

ForgeFPGA SLG47921V GameBuddy

Description

GameBuddy is a compact, retro-inspired handheld gaming console built on the modern ForgeFPGA™ architecture. It showcases the capabilities of the SLG47921V mixed-signal IC in a practical embedded application, blending nostalgic design with advanced customization and expandability for developers and hobbyists.

Specifications

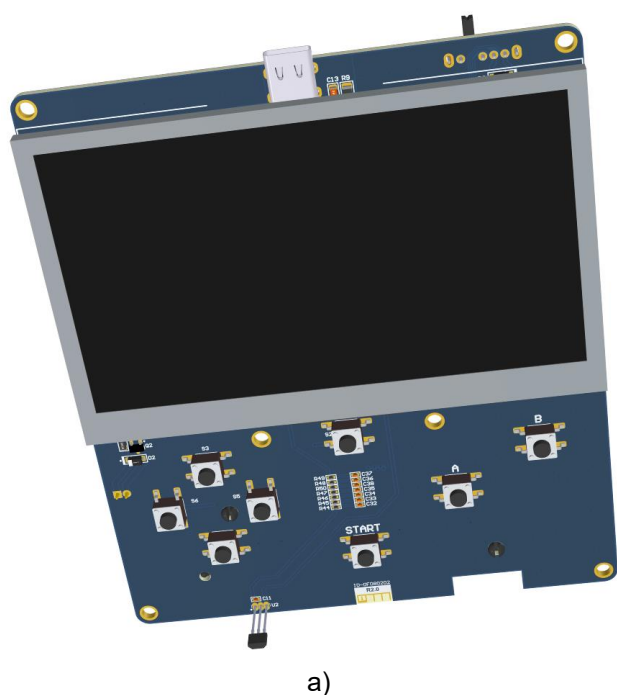
- FPGA core: SLG47921V
- Display: 4" LCD
- Controls: classic D-pad, Start/A/B buttons.
- Audio: 13mm speaker
- Storage: SPI flash

Features

- Battery-powered (Li-Ion 18650) with USB-C charging
- Virtual COM port mode
- Support for two-player games via LVDS interface
- Onboard Hall sensor
- Lightweight and portable design
- Optional enclosure with retro aesthetics
- Renesas GoConfigure supported

Board Contents

- Forge FPGA GameBuddy console
- USB-C cable



a)



b)

Figure 1. GameBuddy Views

(a – board, b – board equipped with enclosure)

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1. Functional Description

1.1 Functional Diagram

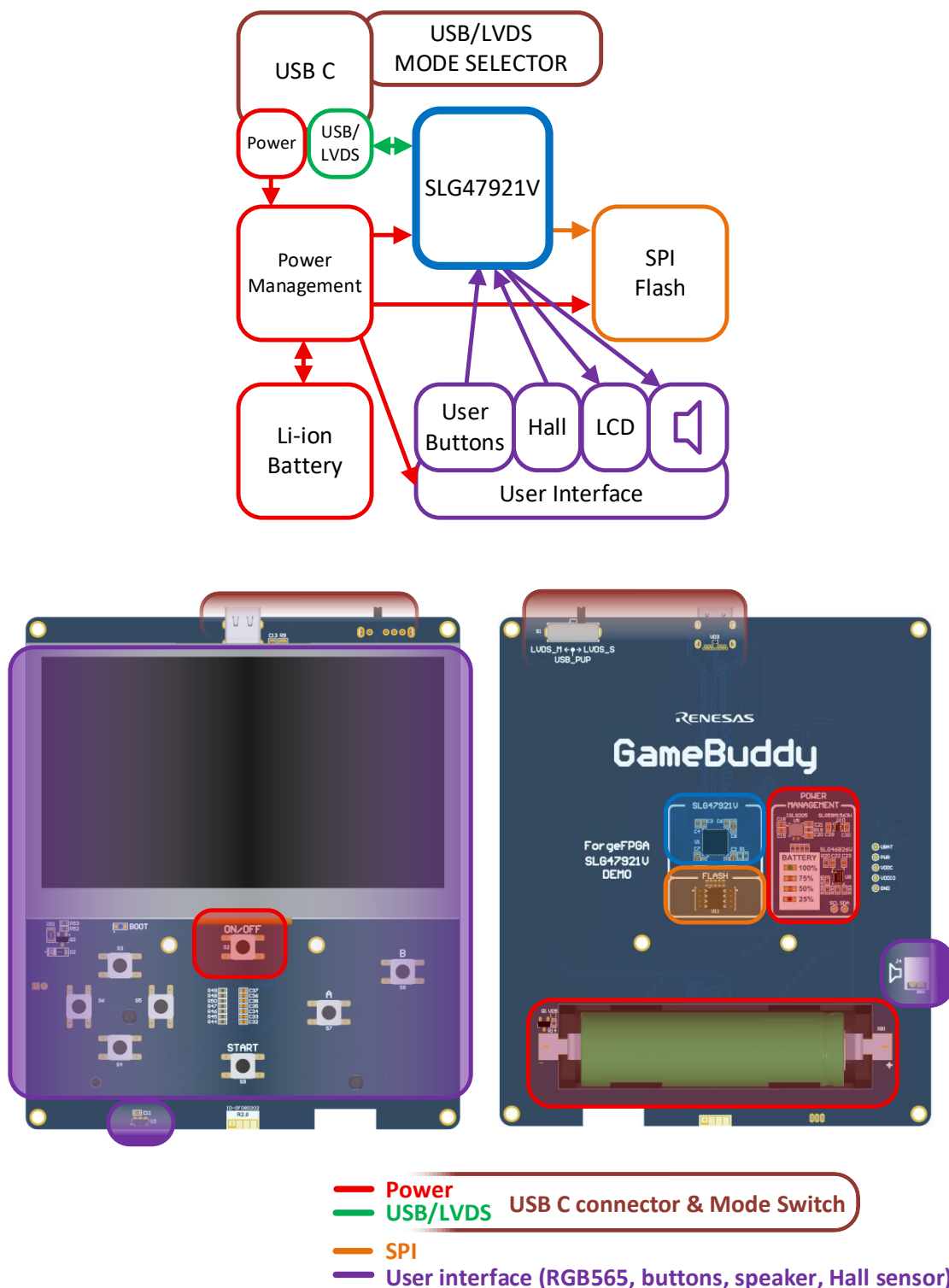


Figure 2. GameBuddy Block Diagram

1.1.1. SLG47921V

The SLG47921V is a compact, low-power component designed for typical FPGA applications. The GameBuddy Demo Board serves as a practical use case for the device.

1.1.2. Power Management

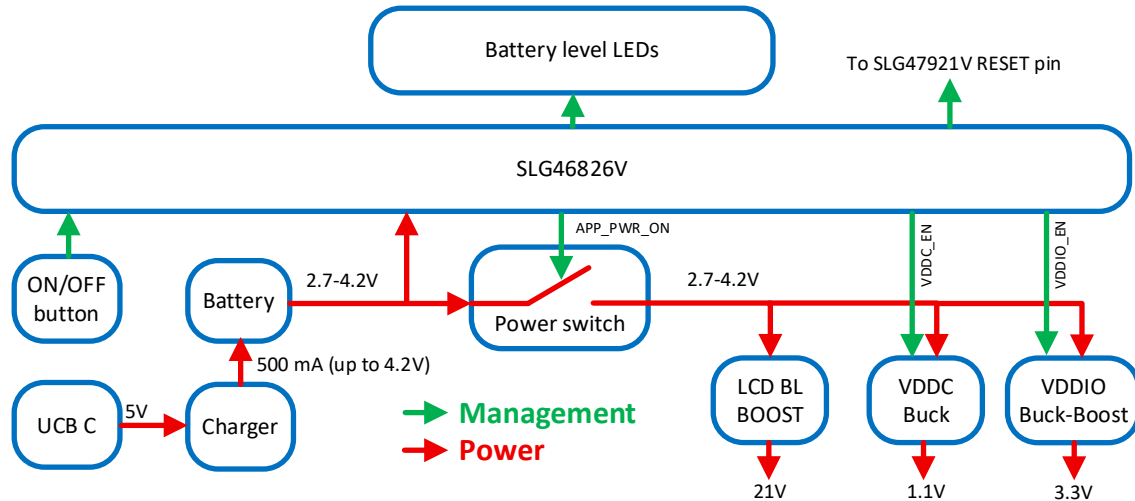


Figure 3. Power Management Block Diagram

The device's power management logic is implemented using the GreenPAK SLG46826 IC and performs the following functions:

- Device ON/OFF/BOOT (see section 1.3.3)
- Battery level indication: four LEDs. Blinking when charging.

1.1.3. SPI Flash

SPI Flash is a non-volatile memory device that uses the Serial Peripheral Interface (SPI) for communication. It is typically used to store:

- FPGA configuration bitstream
- Service data

1.1.4. User Interface

- 4" LCD
- D-pad (Directional Pad), A/B/Start Buttons
- 13mm speaker
- Hall effect sensor for demonstration purposes

1.1.5. USB-C Connector

1.1.5.1. Connector

Option 1. Device charging. Used when connected to a source with 5V power available.

Option 2. Virtual COM Port Mode.

Option 3. Using differential pairs of the USB 3.2 cable/connector to transfer data through the LVDS interface.

1.1.5.2. Mode Selector Switch

For available modes, see the FW/SW description.

Appropriate hardware configuration for the LVDS_CLK line can be selected according to **Table 1**.

Table 1. LVDS_CLK Line Hardware Configuration

Mode	Switch position	PCB Label	Description
LVDS MASTER	Left	LVDS_M	Termination resistor for LVDS_CLK line disabled
USB Virtual Com Port	Center	USB_PUP	Termination resistor for LVDS_CLK line disabled LVDS_CLK_P line pulled (1.5 kΩ) to GPIO8 state
LVDS SLAVE	Right	LVDS_M	Termination resistor for the LVDS_CLK line enabled

1.2 Operational Characteristics

Table 2. Operational Characteristics

Parameter	Description	Condition	Min	Typ	Max	Unit
V _{USB}	USB Input Voltage	-	-	5	6	V
I _{USB}	USB Input Current	Charging	-	500	550	mA
U _{BAT}	Battery voltage	-	2.7		4.2	V
I _{OFF}	Consumption from the battery	OFF State	-	-	2	μA
I _{ON}	Consumption from the battery	ON State	-	300	-	mA
VDD _{LCDBL}	LDC Backlight voltage	-	20	21	22	V
VDDC	FPGA core voltage	-	-	1.1	1.15	V
VDDIO	FPGA IO Bank voltage	-	3.27	3.3	3.35	V
T _A	Operating Ambient Temperature	-	10	-	45	0C

1.3 Setup and Configuration

1.3.1. Battery

The GameBuddy has an 18650-type battery with a capacity of 2500 mAh. However, the battery can be replaced in different scenarios. In such cases, the average device lifetime in the ON state can be calculated using the following equation:

$$\text{Battery Life (h)} = \text{Battery Capacity(mAh)} / I_{ON} \text{ (mA)}$$

Generally, the battery should be installed just before first use and does not need to be replaced. However, if battery replacement or removal becomes necessary, the following steps should be performed.

1.3.1.1. Installation

1. Disconnect the USB cable, if connected.
2. Verify the battery type and model to ensure compatibility.
3. Inspect the battery for damage, swelling, or leakage. Do not use a damaged battery.
4. Align the battery terminals: match the positive (+) and negative (–) ends with those in the device.
5. Monitor for unusual signs such as excessive heat, strange odors, or performance issues.
1. If anything seems abnormal, stop using the device immediately and inspect the battery.

1.3.1.2. Removing

2. Power off the device and disconnect the USB cable (if connected).
3. Open the battery cover carefully.
4. Do not use metal tools near the battery terminals to avoid short circuits.
5. Avoid bending, puncturing, or damaging the battery during removal.

6. Remove the battery gently and carefully.

1.3.1.3. Warnings

To prevent damage, fire, or injury, always follow these precautions:

1. Use only the charger provided or recommended by the manufacturer.
2. Avoid cheap or third-party chargers that may not regulate voltage properly.
3. Do not leave devices plugged in overnight or for extended periods after a full charge.
4. Recharge before the battery is completely drained. Deep discharges reduce battery lifespan and performance.
5. Unplug immediately if the device becomes unusually hot during charging or use. Heat can indicate internal damage or malfunction.
6. Never use batteries that are swollen, leaking, or physically damaged. Damaged batteries pose a fire and explosion risk.
7. Keep devices and batteries dry. Water exposure can cause short circuits and corrosion.
8. Store batteries in a cool, dry place away from direct sunlight. Avoid hot cars or heat sources.
9. Never attempt to open or modify battery packs. Internal components are hazardous and can ignite if mishandled.
10. Dispose of batteries properly. Do not throw rechargeable batteries in the trash—use certified e-waste or battery recycling programs.

1.3.2. Charging Guidance

1. Do not charge from a computer USB port.
2. Always use a high-quality charger or power bank rated at 5 V at 1 A (minimum).

Warning: Avoid cheap or third-party chargers that may not regulate voltage properly.

The average time of the battery charging could be calculated by equation:

$$\text{Charging time (h)} = \text{Battery Capacity(mAh)} / (I_{\text{USB}} - I_{\text{CONS}}) \text{ (mA)}$$

where:

consumption current $I_{\text{CONS}} = I_{\text{OFF}}$, when the device is OFF, and could be neglected
consumption current $I_{\text{CONS}} = I_{\text{ON}}$, when the device is ON

1.3.3. Device ON/OFF/BOOT

1. **Device ON/OFF:** press and hold the ON/OFF button for more than 2s.
2. **Force device to BOOT mode:** when the device is OFF, press and hold the ON/OFF button for more than 5s
The board is powered, FPGA remains in the reset state (RST pin pulled low).

1.3.4. Gaming

Controls buttons overview:

1. D-pad (Directional Pad): Used to move characters or navigate in four directions: **Up, Down, Left, Right**.
2. **A Button:** Primary action button (e.g., **Jump, Select, Confirm**).
3. **B Button:** Secondary action button (e.g., **Cancel, Attack, Go Back**).
4. **Start Button:** Typically used to start the game or pause gameplay.

Dual-player Setup:

1. Connect the devices using an appropriate USB-C cable.
2. Select a game that supports dual-player mode.
3. Enjoy multiplayer gameplay.

2. Graphical User Interface

2.1 Overview

When the GameBuddy is powered on, a logo is displayed, and during startup, the device functions as a USB-to-SPI converter. If the device is connected to a PC, a USB icon appears on the screen, enabling data transfer via USB. If no computer connection is detected within 2 seconds, the device automatically enters the main menu.



Figure 4. GameBuddy Logo

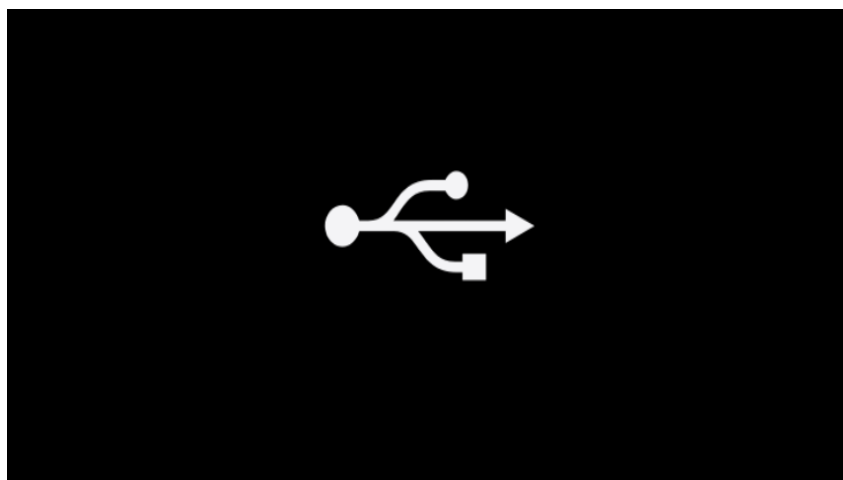


Figure 5. USB Mode

The ForgeFPGA GameBuddy main menu includes five options: Presentation, Ping-Pong vs ForgeFPGA, Ping-Pong vs Buddy, Connect PC and Snake.

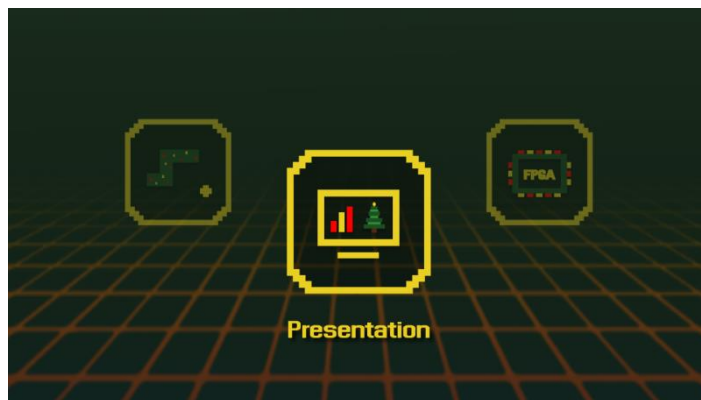


Figure 6. ForgeFPGA GameBuddy Menu Interface

Presentation mode starts a slideshow showcasing the features of the SLG47921V device along with other demo slides. To activate it, use the left/right buttons (D-pad) to select the **Presentation** icon and press the **Start** button. Slides can be changed manually using the **Up** and **Down** buttons, or they automatically advance every few seconds. Press the **B** button to return to the main menu.



Figure 7. Presentation Mode

Ping-Pong vs ForgeFPGA enables the user to play a classic ping-pong game against the ForgeFPGA. To begin, select the **Ping-Pong vs ForgeFPGA** icon and press the **Start** button. Then press the **A** button to launch the game. Use the **Up** and **Down** buttons to move the paddle. Press the **B** button to return to the main menu.

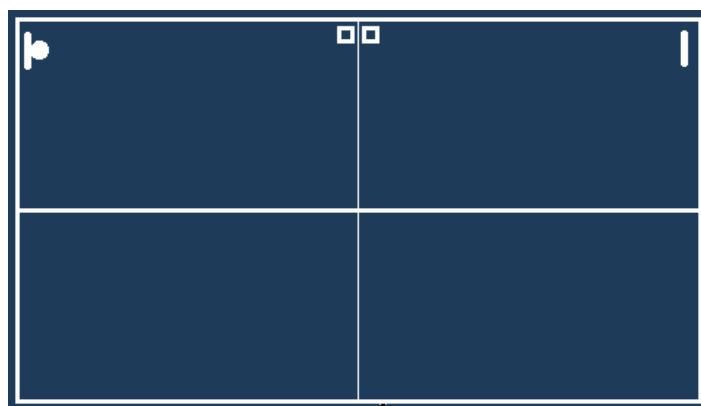


Figure 8. Ping-Pong Game

Ping-Pong vs Buddy enables two players to compete against each other. To begin, select the **Ping-Pong vs Buddy** icon, press the **Start** button, and connect two GameBuddy devices using a USB-C cable. Player A controls the left paddle and initiates the game by pressing the **A** button. Player B controls the right paddle.

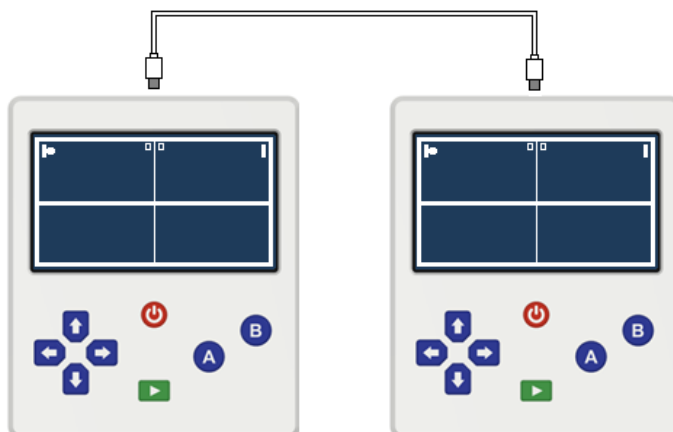


Figure 9. Ping-Pong Multiplayer

In Ping-pong, both game modes (singles and multiplayer) use a scoring system. The first player to reach 6 points wins.

The Snake game allows the player to earn points by collecting hearts. The current score appears in the upper-right screen during, and the last score is shown in the main menu. To start the game, the user should select the **Snake** icon in the main menu and press the **Start** button. The snake is controlled using the D-Pad. To exit the game, press the **B** button. Press the **A** button to restart the game.

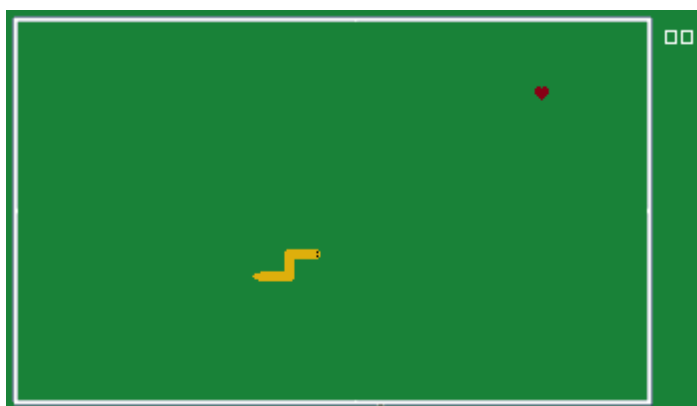


Figure 10. Snake Game

2.2 USB Mode

The user can also enable the USB mode option from the main menu and then press the **Start** button. If the device is connected to a computer, the **USB** icon turns green, indicating an active connection.

If no connection is detected within 2 seconds, the device automatically returns to the main menu.

3. Board Design

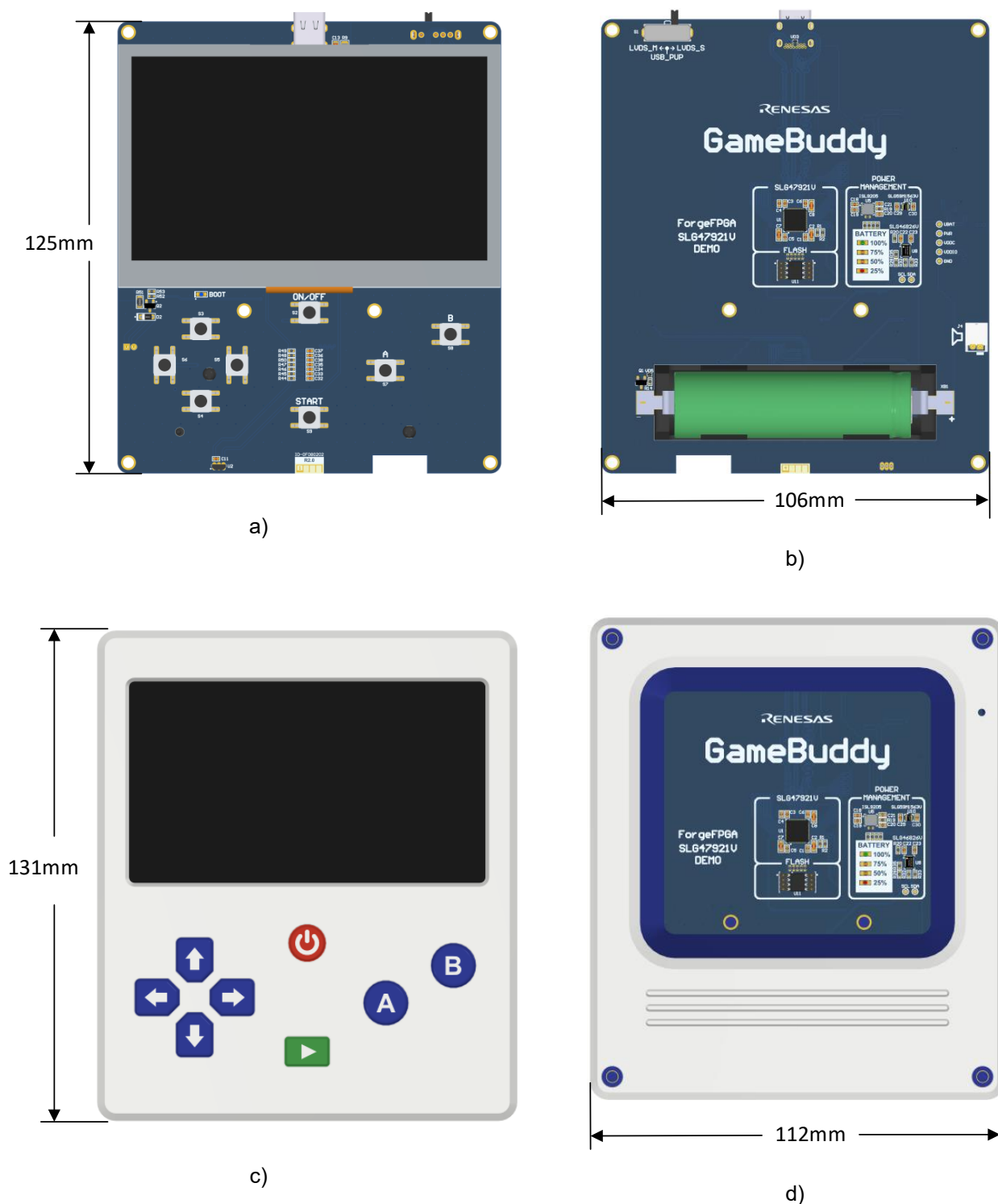
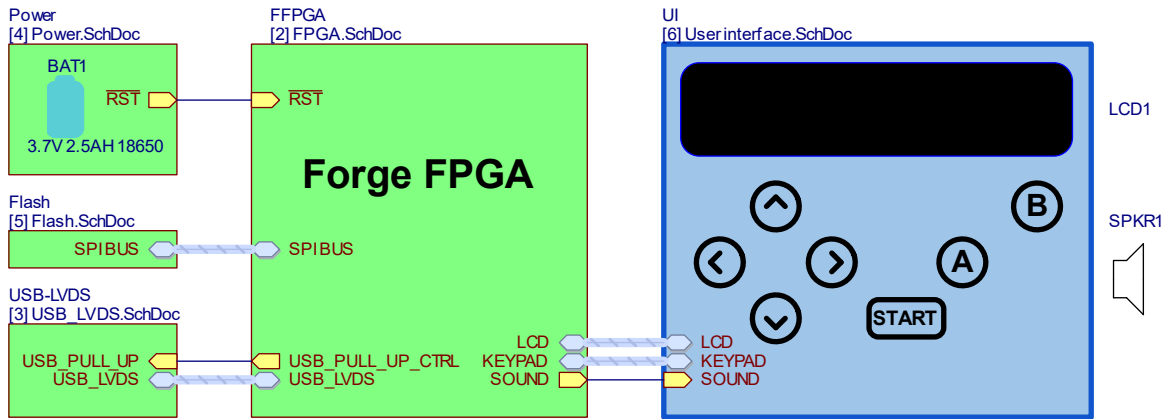


Figure 11. GameBuddy ForgeFPGA SLG47921 Demo Dimensions
a/b – board top/bottom, c/d – equipped with enclosure front/back

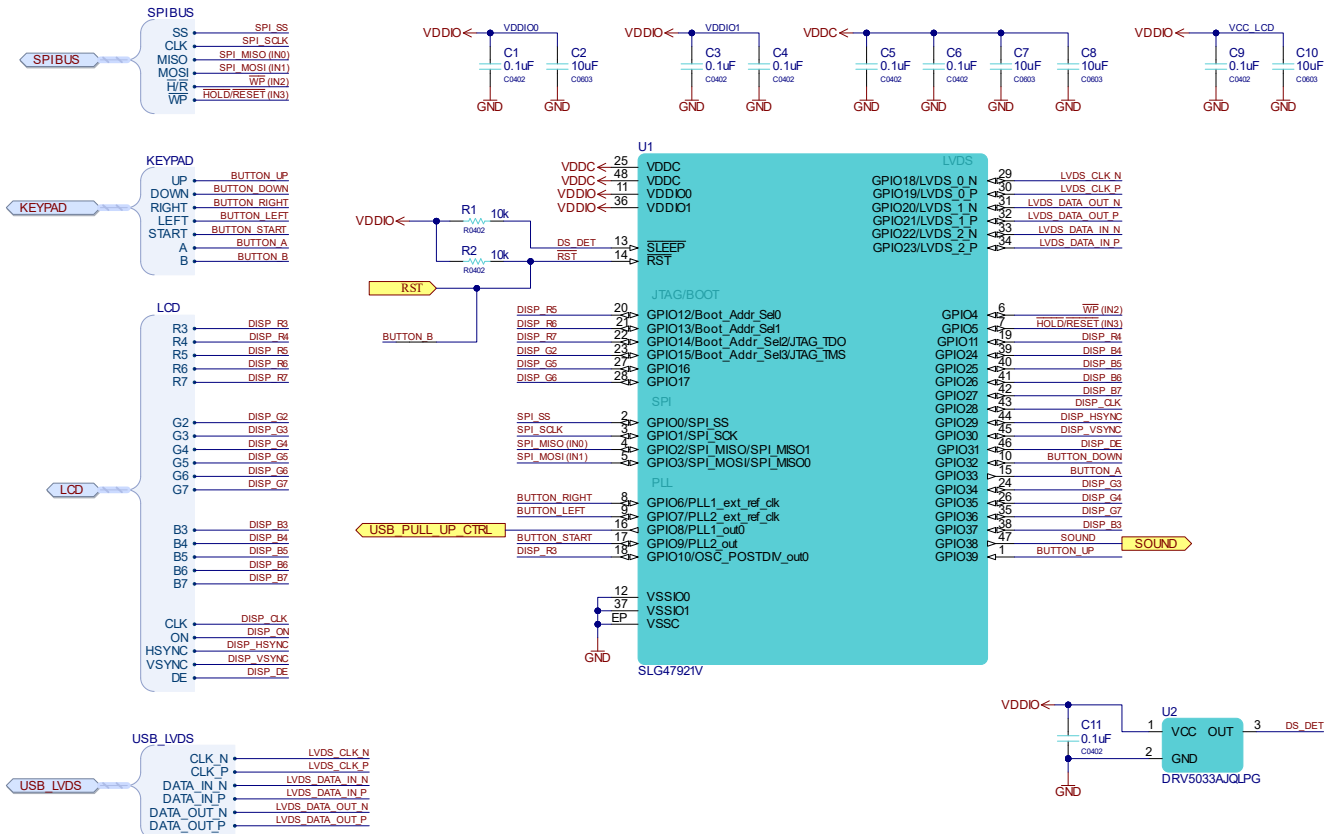
3.1 Schematic Diagrams

The schematic diagrams contain DNP components that could be mounted for debug purposes.

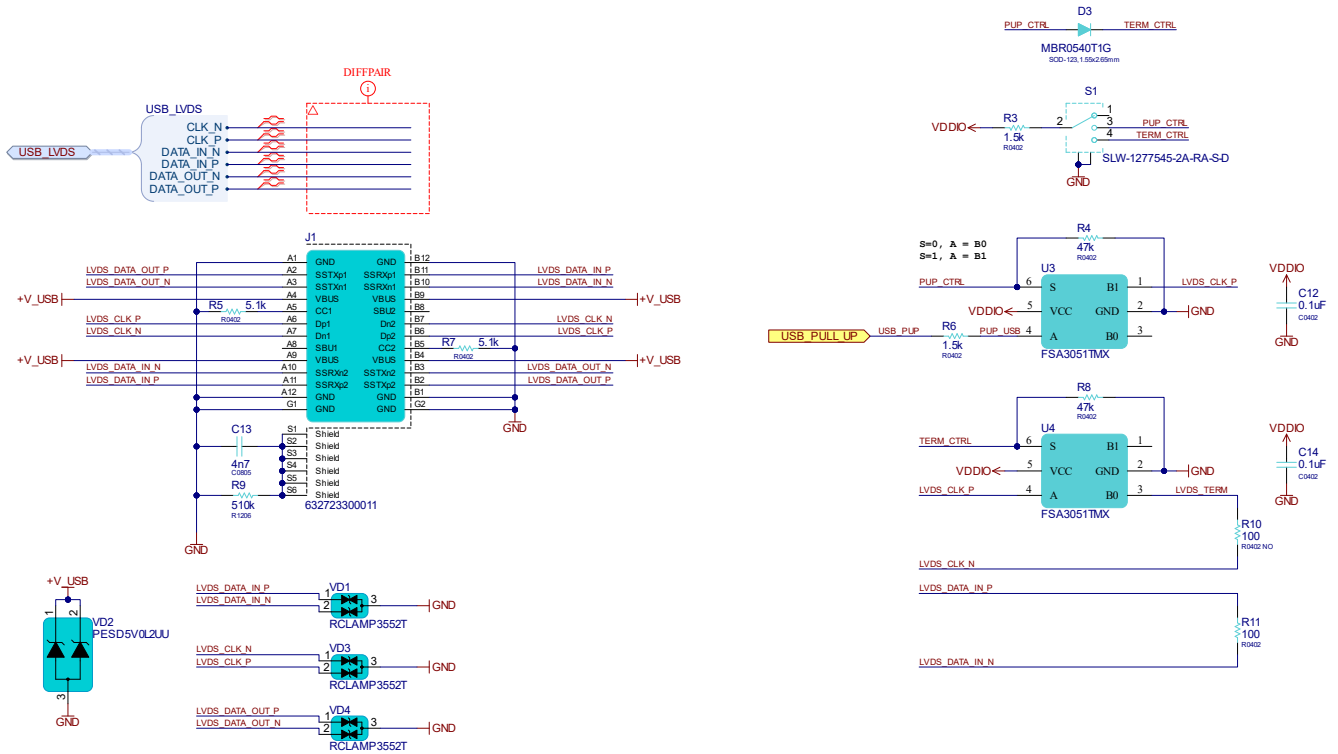
3.1.1. Main



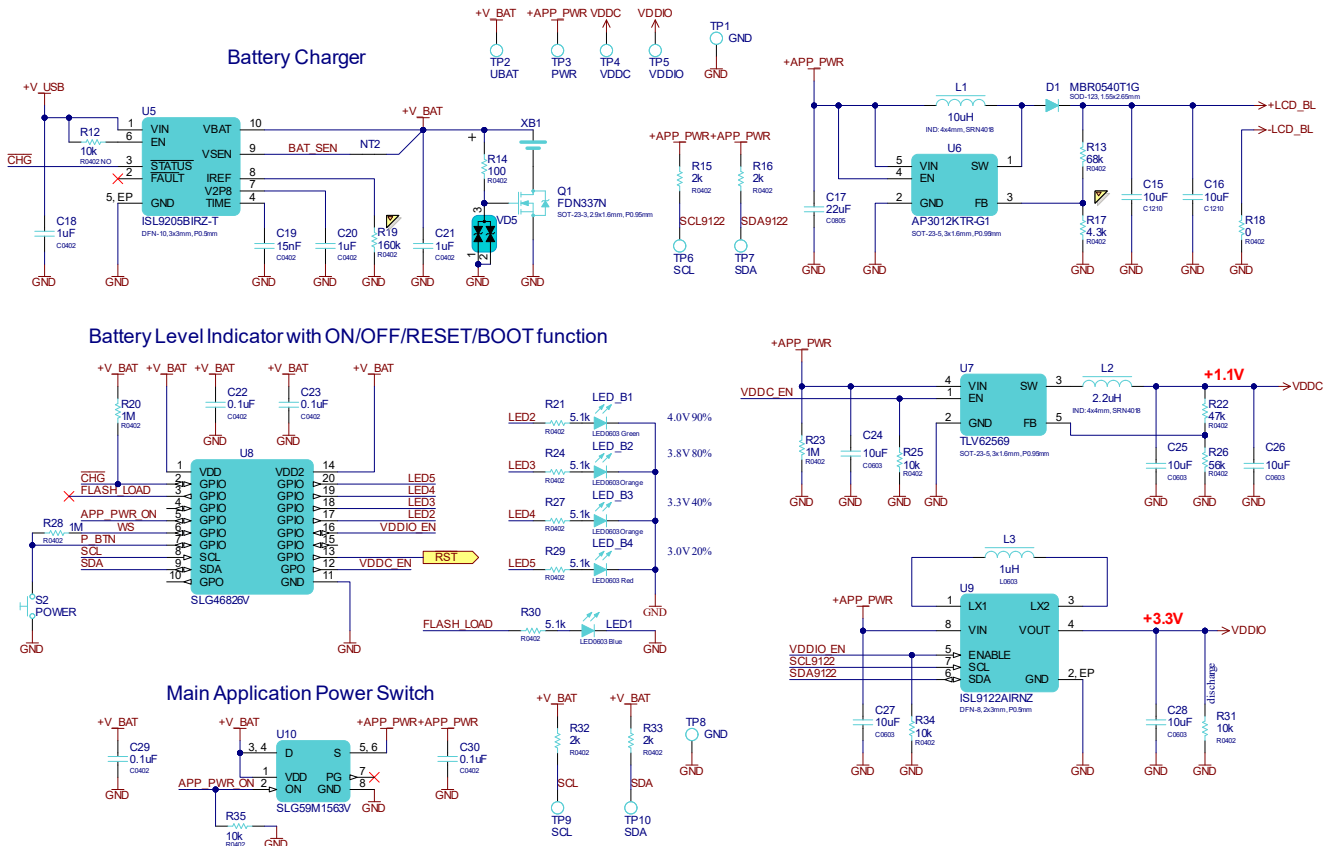
3.1.2. Forge FPGA SLG47921V



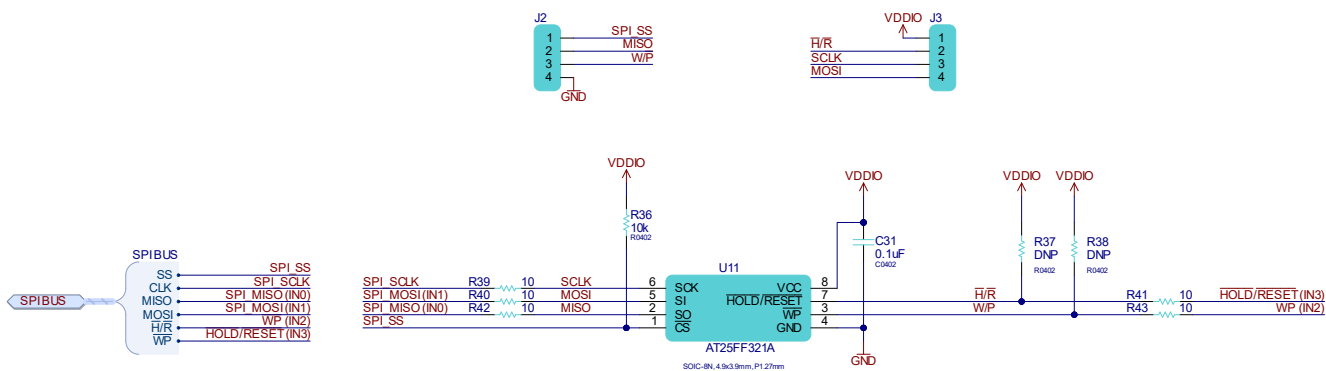
3.1.3. USB+LVDS



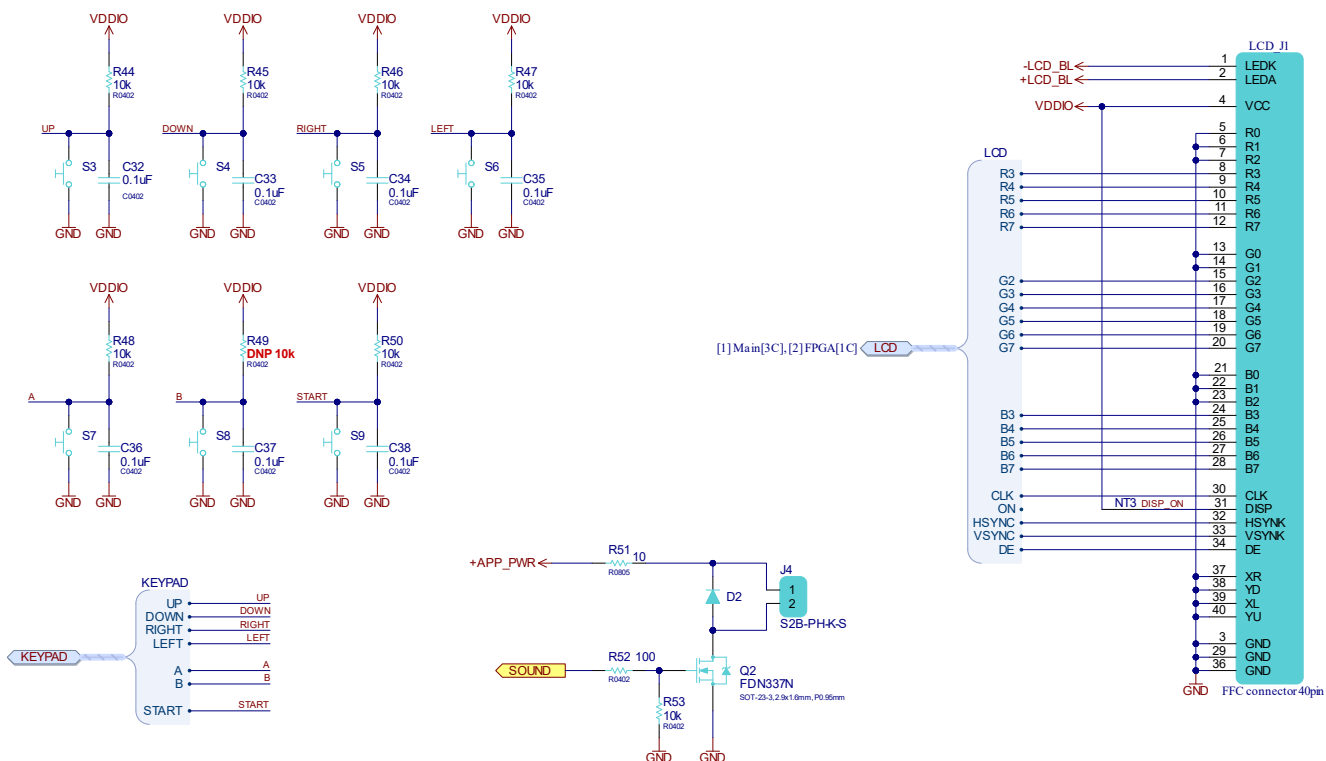
3.1.4. Power



3.1.5. FLASH



3.1.6. User Interface



3.2 Bill of Materials

#	Designator	Description	Part Number	Manufacturer	Qty.
1	BAT1	3.7V 2.5AH 18650	LIINR18650JD-25P 2.5AH	Jauch	1
2	C1, C3, C4, C5, C6, C9, C11, C12, C14, C22, C23, C29, C30, C31, C32, C33, C34, C35, C36, C37, C38	0.1uF 16V X7R 0402	GRM155R71C104KA88D	Murata	21
3	C2, C7, C8, C10, C24, C25, C26, C27, C28	10uF 10V X7R 0603	GRM188Z71A106KA73D	Murata	9
4	C13	4n7 1kV X7R 0805	C0805V472KDRACAUTO	KEMET	1
5	C15, C16	10uF 50V X7R 1210	CL32B106KBJNNNE	Samsung Electro-Mechanics	2
6	C17	22uF 10V X7R 0805	GRM21BZ71A226ME15L	Murata	1
7	C18, C20, C21	1uF 10V X6S 0402	GRM155C81A105KA12D	Murata	3
8	C19	15nF 25V X7R 0402	GRM155R71E153KA61D	Murata	1
9	D1, D2, D3	Diode	MBR0540T1G	onsemi	3
10	J1	632723300011	632723300011	Wurth Elektronik	1
11	J2, J3	Header 4	DNP ¹ M50-3530442	Harwin	2
12	J4	Conn_2_pin	S2B-PH-K-S	JST	1
13	L1	10uH 1.3A	SRN4018-100M	Bourns	1
14	L2	2.2uH 2.9A	SRN4018-2R2M	Bourns	1
15	L3	1uH	DFE18SAN1R0MG0L	Murata	1
16	LCD1	LCD	JST-4300QWA-V01	Shenzhen Sipeed Technology Co., Ltd	1
17	LCD_J1	FFC connector 40-pin	F32R-1A7H1-11040	Amphenol Communications Solutions	1
18	LED1	LED Blue 0603	150060BS75000	Wurth Elektronik	1
19	LED_B1	LED Green 0603	150060VS75000	Wurth Elektronik	1
20	LED_B2, LED_B3	LED Yellow 0603	150060YS75000	Wurth Elektronik	2
21	LED_B4	LED RED 0603	150060SS75000	Wurth Elektronik	1
22	Q1, Q2	MOSFET-N	FDN337N	onsemi	2
23	R1, R2, R12, R25, R31, R34, R35, R36, R44, R45, R46, R47, R48, R50, R53	10k 1% 0402	RC1005F103CS	Samsung Electro-Mechanics	15
24	R3, R6	1.5k 1% 0402	RC0402FR-071K5L	Yageo Group	2
25	R4, R8, R22	47k 1% 0402	RC0402FR-0747KL	YAGEO	3
26	R5, R7, R21, R24, R27, R29, R30	5.1k 1% 0402	RC0402FR-075K1L	Yageo	7
27	R9	510k 1% 1206	RC1206FR-07560KL	Yageo Group	1
28	R10, R11, R14, R52	100 1% 0402	RC0402FR-07100RL	YAGEO	4
29	R13	68k 1% 0402	RC0402FR-0768KL	Yageo Group	1
30	R15, R16, R32, R33	2k 1% 0402	RC0402FR-072KL	Yageo Group	4
31	R17	4.3k 1% 0402	RC0402FR-074K3L	YAGEO	1
32	R18	0 0402	RC0402FR-070RL	Yageo Group	1
33	R19	160k 1% 0402	RC0402FR-07160KL	Yageo Group	1
34	R20, R23, R28	1M 1% 0402	RC0402FR-7W1ML	Yageo Group	3
35	R26	56k 1% 0402	RC0402FR-1356KL	Yageo Group	1
36	R37, R38	DNP ¹ 10k 1% 0402	RC1005F103CS	Samsung Electro-Mechanics	2

#	Designator	Description	Part Number	Manufacturer	Qty.
37	R39, R40, R41, R42, R43	10 1% 0402	RC0402FR-1310RL	Yageo Group	5
38	R49	DNP ¹ 10k 1% 0402	RC1005F103CS	Samsung Electro-Mechanics	1
39	R51	10 1% 0805	RC0805FR-1010RL	Yageo Group	1
40	S1	Sw Toggle SP3T	SLW-1277545-2A-RA-S-D	Same Sky	1
41	S2, S3, S4, S5, S6, S7, S8, S9	Sw Tactile NO 6x6mm	PTS645SL43SMTR92LFS	C&K Components	8
42	SPKR1	SPEAKER 8OHM 0.5W 90DB	CS13-00W130-07-1	Challenge Electronics	1
43	U1	SLG47921V	SLG47921V	Renesas Electronics America Inc	1
44	U2	Hall sensor	DRV5033AJQLPG	Texas Instruments	1
45	U3, U4	FSA3051TMX	FSA3051TMX	onsemi	2
46	U5	ISL9205BIRZ-T	ISL9205BIRZ-T	Renesas	1
47	U6	AP3012KTR-G1	AP3012KTR-G1	Diodes Inc.	1
48	U7	TLV62569	TLV62569DBVR	Texas Instruments	1
49	U8	SLG46826V	SLG46826V	Renesas	1
50	U9	ISL9122AIRNZ	ISL9122AIRNZ-T	Renesas	1
51	U10	SLG59M1563V	SLG59M1563V	Renesas	1
52	U11	IC FLASH 32MBIT SPI/QUAD 8SOIC	AT25FF321A-SSHN-T	Renesas	1
53	VD1, VD3, VD4, VD5	RCLAMP3552T	RCLAMP3552T.TNT	Semtech	4
54	VD2	PESD5V0L2UU	PESD5V0L2UU,115	Nexperia	1
55	XB1	BATTERY HOLDER 18650 SMD	1042	Keystone	1

[1] Do not populate. Not mounted components.

4. Revision History

Revision	Date	Description
1.00	Jan 6, 2026	Initial release.