

# User Guide

## RM126x LoRaWAN Development Board

*Part Numbers: RM1261/RM1262 (453-00140-K1, 453-00139-K1)*

*Version 1.0*

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## REVISION HISTORY

Version	Date	Notes	Contributors	Approver
1.0	23 May 2023	Initial Release	Raj Khatri	Senthooran Ragavan

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## 1 OVERVIEW

The RM126x Development Kit is an ultra-low cost, small form factor development and evaluation platform for the RM126x Wireless LoRaWAN Module.

The RM126x Development Kit is focused on rapid prototyping and concept creation of IoT applications. It is designed around the RM126x Module, based on the EFR32BG22 System-on-Chip and SX126x LoRa chipset, 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	<ul style="list-style-type: none"> <li>▪ RM126x (RM1261 / RM1262) LoRaWAN Module</li> <li>▪ 32-bit ARM® Cortex®-M33 with 76.8 MHz maximum operating frequency</li> <li>▪ 512 kB flash and 32 kB RAM</li> </ul>
Features	<ul style="list-style-type: none"> <li>▪ User LED and push button</li> <li>▪ 20-pin 2.54 mm breakout pads</li> <li>▪ mikroBUS™ socket</li> <li>▪ Qwiic® connector</li> <li>▪ SEGGER J-Link on-board debugger</li> <li>▪ Virtual COM port</li> <li>▪ Packet Trace Interface (PTI)</li> <li>▪ USB-powered.</li> </ul>
Software	<ul style="list-style-type: none"> <li>▪ <b>AT Command Set</b> (Laird Connectivity created) - Fully featured and extensible, proven over 5+ years</li> <li>▪ <b>Native C development Code</b> (Customer created)- Full software development with Silicon Labs SDK and toolchain. Use Simplicity Studio IDE for full functionality of Silicon Labs HW/SW</li> </ul>

## 2 LAIRD CONNECTIVITY RM126X PART NUMBERS

Part Number	Description
453-00140-K1	Development Kit, RM1261, SX1261, MHF4
453-00139-K1	Development Kit, RM1262, SX1262, MHF4

Applicable to following RM126x part numbers:

Part Number	Product Description
453-00140	Module, RM1261, SX1261, MHF4
453-00139	Module, RM1262, SX1262, MHF4

## 3 KIT CONTENTS

All kits contain the following items:

<b>Development Board</b>	Contains soldered RM1261 / RM1262 module and exposes all available hardware interfaces.
<b>Power Options</b>	USB cable (x1) – Type A to micro type B. Also provides serial via onboard USB – UART chip
<b>Antenna with RM1261</b>	1 x Laird FlexPIFA 868MHz antenna 1 x Laird iFlexPIFA 915MHz antenna
<b>Antenna with RM1262</b>	1 x Laird iFlexPIFA 915MHz antenna

## 4 MAIN BOARD – FEATURES

The RM126x Development Kit has been designed to simplify IoT development with the RM126x wireless module. The kit includes a mikroBUS<sup>™</sup> socket and Qwiic<sup>®</sup> connector, allowing users to add features to the kit with a large selection of off-the-shelf boards.

Programming the RM126x 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.

The RM126x Development board Kit DVK-RM126x ships with signed RM126x Bootloader and AT application firmware (customer using AT commands run from a host). Alternatively, the RM126x is supported in Silicon Labs' Simplicity Studio<sup>™</sup> and an initial Board Support Package (BSP) is provided by Silicon Labs to give application developers a flying start. Laird Connectivity provides extensive sample applications RM126x for those customers developing with C code developing with the Silicon Labs SDK, including the mandatory RM126x radio regulatory protection layer.

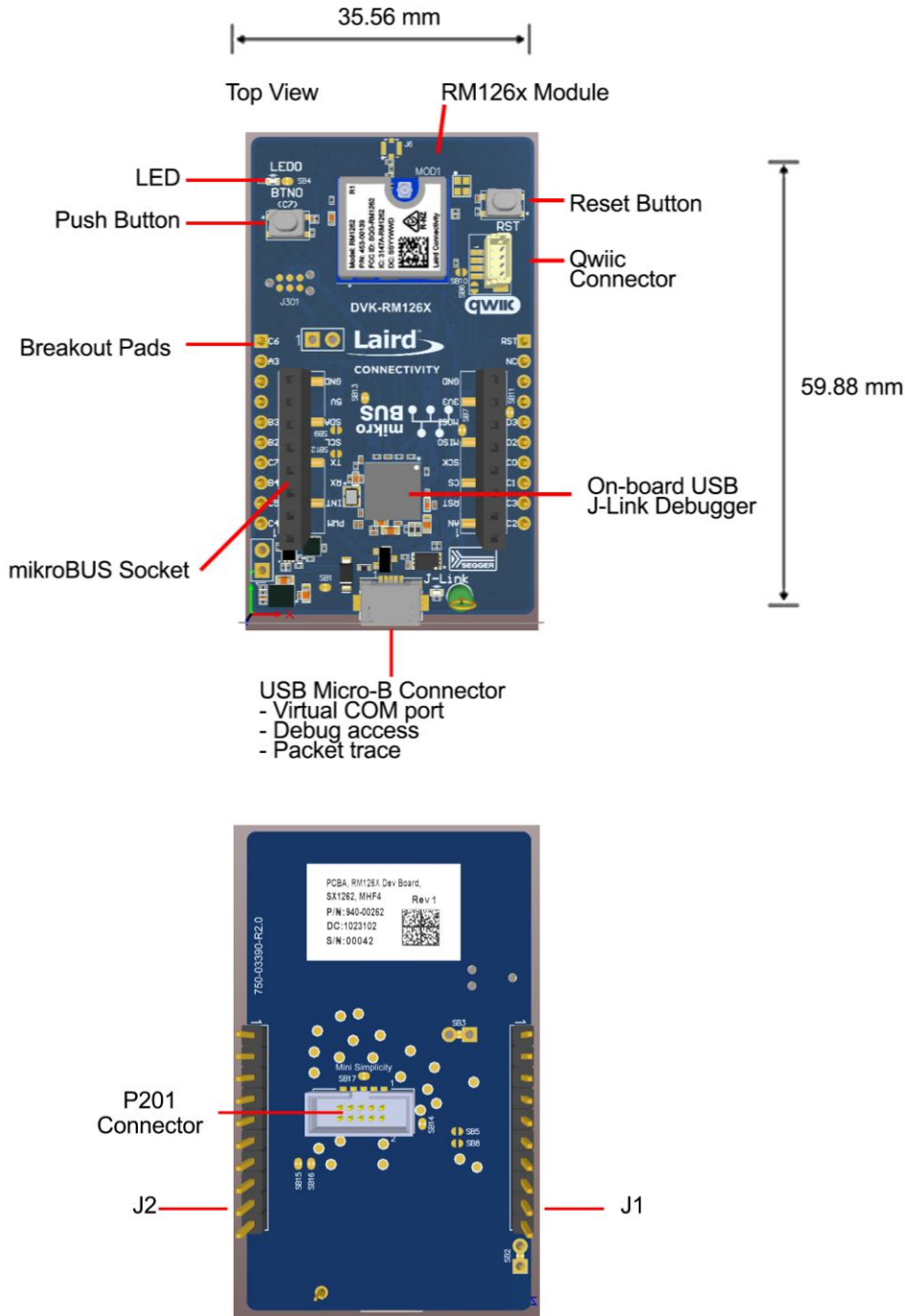
Connecting external hardware to the RM126x Development Kit can be done using the 20 breakout pads which present peripherals from the RM126x such as I2C, SPI, UART and GPIOs. The mikroBUS socket allows inserting mikroBUS add-on boards which interface with the RM126x through SPI, UART or I2C. The Qwiic 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 RM126x Development Kit:

- RM126x (RM1261 / RM1262) LoRaWAN Module (EFR32 with 76.8 MHz operating frequency), connecting to external antenna (MHF4), 512 kB flash, and 32 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<sup>™</sup> socket for connecting click boards<sup>™</sup> and other mikroBUS add-on boards
- Qwiic<sup>®</sup> connector for connecting Qwiic Connect System hardware
- Breakout pads for GPIO access and connection to external hardware
- Reset button
- DVK-RM126x ships with signed RM126x Bootloader and AT application firmware (customer using AT commands run from a host)

## 5 UNDERSTANDING THE DEVELOPMENT BOARD



**Figure 1: RM126x development board layout**

**Note:** Example given is for the RM1262 development board. The development boards are identical with the exception of the included module (RM1261 or RM1262).

## 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 (VMCU1 supplied externally)	$V_{VMCU1}$		+3.3 <sup>1</sup>		V
Operating Temperature	$T_{OP}$	-	+20	-	°C

<sup>1</sup> The typical supply voltage to the RM126x is 3.3 V, but the maximum voltage is a function of temperature and average lifetime current load. See the [RM126x 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 RM126x and the on-board debugger. Note that the numbers are taken from the data sheets for the devices. For a full overview, see the [RM126x datasheet](#).

**Table 2: Current consumption**

Parameter	Symbol	Condition	Typ	Unit
Radio RX current (RM1261 or RM1262)	$I_{RX\_LORA}$	RM1261 or RM1261 LoRa radio system current consumption in Receive mode - RX Boosted, LoRa. Running radio test firmware, EUART open. (VDD=3.3V, at 25 °C).	8.1	mA
	$I_{RX\_FSK}$	RM1261 or RM1261 FSK radio system current consumption in Receive mode - RX Boosted, FSK 50kbps. Running radio test firmware, EUART open. (VDD = 3.3V, at 25 °C).	7.6	mA
Radio TX current (RM1261)	$I_{TX\_LORA}$	RM1261 LoRa radio system current consumption in Transmit mode @ 14dBm, 915MHz (VDD=3.0 V, at 25 °C).	28.8	mA
Radio TX current (RM1262)	$I_{TX\_LORA}$	RM1262 LoRa radio system current consumption in Transmit mode @ 22dBm, 915MHz (VDD=3.0 V at 25 °C). VDD=3.3V minimum to achieve RF TX power 22dBm.	109	mA
On-board Debugger Sleep Current Consumption <sup>2</sup>	$I_{DBG}$	On-board debugger current consumption when USB cable is not inserted (EFM32GG12 EM4S mode current consumption).	80	nA

1 From [RM126x data sheet](#)

2 From [EFR32BG22 data sheet](#)

## 7 FUNCTIONAL BLOCKS

The core of the RM126x Development Kit is the RM126x LoRaWAN Module. Refer to [Understanding the Development Board](#) for placement and layout of the hardware components.

### 7.1 Hardware Block Diagram

An overview of the RM126x Development Kit is illustrated in the figure below.

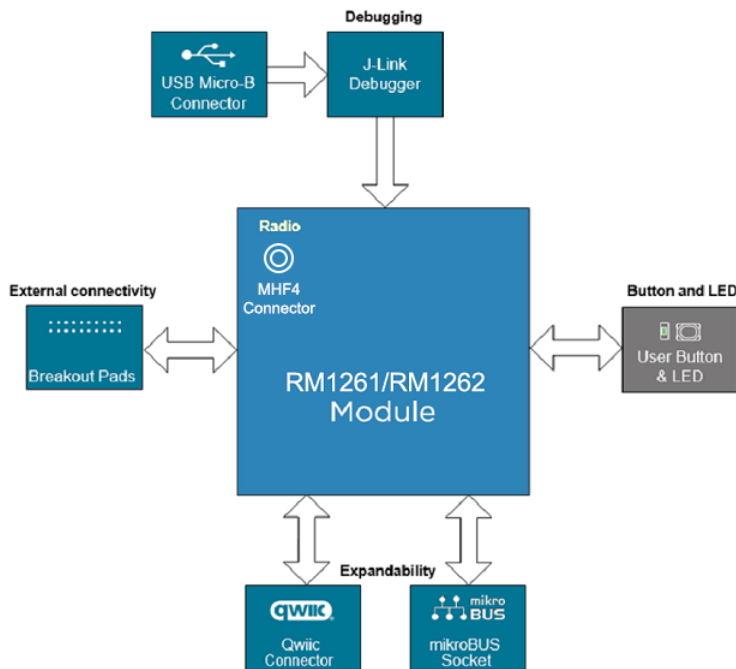


Figure 2: RM126x DVK block diagram

### 7.2 Power Supply

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

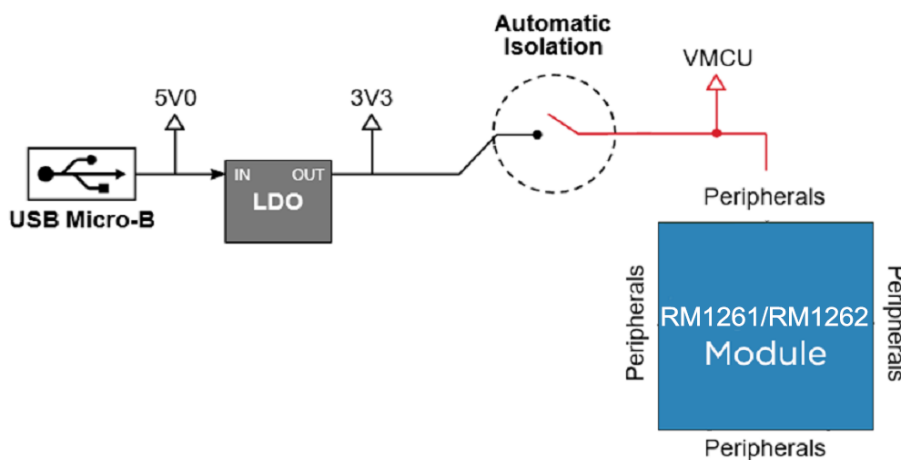


Figure 3: RM126x DVK power diagram



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 VMCU1 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 RM126x Reset

The RM126x 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 RM126x. The button is connected to pin PC06 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 \(PC06\)](#) and [BUTTON 0 \(silkscreen BTN0\)](#) usage information.

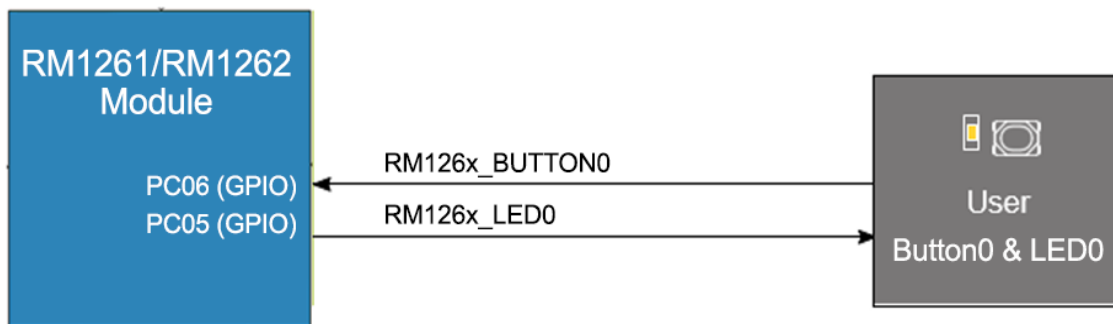


Figure 4: RM126x DVK Button and LED

### 7.4.1 BOOT pin (PC06) and BUTTON 0 (silkscreen BTN0)

For the RM126x module the BOOT pin is on PC06 (pin19). On the RM126x development board BTN0 (Button0) is by default mapped to the BOOT pin for easier utilisation.

The BOOT pin (PC06) 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 – RM126x Series for more information at:

<https://www.lairdconnect.com/rm126x-series>

## 7.5 On-board Debugger

The RM126x Development Kit contains a microcontroller separate from the RM126x 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 RM126x device and the on-board debugger. See [Debugging](#) for more details.

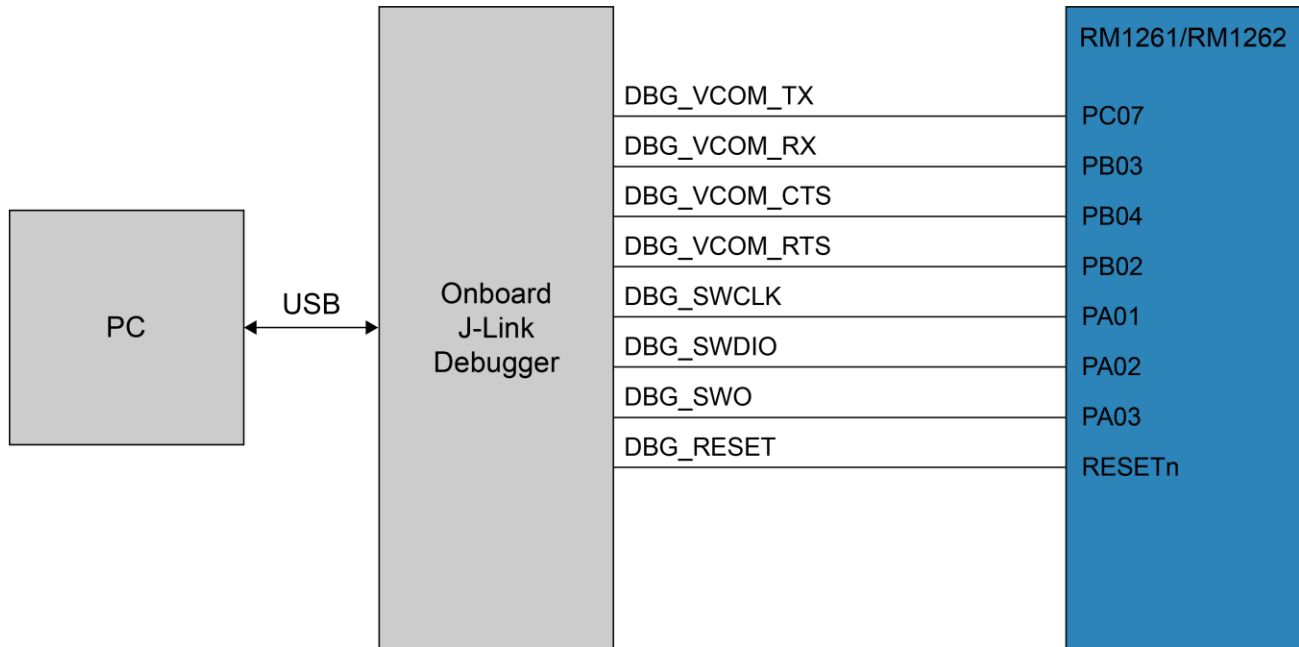


Figure 5: RM126x DVK Debugger Connections

## 7.6 Hardware Connectors

The RM126x 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.

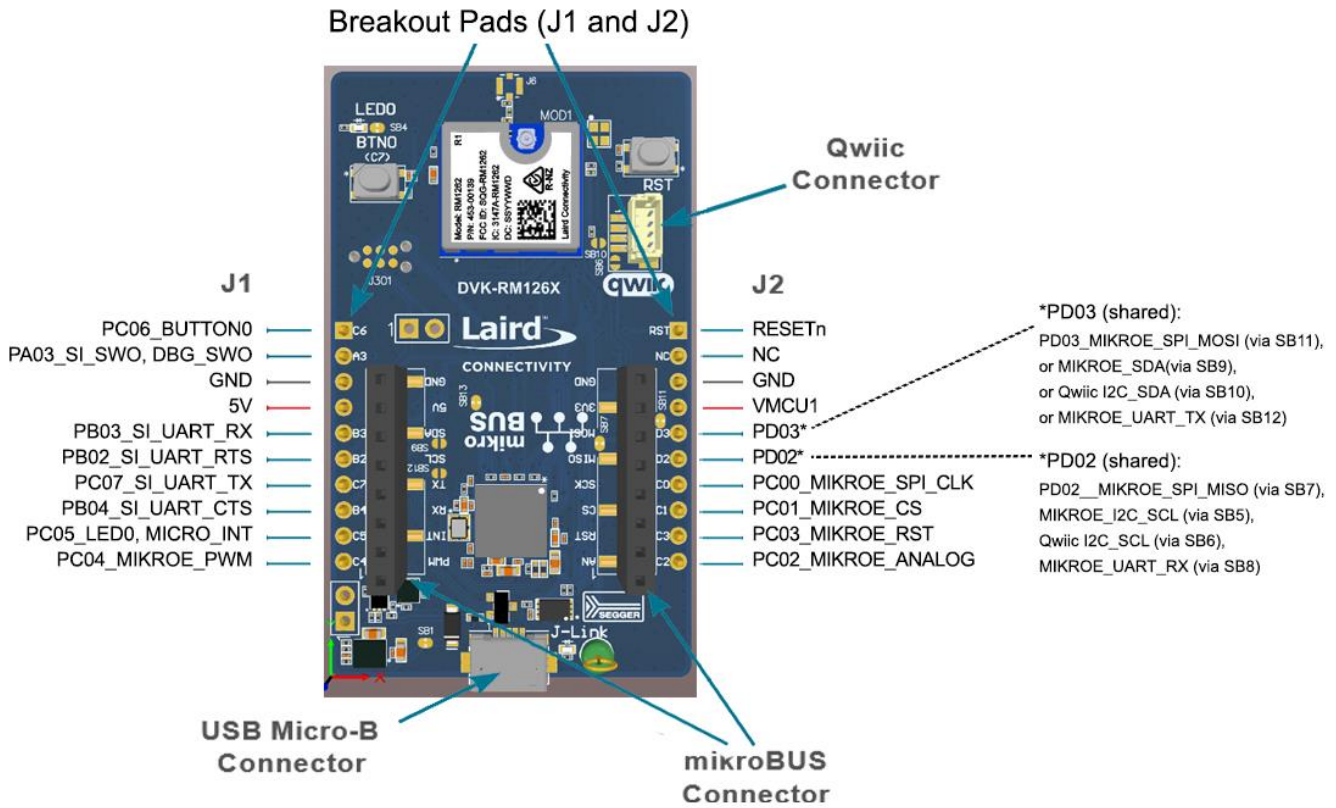


Figure 6: RM126x DVK hardware connectors

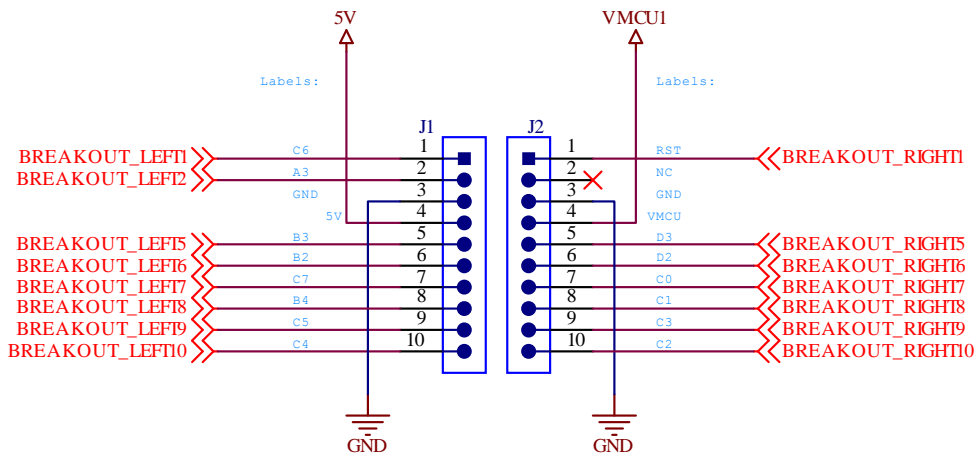
## 7.6.1 Breakout Pads Pinout

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 RM126x features. Additionally, the VMCU1 (main board power rail), 3V3 (LDO regulator output), and 5V power rails are also exposed on the pads.

The pin-routing on the RM126x 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 RM126x Development Kit. The table below includes an overview of the breakout pads and functionality that is shared with the kit.

**Table 3: RM126x DVK Breakout Pads Pinout**

Pin	Connection	Shared Feature
<b>(Top View) Left Side Breakout Pins (J1)</b>		
1	PC06	BUTTON0
2	PA03	DBG_SWO, SI_SWO
3	GND	Ground
4	5V	Board USB voltage
5	PB03	SI_UART_RX
6	PB02	SI_UART_RTS
7	PC07	SI_UART_TX
8	PB04	SI_UART_CTS
9	PC05	LED0(via SB4), MikroBUS INT
10	PC04	MikroBUS PWM
<b>(Top View) Right Side Breakout Pins (J2)</b>		
1	RST	RM126x reset, active low
2	NC	
3	GND	Ground
4	VMCU1	RM126x voltage domain
5	PD03	MikroBUS SPI_MOSI default via closed SB11 <b>Optional (cut SB11 first):</b> MikroBUS I2C_SDA (via shorting SB9), Qwiic I2C_SDA (via shorting SB10), MikroBUS UART_TX (via shorting SB12)
6	PD02	MikroBUS SPI_MISO default via closed SB7 <b>Optional (cut SB7 first):</b> MikroBUS I2C_SCL (via shorting SB5), Qwiic I2C_SCL (via shorting SB6), MikroBUS UART_RX (via shorting SB8)
7	PC00	MikroBUS SPI_SCK
8	PC01	MikroBUS SPI_CS
9	PC03	MikroBUS RST
10	PC02	MikroBUS Analog



Breakout Pads (J1 and J2)

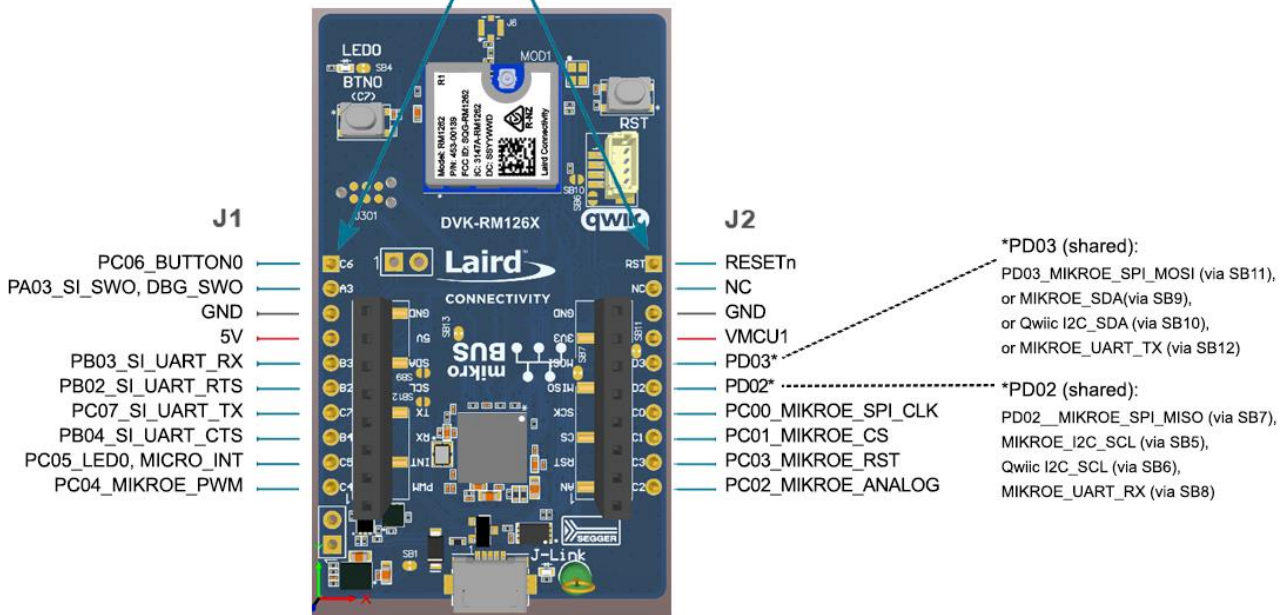
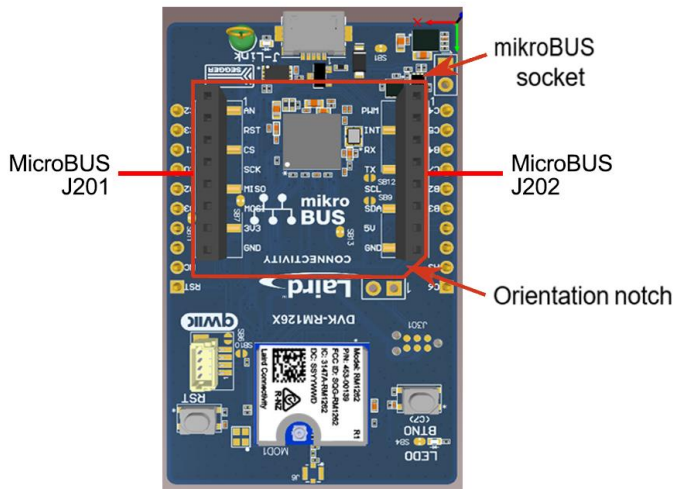


Figure 7: RM126x DVK Breakout Pad (J1 and J2)

## 7.6.2 MikroBUS Socket



The RM126x 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 RM126x through UART, SPI or I<sup>2</sup>C. Several GPIOs are exposed on the mikroBUS socket. MikroBUS add-on boards can be powered by the 5V or VMCU1 power rails, which are available on the mikroBUS socket.

The pinout of the RM126x on the kit is made such that all required peripherals are available on the mikroBUS socket. The I<sup>2</sup>C 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 RM126x 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.

### MikroE Socket

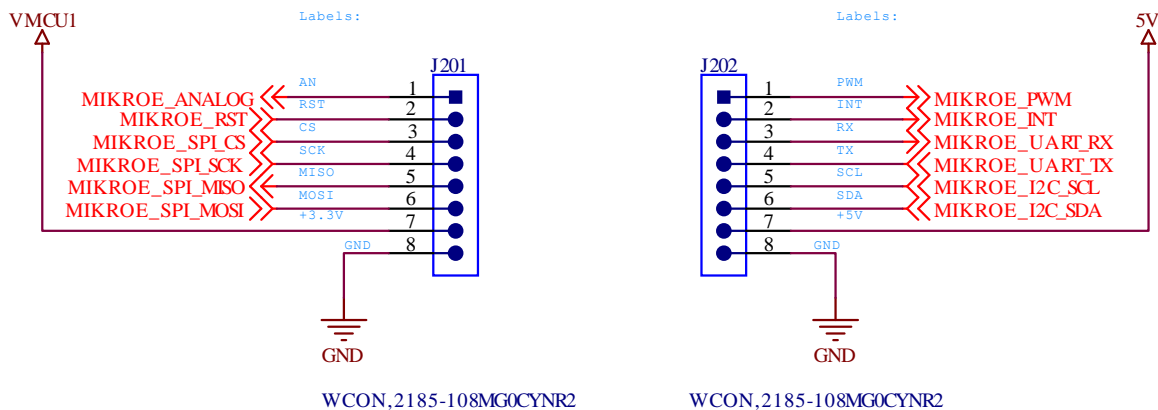


Figure 8: mikroBUS add-on board orientation

The table below gives an overview of the mikroBUS socket pin connections to the RM126x.

Table 4: Pin connections from mikroBUS socket to RM126x

Pin Name	Pin Function	Connection	Shared Feature	Suggested Mapping
AN	Analog	PC02	BREAKOUT_RIGHT10	IADC0
RST	Reset	PC03	BREAKOUT_RIGHT9	
CS	SPI Chip Select	PC01	BREAKOUT_RIGHT8	USARTx.CS
SCK	SPI Clock	PC00	BREAKOUT_RIGHT7	USARTx.CLK
MISO	SPI Master Input Slave Output	PD02 (via closed SB7, default)	BREAKOUT_RIGHT6	USARTx.RX
MOSI	SPI Master	PD03 (via closed SB11, default)	BREAKOUT_RIGHT5	USARTx.TX

Pin Name	Pin Function	Connection	Shared Feature	Suggested Mapping
	Output Slave Input	SB11)		
3V3	VCC 3.3V power	VMCU1	RM126x voltage domain	3V3
GND	Reference Ground	GND	Ground	GND
PWM	PWM output	PC04	BREAKOUT_LEFT10	TIMER0.CCx
INT	Hardware Interrupt	PC05	BREAKOUT_LEFT9	
RX	UART Receive	PD02 (via shorting SB8, cut default SB7)	BREAKOUT_LEFT8	USARTx.RX
TX	UART Transmit	PD023 (via shorting SB12, cut default SB11)	BREAKOUT_LEFT7	USARTx.TX
SCL	I2C Clock	PD02 (via shorting SB5, cut default SB7)	QWIIC_I2C_SCL (via shorting SB6, cut default SB7); BREAKOUT_LEFT6	I2Cx.SCL
SDA	I2C Data	PD03 (via shorting SB9, cut default SB11)	QWIIC_I2C_SDA (via shorting SB10, cut default SB11), BREAKOUT_LEFT5	I2Cx.SDA
5V	VCC 5V power	5V	Board USB voltage	5V
GND	Reference Ground	GND	Ground	GND

The below figure XYZ shows RM126x GPIO's PD02 and PD03 are shared with multiple signals, with default the MIKROE\_SPI\_MISO wired to RM126x PD02 (via closed solder bridge SB7) and MIKROE\_SPI\_MOSI wired to RM126x PD03 (via closed solder bridge SB11).

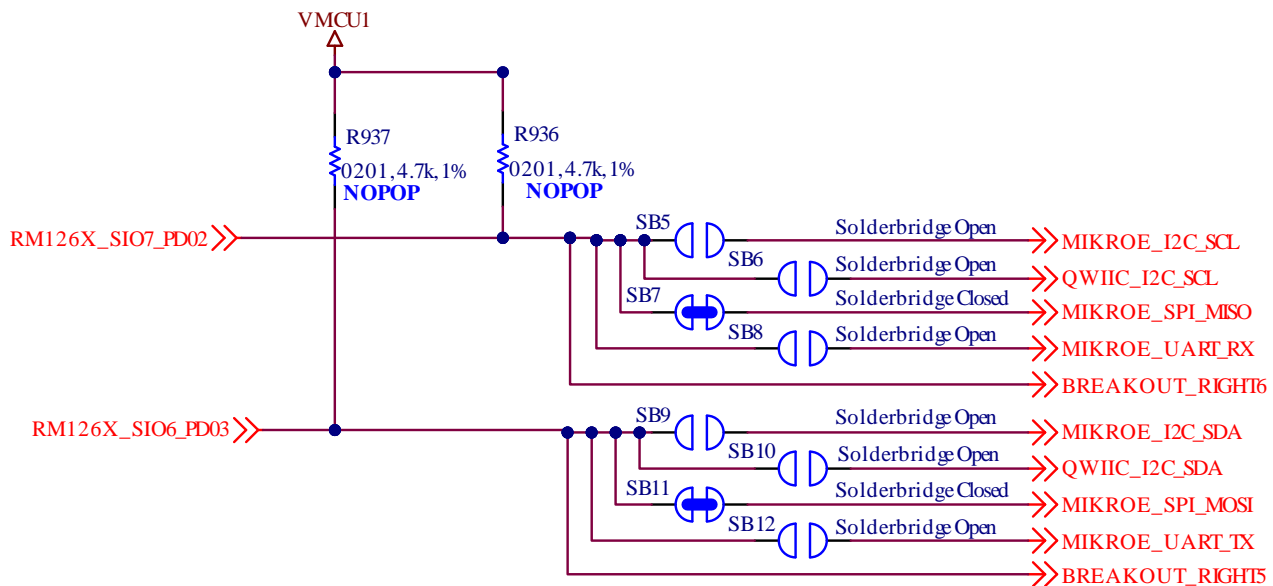


Figure 9: PD02 and PD03 Schematic

### 7.6.3 Qwiic Connector

The RM126x Development Kit features a Qwiic® connector compatible with Qwiic Connect System hardware. The Qwiic connector provides an easy way to expand the functionality of the RM126x Development Kit with sensors, LCDs, and other peripherals over the I<sup>2</sup>C 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 I<sup>2</sup>C device in the chain has a unique I<sup>2</sup>C address.

**Note:** The Qwiic I<sup>2</sup>C connections on the RM126x Development Kit are shared with the mikroBUS I<sup>2</sup>C signals.

The Qwiic connector and its connections to Qwiic cables and the RM126x are illustrated in the figure below.

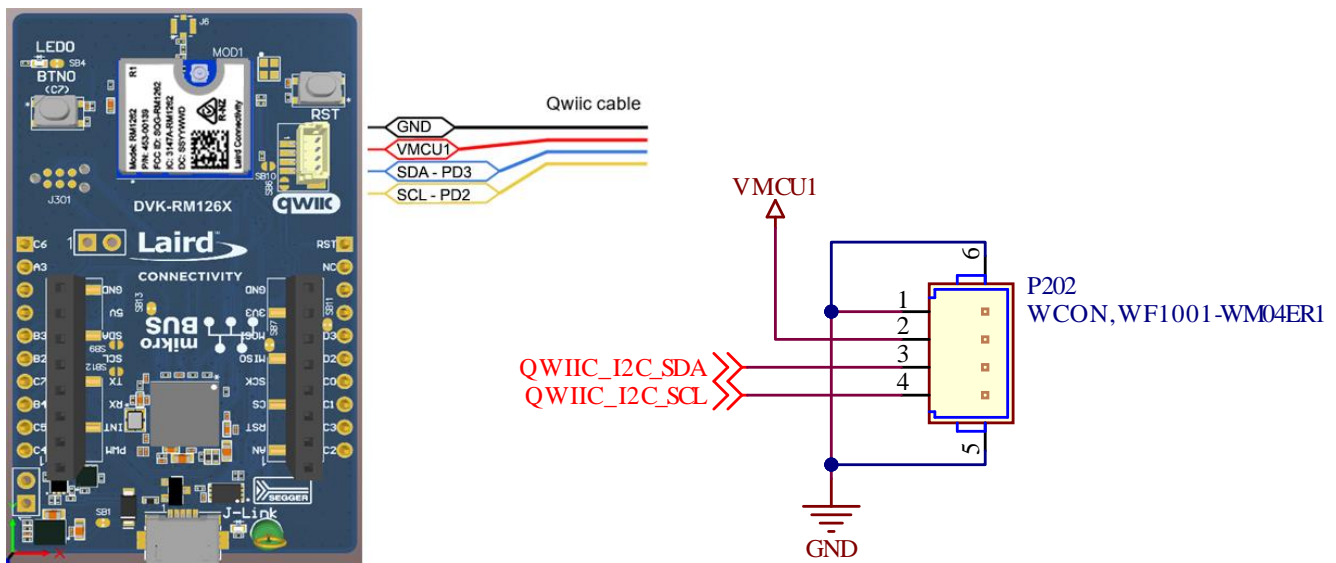


Figure 10: Qwiic connector

The table below gives an overview of the Qwiic connections to the RM126x.

Table 5: Qwiic connections to RM126x

Qwiic Pin	Connection	Shared Feature	Suggested Peripheral Mapping
Ground	GND	Ground	
3.3V	VMCU1	RM126x voltage domain	
SDA	PD03	Default (via solder bridge SB11): MIKROE_SPI_MOSI, <b>Optional</b> (cut solder bridge SB11): QWIIIC_I2C_SDA (via shorting solder bridge (SB10))	I2Cx.SDA
SCL	PD02	Default (via solder bridge SB7): MIKROE_SPI_MISO, <b>Optional</b> (cut solder bridge SB7): QWIIIC_I2C_SCL (via shorting solder bridge (SB6))	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.



## 8 DEBUGGING

The RM126x Development Kit contains an on-board SEGGER J-Link Debugger that interfaces to the target RM126x using the Serial WireDebug (SWD) interface. The debugger allows the user to download code and debug applications running in the target RM126x. 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 RM126x.

When the debug USB cable is inserted, the on-board debugger is automatically active and takes control of the debug and VCOM interfaces. 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 debugger remains 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 RM126x 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

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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 Rm126x Series product page in Documentation->Technical drawings:

<https://www.lairdconnect.com/rm126x-series>