences without having to connect to a physical instrument.

Sequence Steps

Selecting a step in the Sequence Pane reveals details about the command and its parameters.

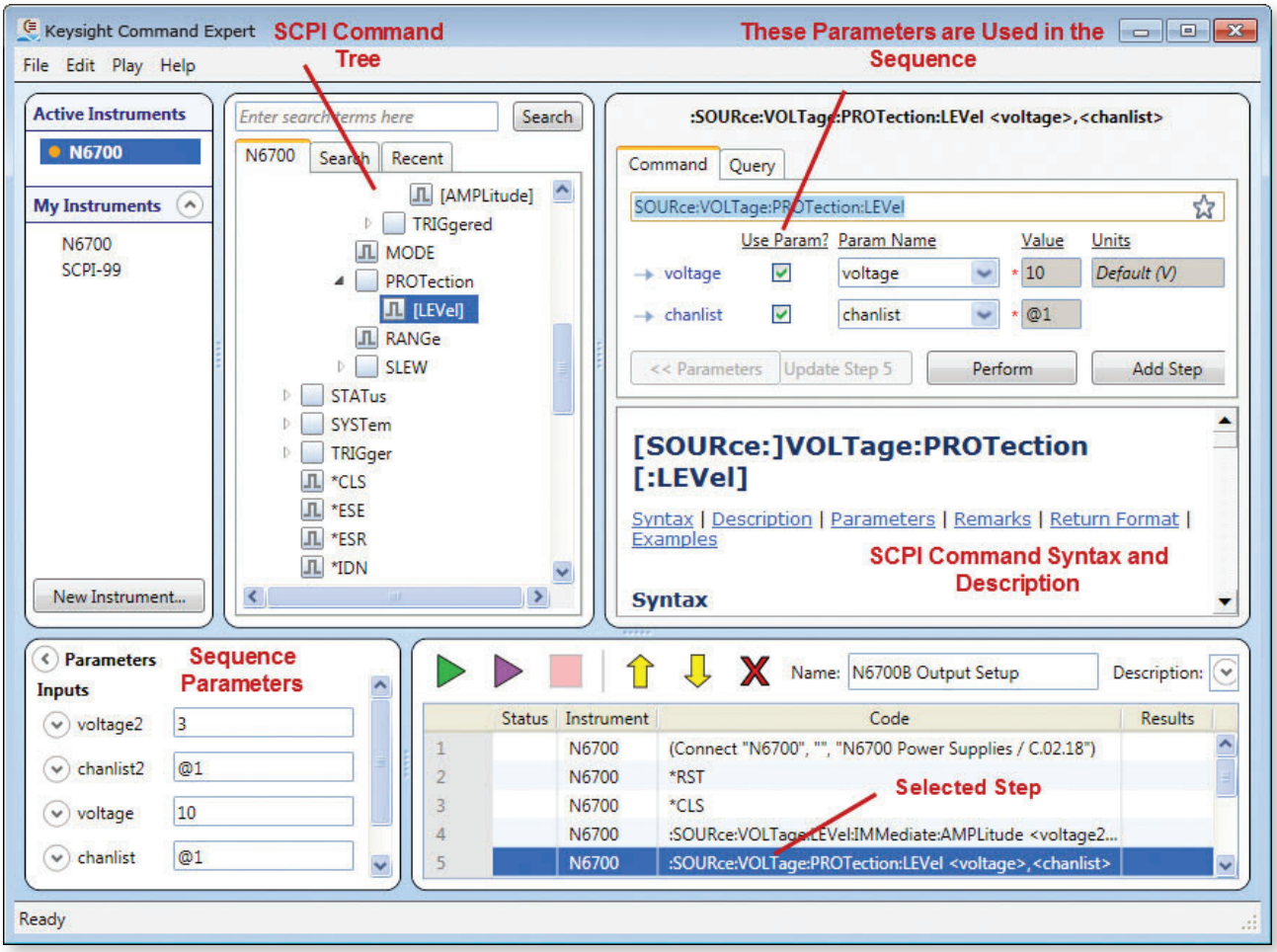

Figure 6. Command Details

Command Expert uses these types of steps:

- Connect steps (to connect to instruments)
- Command steps (SCPI or IVI-COM commands)
- Wait statements
- Comments
- Steps to control timeouts and error handling

Sequence Debugging

You can debug a sequence by inserting breakpoints. When you run the sequence, execution pauses at the first step with a breakpoint and Command Expert enters single-step mode. In single-step mode you can single-step the sequence, monitor parameters and results, replay the sequence, and play selected steps. When you are ready to run the sequence without pausing at the breakpoint, remove the breakpoint and run the sequence normally.

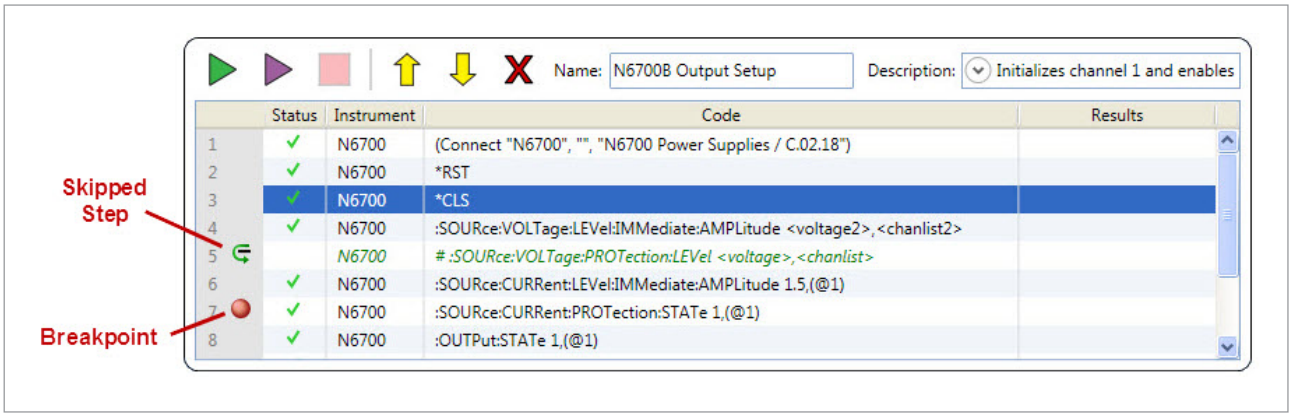

Figure 7. Debugging the Sequence

You can also skip steps to help with debugging.

Substituting an instrument

You can temporarily switch command sets in a sequence to see the effects of switching to a different instrument. Any commands that aren't supported by the new instrument are highlighted in red.

Using IVI-COM

If you prefer, you can use IVI-COM commands instead of SCPI commands. Command Expert has a number of IVI-COM examples and the operation is very similar to SCPI. The example below (filename: ***AgN67xx_PowerSupply_OutputSetup.xlsx***) uses IVI-COM commands:

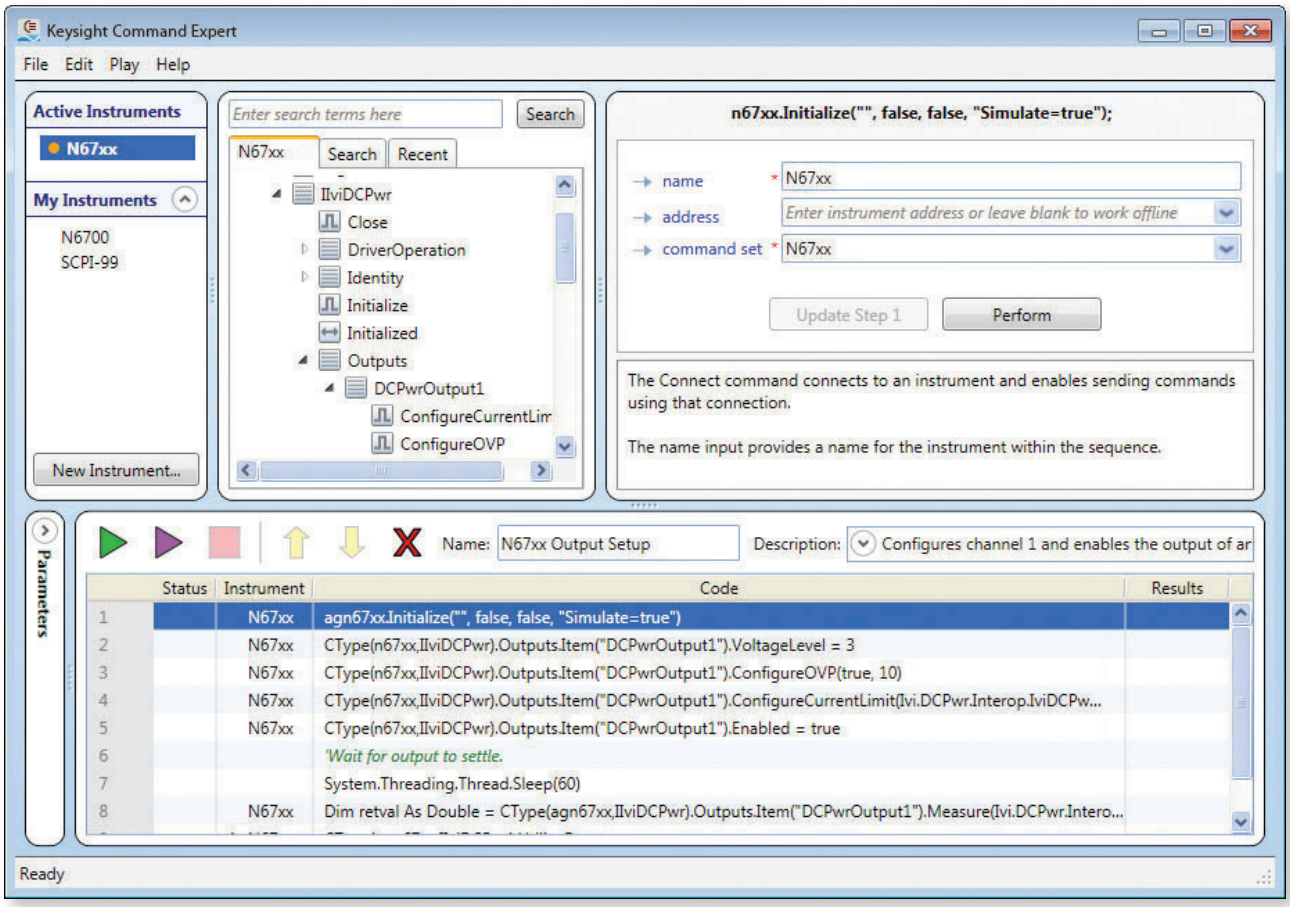

Figure 8. IVI-COM Commands

IVI-COM command sets and drivers

IVI-COM command sets are automatically extracted from IVI-COM drivers. You must install an IVI-COM driver (outside of Command Expert) before you can use the driver's command set in Command Expert.
You can download Keysight IVI-COM drivers from **www.keysight.com/find/ivi**.

Using IVI-COM *(continued)*

The Command Expert IVI-COM interface is very similar to the SCPI interface. All elements within the interface operate as described earlier in this application note. For more information, see ***Command Expert for IVI-COM Tutorial*** in the Command Expert help:

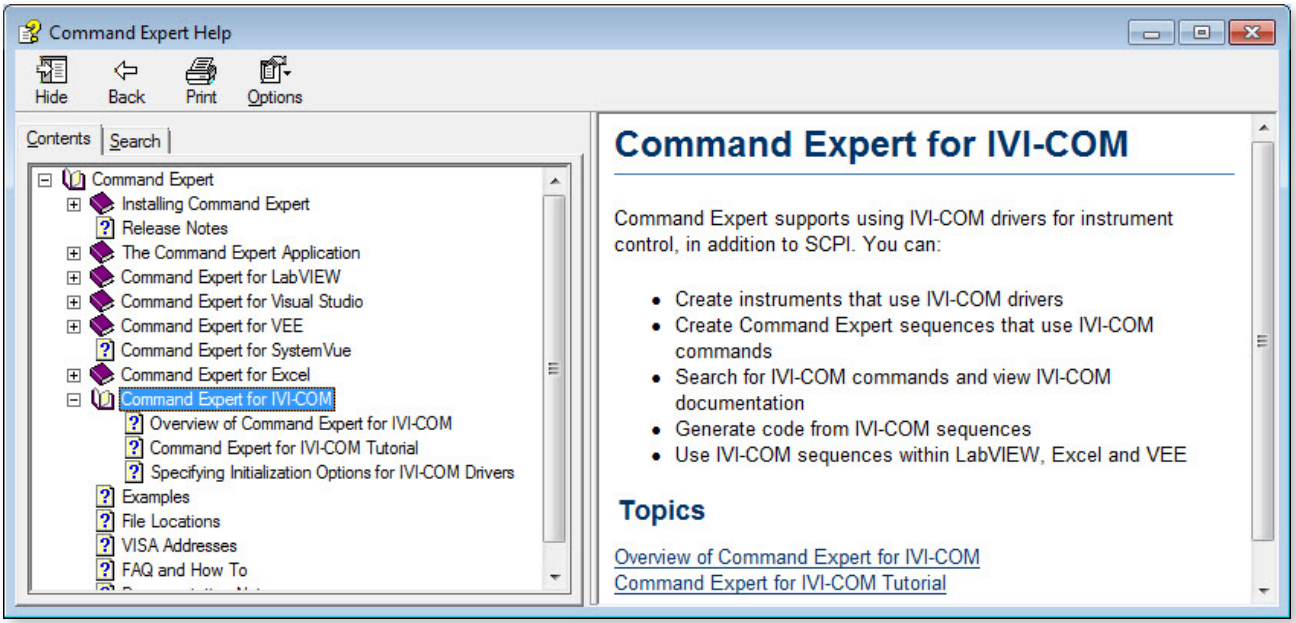

Figure 9. IVI-COM Help

Using Command Expert with Non-Keysight Instruments

You can use Command Expert with any SCPI instrument that follows the SCPI-99 standard, using the ***Generic SCPI-99 Instrument*** command set. This command set provides the commands that are common to SCPI-99 instruments.
You can also use direct commands to send additional SCPI commands. Using direct commands, you can send any SCPI command to any SCPI instrument.
Any instrument that has an IVI-COM driver can be used with Command Expert, regardless of the manufacturer.

Getting Started with Command Expert

To get started using Command Expert, you can start with one of the many example sequences and modify that sequence, or you can create your own sequence. For a step-by-step tutorial showing how to create a sequence, see ***Command Expert Tutorial*** in the Command Expert help:

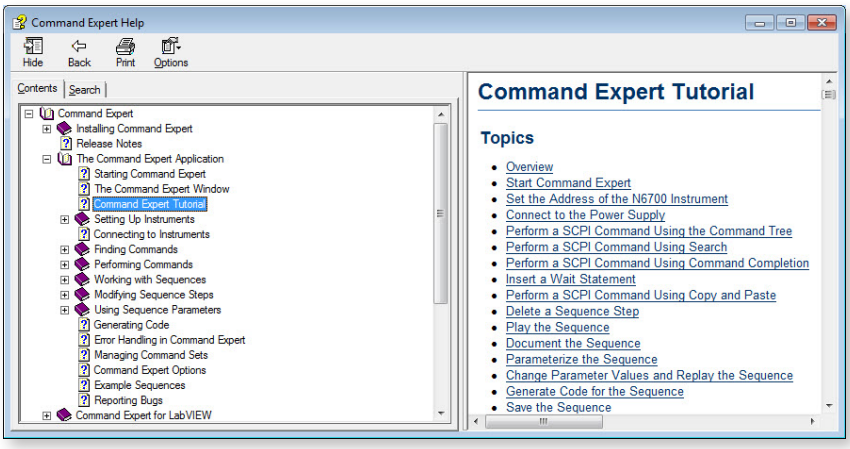

Figure 10. Command Expert Tutorial

Command Expert in the MATLAB Environment

You can use Command Expert to help automate instrument control in MATLAB using either or both of
these approaches:

- Running Command Expert sequences in MATLAB
- Generating MATLAB code from Command Expert

Running Command Expert Sequences in MATLAB

The Command Expert MATLAB Add-On provides a set of MATLAB functions that let you run Command Expert sequences from MATLAB. The advantages of this approach are:

- You can run an entire sequence from a single MATLAB command line.
- The sequence can contain SCPI commands and/or IVI-COM.
- There is no generated code to keep in sync with the Command Expert sequence. You just update the Command Expert sequence as needed.
- The Command Expert MATLAB Add-On handles translation between MATLAB data types and the inputs/outputs of the SCPI and IVI-COM commands.

The limitation of this approach is that the Command Expert MATLAB Add-On only works on Windows operating systems.

Using agRunSequence

The agRunSequence function allows you to run a Command Expert sequence from MATLAB. For example, this command runs the Command Expert ***OutputSetup.iseq*** sequence:

```
agRunSequence('OutputSetup')
```

You can pass input parameters into the Command Expert sequence from MATLAB, and return sequence outputs from Command Expert to MATLAB. In the following example, the *waveform, voltageMax, voltageMin, voltageAverage, xIncrement* parameters are output parameters from the Command Expert sequence (measurement data) and the *address, range, offset, recordSize, sampleRate* are input parameters for the Command Expert sequence.

Command Expert in the MATLAB Environment *(continued)*

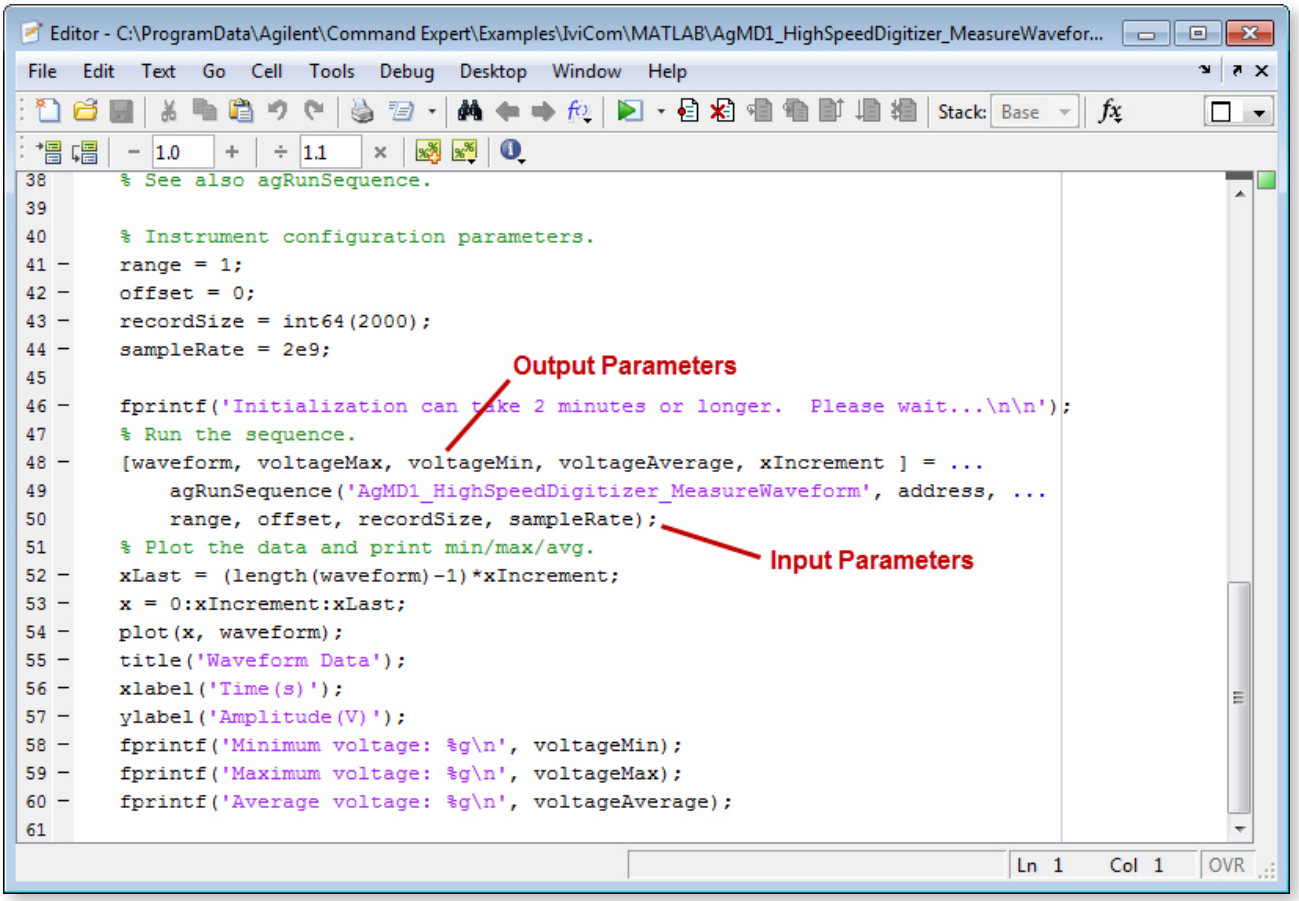

Figure 11. Sequence Input and Output Parameters

The above example and a number of other examples showing agRunSequence are located in:

C:\Documents and Settings\All Users\Keysight\Command Expert\Examples (for Windows XP)

C:\ProgramData\Keysight\Command Expert\Examples (for Windows 7)

MATLAB examples are in these subfolders:

...\Scpi\MATLAB (SCPI examples)

...\IviCom\MATLAB (IVI-COM examples)

Other MATLAB Functions

In addition to agRunSequence, these functions are also available in the add-on:

- agResetConnections - resets all Command Expert instrument connections.
- agInstallCommandSets - installs any missing command set(s) for the sequence.
- agSequenceInfo - displays information about the sequence.
- agDefault - constructs a default argument object; the corresponding parameter's default value is used when running the sequence.
- agSequence – (for advanced users) constructs a Command Expert sequence object.

Getting Help on Functions

To display information about any add-on function, including descriptions, syntax, and examples, type ***help*** ***<function>*** in the MATLAB Command Window. For example:

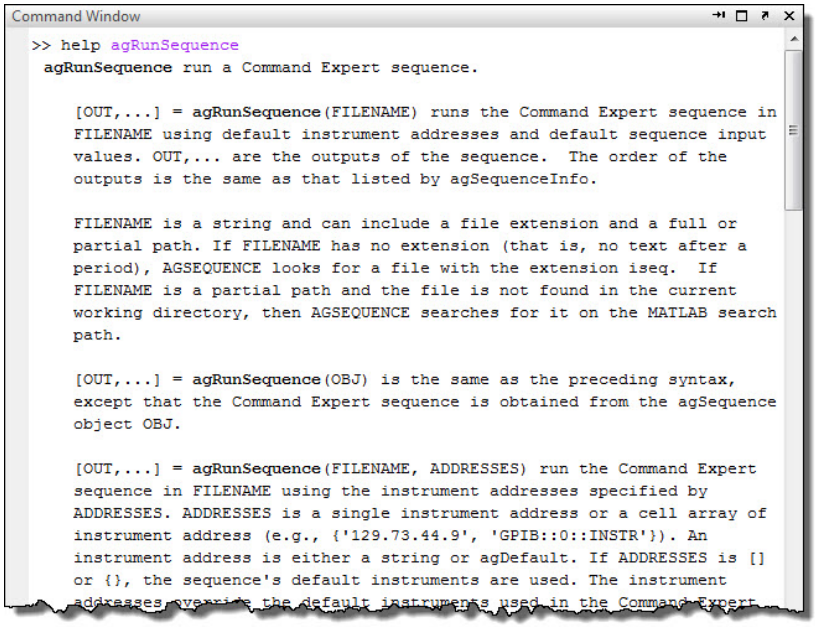

Figure 12. Getting Help on Functions

For More Information

For a step-by-step tutorial, see *Tutorial – Running Sequences in MATLAB* in the Command Expert help:

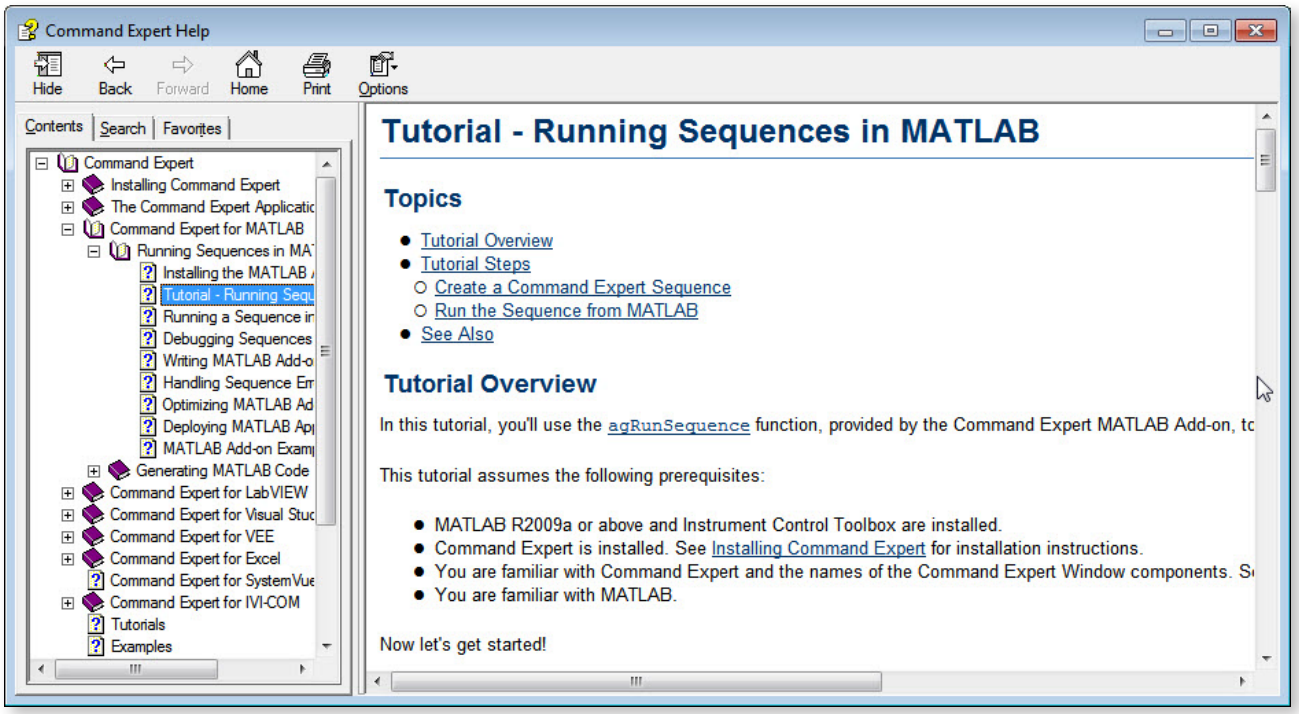

Figure 13. *Tutorial -- Running Sequences in MATLAB*

Generating Code from Command Expert

You can use Command Expert to generate code from SCPI command sequences. This allows you to efficiently develop and test instrument command sequences before incorporating the code into the MATLAB Instrument Control Toolbox.
The advantages of the code generation approach are:

- The generated code can be used on Windows and non-Windows platforms.
- If you have already written instrument control code using the MATLAB Instrument Control Toolbox, the generated code will be a closer fit with your existing code.

The limitations of this approach are:

- The generated code can get out of sync with the Command Expert sequence. That is, code edits made in either Command Expert application or MATLAB application are not automatically reflected in the other application.
- MATLAB code generation is available for SCPI command sequences only. You cannot generate MATLAB code from an IVI-COM command sequence. You can, however, run a Command Expert IVI-COM sequence from MATLAB using the agRunSequence function as described earlier in this application note.

The steps for generating code are (these steps are described in detail in the following example):

1. Create a SCPI command sequence in Command Expert.
2. Export the sequence to the clipboard with MATLAB calls to Instrument Control Toolbox enabled.
3. Paste the generated code into a MATLAB file (also called a .m file).

You can then run the function, modify it, or use it in your application.

MATLAB Code Generation Example

The following steps use the *SCPI N6700_PowerSupply_OutputSetup* example to show how to generate and paste code into a MATLAB file.

1. If not already open, open the ***N6700_PowerSupply_OutputSetup*** example from the Command Expert Welcome Window.
2. The example opens with the SCPI commands listed (default mode). This example sets the output voltage and current of a Keysight N6700B Power Supply:

MATLAB Code Generation Example *(continued)*

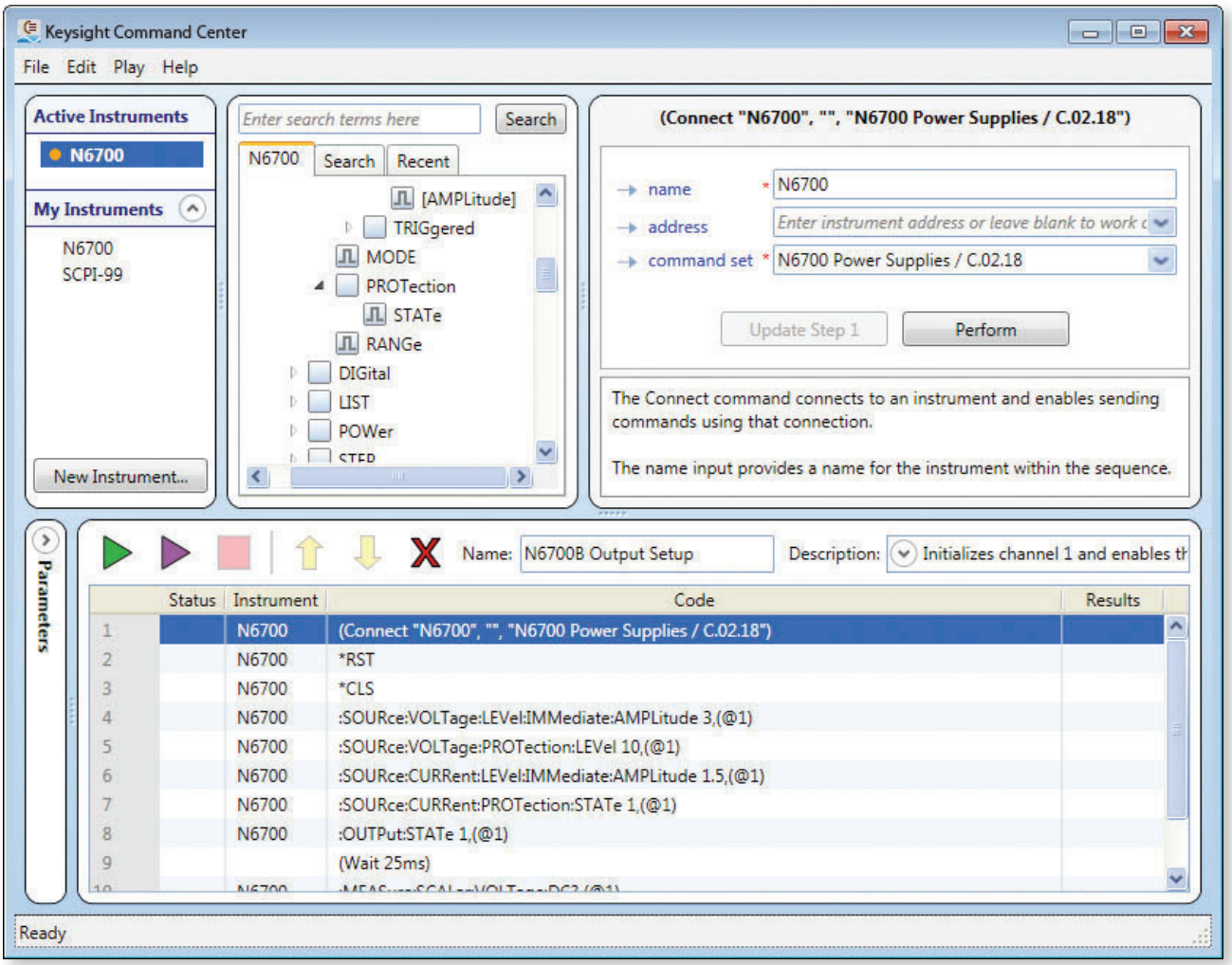

Figure 14. N6700 Example

3. Click **File > Export Sequence**... and select **MATLAB with calls to Instrument Control Toolbox:**

MATLAB Code Generation Example *(continued)*

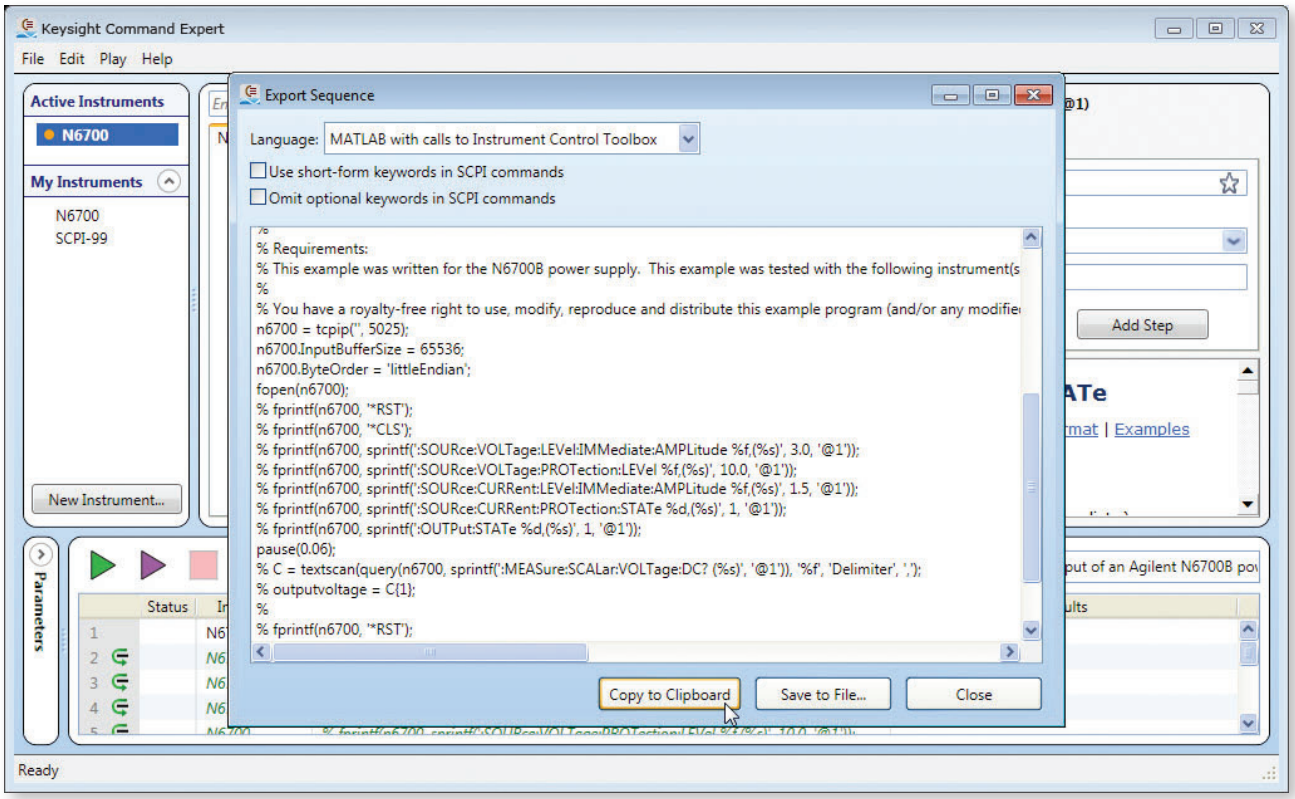

Figure 15. Exporting the Sequence (MATLAB with calls to Instrument Control Toolbox)

4. Click **Copy to Clipboard** followed by **Close**. The MATLAB calls (such as fprint and sprint) are automatically added to the sequence and the sequence is copied to the clipboard.

When Command Expert generates code:

- The generated code for skipped statements is commented out.
- Comments in a sequence become comments in the generated code.
- Wait statements become calls to appropriate library functions.

5. You can now paste this code into a MATLAB file. The following graphic shows the generated code from the ***N6700_PowerSupply_OutputSetup*** example pasted into a MATLAB file:

MATLAB Code Generation Example *(continued)*

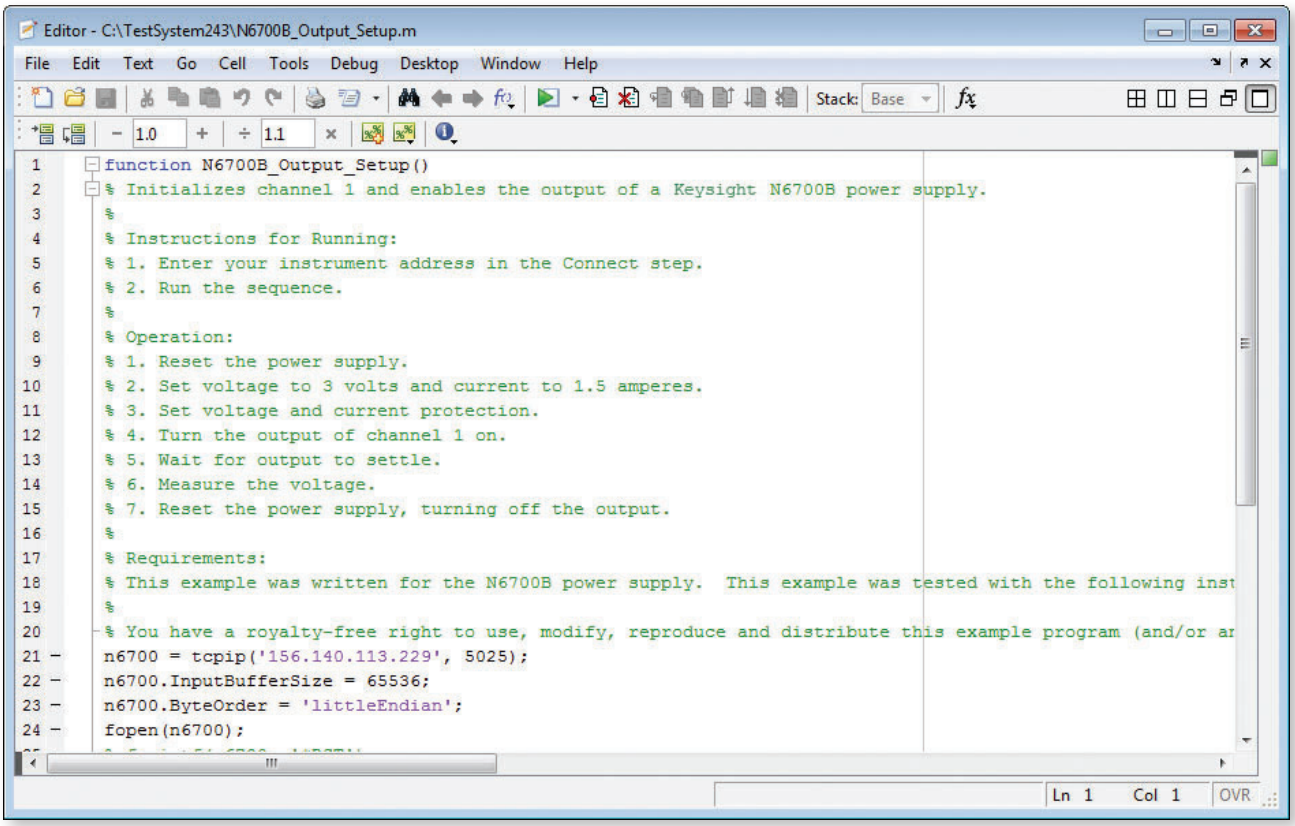

Figure 16. Generated Code Pasted into a MATLAB File

For More Information

For a step-by-step tutorial, see *Tutorial - Generating MATLAB Code* in the Command Expert help:

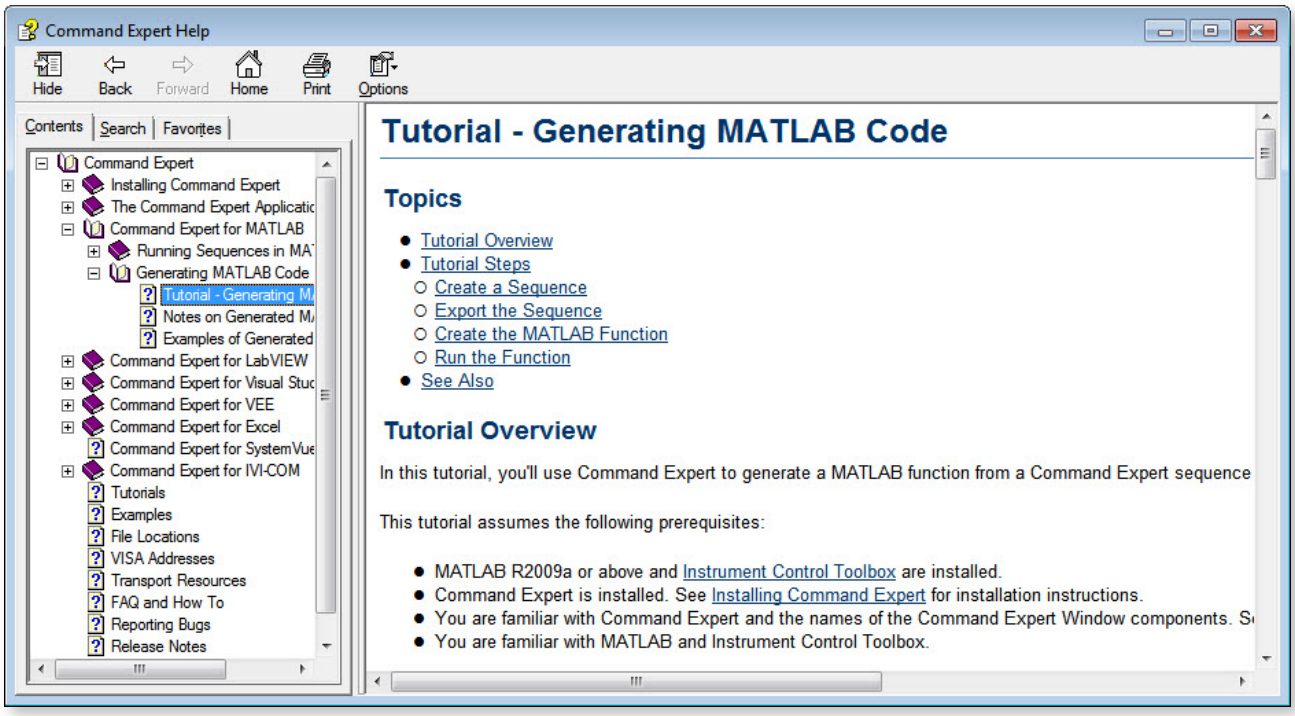

Figure 17. *Tutorial - Generating MATLAB Code*

Where to Go Next

An easy way to get started using Command Expert with MATLAB is to browse through the example folders and select an example that is similar to your test and measurement application. Examples are located in:

C:\Documents and Settings\All Users\Keysight\Command Expert\Examples (for Windows XP)

C:\ProgramData\Keysight\Command Expert\Examples (for Windows 7)

MATLAB examples are in these subfolders:

...\Scpi\MATLAB (SCPI examples)

...\IviCom\MATLAB (IVI-COM examples)

Command Expert has extensive application documentation containing FAQs, tutorials, examples, and getting started information. You can use one of these tutorials, available in the Command Expert help, for step-by-step information on how to use Command Expert with MATLAB:

- *Tutorial – Running Sequences in MATLAB*
- *Tutorial – Generating MATLAB Code*

You can find more information on Command Expert, including links to other application notes, at **www.keysight.com/find/commandexpert**.

Command Expert PC Operating Requirements

Operating System	Windows XP, Service Pack 2 or above, 32-bit only. Editions: Home, Professional Windows 7, 32-bit or 64-bit. Editions: Starter, Home Basic, Home Premium, Professional, Ultimate, or Enterprise
Disk	At least 1GB free disk space
Keysight IO Libraries Suite	Version 15.0 or above **www.keysight.com/find/iosuite**
Monitor	At least 1024x768 monitor resolution
Browser	Internet Explorer 6 or above (7 or above recommended)

You can find the current list of instrument SCPI command sets at:
www.keysight.com/find/commandsetlist

Application Development Environment Requirements

MATLAB	MATLAB R2009a or above and Instrument Control Toolbox
Visual Studio	Visual Studio 2005, 2008, 2010 or above
LabVIEW	LabVIEW 8.2.1 or above.
VEE	VEE Pro 9.22 or above.
Excel	Excel 2007 or Excel 2010.

Download Command Expert now and experience fast and easy instrument control:
www.keysight.com/find/commandexpert

myKeysight

myKeysight

www.keysight.com/find/mykeysight
A personalized view into the information most relevant to you.

Keysight Assurance Plans
www.keysight.com/find/AssurancePlans
Up to five years of protection and no budgetary surprises to ensure your instruments are operating to specification so you can rely on accurate measurements.

www.keysight.com/quality
Keysight Technologies, Inc.
DEKRA Certified ISO 9001:2008
Quality Management System

Keysight Channel Partners
www.keysight.com/find/channelpartners
Get the best of both worlds: Keysight's measurement expertise and product breadth, combined with channel partner convenience.

www.keysight.com/find/commandexpert

For more information on Keysight Technologies' products, applications or services, please contact your local Keysight office. The complete list is available at:
www.keysight.com/find/contactus

Americas

Canada	(877) 894 4414
Brazil	55 11 3351 7010
Mexico	001 800 254 2440
United States	(800) 829 4444

Asia Pacific

Australia	1 800 629 485
China	800 810 0189
Hong Kong	800 938 693
India	1 800 112 929
Japan	0120 (421) 345
Korea	080 769 0800
Malaysia	1 800 888 848
Singapore	1 800 375 8100
Taiwan	0800 047 866
Other AP Countries	(65) 6375 8100

Europe & Middle East

Austria	0800 001122
Belgium	0800 58580
Finland	0800 523252
France	0805 980333
Germany	0800 6270999
Ireland	1800 832700
Israel	1 809 343051
Italy	800 599100
Luxembourg	+32 800 58580
Netherlands	0800 0233200
Russia	8800 5009286
Spain	0800 000154
Sweden	0200 882255
Switzerland	0800 805353 Opt. 1 (DE) Opt. 2 (FR) Opt. 3 (IT)
United Kingdom	0800 0260637

For other unlisted countries:
www.keysight.com/find/contactus
(BP-07-10-14)

KEYSIGHT TECHNOLOGIES

Published in USA, August 2, 2014
5991-0502EN
www.keysight.com