UM11711

PCAL6524EV-ARD evaluation board

Rev. 1.0 — 19 January 2022 **User manual**

Document information

Information	Content
Keywords	PCAL6524, I^2C-bus, 24-bit I/O bus, Arduino port, EVK
Abstract	The PCAL6524EV-ARD evaluation board is a daughter card equipped with Arduino port, designated for easy test and design of PCAL6524 IC, 24-bit port expander, controlled through FM+ I^2C 2-wire bus, with RESET. The board is fully compliant with IMXRT1050 EVK, LPCXpresso55S69 (LPC55S69-EVK) and i.MX 8M Mini LPDDR4 EVK (8MMINILPD4-EVK, 8MMINID4-EVK), including GUI software control. The board can be attached to any device equipped with Arduino port.

Revision history

Rev	Date	Description
v.1.0	20220119	Initial version

IMPORTANT NOTICE

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NXP provides the product under the following conditions:

This evaluation kit is for use of ENGINEERING DEVELOPMENT OR EVALUATION PURPOSES ONLY. It is provided as a sample IC pre-soldered to a printed-circuit board to make it easier to access inputs, outputs and supply terminals. This evaluation board may be used with any development system or other source of I/O signals by connecting it to the host MCU computer board via off-the-shelf cables. This evaluation board is not a Reference Design and is not intended to represent a final design recommendation for any particular application. Final device in an application heavily depends on proper printed-circuit board layout and heat sinking design as well as attention to supply filtering, transient suppression, and I/O signal quality.

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1 Introduction

This document describes the PCAL6524EV-ARD evaluation board. The evaluation board is built around the PCAL6524, ultra-low voltage translating 24-bit I^2C-bus/SMBus I/O expander with interrupt output, reset, and configuration registers, produced by NXP Semiconductors. The evaluation board serves as a daughter card that can be connected through an Arduino port to various Arduino compatible (including original Arduino Uno R3) EVK / mother boards for testing and measuring the characteristics of the PCAL6524 Device Under Test (DUT).

The PCAL6524EV-ARD daughter card communicates through the Arduino port with the host device via the Fast-mode I^2C-bus. Alongside the I^2C-bus, three additional digital lines allows the motherboard to control the DUT through the same Arduino port.

Power is delivered from the motherboard (EVK) through the Arduino port also.

The I/O pins of the DUT are organized in three ports. Each port (P0, P1 and P2) is 8-bit wide, so the PCAL6524 manages a total amount of 24 I/O lines. The port P0 and P1 controls an on-board four-digit LED display through the MAX V CPLD (Intel/Altera). The board contains also four on-board LEDs and four switches, connected to P2 port of the DUT. All I/O lines are shared with two connectors for external access to the I/O pins (J6 and J7, see the schematic diagram of the PCAL6524EV-ARD evaluation board).

Additionally, a Graphical User Interface (Windows platform) is provided to facilitate the evaluation of the daughterboard. The GUI is used with the following NXP evaluation boards: IMXRT1050 EVK Board, LPCXpresso55S69 Development Board and i.MX 8M Mini LPDDR4 EVK Board.

2 Finding kit resources and information on the NXP web site

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

The information page for PCAL6524EV-ARD evaluation board is at http://http://www.nxp.com/PCAL6524EV-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 PCAL6524EV-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 PCAL6524EV-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 antistatic 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.

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 or 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 PCAL6524EV-ARD features

- I/O connectors for external access to IC input-output pins
- Four user switches connected to I/O pins of the IC
- Four user LEDs connected to I/O pins of the IC
- On-board LED display controlled from the I/O pins of the IC
- Equipped with Arduino Uno R3 port for direct connection with Arduino devices
- Fully compliant with IMXRT1050 EVK board, including GUI (Windows 10)
- Fully compliant with LPCXpresso55S69 dev. board, including GUI (Windows 10)
- Compliant with i.MX Mini LPDDR4 EVK board, including GUI (Windows 10)

Note: For i.MX Mini LPDDR4 EVK Board is necessary to use IMX8MMINI-IARD interposer board between the EVK and PCAL6524EV-ARD daughterboard (see IMX8MMINI-IARD User Manual).

4.2 Kit featured components

Figure 1 identifies the main components on the board. The main elements are called out in the picture. The Arduino port connectors (J1, J2, J3, J4) are located on the bottom side of the board.

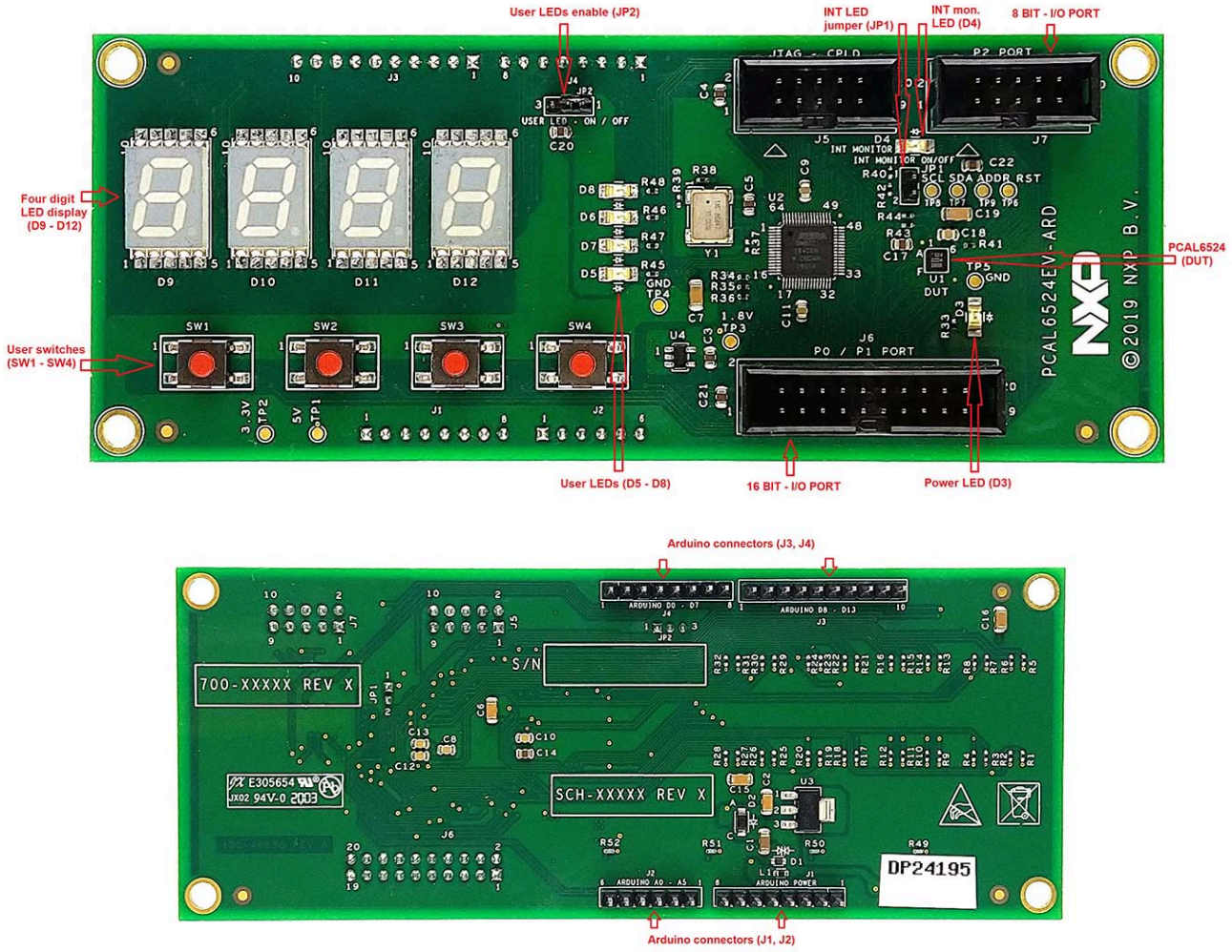


Figure 1. PCAL6524EV-ARD board, top view (up) and bottom view (down)

4.3 Block diagram

Figure 2 shows a block diagram of the PCAL6524EV-ARD daughterboard. Alongside the DUT (U1), the board includes a series of peripherals that assures the operation of the board. U1 is linked to Arduino interface (J1 to J4) through two busses: the I^2C-bus and the control bus.

The port P0 and P1 (8-bit wide each) controls the four-digit LED display (D9 to D12) located on the board, through the MAX V CPLD which acts as display decoder/driver. Al sixteen I/O lines are shared with the 16 BIT I/O PORT (J6).

The port P2 (8-bit wide) is shared with the on-board user LEDs D5 to D8, user switches SW1 to SW4, and the 8 BIT I/O PORT (J7). The first four LSB I/O lines of the port P2

drives the user LEDs, while the last four MSB lines are configured as inputs and are controlled by the user switches.

The board contains two LDO voltage regulators, for 3.3 V (U3) and 1.8 V (U4), power rails.

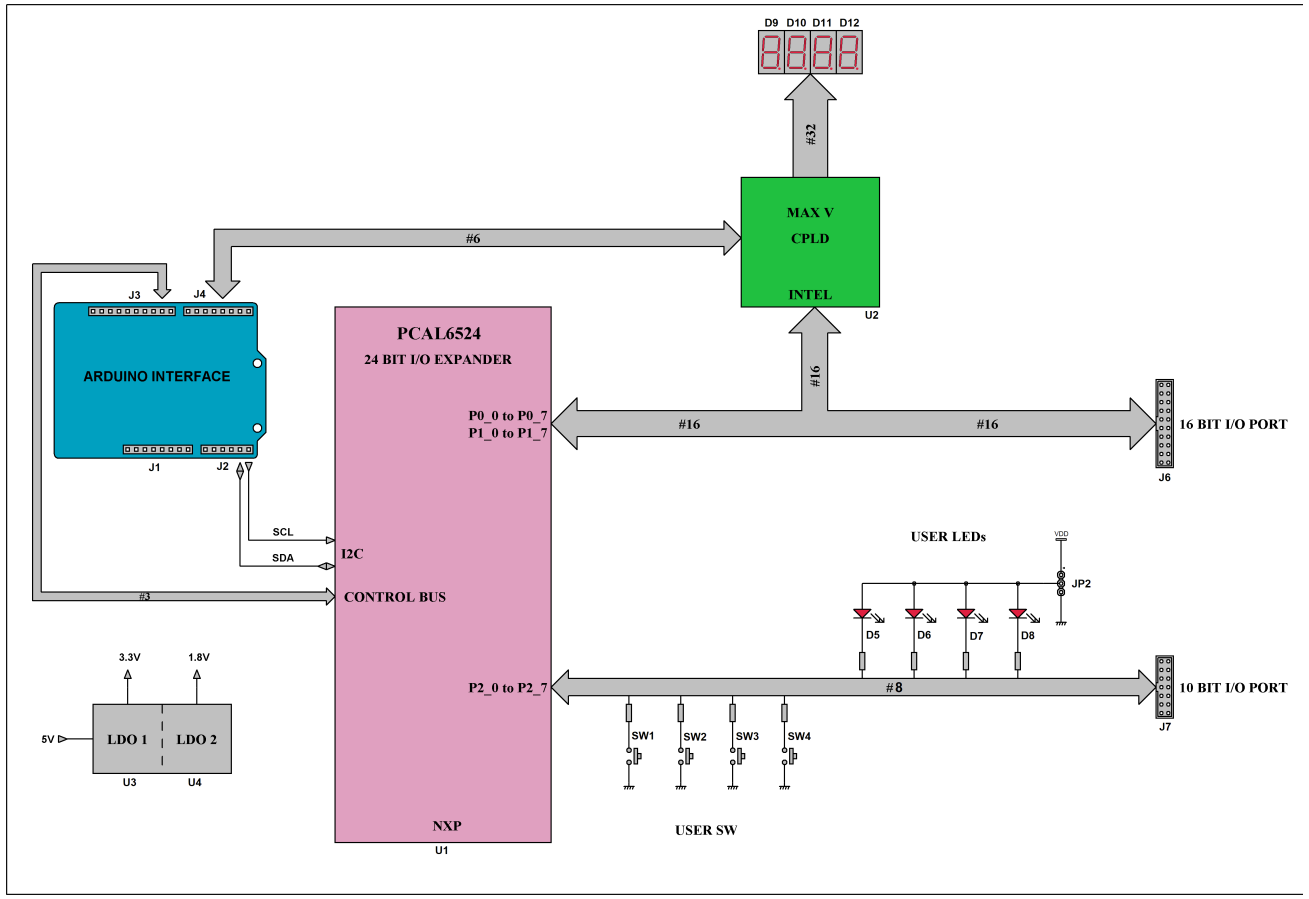


Figure 2. PCAL6524EV-ARD block diagram

4.4 Schematic diagram

The schematic diagram of PCAL6524EV-ARD is available at URL: http://www.nxp.com/PCAL6524EV-ARD.

4.5 Arduino port

J1, J2, J3, and J4 are the mated pin headers of Arduino Uno R3 connectors, with the same electrical function and placed on the board, so that the daughterboard can be directly inserted in the Arduino port. The daughter card uses only five signal lines. Table 1 details the pin chart of connectors, and the lines used in the circuit (see also the SPF-46658.pdf schematic file).

Table 1. The pin chart of Arduino connectors and their usage

Ref Des	#	Arduino label	PCAL6524EV-ARD function
J1 (Power)	1	NC	Not used

Table 1. The pin chart of Arduino connectors and their usage*...continued*

Ref Des	#	Arduino label	PCAL6524EV-ARD function
	2	IOREF	Not used
	3	RESET	Not used
	4	3.3V	Not used
	5	5V	Power supply
	6	GND	Power supply return
	7	GND	Power supply return
	8	Vin	Not used
J2 (analog, digital, I^2C)	1	A0	Not used
	2	A1	Not used
	3	A2	Not used
	4	A3	Not used
	5	A4 / SDA	I^2C – SDA
	6	A5 / SCL	I^2C – SCL
J4 (digital, UART, PWM)	1	D0 / RX	Not used
	2	D1 / TX	Not used
	3	D2	MAX_CLR
	4	D3 / PWM	MAX_OE
	5	D4	MAX_CTRL_2
	6	D5 / PWM	MAX_CTRL_1
	7	D6 / PWM	MAX_CTRL_0
	8	D7	MAX_CLK
J3 (mixed)	1	D8	RESET (control bus)
	2	D9 / PWM	ADDR (control bus)
	3	D10 / SS / PWM	INT (control bus)
	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	Not used
	10	A5 / SCL	Not used

The circuit is supplied with 5V from Arduino port through J1 and J3. Pin no. 5 of J1 is 5V power supply, while pin no. 6, 7 of J1, and pin no. 7 of J3 represents the power supply return (ground).

4.6 I²C-bus

The PCAL6524EV-ARD board communicates with the host through an I²C-bus (pin A3 – SCL, pin A2 – SDA). The communication provides internal configuration of the I/O expander, reads the logic levels of the I/O pins configured as inputs, and sets the logic level on the I/O pins configured as outputs. The internal configuration of the DUT includes: direction of the digital I/O lines (input or output), polarity inversion, pull-up / pull-down resistor enable, output strength, output configuration (push-pull or open-drain), input latch configuration, interrupt register. The transaction speed of the I²C-bus is compliant with Standard-mode (100kHz), Fast-mode (400kHz), and Fast-mode plus (1MHz). For more details about I²C description and bus transactions, see PCAL6524 datasheet (NXP Semiconductors). The pull-up resistors of the I²C-bus are R43 and R44 (see SPF-46658.pdf schematic file).

4.7 Control bus

The control bus manages RESET, ADDR, and INT pins of the PCAL6524 IC. The RESET pin is digital input and is controlled by the system host. Its role is to reset the I/O expander when a time-out or other improper operation occurs. Asserting a low level of this line forces a reset operation of the internal control section of the IC (puts the internal registers in their default state and force a re-initialization of the I²C state machine, in the same manner as power-on sequence). The RESET pin is controlled by the EVK motherboard through J3-1 (ARDUINO port).

The ADDR pin is digital input and represents a programmable hardware address package which can be asserted low or high, to assign two different slave addresses. The input is controlled by the EVK through J3-2 (Arduino port).

The INT pin is an open-drain interrupt output, activated when any input state differs from its corresponding input port register state, indicating to the host system that an input state has changed. The line is monitored by the EVK through J3-3 ARDUINO port and locally by the LED (D4) located on the daughterboard. The LED D4 can be deactivated by removing JP1 jumper. When D4 is inactive (JP1 removed) the open-drain is polarized through R42. R42 also has the role to compensate the voltage drop of D4 assuring 3.3V high level in high state of the interrupt line (see SPF-46658.pdf schematic file).

4.8 I/O bus

The PCAL6524 IC contains 24 configurable I/O pins, organized in three ports, P0, P1, and P2. All three ports are 8-bit wide. P0 and P1 are allocated to the four-digit LED display (through MAX V CPLD, U2). The on-board LEDs (D5 to D8) and user switches SW1 to SW4 are connected to port P2. All I/O lines of the PCAL6524 IC are linked to the I/O port connectors for external access of the I/O lines (see the schematic file of the PCAL6524EV-ARD daughterboard). Table 2 shows the allocation of the PCAL6524 I/O lines (U1).

Table 2. I/O allocation

PCAL6524 (U1) pin	Direction	CPLD (U2) pin	LED	Switch	16 BIT – I/O PORT (J6)	8 BIT – I/O PORT (J7)
P0_0	I/O	IO_9	-	-	3	-
P0_1	I/O	IO_10	-	-	4	-
P0_2	I/O	IO_11	-	-	5	-

Table 2. I/O allocation*...continued*

PCAL6524 (U1) pin	Direction	CPLD (U2) pin	LED	Switch	16 BIT – I/O PORT (J6)	8 BIT – I/O PORT (J7)
P0_3	I/O	IO_12	-	-	6	-
P0_4	I/O	IO_13	-	-	7	-
P0_5	I/O	IO_14	-	-	8	-
P0_6	I/O	IO_15	-	-	9	-
P0_7	I/O	IO_16	-	-	10	-
P1_0	I/O	IO_17	-	-	11	-
P1_1	I/O	IO_18	-	-	12	-
P1_2	I/O	IO_19	-	-	13	-
P1_3	I/O	IO_22	-	-	14	-
P1_4	I/O	IO_23	-	-	15	-
P1_5	I/O	IO_24	-	-	16	-
P1_6	I/O	IO_25	-	-	17	-
P1_7	I/O	IO_26	-	-	18	-
P2_0	Output	-	D5	-	-	2
P2_1	Output	-	D6	-	-	3
P2_2	Output	-	D7	-	-	4
P2_3	Output	-	D8	-	-	5
P2_4	Output	-	-	SW1	-	6
P2_5	Output	-	-	SW2	-	7
P2_6	Output	-	-	SW3	-	8
P2_7	Output	-	-	SW4	-	9

The on- board LEDs can be disabled by placing JP2 jumper in 2-3 position (OPTION 1, see SPF-46658.pdf file). This feature is useful when the user uses the board with external device connected to J7 I/O port. The switches are connected to the bus through 620-ohm series resistors (R49 – R52), to avoid bus conflict (short-circuit if the line is set accidentally as output and the switch is pressed).

4.9 CPLD

The PCAL6524EV-ARD board contains a MAX V series CPLD from Intel/Altera (U2, 5M80ZE64C5N). The role of this IC is decoder / driver for the on-board four-digit LED display (D9 to D12). The CPLD works as signal bridge between the ports P0 and P1 of the PCAL6524 IC and the LED displays. Additionally, a six-line control bus is linked between the MAX V IC and the Arduino port. For details, see SPF-46658.pdf schematic file of PCAL6524EV-ARD daughterboard. The internal firmware of the MAX V CPLD is controlled from the GUI application through the control bus. The CPLD control bus sets the operation modes of MAX V CPLD. The MAX_CLK line is not used (IO_5/CLK0 pin of U2 is masked). Table 3 details the operation modes and the corresponding logic states of CPLD control bus.

Table 3. CPLD control bus

Bus line	Direct Write	Count	Idle
MAX_CLK	*Not used*	*Not used*	*Not used*
MAX_CLR	0	0	1
MAX_OE	0	1	0
MAX_CTRL_0	X [1]	Controls the speed of counting [2]	X [1]
MAX_CTRL_1	Controls the indication of digit 4 (D9). [3]	Controls the direction of counting [2]	0
MAX_CTRL_2	X [1]	Controls the counting status [2]	X [1]

[1] Don't care
[2] See Section 4.9.2 and Table 4
[3] See Section 4.9.1

4.9.1 Direct write

When this mode is activated, the user can write decimal values from the GUI directly to the on-board LED display on the PCAL6524EV-ARD board. For the Digit 1, 2, and 3 (D10, D11, and D12), the user can write decimal numbers from 0 to 9. For Digit 4 (D9), the user can set the letter "U" or "d" (the initials of "Up" and "down"). Note that the digit 4 indication is controlled by the MAX_CTRL_1 control line (not through the one of I/O line of the PCAL6524 IC). The dots of the digits can be set separately. See Table 4 and Figure 3 for details.

Table 4. MAX V data bus

PCAL6534 pin	Direct write	Count	Idle
P0_0	Write decimal numbers from the GUI to Digit 1 (D12). The PCAL6524 pins are configured as outputs.	Read the current data from Digit 1 (D12). The PCAL6524 pins are configured as inputs.	No action. The MAX V corresponding pins are in high Z.
P0_1			
P0_2			
P0_3			
P0_4	Write decimal numbers from the GUI to Digit 2 (D11). The PCAL6524 pins are configured as outputs.	Read the current data from Digit 2 (D11). The PCAL6524 pins are configured as inputs.	
P0_5			
P0_6			
P0_7			
P1_0	Write decimal numbers from the GUI to Digit 3 (D10). The PCAL6524 pins are configured as outputs.	Read the current data from Digit 3 (D10). The PCAL6524 pins are configured as inputs.	
P1_1			
P1_2			
P1_3			
P1_4	Set ON/OFF the dot of Digit 1 (D12)	The PCAL6524 pins are configured as inputs. The lines are set in high state in MAX V.	
P1_5	Set ON/OFF the dot of Digit 2 (D11)		
P1_6	Set ON/OFF the dot of Digit 3 (D10)		
P1_7	Set ON/OFF the dot of Digit 4 (D9)		

4.9.2 Count mode

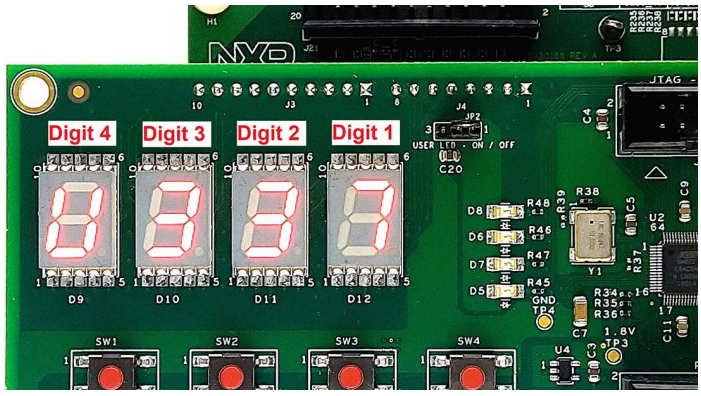
In this mode, an internal counter clocked by the RC oscillator of MAX V counts up and down, at low speed (clock frequency: 7.6 Hz), or high speed (clock frequency: 61 Hz). The counting status, direction, and speed are set by the MAX_CTRL_# lines of the control bus. See Table 5 for MAX_CTRL lines. The current value of the counter is send to ports P0 and P1 of the DUT IC (configured as inputs) and displayed in the GUI. The range of the counter value is from 000 to 999.

Table 5. MAX_CTRL_# control lines in Count mode

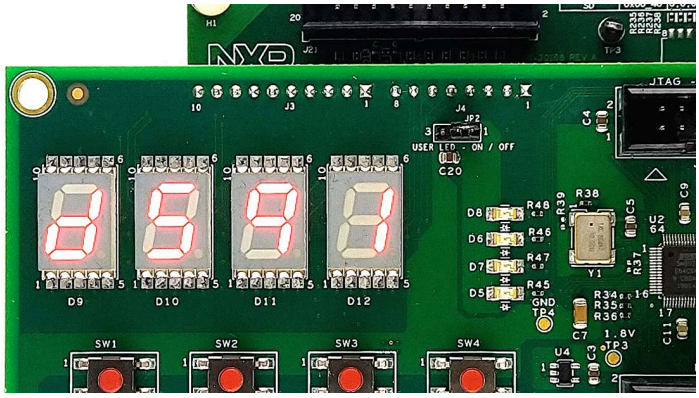
Bus line	Function	State	Description
MAX_CTRL_0	Speed	0	Low speed (7.5 Hz)
		1	High speed (60 Hz)
MAX_CTRL_1	Direction	0	down
		1	up
MAX_CTRL_2	Status	0	Counter is ON
		1	Counter is OFF (the counting is stopped)

4.9.3 Idle mode

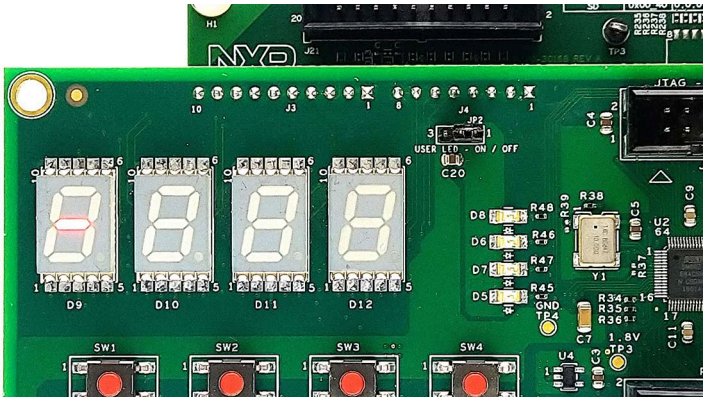
In this mode, the internal counter is stopped, the LED display is OFF, except the Digit 4 (D9) which is displaying “-“ (minus) sign (see Figure 3).



Count mode - counting up



Count mode - counting down



Idle mode

Figure 3. PCAL6524EV-ARD on-board LED display

4.10 Jumpers and test points

The board contains two jumpers and several test points. Table 6 and Figure 4 detail the jumper locations and their default configurations. Table 7 describes the test points located on the PCAL6524EV-ARD board.

Table 6. PCAL6524EV-ARD jumpers

Ref Des	Label	Default	Description
JP1	INT MONITOR - ON / OFF	OFF	OFF: Disable the interrupt monitor LED (D4)

Table 6. PCAL6524EV-ARD jumpers...*continued*

Ref Des	Label	Default	Description
			ON: Enable the interrupt monitor LED (D4)
JP2	USER LED – ON / OFF	1-2	1-2: Enable the user LEDs (D5 – D8)
			2-3: Disable the user LEDs (D5 – D8)

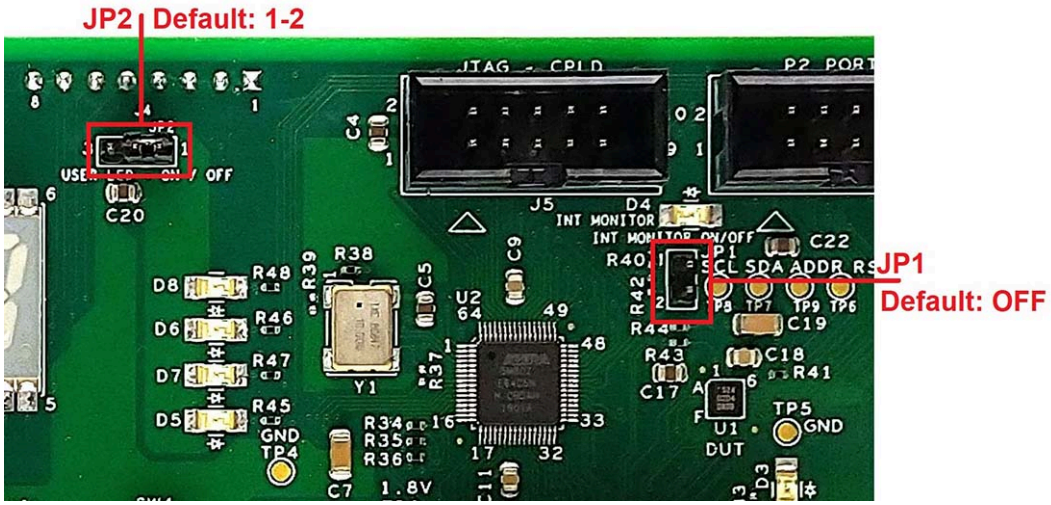


Figure 4. PCAL6524EV-ARD jumper locations

Table 7. PCAL6524EV-ARD test points

Ref Des	Test point / jumper label	Description
TP1	5V	5 V power rail
TP2	3.3V	3.3 V power rail
TP3	1.8V	1.8 V power rail
TP4	GND	Ground
TP5	GND	Ground
TP6	RST	RESET input of PCAL6524 IC
TP7	SDA	SDA line (I^2C-bus)
TP8	SCL	SCL line (I^2C-bus)
TP9	ADDR	ADDR input of PCAL6524 IC

5 Installing and configuring software tools

PCAL6524EV_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 was built to be fully compatible with the following NXP Evaluation (EVK) boards:

- IMXRT1050 EVK Board;
- LPCXpresso55S69 Development Board;

- i.MX 8M Mini LPDDR4 EVK Board;

Each mentioned above evaluation / development board benefits by firmware support which can be downloaded from NXP company site (www.nxp.com/). Before starting, the EVK motherboard must be programmed with the corresponding firmware package. Additionally, a GUI application (Windows 10) is available for download from the NXP site, allowing rapid testing and operation of PCAL6524EV-ARD daughterboard through the one of above mentioned EVK. The GUI application is common for all three EVKs and for the PCAL6xxx I/O expander development card family, manufactured by NXP (PCAL6408A, PCAL6416A, PCAL6524 and PCAL6534 ICs). For details regarding installation of the EVK firmware and GUI host software on PC please download EVK_Firmware_And_GUI_Install_Guide_For_Arduino_Boards.pdf instruction file from NXP site (www.nxp.com/). Once the software is installed, the first step is to select the correct combination EVK – PCAL6524EV-ARD daughter card, and then the board can be controlled from the GUI interface. See Section 6 and Section 7 for more details regarding the operation of PCAL6524EV-ARD from GUI software.

6 Configuring the hardware

6.1 Using the PCAL6524EV-ARD with an IMXRT1050 EVK board

Figure 5 shows the required hardware for operation of the PCAL6524EV-ARD daughterboard with IMXRT1050 EVK. The following items are necessary:

- One IMXRT1050-EVK board
- One PCAL6524EV-ARD daughterboard
- One USB-A / USB Micro-B cable
- A PC with Windows 10 operating system

The IMXRT1050 EVK motherboard can be powered by one of the three methods:

- Connecting an external 5VDC power supply to the barrel power connector (J2) on the board
- Connecting a USB cable from the PC to the Micro-B USB connector (J9) on the board
- Connecting a USB cable from the PC to the USB connector (J28) on the board. When the PC is connected in this fashion, the USB port can simultaneously act as a debug interface. Therefore, by using a single USB cable connected to J28, the EVK can be powered and at the same time linked to the PC for data exchange.

The older USB ports (from PC) are not able to deliver the necessary current (500mA), before establishing the communication, use an external power supply (connected to J2).

From J1 on the EVK board (see Figure 5) the user can select the power configuration for the motherboard. For further details, refer to the IMXRT1050 EVK Board Hardware User Guide.

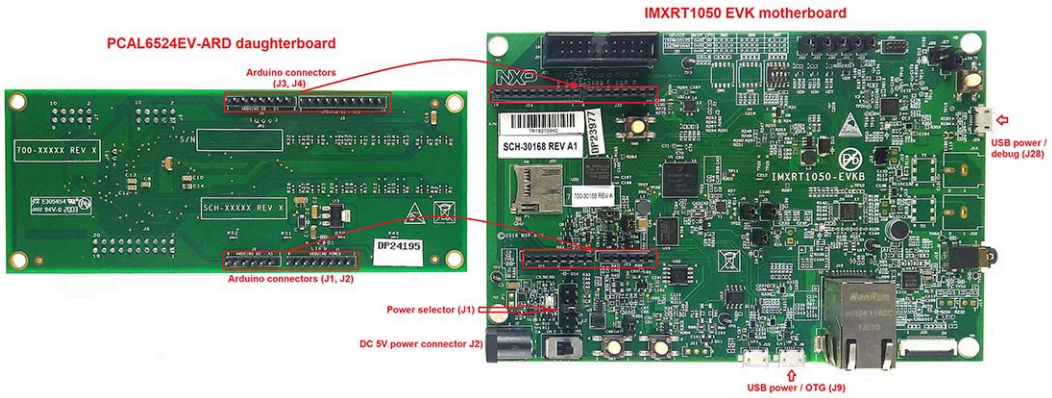


Figure 5. PCAL6524EV-ARD daughterboard and IMXRT1050 EVK board, before starting

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 PCAL6524EV-ARD daughter card on the Arduino connector of the EVK (see Figure 5).
3. Using USB connector J28, connect the EVK board to an USB port of the computer.
4. Install the IMXRT1050 target firmware (download from NXP site and see UM11581, Arduino 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.

Figure 6 shows the boards during the operation.

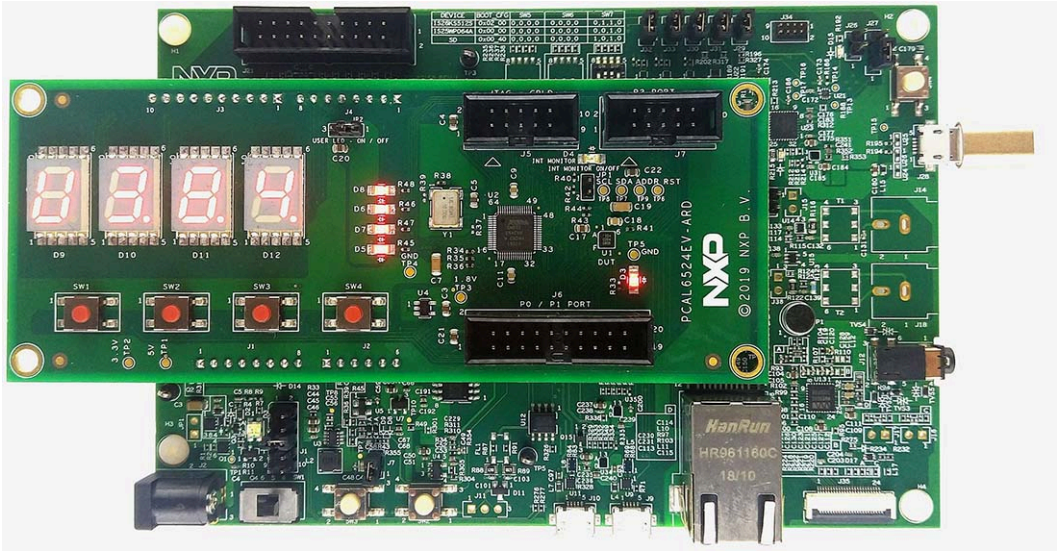


Figure 6. The assembly PCAL6524EV-ARD daughterboard / IMXRT1050 EVK board operation

6.2 Using the PCAL6524EV-ARD with an LPCXpresso55S69 development board

Figure 7 shows the required hardware for operation of the PCAL6524EV-ARD and LPCXpresso55S69 EVK board. This configuration consists of:

- One LPCXpresso55S69 EVK board
- One PCAL6524EV-ARD daughterboard
- One USB-A / USB Micro-B cable
- A PC with Windows 10 operating system

The LPCXpresso55S69 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 simplifies the start-up operation because P6 is designated for debugging and the USB cable thus accomplishes two tasks at the same time: powering the board, and serving as a data link between the EVK board and PC. For more details regarding power-up and operation of the LPCXpresso55S69 development board, see the *LPCXpresso55S69/LPCXpresso55S28 Development Board User Manual* here.

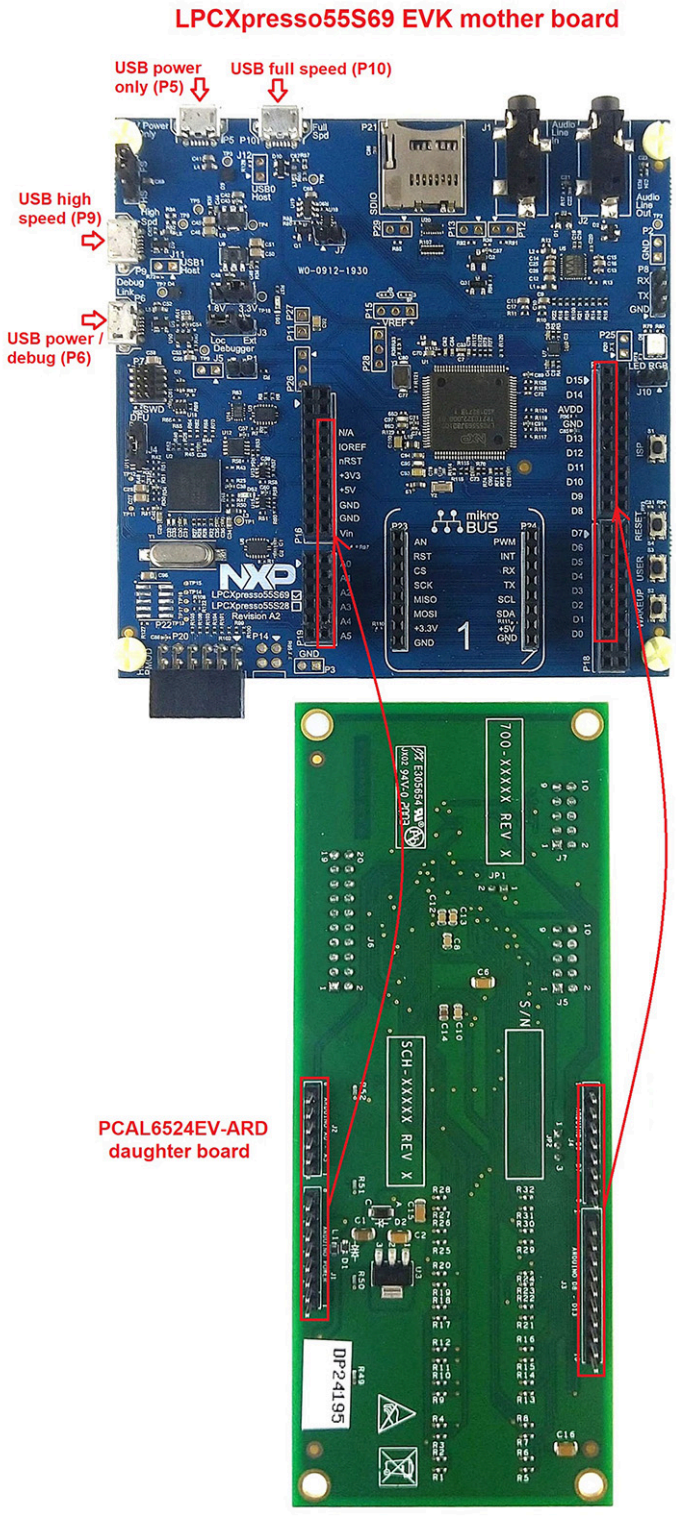


Figure 7. PCAL6524EV-ARD daughterboard and LPCXpresso55S69 motherboard, before starting

The following steps describe how to assemble, program, and operate the configuration shown in Figure 7.

1. Insert the PCAL6524EV-ARD daughter card to P16 – P19 connectors located on LPCXpresso55S69 development board (see the marked pins of P16 – P19, Figure 7);
2. Connect the development board using port P6 USB port of PC;
3. Install the LPCXpresso55S69 target firmware (download from NXP site and read the *EVK_Firmware_And_GUI_Install_Guide_For_Arduino_Boards.pdf* instruction file);
4. Install GUI application on PC (see the instruction file called out in the previous step);
5. Open the GUI application to operate the device from the PC. For details regarding GUI operation see Section 7.

Figure 8 shows the two boards in operation.

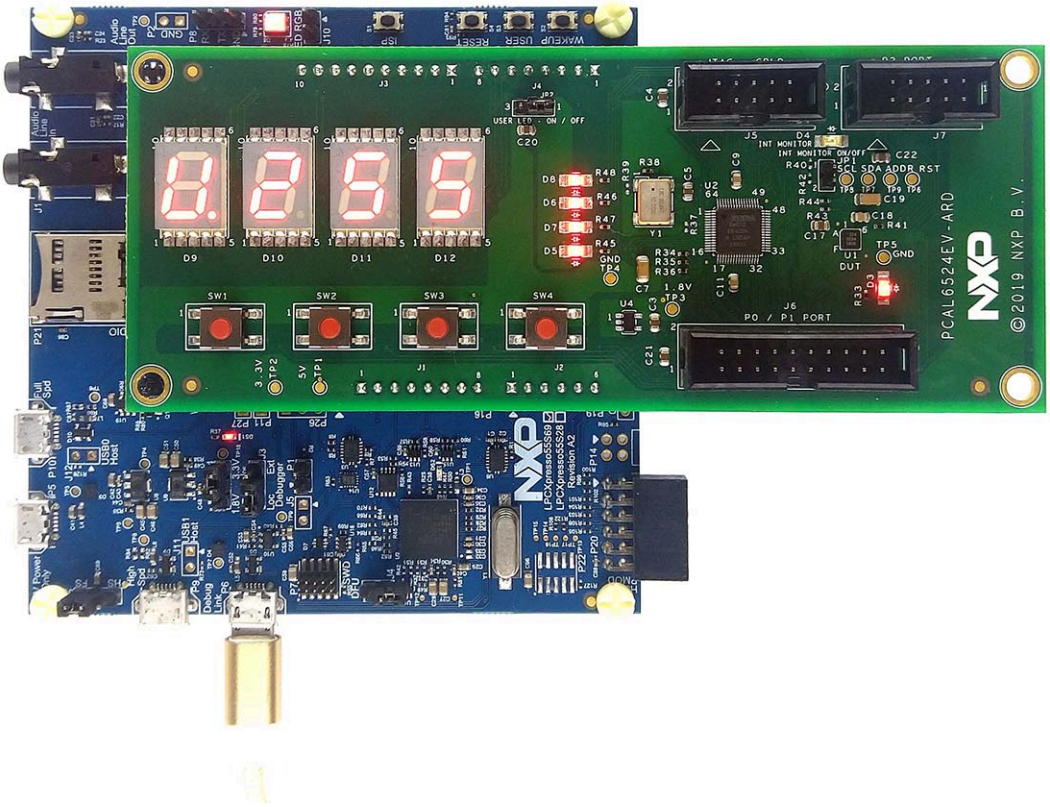


Figure 8. PCAL6524EV-ARD daughterboard/LPCXpresso55S69 motherboard operation

6.3 Using the PCAL6524EV-ARD with an i.MX 8M Mini LPDDR4 EVK board

When an i.MX 8M Mini LPDDR4 EVK board is used with the PCAL6524EV-ARD board, a third board (IMX8MMINI-IARD interposer board) must be used, especially designed and built as EVK – daughterboard interconnection. The EVK board i.MX 8M Mini LPDDR4 is not equipped with an Arduino port; instead it has a 2 x 20 pin expansion connector (J1003, see i.MX 8M Mini LPDDR4 EVK user manual). J1003 is a multipurpose port, containing various 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, with the role of signal-to-signal bridge between the 2 x 20 connector pins on the i.MX 8M Mini LPDDR4 EVK and the mated connectors of the Arduino port present on the PCAL6524EV-ARD daughterboard.

To operate the setup, along with the EVK and the daughterboard, a third board must be included in the setup assembly. Figure 9 shows the necessary boards and how these boards are connected. The configuration consists of:

- One i.MX 8M Mini LPDDR4 EVK board
- One PCAL6524EV-ARD daughterboard
- One IMX8MMINI-IARD interposer board
- One USB-A / USB-C cable
- One USB-A / USB Micro-B cable
- A PC with Windows 10 operating system

It is recommended to attach the PCAL6524EV-ARD to the Arduino connectors of the IMX8MMINI-IARD interposer board first, and then the resulting assembly to the i.MX 8M Mini LPDDR4 EVK. This can be done by plugging J1 connector located on the interposer board to J1003 connector on the EVK.

To power-up the EVK, an USB-C type cable connected to PORT 2 of the EVK is used. The power switch SW101 on the EVK board must be set to ON position to power-up the setup. Data communication is achieved by routing a separate USB (Micro-B type) cable from an USB port on the PC to debug port (J901) on the EVK (see Figure 9 and Figure 10).

The user may find details regarding power-up and operation of the setup assembly in 8MMINILPDDR4-EVK user manual and IMX8MMINI-IARD User Manual. The files can be downloaded from www.nxp.com/.

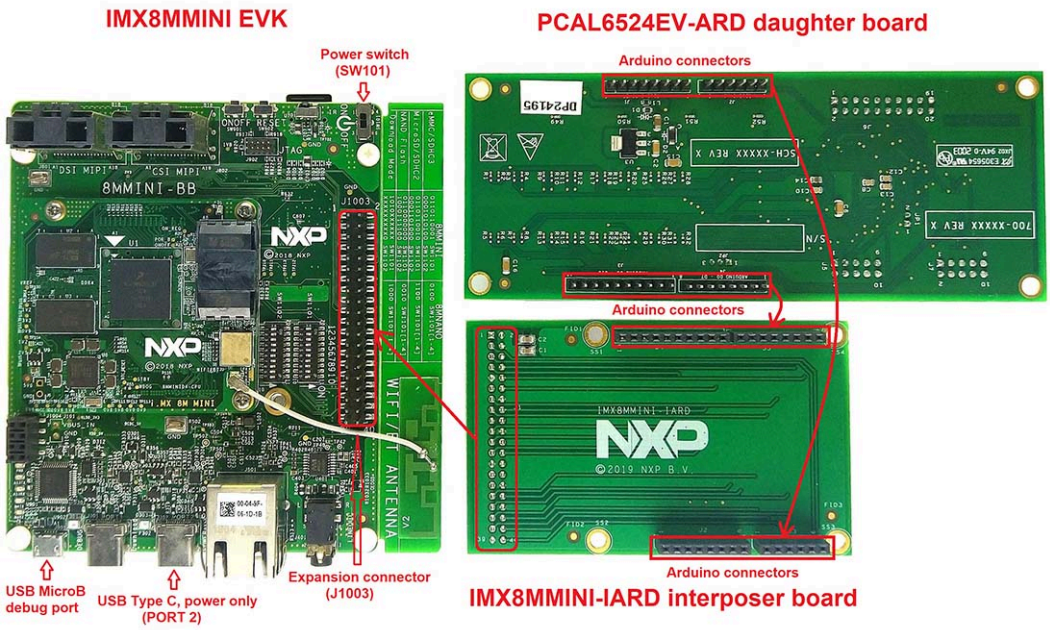


Figure 9. The assembly PCAL6524EV-ARD daughterboard, IMX8MMINI-IARD interposer board, and i.MX 8M Mini LPDDR4 EVK, before starting

To configure and operate the setup, follow the below steps:

1. Insert the PCAL6524EV-ARD onto the IMX8MMINI-IARD interposer board Arduino connectors (located on the top side);

2. Attach IMXMMINI-IARD connector plug J1 (located on the bottom of the board) into J1003 expansion board located on the top side of i.MX 8M Mini LPDDR4 EVK (see Figure 9);
3. Power-up the EVK board using an USB Type C cable attached to PORT 2;
4. Connect the EVK to the PC, using an 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 UM11581, Arduino shields GUI and firmware installation manual from NXP site);
7. Install GUI application on the PC (see the instruction file referred in the above step);
8. Open the GUI application to operate the device from the PC. For details regarding GUI operation see Section 7;

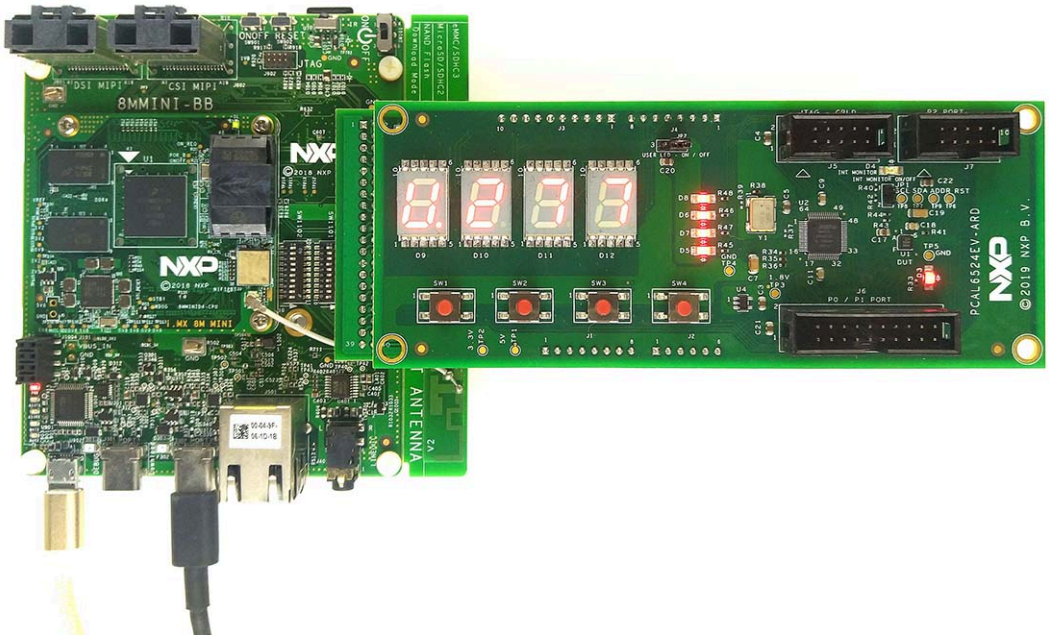


Figure 10. PCAL6524EV-ARD daughterboard / i.MX 8M Mini LPDDR4 EVK board operation

6.4 Using PCAL6524EV-ARD with another device

The PCAL6524EV-ARD daughterboard can be operated with other EVK board, which has 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 shall be developed according with PCAL6524EV specifications, and then simply attach PCAL6524EV-ARD daughterboard 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, assuring that is compliant with IC specifications. Use PCAL6524 datasheet to read details about internal registers of the DUT IC and data exchange between internal controller and the EVK. Assure for correct electrical connections and avoid data conflicts on the signal lines, 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 and the development boards of the entire family of IO expanders produced by NXP Semiconductors (PCAL6408A-ARD, PCAL6416AEV-ARD, PCAL6524EV-ARD, and PCAL6534EV-ARD).

This section describes the GUI application and how the user can control the PCAL6524EV-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 mentioned three EVKs with attached PCAL6524EV-ARD daughterboard is connected to a PC and powered-on. Open NXP_(PCAL65x4,PCAL64xxA) GUI application. An interface will appear as is shown in Figure 11:

The GUI application starts with **Settings** tab (marked with red arrow). The left side of the window displays **Board settings**. The section provides the following settings:

- **Select EVK:** displays the 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 (in the picture is COM 3).
- **Select Board:** allows the user to select the correct daughterboard (the application can support four different boards). In Figure 10, the selected board is PCAL6524. Selecting a wrong daughterboard causes the connection to fail and a pop-up window with the message: *"Unable to Connect with Daughter Card"* appears on the screen.

In the right side of the window is located **Device setting** section. The following settings are provided:

- **I2C Frequency:** displays the I^2C-bus clock frequency (100 kHz, 400 kHz, and 1 MHz). With the **Set** button the value is written in the internal register of PCAL6524 IC.
- **Address Selection:** allows the user to select the hardware address of PCAL6524 IC.
- **Reset Chip:** reset the internal register of PCAL6524.

Assuming the correct parameters are chosen, clicking the **Connect** button establishes the connection with the EVK. In the bottom side of the GUI window a status bar shows in real time the status connection between PC and the EVK.

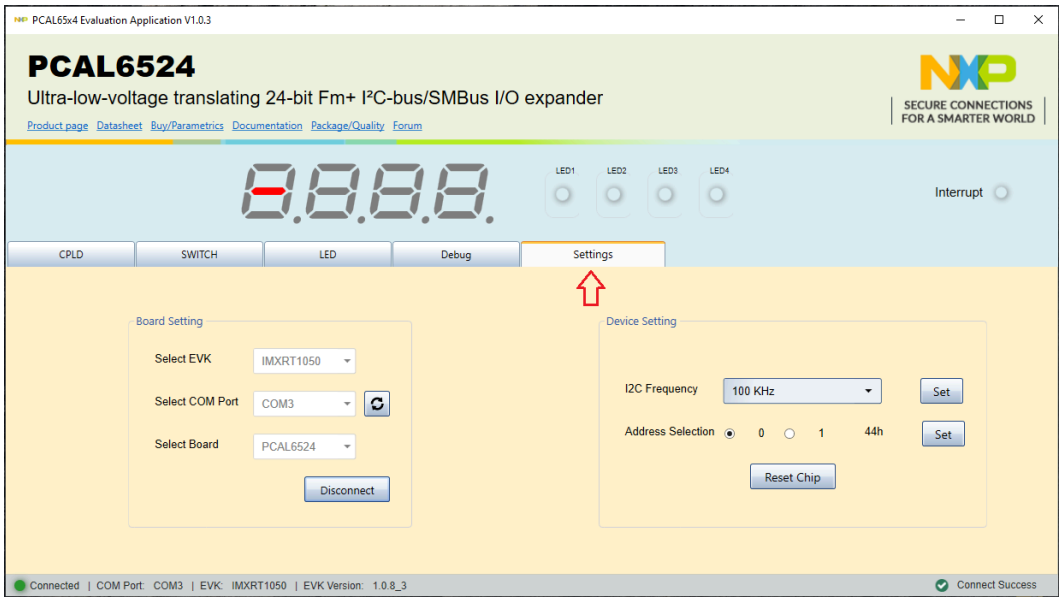


Figure 11. Graphical interface at start-up (“Settings” tab activated by default)

In the tab bar, from left to right the first tab is **CPLD**. Clicking on **CPLD** tab, a new window appears as it is shown in Figure 12. The user can select one of three modes:

- **Count mode:** when activated, three additional parameters (speed, direction and counting status) can be set. For details regarding Count Mode and its additional settings see Section 4.9. Use the **Write** button to send the configuration to the daughterboard. The four-digit display in the upper (blue) area indicates the current value of the physical LED display (D9 to D12) located on the PCAL6524EV-ARD daughterboard.
- **Direct Write Mode:** in this mode the user can set the value indicated by the LED display on the PCAL6524EV-ARD daughterboard. The values “Up” and “Down” can be chosen for LCD 1 (D9), while the other three digits can be set with numbers from 0 to 9. The dot for each digit can be set to be on/off individually. Clicking on **Write** button the values will be written in the daughterboard.
- **Idle Mode:** In this mode the display is off, except LCD 1 (D9) which indicates the “-“ sign.

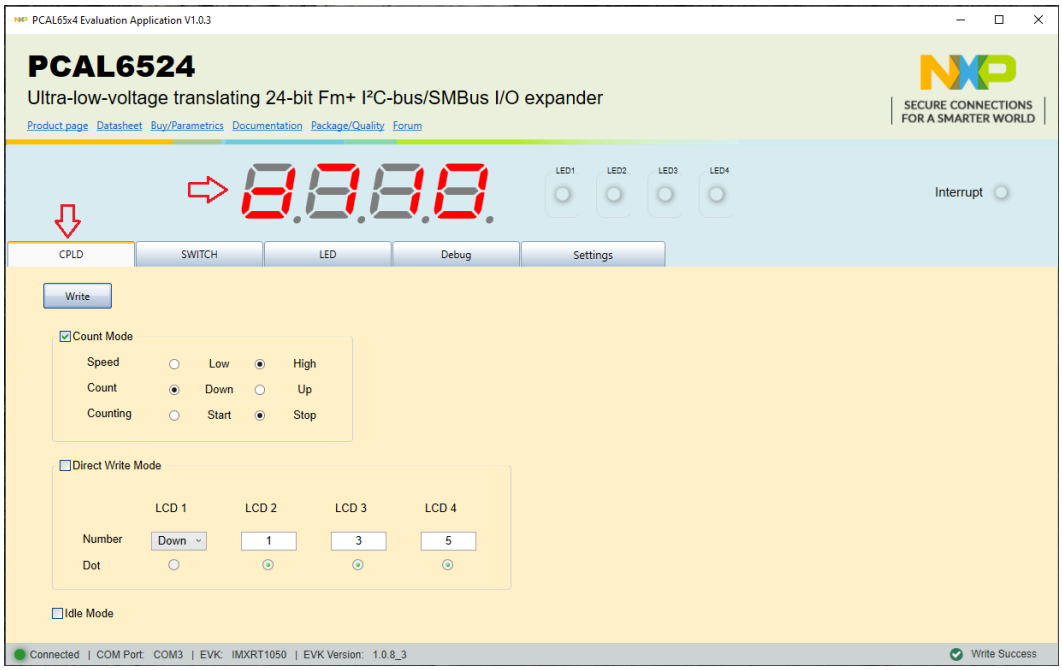


Figure 12. Graphical interface – "CPLD" tab activated

Clicking on **SWITCH** tab, a new window appears (see Figure 13). In the left side of the window, the parameters of the I/O connected to on-board switches (SW1 to SW4) can be set. The parameters are:

- **Latch:** enable / disable the corresponding latch of the input.
- **Pull Up/Down Enable:** enable / disable the internal pull-up or pull-down resistor.
- **Pull UP/Down Selection:** select the internal pull-up or pull-down resistor.
- **Interrupt Mask:** enable / disable the interrupt mask for the input;
- **Polarity Inversion:** enable / disable the polarity inversion function for the input;
- **Interrupt Edge:** select the trigger type of the interrupt (level or edge);
- **Interrupt Clear:** clear the interrupt register;

The **Write** button sets the internal registers of the DUT with the selected value in the GUI. The on-board switches (SW1 to SW4) does not have pull-up resistors, the user should select and activate the internal pull-up resistors from the GUI. In the right side of the window, the **Read** button, bring back the current values of the registers on the graphical user interface.

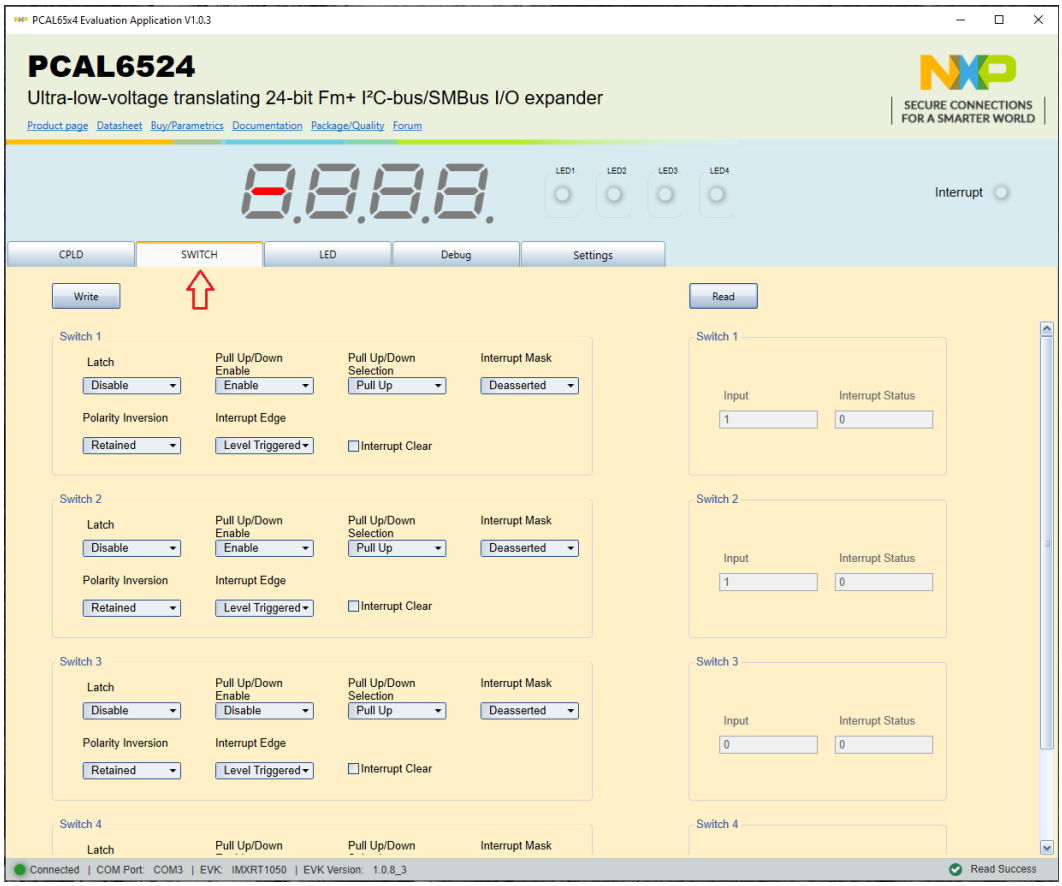


Figure 13. Graphical interface – "SWITCH" tab activated

The **LED** tab, allows the user to control the on-board user LEDs D5 to D8. (see Figure 14). In the yellow area of the window, the parameters of the I/O connected to on-board user LEDs can be set. The parameters are:

- **Value:** set the status of the on-board user LED (the logic state of the output).
- **Output drive strength:** sets the drive strength of the output.

The **Write** button sets the internal registers of the DUT with the selected value in the GUI. In the upper side of the window (the blue region) the LED1 to LED4 indicators displays the current state of the on-board LEDs (D5 to D8).

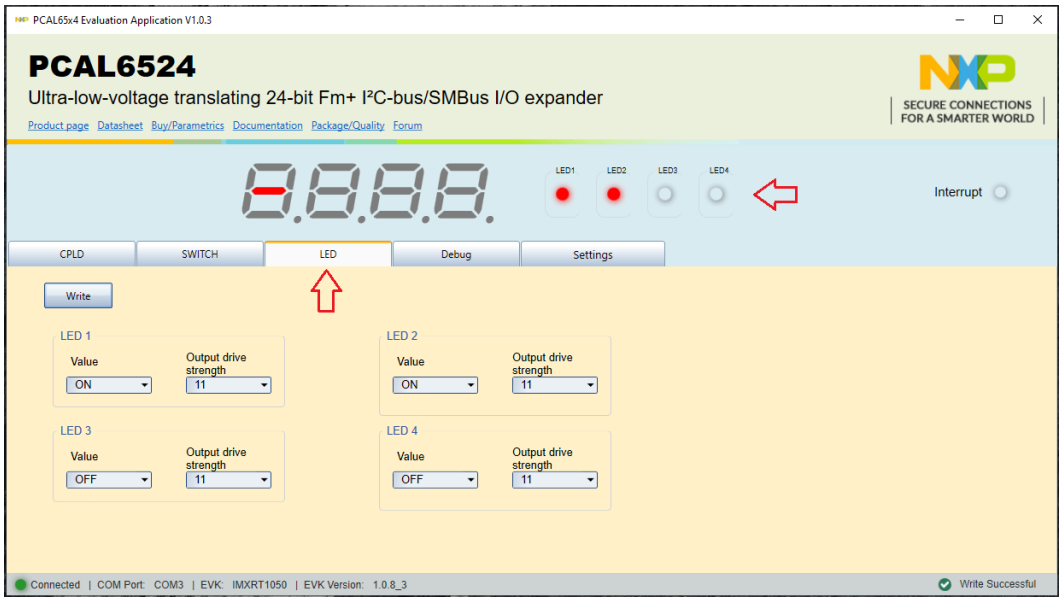


Figure 14. Graphical interface – “LED” tab activated

The **Debug tab** (Figure 15) displays the current value of the internal registers of the IC, every time when **Read** button is clicked. To find details about internal registry see the PCAL6524 datasheet (https://www.nxp.com/docs/en/data-sheet/PCAL6524.pdf).

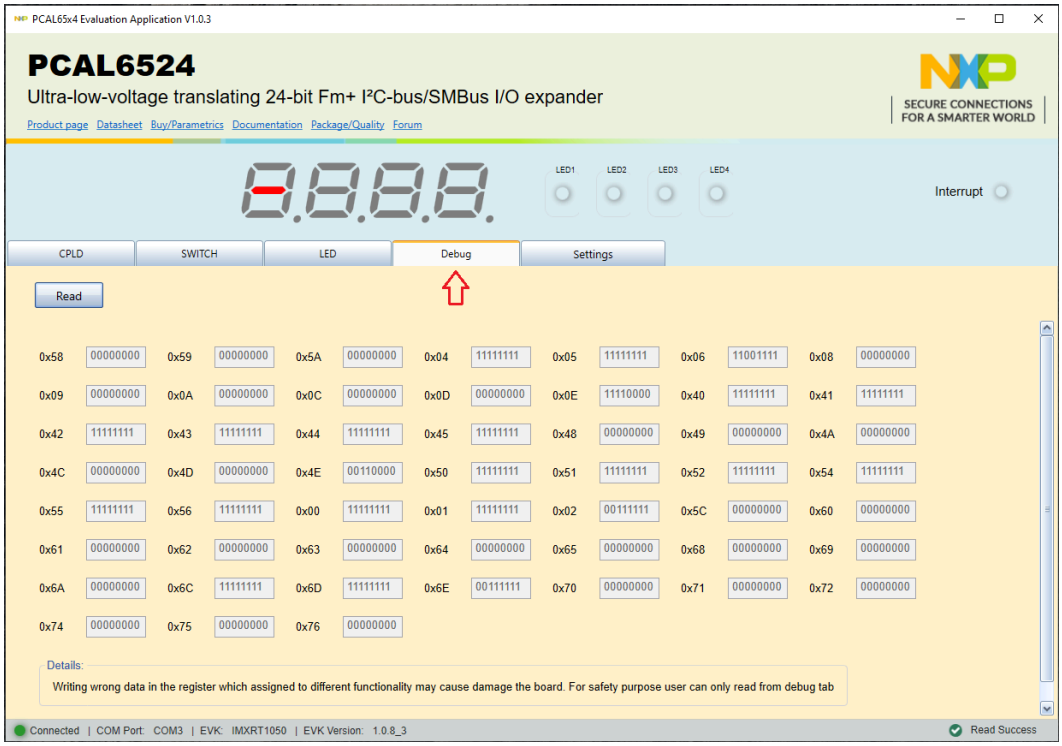


Figure 15. Graphical interface – “Debug” tab activated

8 Abbreviations

Table 8. Abbreviations

Acronym	Description
CPLD	Complex Programmable Logic Device
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
I/O	Input / Output
LED	Light Emitting Diode
PC	Personal Computer
USB	Universal Serial Bus

9 References

1. *PCAL6524, Ultra low-voltage translating 24-bit FM+ I^2C-bus/SMBus I/O expander with Agile I/O features, interrupt output and reset*
   Product data sheet; NXP Semiconductors;
2. *MIMxrt1050 EVK Board Hardware User's Guide*
   User manual; NXP Semiconductors;
3. *i.MX RT1050 Crossover Processors Data Sheet for Consumer Products*
   Data sheet; NXP Semiconductors;
4. *UM11158 – LPCXpresso55S69 Development Board*
   User manual; NXP Semiconductors;
5. *LPC556x 32-bit ARM Cortex-M33; M33 coprocessor, TrustZone, PowerQuad, CASPER, 320KB SRAM; 640 KB flash, USB HS, Flexcomm Interface, SDIO, 32-bit counter/timers, SCTimer/PWM, PLU, 16-bit 1.0 Msamples/sec ADC, Comparator, Temperature Sensor, AES, PUF, SHA, CRC, RNG*
   Product data sheet; NXP Semiconductors;
6. *i.MX 8M Mini LPDDR4 EVK Board Hardware User's Guide*
   User guide; NXP Semiconductors;
7. *i.MX 8M Mini Application Processor Datasheet for Consumer Products*
   Data sheet; NXP Semiconductors;
8. *i.MX 8M Mini Application Processor Reference Manual*
   Reference manual; NXP Semiconductors;
9. *Arduino Uno R3 Reference Manual*
   Reference manual; NXP Semiconductors;
10. *IMX8MMINI-IARD interposer board User Manual*
    User manual; NXP Semiconductors;
11. *NXP EVK Firmware and GUI Installation Guide for Arduino Series Boards*
    User manual; NXP Semiconductors;

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