



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. “GUI application layout and interface”** – Describes all major components of the User Interface
- **Chapter 4. “Delta-Sigma support through Generic SPI”** – Describes the Delta-Sigma features and the method through which these features are supported (Generic SPI)
- **Chapter 5. “DAC Support Through Generic SPI”** - Describes the support for DAC 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	<code>#define START</code>
	Filenames	<code>autoexec.bat</code>
	File paths	<code>c:\mcc18\h</code>
	Keywords	<code>_asm, _endasm, static</code>
	Command-line options	<code>-Opa+, -Opa-</code>
	Bit values	<code>0, 1</code>
	Constants	<code>0xFF, 'A'</code>

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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	mcc18 [options] <i>file</i> [options]
Curly brackets and pipe character: { }	Choice of mutually exclusive arguments; an OR selection	errorlevel {0 1}
Ellipses...	Replaces repeated text	var_name [, var_name...]
	Represents code -supplied by user	void main (void) { ... }

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RECOMMENDED READING

This user's guide describes how to use the Mixed-Signal Explorer 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

THE MICROCHIP WEBSITE

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- **General Technical Support** – Frequently Asked Questions (FAQs), technical support requests, online discussion groups, Microchip consultant program member listing
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- Distributor or Representative
- Local Sales Office
- Field Application Engineer (FAE)
- Technical Support

Customers should contact their distributor, representative or field application engineer (FAE) for support. Local sales offices are also available to help customers. A listing of sales offices and locations is included in the back of this document, under **Worldwide Sales and Service**.

Technical support is available at: microchip.com/support.

DOCUMENT REVISION HISTORY

Revision D (May 2025)

- Update for DAC devices support.

Revision C (March 2025)

- Update for firmware update support.

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Revision B (February 2025)

- Update for Delta-Sigma support.

Revision A (November 2024)

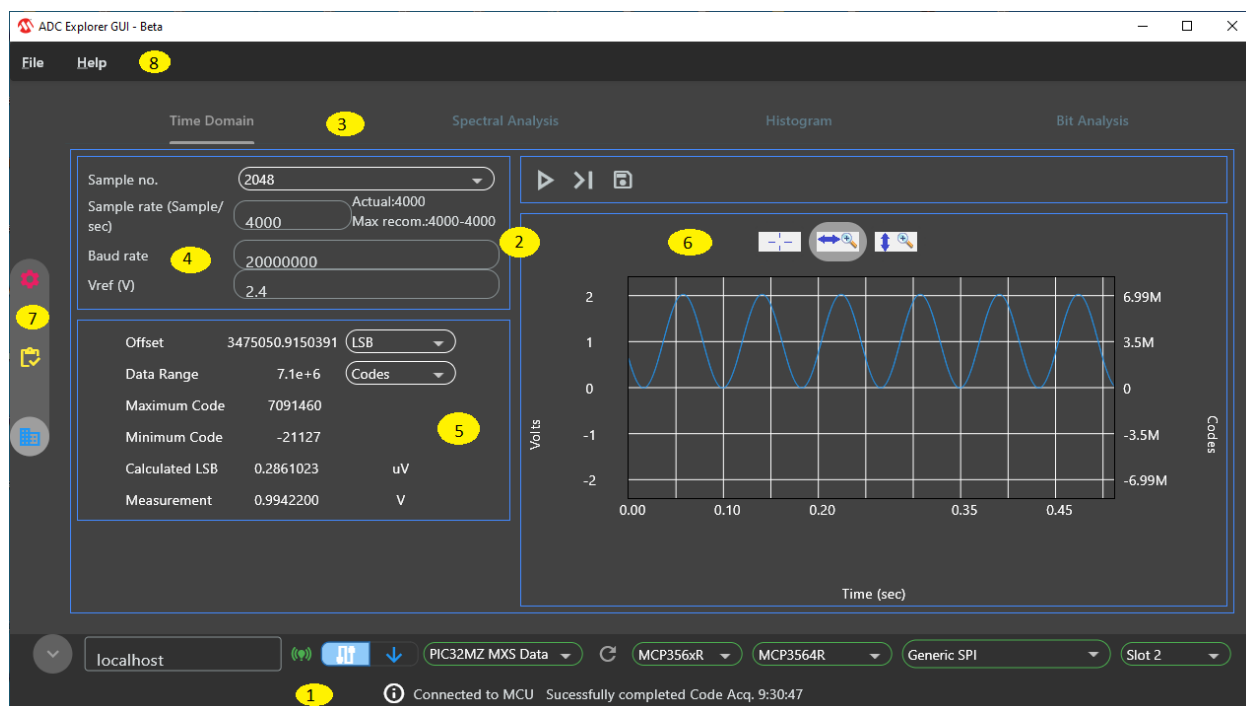
- Initial Release of this document.

Chapter 2. 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"

Below is the image of the main visual components of the GUI.



- (1) Connection, FW update and status bar
- (2) Analysis Panel
- (3) Analysis Tab Selection
- (4) Analysis Settings Panel
- (5) Metrics (Results) Panel
- (6) Plot Panel
- (7) Results/Settings/(Register View) Selection
- (8) Menu

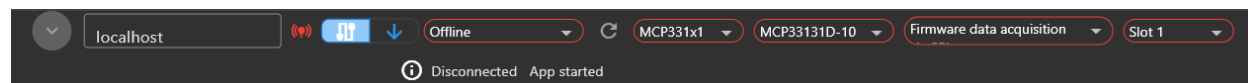
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Chapter 3. USAGE WORKFLOW

The application can be used in offline mode without connecting it to the MCHP USB Bridge Service. However, in offline mode, the application only provides Volts/Codes Analyses.

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 make a connection, use the "Connection, FW update and status bar".

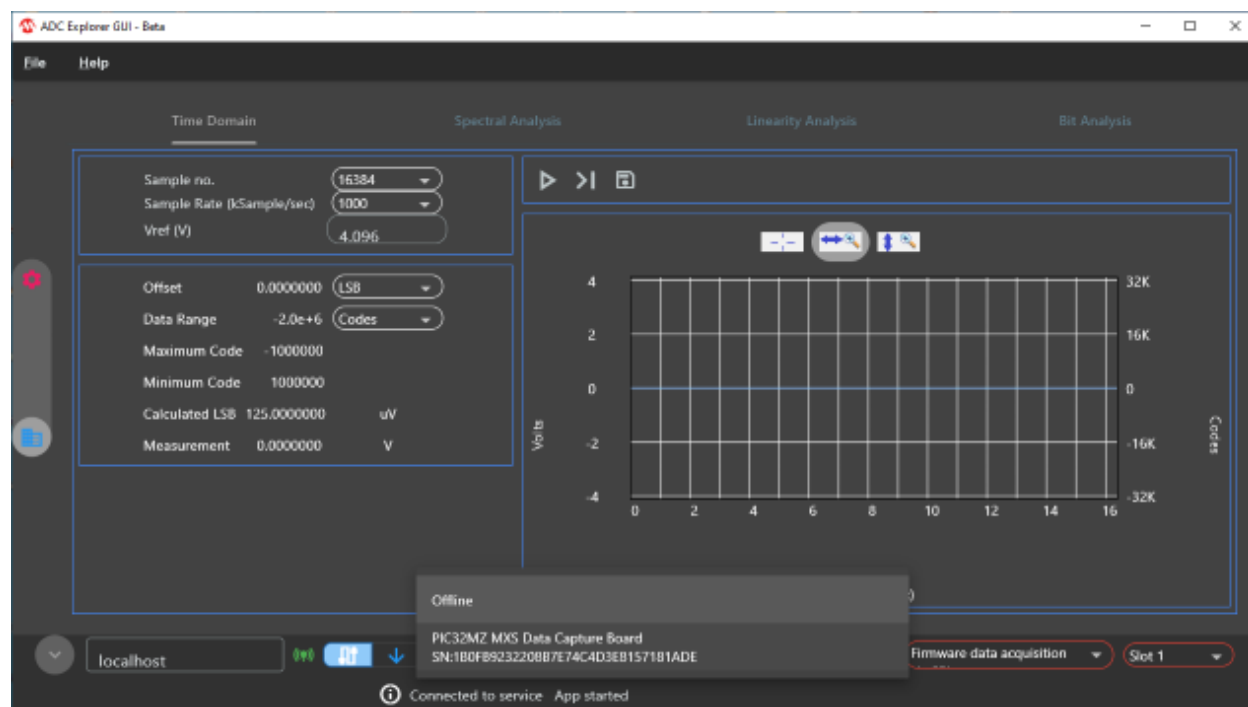


Type in the first box the host of the service (the name or the IP Address, for example 'local' or 'localhost' for the service running on the same PC as the GUI). When connecting to localhost, the service will be started automatically, which momentarily opens a command prompt to do this operation.

Then click the online red icon to establish a connection to the service. The buttons turn green on a successful connection to the service.

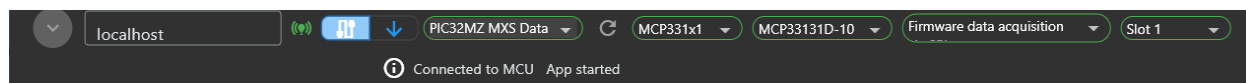
After establishing a successful connection, select the right Device Family and Device from the dropdowns to ensure correct processing in the GUI.

Next, expand the dropdown to view the available MCU boards and select one.



Upon selection of the MCU board, a successful connection to the attached Evaluation Board is established, which is indicated by the green border surrounding the Operation Mode and the Selected Slot dropdowns. For each Device Family a default operation mode is provided, which can be changed from the dropdown. Also, set the desired slot.

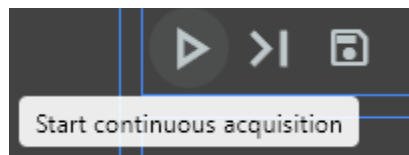
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The GUI can, in rare circumstances, disconnect due to an Ethernet connection timeout, which is indicated by a red border around the dropdowns. In such cases, disconnect the host by clicking the button and do the connection steps again.

When connecting a device after the GUI has started, press the refresh button to update the device lists before the default refresh interval of 30 seconds.

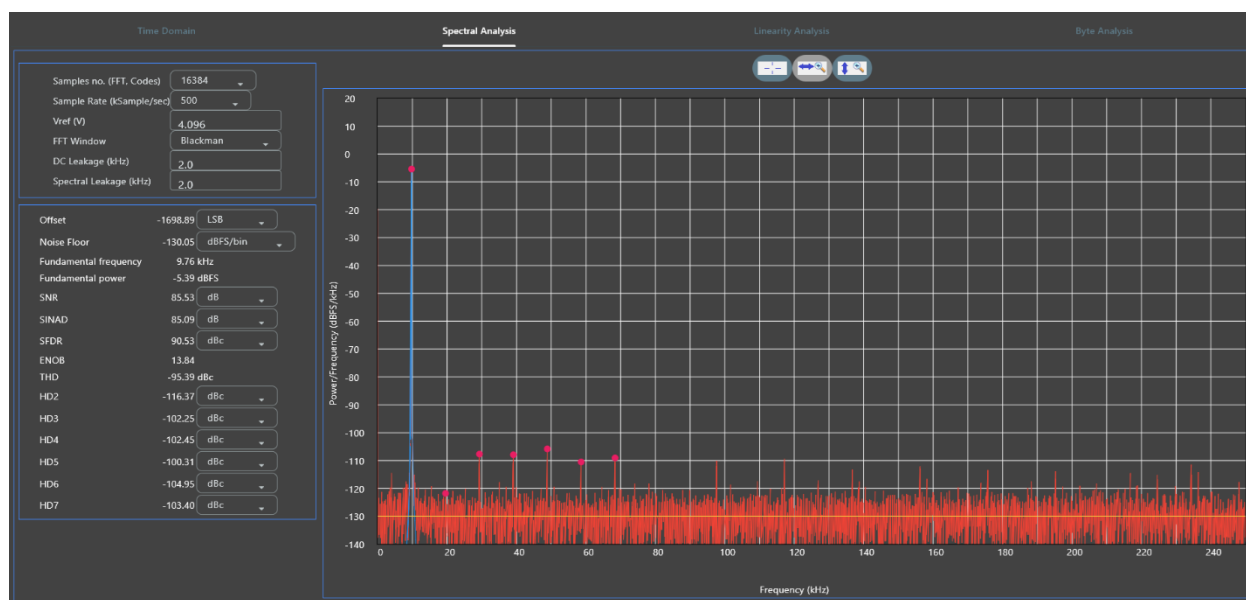
To continuously acquire data from the ADC, press the play button. The button will then change to a stop icon.



To save 5 seconds of data while continuous acquisition is in Time Domain mode, press the Save Button. The data are 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.

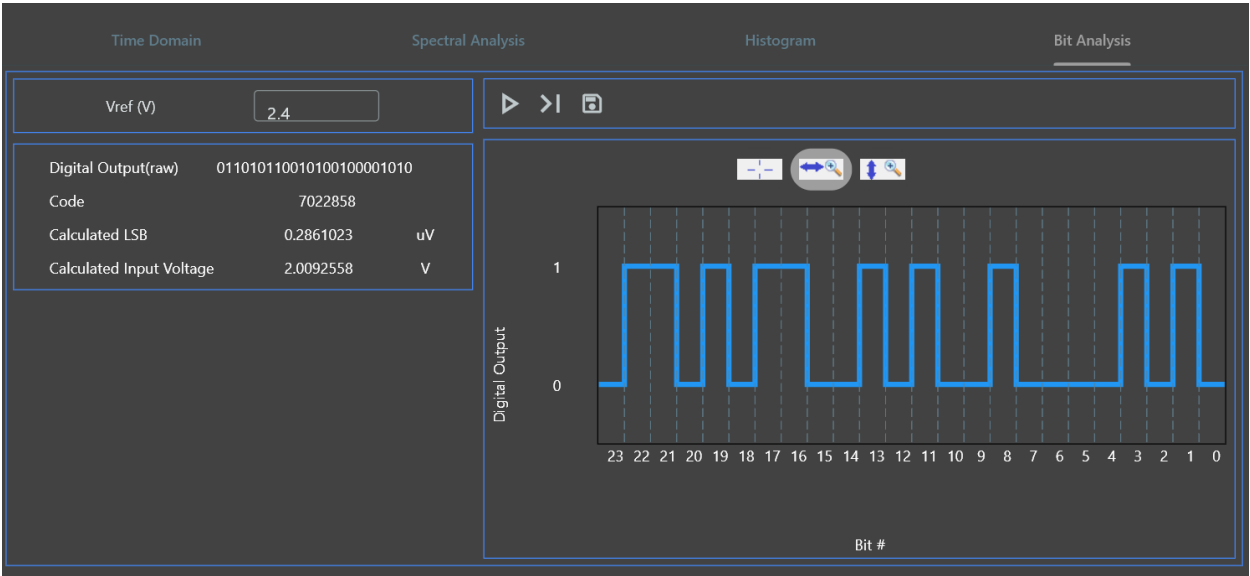
To view other types of analyses running in continuous mode, click the corresponding tab in the Analysis Tab Selection.

The following figure is the FFT plot for 9.76 kHz, -5.39 dBFS input signal.

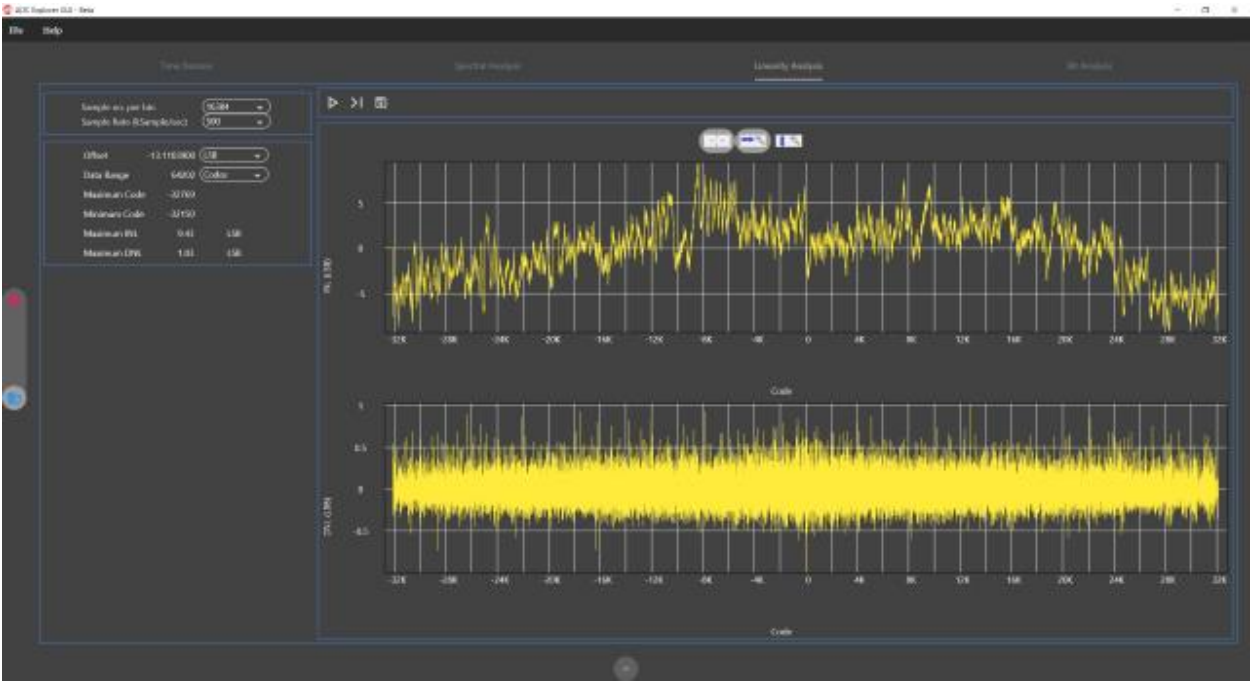


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The following figure represents the digital output code with DC input = 2V.

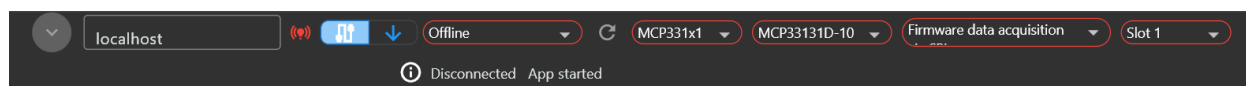


The following figure represents the INL for a 7 kHz, 4V input signal.



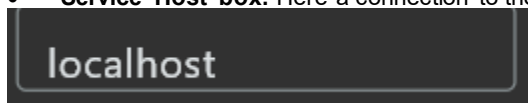
Chapter 4. MIXED-SIGNAL EXPLORER GUI LAYOUT

3.1 Connection and Status Bar




1. Connection group

- **'Service Host' box:** Here a connection to the MCHP USB Bridge Service needs to be done.



- Select the connectivity type:
 - Select 'localhost' or 'local' for local connectivity
 - Select an IP address/host name for remote connectivity
- **Connection mode** refers to the connection between the Mixed-Signal Explorer GUI and the MCHP USB Bridge Service. Once this connection is established, all GUI operations function identically from the perspective of the user, whether the connection is local or remote.
- Also, target devices are accessible through USB connections using the MCHP USB Bridge Service.
 - Local host connection mode:
 - In this mode the PIC32MZ Mixed Signal Data Capture Board (EV64F02A) and the Evaluation Board are physically attached to the same machine running the GUI, referred to as local host. The MCHP USB Bridge Service must also run on this local host to enable the GUI to communicate with the USB-connected device.
 - Remote host connection mode:
 - In this mode, the PIC32MZ Mixed Signal Data Capture Board (EV64F02A) and the Evaluation Board are physically attached to a remote host accessible over the local network. The MCHP USB Bridge Service must run on this remote host as well and must be able to manage several client connections over TCP/IP simultaneously.

- **'Connect to Service' button:**  This button turns green when the GUI is connected to the MCHP USB Bridge Service and red when the connection fails or is not established. Clicking this button either connects to or disconnects from the service. A connection to the service is required for the GUI to operate in online mode and to gather data from the attached board.



- **Connection mode/Firmware update mode toggle button**
If a firmware update is required, select the down arrow icon. This changes the Connection bar view to Firmware Update. Firmware Update is only available after a connection to the host was established.



To update the firmware, follow these steps:

1. Select the desired device
2. Select the text box. This opens a window to select the firmware file.
3. Select the **FW Update** button. A message appears on top of the bar indicating if the update succeeded or failed.



- **List of connected devices:**
Devices connected to the host where the MCHP USB Bridge Service is running (either local or remote) are displayed here and can be selected for connection. The list of attached devices automatically refreshes approximately every 30 seconds.
NOTE: the dropdown cannot be accessed while continuous acquisition is running. To select a device, first stop the continuous acquisition.



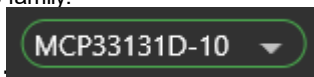
- **'Refresh Connected Devices' button:**

This button is used to manually refresh the list of connected devices. The refresh is immediate. Use this button when a new device is attached or removed, instead of waiting for the 30 second automatic update.



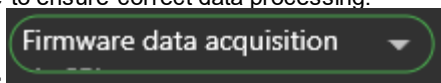
- **Device Family dropdown:**

Select the correct device family.



- **Device Type dropdown:**

Select the appropriate Device to ensure correct data processing.



- **Operation Mode dropdown:**

Select the desired operation mode for the connected device.

NOTE: The Mixed-Signal Explorer GUI selects an appropriate default operation mode.



- **Slot:**

Selecting the correct slot ensures correct output data.

2. Status group



- **Errors Status Indicator:**

The red color indicates an error. Hovering over the indicator displays a tooltip showing the error message. Clicking on it removes the errors and sets up a clean report. For this release, the following scenarios can result in an error message:

- API mismatch between the backend and GUI
- In case data is discarded at the firmware level, service level or backend level, this error usually occurs when the CPU/RAM of the PCs hosting MCHP USB Bridge Service and the Mixed-Signal Explorer GUI reach their maximum load levels.
- When the FFT algorithm does not detect any frequencies significantly higher than the noise floor.
- When a register read fails because of simultaneous operations.

Successfully completed Code Acq. 8:17:1

- **Acquisition status:**

This displays whether the acquisition or data processing succeeded or failed, including a message timestamp.

Connected to MCU

- **Connection status:**

Displays the current connection status for the device previously selected.

This could be "Disconnected", "Connected to service" or "Connected to MCU".

3.2 Settings/Results toggle



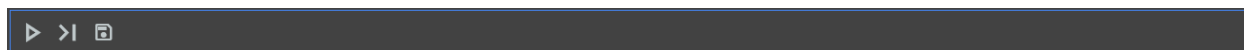
- 1) Clicking the **Settings** button displays/hides the Settings Panel
- 2) Clicking the **Results** button displays/hides the Results/Metrics Panel for the current tab: Codes/FFT/INL
- 3) The selected button is underlined with a lighter color. If none is underlined, then neither the Settings Panel nor the Results Panel is displayed.

3.3 Tab selection



- 1) Selecting one of the following items in the tab area displays the respective panel: Time Display, Spectral Analysis, Linearity Analysis or Bit Analysis.
- 2) The currently selected tab is underlined with a lighter color.

3.4 Acquisition group



- **'Start/Stop Continuous Acquisition' button:** Displays a different icon based on the state of the acquisition. This button starts the Codes/FFT/INL acquisition based on the tab selected in the main area of the GUI.
- **'Single Acquisition' button:** This button enables the collection of one sample set of data and perform the necessary data processing on it. Note that data processing is done in a different library than the GUI (the backend) and switching tabs will not display the processed data on the exact samples acquired in a different tab.
- **'Save Data' button:** Depending on the context, this button will either save 5 seconds of Codes to a file in the Downloads folder, when continuous acquisition is started and the current tab is Codes or it will capture a snapshot of the current data, such as: Codes in the Codes tab, FFT plots and metrics or INL plots and metrics based on the active data set.

3.5 Menu bars



- 1) The File Menu shows the option to download (export) the current set of data from Codes into a file in the Downloads folder. Import option can be also used, but the length of the codes in the imported file must match the Samples No. in the GUI.
- 2) 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.

3.6 Results Pannel

Samples no. (FFT, Codes)	16384	▼
Sample Rate (kSample/sec)	500	▼
Vref (V)	4.096	

Offset	-1.96	LSB ▼
Data Range	16077	Codes ▼
Maximum Code	8042	
Minimum Code	-8035	
Vref	4.096 V	
Calculated LSB	500.00 μ V	
Measurement	-0.001 V	

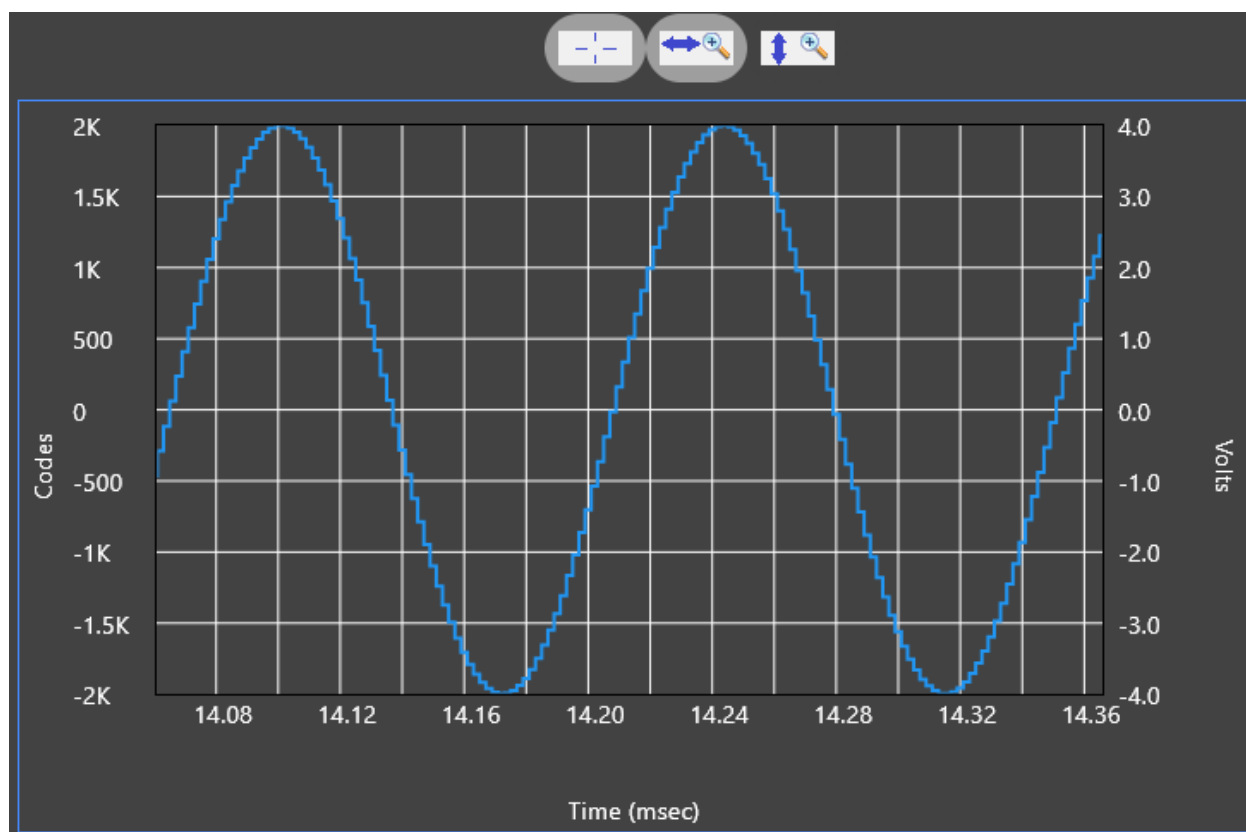
This panel displays the current metrics/results for the data processing corresponding to the currently selected tab.

3.7 Settings Panel

No. of sec. of data to save	5 ▼
Slowdown display factor (Time Domain)	1 ▼
Theme	Dark ▼

This panel displays all currently supported settings at the GUI level.

3.8 Chart Pannel



1. Buttons:

- The Auto scale Y-axis button 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.
- Zoom X-axis: Clicking this button enables horizontal zoom. When the button is colored in a lighter shade, it is selected.
- Zoom Y-axis: Clicking this button 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.

2. Chart area: The plot is displayed here depending on the currently selected tab: Codes, FFT, INL, Bit Analysis.

CHAPTER 5. Delta-Sigma Support Through Generic SPI

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 kbps, thus restricting the recognized signal to a maximum of 2 kbps (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.

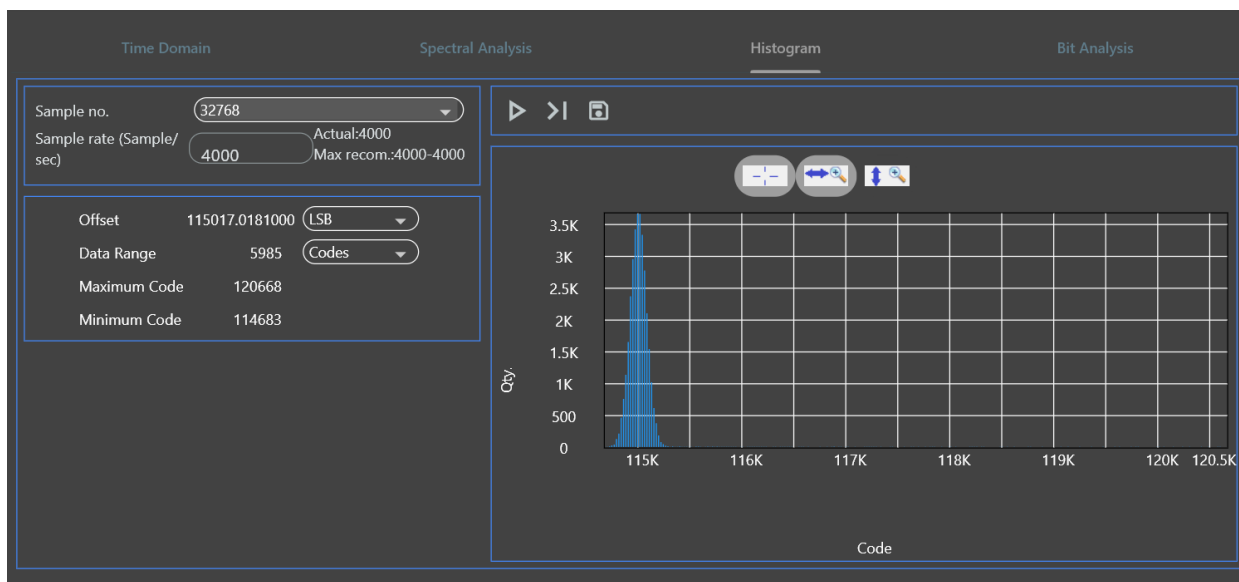
The options provided by the sample number field (**Sample no.**) are powers of 2 with values around the actual sample rate. This ensures acquisition time is short when acquiring the same amount of data as a SAR ADC but with lower sample rates.

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 Histogram

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



4.4 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.

4.5 Register View



OSR	64
MUX_VIN+	CH0 (default)
MUX_VIN-	AGND
GAIN	1X (default)
BOOST	1X (default)
PRE	MCLK (default)
VREF_SEL	Internal
Partial Shutdown mode	Disable (default)
CLK_SEL	Internal & no output on CLK pin.
CS_SEL	Off
ADC_MODE	Standby
AZ_MUX	Off
AZ_REF	On
CONV_MODE	One-shot Standby





Registers can be modified for Generic SPI through **Register View**, accessed by clicking the yellow button in the




ribbon on the left side of the GUI.

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.

- 
 Registers can be reset to default Device values by using this button.
- 
 Register values can be refreshed from the device.
- 
 Register values can be saved to the device.
- 
 This button saves the current register values displayed in the application to an external file.

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-  This button can be used to import registers values from a previously saved file.

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.

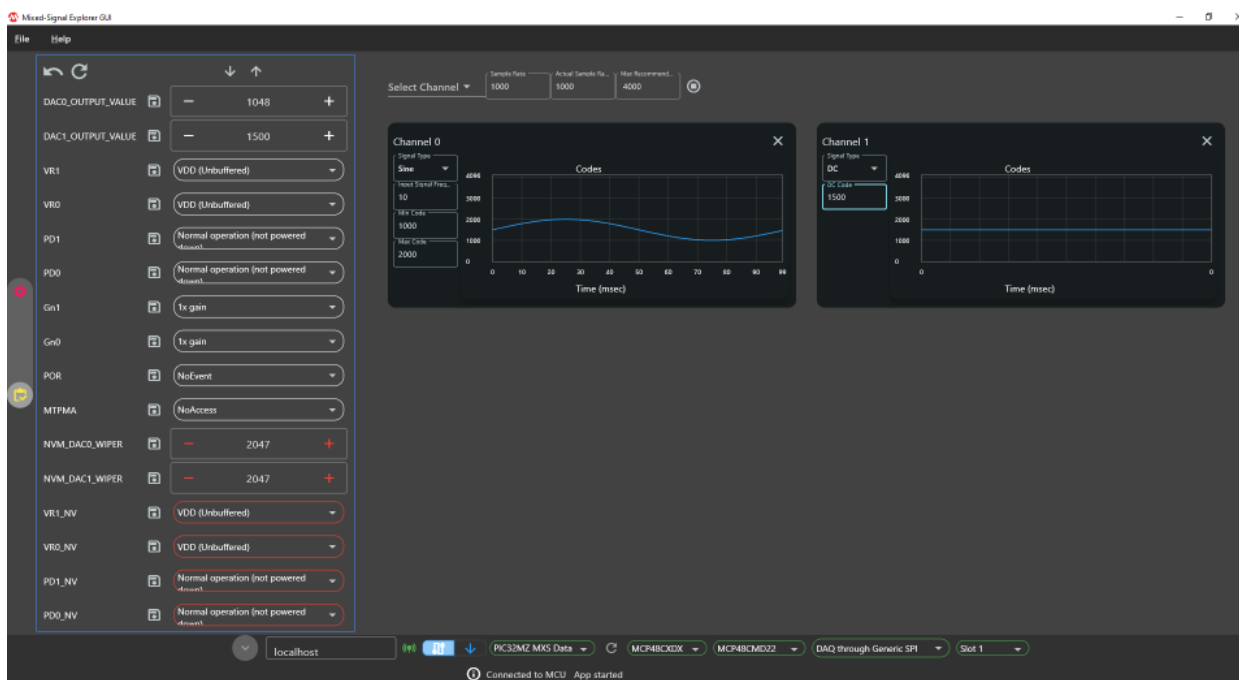
If the Mixed-Signal Explorer GUI is connected to an incorrect slot (which does not have a MCP356xR device connected), **Register View** returns false values.

CHAPTER 6. DAC Support Through Generic SPI

The MCP48CXB_X and MCP48CXDX families of DAC devices both support the Generic SPI communication protocol.

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.

If the MCP48CXB_X/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)."



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