User Guide

Lyra 24S Development Board

Version 1.0

REVISION HISTORY

Version	Date	Notes	Contributors	Approver
1.0	1 Aug 2023	First Release	Raj Khatri Dave Drogowski	Jonathan Kaye

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1 Overview

The Lyra 24S Development Kit is an ultra-low cost, small form factor development and evaluation platform for the Lyra 24S Wireless Bluetooth® Module.

The Lyra 24S Development Kit is focused on rapid prototyping and concept creation of IoT applications. It is designed around the Lyra 24S Module, based on the EFR32BG22 System-on-Chip, which is an ideal device family for developing energy-friendly connected IoT applications.

The kit features a USB interface, an on-board SEGGER J-Link debugger, one user-LED and button, and support for hardware add-on boards via a mikroBus socket and a Qwiic connector. The hardware add-on support allows developers to create and prototype applications using a virtually endless combination of off-the-shelf boards from mikroE, sparkfun, AdaFruit, and Seeed Studios.

Module	▪ Lyra 24S Wireless Bluetooth® Module ▪ High performance 2.4 GHz radio ▪ 32-bit ARM® Cortex®-M33 with 76.8 MHz maximum operating frequency ▪ 512 kB flash and 32 kB RAM
Features	▪ User LED and push button ▪ 20-pin 2.54 mm breakout pads ▪ mikroBUS™ socket ▪ Qwiic® connector ▪ SEGGER J-Link on-board debugger ▪ Virtual COM port ▪ Packet Trace Interface (PTI) ▪ USB-powered.
Software	▪ **AT Command Set** - Fully featured and extensible, proven over 5+ years. Simplest implementation with all key Wireless Xpress features, proven over 5 years ▪ **C Code** - Full software development with Silicon Labs SDK and toolchain. Use Simplicity Studio IDE for full functionality of Silicon Labs HW/SW

2 Laird Connectivity Lyra 24S Part Numbers

Part Number	Description
453-00170-K1	Development Kit, SIP, LYRA 24S, Integrated Antenna

Applicable to the following Lyra 24S part numbers:

Part Number	Product Description
453-00170C	Module, SIP, LYRA 24S, Integrated Antenna (Silicon Labs EFR32BG24) – Cut/Tape
453-00170R	Module, SIP, LYRA 24S, Integrated Antenna (Silicon Labs EFR32BG24) – Tape/Ree

3 Kit Contents

All kits contain the following items:

Development Board	Contains soldered Lyra 24S module and exposes all available hardware interfaces.
Power Options	USB cable (x1) – Type A to micro type B. Also provides serial via onboard USB – UART chip
External antenna	2.4GHz FlexPIFA Antenna (Part#001-0022), (x1)

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4 Main Board – Features

The Lyra 24S Development Kit has been designed to simplify IoT development with the Lyra 24S wireless module. The kit includes a mikroBUS™ socket and Qwiic® connector, allowing users to add features to the kit with a large selection of off-the-shelf boards.

Programming the Lyra 24S Development Kit is easily done using a USB Micro-B cable and the on-board J-Link debugger. A USB virtual COM port provides a serial connection to the target application, and the Packet Trace Interface (PTI) offers invaluable debug information about transmitted and received packets in wireless links. The Lyra 24S Development Kit is supported in Silicon Labs' Simplicity Studio™ and a Board Support Package (BSP) is provided to give application developers a flying start.

Connecting external hardware to the Lyra 24S Development Kit can be done using the 20 breakout pads which present peripherals from the Lyra 24S such as I2C, SPI, UART and GPIOs. The mikroBUS socket allows inserting mikroBUS add-on boards which interface with the Lyra 24S through SPI, UART or I2C. The Qwiic connector can be used to connect hardware from the Qwiic Connect System through I2C.

4.1 Key Features

The following key hardware elements are included on the Lyra 24S Development Kit:

- Lyra 24S Wireless Module with 76.8 MHz operating frequency, 2.4 GHz ceramic antenna for wireless transmission, 1.5MB flash, and 256 kB RAM
- One LED and one push button
- On-board SEGGER J-Link debugger for easy programming and debugging, which includes a USB virtual COM port and Packet Trace Interface (PTI)
- MikroBUS™ socket for connecting click boards™ and other mikroBUS add-on boards
- Qwiic® connector for connecting Qwiic Connect System hardware
- Breakout pads for GPIO access and connection to external hardware
- Reset button

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5 UNDERSTANDING THE DEVELOPMENT BOARD

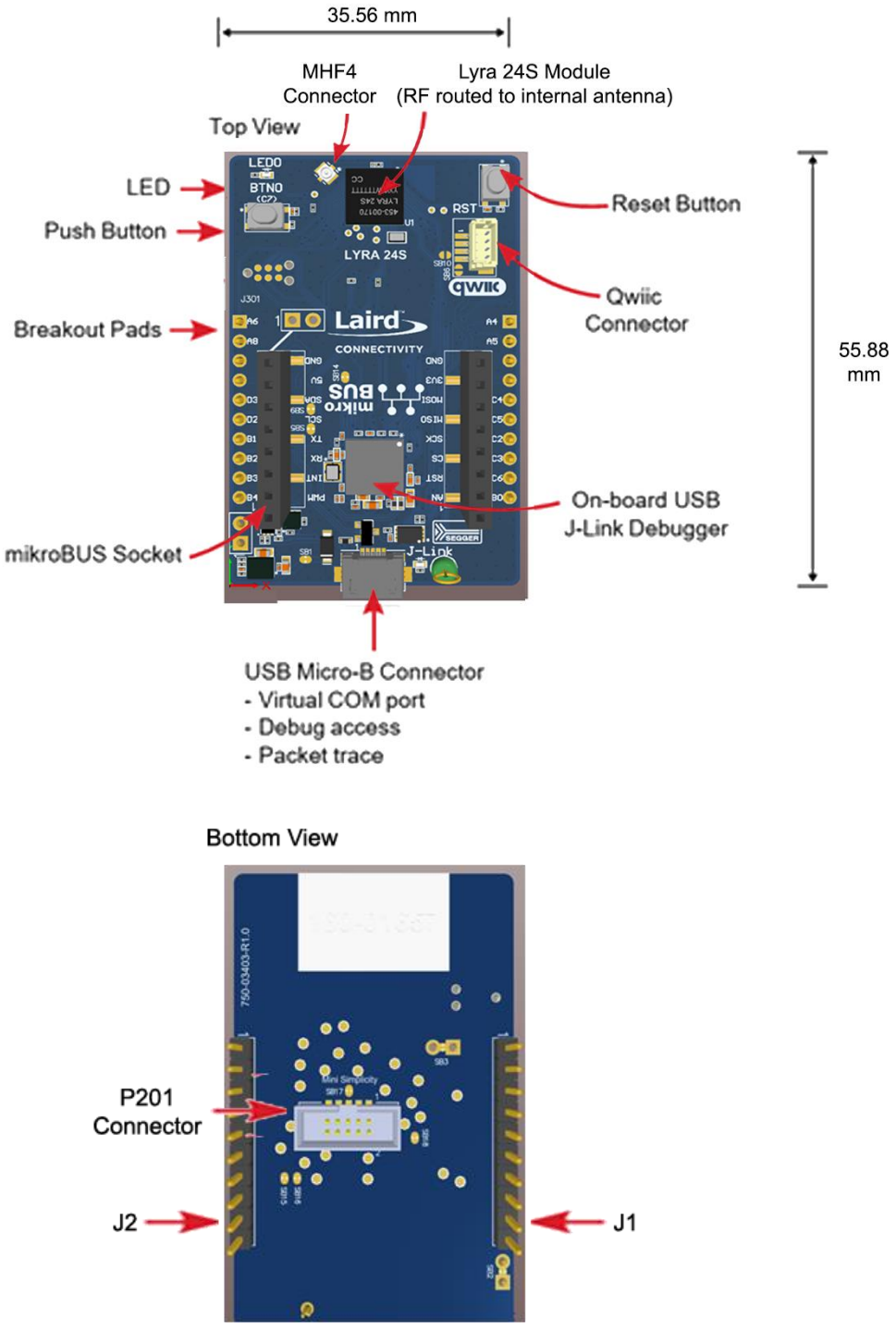

Figure 1: Lyra 24S development board layout

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6 SPECIFICATIONS

6.1 Recommended Operating Conditions

Table 1: Recommended operating conditions

Parameter	Symbol	Min	Typ	Max	Unit
USB Supply Input Voltage	V_{USB}	-	+5.0	-	V
Supply Input Voltage (VMCU supplied externally)	V_{VMCU}		+3.3[1]		V
Operating Temperature	T_{OP}	-	+20	-	˚C

[1] The typical supply voltage to the Lyra 24S is 3.0 V, but the maximum voltage is a function of temperature and average lifetime current load. Over a 10-year lifespan, the average lifetime current load should not exceed 60 mA when the supply voltage is 3.3 V. See the Lyra 24S datasheet for more information.

6.2 Current Consumption

The operating current of the board greatly depends on the application and the amount of external hardware connected. See Table 2 for typical current consumptions for the Lyra 24S and the on-board debugger. Note that the numbers are taken from the data sheets for the devices. For a full overview, see the Lyra 24S datasheet.

Table 2: Current consumption

Parameter	Symbol	Condition	Typ	Unit
Lyra 24S Current Consumption1	I_{BGM}	MCU current consumption in EM0 mode with all peripherals disabled (module supply voltage = 3.0 V, VSCALE2, 38.4 MHz crystal, CPU running Prime from flash at 25 ˚C)	33.9	µA/MHz
		Radio system current consumption in receive mode, active packet reception (VDD = 3.0 V, MCU in EM1 and all MCU peripherals disabled, HCLK = 38.4 MHz, 1Mbit/s, 2GFSK, f = 2.4 GHz at 25 ˚C)	5.1	mA
		Radio system current consumption in transmit mode (VDD = 3.0 V, MCU in EM1 and all MCU peripherals disabled, HCLK = 38.4 MHz		
		f = 2.4 GHz, CW, 10 dBm output power (at 25 ˚C)	23.4	mA
On-board Debugger Sleep Current Consumption[2]	I_{DBG}	On-board debugger current consumption when USB cableis not inserted (EFM32GG12 EM4S mode current consumption)	80	nA

1 From Lyra 24S data sheet

2 From EFM32GG12 data sheet

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7 FUNCTIONAL BLOCKS

The core of the Lyra 24S Development Kit is the Lyra 24S Bluetooth® Module. Refer to Understanding the Development Board for placement and layout of the hardware components.

7.1 Hardware Block Diagram

An overview of the Lyra 24S Development Kit is illustrated in the figure below.

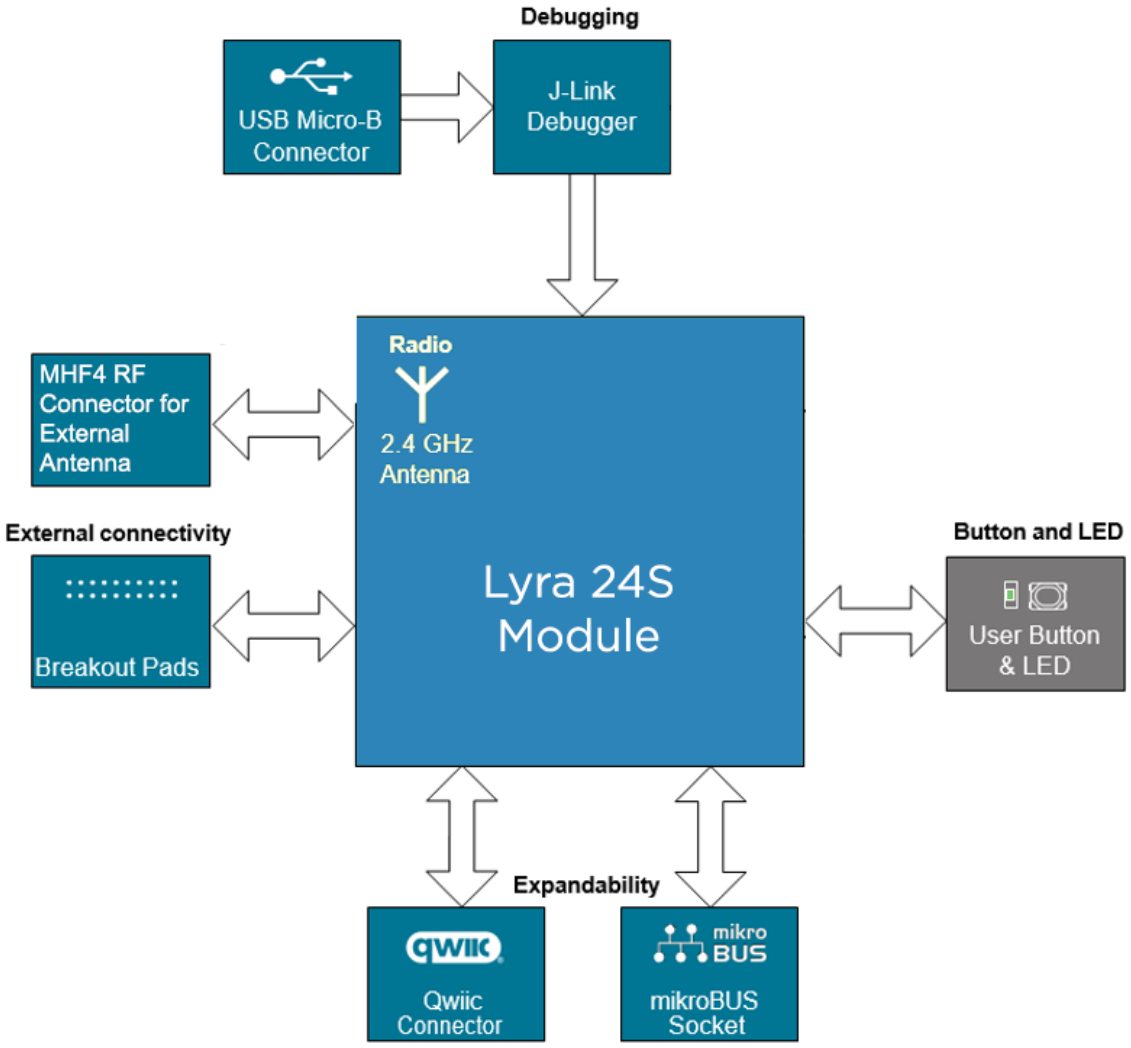

Figure 2: Lyra 24S DVK block diagram

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7.2 Power Supply

The kit is powered by the debug USB cable as illustrated in the figure below.

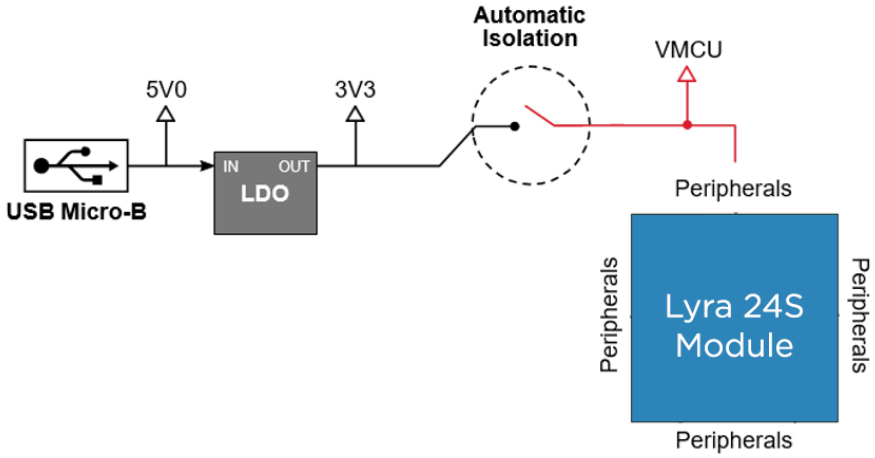

Figure 3: Lyra 24S DVK power diagram

The 5 volt power net on the USB bus is regulated down to 3.3 V using an LDO (low-dropout regulator). An automatic isolation circuit isolates the LDO when the USB cable is not plugged in.

Power can be injected externally on the VMCU net if the USB cable is removed, and no other power sources are present on the kit. Failure to follow this guideline can cause power conflicts and damage the LDO.

7.3 Lyra 24S Reset

The Lyra 24S can be reset by a few different sources:

- A user pressing the RESET button.
- The on-board debugger pulling the #RESET pin low.

7.4 Push Button and LED

The kit has one user push button marked BTN0 and one LED marked LED0 that are each connected to a GPIO on the Lyra 24S. The button is connected to pin PC07 and it is debounced by an RC filter with a time constant of 1 ms. The logic state of the button is high while the button is not being pressed, and low when the button is pressed. The LED is configurable in firmware for user's application. See BOOT pin (PC07) and BUTTON 0 (silkscreen BTN0) usage information.

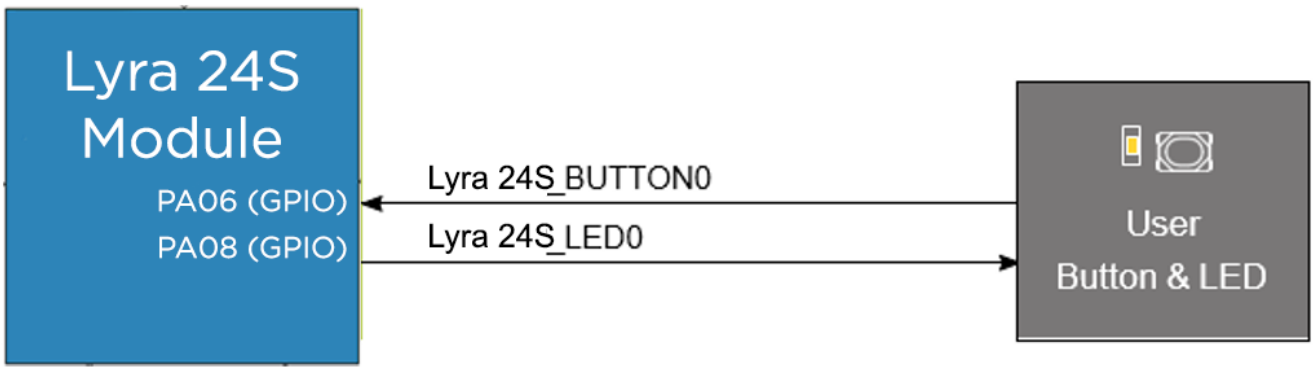

Figure 4: Lyra 24S DVK Button and LED

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7.4.1 BOOT pin (PC07) and BUTTON 0 (silkscreen BTN0)

For the Lyra 24S module the BOOT pin is on PC07 (pin29). On the Lyra dev board BTN0 (Button0) is by default mapped to the BOOT pin for easier utilisation.

The BOOT pin (PC07) is used to determine when execution of the bootloader is required. Upon reset, execution of the bootloader begins. The state of the BOOT pin is read immediately upon start-up of the bootloader. If LOW (BTN0 pressed), execution of the bootloader continues, facilitating firmware update via the UART. If the BOOT pin is HIGH (BTN0 not pressed), the bootloader will stop execution and pass control to the main application firmware.

Please refer to respective DVK schematics and Serial DFU section of User Guide - Firmware Options and Upgrading - Lyra Series for more information at: www.lairdconnect.com/lyra24-series

7.5 On-board Debugger

The Lyra 24S Development Kit contains a microcontroller separate from the Lyra 24S that provides the user with an on- board J-Link debugger through the USB Micro-B port. This microcontroller is referred to as the "on-board debugger" and is not programmable by the user. When the USB cable is removed, the on-board debugger goes into a very low power shutoff mode (EM4S), consuming around 80 nA typically (EFM32GG12 data sheet number).

In addition to providing code download and debug features, the on-board debugger also presents a virtual COM port for general purpose application serial data transfer. The Packet Trace Interface (PTI) is also supported which offers invaluable debug information about transmitted and received packets in wireless links.

The figure below shows the connections between the target Lyra 24S device and the on-board debugger. See Debugging section.

Debugging for more details on debugging.

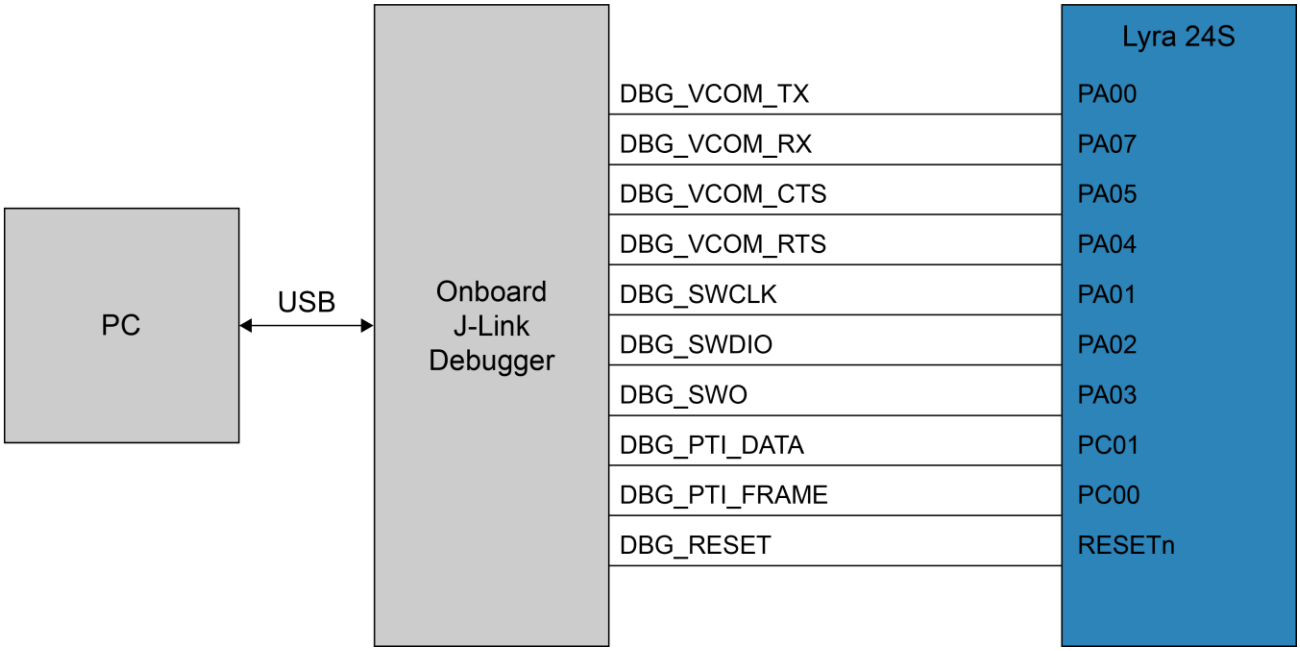

Figure 5: Lyra 24S DVK Debugger Connections

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7.6 Hardware Connectors

The Lyra 24S Development Kit features a USB Micro-B connector, 20 breakout pads, a mikroBUS connector for connecting mikroBUS add-on boards, and a Qwiic connector for connecting Qwiic Connect System hardware. The connectors are placed on the top side of the board, and their placement and pinout are shown in the figure below. For additional information on the connectors, see the following sub chapters.

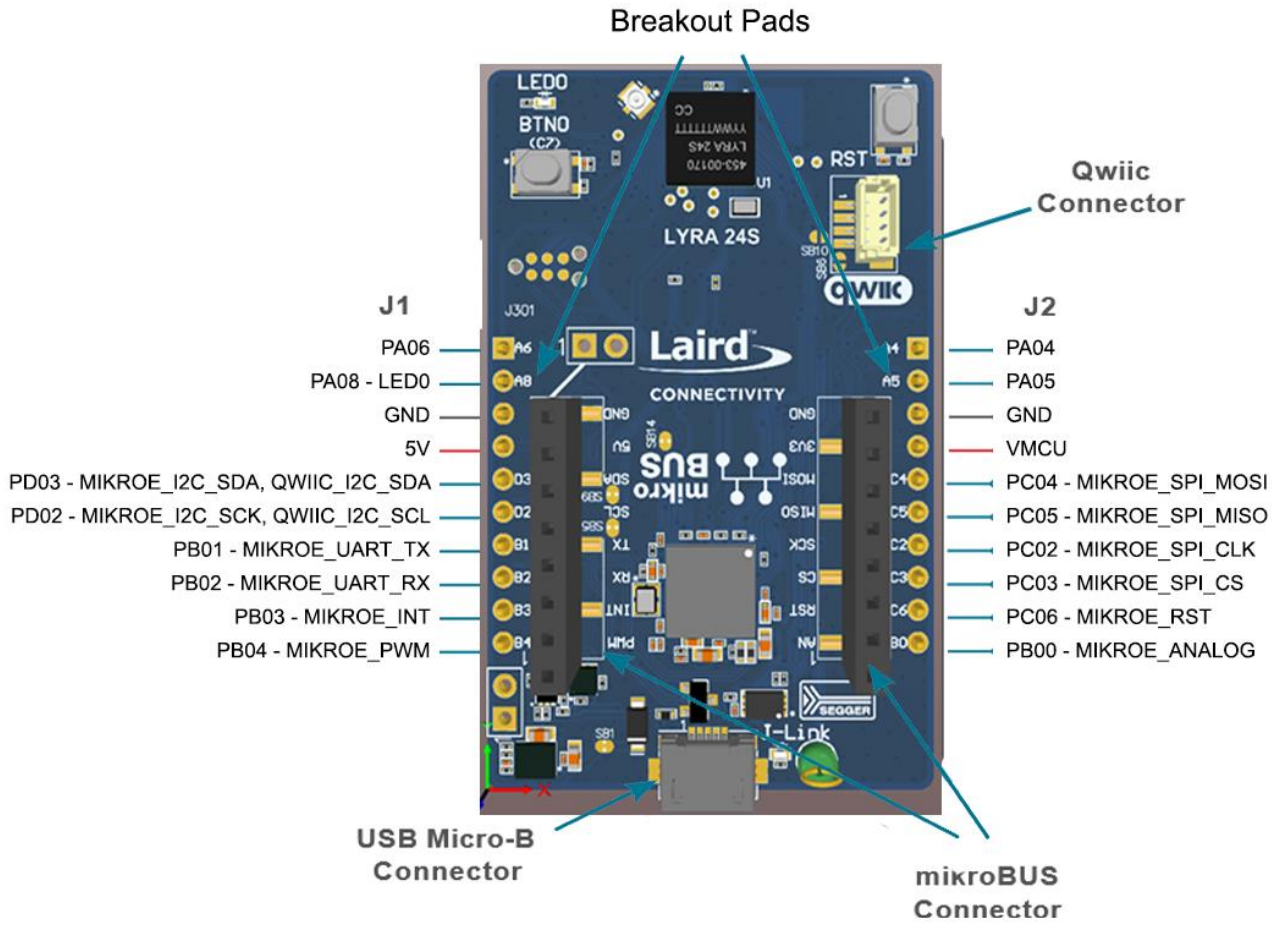

Figure 6: Lyra 24S DVK hardware connectors

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7.6.1 Breakout Pads Pinout

Twenty breakout pads are provided and allow connection of external peripherals. There are 10 pads on the left side of the board, and 10 pads on the right. The breakout pads contain a number of I/O pins that can be used with most of the Lyra 24S features. Additionally, the VMCU (main board power rail), 3V3 (LDO regulator output), and 5V power rails are also exposed on thepads.

The pin-routing on the Lyra 24S is very flexible, so most peripherals can be routed to any pin. However, pins may be shared between the breakout pads and other functions on the Lyra 24S Development Kit. The table below includes an overview of the breakout pads and functionality that is shared with the kit.

Table 3: Lyra 24S DVK Breakout Pads Pinout

Pin	Connection	Shared Feature
		(Top View) Left Side Breakout Pins (J1)
1	PA06	BREAKOUT_LEFT1
2	PA08	LED
3	GND	Ground
4	5V	Board USB voltage
5	PD03	MikroBUS I2C_SDA, Qwiic I2C_SDA
6	PD02	MikroBUS I2C_SCL, Qwiic I2C_SCL
7	PB01	MikroBUS UART_TX
8	PB02	MikroBUS UART_RX
9	PB03	MikroBUS INT
10	PB04	MikroBUS PWM
		(Top View) Right Side Breakout Pins (J2)
1	PA04	DBG_VCOM_RTS via closed solderbridge SB16. BREAKOUT_RIGHT1.
2	PA05	DBG_VCOM_CTS via closed solderbridge SB15. BREAKOUT_RIGHT2.
3	GND	Ground
4	VMCU1	Lyra 24S voltage domain
5	PC04	MikroBUS SPI_MOSI
6	PC05	MikroBUS SPI_MISO
7	PC02	MikroBUS SPI_SCK
8	PC03	MikroBUS SPI_CS
9	PC06	MikroBUS RST
10	PB00	MikroBUS Analog

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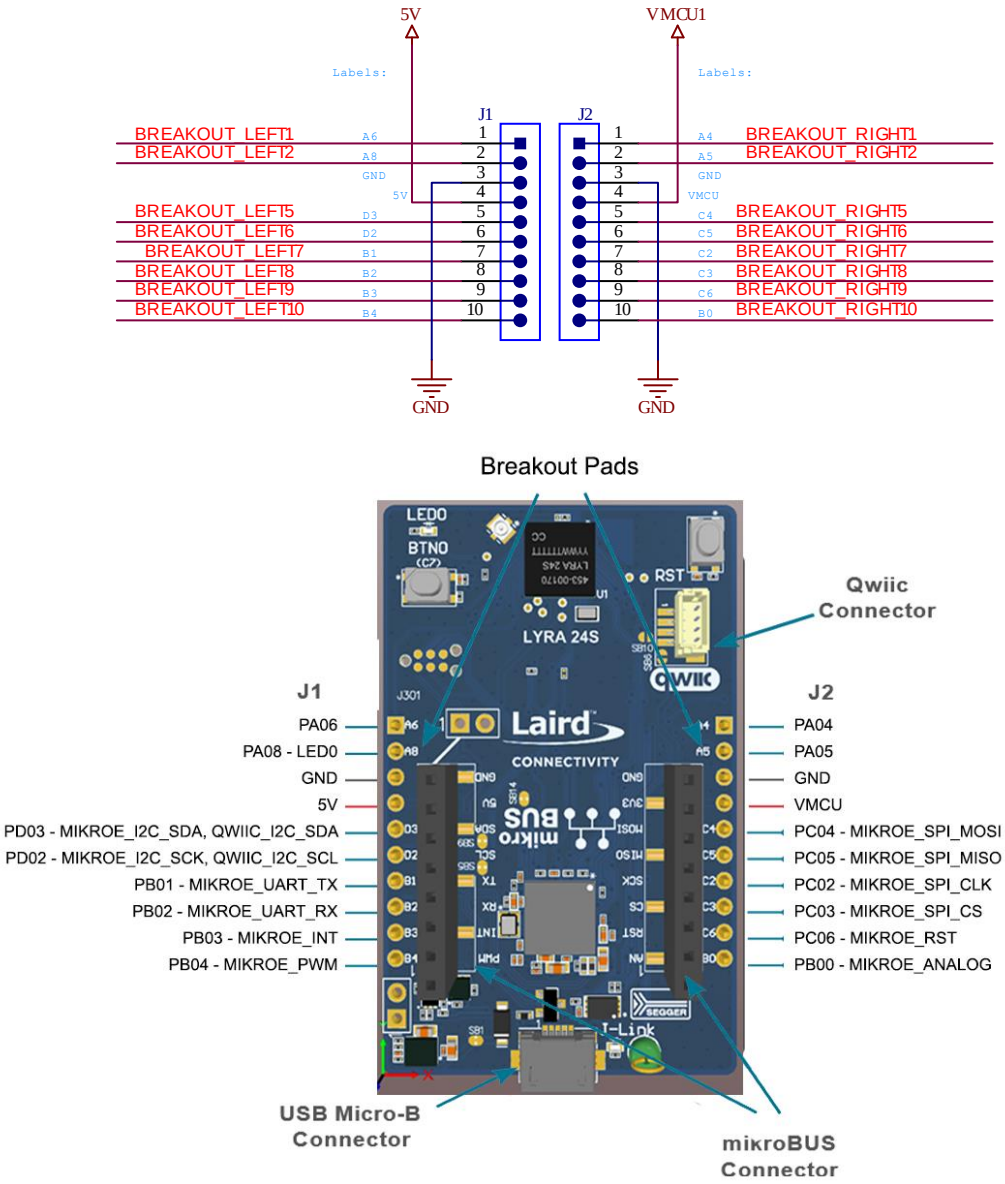

Figure 7: Lyra 24S devevelopment board Breakout Pads (J1 and J2)

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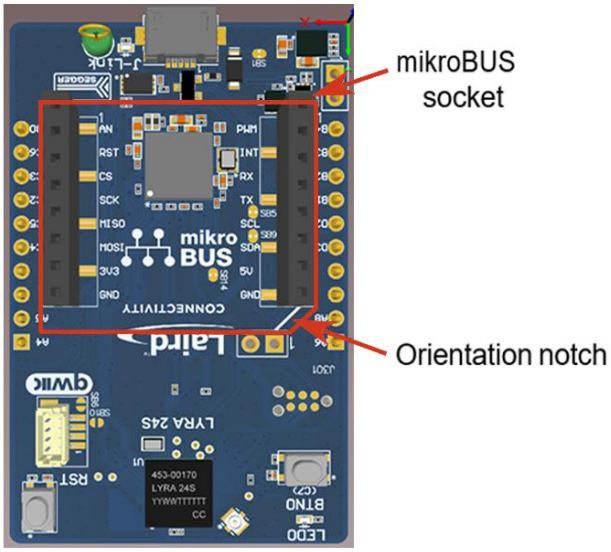
7.6.2 MikroBUS Socket



The Lyra 24S Development Kit features a mikroBUS™ socket compatible with mikroBUS add-on boards. MikroBUS add-on boards can expand the functionality of the kit with peripherals such as sensors and LCDs. Add-on boards follow the mikroBUS socket pin mapping and communicates with the on-kit Lyra 24S through UART, SPI or I^2C. Several GPIOs are exposed on the mikroBUS socket. MikroBUS add-on boards can be powered by the 5V or VMCU power rails, which are available on the mikroBUS socket.

The pinout of the Lyra 24S on the kit is made such that all required peripherals are available on the mikroBUS socket. The I^2C signals are, however, shared with the Qwiic connector, and all mikroBUS signals are also routed to adjacent breakout pads.

When inserting a mikroBUS add-on board, refer to the orientation notch on the Lyra 24S Development Kit, shown in the figure below, to ensure correct orientation. Add-on boards have a similar notch that needs to be lined up with the one shown below.

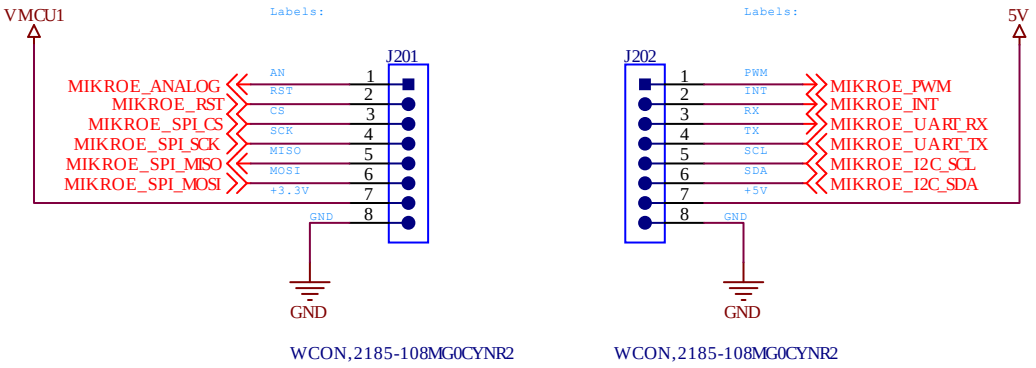


Figure 8: mikroBUS add-on board orientation

The table below gives an overview of the mikroBUS socket pin connections to the Lyra 24S.

Table 4: Pin connections from mikroBUS socket to Lyra 24S

Pin Name	Pin Function	Connection	Shared Feature	Suggested Mapping
AN	Analog	PB00	BREAKOUT_RIGHT10	IADC0
RST	Reset	PC06	BREAKOUT_RIGHT9	
CS	SPI Chip Select	PC03	BREAKOUT_RIGHT8	USARTx.CS
SCK	SPI Clock	PC02	BREAKOUT_RIGHT7	USARTx.CLK
MISO	SPI Master Input Slave Output	PC05	BREAKOUT_RIGHT6	USARTx.RX
MOSI	SPI Master Output Slave Input	PC04	BREAKOUT_RIGHT5	USARTx.TX
PWM	PWM output	PB04	BREAKOUT_LEFT10	TIMER0.CCx
INT	Hardware Interrupt	PB03	BREAKOUT_LEFT9	
RX	UART Receive	PB02	BREAKOUT_LEFT8	USARTx.RX

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Pin Name	Pin Function	Connection	Shared Feature	Suggested Mapping
TX	UART Transmit	PB01	BREAKOUT_LEFT7	USARTx.TX
SCL	I2C Clock	PD02 (via closed solderbridge SB5)	QWIIC_I2C_SCL (via open solder bridge SB6), BREAKOUT_LEFT6	I2Cx.SCL
SDA	I2C Data	PD03(via closed solderbridge SB9)	QWIIC_I2C_SDA (via open solder bridge SB10), BREAKOUT_LEFT5	I2Cx.SDA
3V3	VCC 3.3V power	VMCU1	Lyra 24S voltage domain	3V3
5V	VCC 5V power	5V	Board USB voltage	5V
GND	Reference Ground	GND	Ground	GND

The below Figure 9 shows Lyra 24S GPIO's PD02 and PD03 are shared with multiple signals, with default the MIKROE_I2C_SCL wired to Lyra 24S PD02 (via closed solder bridge SB5) and MIKROE_I2C_SDA wired to Lyra 24S PD03 (via closed solder bridge SB9).

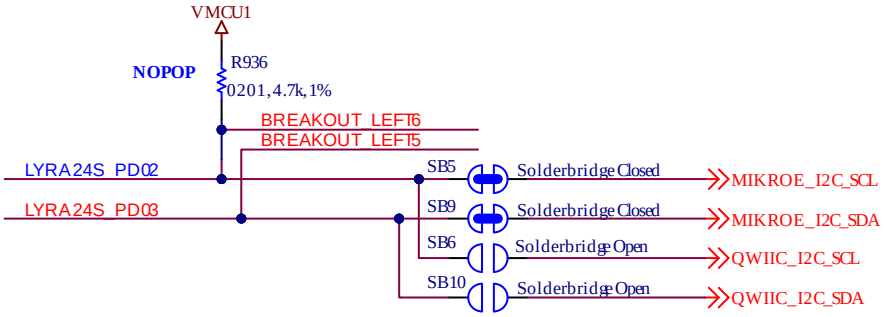

Figure 9: PD02 and PD03 Schematic

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7.6.3 Qwiic Connector

The Lyra 24S Development Kit features a Qwiic® connector compatible with Qwiic Connect System hardware. The Qwiic connector providesan easy way to expand the functionality of the Lyra 24S Development Kit with sensors, LCDs, and other peripherals over the I²C interface. The Qwiic connector is a 4-pin polarized JST connector, which ensures the cable is inserted the right way.

Qwiic Connect System hardware is daisy chainable as long as each I²C device in the chain has a unique I²C address.

Note: The Qwiic I²C connections on the Lyra 24S Development Kit are shared with the mikroBUS I²C signals.

The Qwiic connector and its connections to Qwiic cables and the Lyra 24S are illustrated in the figure below.

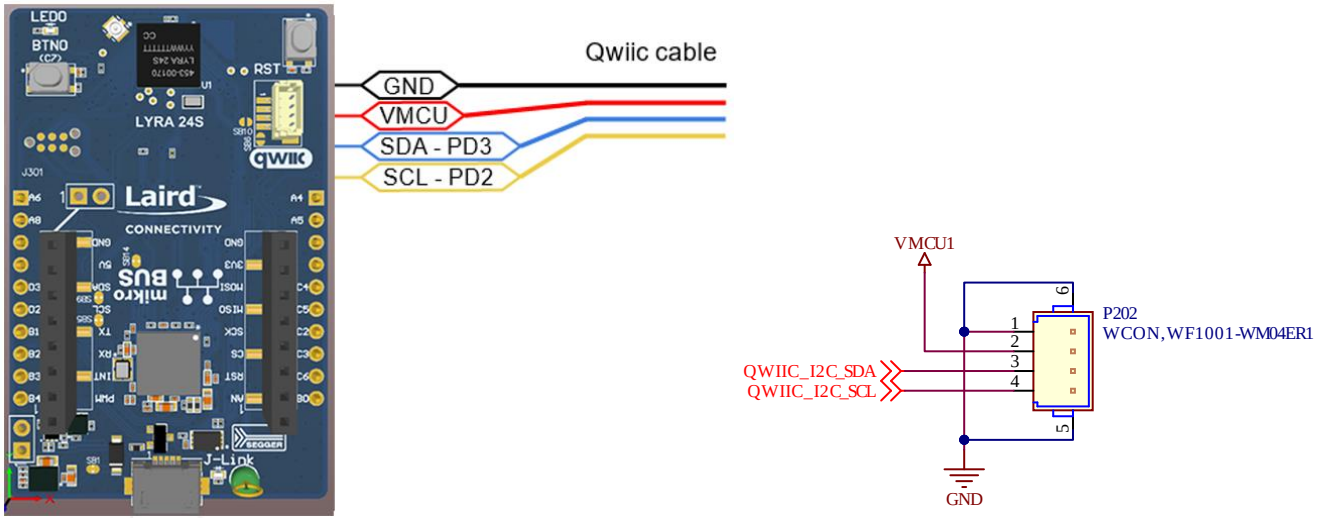

Figure 10: Qwiic connector

The table below gives an overview of the Qwiic connections to the Lyra 24S.

Table 5: Qwiic connections to Lyra 24S

Qwiic Pin	Connection	Shared Feature	Suggested Peripheral Mapping
Ground	GND	Ground	
3.3V	VMCU1	Lyra 24S voltage domain	
SDA	PD03 (via open solderbridge SB10)	MIKROE_I2C_SDA (via closed solder bridge SB9), BREAKOUT_LEFT5	I2Cx.SDA
SCL	PD02 (via open solderbridge SB6)	MIKROE_I2C_SCL (via closed solder bridge SB5), BREAKOUT_LEFT6	I2Cx.SCL

7.6.4 Debug USB Micro-B Connector

The debug USB port can be used for uploading code, debugging, and as a Virtual COM port. More information is available in Debugging section.

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8 DEBUGGING

The Lyra 24S Development Kit contains an on-board SEGGER J-Link Debugger that interfaces to the target Lyra 24S using the Serial WireDebug (SWD) interface. The debugger allows the user to download code and debug applications running in the target Lyra 24S. Additionally, it also provides a virtual COM port (VCOM) to the host computer that is connected to the target device's serial port, for general purpose communication between the running application and the host computer. The Packet Trace Interface (PTI) is also supported by the on-board debugger, which offers invaluable debug information about transmitted and received packets in wireless links. The on- board debugger is accessible through the USB Micro-B connector.

8.1 On-board Debugger

The on-board debugger is a SEGGER J-Link debugger running on an EFM32. The debugger is directly connected to the debug and VCOM pins of the target Lyra 24S.

When the debug USB cable is inserted, the on-board debugger is automatically active and takes control of the debug and VCOM inter- faces. This means that debug and communication will *not* work with an external debugger connected at the same time. The on-board LDO is also activated which then powers the board. When the USB cable is removed, the on-board debugger goes into a very low power shutoff mode (EM4S), consuming around 80 nA typically (EFM32GG12 data sheet number). This means that an application running off batteries will not be affected too much by the on-board debugger power consumption. Since the I/O voltage rail of the debuggerremains powered in the battery-operated mode, the pins connected to the debug and VCOM interfaces maintain proper isolation and prevent leakage currents.

8.2 Virtual COM Port

The virtual COM port is a connection to a UART of the target Lyra 24S and allows serial data to be sent and received from the device. The on-board debugger presents this as a virtual COM port on the host computer that shows up when the USB cable is inserted.

Data is transferred between the host computer and the debugger through the USB connection, which emulates a serial port using the USB Communication Device Class (CDC). From the debugger, the data is passed on to the target device through a physical UART connection.

The serial format is 115200 bps, 8 bits, no parity, and 1 stop bit by default. For more information on changing the virtual COM Port settings, please refer to:

https://www.lairdconnect.com/documentation/application-note-configuring-lyra-evk-uart-baud-rate

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Note: Changing the baud rate for the COM port on the PC side does not influence the UART baud rate between the debugger and the target device.

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9 SCHEMATIC, ASSEMBLY DRAWING, 3D MODEL

Schematic, assembly drawing, 3D model are available on the Lyra Series product page in Documentation->Technical drawings:

https://www.lairdconnect.com/wireless-modules/bluetooth-modules/bluetooth-5-modules/lyra-24-series-bluetooth-5-modules

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