UM11762

NTS0304EUK-ARD evaluation board

Rev. 1.0 — 27 May 2022 **User manual**

Document information

Information	Content
Keywords	NTS0304EUK, I^2C-bus, level translator, bidirectional, auto direction sensing, Arduino port, EVK
Abstract	The NTS0304EUK-ARD evaluation board is a daughterboard equipped with an Arduino port, designated for easy test and design of NTS0304E IC, 4-bit dual supply translating transceiver, with open drain, and auto direction sensing. The board is fully compliant with IMXRT1050 EVK, LPCXpresso55S69 (LPC55S69-ECK) 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 an Arduino port.

Revision history

Rev	Date	Description
v.1.0	20220527	Initial version

IMPORTANT NOTICE

For engineering development or evaluation purposes only

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.

The product provided may not be complete in terms of required design, marketing, and or manufacturing related protective considerations, including product safety measures typically found in the end device incorporating the product. Due to the open construction of the product, it is the responsibility of the user to take all appropriate precautions for electric discharge. In order to minimize risks associated with the customers' applications, adequate design and operating safeguards must be provided by the customer to minimize inherent or procedural hazards. For any safety concerns, contact NXP sales and technical support services.

1 Introduction

This document describes the NTS0304EUK-ARD evaluation board. The evaluation board is built around the NTS0304E, a 4-bit dual supply translating transceiver controlled via the I^2C-bus, produced by NXP Semiconductors. The evaluation board serves as a daughterboard that can be connected through an Arduino port to various Arduino compatible (including original Arduino Uno R3) EVK / motherboards with the purpose of testing and measuring the characteristics of the NTS0304E Device Under Test (DUT).

The NTS0304EUK-ARD daughterboard allows the ability to test and measure the static and dynamic characteristics of the DUT by accessing a digital potentiometer with SPI and I^2C interface. Alongside the digital potentiometer, the board contains a loopback circuit allowing the user to test the bidirectional capabilities of the DUT IC.

The DUT is tested for different logic levels applied to both sides of the level translator, by supplying the NTS0304E IC with two independent voltage programmable power supplies. The power supplies are controlled by the motherboard (EVK) through the same Arduino port. Power is delivered from the motherboard (EVK) through the Arduino port also.

Additionally, a Windows Graphical User Interface (GUI) 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 the evaluation board and its supported device(s) on http://www.nxp.com.

The information page for NTS0304EUK-ARD evaluation board is at http://www.nxp.com/NTS0304E-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 NTS0304EUK-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, asking and answering technical questions, and receiving input on just about any embedded design topic.

The NXP community is at http://community.nxp.com.

3 Getting ready

Working with the NTS0304EUK-ARD evaluation board 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 SPI and 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 NTS0304EUK-ARD features

- Equipped with SPI / I^2C digital potentiometer for rapid test and measurements
- Equipped with programmable power supplies for logic level combination
- On-board SPI / I^2C-bus connector for easy access from external
- On-board jumpers for signal isolation of the DUT
- 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 it is necessary to use IMX8MMINI-IARD interposer board between the EVK and NTS0304EUK-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 NTS0304E (U6) is placed in the center of the board. The jumper headers for signal isolation (J8, and J9) are placed near the DUT.

The Arduino port connectors (J1, J4, J5, J6) are located on the bottom side of the board.

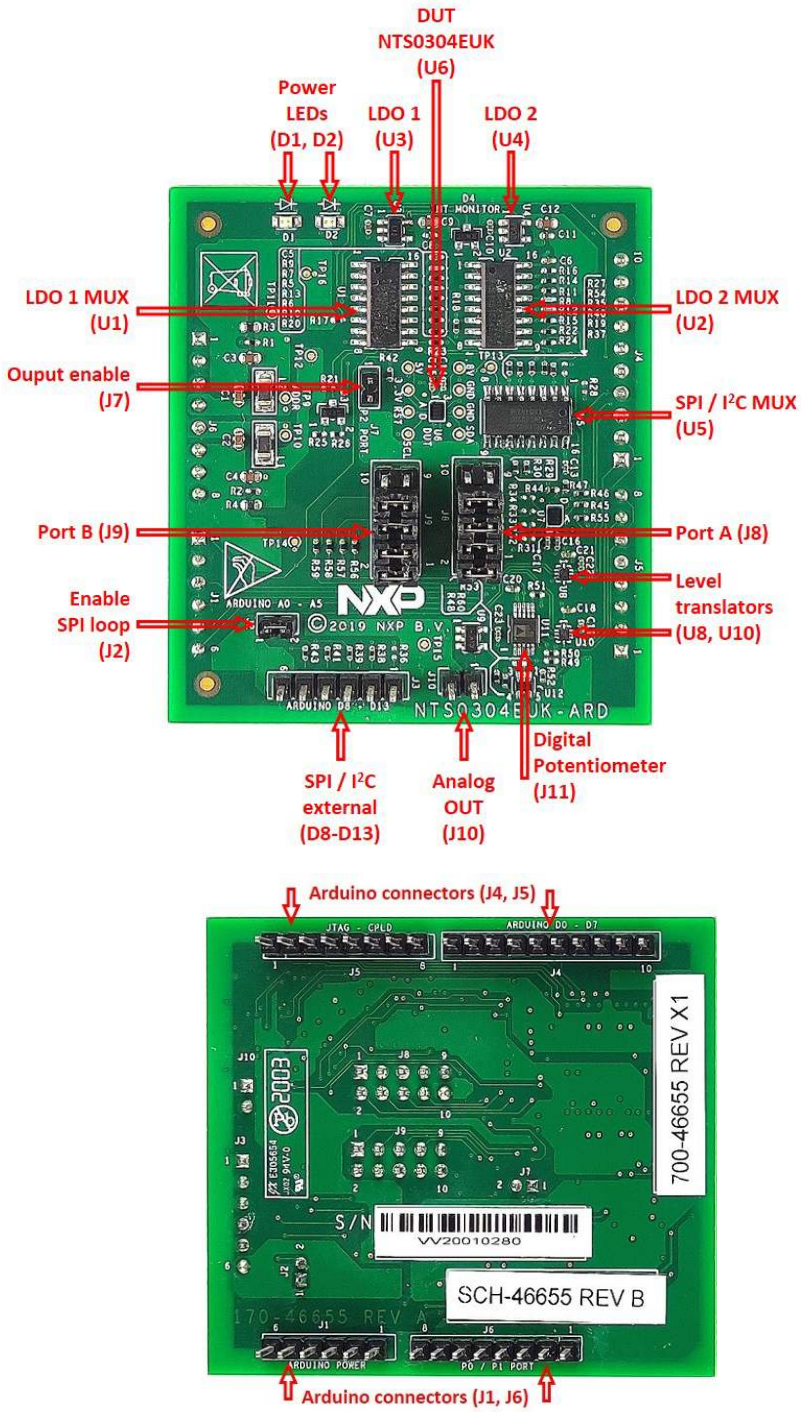

Figure 1. The NTS0304EUK-ARD board picture, top view (up) and bottom view (down)

4.3 Block diagram

Figure 2 shows the block diagram of the NTS0304EUK-ARD daughterboard. The DUT is the NTS0304E IC (U6). The signal lines of the 4-bit level translator (the DUT) are connected to the circuit through the jumper headers J8 (PORT A), and J9 (PORT B). J7 controls the output enable input of U6.

From the Arduino interface, the SPI and I^2C bus goes to the 4-bit level translator U7 (the same IC as the DUT). The multiplexer U5 selects between the I^2C-bus and “SCLK” / “MOSI” lines of the SPI bus. From U7, the signal lines arrive to PORT A of U6 through J8. After the level shift occurs, the signal lines go through J9 to level translators U8 and U10 (PORT A). At the same time, the signals go to the external connector J3. The jumper header J2 closes the daisy chain loop of the SPI bus.

PORT B of U8 / U10 goes to the SPI / I^2C digital potentiometer U11. The lines also return to the Arduino interface in a loopback configuration, allowing for bidirectional tests of the DUT. The analog output of the digital potentiometer (“W” terminal) is buffered by the voltage follower U9, and goes to J10 analog output connector, and to the analog input A0 of the Arduino interface.

The board contains two programmable LDO voltage regulators: LDO1 supplies the VCCA of U7 and U6, and LDO2 supplies VCCB of U6 (the DUT), and VCCA of U8 / U10. The interlock circuit disables both LDOs if the condition VCCA > VCCB occurs. For more details regarding power configuration, see the NTS0304E datasheet.

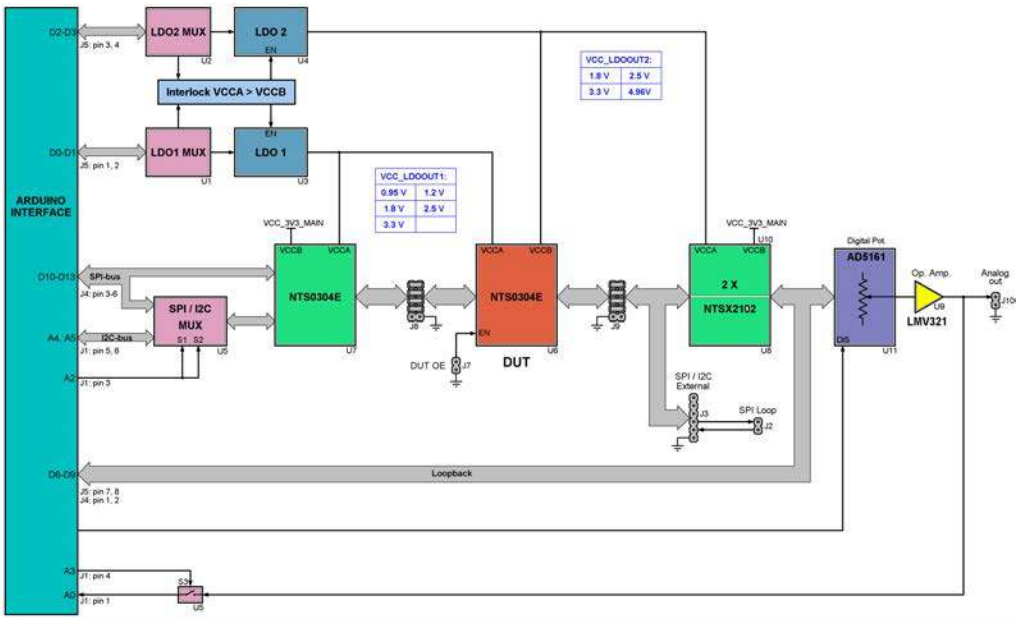

Figure 2. NTS0304EUK-ARD block diagram

4.4 Schematic diagram

The schematic diagram of NTS0304EUK-ARD is available at URL: http://www.nxp.com/NTS0304E-ARD.

4.5 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. Table 1 shows the pin chart of connectors, and the lines used in the circuit (see also the SPF-46655_B.pdf schematic file):

Table 1. Arduino connectors pin chart and usage

Ref Des	#	Arduino label	NTS0304EUK-ARD net
J6 (Power)	1	NC	Not used
	2	IOREF	Not used
	3	RESET	Not used
	4	3.3V	Power supply (3.3V)
	5	5V	Power supply (5V)
	6	GND	Power supply return
	7	GND	Power supply return
	8	Vin	Not used
J1 (analog, digital, I^2C)	1	A0	OP-AMP_OUT
	2	A1	Not used
	3	A2	MUX3_POT_SEL
	4	A3	MUX3_NTS_S3
	5	A4 / SDA	I2C_3V3_SDA
	6	A5 / SCL	I2C_3V3_SCL
J5 (digital, UART, PWM)	1	D0 / RX	MUX1_LDO1_S0
	2	D1 / TX	MUX1_LDO1_S1
	3	D2	MUX2_LDO2_S0
	4	D3 / PWM	MUX2_LDO2_S1
	5	D4	MUX_VCCA_En
	6	D5 / PWM	POT_IDLE
	7	D6 / PWM	CS0_AD0_D6
	8	D7	MISO_NC_D7
J4 (mixed)	1	D8	MOSI_SDA_D8
	2	D9 / PWM	CLK_SCL_D9
	3	D10 / SS / PWM	SPI_CS0_D10
	4	D11 / MOSI / PWM	SPI_MOSI_D11
	5	D12 / MISO	SPI_MISO_D12
	6	D13 / SCK	SPI_CLK_D13
	7	GND	Power supply return
	8	AREF	Not used
	9	A4 / SDA	Not used
	10	A5 / SCL	Not used

The circuit is supplied from Arduino port through J6 and J4. Pin 4 of J6 is a 3.3 V power supply while pin 5 of J6 is a 5 V power supply. Pins 6 and 7 of J6, and pin 7 of J4 represents the power supply return (ground).

Figure 3 shows the Arduino connectors. See also the SPF-46655_B.pdf schematic file of NTS0304EUK-ARD daughterboard.

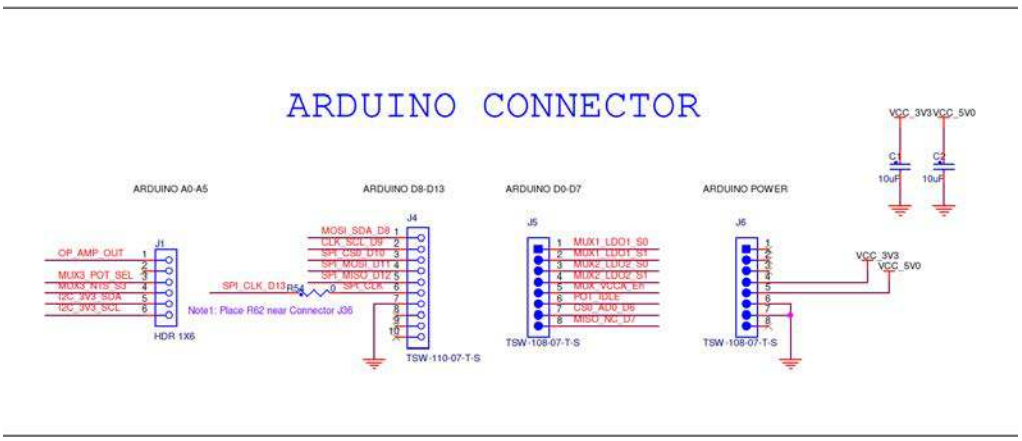

Figure 3. NTS0304EUK-ARD – Arduino connectors

4.6 Level translator

From the Arduino interface, the SPI and I^2C-bus are connected to PORT B of the 4-bit level translator U7. The are six total bus lines, therefore the SDA / SCL lines of the I^2C-bus are multiplexed with MOSI / SCLK of SPI bus. The signal switch is realized with 74HCT4053D (U5). PORT B of U7 is set to 3.3 V, the logic level of the Arduino interface.

From PORT A of U7, the signals go to PORT A of U6 (the DUT) through the jumper header J8. PORT A of both level translators U6 and U7 are supplied from programmable power supply “LDO1”. The output enable input of U6 is set with the jumper header J7. The OE input of U7 is set HIGH (OE active).

After the level shift, the signal lines go from PORT B of the DUT to PORT A of the level translators U8 and U10, through the jumper header J9. The jumper headers J8 and J9 isolate the pins of U6 from the circuit and can be used for direct access from external to the IO lines of the DUT. PORT B of U6 along with the PORT A of U8 and U10 are supplied from “LDO2”.

PORT B of level translators U8 and U10 is connected to digital potentiometer U11. The lines also return to the Arduino interface (the IO lines D6 to D9), in a loopback configuration. This allows the ability to test the bidirectional capability of the DUT. Figure 4 depicts the entire path for signal lines.

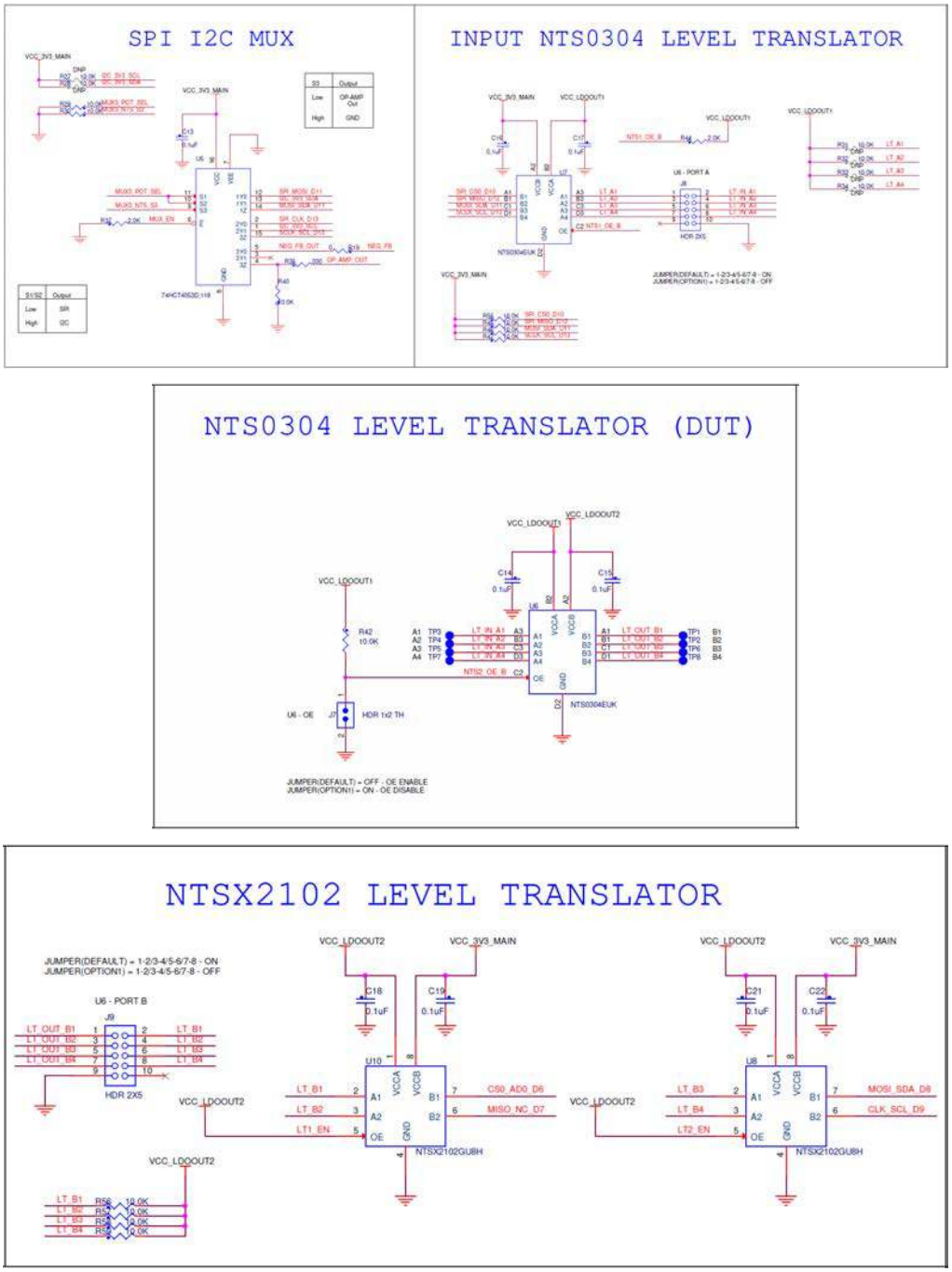

Figure 4. NTS0304EUK-ARD – Level translator

4.7 Digital potentiometer

The signal lines from PORT B of level translators U8 and U10 are connected to the digital interface of U11 (Figure 5). The digital potentiometer AD5161 (U11) can be controlled through both SPI and I^2C-bus. The bus selection is realized from the input “DIS” (pin 8) of U11, connected to input A2 of the Arduino port. The switch U12 disables the digital potentiometer when the loopback circuit is used. U12 is controlled from the Arduino interface (D5). The output (wiper, pin 10) of the digital potentiometer is buffered with

the operational amplifier U9. The buffer output is available at analog out connector J10. Through the MUX U5, the analog out goes to input A0 of the Arduino interface.

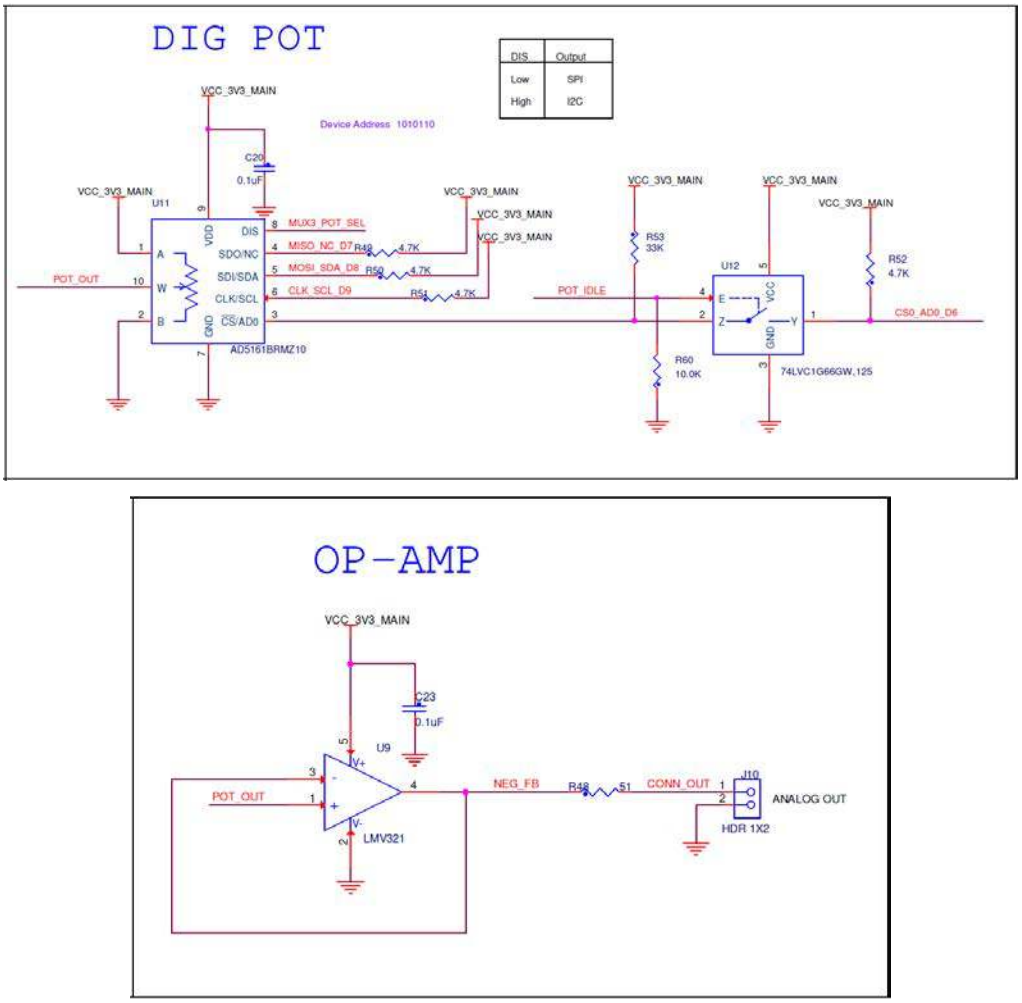

Figure 5. NTS0304EUK-ARD – Digital potentiometer

4.8 SPI / I²C external connector

The SPI / I²C-bus lines can be accessed externally through connector J3. Figure 6 shows the SPI / I²C – EXTERNAL connector. J3 is connected to the bus in the section between the jumper header J9 and PORT A of level translators U8 and U10. J2 closes the daisy chain path for the SPI bus.

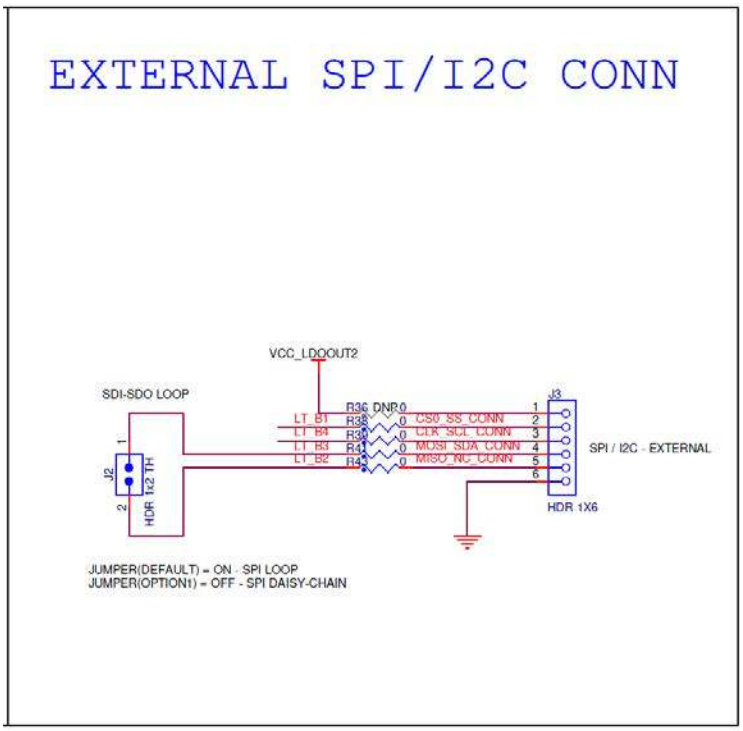

Figure 6. NTS0304EUK-ARD – SPI / I^2C-bus external connector

4.9 Programmable power supplies LDO1 and LDO2

NTS0304EUK-ARD contains two programmable power supplies: LDO1 and LDO2. Figure 7 depicts the LDO section of the schematic diagram. LDO1 provides the power for VCC_LDOUT1, and LDO2 supplies VCC_LDOUT2 power rail. Both regulators are controlled from the EVK through the Arduino port.

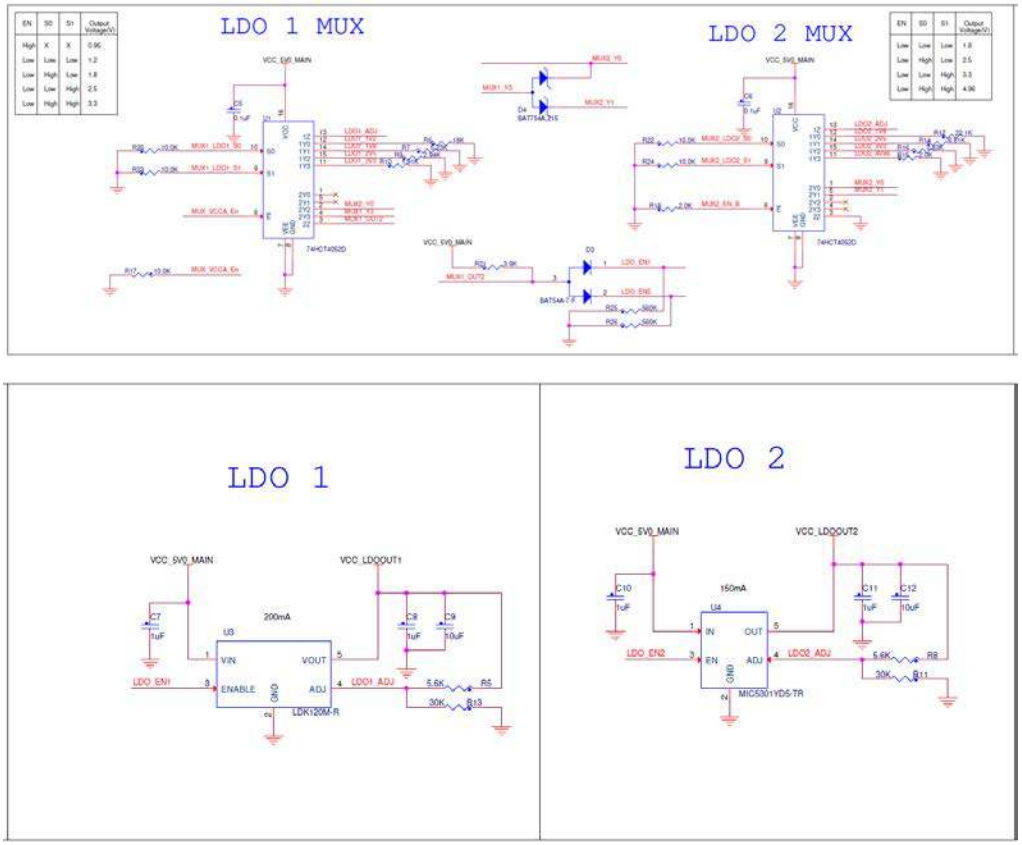

Figure 7. NTS0304EUK-ARD – LDO section

4.9.1 LDO1

The programmable power supply LDO1 consists of an adjustable voltage regulator LDK120M (U3) and the analog switch 74HCT4052D (U1). The analog switch selects the resistor divider ratio in the feedback loop of the voltage regulator (U3). Table 2 shows the output voltages of LDO1 as a function of switch position. U1 is controlled from the Arduino port through “MUX1_LDO1_S0”, “MUX1_LDO1_S1”, “MUX1_EN_B” (pins 1, 2, and 5 of Arduino connector J5). The VCC_LDOOUT1 rail feeds the VCCA power pins of U6 (the DUT) and U7 level translators.

Table 2. VCC_LDOOUT1 voltages

MUX1_EN_B	MUX1_LDO1_S1	MUX1_LDO1_S0	VCC_LDOOUT1
High	X (don’t care)	X (don’t care)	0.95 V
Low	Low	Low	1.2 V
Low	Low	High	1.8 V
Low	High	Low	2.5 V
Low	High	High	3.3 V

4.9.2 LDO2

The programmable power supply LDO2 is realized with the adjustable voltage regulator MIC5301 (U4), and the analog switch 74HCT4052D (U2). Similarly, the analog switch selects the resistor divider ratio in the feedback loop of the voltage regulator (U4). Table 3 shows the output voltages of LDO2 as a function of the switch position. U1 is controlled from the Arduino port through “MUX2_LDO2_S0” and “MUX2_LDO2_S1”, (pins 3 and 4 of Arduino connector J5). The control line “MUX2_EN_B” is connected to ground through pull-down resistor R18. The VCC_LDOOUT2 rail feeds the VCCB power pin of U6 (the DUT) and the VCCB pins of U8 and U10 level translators.

Table 3. VCC_LDOOUT2 voltages

MUX2_LDO2_S1	MUX2_LDO2_S0	VCC_LDOOUT2
Low	Low	1.8 V
Low	High	2.5 V
High	Low	3.3 V
High	High	4.96 V

4.9.3 The interlock

To ensure proper operation, the NTS0304E needs to comply with the following condition: VCCA ≤ VCCB. An interlock circuit was implemented to avoid the above described condition. The components involved in the interlock circuit are U1, U2, D3, and D4. The voltage level applied to the enable inputs of the LDOs (U3, and U4) depends on the voltage selection performed by the switches U1 and U2. Therefore, the LDOs are ON only if the condition VCC_LDOUT1 ≤ VCC_LDOUT2 occurs. Table 4 shows the enable status of the LDOs, as a function of the selected output voltages.

Table 4. LDO enable status

VCC_LDOUT2 / VCC_LDOUT1	1.8 V	2.5 V	3.3 V	4.96 V
0.95 V	ON	ON	ON	ON
1.2 V	ON	ON	ON	ON
1.8 V	ON	ON	ON	ON
2.5 V	OFF	ON	ON	ON
3.3 V	OFF	OFF	ON	ON

4.10 Jumpers and test points

The board contains four jumpers and several test points. Table 5 and Figure 8 details the jumper locations and their default configurations. Table 6 describes the test points located on the NTS0304EUK-ARD board.

Table 5. NTS0304EUK-ARD jumpers

Ref Des	Label	Default	Description
J2	J2	ON	ON – SPI chain loop closed
			OFF – SPI chain loop open
J7	J7	OFF	OFF – OE Enable

Table 5. NTS0304EUK-ARD jumpers...*continued*

Ref Des	Label	Default	Description
			ON – OE Disable
J8	J8	1-2 / 3-4 / 5-6 / 7-8	1-2 / 3-4 / 5-6 / 7-8 – PORT A (U6) connected
			OFF - PORT A (U6) disconnected
J9	J9	1-2 / 3-4 / 5-6 / 7-8	1-2 / 3-4 / 5-6 / 7-8 – PORT B (U6) connected
			OFF - PORT B (U6) disconnected

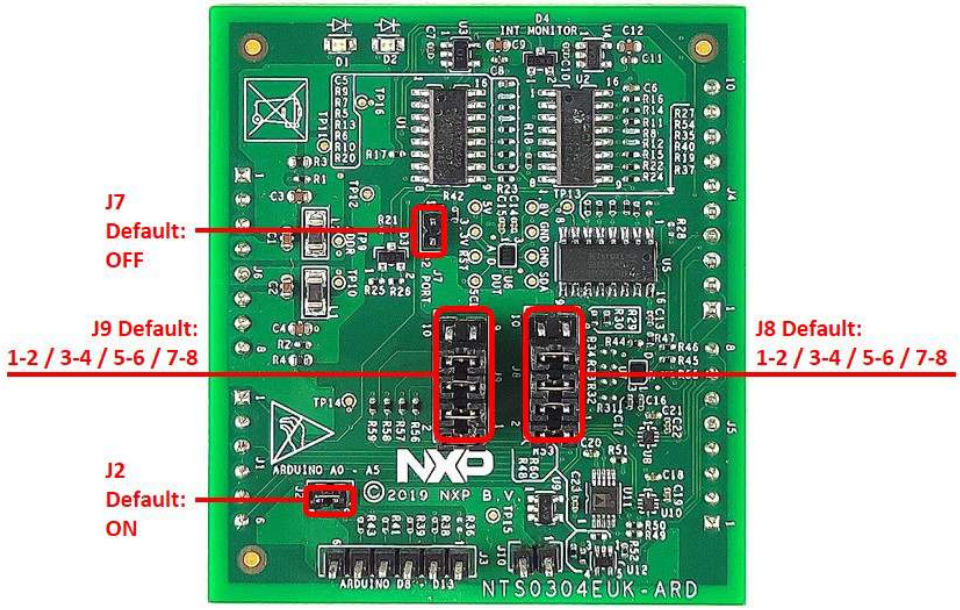

Figure 8. NTS0304EUK-ARD Jumper locations

Table 6. NTS0304EUK-ARD test points

Ref Des	Label	Description
TP1	B1	U6, PORT B
TP2	B2	U6, PORT B
TP3	A1	U6, PORT A
TP4	A2	U6, PORT A
TP5	A3	U6, PORT A
TP6	B3	U6, PORT B
TP7	A4	U6, PORT A
TP8	B4	U6, PORT B
TP9	VCC_3V3	VCC_3V3 rail
TP10	VCC_5V0	VCC_5V0 rail
TP11	VCC_3V3_MAIN	VCC_3V3_MAIN rail

Table 6. NTS0304EUK-ARD test points...*continued*

Ref Des	Label	Description
TP12	VCC_5V0_MAIN	VCC_5V0_MAIN rail
TP13	VCC_LDO OUT1	VCC_LDOOUT1 rail
TP14	VCC_LDO OUT2	VCC_LDOOUT2 rail
TP15	GND	Ground
TP16	GND	Ground

5 Installing and configuring software tools

NTS0304EUK-ARD evaluation board is designed and built as a daughterboard working in conjunction with an Arduino port equipped motherboard. 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 of the above mentioned evaluation / development boards 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 NTS0304EUK-ARD daughterboard through the one of above mentioned EVKs. For details regarding installation of the EVK firmware and GUI host software on PC please download *UM11581 - Arduino Shields GUI and firmware installation* available at https://www.nxp.com/docs/en/user-guide/UM11581.pdf. Once the software is installed, the first step is to select the correct combination EVK – NTS0304EUK-ARD daughterboard, and then the board can be controlled from the GUI interface. See Section 6 and Section 7 for more details regarding the operation of NTS0304EUK-ARD from GUI software.

6 Configuring the hardware

6.1 Using the NTS0304EUK-ARD with an IMXRT1050 EVK board

Figure 9 shows the required hardware for operation of the NTS0304EUK-ARD daughterboard with IMXRT1050 EVK. The following items are necessary:

- One IMXRT1050-EVK board
- One NTS0304EUK-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 an USB cable from the PC to the Micro-B USB connector (J9) on the board
- Connecting an 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 (500 mA); before establishing the communication, use an external power supply (connected to J2).

From J1 on the EVK board (see Figure 9) the user can select the power configuration for the motherboard. For further details, see the i.MX RT1050 Processor Reference Manual i.MX RT1050 Processor Reference Manual.

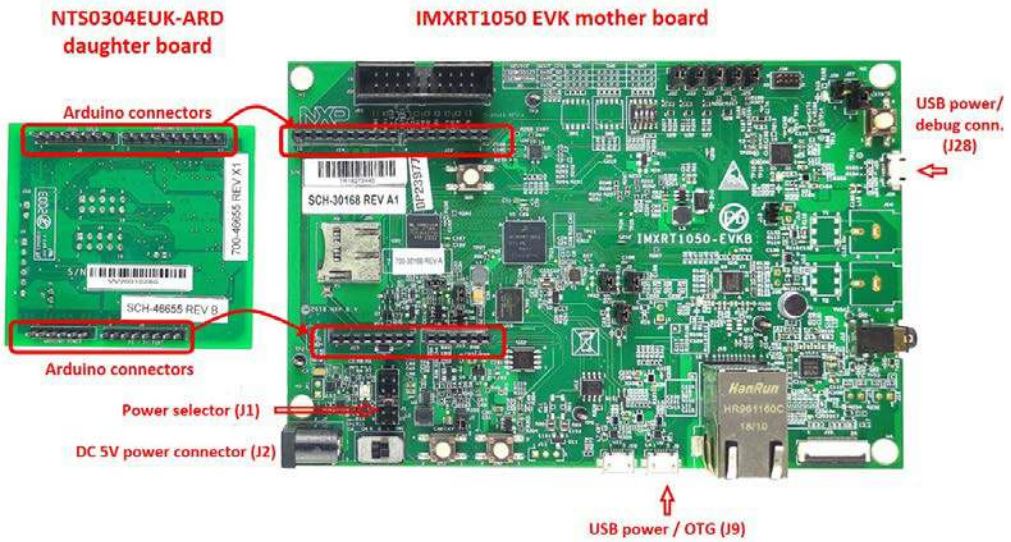

Figure 9. NTS0304EUK-ARD daughterboard and IMXRT1050 EVK board, before starting

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 NTS0304EUK-ARD daughterboard on the Arduino connector of the EVK (see Figure 9).
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 10 shows the boards during the operation.

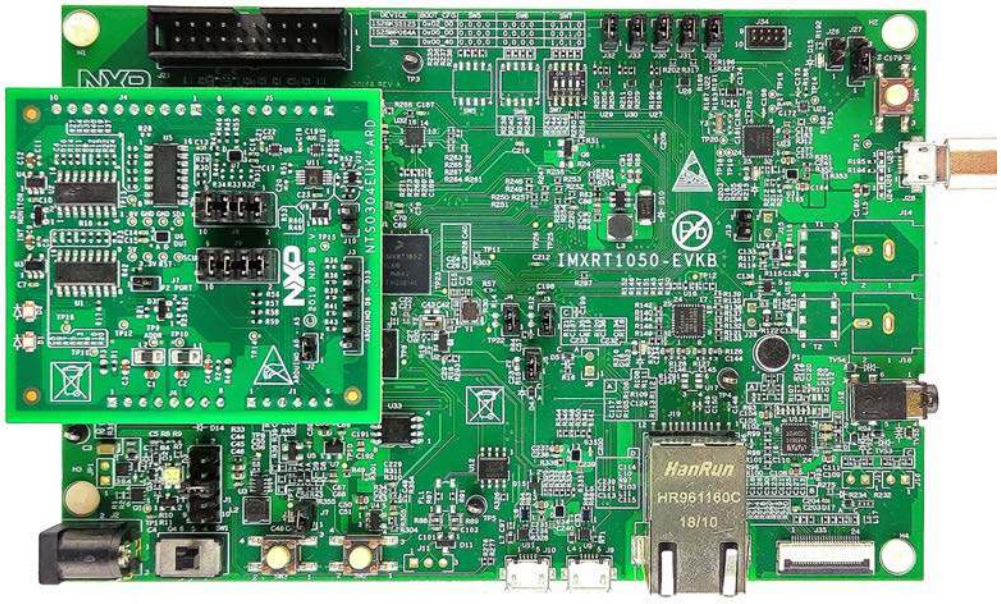

Figure 10. The assembly NTS0304EUK-ARD daughterboard / IMXRT1050 EVK board operation

6.2 Using the NTS0304EUK-ARD with an LPCXpresso55S69 development board

Figure 11 shows the required hardware for operation of the NTS0304EUK-ARD and LPCXpresso55S69 EVK board. This configuration consists of:

- One LPCXpresso55S69 EVK board
- One NTS0304EUK-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 *UM11158 - LPCXpresso55S69/55S28 Development Boards User Manual* here.

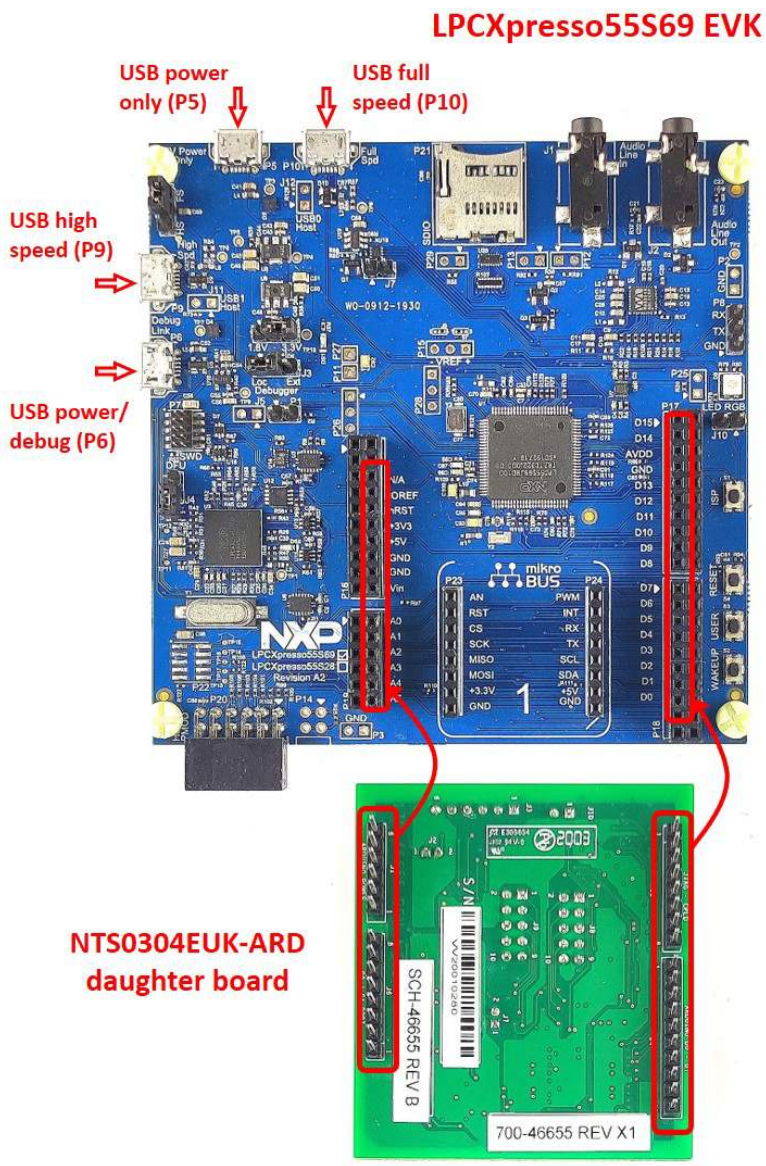

Figure 11. NTS0304EUK-ARD daughterboard and LPCXpresso55S69 mother board, before starting

The following steps describe how to assemble, program, and operate the configuration shown in Figure 11.

1. Insert the NTS0304EUK-ARD daughterboard to P16 – P19 connectors located on LPCXpresso55S69 development board (see the marked pins of P16 – P19, Figure 11)
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 12 shows the two boards in operation.

Figure 12. NTS0304EUK-ARD daughterboard / LPCXpresso55S69 motherboard operation

6.3 Using the NTS0304EUK-ARD with an i.MX 8M Mini LPDDR4 EVK board

When an i.MX 8M Mini LPDDR4 EVK board is used with the NTS0304EUK-ARD board, a third board (IMX8MMINI-IARD interposer board) must be used, especially designed and built as an 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 NTS0304EUK-ARD daughterboard.

To operate the setup, along with the EVK and the daughterboard, a third board must be included in the setup assembly. Figure 13 shows the necessary boards and how these boards are connected. The configuration consists of:

- One i.MX 8M Mini LPDDR4 EVK board
- One NTS0304EUK-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 NTS0304EUK-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, a 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 the USB port on the PC to debug port (J901) on the EVK (see Figure 13 and Figure 14).

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

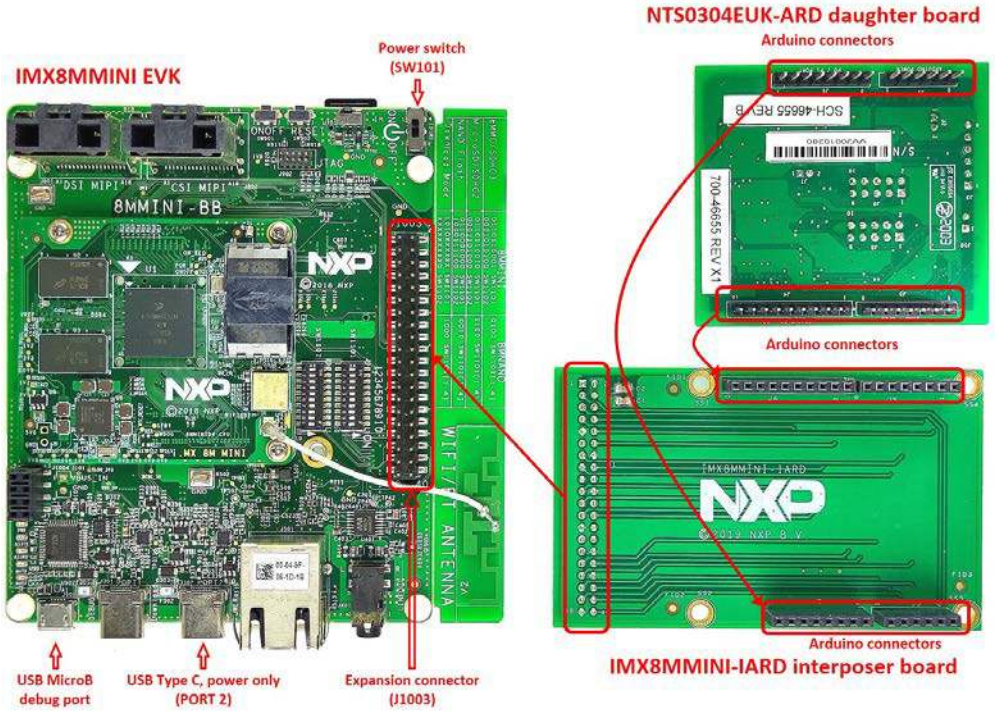

Figure 13. The assembly NTS0304EUK-ARD daughterboard, IMX8MMINI-IARD interposer board, and i.MX 8M Mini LPDDR4 EVK, before starting

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

1. Insert the NTS0304EUK-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 13)
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

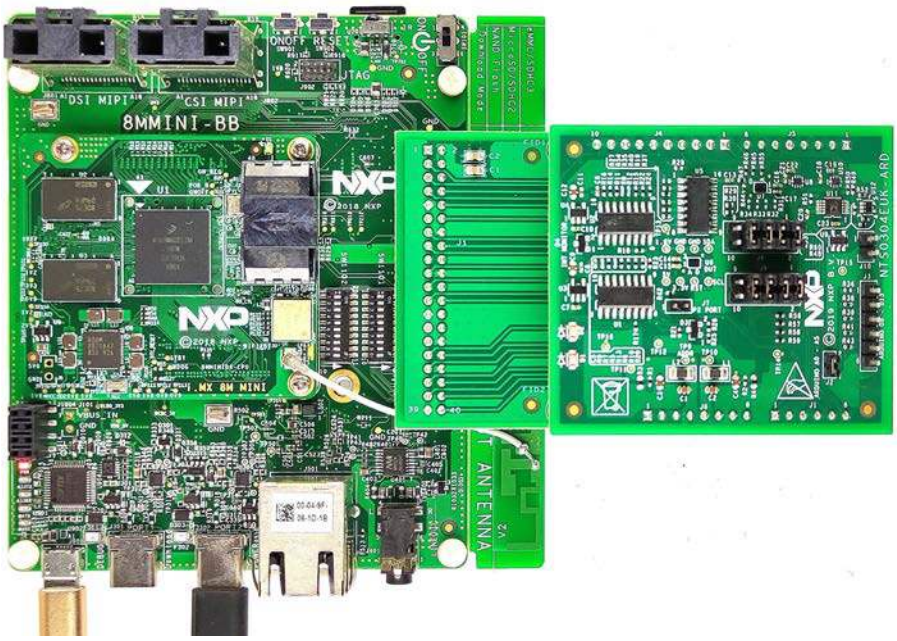

Figure 14. NTS0304EUK-ARD daughterboard / i.MX 8M Mini LPDDR4 EVK board operation

6.4 Using NTS0304EUK-ARD with another device

The NTS0304EUK-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 NTS0304E specifications, and then simply attach NTS0304EUK-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 NTS0304E 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 three EVKs described in Section 6.

This section describes the GUI application and how the user can control the NTS0304EUK-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 NTS0304EUK-ARD daughterboard is connected to a PC and powered-on. Open “NXP_GUI_NTS0304” GUI application. An interface appears as shown in Figure 15.

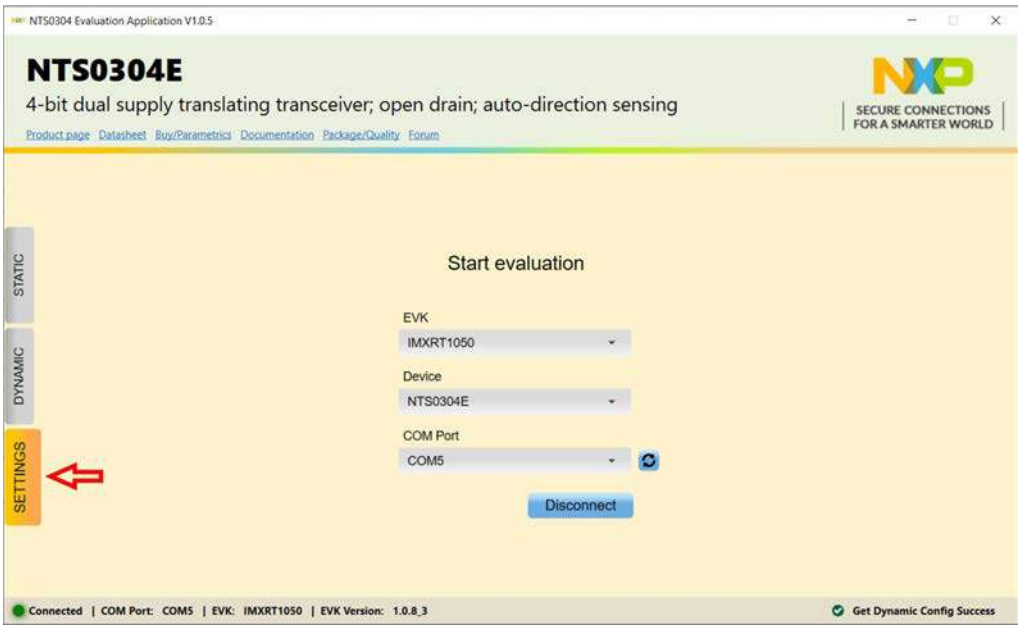

Figure 15. Graphical interface at start-up ("SETTINGS" tab activated by default)

The GUI application starts with **SETTINGS** tab (marked with red arrow). The center of the window displays the board settings. The section provides the following settings:

- **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.
- **Device:** displays the name of the device under test. This GUI supports only **NTS0304EUK-ARD** daughterboard.
- **COM port:** displays port selected for the communication. The port is automatically selected by the system (in the picture is COM 5).

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 regarding connection between PC and the EVK.

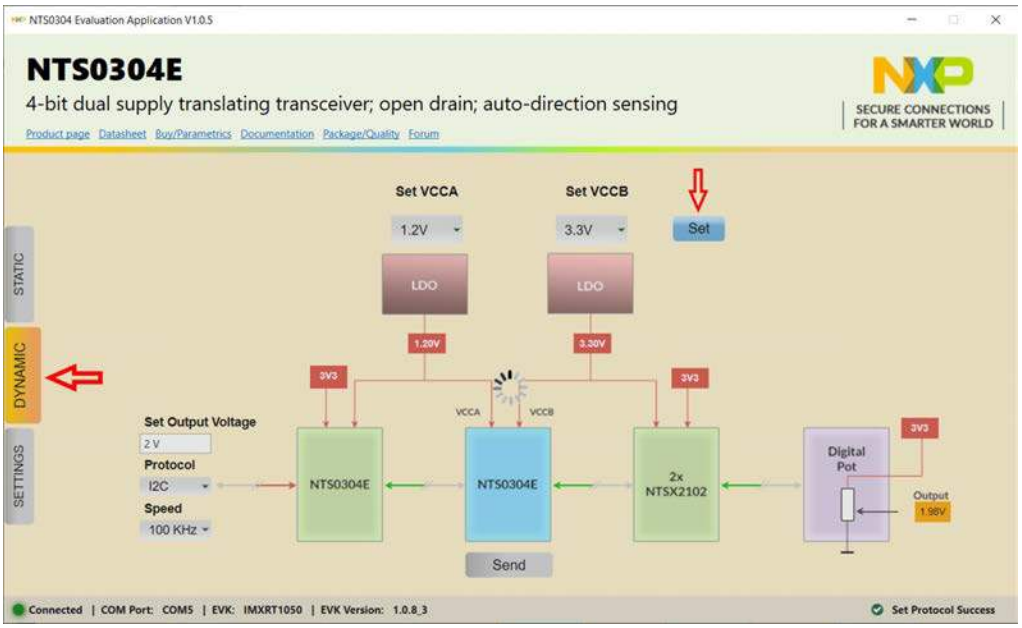

Figure 16. Graphical interface – "Dynamic" tab activated

The second tab is **DYNAMIC**. Clicking on this new tab, a new window appears (see Figure 16).

In the upper side of the window, from **Set VCCA** and **Set VCCB** drop-down lists, the user can select the power supply voltages. For VCCA, one of the four values: 0.95 V (default value), 1.2 V, 1.8 V, 2.5 V or 3.3 V can be selected. For VCCB the selectable values are: 1.8 V (default value), 2.5 V, 3.3 V and 4.96V. The **Set** button sets the power supply voltages to NTS0304EUK IC (see the red vertical arrow in Figure 16). VCCA must be less or equal to VCCB. Otherwise, a pop-up window appears with the message *"VCCA must be less than or equal to VCCB"*. Click "**OK**" to close the pop-up window. If the voltages are successfully set, the values are confirmed in the red boxes placed in the center of the display under LDO.

In the center of the window is sketched a chain of blocks connected with bidirectional arrows indicating the data flow through the chain.

Set Output Voltage input box: allows the user to set the output voltage. The voltage should be less than or equal to 2.5 V.

Protocol drop-down list: allows the user to select between I^2C and SPI protocols. SPI is selected by default.

The **Speed** drop-down list allows the user to select the bus clock frequency, depending on the selected protocol I^2C or SPI. If I^2C-bus is selected, the **Speed** drop-down list allows the selection of one of three values: 100 kHz (default value), 400 kHz and 1 MHz. For SPI only one value (2 MHz) is available.

Send button: sends the new values to NTS0304EUK IC. The **Output** box located to the wiper output of the digital potentiometer shows the translated output voltage.

If the voltage typed in the **Set Output Voltage** box is greater than 2.5 V, a pop-up window appears with the message *"Voltage should be less than or equal to 2.5V"*. If the **Set Output Voltage** box remains empty, a pop-up window appears with the message *"Please enter the output voltage"*. Click "**OK**" to close the pop-up window.

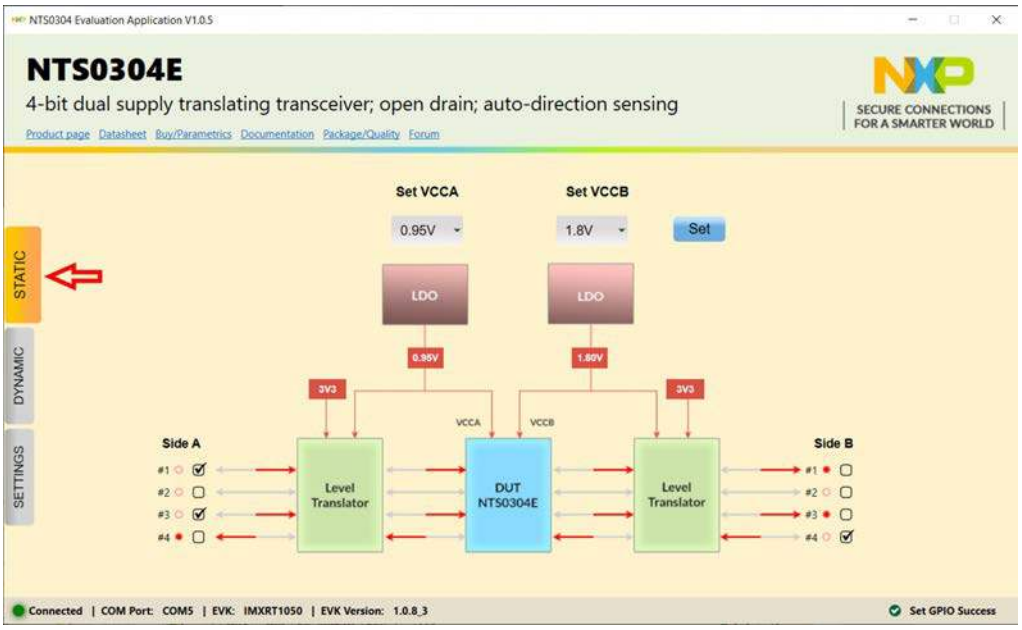

Figure 17. Graphical interface – "Static" tab activated

The third tab is **STATIC**. Click on this tab and a new window appears (see Figure 17).

The upper part of the display shows the same settings for **Set VCCA** and **Set VCCB** as in **DYNAMIC** tab.

In the center of the window is a chain of blocks connected with bidirectional arrows indicating the data flow through the signal paths of the level translators. For each signal path the data flow direction can be chosen for both sides (from Side A to Side B or Side B to Side A) by enabling the corresponding checkbox.

8 Abbreviations

Table 7. Abbreviations

Acronym	Description
DUT	Device Under Test
EEPROM	Electrically Erasable Read-Only Memory
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
SPI	Serial Peripheral Interface
USB	Universal Serial Bus

9 References

1. *NTS0304E, 4-bit dual supply translating transceiver; open drain; auto direction sensing*
   Product data sheet; NXP Semiconductors
2. *MIMXRT1050-EVKB 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 – LPCXpresso55S69/55S28 Development Boards*
   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 EVKB 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. *UM11612 - IMX8MMINI-IARD interposer board*
    User manual; NXP Semiconductors
11. *UM11581 - Arduino Shields GUI and firmware installation*
    User manual; NXP Semiconductors

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