SLN-VIZNLC-IOT-HDG

SLN-VIZNLC-IOT Hardware Design Guide

Rev. 0 — 12 April 2023 User guide

Document Information

Information	Content
Keywords	SLN-VIZNLC-IOT, RT106F, Smart Lock, Smart Access
Abstract	This document provides details about the hardware design of the SLN-VIZNLC-IOT development kit, which implements the NXP Edge Ready turnkey solution for face-recognition-based access control using an RGB+IR dual camera module

1 Introduction

The SLN-VIZNLC-IOT development kit implements NXP Edge Ready turnkey solution for face recognition-based access control using a Red, Green, Blue + Infrared (RGB+IR) dual camera module. It includes the LPC845 low-power control, the i.MX RT106F runtime library, pre-integrated machine learning face-recognition algorithms, and all required drivers for peripherals, such as memories, cameras, display, Bluetooth Low Energy (BLE), and Wi-Fi as optional.

This cost-effective, easy-to-use solution facilitates deploying highly accurate face recognition with robust liveness detection capability. By leveraging an MCU platform, this solution can deliver the low cost and low power consumption required for battery-powered consumer smart locks, combined with the quick inferencing and short boot times needed to deliver a great user experience.

Target applications:

- **Smart door locks:** For consumer and hospitality applications, including single-family homes, multiple dwelling units, and hotels.
- **Access control:** For office and industrial smart-building applications.

1.1 i.MX RT106F vision crossover processor overview

The i.MX RT106F is an Edge Ready member of the i.MX RT1060 family crossover processors and targeting low-cost embedded face recognition applications. It features NXP's advanced implementation of the Arm Cortex-M7 core, which operates at speeds up to 600 MHz to provide high CPU performance and the best real-time responses. This i.MX RT106F based solution enables system designers to easily and inexpensively add face recognition capabilities to a wide variety of smart appliances, smart homes, and smart industrial devices. The i.MX RT106F processor is licensed to run NXP i.MX RT runtime library for face recognition, which includes:

- Unified cross-platform framework
- Camera drivers, image capture, and pre-processing
- Face detection, tracking, alignment, recognition (with quantified results and confidence measure), and liveness detection
- Display drivers, Two-Dimensional (2D) graphics accelerator supported
- Built-in security, bootloader, and application validation
- All drivers, including BLE and Wi-Fi
- Universal Serial Bus (USB) mass storage device updates
- Factory automation scripts
- Supported by an MCUXpresso Software Development Kit (SDK), Integrated Development Environment (IDE), and configuration tools

1.2 LPC845 low-power MCU overview

In addition to the i.MX RT106F, there is one more MCU based on Arm Cortex-M0 + core, called LPC845. The LPC845 is a low-cost, 32-bit Microcontroller Unit (MCU) operating at up to 30 MHz frequencies. It supports up to 64 kB of flash memory and 16 kB of Static Random-Access Memory (SRAM), features exceptional power efficiency in the Low-power mode, and includes rich peripheral complement Input/Output (I/O) ports.

System requirements and prerequisites:

Once you are ready to begin development, you must download **MCUXpresso Integrated Development Environment (IDE)**. The current SDK is tested with version 11.6.1 (or newer) of MCUXpresso IDE and SEGGER J-Link v7.6x, see Table 1.

Table 1. Supported computer configurations

Personal Computer (PC) type	Operating System (OS) version	Terminal
Apple	Mac OS	PuTTY
Windows	Windows 7/10/11	PuTTY/Tera Term
Ubuntu	Linux	PuTTY

Used condition:

The following information is provided as per *Article 10.8 of the Radio Equipment Directive 2014/53/EU*, see Table 2:

Table 2. RF frequency and power

Part number	RF technology	Frequency range[1]	Maximum transmitted power[2]
SLN-VIZNLC-IOT	Bluetooth Low Energy	2402 MHz - 2480 MHz	10 dBm

[1] Frequency bands in which the equipment operates
[2] The maximum RF power transmitted

Note: *This document is simplified as per the European declaration of conformity (Article 10.9 of the Radio Equipment Directive 2014/53/EU).*

Note: *This apparatus, SLN-VIZNLC-IOT conforms to the Radio Equipment Directive 2014/53/EU. The full EU Declaration of Conformity for this apparatus can be found at* ***NXP EdgeReady MCU-Based Solution for Face Recognition with Liveness Detection***.

2 Introduction to SLN-VIZNLC-IOT

This section provides details about the hardware overview and features.

2.1 Hardware overview

The SLN-VIZNLC-IOT kit is intended to provide a reference for an original product design. Many design concerns that a hardware engineer would make when producing a product must be considered when designing the kit because of its compact form factor. With that said, NXP has also fashioned the hardware to have some of the key hallmarks of a traditional development kit.

Figure 1 shows the SLN-VIZNLC-IOT kit, which includes a Printed-Circuit Board (PCB), a Liquid Crystal Display (LCD), a black bracket enclosure, four standoffs, and a USB cable.

The SLN-VIZNLC-IOT kit size:

- Length - 93 mm
- Width - 60 mm
- Thickness - 9 mm

Figure 1. SLN-VIZNLC-IOT Kit

For more details about SLN-VIZNLC-IOT kit, see Figure 2.

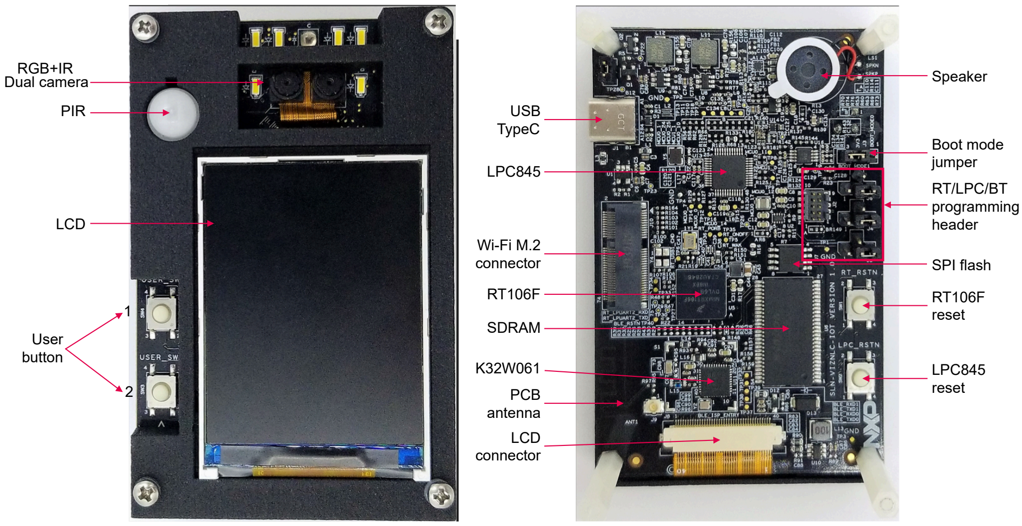


Figure 2. SLN-VIZNLC-IOT kit top and bottom view

Note: *The SLN-VIZNLC-IOT kit comes with an RGB+IR dual camera to use in secure applications.*

2.2 Hardware features and details

This chapter introduces the hardware design details designed to help developers to get familiarized with the hardware system.

2.2.1 Hardware features

Table 3 lists the main hardware features of SLN-VIZNLC-IOT.

Table 3. Hardware Features of SLN-VIZNLC-IOT

Features	SLN-VIZNLC-IOT
MCU	• MIMXRT106FDVL6A/B Crossover MCU • LPC845M301JBD48E (System Low-Power control)
Memory	• 1 MB integrated SRAM in RT106F • 16 MB Quad Serial Peripheral Interface (QSPI) flash • 16 MB Synchronous Dynamic Random Access Memory (SDRAM)
Cameras and Display	• Camera module with GalaxyCore GC0308 image sensors (parallel Camera Serial Interface (CSI) interface and RGB or IR pass filter) • Liquid Crystal Display (LCD) with Rocktech RK024HH298 Enhanced LCD Interface (LCDIF)
Connectivity	• NXP K32W061 BLE MCU and integrated antenna on PCB • Optional Murata 1XK M.2 Wi-Fi module
Sensors	Passive Infrared (PIR) sensor (IRA-S210ST01)

2.2.2 Hardware block diagram

Figure 3 shows the block diagram of SLN-VIZNLC-IOT.

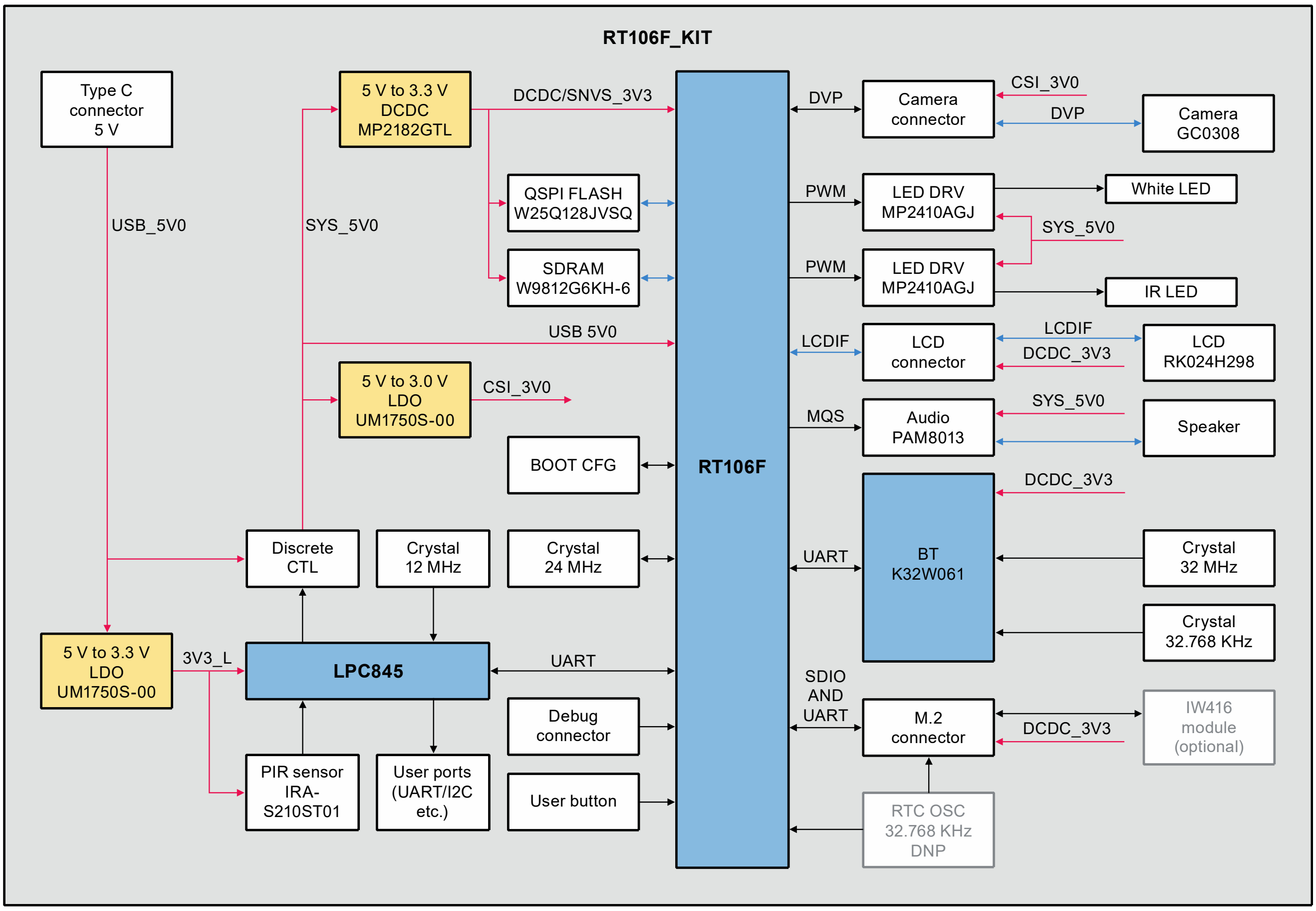


Figure 3. SLN-VIZNLC-IOT hardware block diagram

2.2.3 Power supply

The SLN-VIZNLC-IOT is supplied with USB-Type C connector (J1), 5 V. The whole system can operate in a Low-power mode or normal mode, refer to the block diagram in Figure 3.

As long as J1 is connected to the 5 V supply `USB_5V0`, LPC845, PIR sensor, and its signal conditioning circuit are supplied by a Low Drop Out (LDO) `(UM1750S-00)` which converters `USB_5V0` to 3.3 V. When the PIR sensor does not detect any live body, LPC845 works in Deep power-down mode, the system works in the Low-power mode.

Once the PIR sensor detects a live body, LPC845 wakes-up and controls the power on of system `5V(SYS_5V0)`, then `SYS_5V0` is down-converted to 3.3 V using a DC-to-DC buck converter (`MP2181`), which supplies for RT106F control system and all kinds of peripheral interfaces including LCD, BLE, Wi-Fi and audio interfaces, and so on. `SYS_5V0` is also down-converted to 3.0 V using an LDO `(UM1750S-00)`, which supplies for camera module. Thereby the whole system enters the normal power mode.

In order to easily debug this board, a two-pin jumper `J11` is reserved here to directly power on the RT106F system during the debugging process. For more details, see Figure 4.

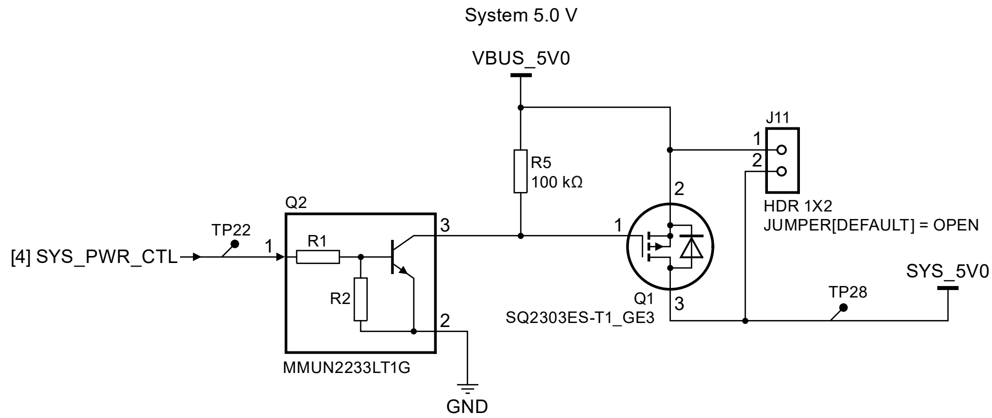


Figure 4. LPC845 control power-on circuit

2.2.4 Low-power MCU LPC845

NXP LPC845 is based on the Arm Cortex-M0+ core, and it is a low-cost, low-power, 32-bit MCU family which operates at frequencies of up to 30 MHz.

The PIR sensor, which uses the Murata IRA-S210ST01 sensor, is used to wake up the low-power LPC845. Then LPC845 controls the power delivered to the RT106F control system and its various peripheral interfaces. For more details, see Figure 5.

Note: *Ensure that a series resistor (10 ohms ~ 100 ohms) is added to UART pins of RT106F.*

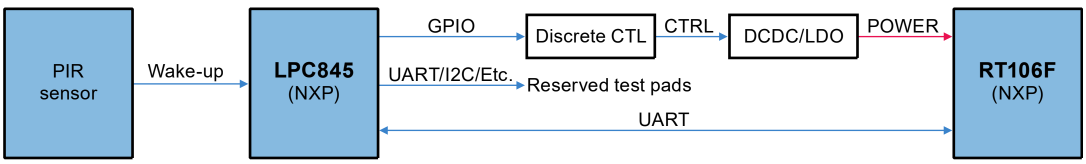


Figure 5. LPC845 communication

Meanwhile, the LPC845 provides multiple Universal Asynchronous Receiver/Transmitter (UART), Inter-Integrated Circuit (I^2C), or General-Purpose Input/Output (GPIO) peripheral interfaces, see Figure 6. Developers can configure them as per the product and application requirements.

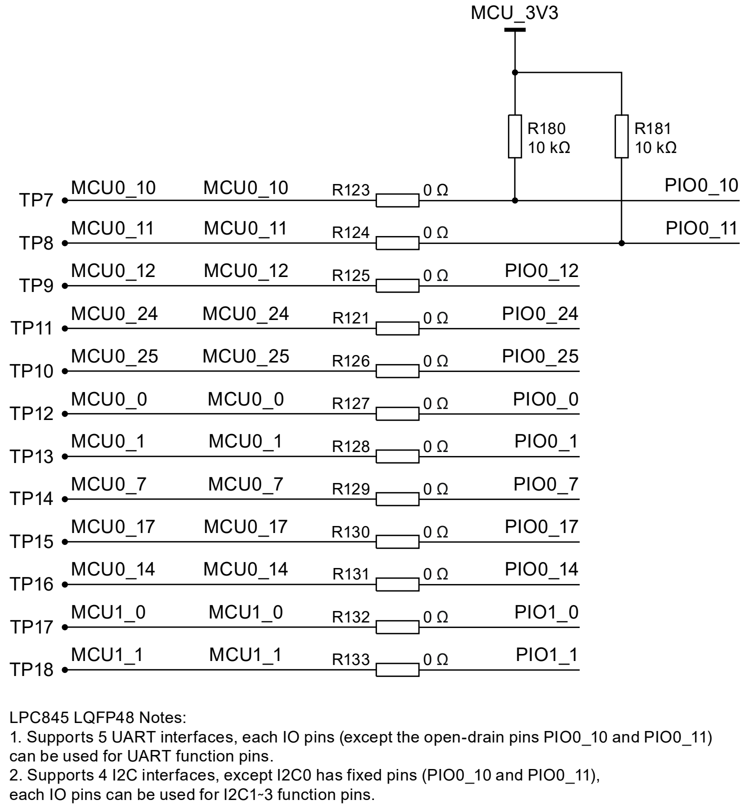


Figure 6. LPC845 reserved peripheral interfaces

2.2.5 RT106F control system

The RT106F and its 16 MB of SDRAM and 16 MB of Quad Serial Peripheral Interface (QSPI) flash memory make up the primary processing center of the SLN-VIZNLC-IOT. The 16 MB SDRAM uses Winbond W9812G6KH-6, Thin Small Outline Package (TSOP) II 54-pin. The 16 MB flash uses Winbond W25Q128JVSIM, Small Outline Integrated Circuits (SOIC) 8-pin. For more details about the interfaces, see Figure 7.

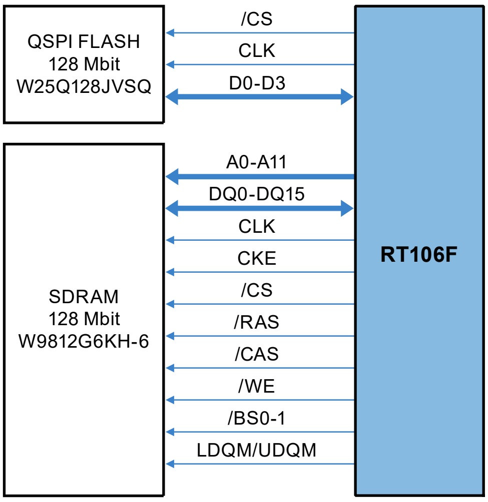


Figure 7. RT106F control system

The Boot mode of RT106F can be selected via the three-pin connector `J3`, see Figure 8.

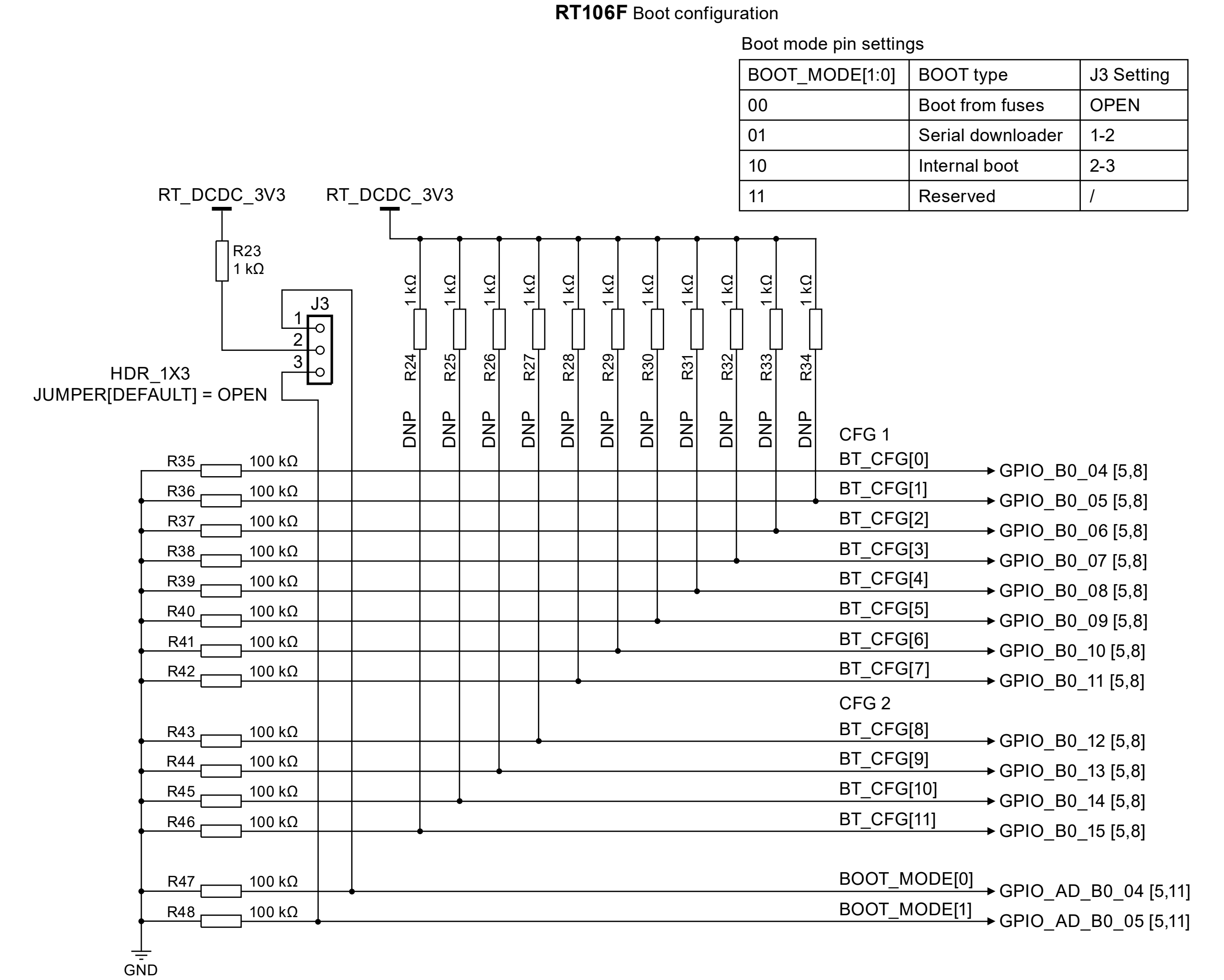


Figure 8. RT106F boot mode selection

2.2.6 Camera and Interface

The SLN-VIZNLC-IOT uses low-cost IR and RGB cameras based on the GalaxyCore GC0308 sensor. Two Manufacturer Part Number (MPN) can be chosen from Table 4.

Table 4. Camera MPN

Manufacturer	MPN
Ningbo JinshengXin Vision Technology	GC03-0CCM-D1
Shenzhen Yuantu Photoelectric Technology Co., Ltd	YT-MT0308-2-V1-850

The cameras connect to the board via a Flexible Printed Circuit (FPC) connector and communicate with the RT106F using a Digital Video Port (DVP) interface. For more details, see Figure 9.

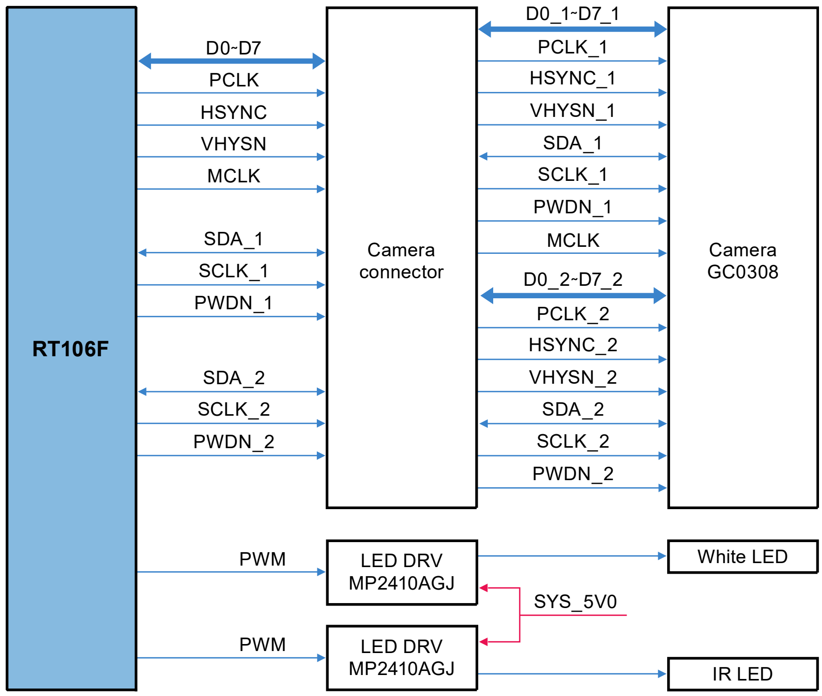


Figure 9. Camera and interface

Additionally, the SLN-VIZNLC-IOT uses two MP2410AGJ Monolithic Power Systems (MPS) Light-Emitting Diode (LED) lighting drivers Integrated circuits (ICs), one is used to drive the white LEDs, while the other drives the IR LED.

2.2.7 Display and interface

The LCD module uses the Rocktech RK024HH298 display - 2.4 inches TFT 240x320 Pixels with LED backlight, and the outline dimensions are:

- Length - 60.3 mm
- Width - 42.72 mm
- Thickness - 2.2 mm

The display connects to the board via a Flexible Printed Circuits (FPC) connector, communicates with the RT106F via an LCDIF interface, and uses LED driver IC UM1663S to drive the backlight. For more details, see Figure 10.

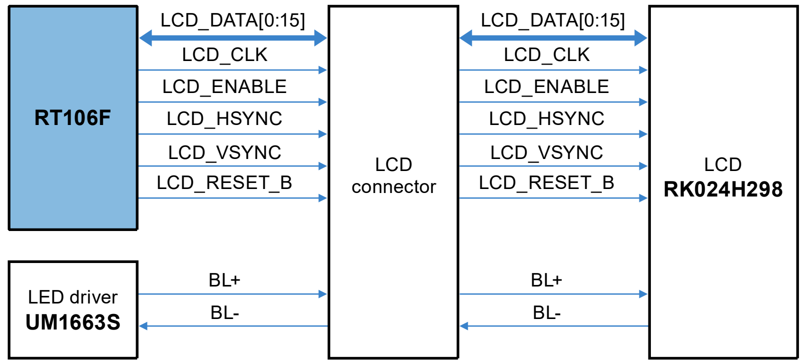


Figure 10. Display and interface

Note: *The RK024HH298 does not support touch-panel functionality.*

2.2.8 Audio

The SLN-VIZNLC-IOT uses the Medium Quality Sound (MQS) audio output of the RT106F and an audio amplifier PAM8013, to drive a 1 W speaker. The speaker is installed on the bottom side of the board. For more details, see Figure 11.

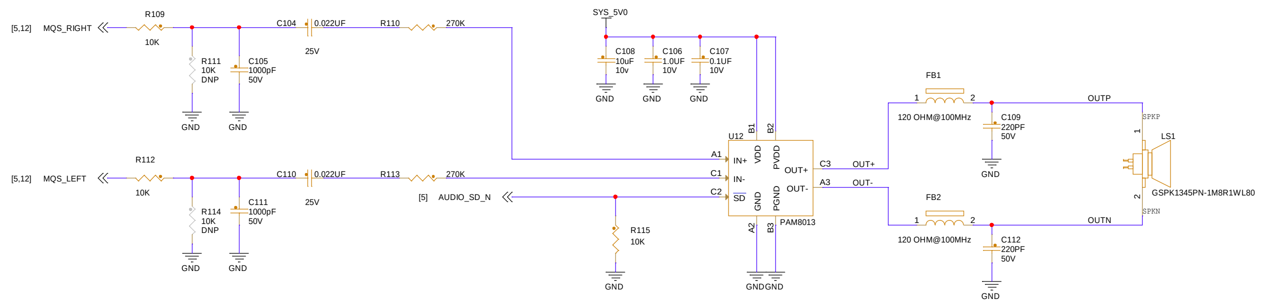


Figure 11. Audio circuit

Note: *The volume of the speaker is low. Users can change with a new speaker as per the actual application. If replacing the speaker with a more powerful one, increase the audio amplifier gain by changing R110 / R113 values. For more details, refer to PAM8013 data sheet.*

2.2.9 BLE

The SLN-VIZNLC-IOT uses NXP K32W061 to enable its BLE functionality. The K32W061 communicates using a UART interface between K32W061 and RT106F. The SLN-VIZNLC-IOT integrates a 2.4 GHz PCB antenna.

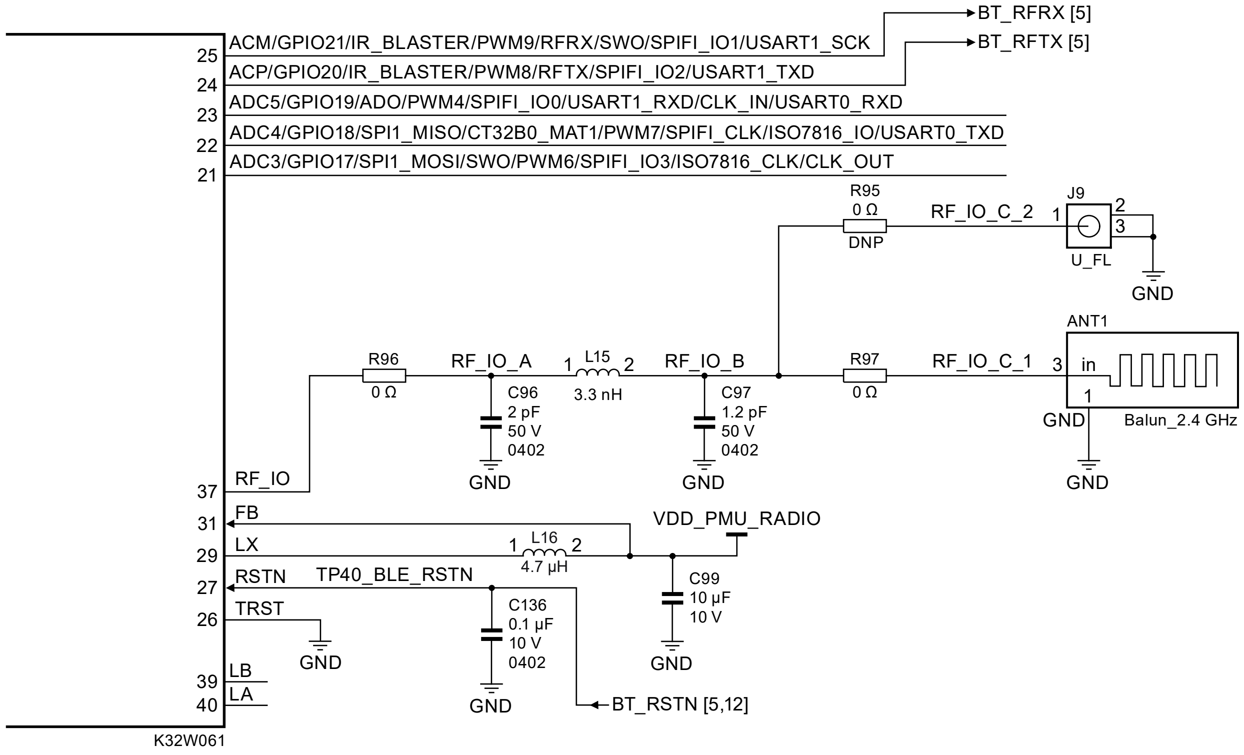


Figure 12. BLE circuit

2.2.10 Wi-Fi interface

The SLN-VIZNLC-IOT reserves an M.2 connector to connect to an IW416 Wi-Fi module (1XK M.2 Module).

For more details, refer to Murata NXP IW416 Shielded Ultra Small Dual band Wi-Fi® 11a/b/g/n + Bluetooth® 5.2 Module.

Note: *The SLN-VIZNLC-IOT Rev. A does not support this functionality. However, Rev. B versions of the board do.*

2.2.11 Buttons

The SLN-VIZNLC-IOT has four onboard buttons, two of them are used for reset functions, while the other two are provided to enable user application functionality like registering and deregistering users, see Table 5. For more details, please refer to *SLN-VIZNLC-IOT User's Guide* (document SLN-VIZNLC-IOT-UG).

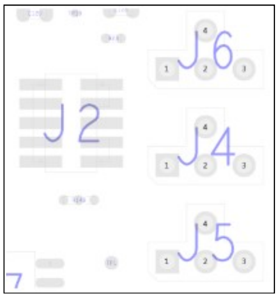
Table 5. Button Details

Reference	Function	Position on PCB
SW1	RT106F RESET	Bottom side
SW2	LPC845 RESET	Bottom side
SW3	User button 1	Top side
SW4	User button 2	Top side

2.2.12 Debug interface

The SLN-VIZNLC-IOT has a single serial wire debug interface connector `J2`, which supports programming and debugging the RT106F, LPC845, and K32W061 via a SEGGER J-Link debug probe. To select which MCU to program/debug, the `J4`, `J5`, and `J6` connectors, each need to be set to the position as listed in Table 6.

Table 6. J4, J5, and J6 setting

Programming	J4, J5, and, J6	Layout position
LPC845	1 - 2 (Default)	
RT106F	2 - 3	
K32W061 (BLE)	2 - 4	

2.2.13 Power consumption

The SLN-VIZNLC-IOT can work in a Low-power mode or Normal mode. In the Low-power mode, the PIR sensor and LPC845 are only supplied by 5 V USB power, and LPC845 works in Deep power-down mode. The current of the PIR sensor and LPC845 draw from the 5 V supply, which is about 30 μA and the quiescent current of UM1750S LDO (U1) draws from the 5 V supply is about 190 μA, so the total current of the whole board about 220 μA.

In the Normal mode, all functions work, and the average current drawn from the 5 V supply is typically 303 mA. It is equivalent to an average of 1.525 W. In that configuration, the main contributors are as follows:

- i.MX RT106A - 90 mA
- SDRAM - 15.75 mA
- QSPI Flash - 12 mA
- LCD - 113.5 mA
- Camera - 55.8 mA
- BLE - 1.9 mA

While other functions represent, the current draw is about 8.5 mA.

Note: *Changing U1 LDO (UM1750S) with a new LDO with ultra-low quiescent current shall reduce the whole board's current into Low-power mode.*

Note: *The details of the current measurement can refer to SLN-VIZNLC-IOT Power Consumption Features (document AN13804).*

3 References

- MCU Minutes | MCUXpresso IDE Overview
- MCUXpresso Software and Tools
- *MCUXpresso IDE User Guide* (document MCUXPRESSO-UG)
- NXP EdgeReady MCU-Based Solution for Face Recognition with Liveness Detection
- *SLN-VIZNLC-IOT User's Guide* (document SLN-VIZNLC-IOT-UG)
- *SLN-VIZNLC-IOT Power Consumption Features* (document AN13804)

Revision history

Table 7 summarizes the changes done to this document since the initial release.

Table 7. Revision history

Revision number	Date	Substantive change
0	12 April 2023	Initial release

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