UM11580

PCT2075DP-ARD evaluation board

Rev. 1.0 — 22 February 2021 User manual

Document information

Information	Content
Keywords	PCT2075DP, I^{2}C-bus, Fm+, Arduino port, EVK
Abstract	The PCT2075DP-ARD evaluation board is a daughter card equipped with an Arduino port, designated for easy test and design of PCT2075DP IC, I^{2}C-bus Fm+, 1 °C accuracy, digital temperature sensor and thermal watchdog. The board is fully compliant with MIMXRT1050-EVK, LPC55S69-EVK and 8MMINILPD4-EVK, including GUI software control. The board can be attached to any device equipped with an Arduino port.

Revision history

Rev	Date	Description
v.1.0	20210222	Initial version

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1 Introduction

This document describes the PCT2075DP-ARD demo board. The evaluation board is built around the PCT2075DP IC and works as a daughter card which can be connected through an Arduino port to various Arduino compatible (including original Arduino Uno R3) boards. The board is intended to test and measure the characteristics of the PCT2075DP 1 °C accuracy digital temperature sensor and thermal watchdog, produced by NXP Semiconductors.

Additionally, the daughterboard has software support and a graphical user interface (Windows platform) for the following NXP evaluation boards: MIMXRT1050-EVK board LPC55S69-EVK development board, and 8MMINILPD4-EVK board

The host device communicates with the sensor through a bidirectional Fm+ I^2C-bus. Among the device under test (DUT) IC, the board is equipped with an Arduino port and the necessary components for easy testing, shortening the time to make measurements and check operation of the PCT2075DP IC. A special feature of the evaluation board is the presence of a heating resistor, placed on the top of the DUT IC. The heating resistor is controlled with an NMOS transistor which acts as an ON/OFF circuit, allowing the user to slightly modify the temperature of the sensor. The GUI software is able to control the heating element and to monitor the temperature measured by the sensor.

2 Finding kit resources and information on the NXP web site

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

The information page for PCT2075DP-ARD evaluation board is at http://www.nxp.com/PCT2075DP-ARD. 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 PCT2075DP-ARD evaluation board, including the downloadable assets referenced in this document.

2.1 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.

3 Getting ready

Working with the PCT2075DP-ARD requires the kit contents, additional hardware, and a Windows PC workstation with installed software.

3.1 Kit contents

- Assembled and tested evaluation board in an anti-static bag.
- Quick Start Guide

3.2 Assumptions

Familiarity with the I^2C-bus is helpful but not required.

3.3 Static handling requirements

CAUTION

This device is sensitive to ElectroStatic Discharge (ESD). Therefore care should be taken during transport and handling. You must use a ground strap or touch the PC case or other grounded source before unpacking or handling the hardware.

Note: *This product has not undergone formal EU EMC assessment. As a component used in a research environment, it will be the responsibility of the user to ensure the finished assembly does not cause undue interference when used and cannot be CE marked unless assessed.*

3.4 Minimum system requirements

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

- Computer with Windows 10
- One USB port (either 3.0, 2.0 or 1.1 compatible)
- One of three EVK boards (MIMXRT1050-EVK, LPC55S69-EVK, 8MMINILPD4-EVK) along with the associated firmware / GUI software
- USB cable for power and data connection between PC and EVK board (if not included in the EVK package)

4 Getting to know the hardware

4.1 PCT2075DP-ARD features

- Connector for external access to I^2C-bus
- On-board heating resistor with ON/OFF control circuit
- On-board LED for overtemperature signaling
- Equipped with Arduino Uno R3 port for direct connection with Arduino devices
- Fully compliant with MIMXRT1050-EVK board, including GUI (Windows 10)
- Fully compliant with LPC55S69-EVK board, including GUI (Windows 10)
- Compliant with 8MMINILPD4-EVK board, including GUI (Windows 10)

Note:

For 8MMINILPD4-EVK board it is necessary to use IMX8MMINI-IARD interposer board between the EVK and PCT2075DP-ARD daughterboard (see IMX8MMINI-IARD User Manual).

4.2 Kit featured components

The board was developed around the PCT2075DP DUT IC (U1). The board also features an Arduino interface (J1, J4 to J6), which powers the circuit and communicates between the controller and DUT IC through an I^2C-bus, with a maximum speed of 1 MHz. The

I^2C-bus is linked to the dedicated pins of the Arduino connector (J1) and to on-board connector (J2), allowing the user to access the I^2C-bus externally. For more details about I^2C description and bus transactions, see PCT2075 datasheet.

The Overtemp Shutdown (OS) output of PCT2075DP IC (pin 3) is connected to J5, pin 3 through 0 Ω resistor R6. An on-board LED (D2) can be connected through J3 jumper to TMP_OS line for monitoring purposes. The output (pin 3 of the IC) is open-drain, therefore a pull-up resistor (R17) is needed to assure correct polarization of the internal MOS transistor. The IC has a 3-bit address input, allowing a total of 27 distinct addresses. For more details regarding the address setting, see PCT2075DP datasheet (NXP Semiconductors). The jumpers J7 to J9 located on the development board allow the user to set any address specified in the datasheet.

The resistor R19 (68 Ω / 600 mW) is placed over the sensor (DUT IC), and acts as a heating element. When the heating is ON the temperature of the sensor increases, so that the user can test and measure the temperature variation of the DUT IC. The heating resistor is driven by the NMOS transistor Q1, which works as an ON/OFF switch. The transistor state is controlled from the Arduino connector J5, pin 4 (the “NMOS_CTRL” line shown in).

The board is powered through the Arduino connector J6 (pin 4 – 3.3 V, pin 5 – 5 V, pin 6, 7 – GND). The 3.3 V rail voltage supplies the sensor circuit, while the 5 V power line is used for the heating resistor circuit.

4.2.1 Board layout and component placement

Figure 1 represents the top silkscreen of the board. The connectors of the Arduino port (J1, J4 to J6) are located on the bottom.

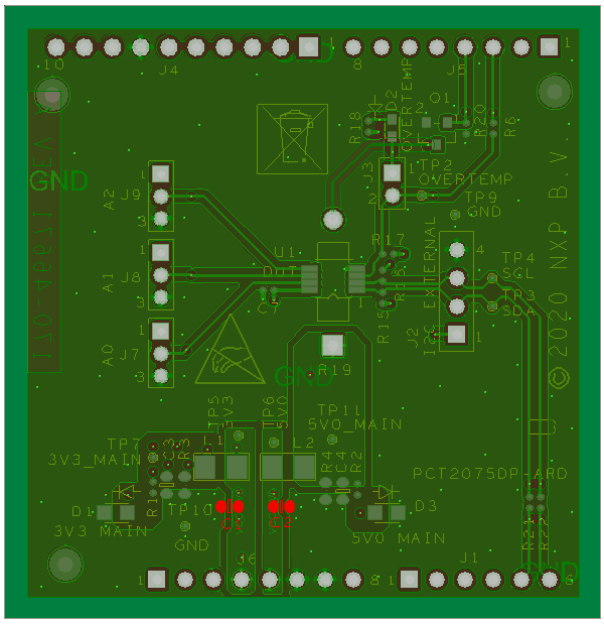

Figure 1. PCT2075DP-ARD board layout (top view)

See Figure 2 and Figure 3 for top and bottom view of the PCT2075DP-ARD daughter card.

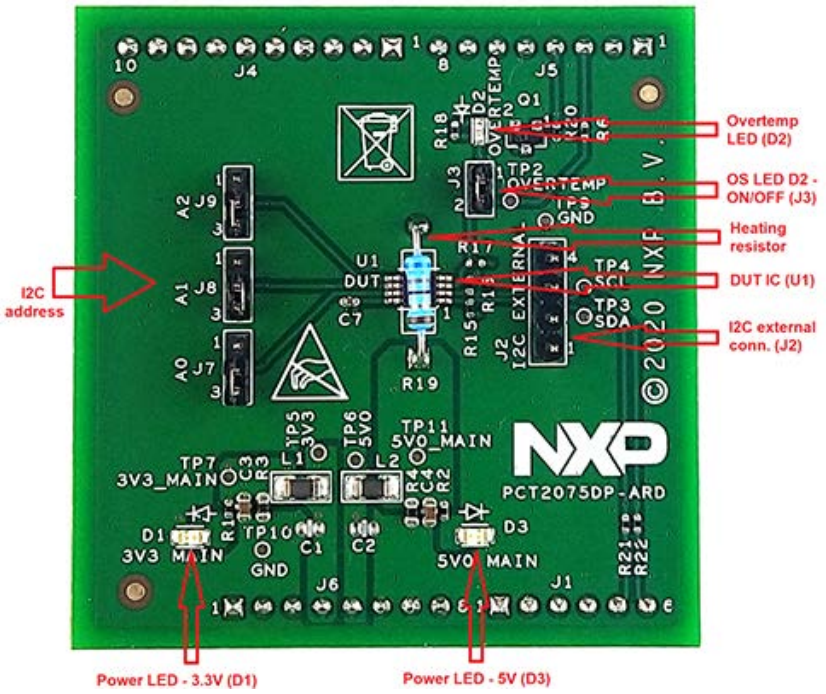

Figure 2. PCT2075DP-ARD board, top view

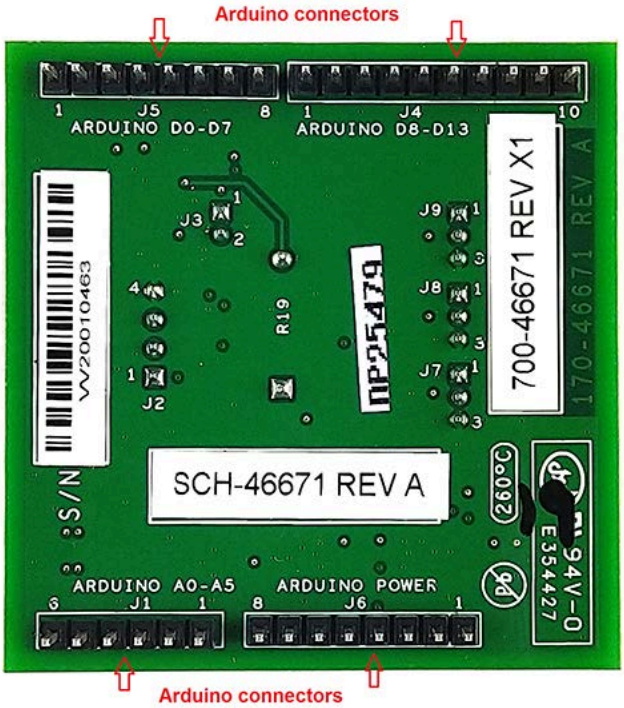

Figure 3. PCT2075DP-ARD board, bottom view

4.2.2 Arduino port

J1, J4, J5, and J6 are the mated pin headers of Arduino Uno R3 connectors, having the same electrical function and placed on the board, so that the daughterboard can be directly inserted in the Arduino port. The daughterboard circuit uses only four signal lines. See Table 1 for the connector pin chart, and the lines used in the circuit.

Table 1. Pin chart of Arduino connectors and their usage

Ref des	#	Arduino label	PCT2075DP-ARD function
J6 (Power)	1	NC	Not used
	2	IOREF	Not used
	3	RESET	Not used
	4	3.3V	Power supply
	5	5V	Not used
	6	GND	Power supply return
	7	GND	Power supply return
	8	Vin	Not used
J1 (analog, digital, I^2C)	1	A0	Not used
	2	A1	Not used
	3	A2	Not used
	4	A3	Not used
	5	A4 / SDA [1]	Used as I^2C – SDA (I^2C_SDA)
	6	A5 / SCL [1]	Used as I^2C – SCL (I^2C_SCL)
J5 (digital, UART, PWM)	1	D0 / RX	Not used
	2	D1 / TX	Not used
	3	D2	Overtemp Shutdown Output (OS)
	4	D3 / PWM	Heater ON/OFF (NMOS_CNTRL)
	5	D4	Not used
	6	D5 / PWM	Not used
	7	D6 / PWM	Not used
	8	D7	Not used
J4 (mixed)	1	D8	Not used
	2	D9 / PWM	Not used
	3	D10 / SS / PWM	Not used
	4	D11 / MOSI / PWM	Not used
	5	D12 / MISO	Not used
	6	D13 / SCK	Not used
	7	GND	Power supply return
	8	AREF	Not used
	9	A4 / SDA [1]	Not used
	10	A5 / SCL [1]	Not used

[1] A4 / SDA common line for J2 – 5 and J4 – 9. A5 / SCL common line for J2 – 6 and J4 – 10.

4.3 Schematic, board layout and bill of materials

The schematic, board layout and bill of materials for the PCT2075DP-ARD evaluation board are available at http://www.nxp.com/PCT2075DP-ARD

5 Installing and configuring software and tools

PCT2075DP-ARD evaluation board is designed and built as a daughterboard able to work in conjunction with a motherboard equipped with an Arduino port. The board built to be fully compatible with the following NXP evaluation boards:

- MIMXRT1050-EVK
- LPC55S69-EVK
- 8MMINILPD4-EVK

The required firmware for the EVK boards is available for download at www.nxp.com. Before starting EVK – PCT2075DP-ARD, the EVK motherboard must be programmed with the corresponding firmware package. Additionally, a GUI application (Windows 10) is available for download from the same NXP site, allowing rapid testing and operation of PCT2075DP-ARD daughterboard through the mentioned EVK.

The GUI application is common for all three EVKs. For details regarding installation of the EVK firmware and GUI host software, see UM11581, Arduino shields GUI and firmware installation manual.

Once the software is installed, the first step is to select the correct combination of EVK/daughterboard from the GUI, and then the board can be controlled from the GUI interface. See Section 6 "Configuring the hardware" and Section 7 "GUI description" for more details.

6 Configuring the hardware

6.1 Using PCT2075DP-ARD with MIMXRT1050-EVK board

Figure 4 shows the required hardware for operation of the PCT2075DP-ARD daughterboard with MIMXRT1050-EVK.

- One MIMXRT1050-EVK board
- One PCT2075DP-ARD daughterboard
- One USB-A / USB Micro-B cable
- PC with Windows 10 operating system

The MIMXRT1050-EVK motherboard can be powered through three different connectors: using an external 5.0 V DC power supply, connected to J2 barrel power connector, directly from an USB port through J9 USB Micro-B connector (J9), or from the same USB port through J28 connector. J28 can be used as a debug connector, therefore using J28, through the same USB cable, the EVK can be powered and in the same time linked to PC for data exchange. The older USB ports (from PC) are not able to deliver the necessary current (500 mA), before establishing the communication, use an external power supply (connected to J2). From J1 (see Figure 4) the user can select the power configuration for the motherboard. For further details, see i.MX RT1050 Evaluation Kit.

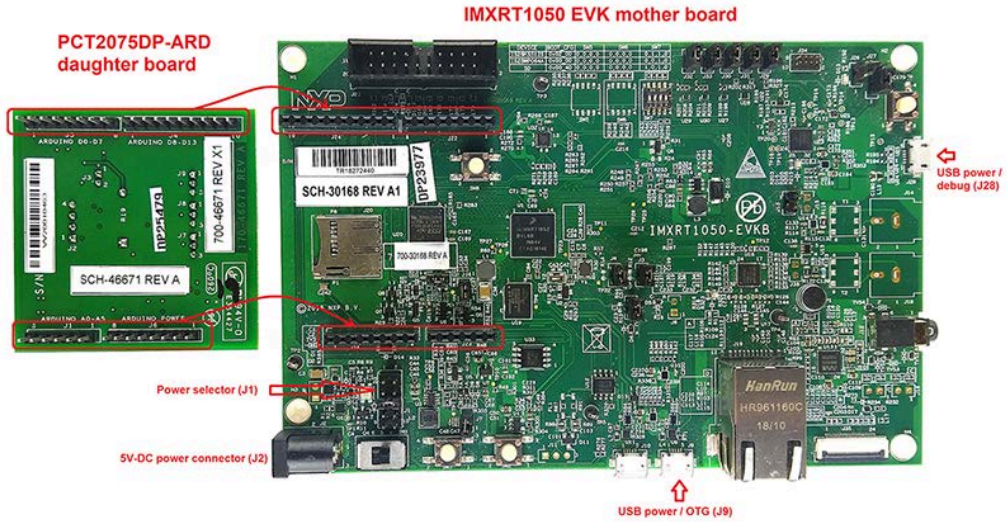

Figure 4. PCT2075DP-ARD daughterboard and IMXXRT1050 EVK board, before starting

To configure the hardware and workstation, complete the following procedure:

1. Configure the suitable power configuration of EVK (J1). If using J28 for power supply, the J1 jumper shall be placed in position 5-6. If using an external power supply (connected to J2), the jumper J1 will be placed in position 1-2
2. Insert the PCT2075DP-ARD daughter card on the Arduino port of the EVK (see Figure 4)
3. Connect the EVK board using J28 connector to USB port of the computer
4. Install the IMXRT1050 target firmware (download from NXP site and see UM11581, Arduino shields GUI and firmware installation manual for step-by-step instructions)
5. Install GUI application (see UM11581, Arduino shields GUI and firmware installation manual)
6. Open the GUI application to operate the device from the PC. For details regarding GUI operation see Section 7 "GUI description".

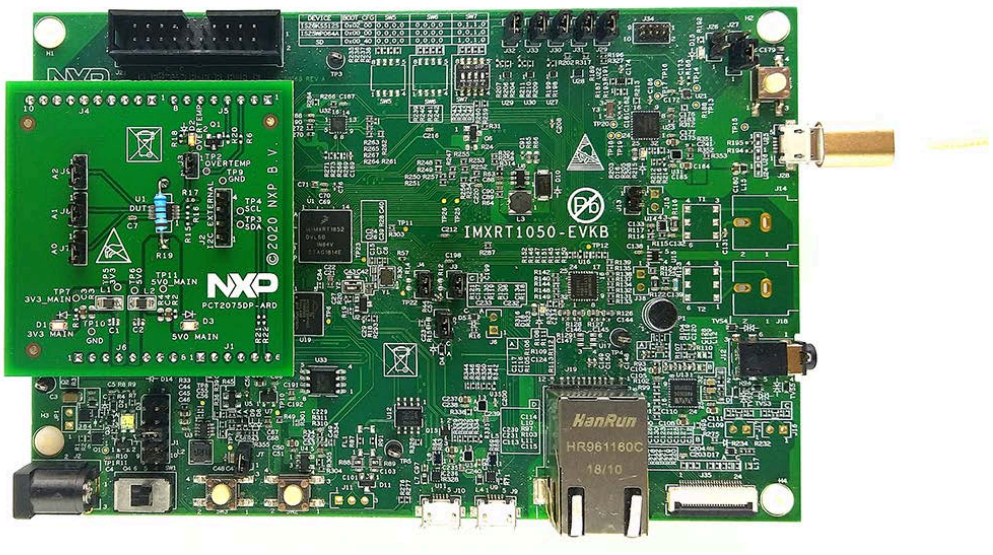

Figure 5. PCT2075DP-ARD daughterboard / IMXXRT1050 EVK board assembly

6.2 Using PCT2075DP-ARD with LPC55S69-EVK board

Figure 6 shows the required hardware for operation of the PCT2075DP-ARD and LPC55S69-EVK board.

- One LPC55S69-EVK board
- One PCT2075DP-ARD daughterboard
- One USB-A / USB Micro-B cable
- PC with Windows 10 operating system

The LPC55S69-EVK development board is equipped with four USB Micro-B connectors: P5, P6, P9 and P10. The board can be powered through any USB port. Using P6 USB connector to connect the board to the PC, the bring-up operation is simplified because P6 is designated for debug and the USB cable will accomplish two tasks in the same time: powering the board, and data link between the EVK board and PC. For more details, see LPCXpresso55S69 Development Board.

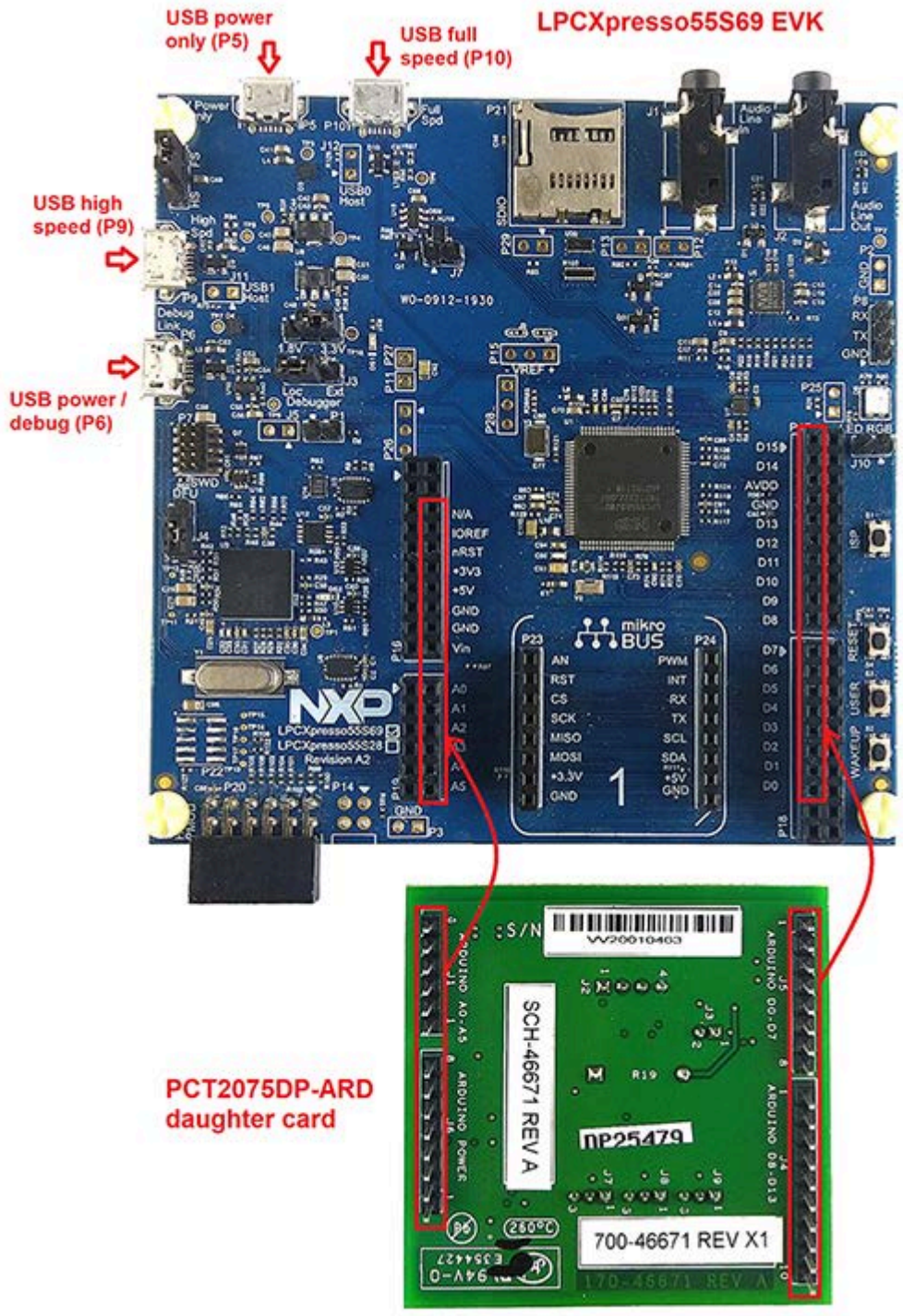

Figure 6. PCT2075DP-ARD daughterboard and LPC55S69-EVK motherboard

To configure the hardware and workstation, complete the following procedure:

1. Insert the PCT2075DP-ARD daughter card to P16 – P19 connectors located on LPC55S69-EVK development board (see the marked pins of P16 – P19, Figure 6)
2. Connect the development board using port P6 USB port of PC

3. Install the LPC55S69-EVK target firmware (download from NXP site and see UM11581, Arduino shields GUI and firmware installation manual for step-by-step instructions)
4. Install GUI application on PC (see UM11581, Arduino shields GUI and firmware installation manual)
5. Open the GUI application to operate the device from the PC. For details regarding GUI operation see Section 7

Figure 7. PCT2075DP-ARD daughterboard / LPC55S69-EVK board assembly

6.3 Using PCT2075DP-ARD with 8MMINILPD4-EVK board

If 8MMINILPD4-EVK board is used for PCT2075DP-ARD operation, a third board (IMX8MMINI-IARD interposer board) must be used, especially designed and built as EVK – daughterboard interconnection. The 8MMINILPD4-EVK is not equipped with an Arduino port; instead it has a 2x20 pin expansion connector (J1003, see 8MMINILPD4-EVK user manual). J1003 is a multipurpose port, containing different digital I/O lines, including specialized I^2C and SPI buses. Starting from the expansion connector pin chart, an Arduino port interposer board was developed.

Figure 8 shows, along with the EVK and daughterboard, a third board is included in the setup assembly. To power-up and operate the setup, it is also necessary to have one USB-C cable for power (see Figure 9), connected to Port 2 of the EVK board. The board is equipped with a power switch (SW101) which is positioned in ON position to power-up the setup. Data communication is assured through a second (USB Micro-B) cable connected to PC and debug port of the EVK (J901).

To attach the daughterboard to the EVK, it is necessary to use the IMX8MMINI-IARD interposer boards by plugging PCT2075DP-ARD to the Arduino connector of the interposer, and then the interposer to expansion connector (J1003), located on the i.MX8MMINI EVK board (see Figure 8). The user may find more details regarding power-up and operation of the setup assembly in 8MMINILPD4-EVK user manual and IMX8MMINI-IARD User Manual. The files can be downloaded from www.nxp.com/.

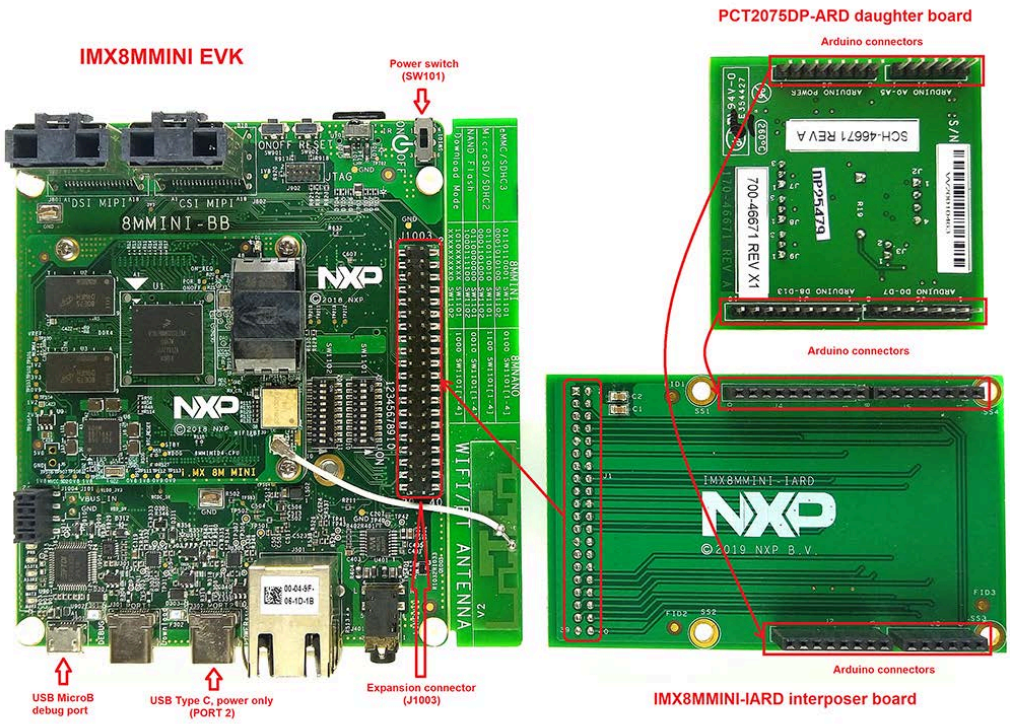

Figure 8. PCT2075DP-ARD daughterboard, IMX8MMINI-IARD interposer board, and 8MMINILPD4-EVK board assembly

To configure the hardware and workstation, complete the following procedure:

1. Insert the PCT2075DP-ARD on IMX8MMINI-IARD interposer board Arduino connectors (located on the top side).
2. Attach the obtained assembly to EVK (plug J1 connector of IMX8MMINI-IARD, located on the bottom side into J1003 expansion board located on the top side of 8MMINILPD4-EVK board.
3. Power-up the EVK board using a USB Type-C cable attached to Port 2.
4. Connect the EVK to the PC, using a USB Micro-B cable, attached to J901 debug port.
5. Place SW101 in ON position to power-up the boards.
6. Install the MIMXRT1050 target firmware (download from NXP site and see UM11581 for step-by-instructions).
7. Install GUI application on PC (see the same instruction file).
8. Open the GUI application to operate the device from the PC. For details regarding GUI operation see Section 7.

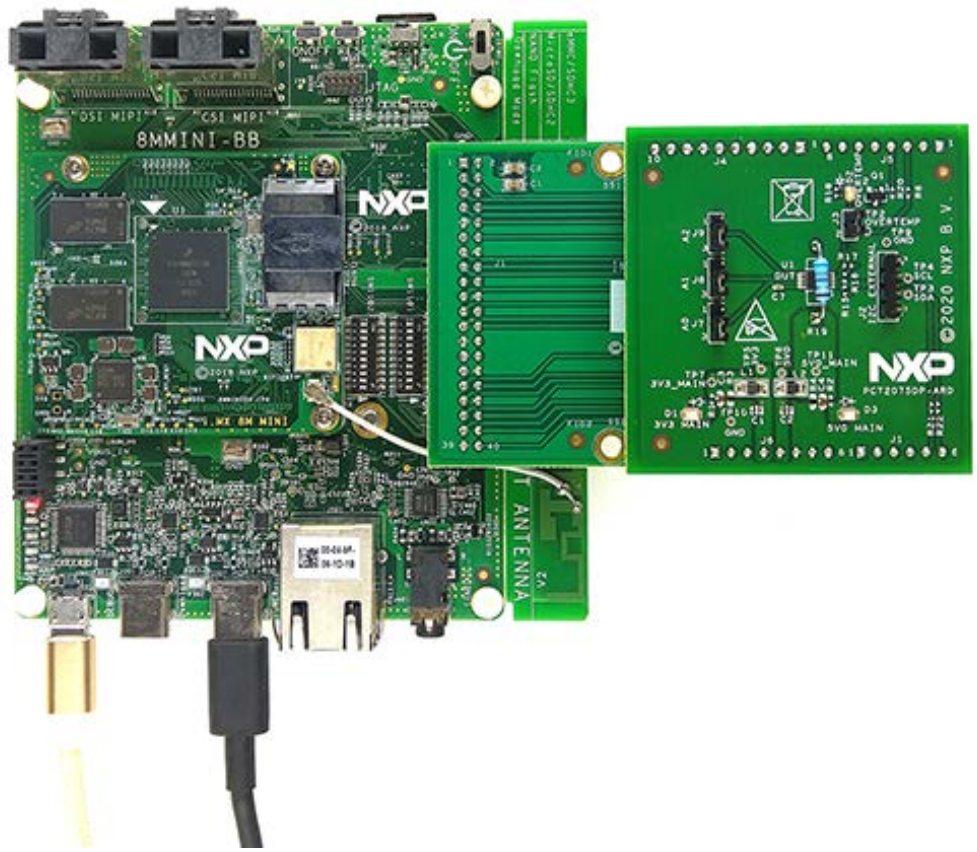

Figure 9. PCT2075DP-ARD daughterboard / 8MMINILPD4-EVK board operation

6.4 Using PCT2075DP-ARD with another Arduino device

The PCT2075DP-ARD daughterboard can be operated with different EVK boards with an Arduino port. There are two options to connect the board: using other EVK equipped with an Arduino port, and an EVK without Arduino port.

In the first case, a firmware is developed according to PCT2075 specifications, and then the PCT2075DP-ARD daughterboard is attached to the EVK to operate the board.

In the second case, using the pin chart of Arduino connectors (Table 1), make the necessary electrical connections (for power, I^2C-bus and control lines), and develop the desired firmware compliant with IC specifications. Use PCT2075 datasheet to read details about internal registers of PCT2075 and data exchange between internal controller and the EVK. Ensure that the electrical connections are accurate and avoid data conflicts on the signal lines in order to prevent IC damage.

7 GUI description

A GUI application is available for the three EVK boards from NXP Semiconductors. The application is common for all EVKs / development boards.

This section describes the GUI application and how the user can control the PCT2075DP-ARD daughterboard from the graphical interface. First, install the GUI package and software on the PC (Windows 10). For more details, see UM11581.

Once installation is complete, assure that one of the three EVKs with attached PCT2075DP-ARD daughterboard is connected to PC and powered-on. Open NXP_GUI (PCT2075) GUI application.

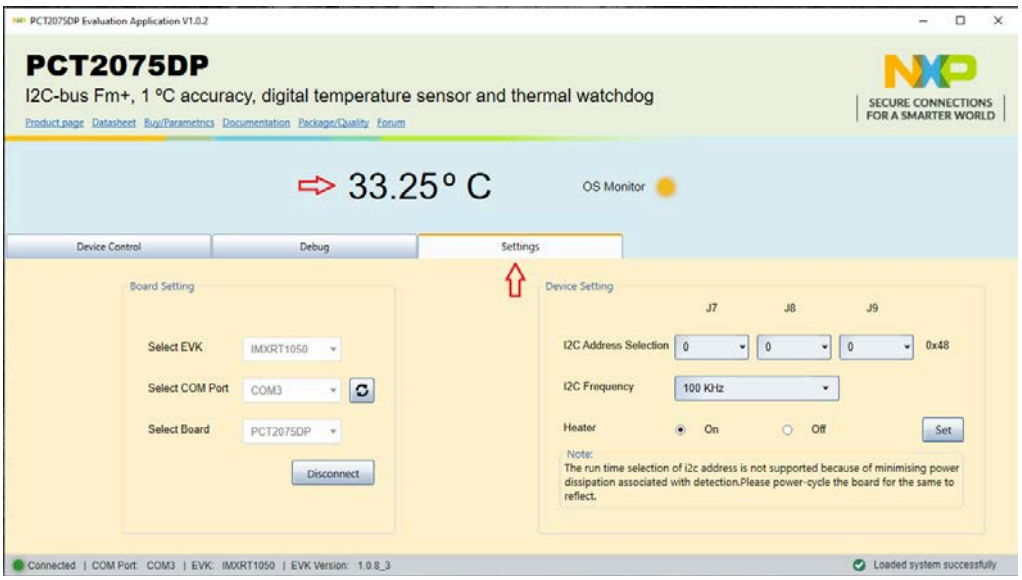

Figure 10. Graphical interface at start-up ("Settings" tab activated by default)

The GUI application starts with **Settings** tab (marked with red arrow). The left side of the window displays **Board setting**.

- **Select EVK:** displays list of EVKs. Selecting a wrong EVK board causes the connection to fail and a pop-up window with the message: *"Unable to Connect with EVK"* appears on the screen.
- **Select COM Port**: displays port selected for the communication. The port is automatically selected by the system (COM 3).
- **Select Board:** allows the user to select the correct daughter board (the application can support three different boards). In Figure 10, the selected board is PCT2075.

The next tab is redundant, since the GUI application is addressing to PCT2075DP IC only, therefore there is nothing to select here. Before clicking on the **Connect** button, assure correct configuration of the J7, J8, and J9, from the **I2C Address Selection** (in the right side of the window, **Device Setting** section). J7, J8 and J9 are the reference designators of the address jumpers, located on the PCT2075DP-ARD daughterboard.

The user sets the tabs in the GUI according to the physical position of the on-board address jumpers, otherwise the communication through the I^2C-bus fails. Choosing a different address than was set on the PCT2075DP-ARD daughterboard, when **Connect** button is activated a pop-up window with the message: "*Unable to Connect with Daughter Card*" appears on the screen. Assuming the correct parameters are chosen, clicking the **Connect** button establishes connection with the EVK.

In the bottom side of the GUI window a status bar shows in real time the status regarding connection between PC and the EVK. On the left side of the window is **Device Setting** section. The upper tab in this section is **I2C Address Selection**. The next tab allows the user to select the speed of I^2C-bus (standard – 100 kHz, Fm - 400 kHz, or Fm+ - 1 MHz). Clicking on the **I2C Frequency** tab, a drop-down list allows the user to select the desired speed. The last tab is **Heater**. From this tab, the user can activate or deactivate the heater circuit (explained in Hardware description). The communication speed and

heater status is sent to the daughterboard when **Set** button (located on the right / bottom side of the section) is clicked. After the connection is established, the current value of temperature measured by the sensor is displayed in the upper blue region (marked with the red arrow).

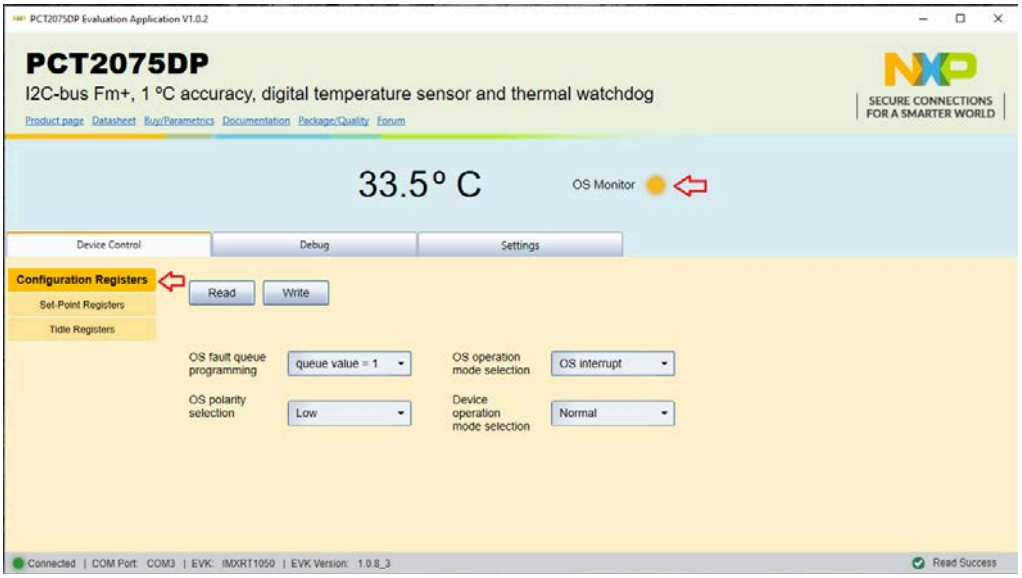

Figure 11. Graphical interface – “Device Control” / “Configuration Registers” tab activated

After clicking on **Device Control** tab, a new window appears in Figure 11. On the left side of the window, three secondary tabs are displayed: the upper one activated by default, **Configuration Registers**. The registers displayed in this window refer to a group of settings regarding the configuration of Overtemp Shutdown output (pin 3 of the DUT IC). For more details regarding this feature, see Hardware description and PCT2075 datasheet.

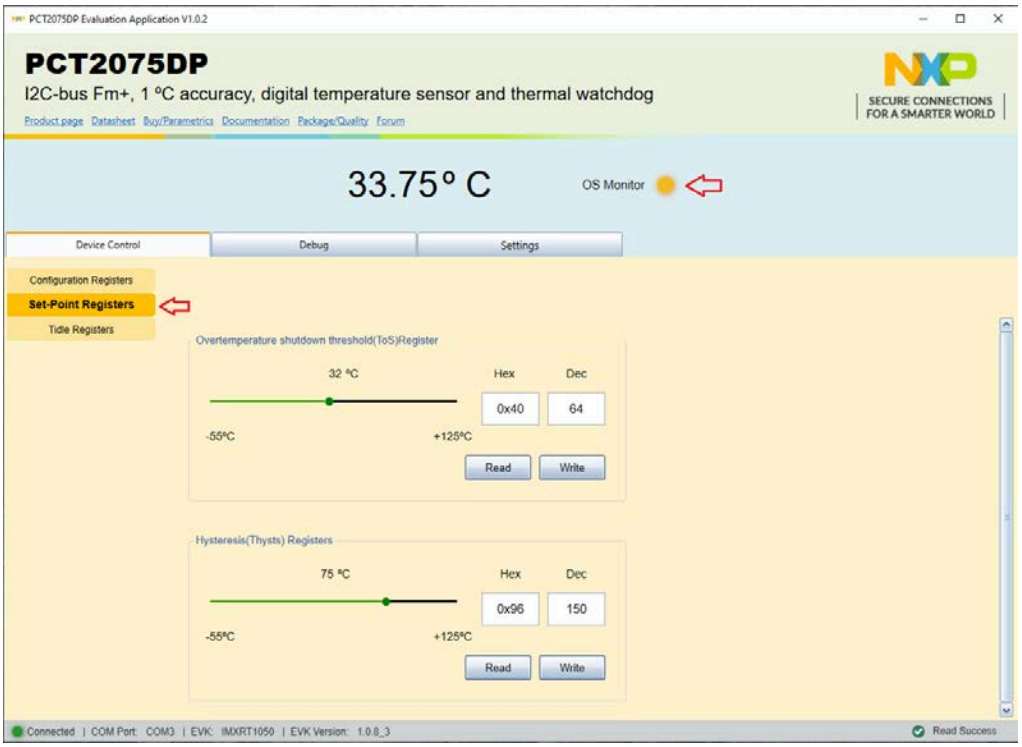

Figure 12. Graphical interface – “Device Control” / “Set-Point Registers” tab activated

The next secondary tab under the root tab **Device Control** is **Set-Point Registers**. From here, the user adjusts the Overtemperature shutdown threshold (Tos) and hysteresis (Thyst) parameters. The data to be read in the corresponding registers is introduced by dragging the graphical sliders, or by introducing the Hex or Dec values directly from the keyboard. The **Write** buttons set the register in the DUT IC, and the **Read** buttons allow the user to bring back the date from the internal registers of the IC to GUI. More details regarding Tos and Thyst are detailed in the PCT2075 datasheet. Figure 12 shows the **Device Control** / **Set-Point Registers** window. In the upper blue region, left side (and marked with the red arrow) the OS indicator shows the logic level of Overtemp Shutdown (OS) output of the DUT IC. The indicator replicates the status of the on-board LED (D2) located on PCT2075DP-ARD daughterboard.

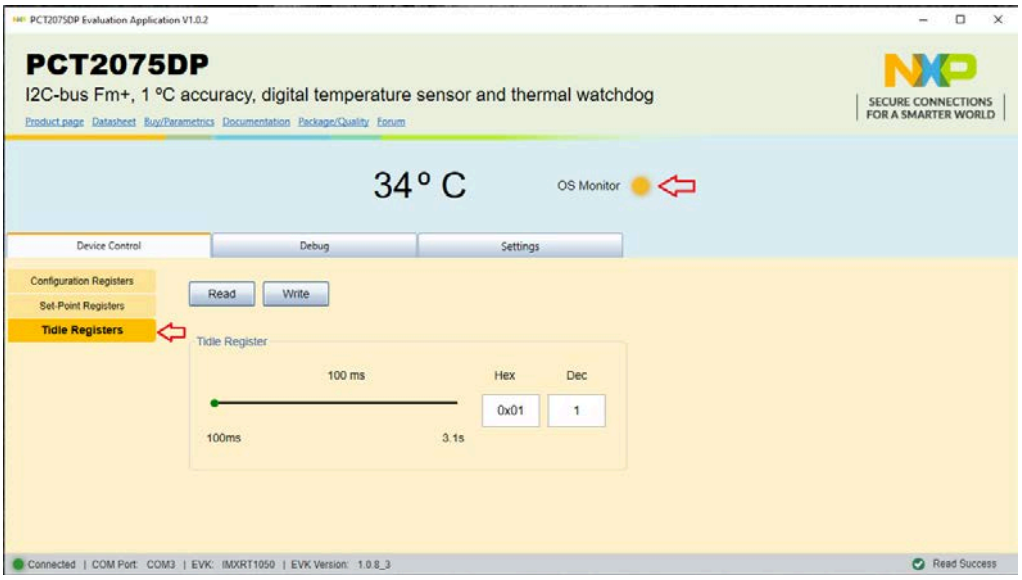

Figure 13. Graphical interface – "Device Control" / "Tidle Registers" tab activated

The last secondary tab (Figure 13) is **Tidle registers**. This parameter refers to sampling period of temperature measurement feature. Since the temperature variations are generally slow, the DUT IC offers to set the time between measurements, keeping the IC idle between measurements to save power. A dedicated register can be set, allowing modification of the idle time between 0.1 s and 3.1 s. From the interface the user can set this parameter, by dragging the slider, or by directly writing the register value in Hex or Dec representation. In the same fashion, the **Write** buttons set the register in the DUT IC, and the **Read** buttons allow the user to bring back the date from the internal registers of the IC to GUI.

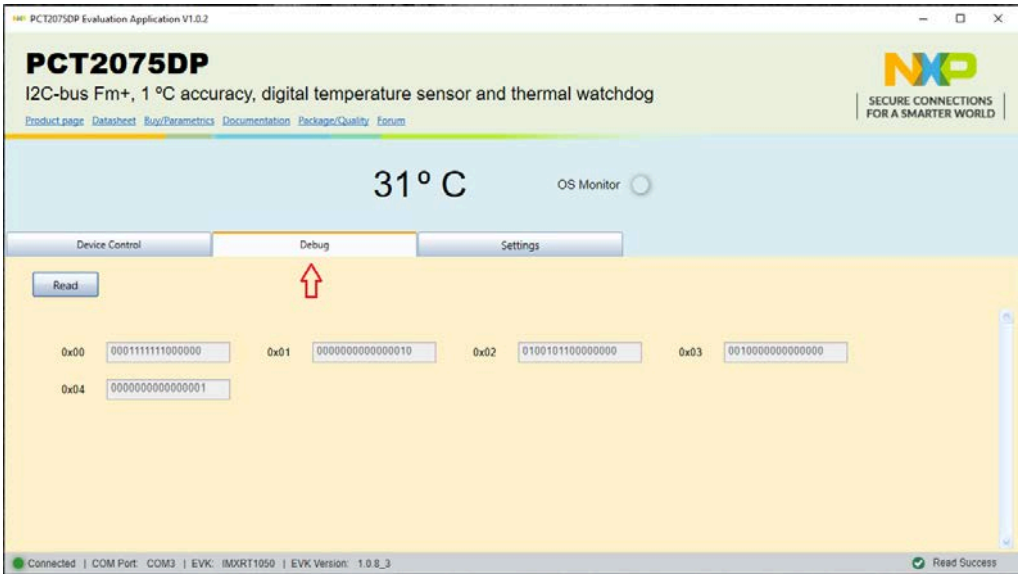

Figure 14. Graphical interface – "Debug" tab activated

Finally, the last main tab is **Debug**. When selected, the corresponding window is shown in Figure 14. When the **Read** button is clicked, all internal registers of the IC are

read, and displayed on the GUI. For details regarding the register map, see PCT2075 datasheet.

8 Abbreviations

Table 2. Abbreviations

Acronym	Description
DUT	Device Under Test
ESD	Electro Static Discharge
EVK	Evaluation Board
GUI	Graphical User Interface
I^2C-bus	Inter-Integrated Circuit bus
IC	Integrated Circuit
LED	Light Emitting Diode
OS	Overtemp Shutdown
PC	Personal Computer
USB	Universal Serial Bus

9 References

[1] **MIMXRT1050-EVK** — i.MX RT1050 Evaluation Kit

[2] **LPC55S69-EVK** — https://www.nxp.com/design/development-boards/lpcxpresso-boards/lpcxpresso55s69-development-board:LPC55S69-EVK

[3] **8MMINILPD4-EVK** — https://www.nxp.com/design/development-boards/i-mx-evaluation-and-development-boards/evaluation-kit-for-the-i-mx-8m-mini-applications-processor:8MMINILPD4-EVK

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