



Mixed-Signal Explorer GUI

User's Guide

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Preface

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Documents are identified with a “DS” number. This number is located on the bottom of each page, in front of the page number. The numbering convention for the DS number is “DSXXXXXXXXA”, where “XXXXXXXX” is the document number and “A” is the revision level of the document.

For the most up-to-date information on development tools, see the MPLAB® IDE online help. Select the Help menu, and then Topics, to open a list of available online help files.

INTRODUCTION

This chapter contains general information that is useful to know before using the Mixed-Signal Explorer GUI. Items discussed in this chapter include:

- [Document Layout](#)
- [Conventions Used in this Guide](#)
- [Recommended Reading](#)
- [The Microchip Website](#)
- [Product Change Notification Service](#)
- [Customer Support](#)
- [Document Revision History](#)
- [Index](#)

DOCUMENT LAYOUT

This document describes how to use the Mixed-Signal Explorer GUI. The manual layout is as follows:

- **Chapter 1. “Software Overview”** – Important information about the Mixed-Signal Explorer GUI.
- **Chapter 2. “Usage workflow”** – Describes how this GUI can be used.
- **Chapter 3. “SAR ADC”** – Describes SAR ADC application support
- **Chapter 4. “Delta-Sigma ADC support”** – Describes the Delta-Sigma features and the methods through which these features are supported (Generic SPI and Firmware acquisition)
- **Chapter 5. “DAC Support Through Generic SPI”** - Describes the support for DAC Families
- **Chapter 6. “DAC Support Through Generic I2C”** - Describes the support for DAC Families
- **Chapter 7. “Digipot Support Through Generic I2C/SPI”** - Describes the support for Digipot Families

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CONVENTIONS USED IN THIS GUIDE

This manual uses the following documentation conventions:

DOCUMENTATION CONVENTIONS

Description	Represents	Examples
Arial font:		
Italic characters	Referenced books	<i>MPLAB® IDE User's Guide</i>
	Emphasized text	...is the <i>only</i> compiler...
Initial caps	A window	the Output window
	A dialog	the Settings dialog
	A menu selection	select Enable Programmer
Quotes	A field name in a window or dialog	"Save project before build"
Underlined, italic text with right angle bracket	A menu path	<u><i>File > Save</i></u>
Bold characters	A dialog button	Click OK
	A tab	Click the Power tab
N'Rnnnn	A number in verilog format, where N is the total number of digits, R is the radix and n is a digit.	4'b0010, 2'hF1
Text in angle brackets < >	A key on the keyboard	Press <Enter>, <F1>
Courier New font:		
Plain Courier New	Sample source code	#define START
	Filenames	autoexec.bat
	File paths	c:\mcc18\h
	Keywords	_asm, _endasm, static
	Command-line options	-Opa+, -Opa-
	Bit values	0, 1
	Constants	0xFF, 'A'

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Italic Courier New	A variable argument	<i>file.o</i> , where <i>file</i> can be any valid filename
Square brackets []	Optional arguments	<code>mcc18 [options] file [options]</code>
Curly brackets and pipe character: { }	Choice of mutually exclusive arguments; an OR selection	<code>errorlevel {0 1}</code>
Ellipses...	Replaces repeated text	<code>var_name [, var_name...]</code>
	Represents code -supplied by user	<code>void main (void) { ... }</code>

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RECOMMENDED READING

This user's guide describes how to use the Mixed-Signal Explorer Graphical User Interface (GUI). Other useful documents are listed below. The following Microchip document is available and recommended as a supplemental reference resource:

- Mixed-Signal-Explorer-User-Guide.pdf
- Mixed-Signal-Explorer-Release-Notes.pdf

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- Field Application Engineer (FAE)
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Technical support is available at: microchip.com/support.

DOCUMENT REVISION HISTORY

Revision E (September 2025)

- Update for Delta-Sigma ADC Full-Speed, Digital potentiometer and I2C DAC devices support.

Revision D (May 2025)

- Update for DAC devices support.

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Revision C (March 2025)

- Update for firmware update support.

Revision B (February 2025)

- Update for Delta-Sigma support.

Revision A (November 2024)

- Initial Release of this document.

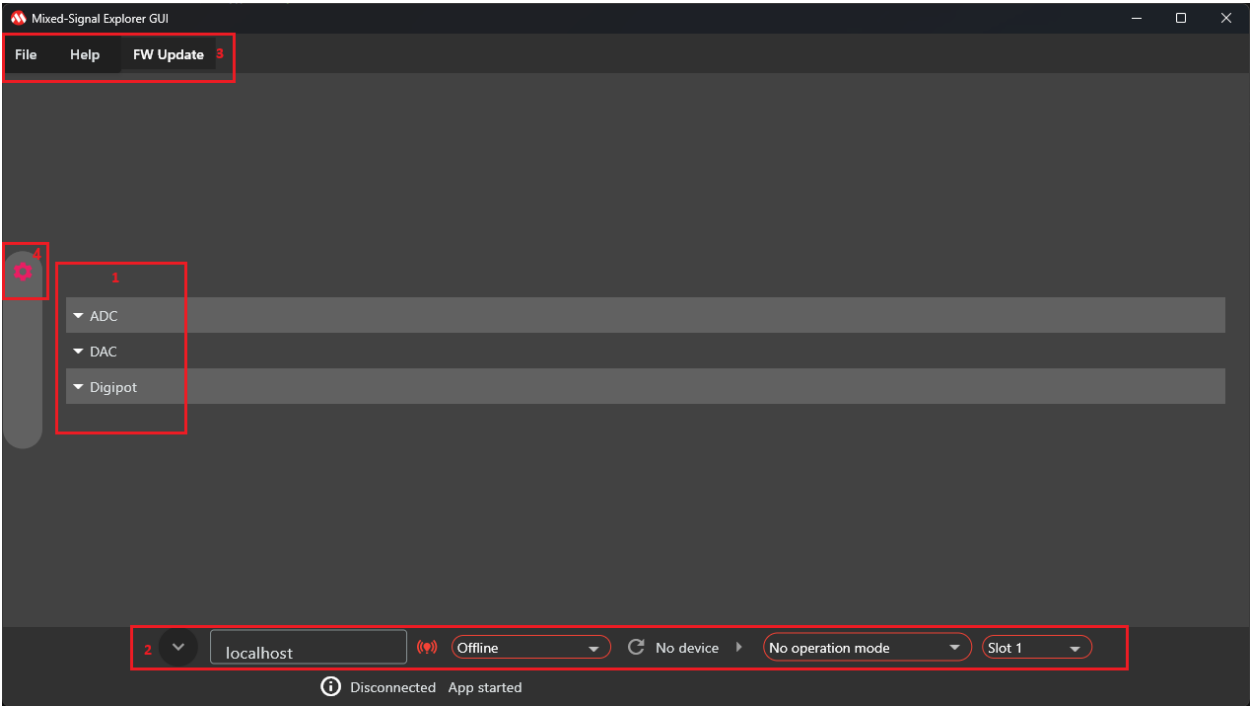
Chapter 1. SOFTWARE OVERVIEW

Mixed-Signal Explorer GUI is a GUI software for showcasing the Microchip Mixed-Signal Evaluation boards capabilities. It is a component of the Mixed-Signal Explorer software package.

For more detailed information and instruction on how to install the package and implicitly the GUI, see the following documentation: “Mixed-Signal Explorer User Guide.pdf”

When the GUI starts the device selection view is available, as shown in Figure 1-1.

Figure 1-1: GUI Window – device selection

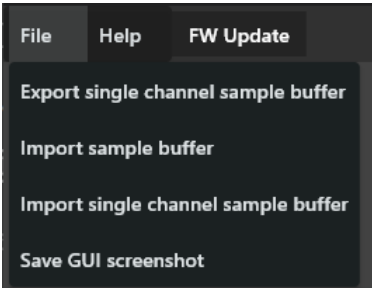


The **Device Selection** section (1) can be expanded and the desired device selected.

The **Connection and status toolbar** (2) provides the board connection options and information about its status.

The **Menu** (3) contains several sections detailed below.

Figure 1-2 File Menu



The **File** Menu Figure 1-2 offers the option to download (export) the current set of data acquired for ADCs into a file in the Downloads folder. Data can also be imported, but the length of the codes in the imported file must match the Samples No. selected in the application.

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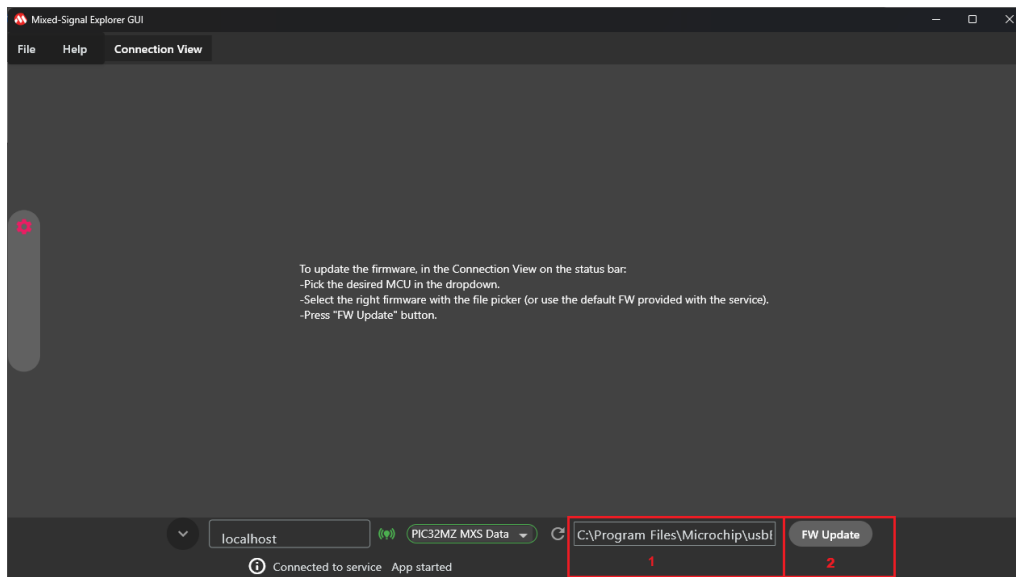
The **Help** Menu will display the GUI help (User's Guide) and an About popup, which will show the licenses of all the Flutter dependencies and the versions of the Service and backend library.

The **Firmware Update** Menu opens the Firmware Update [Figure 1-3](#) from where the connected Data Capture board firmware can be updated.

To update the firmware

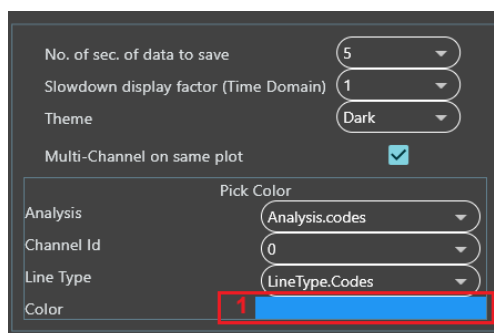
1. Connect to the service and select the desired device
2. The application will try to automatically select a firmware file. To manually select the file, click the **Firmware** text box (1). This opens a window to select the firmware file.
3. Select the **FW Update** button (2). A message appears on top of the bar indicating if the update succeeded or failed.
4. To switch back to the Connection View, press the **Connection View** menu button.

Figure 1-3 Firmware Update



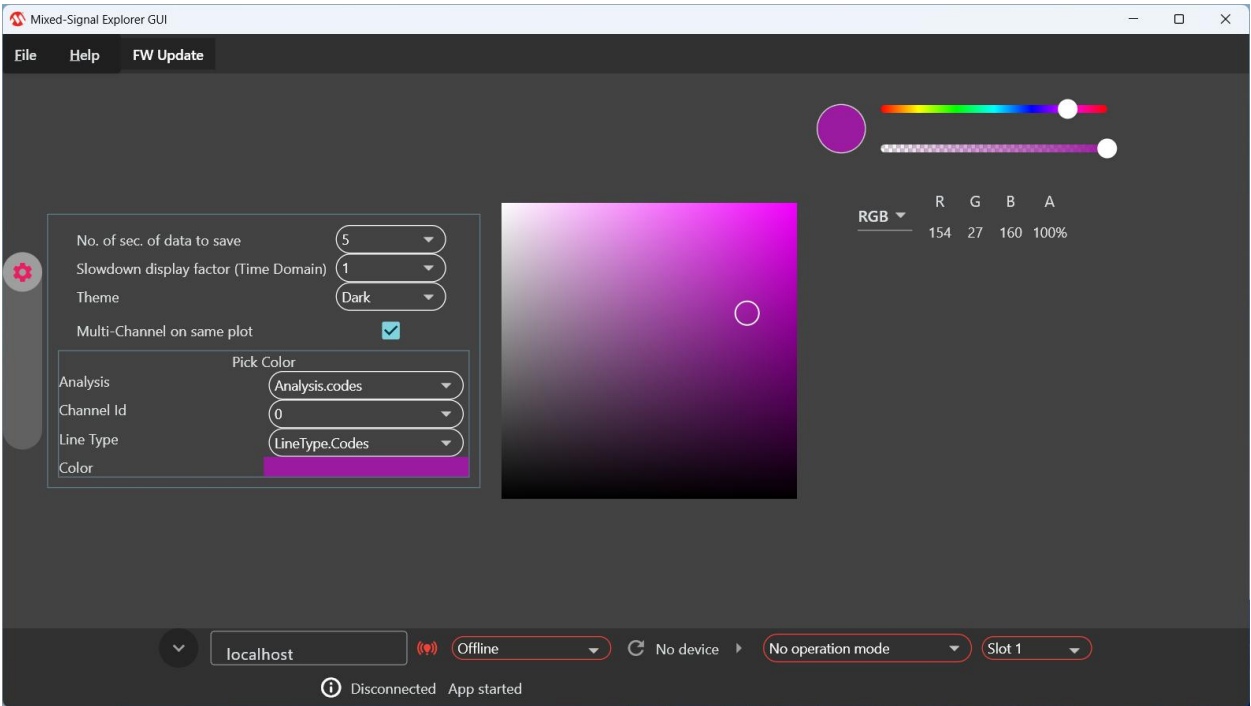
The **Settings** (4) button shows/hides the general application settings [Figure 1-4](#)

Figure 1-4 Settings Panel



One of the settings is the color of the plots. To pick a color for a certain plot, pick the analysis, channel id, line type and click on **Color button** (1). A new control ([Figure 1-5](#)) will appear in the main panel where you can pick the desired color for the plot line. **After selecting the desired color (by using the sliders and then the color picker), click once again on the Color button (1) control in Settings. This will restore the initial main panel and use the selected color for the desired plot line.**

Figure 1-5 Chart line color selection



Chapter 2. USAGE WORKFLOW

The application can be used in offline mode without connecting it to the MCHP USB Bridge Service. However, in offline mode, the application has limited functionality.

To use the GUI in online mode (connected to an actual device), connect to a MCHP USB Bridge Service instance, either installed locally on the same PC with the GUI or installed remotely on an accessible host. The devices should be connected to the PC hosting the MCHP USB Bridge Service. The MCHP USB Bridge Service needs to be started as per information described in "*Mixed-Signal Explorer User Guide.pdf*". The GUI does this operation for the service installed on localhost upon connection to localhost.

To establish a connection, use the **Connection and Status toolbar** [Figure 2-1](#).

Figure 2-1 Connection and status toolbar



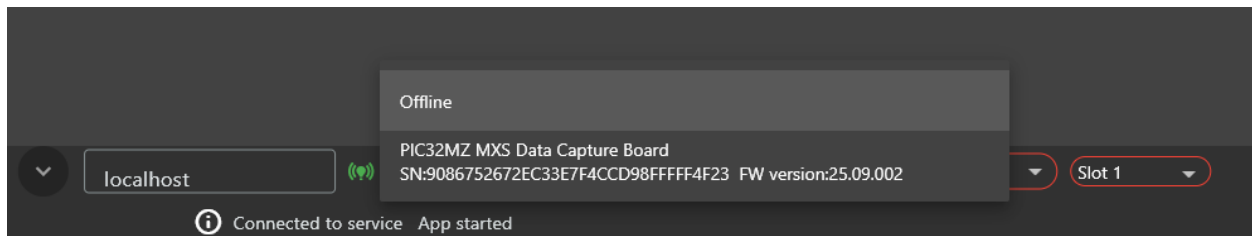
The **Connection toolbar** can be hidden by pressing the **Hide Connection View** button (1)

The **Host** field (2) contains the service host address: IP address for remote connections, *local* or *localhost* if using the service running on the same computer as the GUI. When connecting to *localhost*, the service will be started automatically, which momentarily opens a command prompt to do this operation.

The **Connect** button (3) establishes a connection to the service. The button turns green on a successful connection to the service.

Once connected to the service, the connection to a board can be established from the **Board List** (4) drop down menu [Figure 2-2](#). If the connection to the board is successful, the **Board List** field will have a green border. The **Refresh** button (5) updates the **Board List** with the boards that are currently available on the machine. The list also refreshes automatically every 30 seconds.

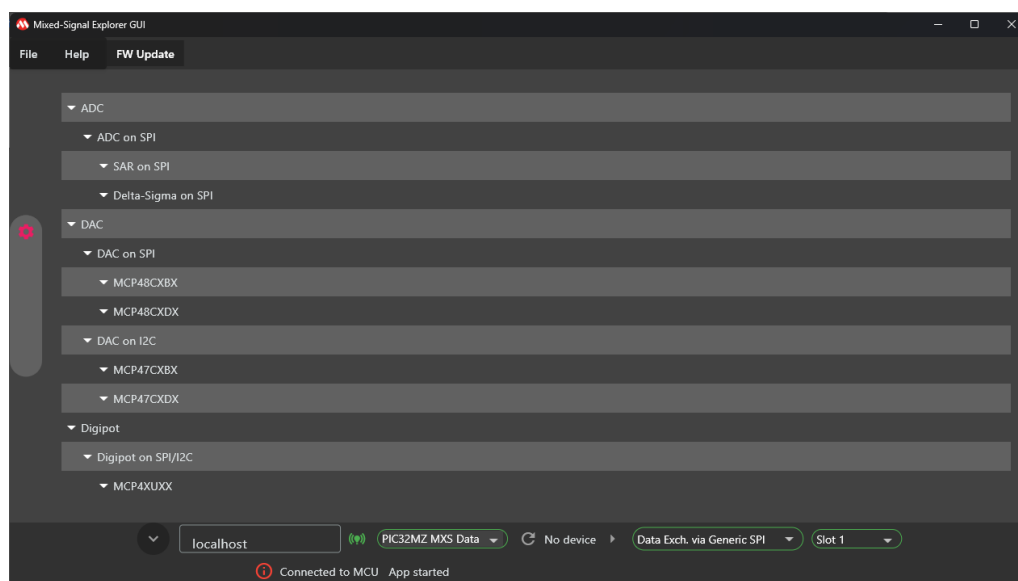
Figure 2-2 Board List selection



The **Device Selection** (6) button opens the **Device Selection** view [Figure 2-3](#). Each row can be expanded to show available communication protocols for each device type and currently supported device families. Each device family can be expanded and the desired device selected.


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Figure 2-3 Expanded Device Selection view



The **Operation Mode** (7) is automatically set to a compatible mode for the selected device. Some devices support multiple operation modes.

The **Slot Selection** (8) drop down menu chooses which mikroBUS™ slot from the connected Data Capture board will be used for the currently selected device.

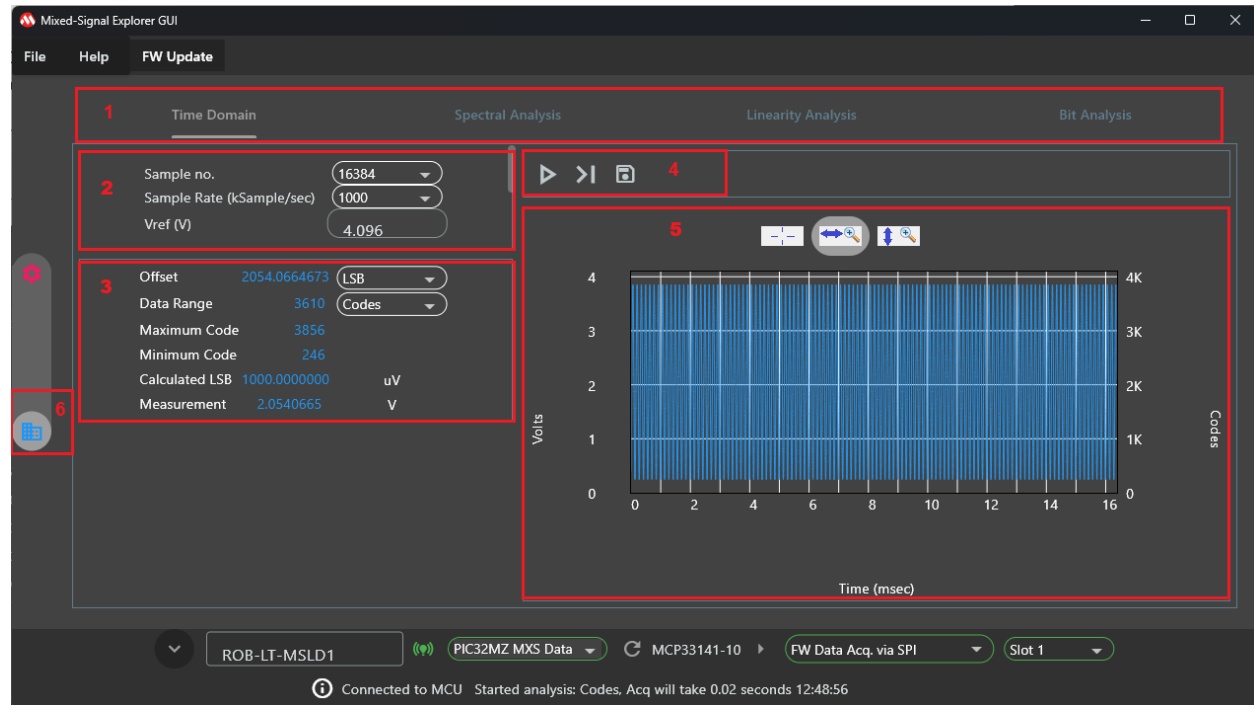
The **Status** section (9) displays information about the application operation. If an error is detected the  icon will turn red and more details will be displayed when hovering over it.

The software can, in rare circumstances, disconnect due to an Ethernet connection timeout, which is indicated by a red border around the connection fields. In such cases, disconnect the host by clicking the **Connection** button (3) and perform the connection steps again.

Chapter 3. SAR ADC

The SAR ADC interface contains multiple options for viewing and analyzing the data captured from the ADC. By default, the **Time Domain** analysis [Figure 3-1](#) is loaded when a SAR ADC is selected.

Figure 3-1 SAR ADC Time Domain view



To change to a different analysis type, select the desired mode from the **Analysis Tabs** (1).

The **Analysis Settings** section (2) contains options for the currently selected analysis mode.

The **Metrics / Results** panel (3) displays the current metrics/results for the data processing corresponding to the currently selected analysis mode. This panel can be hidden by pressing the **Results** button (6).

The **Acquisition toolbar** (4) is used to control data acquisition from the connected device.

Figure 3-2 Acquisition control



To continuously acquire data from the ADC, press the **Start/Stop Acquisition** button (1). The button will then change to a stop icon.

The **Single Acquisition** button (2) can be used to perform a single data acquisition from the connected ADC.

The **Save** button (3) will save 5 seconds of data while continuous acquisition is in Time Domain mode. The data is saved as a file in the Downloads folder. While not all data is displayed in the GUI for some configuration, like the SAR ADC 1MSPS sample rate with lower periodogram lengths, all data can be retrieved from the backend using the **Save** button and can be later replayed by using other tools like the ADC Evaluation GUI.

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After the acquisition is started the signal is displayed in the **Plot Panel** (5).

Figure 3-3 Plot controls



The Plot panel contains several control buttons [Figure 3-3](#). The **Auto scale Y-axis** button (1) is useful when the data is out of the range of the GUI's sensible limits for the current plot. When the button is colored in a lighter shade, it is selected.

The **Zoom X-axis** button (2) enables horizontal zoom. When the button is colored in a lighter shade, it is selected.

The **Zoom Y-axis** button (3) enables vertical zoom. When the button is colored in a lighter shade, it is selected. To zoom in, keep the left mouse button pressed and span the area to be zoomed. After that, release the button. Also, another method to zoom in includes clicking the desired center of zooming then pressing CTRL+.

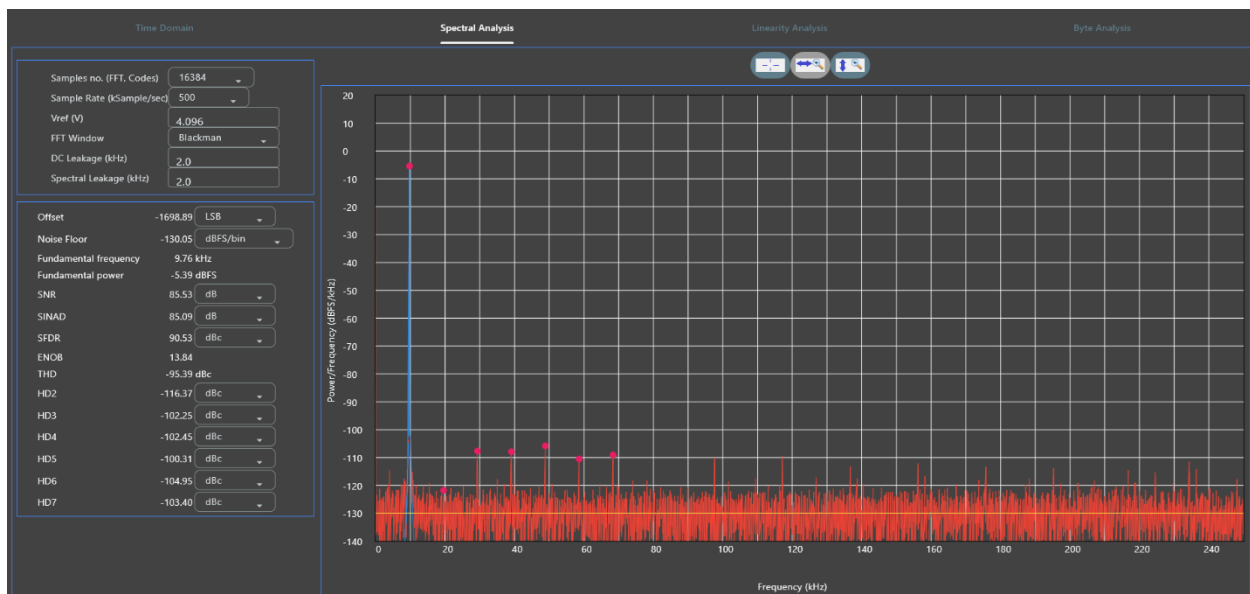
To zoom out, right-click or press CTRL-.

To restore the original view, double-click the left mouse button.

To view other types of analyses running in continuous mode, click the corresponding tab in the **Analysis Tab Selection**.

[Figure 3-4](#) shows the FFT plot for a 9.76 kHz, -5.39 dBFS input signal.

Figure 3-4 Spectral Analysis



[Figure 3-5](#) represents the INL for a 7 kHz, 4V input signal. To test INL use a Signal Generator with better resolution and INL than the tested device.

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Figure 3-5 Linearity Analysis

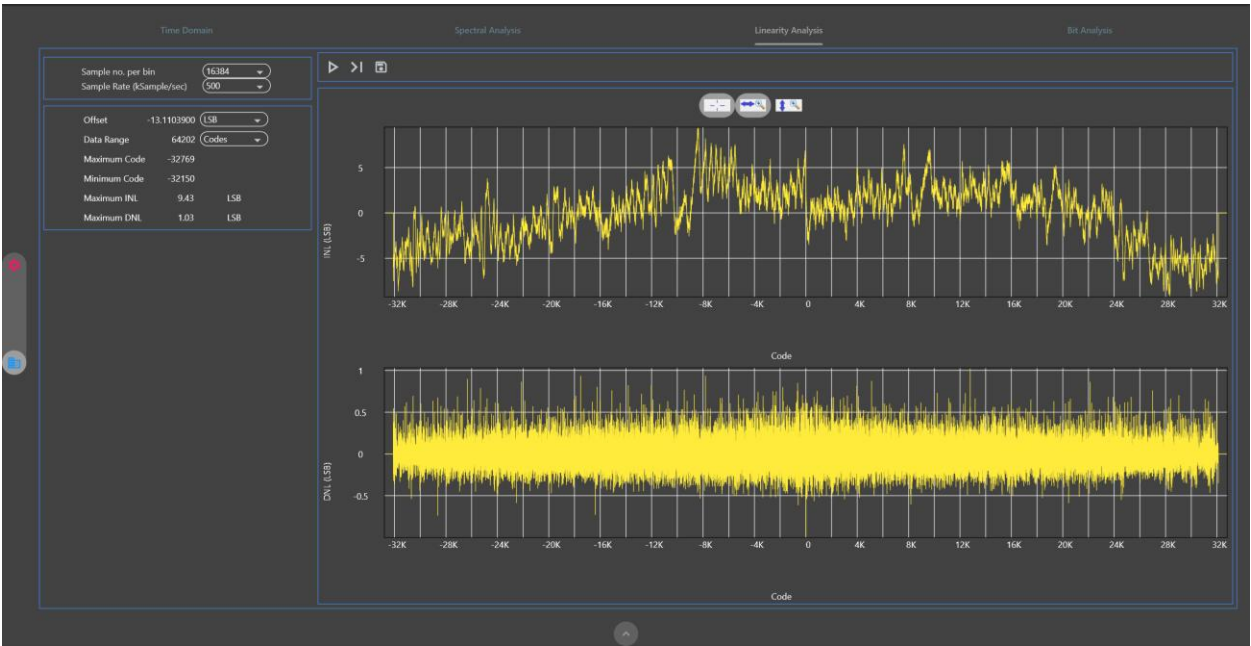
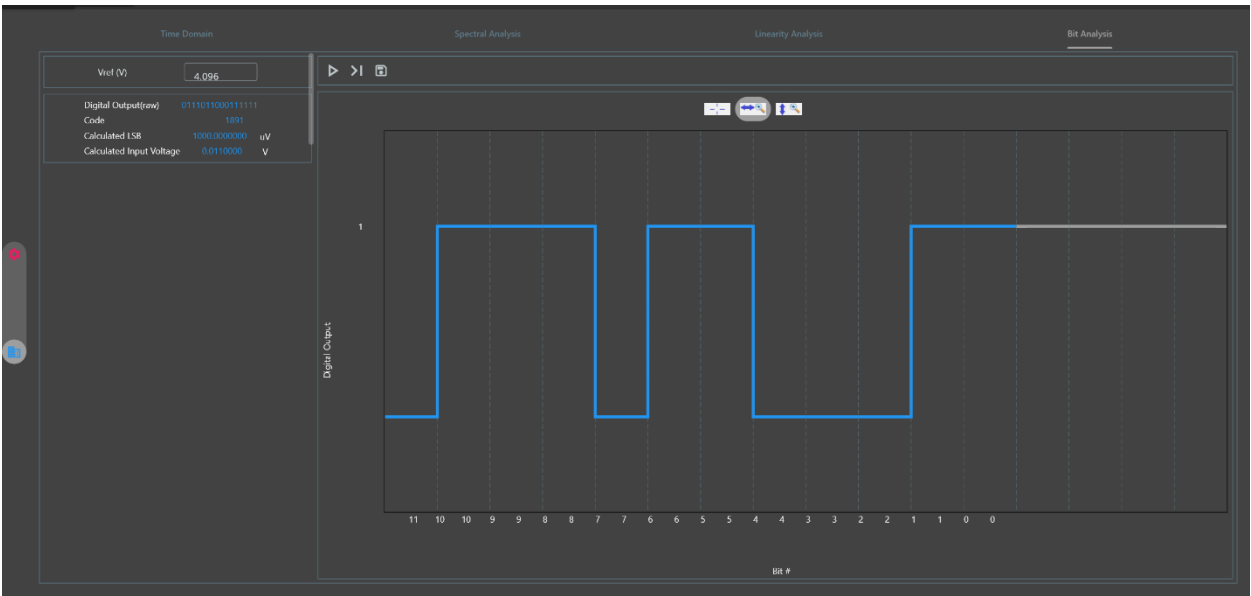


Figure 3-6 Bit Analysis

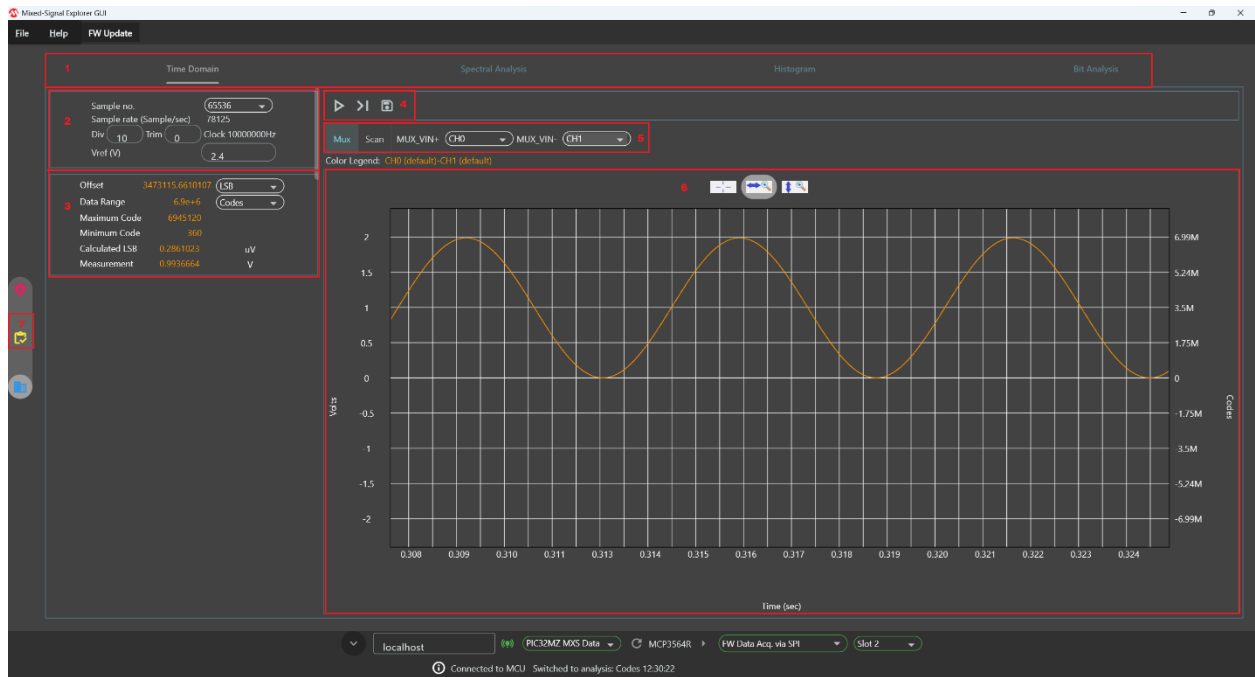


Chapter 2. DELTA-SIGMA ADC SUPPORT

The Delta-Sigma ADC family supports two operating modes: *Data Exchange via Generic SPI* and *Firmware Acquisition via SPI*. By default, *Firmware Acquisition* is selected. This mode can use full speed supported by the part, but not all registers can be read in this mode.

The Delta-Sigma ADC interface contains multiple options for viewing and analyzing the data captured from the ADC. By default, the **Time Domain** analysis is shown.

Figure 2-1 Time Domain Analysis



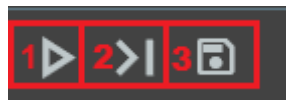
To change to a different analysis type, select the desired mode from the **Analysis Tabs** (1).

The **Analysis Settings** section (2) contains options for the currently selected analysis mode.

The **Metrics / Results** panel (3) displays the current metrics/results for the data processing corresponding to the currently selected analysis mode. This panel can be hidden by pressing the **Results** button (6).

The **Acquisition toolbar** (4) is used to control data acquisition from the connected device.

Figure 2-2 Acquisition control



To continuously acquire data from the ADC, press the **Start/Stop Acquisition** button (1). The button will then change to a stop icon.

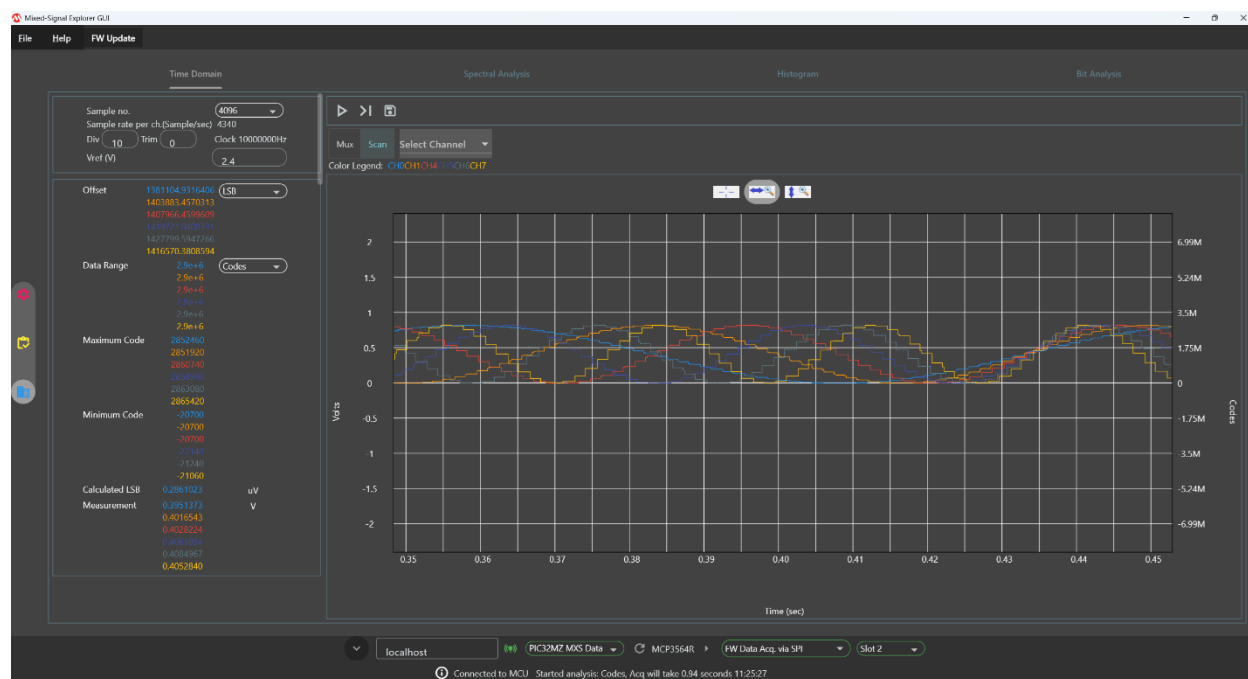
The **Single Acquisition** button (2) can be used to perform a single data acquisition from the connected ADC.

The **Save** button (3) will save 5 seconds of data while continuous acquisition is in Time Domain mode. The data is saved as a file in the Downloads folder.

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The ADC operation mode can be selected from the **Channel Control** toolbar (5). Here the desired mode can be switched between MUX and Scan (Figure 2-3) and the acquisition channels selected.

Figure 2-3 Scan Mode



After the acquisition is started the signal is displayed in the **Plot Panel** (6).

Figure 2-4 Plot controls



The Plot panel contains several control buttons Figure 3-3. The **Auto scale Y-axis** button (1) is useful when the data is out of the range of the GUI's sensible limits for the current plot. When the button is colored in a lighter shade, it is selected.

The **Zoom X-axis** button (2) enables horizontal zoom. When the button is colored in a lighter shade, it is selected.

The **Zoom Y-axis** button (3) enables vertical zoom. When the button is colored in a lighter shade, it is selected. To zoom in, keep the left mouse button pressed and span the area to be zoomed. After that, release the button. Also, another method to zoom in includes clicking the desired center of zooming then pressing CTRL+.

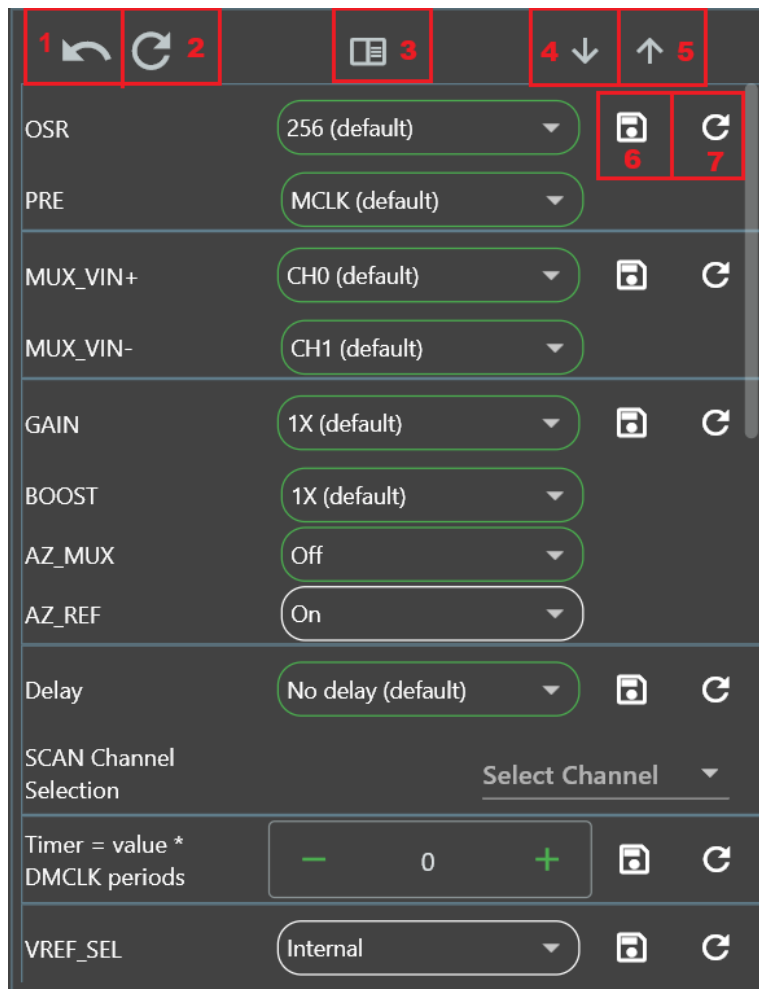
To zoom out, right-click or press CTRL-.

To restore the original view, double-click the left mouse button.

To view other types of analyses running in continuous mode, click the corresponding tab in the **Analysis Tab Selection**.

The **Register** button (7) opens the **Register View** (Figure 2-5) which allows read-write access to the ADC's registers.

Figure 2-5 Register View



Fields recommended to be modified for the current Generic SPI configuration are highlighted with a green outline.

The upper part of Register View contains five buttons for various register operations.

The **Reset to Default** button (1) will reset the device registers to their default values. The registers are not automatically written to the device, only the register view is updated. To save the new value into the device press the **Save** (6) button next to each register line. Register values can be modified. However, some of them are changed by the backend when the operation mode is set to Generic SPI. This provides a working baseline for acquisitions.

The **Read All** (2) button will read all the device registers and update the **Register View**. Each register can also be individually read by pressing the **Read Register** (7) button available on each register line.

After changing a register value, use the **Save Register** (6) button to write the value into the device.

The **Save Register to File** (4) and **Import Registers** (5) can be used to save the current register values to an external file and then import the values back into the application.

If the Mixed-Signal Explorer GUI is connected to an incorrect slot (which does not have a MCP356xR device connected), **Register View** returns false values.

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Pressing the **Change View** (3) button changes the **Register View** into the **Register Value View** (Figure 2-6), where the value of each register can be viewed and modified.

Figure 2-6 Register Value View


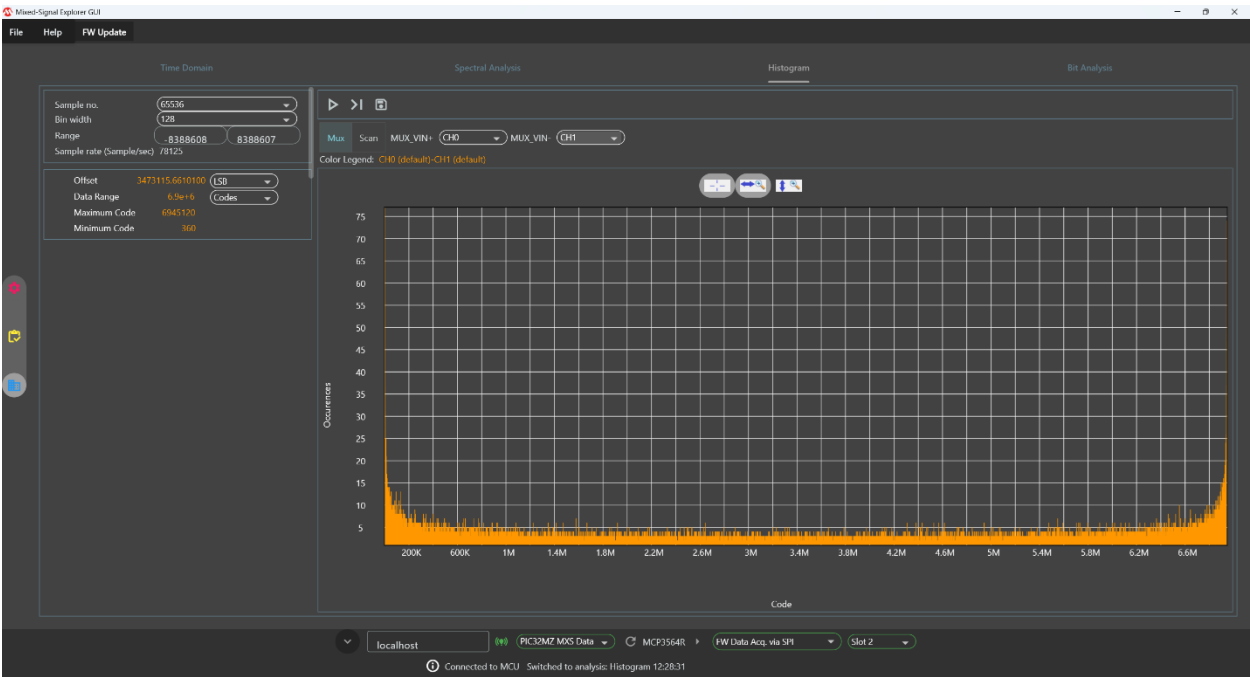
0x00			—	0	+
0x01			—	192	+
0x02			—	12	+
0x03			—	139	+
0x04			—	0	+
0x05			—	123	+
0x06			—	1	+
0x07			—	0	+
0x08			—	0	+
0x09			—	0	+

Figure 2-7 Histogram view



The integral nonlinearity (INL) analysis is not currently available for Delta-Sigma ADCs, instead replaced with a Histogram analysis.

Figure 2-8 Bit Analysis



4.1 Generic SPI Sample Rate Limitation

The Mixed-Signal Explorer GUI currently supports only a single family of Delta-Sigma devices: **MCP3564xR**.

Delta-Sigma support is currently provided through Generic SPI. The backend functionality of this method consists of sending SPI acquisition commands from the PC to the connected ADC device; commands that are relayed through the Generic SPI firmware module. This method has a data rate limit of around 4 ksp/s, thus restricting the recognized signal to a maximum of 2 ksp/s (which is the related Nyquist frequency). The desired sample rate can be set in Mixed-Signal Explorer GUI with limits based on factors like baud rate, over-sampling ratio (OSR), internal clock, Generic SPI and ADC sample rate. The desired sample rate is rounded to achieve a sample period that is a multiple of 25µs which modifies the actual sample rate.

The options provided by the sample number field (**Sample no.**) are powers of 2 with values around the actual sample rate. This ensures acquisition time is short when acquiring the same amount of data as a SAR ADC but with lower sample rates.

4.2 Generic SPI FFT Considerations

When doing signal processing on the samples provided by Generic SPI, two fields must be filled with custom values for the FFT fundamental signal and metrics to be correctly calculated. These fields are **DC leakage** and **Spectral Leakage** and are measured in kHz. They need to be adjusted for Generic SPI: 0.01 kHz for a signal of at least 10 Hz to be detected properly. Switching tabs reloads the default values for the DC and Spectral Leakage fields: 0.01kHz for Generic SPI and 2kHz for other operation modes. For Generic SPI, these settings change also based on the sample rate.

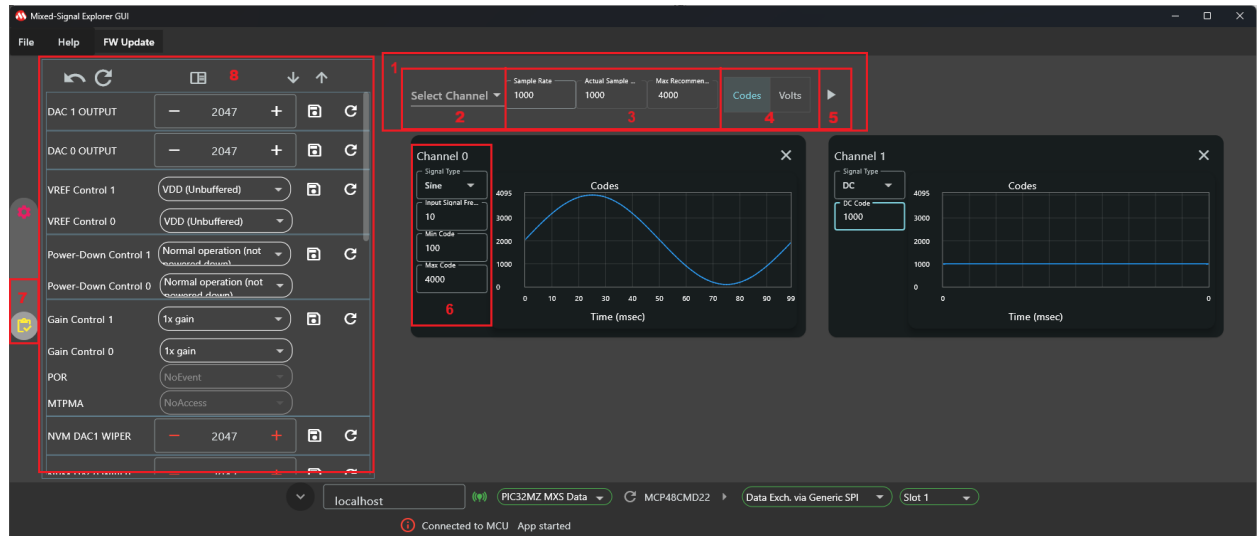
4.3 Generic SPI Baud Rate

The Baud Rate can be set in the **Codes** Tab. It has a minimum value of 1, a default value of 20,000,000 and a maximum value of 100,000,000.

Chapter 3. DAC SUPPORT THROUGH GENERIC SPI

The MCP48CXBX and MCP48CXX families of DAC devices both support the Generic SPI communication protocol.

Figure 3-1 Codes display with registers



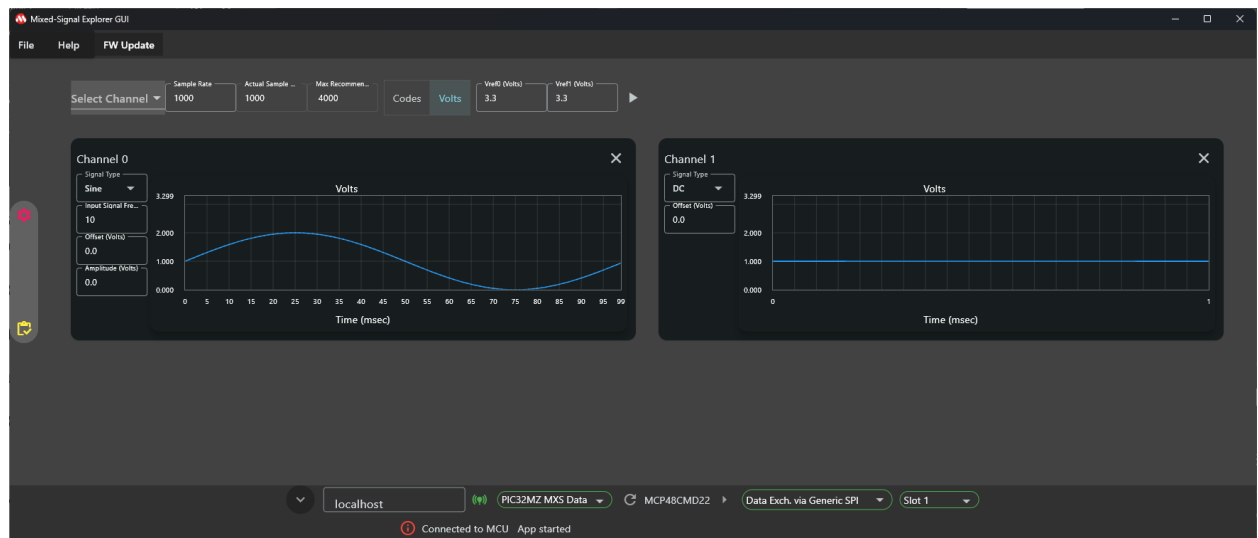
The **Control Toolbar** (1) provides options related to the main view.

The **Channel** drop down (2) selects which channels are visible and configurable in the main view.

The **Sample rate** controls (3) affect the communication speed with the device.

The **Codes/Volts** (4) buttons control which type of view is displayed. [Figure 3-2](#) shows the Volts view charts.

Figure 3-2 Volts display



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The **Start** button (5) starts/stops the signal injection configured for each channel. A sinusoidal or DC form signal can be injected into any DAC channel. While the signal is injected, **Register View** and **Connection View** options are disabled.

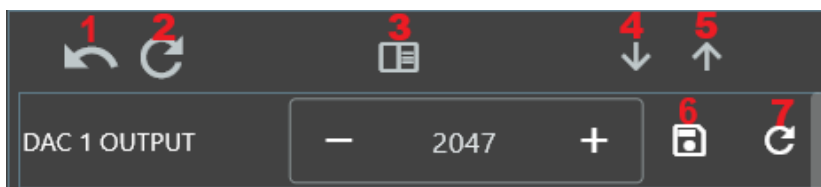
The **Signal Configuration** section (6) in each channel provides control over the generated signal parameters.

The **Register View** button (7) opens the **Register View** section (8) which allows read-write access to the DAC's registers

Fields recommended to be modified for the current Generic SPI configuration are highlighted with a green outline.

The upper part of Register View contains five buttons for various register operations.

Figure 3-3 Register view fields



The **Reset to Default** button (1) will reset the device registers to their default values. The registers are not automatically written to the device, only the register view is updated. To save the new value into the device press the **Save** (6) button next to each register line.

The **Read All** (2) button will read all the device registers and update the **Register View**. Each register can also be individually read by pressing the **Read Register** (7) button available on each register line.

After changing a register value, use the **Save Register** (6) button to write the value into the device.

The **Save Register to File** (4) and **Import Registers** (5) can be used to save the current register values to an external file and then import the values back into the application.

If the MCP48CXB/DX device is misconfigured in the Device Drop-down (for example, selecting an ADC device on slot 1 when a DAC device is already physically attached), displaying **Register View** corrupts the SPI connection. To fix this issue, reset both the GUI and the PIC32MZ Mixed Signal Data Capture Board (EV64F02A)."

Pressing the **Change View** (3) button changes the **Register View** into the **Register Value View** (Figure 3-4), where the value of each register can be viewed and modified.

Figure 3-4 Register value view

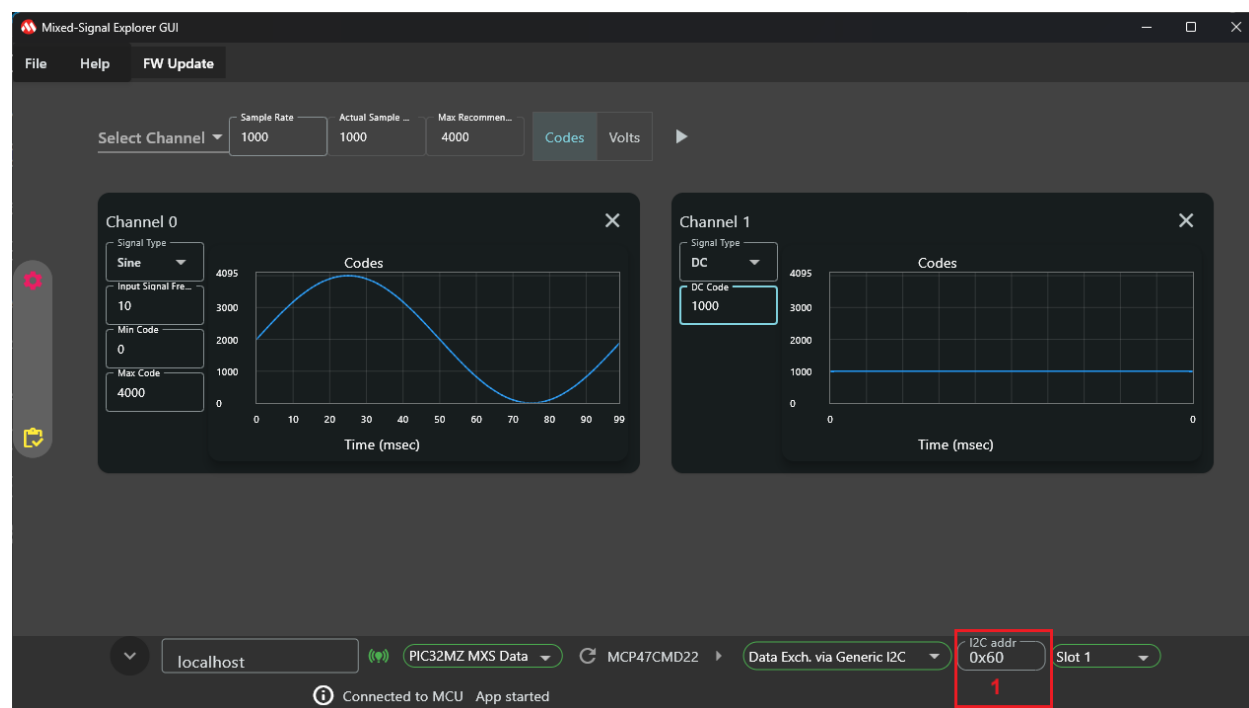
0x00			-	0	+
0x01			-	192	+
0x02			-	12	+
0x03			-	139	+
0x04			-	0	+
0x05			-	123	+
0x06			-	1	+
0x07			-	0	+
0x08			-	0	+
0x09			-	0	+

Chapter 4. DAC SUPPORT THROUGH GENERIC I2C

The MCP47CXBX and MCP47CXBX DAC families are supported via the Generic I2C communication protocol from the Mixed Signal Explorer GUI. The view and control features are described in more detail in the [DAC SUPPORT THROUGH GENERIC SPI](#) chapter.

Each I2C device has the I2C address defined in its device file, saved in the *devices* folder from your program installation location. The value is listed under the `<unitId>...</unitId>` section. This value is automatically read and input into the **I2C address field** (1). The address can be manually changed, or the device xml file modified for future automatic loading.

Figure 4-1 DAC I2C view

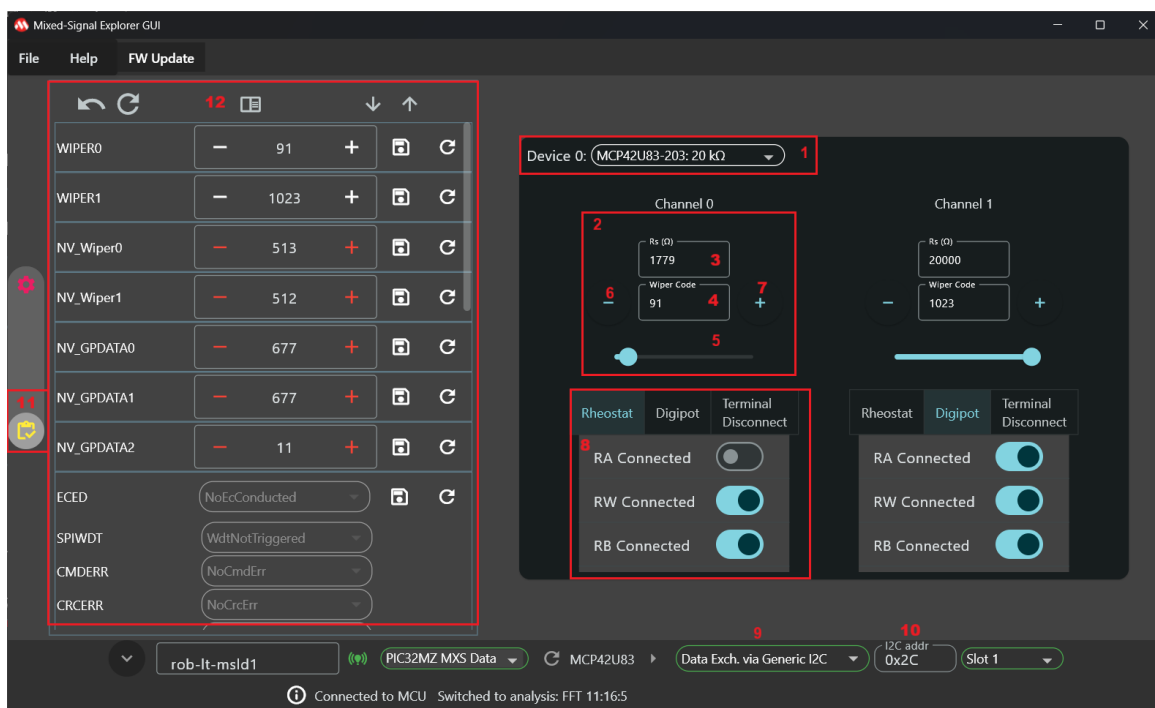


Chapter 5. DIGIPOT SUPPORT THROUGH I2C/SPI

The MCP4xU83 device family is supported in both SPI and I2C communication modes. When selecting the part, I2C is used by default. The operating mode can be changed from the Operation Mode field (9).

Each I2C device has the I2C address defined in its device file, saved in the *devices* folder from your program installation location. The value is listed under the `<unitId>...</unitId>` section. This value is automatically read and input into the **I2C address field** (10). The address can be manually changed, or the device xml file modified for future automatic loading.

Figure 5-1 Digipot View



The main view contains controls for the device's wiper values and terminal pin configurations.

The **Device selection** (1) drop down menu contains the different resistance part numbers available. This selection affects the Rs calculation in the main view.

The **Wiper control** section (2) provides different options to modify the wiper value for each channel. The desired resistance can be input in the **Rs** field (3) and the closest available value, based on the device's resolution, will be chosen and written into the wiper.

The **Wiper code** field (4) can be written directly or modified using the **Wiper slider** control (5).

The **Increment** (7) button and the **Decrement** (6) button send the increment/decrement commands to the device and will affect the wiper values according to the device's settings.

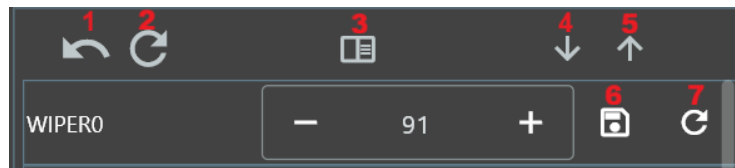
The **Terminal control** section (8) provides an easy option to configure each channel's terminal pins. Based on the selected options, the **Rheostat / Digipot / Terminal Shutdown** modes will be selected.

The **Register View** button (11) opens the **Register View** section (12) which allows read-write access to the device's registers

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The upper part of Register View contains five buttons for various register operations

Figure 5-2 Register View fields



The **Reset to Default** (1) will reset the device registers to their default values. The registers are not automatically written to the device, only the register view is updated. To save the new value into the device press the **Save** (6) button next to each register line.

The **Read All** (2) button will read all the device registers and update the **Register View**. Each register can also be individually read by pressing the **Read Register** (7) button available on each register line.

After changing a register value, use the **Save Register** (6) button to write the value into the device.

The **Save Register to File** (4) and **Import Registers** (5) can be used to save the current register values to an external file and then import the values back into the application.

Pressing the **Change View** (3) button changes the **Register View** into the **Register Value View** (Figure 5-3), where the value of each register can be viewed and modified.

Figure 5-3 Register value view



INDEX

Alphabetical order	Meaning
ADC	Analog-to-digital converter
BE	Big Endian
CLI	Command Line Interface
CSV	Comma Separated Values
DAL	Device Access Layer
DNL	Differential Nonlinearity
FFT	Fast Fourier Transform
FW	Firmware
GUI	Graphical User Interface
HW	Hardware
INL	Integral Nonlinearity
INSTALLDIR	Installation Directory
IP	Internet Protocol
ksps	Kilo-Samples Per Second
LE	Little Endian
MCHP	Microchip
MCU	Microcontroller Unit
S/N	Serial Number
SW	Software
Rev	Revision
PC	Personal Computer
SPI	Serial Peripheral Interface
TCP	Transmission Control Protocol
USB	Universal Serial Bus