

UM12203

NAFE13388-UIM 8-channel universal input AFE expansion board

Rev. 1.0 — 22 November 2024

User manual

Document information

| Information | Content |
|-------------|--|
| Keywords | NAFE13388, Universal Input, Analog Input |
| Abstract | This document describes the operation of the NAFE13388-UIM AFE expansion board and provides a detailed overview on board operation, hardware settings, and MCUXpresso example codes. |



1 Introduction

The NAFE13388-UIM expansion board features a highly configurable, industrial-grade, multichannel analog input AFE (AI-AFE) family of parts that meets high-precision measurement requirements. The device is composed of a low-leakage, high-voltage multiplexer, low-offset drift buffers, a low noise and drift PGA, a precision 24-bit sigma-delta analog-to-digital converter (ADC), and a low-drift voltage reference.

The AI-AFE family integrates:

- Input protection circuit for electromagnetic compatibility (EMC) and misuse wire scenarios
- Diagnostic circuits for input, open, and short circuit and impedance detection

An advanced diagnostic circuit is implemented for channel loopback reading, and output voltage or current bias circuits. The two precise reference voltage sources enable end-to-end system self-calibration and advanced anomaly detection for predictive maintenance.

This NAFE13388-UIM expansion board enables quick evaluation of AFE and plug and play compatibility with MCU boards having Arduino connector.

A graphical interface allows the user to easily explore the different functions of the driver. The IC communicates to the host via the industry standard SPI-bus port. The evaluation software runs under the Microsoft Windows 7, 8, and 10 PC platforms.

2 NAFE13388-UIM expansion board key features/benefits

Compact design:

- 89 mm x 50 mm size
- Arduino UNO connector connects to any NXP FRDM MCU platform
- FRDM compatible

Enhanced analog sensing:

- Eight software configurable analog inputs to measure voltage, current, RTD, and thermocouple
- Embedded RTD for cold junction compensation
- Current sense resistors controlled by GPIO

Advanced analog features:

- Voltage or current excitation sources
- Factory and user calibration support
- Advanced diagnostics and anomaly detection

Plug and play:

- Open-CMSIS driver pack
- NAFE GUI
- Code examples

3 Applications

- PLC or remote I/O
- Data acquisition
- Industrial instruments
- Servo control

4 Finding kit resources and information on the NXP web site

NXP Semiconductors provides online resources for evaluation boards and its supported device(s) on <http://www.nxp.com>.

The information page for NAFE13388-UIM expansion board is at <http://www.nxp.com/NAFE13388-UIM>.

The information page provides overview information, documentation, software and tools, parametrics, ordering information and a Getting Started tab. The Getting Started tab provides quick-reference information applicable to using the NAFE13388-UIM expansion board, including the downloadable assets referenced in this document.

4.1 Collaborate in the NXP community

The NXP community is for sharing ideas and tips, ask and answer technical questions, and receive input on just about any embedded design topic. The NXP community is at <http://community.nxp.com>.

5 Getting ready

Working with the NAFE13388-UIM expansion board requires the kit contents, additional hardware, and a Windows PC workstation with installed software.

5.1 Evaluation kit components

- Assembled and tested NAFE13388-UIM expansion board in an antistatic bag
- Spare jumpers

FRDM-MCXN947 evaluation board is needed to run MCUXpresso example codes or to run the GUI. Please order this board from below link: <https://www.nxp.com/FRDM-MCXN947>

5.2 Windows PC workstation

This evaluation board requires a Windows PC workstation. Meeting these minimum specifications should produce great results when working with this evaluation board.

- USB-enabled computer with Windows 7, Windows 8, or Windows 10

5.3 Power requirements

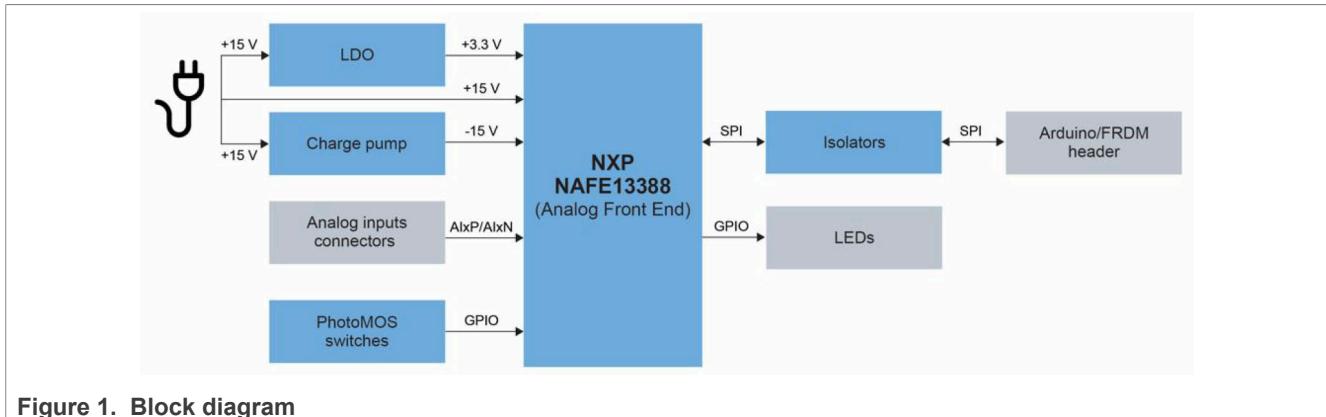
For NAFE13388-UIM expansion board setup, connect 15 V DC power adapter to DC power jack (J7) on NAFE13388-UIM expansion board. Connect the Type-C cable to the USB port J2 (out of the three USB ports J1, J2, and J3) to power up the FRDM MCXN-947 evaluation board.

6 Getting to know the hardware

6.1 Board features

- A complete evaluation platform for the NAFE13388
- Eight input SW configurable AI-AFE
- Easy-to-use GUI-based software demonstrates the capabilities of the NAFE11388 and NAFE13388, which are representative of the AI-AFE family, depending on the part installed on the board
- An external power supply can be used to power the NAFE13388-UIM expansion board
- Convenient test points for easy scope measurements and signal access
- USB interface to the host PC

6.2 Block diagram



6.3 Kit featured components

[Figure 2](#) and [Figure 3](#) identify important components on the board and [Table 1](#) provides additional details on these components.

NAFE13388-UIM 8-channel universal input AFE expansion board

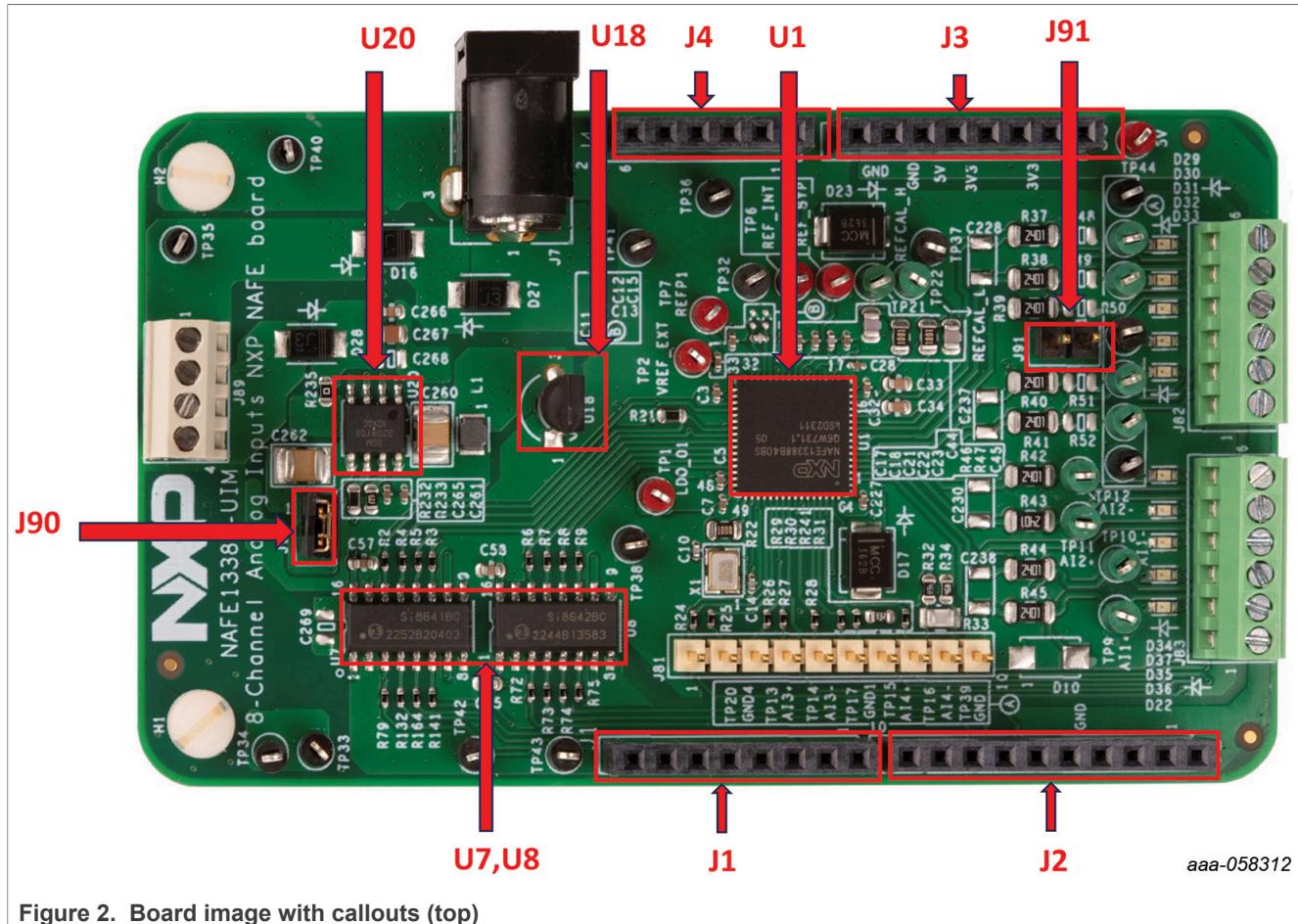


Figure 2. Board image with callouts (top)

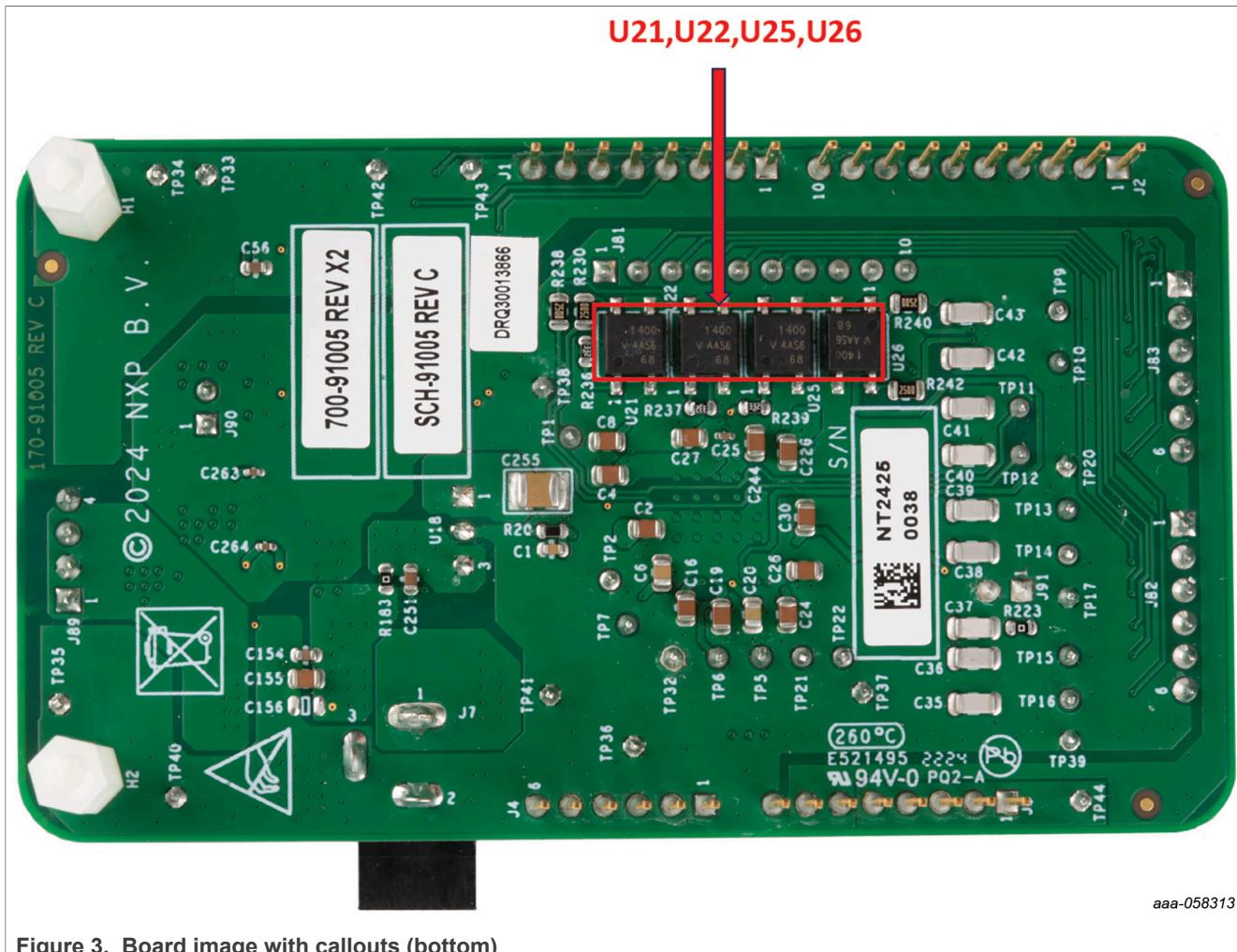


Figure 3. Board image with callouts (bottom)

Table 1. Evaluation board featured components location

| Device | Description | Location |
|---|--|-----------------|
| Eight-input SW configurable AI-AFE | NAFE13388 | U1 |
| SPST Analog Switches | Switches | U21,U22,U25,U26 |
| Linear drop-out regulator | LDO | U18 |
| High-Voltage, charge pump DC-DC converter | Charge pump | U20 |
| Quad-channel digital isolators | Digital Isolator | U7,U8 |
| Single line connectors | Mounting connection with FRDM-MCXN board | J1,J2,J3,J4 |

6.3.1 Jumpers

Table 2. Jumpers

| Setting (Default) | Jumper | Comment |
|-------------------|--------|----------------------|
| 1-2 (Closed) | J90 | External -15V supply |
| 1-2 (Closed) | J91 | AIMCOM connection |

6.4 Schematic, board layout, bill of materials

The schematic, board layout and bill of materials for the NAFE13388-UIM expansion board are available at <http://www.nxp.com/NAFE13388-UIM>

7 Configuring the hardware

To evaluate a complete solution, a FRDM-MCXN 947 evaluation board and a USB cable is needed along with the NAFE13388-UIM expansion board. To set up the hardware, do the following:

1. Firmly connect the NAFE13388-UIM expansion board to the FRDM MCXN-947 evaluation board using the Arduino connectors.
2. To connect both boards, slide J1, J2, J3, and J4 male connectors at the bottom side of the NAFE13388-UIM expansion board into the appropriate female connectors on the FRDM MCX-N 947 evaluation board as shown in [Figure 4](#)



Figure 4. NAFE13388-UIM expansion board connected to the FRDM MCXN-947 evaluation board

3. Connect a DC power adapter to a DC power jack (J7) on the NAFE13388-UIM expansion board. Approximately 0.4 V accounts for the voltage drop across the Schottky diode for reverse polarity protection.
4. Use a USB to Type-C cable to connect the PC (USB) to the FRDM MCXN-947 evaluation board.

7.1 NAFE13388-UIM expansion board with MCUXpresso SDK

7.1.1 Download and install required software

- [IoT Sensing SDK \(ISSDK\) v1.8](#) offered as middleware in MCUXpresso SDK for supported platforms
- [MCUXpresso IDE v11.9.0](#)
- Tera Term 5.3
- GitHub

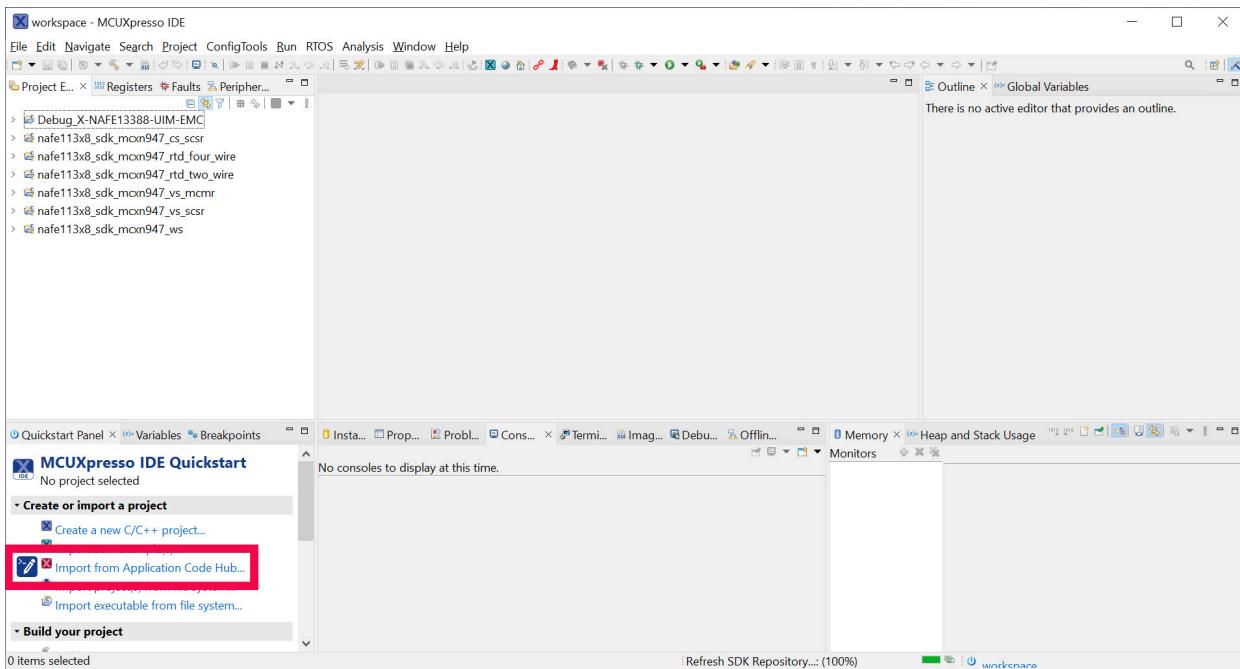
7.1.2 NAFE13388-UIM expansion board applications

The Application Code Hub provides example codes and a detailed overview about hardware and software steps to evaluate the NAFE13388-UIM expansion board. Below applications are explained in detail.

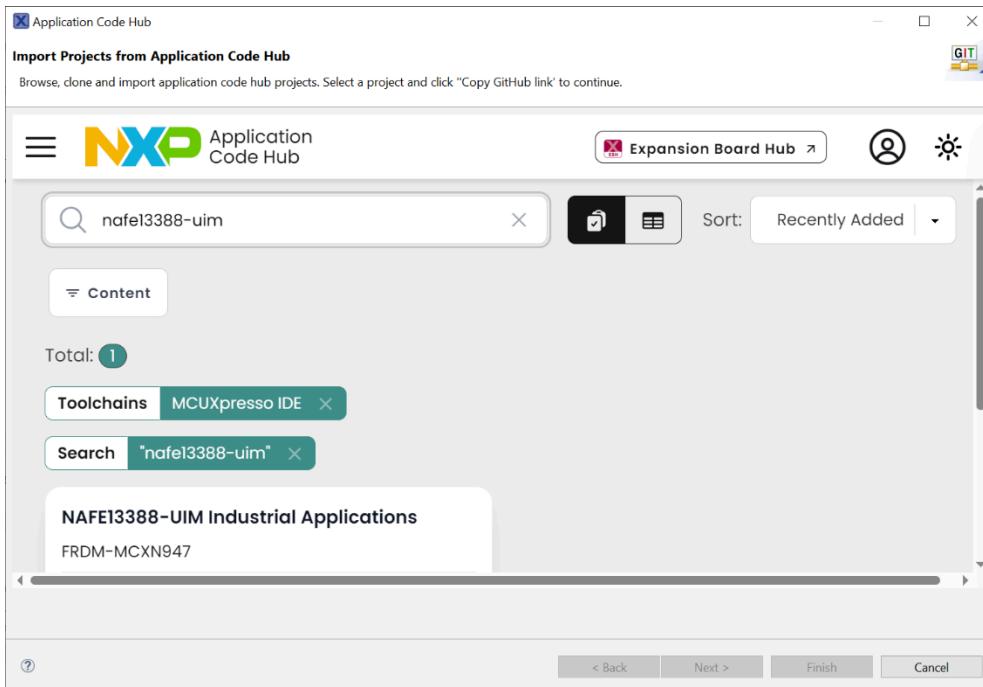
- [Voltage Sensing SCSR](#)
- [Voltage Sensing MCMR](#)
- [Current Sensing SCSR](#)
- [Two Wire RTD SCCR](#)
- [Four Wire RTD SCCR](#)
- [Weight Scale SCCR](#)

Follow the steps below to run the NAFE13388-UIM expansion board example codes.

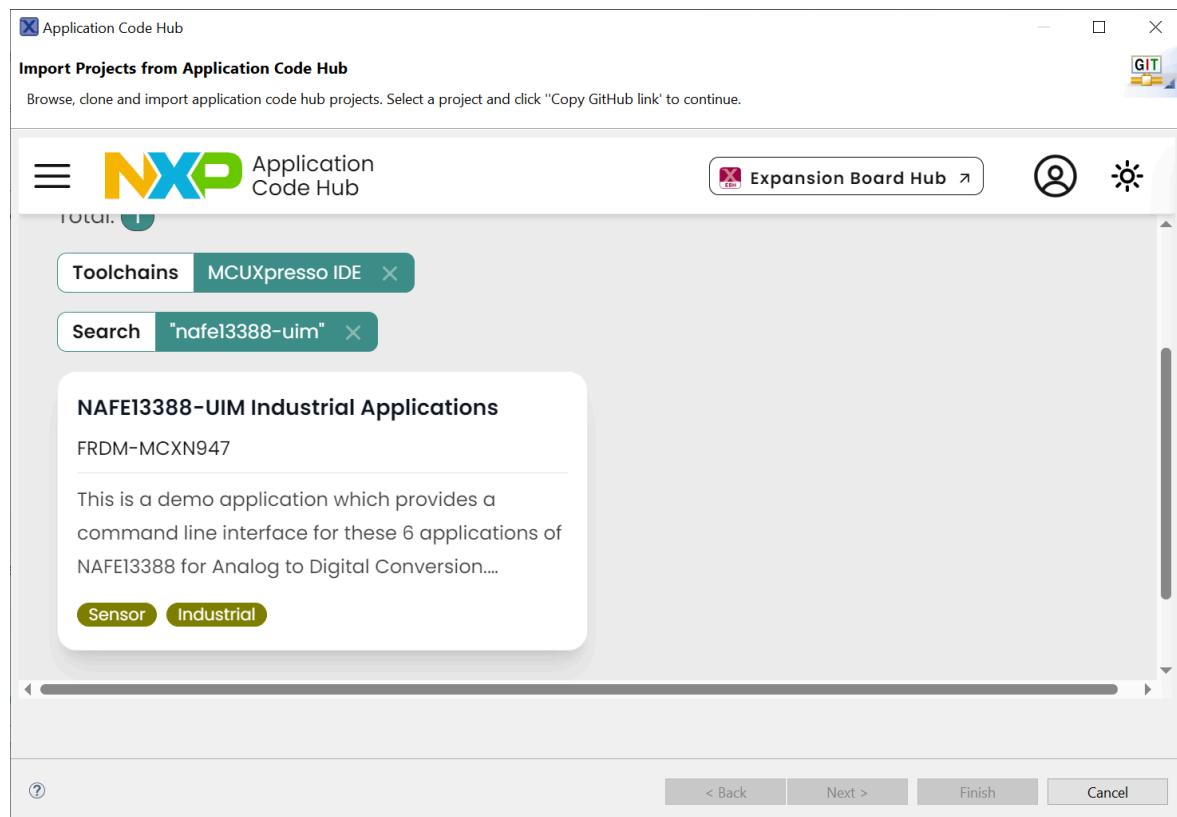
1. Open MCUXpresso IDE and Click “Import from Application Code Hub”.



2. Type "NAFE13388-UIM" in a search bar.



3. Click "NAFE13388-UIM Industrial Applications"



7.1.3 Steps to build example projects

1. Click "Visit on Github".

Application Code Hub

Import Projects from Application Code Hub

Browse, clone and import application code hub projects. Select a project and click "Copy GitHub link" to continue.

NXP Application Code Hub

NAFE13388-UIM (Analog Front End) Industrial Applications running on FRDM-MCXN947

The NAFE13388 is a highly configurable, industrial-grade, multichannel universal input analog front-end (AFE) that meets high-precision measurement requirements. The device integrates

2. Open command prompt and set the location of your current directory, where you would like to copy the code.
3. Click on Code → GitHub CLI and copy the link.

GitHub - nxp-appcodehub/dm-nafe13388-application-examples: This is a demo application which provides a command line interface for these 6 applications of NAFE13388 for Analog to Digital Conversion.<br...>

<https://github.com/nxp-appcodehub/dm-nafe13388-application-examples>

Code Issues Pull requests Security Insights

Clone

HTTPS GitHub CLI

Work fast with our official CLI. [Learn more](#)

Open with GitHub Desktop

Download ZIP

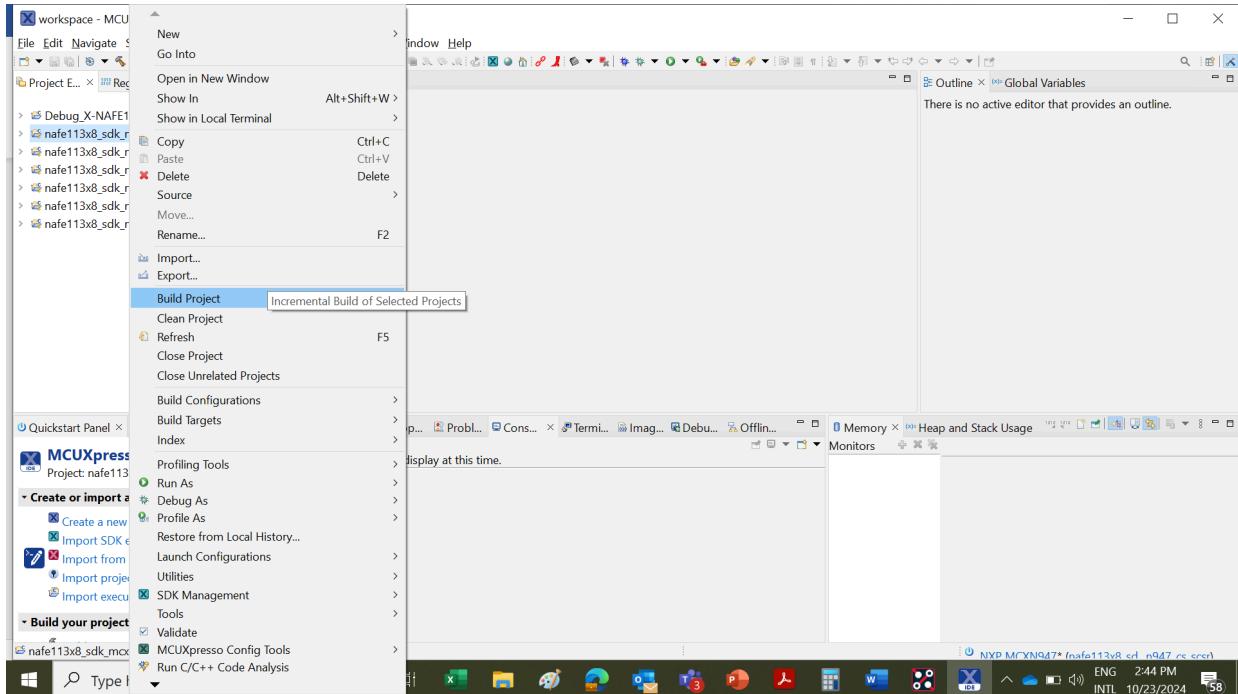
About

This is a demo application which provides a command line interface for these 6 applications of NAFE13388 for Analog to Digital Conversion.<br...>Current Sensing using SCSR Conversion Voltage Sensing using SCSR Conversion Voltage Sensing using MCMR Conversion RTD 2/4 Wires using SCCR Conversion Weight Scale

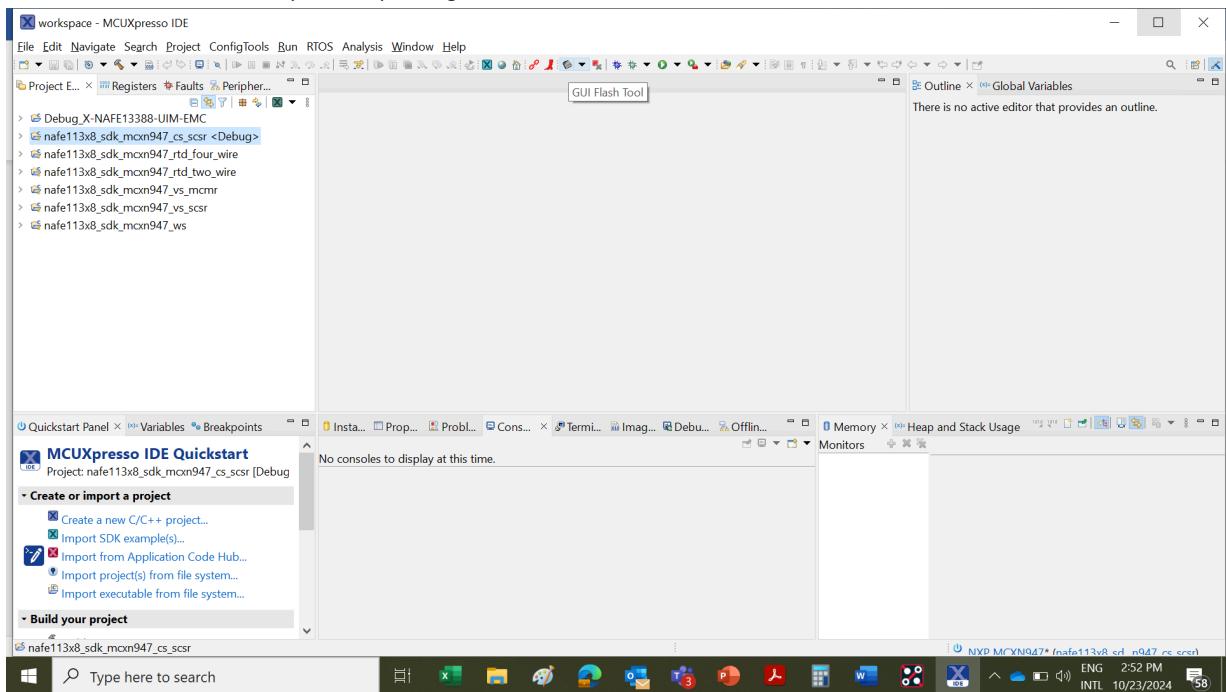
4. Clone Git repository by typing below command.

```
git clone <repository-url> <directory-name>
```

5. Open MCUXpresso IDE and “Import project from file system”. You will see 5 projects on left side of panel.
 6. Click on each project and right click. Click “Build Project” as shown in image below.



7. Download the firmware (.axf file) using a GUI flash tool.



8. Follow the instructions on “readme file” on Application Code Hub to execute the example code.

NAFE13388-UIM 8-channel universal input AFE expansion board

The screenshot shows the NXP Application Code Hub interface. On the left, a sidebar lists 'Device Families' including DSC, i.MX, i.MX RT, K32W, Kinetis, KW45, LPC, MCX, and MW. A 'Clear All Properties' button is at the bottom of this sidebar. The main content area shows a project titled 'NAFE13388-UIM' with a GitHub link. A modal window is open, providing instructions for running the demo application. The modal has buttons for 'About', 'Help', 'Open' (which is highlighted in blue), and 'Cancel'. Below the modal, the project details are shown, including a description of the NAFE13388-UIM applications and a section on '4.1 Voltage sensing SCSR' with two bullet points. At the bottom of the main content area are buttons for '?', '< Back', 'Next >', 'Finish', and 'Cancel'.

8 Revision history

Table 3. Revision history

| Document ID | Release date | Description |
|---------------|------------------|---|
| UM12203 v.1.0 | 22 November 2024 | <ul style="list-style-type: none">Initial version |

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