UM11883

PCA9451A-EVK evaluation board

Rev. 1.0 — 30 March 2023 **User manual**

Document information

Information	Content
Keywords	PCA9451A, PMIC, i.Mx93x
Abstract	This document describes the operation of the PCA9451A-EVK evaluation board

Revision history

Rev	Date	Description
v.1.0	20230330	Initial version

Important notice

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

The PCA9451A is a single chip Power Management IC (PMIC) designed to support the i.Mx 93x processors family in both 1 cell Li-ion and Li-polymer battery portable application and 5 V adapter non-portable applications.

This document is the user manual for the PCA9451A evaluation kit. It is intended for the engineers involved in the evaluation, design, implementation, and validation of this single power management-integrated circuit PCA9451A.

The PCA9451A-EVK user manual covers information regarding connecting the hardware, installing the software and tools, configuring the environment and using the kit.

This customer evaluation board provides full access to all the features in the PCA9451A device.

2 PCA9451A key features

- Six high-efficiency step-down regulators
  - One 4 A dual phase buck regulator with DVS feature and remote sense
  - One 2 A buck regulator with DVS feature and remote sense
  - One 3 A buck regulator
  - One 2 A buck regulator
  - One 1.5 A buck regulator
- Three linear regulators
  - One 10 mA LDO
  - One 150 mA LDO
  - One 200 mA LDO
- 400 mA load switch with built-in active discharge resistor
- 32.768 kHz crystal oscillator driver and buffer output

- Two channel logic level translator
- Power control I/O
  - Power ON/OFF control
  - Standby/run mode control
- Fm+ 1 MHz I^2C-bus interface
- ESD protection
  - Human Body Model (HBM): +/- 2000 V
  - Charged Device Model (CDM): +/-500 V
- 7 mm x 7 mm, 56-pin HVQFN with 0.4 mm pitch

3 Applications

- IoT devices
- Tablet
- Electronic Point of Sale (ePOS)
- Industrial application
- Monitoring system
- Infotainment

4 Finding kit resources and information on the NXP website

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

The information page for evaluation boards is http://www.nxp.com/PCA9451A-EVK.

The information page provides overview information, documentation, software and tools, parametric, ordering information and a Getting Started tab. The Getting Started tab provides quick-reference information applicable to these evaluation boards, including the downloadable assets referenced in this document.

4.1 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.

5 Getting ready

Working with this evaluation board requires the evaluation kit components, additional hardware, and a Windows PC workstation with installed software.

5.1 Evaluation kit components

- 1x PCA9451A evaluation board, which allows easy evaluation on function and features
- 1x Interface (FTDI C232HM-DDHSL-0) cable, which serves as a USB to I^2C interface between the computer and the PCA9451A evaluation board.

5.2 Additional hardware

In addition to the kit components, the following hardware is necessary or beneficial when working with this kit.

- Power supply with a range of 3.0 V to 5.0 V and a current limit set initially to 1.0 A (maximum current consumption can be up to 7.0 A)
- Oscilloscope/multimeter
- Electronic load (optional) - each power rail output can be connected to e-load for testing

5.3 Windows PC workstation

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

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

5.4 PCA9451A-EVK GUI software

Installing software is necessary to work with this evaluation board.

- Go to http://www.nxp.com/PCA9451A-EVK.
- Extract the zip file PCA9451_EVB_GUI.zip into selected folder. No need to install. (if password is asked during unzip, then type “NXP”)
- Install the FTDI cable driver from website https://www.ftdichip.com/Drivers/D2XX.htm
- Run the file PCA9451.exe. The interface window is shown in Figure 1.

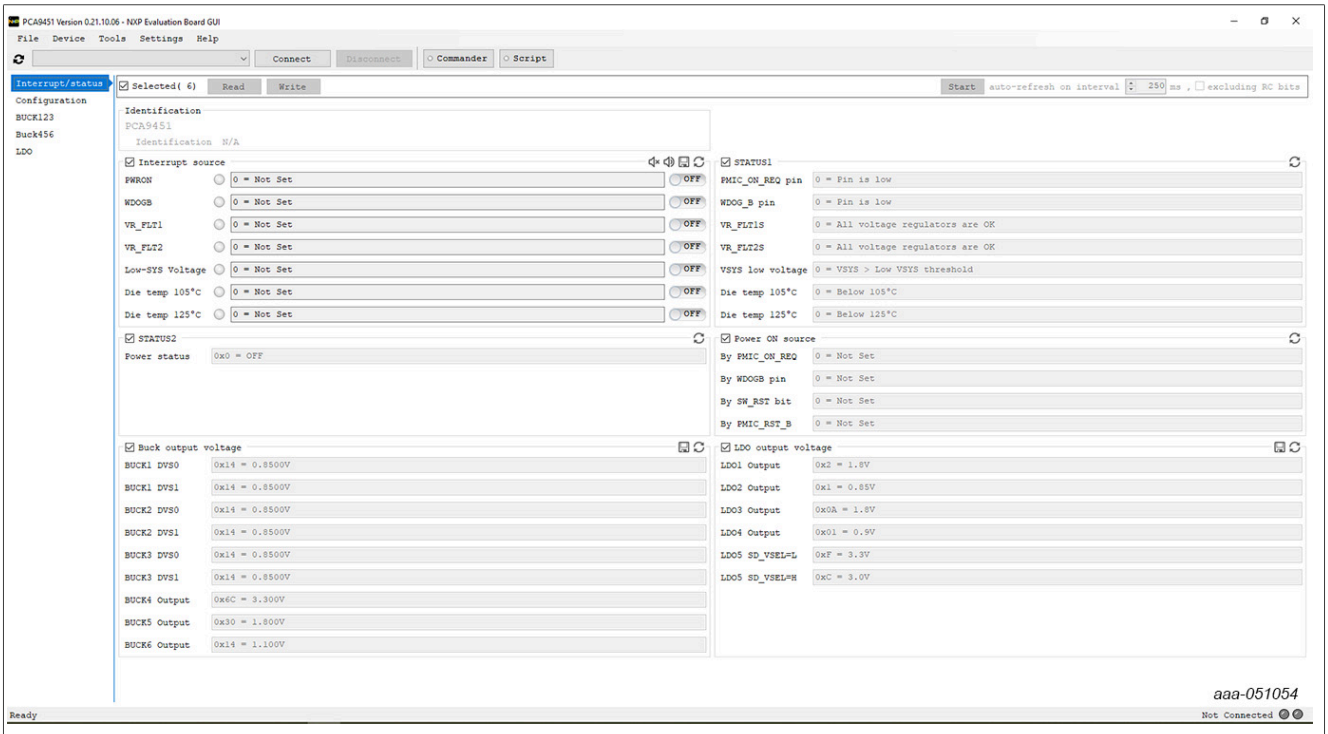


Figure 1. Interface window

6 Getting to know the hardware

The NXP analog product development boards provide an easy-to-use platform for evaluating NXP products. The boards support a range of analog, mixed-signal, and power solutions. They incorporate monolithic integrated circuits and system-in-package devices that use proven high-volume technology. NXP products offer

longer battery life, a smaller form factor, reduced component counts, lower cost, and improved performance in powering state-of-the-art systems.

6.1 Kit overview

This evaluation board features the PCA9451A power management IC. The kit integrates all hardware needed to fully evaluate the PMIC. It integrates a communication bridge based on FTDI to interface with the PCA9451A GUI software interface to fully configure and control the PMIC.

6.1.1 Evaluation board features

- Six buck regulators
  - One 4 A buck regulator with DVS
  - One 2 A buck regulator with DVS
  - One 3 A buck regulator
  - One 2 A buck regulator
  - One 1.5 A buck regulator
- Three linear regulators
  - One 10 mA LDO
  - One 150 mA LDO
  - One 200 mA LDO
- 400 mA load switch with a built-in active discharge resistor
- 32.768 kHz crystal oscillator driver and buffer output
- Two-channel logic level translator
- System features
  - 2.85 V to 5.5 V operating input voltage range
  - Power ON/OFF control
  - Standby/run mode control
  - Smart DVS control
  - Interrupt configuration
  - Fm+ 1 MHz I^2C Interface (via FTDI USB to I^2C cable)

6.2 Kit featured components

Figure 2 helps to identify the different main components on the board.

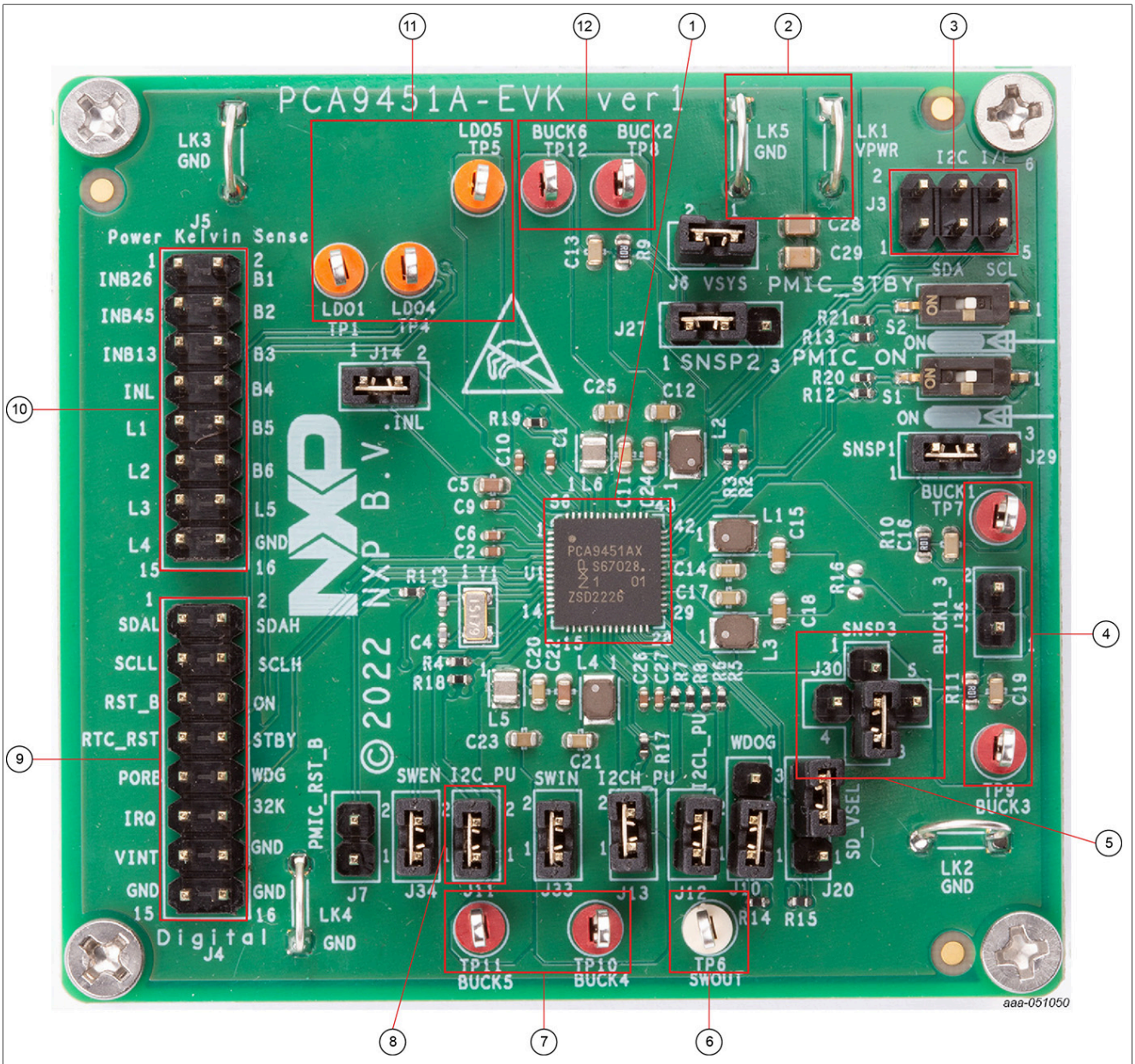


Figure 2. Evaluation board featured component locations

1. PCA9451A PMIC
2. VPWR and GND input power connectors
3. I^2C connector
4. BUCK1 and BUCK3 output test points
5. BUCK3 Feedback connection
6. Load switch output test point
7. BUCK4 and BUCK5 output test points
8. I^2C pullup voltage jumper (I2C_PU)
9. Digital IO connector
10. Kelvin sense connector
11. LDO outputs test points

12. BUCK2 and BUCK6 output test points

6.3 Default jumper configuration

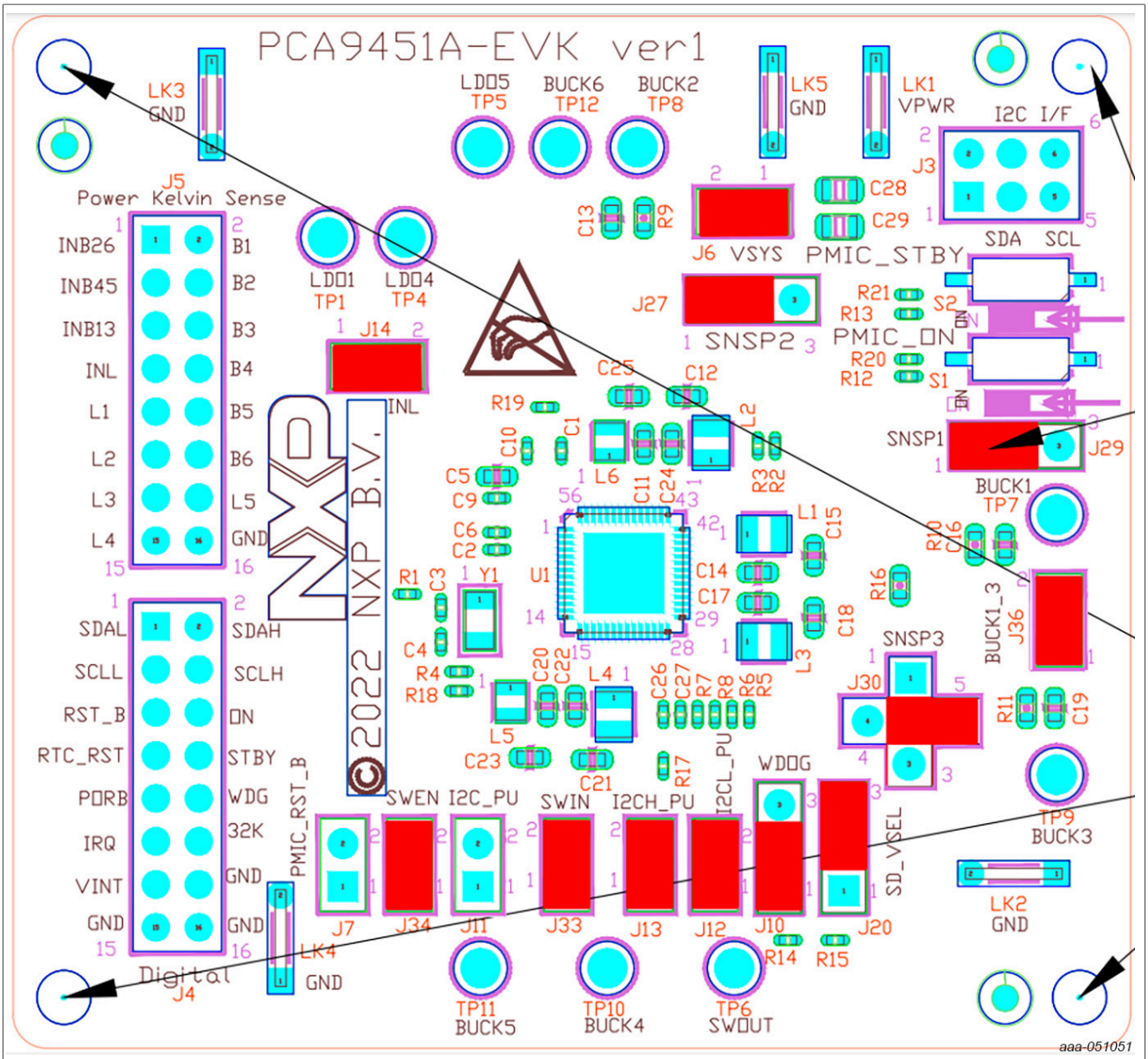


Figure 3. Default jumper configuration

Table 1. Evaluation board jumper description

Name	Default	Description
J6	1-2	Connects PMIC VSYS pin to main board VSYS
J7	No connection	Controls PMIC_RST_B (PMIC Reset) signal • Once it is asserted low (J7 = 1-2), PMIC performs reset.

Table 1. Evaluation board jumper description*...continued*

Name	Default	Description
J10	1-2	Controls WDOG_B (Watchdog reset input) signal • 1-2 -> Pull-up to VPWR (normal operation) • 2-3 -> Pull-down to GND
J11	1-2	Pull up of SDA,SCL, IRQ_B pins to BUCK5. ***Note: REMOVE JUMPER FOR USE WITH FTDI CABLE AND GUI***
J12	1-2	Pull up of SCLL,SDAL pins to BUCK5
J13	1-2	Pull up of SCLH,SDAH pins to BUCK4
J14	1-2	INL1 Enablement. Connects the INL input for LDOs to VPWR
J20	2-3	Selects SD_VSEL level • 1-2 -> SD_VSEL = High (LDO5 = 1.8 V default output) • 2-3 -> SD_VSEL = Low (LDO5 = 3.3 V default output)
J27	1-2	BUCK2 Feedback connection: • 1-2 -> Remote sense • 2-3 -> Local sense
J29	1-2	BUCK1 Feedback connection: • 1-2 -> Remote sense • 2-3 -> Local sense
J30	2-5	BUCK3 Feedback connection and BUCK1/BUCK3 Dual Phase control: • 1-2 -> Local sense for BUCK3 • 2-3 -> Remote sense for BUCK3 • 2-4 -> Pull-up to INB13 (VPWR rail), BUCK 3 is disabled. • 2-5 -> Pull-down to GND, BUCK1 and BUCK3 are configured as dual phase buck. ***Note: MAKE SURE J30 IS SET TO 2-5 FOR DUAL-PHASE CONFIGURATION. SOME BOARDS CAME WITH J30=2-3 BY DEFAULT***
J33	1-2	SWIN Connect to BUCK4
J34	1-2	SW_EN connect to BUCK4
J36	1-2	BUCK1 and BUCK3 Single/Dual Phase • 1-2 -> Dual Phase configuration • No connection -> Single Phase configuration ***Note: SOME BOARDS CAME WITH J36 OPEN BY DEFAULT, MAKE SURE J36 IS SET TO 1-2 FOR DUAL PHASE CONFIGURATION***

6.4 Test points

Use the test points to measure the output voltage signal of the PMIC regulators and load switch by oscilloscope/ multimeter.

Table 2. Evaluation board test point descriptions

Name	Signal	Description
TP1	LDO1	Power path for the LDO1 output.
TP4	LDO4	Power path for the LDO4 output.
TP5	LDO5	Power path for the LDO5 output.
TP6	SWOUT	Output of the Load Switch

Table 2. Evaluation board test point descriptions*...continued*

Name	Signal	Description
TP7	BUCK1	Power path for the BUCK1 output.
TP8	BUCK2	Power path for the BUCK2 output.
TP9	BUCK3	Power path for the BUCK3 output.
TP10	BUCK4	Power path for the BUCK4 output.
TP11	BUCK5	Power path for the BUCK5 output.
TP12	BUCK6	Power path for the BUCK6 output.

6.5 Connectors

6.5.1 Main input power connectors

Main input power VPWR is supplied using LK1 and LK5 connectors.

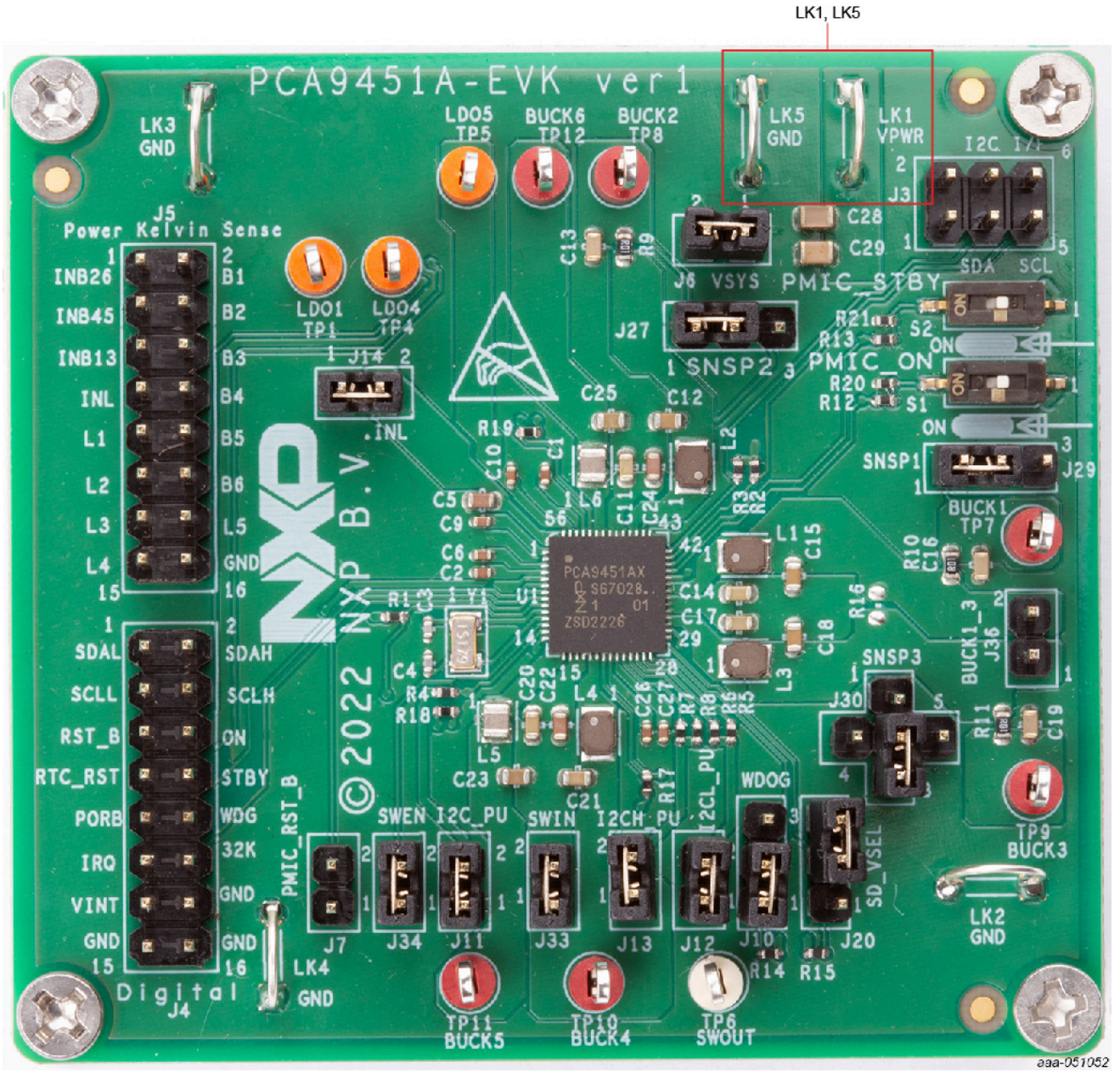


Figure 4. Main input power connectors

Table 3. Main input power connectors

Name	Signal	Description
LK1	VPWR	Main system input power supply System operating range from 2.85 V to 5.5 V (5.0 V Typ)
LK5	GND	Main system ground

6.5.2 Interface connectors

Digital IO connector (J4) is used to have access for easy monitoring of some of the analog and digital pins of the PCA9451A. Table 4 explains each of the pins included in this connector.

Table 4. Digital IO connector (J4)

Name	Signal	Type	Description
J4-1	SDAL	Input/Output	Level translator low voltage IO pin, SDA referenced to VINT, 1.8 V
J4-2	SDAH	Input/Output	Level translator high voltage IO pin, SDA referenced to SWIN, 3.3 V
J4-3	SCLL	Output	Level translator low voltage IO pin, SCL referenced to VINT, 1.8 V
J4-4	SCLH	Output	Level translator high voltage IO pin, SCL referenced to SWIN, 3.3 V
J4-5	RST_B	Input	PMIC reset input pin.
J4-6	ON	Input	PMIC ON input from Application processor.
J4-7	RTC-RST	Output	Reset output pin.
J4-8	STBY	Input	Standby mode input from Application processor.
J4-9	PORB	Output	Power On reset output pin.
J4-10	WDG	Input	Active low watchdog reset input pin from application processor.
J4-11	IRQ	Output	Direct connection to IRQ_B pin for interrupt signal
J4-12	32K	Output	32.768kHz clock CMOS output with LDO1 power rail.
J4-13	VINT	Power	Internal Power supply output pin.
J4-14	GND	GND	Analog ground.
J4-15			
J4-16			

I^2C connector (J3) is used to interface the PMIC with external I^2C controllers. This connector is typically used to interface the PCA9451A-EVK with the external FTDI cable, for proper communication with the PCA9451A-GUI.

Table 5. I^2C connector (J3)

Name	Signal	Type	Description
J3-1	I2C PU	Power	Voltage connection for the interface Pull-up resistors
J3-2	GND	Power	Direct connection to system ground
J3-3	SDA	Input/Output	Connection to I^2C serial data signal
J3-4	SDA	Input/Output	Connection to I^2C serial data signal
J3-5	SCL	Input	Connection to I^2C serial clock signal
J3-6	GND	Power	Direct connection to system ground

Kelvin sense connector (J5) is used to have access for easy monitoring of some of the voltage rails of the PMIC. Kelvin measurement makes it possible to accurately measure voltages while eliminating the inherent resistance of the PCB traces.

Table 6. Kelvin sense connector (J5)

Name	Signal	Description
J5-1	VPWR	Sense from INB26
J5-2	R_SNSP1	Remote sense for BUCK1 regulator output
J5-3	VPWR	Sense from INB45
J5-4	R_SNSP2	Remote sense for BUCK2 regulator output
J5-5	VPWR	Sense from INB13

Table 6. Kelvin sense connector (J5)*...continued*

Name	Signal	Description
J5-6	R_SNSP2	Remote sense for BUCK3 regulator output
J5-7	INL1	Sense from LDO inputs
J5-8	BUCK4FB	Remote sense for BUCK4 regulator output
J5-9	LDO1	LDO1 sense from LDO load caps
J5-10	BUCK5FB	Remote sense for BUCK5 regulator output
J5-12	BUCK6FB	Remote sense for BUCK6 regulator output
J5-14	LDO5	LDO5 sense from LDO load caps
J5-15	LDO4	LDO4 sense from LDO load caps
J5-16	GND	Direct connection to system ground

7 Evaluation kit connections and configuration

7.1 Test setup

Figure 5 shows test setup block diagram.

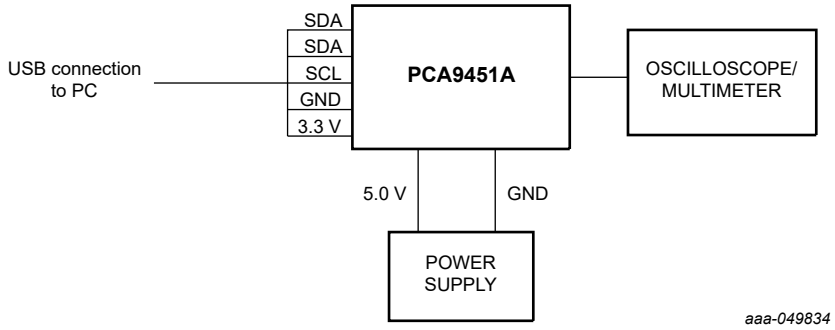


Figure 5. PCA9451A-EVK test setup

7.2 Evaluation board connection

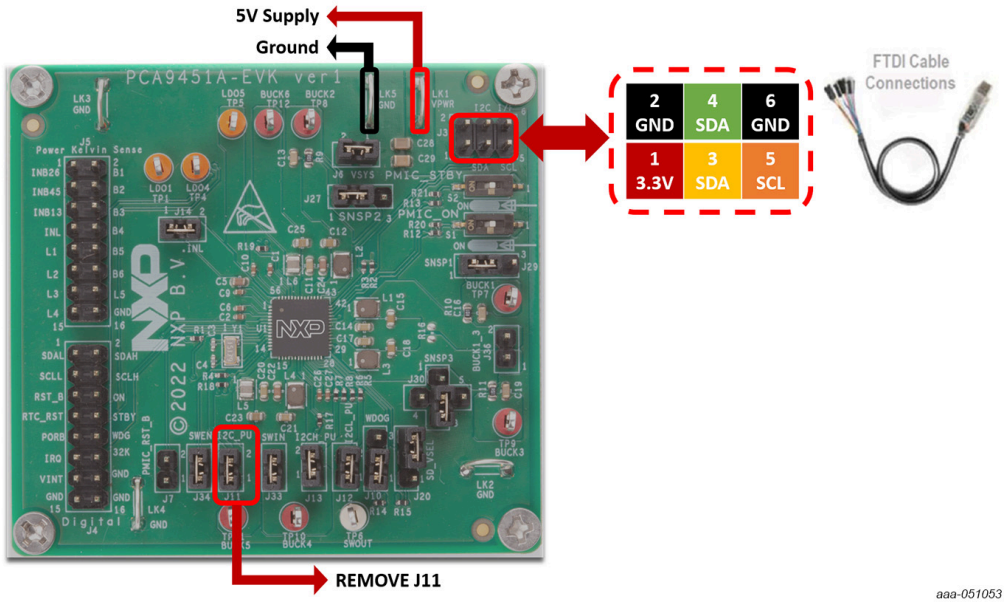


Figure 6. PCA9451A-EVK connections

7.2.1 Configure and power the board

Connect the wires of the FTDI cable on the following pins as shown in Figure 6, and make sure the power supply is turned off and the USB connector is disconnected during the wiring stage:

1. Connect both SDAs, SCL, GND, and the 3.3 V wires from the FTDI cable as mentioned in Figure 6 above.
   a. SCL serial clock signal (orange cable) should be connected to pin 5 of the ‘Digital IO’ connector (J3).
   b. Both SDA serial data wires (yellow and green cables) should be connected to create bidirectional data. Connect yellow cable to pin 3, and green cable to pin 4 of the ‘Digital IO’ connector (J3).
   c. GND ground signal (black cable) should be connected to pin 6 or pin 2 of the ‘Digital IO’ connector (J3).
   d. Remove jumper from J11.
   e. 3.3 V supply wire (red cable) from FTDI cable should be connected to pin 1 of the ‘I2C connector’ (J3).
2. With the power supply turned off, connect 5 V power supply to LK1 connector and corresponding ground to LK5.
3. Turn ON power supply.
4. Connect USB connector of the FDTI cable to PC.
5. Set switch S1 to "ON" position.

7.2.2 Default power configuration

The default power configuration can be checked without doing any HW or SW modifications. Check the default voltage configuration using a multimeter on BUCK1, BUCK2, BUCK3, BUCK4, BUCK5, BUCK6, LDO1, LDO4, and LDO5 test points:

Table 7. Default voltage configuration

Regulator	PCA9451A
BUCK1	0.8 V
BUCK2	0.6 V

Table 7. Default voltage configuration...*continued*

Regulator	PCA9451A
BUCK3	0.8 V
BUCK4	3.3 V
BUCK5	1.8 V
BUCK6	1.1 V
LDO1	1.8 V
LDO4	0.8 V
LDO5	1.8 V/3.3 V

8 PCA9451A GUI software

As shown in Figure 7, the PCA9451A software GUI is an user friendly tool to access the on-chip registers to perform write/read commands manually or automatically (depending on different setting chosen from the GUI). Below is a quick guide of the key blocks that the PCA9451A software GUI provides.

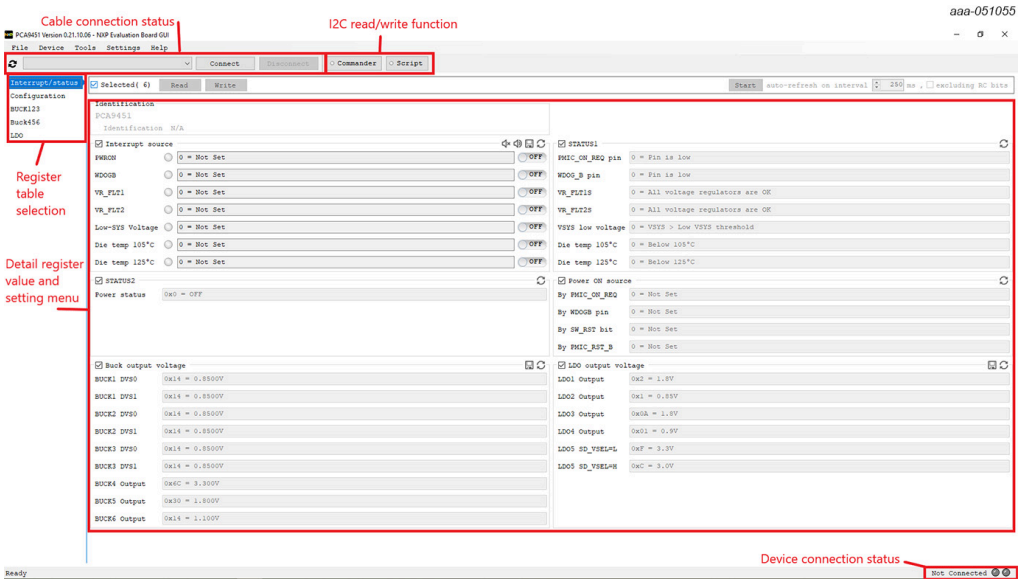


Figure 7. PCA9451A GUI

8.1 GUI setup

After turning on the power supply and plugging in the USB part of the FTDI cable, the GUI detects the cable automatically. Select the cable type (FT2TRWH9) from the drop-down menu, and then click “Connect” button.

On the “Device connection status” section (right bottom part of the screen), the GUI shows “Connected” with green light.

8.2 Register table section

The registers are categorized as shown below:

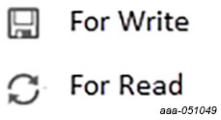
- Interrupt/status – Includes status registers like Interrupts source, power status, power on source, and output regulator levels.

- Configuration - system configuration, power-up/power-down sequence control, reset behaviors, UVLO threshold, fault information, and level translator control.
- Buck123 – Includes all of the configuration registers for all Buck regulators 1, 2, and 3, including DVS controls.
- Buck456 – Includes all of the configuration registers for all Buck regulators 4, 5, and 6.
- LDO – Includes all of the configuration registers for all LDO regulators.

8.3 I^2C read and write

PCA9451A software GUI provides three ways to read and write.

- On register table, click the “read”/“write” button for the whole table, or click:



- Command. Read or write the Hex value to specific register.
- Script. Run the script to read or write a series of registers. Using guideline can be found in help menu.

9 PCA9451A evaluation steps

The following sections show how to perform evaluation of the PCA9451A using the evaluation board and the software GUI.

9.1 I^2C pullup configuration for proper GUI interface

This step must be done with the power supply turned off and USB cable disconnected. For I^2C interface communication using the PCA9451A software GUI, remove J11 jumper (I2C_PU), and connect the red cable (3.3 V) from the FTDI cable to pin 1 of J3 connector (I^2C connector).

9.2 Jumper configuration

This step also needs to be done with the power supply turned off and USB cable disconnected. With exception of J11 jumper, please connect the jumpers in default configuration as shown in Section 6.3.

9.3 Connect and power the board

As shown in Figure 6, connect the wires of the FTDI cable and power supply according to the information in Section 7.2.1.

9.4 Working on the PCA9451A software GUI

Open, setup, and connect the GUI as directed in Section 8.1, then start configuring the PMIC using the different tabs.

9.4.1 BUCK configuration

Select ‘BUCKxxx’ tab from the register table selection.

From here you can change all the configuration registers for all the buck regulators of the PCA9451A, configure the low power modes, enable the active discharge resistor, use forced PWM, change enable modes, configure

the DVS speed (for BUCK1, BUCK2 and BUCK3), and change output voltages by either by writing the value or using the horizontal slide bar.

Use the multimeter to check the voltage on the buck test points to confirm the voltage changes when configured.

9.4.2 LDO configuration

Select ‘LDO’ tab from the register table selection.

From here you can change all the configuration registers for all the LDO regulators of the PCA9451A, configure the low power modes, enable the active discharge resistor, change enable modes, and change output voltages by either by writing the value or using the horizontal slide bar.

Use the multimeter to check the voltage on the LDO test points to confirm the voltage changes when configured.

9.4.3 Load switch configuration

Select ‘LDO’ tab from the register table selection.

From here you can change all the configuration registers for the Load Switch of the PCA9451A, enable the active discharge resistor, change enable modes, and configure the different protection mechanisms.

9.4.4 GUI close

Click ‘Disconnect’ button, disconnect USB cable from the PC and turn OFF the Power Supply and close the PCA9451A GUI.

10 Schematic diagram

The schematic diagram of PCA9451A-EVK is available at URL: http://www.nxp.com/PCA9451A-EVK.

11 Bill of materials

The BOM of PCA9451A-EVK board is based on **SCH-50786 REV A.**

Table 8. PCA9451A-EVK BOM

Description	Qty	BOM Ref	Manufacturers Name ~ Location	Manufacturers Part Number
CAP CER 10 µF 10V 10% X5R 0603	4	C11, C14, C17, C20	TDK	C1608X5R1A106K080AC
CAP CER 47 µF 10V 20% X5R 0805	2	C28, C29	TDK	C2012X5R1A476M125AC
CAP CER 4.7 µF 10V 10% X7S 0603	3	C5, C22, C24	MURATA	GRM188C71A475KE11D
CAP CER 22 µF 10V 20% X5R 0603	6	C12, C15, C18, C21, C23, C25	MURATA	GRM188R61A226ME15D
CAP CER 18pF 50V 5% C0G AEC-Q200 0402	2	C3, C4	MURATA	GCM1555C1H180JA16
CAP CER 47 µF 6.3V 20% X5R 0603	3	C13, C16, C19	MURATA	GRM188R60J476ME15D
CAP CER 1 µF 10V 10% X7S 0402	7	C1, C2, C6, C9, C10, C26, C27	MURATA	GRM155C71A105KE11D
IND WW 0.47 µH@1MHz 3.4A 20% 2016	2	L5, L6	MURATA	1286AS-H-R47M=P2
IND PWR 0.47 µH@1MHZ 4.7A 20% SMT	4	L1, L2, L3, L4	Shenzhen Sunlord Electronics Co., Ltd	WPN252012ER47MT
TEST POINT PC MULTI PURPOSE RED TH	6	TP7, TP8, TP9, TP10, TP11, TP12	KEYSTONE ELECTRONICS	5010
TEST POINT ORANGE 70X220 MIL TH	3	TP1, TP4, TP5	KEYSTONE ELECTRONICS	5008
TEST POINT WHITE 70X220 MIL TH	1	TP6	KEYSTONE ELECTRONICS	5007
HDR 1X2 TH 100MIL SP 342H AU 118L	9	J6, J7, J11, J12, J13, J14, J33, J34, J36	WURTH ELEKTRONIK EISOS GMBH & CO. KG (ELECTRONIC & ELECTROMECHANICAL COMP)	61300211121
HDR 1X3 TH 2.54MM SP 344H AU 118L	4	J10, J20, J27, J29	WURTH ELEKTRONIK EISOS GMBH & CO. KG (ELECTRONIC & ELECTROMECHANICAL COMP)	61300311121
HDR 2X3 TH 100MIL CTR 344H AU 118L	1	J3	WURTH ELEKTRONIK EISOS GMBH & CO. KG (ELECTRONIC & ELECTROMECHANICAL COMP)	61300621121
HDR 2X8 TH 100MIL CTR 344H AU 118L	2	J4, J5	WURTH ELEKTRONIK EISOS GMBH & CO. KG (ELECTRONIC & ELECTROMECHANICAL COMP)	61301621121
CON 2 JUMPER PLUG SHORTING TH 200MIL SP 305H --	5	LK1, LK2, LK3, LK4, LK5	KEYSTONE ELECTRONICS	5026
XTAL 32.768KHZ 12.5PF 20PPM 3.2 X1.5MM SMT	1	Y1	ECS INC. INTERNATIONAL	ECS-.327-12.5-34B

Table 8. PCA9451A-EVK BOM*...continued*

Description	Qty	BOM Ref	Manufacturers Name ~ Location	Manufacturers Part Number
IC POWER MANAGEMENT 2.7-5.5V HVQFN56	1	U1	NXP SEMICONDUCTORS	PCA9451AHNY
RES MF ZERO OHM 1/16W 5% 0402	3	R17, R18, R19	SEI ELECTRONICS INC	RMCF1/16S0.005%R
RES MF 0.01 OHM 1/10W 1% AEC-Q200 0603	3	R9, R10, R11	Yageo	RL0603FR-070R01L
RES MF 100K 1/10W 5% AEC-Q200 0402	6	R1, R4, R12, R13, R14, R15	PANASONIC	ERJ2GEJ104X
RES MF 4.7K 1/10W 5% AEC-Q200 0402	8	R2, R3, R5, R6, R7, R8, R20, R21	PANASONIC	ERJ2GEJ472X
SW DIP 1 POS 0.025A@24VDC SMT	2	S1, S2	WURTH ELEKTRONIK EISOS GMBH & CO. KG (ELECTRONIC & ELECTROMECHANICAL COMP)	416131160801
SUBASSEMBLY HDR 1X3 TH 2.54MM SP 344H AU 118L + HDR 1X1 TH -- 344H AU 118L	1	J30		
RES MF ZERO OHM -- AEC-Q200 0603	0	R16	KOA SPEER	RK73Z1JTTD
DIODE SCH RECT 3A 40V AEC-Q101 SOD123W	0	D1, D2, D3, D4, D5, D6, D7, D8, D9, D10, D11, D12	Nexperia	PMEG4030ER, 115

12 Legal information

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Date of release: 30 March 2023
Document identifier: UM11883

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