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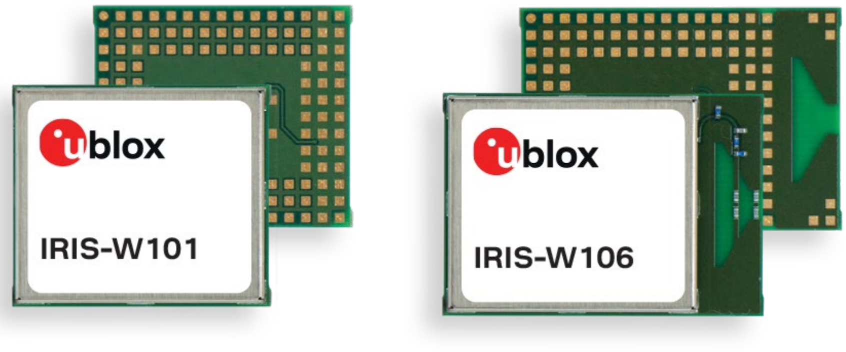
IRIS-W10 series

Stand-alone tri-radio dual-band Wi-Fi 6, Bluetooth® LE or IEEE 802.15.4 modules

System integration manual



Abstract

This manual provides a functional overview combined with best-practice design guidelines for integrating IRIS-W10 series stand-alone Tri-radio dual-band Wi-Fi 6, Bluetooth® LE and IEEE 802.15.4 modules in customer applications. It also describes open CPU application development solutions, hardware design-in, component handling, compliance and testing of the module. The module series also includes variants with or without an internal antenna.

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Document information

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Document status description	
Draft	For functional testing. Revised and supplementary data will be published later.
Objective Specification	Target values. Revised and supplementary data will be published later.
Advance Information	Data based on early testing. Revised and supplementary data will be published later.
Early Production Information	Data from product verification. Revised and supplementary data may be published later.
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This document applies to the following products:

Product name	Document status
IRIS-W101	Early Production Information
IRIS-W106	Early Production Information

☞ For information about the related hardware, software, and status of listed product types, see also the data sheet [2].

Contents

1 Product overview

IRIS-W10 series are ultra-compact, stand-alone tri-radio dual-band Wi-Fi 6, Bluetooth® LE or IEEE 802.15.4 modules, perfect for integrating wireless connectivity in end products.

With Wi-Fi 6 (802.11a/b/g/n/ac/ax) in 2.4 GHz and 5 GHz bands, it can be a Wi-Fi station connecting to a remote access point or act as an access point. IRIS-W10 is qualified against Bluetooth Core 5.4 and can assume peripheral or central roles, or both simultaneously. It can be a GATT client or server.

The module embeds a tri-radio, MCU System-On-Chip (SoC) with the application SW running on the embedded Arm® Cortex®-M33 MCU. The module supports LE Coded for long range, isochronous channels for Bluetooth LE audio, Thread*, Matter over Wi-Fi, ethernet connectivity and a Wi-Fi / Bluetooth coexistence protocol.

The IRIS-W10 series include hardware security features like secure boot, trusted execution environment with Arm TrustZone™, encrypted flash, protection of debug port, and a crypto acceleration engine. Wireless communication is secure with WPA2/WPA3 authentication, TLS encryption, Bluetooth LE secure connection pairing, and HTTPS.

1.1 Module architecture

IRIS-W10 series modules are based on the NXP RW612/RW610 chip and includes an Arm® Cortex®-M33 MCU, clocked up to 260 MHz with 1.2MB SRAM and 8/16 MB eXecute-In-Place (XIP) Flash. An integrated Power management provides supply voltage to the internal power nodes and only a single external power supply is needed.

Module variants allow developers to select either an external antenna with IRIS-W101 or an embedded PCB antenna with IRIS-W106. Wi-Fi and Bluetooth LE, RF front-end components configure the RF section for the different module variants. RF calibration data and MAC address are available in the IRIS-W10's OTP memory.

IRIS-W10 includes USB 2.0, SDIO 3.0, and RMII Ethernet interface. For connection to peripheral components, serial communication interfaces, QSPI, I2C, USART, and I2S are available.

A display interface supports a display up to QVGA (320x240) resolution.

The variants of IRIS-W10 series are described in table below.

Variant	Description	Antenna type
IRIS-W101-00B	Bluetooth LE, or IEEE 802.15.4 and 2.4 GHz / 5 GHz Wi-Fi, 8 MB flash	Antenna pad
IRIS-W106-00B	Bluetooth LE, or IEEE 802.15.4 and 2.4 GHz / 5 GHz Wi-Fi, 8 MB flash	Single embedded PCB antenna
IRIS-W101-10B	Bluetooth LE, or IEEE 802.15.4 and 2.4 GHz / 5 GHz Wi-Fi, 16 MB flash	Antenna pad
IRIS-W106-10B	Bluetooth LE, or IEEE 802.15.4 and 2.4 GHz / 5 GHz Wi-Fi, 16 MB flash	Single embedded PCB antenna
IRIS-W101-30B*	Bluetooth LE and 2.4 GHz / 5 GHz Wi-Fi, 8 MB flash	Antenna pad
IRIS-W106-30B*	Bluetooth LE and 2.4 GHz / 5 GHz Wi-Fi, 8 MB flash	Single embedded PCB antenna
IRIS-W101-40B*	Bluetooth LE and 2.4 GHz / 5 GHz Wi-Fi, 16 MB flash	Antenna pad
IRIS-W106-40B*	Bluetooth LE and 2.4 GHz / 5 GHz Wi-Fi, 16 MB flash	Single embedded PCB antenna

Table 1: Supported configurations of the IRIS-W10 series

☞ * No IEEE 802.15.4/Thread features

2 Module integration

IRIS-W10 series modules can operate completely stand-alone (host-less), open CPU configuration that allows customer applications to run on the module without any need for a supporting host MCU. IRIS-W10 series modules offer a wide range of peripheral interfaces such as USB OTG, GPIOs, UART, SPI, QSPI, I2C, PWM, I2S, RMII and QVGA.

Figure 1 shows a typical integration in which IRIS-W10 is configured as a host.

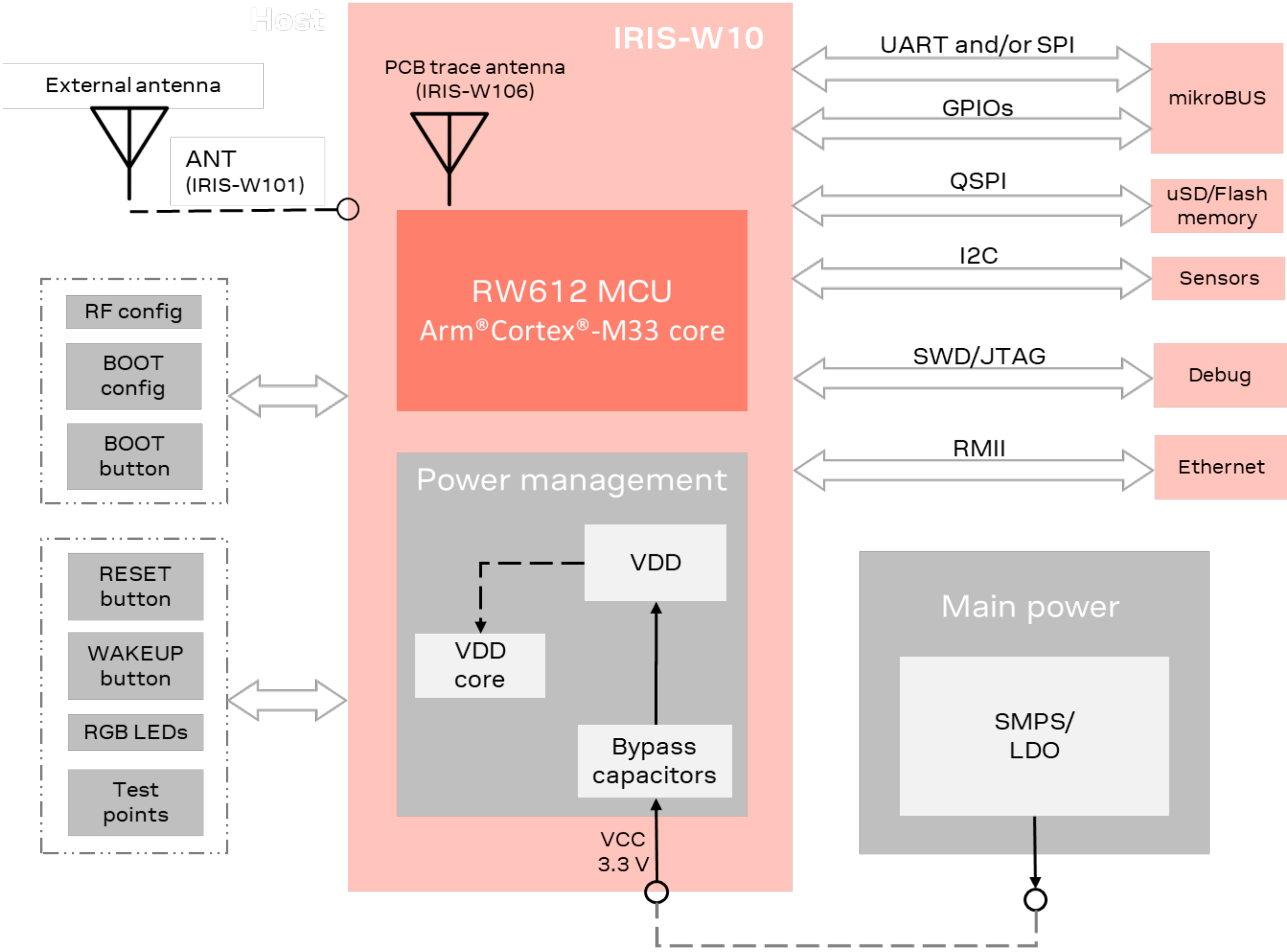


Figure 1: Example of IRIS-W10 integrated as a host

Figure 2 shows an example of controlling IRIS-W10 through a host CPU and interface connections.

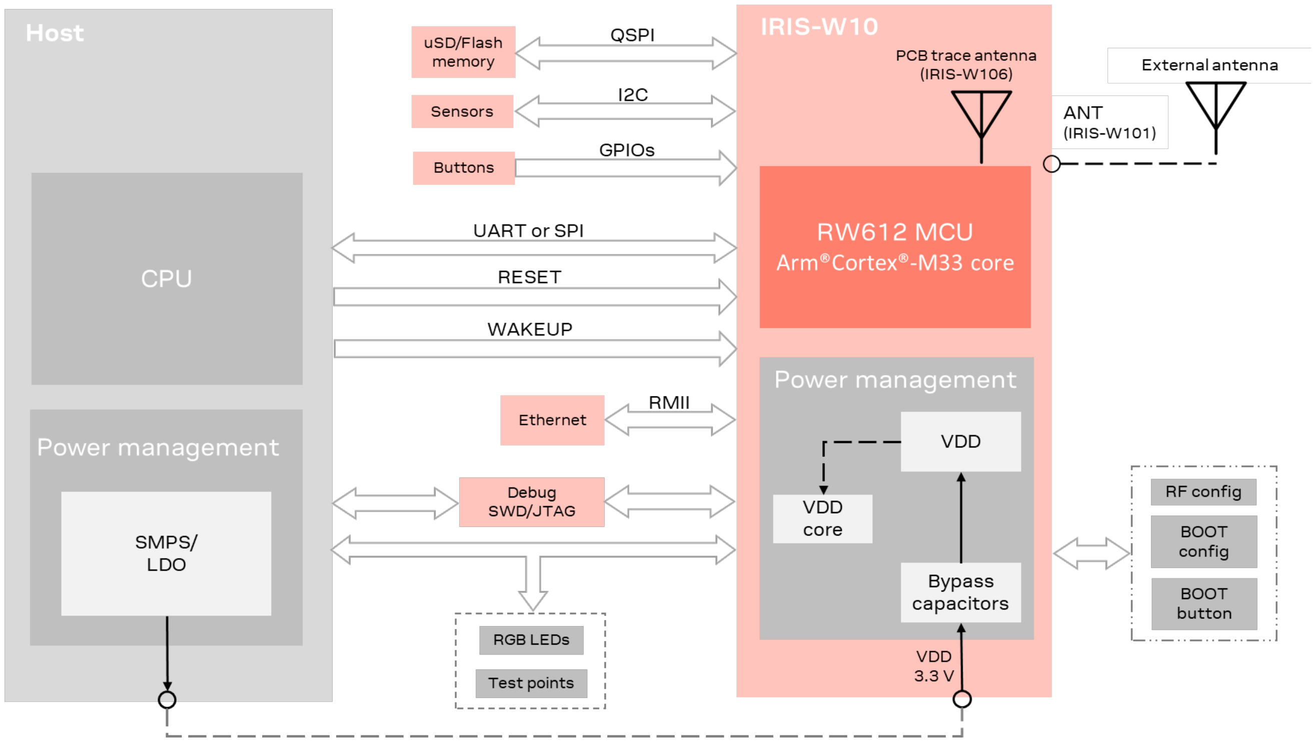


Figure 2: Example of IRIS-W10 integration in a host system with external CPU

With IRIS-W10, application designs are simplified. Developers can either connect an external antenna via the antenna pin on IRIS-W101 or utilize the internal antenna on IRIS-W106.

2.1 CPU and memory

IRIS-W10 series module embeds a 260 MHz Arm® Cortex®-M33 core with Trustzone® technology. FlexSPI external flash interface supports eXecute-In-Place (XIP) and on-the-fly firmware encryption/ decryption and authentication.

The IRIS-W10 series module includes the following memories:

- SRAM: 1.2 MB, expandable up to 128 MB PSRAM
- ROM: 256 kB
- OTP (one-time-programmable): 2 kB
- Flash:
  - IRIS-W10-00B and IRIS-W10-30B: 8 MB QSPI
  - IRIS-W10-10B and IRIS-W10-40B: 16 MB QSPI

2.2 Power management

IRIS-W10 series have single power supply input, **VCC**. Nominal voltage is 3.3 VDC ±10%.

IRIS-W10 I/O interface voltage is set to either 1.8 V or 3.3 V by connecting the **VCCIO** (L6 pin) to:

- pin L7 for 1.8 V
- pin L8 for 3.3 V

2.2.1 VCC application circuits

The power for IRIS-W10 series module is supplied through the **VCC** pin. These supplies can be taken from either of the following sources:

- Switched Mode Power Supply (SMPS)
- Low Drop Out (LDO) regulator

An SMPS is the ideal design choice when the available primary supply source is significantly higher than the operating supply voltage of the module. This offers the best power efficiency for the application design and minimizes the amount of current drawn from the main supply source.

⚠ When taking **VCC** supplies from an SMPS make sure that the AC ripple voltage is kept as low as possible at the switching frequency. Design layouts should focus on minimizing the impact of any high-frequency ringing.

⚠ It's crucial for any power source to meet the specified voltage tolerances and be capable of providing the necessary peak currents.

Use an LDO linear regulator for primary VCC supplies that have a relatively low voltage. As LDO regulators dissipate power linearly related to the step-down voltage, LDOs are not recommended for the step down of high voltages.

When using IRIS-W10 with a battery, ensure the battery can manage the module's peak power. If using a battery supply, consider adding extra capacitance to the supply line to prevent capacity degradation.

For electrical specifications, see also the IRIS-W10 data sheet [2].

☞ The system power supply circuit must be able to support peak power, so ensure to add a 20% margin over the typical current consumption listed. This accounts for the variable current drawn from **VCC** and **VCC_IO**, which can fluctuate significantly with different Wi-Fi power consumption profiles.

2.3 Configuration pins

Table 2 shows the pins used as configuration inputs to set parameters following a reset. For normal operation, the configuration pins must be set before the reset is applied. To set the pins low, use 4.7 kΩ resistors connected to GND. No external circuitry is required to set a configuration pins high due to internal weak pull-up resistors. See EVK-IRIS-W1 user guide [3] for more.

Pin name	Pin number	Function
RF_CNTL2	A7	Debug interface selection 0: SWD **1: JTAG (Default)**
EXT_FREQ (CON[3]) EXT_PRI (CON[2]) EXT_GNT (CON[1]) EXT_REQ (CON[0])	M14 N14 M12 N12	BOOT source - CON[3,2,1,0]: **1111: Boot from FlexSPI FLASH (Default)** 1110: ISP boot (UART/I2C/SPI/USB) 1101: Serial boot (UART/I2C/SPI/USB) *1100: ISP boot (SDIO)*** 1011: Serial boot (SDIO) 1010: Reserved

** Not supported

Table 2: Configuration and Boot strapping pins

2.4 Antenna integration

Antenna interfaces are different for each module variant in the IRIS-W10 series. The modules support either an internal antenna (IRIS-W106) or external/integrated antennas connected through a dedicated antenna pin (IRIS-W101).

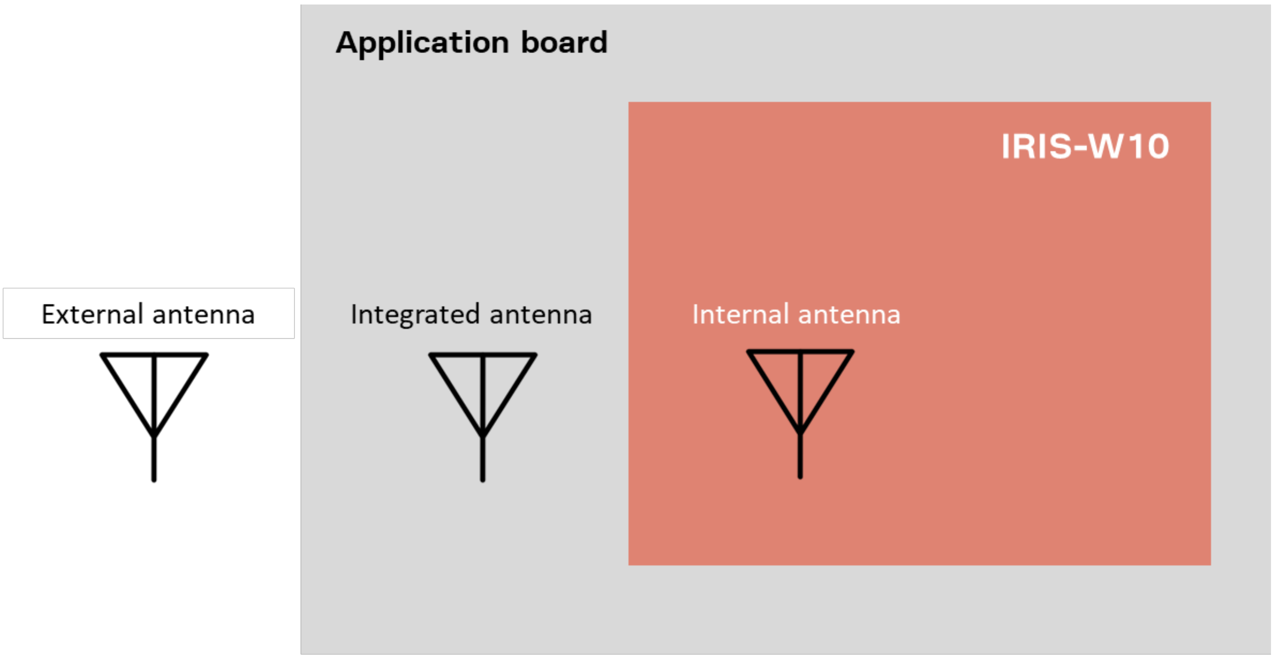
2.4.1 Antenna solutions

IRIS-W10 series modules support various antenna solutions:

- IRIS-W101 has an antenna pin that can be used with either
  - Integrated SMD chip antenna
  - External antenna

- IRIS-W106 includes an internal PCB trace antenna which is specifically designed and optimized for the IRIS-W10 module. There is no need for an RF trace design on the host PCB which means less effort is required in the test lab.

Figure 3 summarizes each of the available antenna options.



External antenna

IRIS-W101 supports an external antenna of choice that connects to the application board through the RF antenna pins, U.FL, or Reverse Polarity SMA connector on the module. Typically, a dipole antenna is connected to the module RF pins through a coaxial cable and U.FL connector on the main PCB.

Integrated antenna

IRIS-W101 supports permanent connection of an integrated antenna within the design of the host application board. Ideally implemented as an SMD chip antenna mounted on the host PCB, the integrated antenna connects to the module RF antenna pin.

Internal antenna

IRIS-W106 includes a 2.4/5 GHz dual band PCB trace antenna. For proper antenna performance the module must be placed on the main PCB, such that the edge containing the antenna is facing the main PCB edge.

Figure 3: Antenna options

2.4.2 Approved antenna designs

IRIS-W10 series modules come with a pre-certified design that can be used to save costs and time during the certification process. To leverage this benefit, customers are required to implement an antenna layout that is fully compliant with the u-blox reference design outlined in this document. Reference design source files are available from u-blox on request.[1]

The designer integrating a u-blox reference design into an end-product is solely responsible for any unintentional RF emission generated by the end product.

For Bluetooth and Wi-Fi operation, IRIS-W10 modules have been tested and approved for use with the antennas featured in the listed in the Approved antennas.

⚠ To avoid invalidating the compliance and pre-certification of u-blox modules with the various regulatory bodies, use only external antennas included on the Approved antennas. Reference design source files are available from u-blox on request.

The module may be integrated with other antennas. In which case, the OEM installer must certify the design with respective regulatory agencies.

2.5 Module reset

IRIS-W10 series modules can be reset (rebooted) with a low-level input on the **RESETn** pin. The logic level of this pin is normally set high using an internal pull-up resistor. The low-level input triggers a “hardware reset” of the module. The **RESETn** signal should be driven by an open-drain output, open-collector output, or contact switch.

2.6 Clock source

IRIS-W10 series modules support three internal clock sources and one external clock source as shown in Table 3.

Clock source	Frequency	Features
Crystal oscillator	40 MHz or 38.4 MHz	Drive a PLL to achieve higher clock rates Higher noise immunity within the oscillator Enable different power modes
32 kHz crystal oscillator	32 kHz	Remains “always-on” and is used to drive the RTC Low-power UART operation Main system clock for very low frequency operation with very high accuracy
RC 32 kHz internal oscillator	32 kHz	Remains “always-on” and is used to drive the RTC Low-power UART operation Main system clock for very low frequency operation with ± 50% accuracy
External clock source	32.768 kHz	Enable different power modes Option to select very high accuracy TCXO Can be used to drive the RTC Low-power UART operation

Table 3: Clock sources and features

☞ See also chapter 3.12 in RW612 data sheet [27], for further information on clock sources.

To get the lowest possible current consumption from the module in sleep mode, an external TCXO is needed. If an external clock source is not connected, the internal, less accurate, oscillator is used.

[1] Reference design available only after certification

2.6.1 External clock source

If additional power savings are required, an external low-frequency Crystal oscillator can be connected to Pin J1 and J2. Table 4 shows the requirements of an external 32.768 kHz crystal oscillator.

☞ Pin J1 and J2 are multiplexed with RMII signals.

Parameter	Min	Typ	Max	Unit
Clock frequency	-	32.768	-	kHz
Frequency accuracy	-	-	-22/-192	PPM
Phase noise requirement @ 100 kHz	60	-125	-	dBc/Hz
Cycle jitter	-	1.5	-	ns (RMS)
Slew rate limit (10-90%)	-	-	100	ns
Duty cycle	46.7	47.4	49.77	%

Table 4: Crystal oscillator requirements

2.7 Data interfaces

IRIS-W10 series modules offer following data interfaces:

- Up to five configurable (Flexcomm) universal serial interfaces, independently configured for:
  - UART, max 6.25 Mbit/s
  - USART, max 20 Mbit/s
  - SPI, max 30 Mbit/s
  - I2C, max 1 Mbit/s (supports high-speed target mode up to 3.4 Mbit/s)
  - I2S
- 1 × High speed USB 2.0 OTG (480Mbit/s)
- 1 x SDIO 3.0 device interface
- 1 x 100-Mbit Ethernet RMII

Table 5 shows the pin assignments of each Flexcomm interface.

Pin name	Flexcomm interface							Ethernet
Pin #	**Flexcomm #**	**USART**	**I2C**	**I2S**	**SPI**	**SDIO**	**JTAG/SWD**	**RMII**
M11	0	USART_CTS	-	-	SPI_CS	-	-	-
M10		USART_RXD	I2C_SDA	I2S_DAT	SPI_MOSI	-	-	-
N10		USART_TXD	I2C_SCL	I2S_WS	SPI_MISO	-	-	-
M9		USART_CLK	-	I2S_CLK	SPI_CLK	-	-	-
N9		USART_RTS	-	I2S_MCLK	-	-	-	-
B14	1	USART_CTS	-	-	SPI_CS	-	JTAG-TCK	-
A14		USART_CLK	-	I2S_CLK	SPI_CLK	-	JTAG-TMS	-
B12		USART_TXD	I2C_SCL	I2S_WS	SPI_MISO	-	JTAG-TDI	-
A12		USART_RXD	I2C_SDA	I2S_DAT	SPI_MOSI	-	JTAG-TDO	-
B11		USART_RTS	-	-	-	-	JTAG-nRST	-
A6	2	USART_RXD	I2C_SDA	I2S_DAT	SPI_MOSI	-	SWCLK	-
B5		USART_TXD	I2C_SCL	I2S_WS	SPI_MISO	-	SWDIO	-
C6		USART_CLK	-	I2S_CLK	SPI_CLK	SDIO_CLK	-	-
C8		USART_CTS	-	-	SPI_CS	SDIO_D3	-	-
C7		USART_RTS	-	-	-	SDIO_CMD	-	-

B8	3	USART_RTS	-	-	-	SDIO_D0	-	-
A9		USART_CTS	-	-	SPI_CS	SDIO_D1	-	-
B9		USART_RXD	I2C_SDA	I2S_DAT	SPI_MOSI	-	-	RMII_TMR2
F3		USART_CLK	-	I2S_CLK	SPI_CLK	-	-	RMII_CLK
A10		USART_TXD	I2C_SCL	I2S_WS	SPI_MISO	-	-	RMII_TMR3
N3	14	USART_CTS	-	-	SPI_CS	-	-	-
N2		USART_CLK	-	I2S_CLK	SPI_CLK	-	-	-
L4		USART_RTS	-	-	-	-	-	RMII_INT
L2		USART_TXD	I2C_SCL	I2S_WS	SPI_MISO	-	-	RMII_MDC
L1		USART_RXD	I2C_SDA	I2S_DAT	SPI_MOSI	-	-	RMII_MDIO
C9	-	-	-	-	-	SDIO-D2	-	-
J1	-	-	-	-	-	-	-	RMII_RXD0
J2	-	-	-	-	-	-	-	RMII_ RXD1
E2	-	-	-	-	-	-	-	RMII_TMR0
K1	-	-	-	-	-	-	-	RMII_TXD0
K2	-	-	-	-	-	-	-	RMII_TXD1
J3	-	-	-	-	-	-	-	RMII_TXEN
K3	-	-	-	-	-	-	-	RMII_TMR1
M1	-	-	-	-	-	-	-	RMII_CRSDV
N1	-	-	-	-	-	-	-	RMII_RXERR

Table 5: Flexcomm interface pin assignments

2.7.1 Universal Synchronous Asynchronous Receiver Transmitter (USART)

IRIS-W10 series modules have up to five UART/USART interfaces for data communication and firmware upgrade as shown in Table 5.

- FC0: UART Max 6.25 Mbit/s, USART Max 20 Mbit/s.
- FC1: UART Max 6.25 Mbit/s, USART Max 20 Mbit/s. Pins are multiplexed with JTAG interface.
- FC2: UART Max 6.25 Mbit/s, USART Max 20 Mbit/s. Pins are multiplexed with SDIO interface.
- FC3: UART Max 6.25 Mbit/s, USART Max 20 Mbit/s. Pins are multiplexed with RMII and SDIO interface. It can be used for firmware upgrade.
- FC14: UART Max 6.25 Mbit/s, USART Max 20 Mbit/s. Pins are multiplexed with RMII interface.

Each interface provides a 4-wire UART/USART communication with a host application processor using AT commands. Each UART supports the following signals:

- Data lines (**RXD** as input, **TXD** as output)
- Hardware flow control lines (**CTS** as input, **RTS** as output)

You can use the UARTs in 4-wire mode with hardware flow control, or in 2-wire mode with **TXD** and **RXD** only.

☞ To avoid buffer overrun, UART operation in 2-wire mode is not recommended for speeds above 115 200 bps.

UART on FC3 interface can also be used for firmware upgrade. It is recommended that this UART is either connected to a header for firmware upgrade or made available with test points.

2.7.2 Serial peripheral interface (SPI)

IRIS-W10 series modules have up to five SPI interface as shown in Table 5. Each interface supports *Main* and *Sub* nodes up to maximum bit rate of 30 Mbps.

IRIS-W10 series also supports QSPI interface for use with external pSRAM. The interfaces are supplied from the VIO power domain.

Table 6 describes the pin assignment and interface functions of each QSPI memory signals.

IRIS-W10 pin	Pin name	Description
A2	QSPI-RCLK	Clock
A5	QSPI-RCE	Chip enable
B4	QSPI-RD0	Data 0
A4	QSPI-RD1	Data 1
B3	QSPI-RD2	Data 2
A3	QSPI-RD3	Data 3

Table 6: QSPI interface signals and pins

2.7.3 Inter-Integrated Circuit interface (I2C)

IRIS-W10 series modules have up to five I2C interfaces as shown in Table 5. Each I2C interface consists of two signals: **SCL** and **SDA**.

Each interface can operate as Main or Sub node supporting data speeds:

- Standard (≤100 kbps)
- Fast (≤400 kbps)
- Fast plus (≤1 Mbps)
- High-speed (≤3.4 Mbps)

☞ External pull up resistors are required on each I2C interface signals. The value of the pull-up resistor should be selected depending on the speed and capacitance of the bus.

2.7.4 Inter-Integrated Sound interface (I2S)

IRIS-W10 series modules have up to five I2S interfaces as shown in Table 5. Each I2S interface consists of three signals: **DAT** (data)**, WS** (word select/frame trigger) and **CLK** (clock).

The I2S interface within one flexcomm interface can implement up to 4 I2S channel pairs. The first pair could be a Main or a Sub, and the rest of the channel pairs would be Sub.

2.7.5 USB 2.0

IRIS-W10 series modules include a USB 2.0 UTMI+ level 3 PHY handling the low-level USB 2.0 protocol and signaling.

The USB 2.0 supports:

- High speed mode - 480 Mbps
- Full speed mode - 12 Mbps
- Low speed mode - 1.5 Mbps

Table 7 describes the pin assignment of USB 2.0 interface.

IRIS-W10 pin	Pin name
E3	USB_VBUS
E1	USB_DM
F1	USB_DP
F2	USB_ID

Table 7: USB interface pins

☞ The USB electrical specification is described in IRIS-W10 data sheet [4].

2.7.5.1 USB OTG

USB interface includes one USB OTG capable host/device controller. For full OTG support, USB_VBUS and USB_ID pins are required. USB_VBUS is a detection pin powered by a 5 V input. For standard USB host/device mode, USB_VBUS is configured to bypass detection.

2.7.6 RMII

IRIS-W10 series modules include a seamless 2-bit Reduced MII (RMII) ethernet interface operating at 50 MHz. The interface is intended to connect an external PHY. Table 5 shows RMII pin assignment on flexcomm and other GPIOs.

The RMII interface requires an external 50 MHz clock source either from a compatible PHY chip or from an external oscillator.

The MAC/NET core includes a 10/100 MAC, with layer 3 network acceleration. It supports all IEEE 1588 features and implements the full 802.3 specification.

2.7.7 SDIO 3.0

IRIS-W10 series modules have a SDIO device interface that is compatible with the industry standard SDIO 3.0 specification (UHS-I, up to 104 Mbyte/s). It allows a controller to use the SDIO bus protocol to access Wi-Fi and Bluetooth LE functions. The module also supports legacy modes, such as default speed and High-Speed modes. Table 5 shows SDIO pin assignment on flexcomm.

IRIS-W10 acts as a device on the SDIO bus. Table 8 shows the supported bus speed modes.

Bus speed mode	Max. bus speed [MB/s]	Max. clock frequency [MHz]	Signal voltage [V]
High Speed	25	50	3.3
Default Speed	12.5	25	3.3
SDR104	104	208	1.8
SDR50	50	100	1.8
SDR25	25	100	1.8
SDR12	12.5	100	1.8
DDR50	50	50	1.8

Table 8: SDIO supported rates

☞ There are typically 100 kΩ pull-up resistor on all SDIO interface pins. The SDIO interface pins are powered by the **VIO** voltage domain.

2.8 Digital interfaces

IRIS-W10 series modules offer following digital interfaces:

- 5 general purpose 32-bit timer/counter

- SCTimer/PWM (SCT)
- Micro-tick timer (UTICK)
- 64 General purpose input/output

Table 9 shows the pin assignments of each digital interface.

Interface	Description	Configurable Pins
32-bit timer/counter	High precision time measurement between two pulses/ Pulse counting with interrupt/event generation.	M11, N11, B10, A6, B5, M2, B9, F3, D3, B4, A4, N4, M3, N3, N2
SCTimer/PWM (SCT)	Timing, counting, output modulation, and input capture operations. The inputs/outputs are shared with the inputs/outputs of the 32-bit general-purpose counter/timers. It can be configured as two 16-bit counters or a unified 32-bit counter.	N10, M9, A11, J1, J2, A10, E2, A2, A5, L4
Micro-tick timer (UTICK)	A 32-bit MicroTick timer that runs at 1 MHz. Ultra simple, ultra-low power timer that can run and wake up the device in reduced power modes other than deep sleep mode.	C6, C7, C8, C9
General purpose input	Digital input with configurable edge detection and interrupt generation.	Any
General purpose output	Digital output with configurable drive strength, pull-up, pull-down, open-source, open-drain and/or slew rate.	Any
Pin disabled	Pin is disconnected from input buffers and output drivers.	Any

Table 9: Digital interfaces pin configuration

☞ See RW612 data sheet [27], for more information on analog interfaces.

2.9 Analog interfaces

IRIS-W10 series modules offer following analog interfaces:

- 8-channel 16-bit Analog digital converter (ADC)
- 2-channel 10-bit Digital analog converter (DAC)
- 2 Analog comparator

Table 10 shows the pin assignments of each analog interface.

Interface	Description	Configurable Pins
ADC	A 2-step converter with up to 16-bit resolution. This ADC offers up to 8 individually configurable channels and a reference voltage regulator. The ADC clock is 64 MHz (normal mode) or 67.07 MHz (audio mode). Both are provided by the AUPLL.	M8, N8, M7, N7, M6, N6, M5, N5
DAC	A 10-bit resistor string-based DAC. Each channel can produce a single-ended signal or combine with another channel to generate a differential signal.	Channel A output: M7 Channel B output: N8 EXT_VREF: N7
Analog comparator	Two analog identical comparators, ACOMP0 and ACOMP1. The Comparator outputs are latched and can be used as interrupts.	M8, N8, M7, N7, M6, N6, M5, N5

Table 10: Analog interfaces pin configuration

☞ See RW612 data sheet [27], for more information on analog interfaces.

2.10 Debug interface

IRIS-W10 series modules offer two interfaces for debugging and flashing IRIS-W10 module: **JTAG** and **SWD**.

On power-up or reset, the status of pin **RF-CNTL2** determines the active interface, as described in Table 2.

⚠ For security reasons, disable the debug interface to prevent the upload or download of unauthorized software – or software that has not been validated.

2.10.1 Joint test action group (JTAG)

JTAG interface pins are multiplexed with flexcomm 1 pins as shown in Table 5. A standard 2x5 pin, 1.27 mm pitch header or a 10-pin needle connector (used with SEGGER J-link probe) can be implemented onboard to access the JTAG pins.

☞ Refer EVK-IRIS-W1 user guide [3] for hardware implementation.

2.10.2 Serial Wire Debug (SWD)

SWD interface pins are multiplexed with flexcomm 2 pins as shown in Table 5. To enable SWD on power-up or reset, pull **RF-CNTL2** to **GND**, as described in Table 2.

3 Design-in

Follow the design guidelines stated in this chapter to optimize the integration of IRIS-W10 series modules in the final application board.

3.1 Overview

Although all application circuits must be properly designed, there are several points that require special attention during application design. A list of these points, in order of importance, follows:

- Module antenna connection: **ANT** Pad (IRIS-W101 only)
  Antenna circuits affect the RF compliance of all applications that include the certification schemes related to the module. To maintain compliance and subsequent certification of the application design, it is important to observe the applicable parts of antenna schematic and layout design described in RF interface.
- Module supply: **VCC, VCC_IO** and **GND** pins.
  Supply circuits can affect RF performance. It is important to observe the schematic and layout design for these supplies. See also VCC application circuits. Modules normally include several supply pins described in the pin out of the IRIS-W10 data sheet [2].
- High-speed data interfaces: **UART**, **SPI**, and **I2C** pins.
  High-speed data interfaces are a potential source of radiated noise that can affect the regulatory compliance standards for radiated emissions. It is important to follow the schematic and layout design recommendations described in the General layout guidelines.
- System functions: **nRESET**, GPIO, and other System input and output pins
  Careful utilization of these pins in the application design is required to guarantee correct boot up and system operation. Ensure that the voltage level is correctly defined during module boot. It is important to follow the schematic and layout design recommendations described in the General layout guidelines.
- Other pins: **ADC** and NC pins.
  Careful utilization of these pins is required to guarantee proper functionality. It is important to follow the schematic and layout design recommendations described in the General layout guidelines.

3.2 RF interface

As the unit cannot be mounted arbitrarily, the placement should be chosen with consideration so that it does not interfere with radio communication. IRIS-W106 module with a PCB trace antenna cannot be mounted in a metal enclosure. No metal casing or plastics using metal flakes should be used. Avoid metallic based paint or lacquer as well. IRIS-W101 module offers more freedom as an external antenna can be mounted further away from the module.

⚠ According to the FCC regulations, the transmission line from the module antenna pin to the antenna or antenna connector on the host PCB is considered part of the approved antenna design. Therefore, module integrators must either follow exactly one of the antenna reference designs used in the module's FCC type approval or certify their own designs.

3.2.1 Antenna design

To optimize the radiated performance of the final product, the selection and placement of both the module and antenna must be chosen with due regard to the mechanical structure and electrical design of the product. To avoid later redesigns, it is important to decide the positioning of these components at an early phase of the product design.

Other than the product performance, the compliance and subsequent certification of the RF design depends heavily on the radiating performance of the antennas. To ensure proper performance of IRIS-W10 modules, carefully follow the guidelines outlined below. Note also that the RF certification of the module is extended through application design.

- External antennas, including, linear monopole classes:
    - Place the module and antenna in any convenient area on the board. External antennas don't impose any restriction on where the module is placed on the PCB.
    - Select antennas with an optimal radiating performance in the operating bands. The radiation performance depends mainly on the antennas.
    - Choose RF cables that offer minimum insertion loss. Unnecessary insertion loss is introduced by low quality or long cables. Large insertion losses reduce radiation performance.
    - Use a high-quality 50 Ω coaxial connector for proper PCB-to-RF cable transition.
- Integrated antennas, such as patch-like antennas:
    - Internal integrated antennas impose some physical restrictions on the PCB design:
        - Integrated antennas excite RF currents on its counterpoise, typically the PCB ground plane of the device that becomes part of the antenna; its dimension defines the minimum frequency that can be radiated. Therefore, the ground plane can be reduced to a minimum size that should be similar to the quarter of the wavelength of the minimum frequency that has to be radiated, given that the orientation of the ground plane related to the antenna element must be considered.
        - Find a numerical example to estimate the physical restrictions on a PCB, where: Frequency = 2.4 GHz → Wavelength = 12.5 cm → Quarter wavelength = 3.5 cm in free space or 1.5 cm on a FR4 substrate PCB.
- Choose antennas with optimal radiating performance in the operating bands. Radiation performance depends on the complete product and antenna system design, including the mechanical design and usage of the product. Table 11 summarizes the requirements for the antenna RF interface.
- Ensure that the RF isolation between the system antennas is maximized and that the correlation between their 3D radiation patterns is minimized. Typically, an RF separation of at least a quarter wavelength between the two antennas is necessary to achieve minimum isolation and low pattern correlation. If possible, increase the separation to maximize the performance and fulfill the requirements in Table 12.

Item	Requirements	Remarks
Impedance	50 Ω nominal characteristic impedance	The impedance of the antenna RF connection must match the 50 Ω impedance of the antenna pins.
Frequency Range	2400 - 2500 MHz 5150 - 5850 MHz	For 802.11b/g/n/ax and Bluetooth LE. For 802.11a/n/ac/ax.
Return Loss	S11 < -10 dB (VSWR < 2:1) recommended S11 < -6 dB (VSWR < 3:1) acceptable	The Return loss or S_{11} S parameter (normally represented on vector network analyzers) in the voltage standing-wave ratio (VSWR) refers to reflected power. This loss is a measurement of how well the primary RF antenna connection matches the 50 Ω characteristic impedance of the antenna pins. To maximize the amount of power transferred to the antenna, the impedance of the antenna termination must match (as far as possible) the 50 Ω nominal impedance of antenna pins over the operating frequency range.
Efficiency	> -1.5 dB (> 70%) recommended > -3.0 dB (> 50%) acceptable	Radiation efficiency is the ratio of the radiated power to the power fed to the antenna input. This is a measurement of how well an antenna receives or transmits data.
Maximum Gain		To comply with regulatory agencies radiation exposure limits, the maximum antenna gain must not exceed the value specified in Approved antennas for equivalent antenna type.

Table 11: Summary of antenna interface requirements

Table 12 specifies additional requirements for implementing a dual antenna design.

Item	Requirements	Remarks
Isolation (in-band)	S21 > 30 dB recommended	The antenna-to-antenna isolation is the S21 parameter between the two antennas in the band of operation. Lower isolation might be acceptable depending on use-case scenario and performance requirements.
Isolation (out-of-band)	S21 > 35 dB recommended S21 > 30 dB acceptable	Out-of-band isolation is evaluated in the band of the aggressor. This ensures that the transmitting signal from the other radio is sufficiently attenuated by the receiving antenna. It also avoids any saturation and intermodulation effect on the receiver port.

Table 12: Summary of Wi-Fi/Bluetooth coexistence requirements

Select antennas that provide:

- Optimal return loss (or VSWR) over all the operating frequencies
- Optimal efficiency figure over all the operating frequencies
- An appropriate gain that does not exceed the regulatory limits specified in some regulatory country authorities like the FCC in the United States.

A useful approach for the antenna microstrip design is to place a U.FL connector close to the embedded PCB or chip antenna. The U.FL connector only needs to be mounted on units used for verification.

3.2.2 RF transmission line design

RF transmission lines, such as those that connect from **RF_ANT** pin to the antenna or antenna connector, must be designed with a characteristic impedance of 50 Ω.

Figure 4 shows the design options for implementing a transmission line, namely:

- Microstrip – track separated with dielectric material and coupled to a single ground plane.
- Coplanar microstrip – track separated with dielectric material and coupled to both the ground plane and side conductor. This is the most common transmission line implementation.
- Stripline – track separated by dielectric material and sandwiched between two parallel ground planes.

The parameters shown in the cross-sectional area of each trace design include:

- Width (W) – shows the width of the copper layer on the top layer
- Distance (S) – shows the distance between the top copper layer and the two adjacent GND planes.
- Dielectric substrate thickness (H) – shows the distance between the GND reference on the bottom plane and the copper layer on the top layer.
- Thickness of the copper layer (T) – can also be represented by "Base Copper Weight", which is commonly used as the parameter for PCB stack-up.

Dielectric constant (ε_r) defines the ratio between the electric permeability of the material against the electric permeability of free space.

☞ The width of a 50 Ω microstrip depends on mainly "ε_r" and "H", which must be calculated for each PCB layer stack-up.

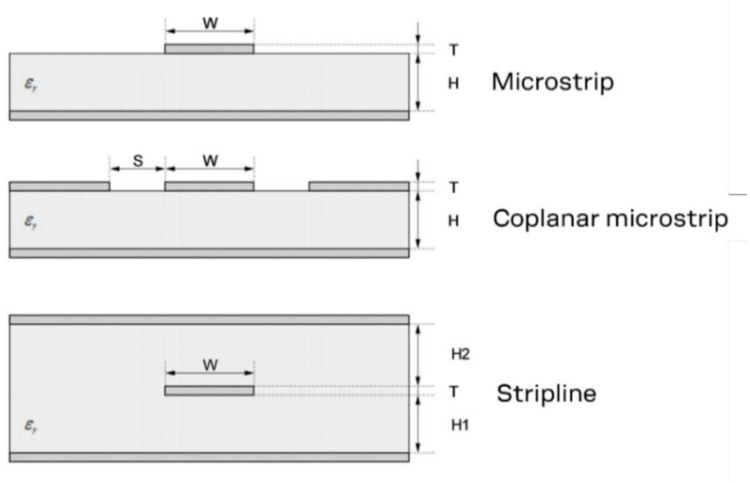


Figure 4: Transmission line trace design

Follow these recommendations to design a 50 Ω transmission line correctly:

- The designer should provide enough clearance from surrounding traces and ground in the same layer; in general, a trace to ground clearance of at least two times the trace width should be considered. The transmission line should also be "guarded" by ground plane area on each side.
- The characteristic impedance can be calculated as first iteration using tools provided by the layout software. It is advisable to ask the PCB manufacturer to provide the final values that are usually calculated using dedicated software and available stack-ups from production. It could also be possible to request an impedance coupon on panel's side to measure the real impedance of the traces.
- FR-4 dielectric material, although its high losses at high frequencies can be considered in RF designs provided that:
  - RF trace length must be minimized to reduce dielectric losses.
  - If traces longer than a few centimeters are needed, it is recommended to use a coaxial connector and cable to reduce losses
  - Stack-up should allow for thick 50 Ω traces and at least 200 µm trace width is recommended to assure good impedance control over the PCB manufacturing process.
  - FR-4 material exhibits poor thickness stability and thus less control of impedance over the trace length. Contact the PCB manufacturer for specific tolerance of controlled impedance traces.
- The transmission lines width and spacing to the GND must be uniform and routed as smoothly as possible: route RF lines in 45 °C angle or in arcs.
- Add GND stitching vias around transmission lines.
- Ensure solid metal connection of the adjacent metal layer on the PCB stack-up to main ground layer, providing enough vias on the adjacent metal layer.
- Route RF transmission lines far from any noise source (as switching supplies and digital lines) and from any sensitive circuit to avoid crosstalk between RF traces and Hi-impedance or analog signals.
- Avoid stubs on the transmission lines, any component on the transmission line should be placed with the connected pad over the trace. Also avoid any unnecessary component on RF traces.

3.2.3 IRIS-W101

IRIS-W101 is best suited for designs where an external antenna is needed due to mechanical integration or placement of the module.

Designers must take care of the antennas from all perspectives at the beginning of the design phase when the physical dimensions of the application board are under analysis/decision, as the RF compliance of the device integrating IRIS-W101 module with all the applicable required certification schemes heavily depends on the radiating performance of the antennas. The designer is encouraged to consider one of the u-blox suggested antenna part numbers and follow the layout requirements.

3.2.3.1 RF connector design

If an external antenna is required, the designer should consider using a proper RF connector. The designer must verify the compatibility between plugs and receptacles used in the design.

Table 13 suggests several RF connector plugs that can be used by the designers to connect RF coaxial cables based on the declaration of the respective manufacturers. The Hirose U.FL-R-SMT RF receptacles (or similar parts) require a suitable mated RF plug from the same connector series. Due to wide usage of this connector, several manufacturers offer compatible equivalents.

Manufacturer	Series	Remarks
Hirose	U.FL® Ultra Small Surface Mount Coaxial Connector	Recommended
I-PEX	MHF® Micro Coaxial Connector	
Tyco	UMCC® Ultra-Miniature Coax Connector	
Amphenol RF	AMC® Amphenol Micro Coaxial	
Lighthorse Technologies, Inc.	IPX ultra micro-miniature RF connector	

Table 13: U.FL compatible plug connector

Typically, the RF plug is available as a cable assembly. Different types of cable assembly are available; the user should select the cable assembly best suited to the application. The key characteristics are:

- RF plug type: select U.FL or equivalent
- Nominal impedance: 50 Ω
- Cable thickness: Typically, 0.8 mm to 1.37 mm. Select thicker cables to minimize insertion loss.
- Cable length: Standard length is typically 100 mm or 200 mm; custom lengths may be available on request. Select shorter cables to minimize insertion loss.
- RF connector on the other side of the cable, for example, another U.FL (for board-to-board connection) or SMA (for panel mounting)

Note that SMT connectors are typically rated for a limited number of insertion cycles. In addition, the RF coaxial cable may be relatively fragile compared to other types of cables. To increase application ruggedness, connect U.FL connector to a more robust connector such as a sub-miniature A (SMA) connector fixed to the panel.

☞ A de-facto standard for SMA connectors suggests that the use of reverse polarity connectors (RP-SMA) on Wi-Fi and Bluetooth end products can deter end users from replacing the antenna with higher gain types that exceed regulatory limits.

Strictly follow the connector manufacturer’s recommended layout:

- SMA Pin-Through-Hole connectors require GND keep-out (clearance/void area) on all the layers around the central pin up to the annular pads of the four GND posts.
- SMA side-mounted connector (or similar): If the RF pad of the connector is wider than the microstrip, remove the GND layer beneath the RF connector. This minimizes stray capacitance and maintains the RF line at 50 Ω.
- U.FL. surface mounted connectors require no conductive traces in the area below the connector between the GND land pads. For instance, the active pad of the U.FL. connector must have a GND keep-out area on at least the first inner layer to reduce parasitic capacitance to ground.

Figure 5 shows the layout of pads for U.FL connector. Consider especially the GND clearance under the signal pad.

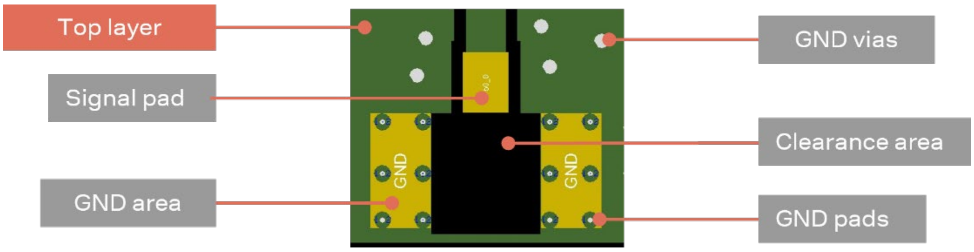


Figure 5: GND keepout on top layer under U.FL connector

3.2.3.2 Integrated antenna design

If integrated antennas are used, the transmission line is terminated by the antennas themselves or by the antenna together with the connected coaxial cable and U.FL connector. Consider the following guidelines when designing the antenna:

- The antenna design process should start at the beginning of the whole product design process. Self-made PCBs and antenna assemblies are useful in estimating overall efficiency and radiation path of the intended design.
- Use antennas designed by an antenna manufacturer to provide the best possible return loss (or VSWR).
- Provide a ground plane large enough to meet the related integrated antenna requirements. The ground plane of the application PCB may be reduced to a minimum size that must be similar to one quarter of wavelength of the minimum frequency that has to be radiated. However, larger ground planes can improve antenna efficiency.
- Proper placement of the antenna and the surrounding area is also critical for antenna performance. Avoid placing the antenna close to conductive or RF-absorbing parts, such as metal objects, ferrite sheets, and so on. These objects tend to absorb part of the radiated power, shift the resonant frequency of the antenna or affect the antenna radiation pattern.
- To correctly install and deploy the antenna system, including PCB layout and matching circuitry, it is strongly advised that you adhere to the manufacturer's detailed guidelines.
- Further to the custom PCB and product restrictions, antennas may require tuning/matching to comply with all the applicable required certification schemes. It is strongly advised that you consult the antenna manufacturer for specific design-in guidelines and plan validation activities for the final prototypes, such as tuning, matching, and performance assessments.
- Avoid placing the antenna close to buses such as DDR or consider taking specific countermeasures like metal shields or ferrite sheets to reduce interference. Noise sources like hi-speed digital buses can affect the RF section.

⚠ Be aware of interaction between co-located RF systems, like LTE sidebands on 2.4 GHz band. Transmitted power can interact or disturb the performance of IRIS-W1 modules in instances where a specific LTE filter isn't included.

3.2.4 IRIS-W106

IRIS-W106 modules include an internal PCB trace antenna that is integrated on the module PCB using antenna technology from Abracon. The RF signal is completely internal and not connected to any module pin.

IRIS-W106 modules can't be mounted inside a metal enclosure. Metal casings or plastics that include metal flakes should not be used. Metallic-based paints and lacquers should also be avoided.

3.2.4.1 Internal PCB trace antenna

For optimal operating performance, observe the following layout considerations when developing the antenna layout:

- The module shall be placed in the center of an edge of the host PCB.
- A large ground plane on the host PCB is a prerequisite for good antenna performance. It is recommended to have the ground plane extending at least 10 mm on the three non-edge sides of the module as shown in Figure 6.
- The host PCB shall include a full GND plane underneath the entire module, with a ground cut out under the internal PCB trace antenna on all layers as shown in Figure 6.
- NORA-W406 has six GND pads located close to the antenna that need to be connected to GND for good antenna performance. Detailed measurements of the footprint can be found in the IRIS-W10 series data sheet [2].
- Include plenty of stitching vias from the module ground pads to the GND plane layer. Ensure that the impedance between the module pads and ground reference is minimal.
- High / large parts including metal shall not be placed closer than 10 mm to the module's antenna.
- At least 10 mm clearance between the antenna and the casing is recommended. If the clearance is less than 10 mm, the antenna performance can be adversely affected. Polycarbonate (PC) and Acrylonitrile butadiene styrene (ABS) materials have less impact on antenna performance than other types of thermoplastics.
- The module shall be placed such that the antenna faces outwards from the product and is not obstructed by any external items in close vicinity of the products intended use case.

Figure 6 shows a typical trace and ground design for IRIS-W106, including the critical dimensions between the ground plane and three non-edge sides of the module.

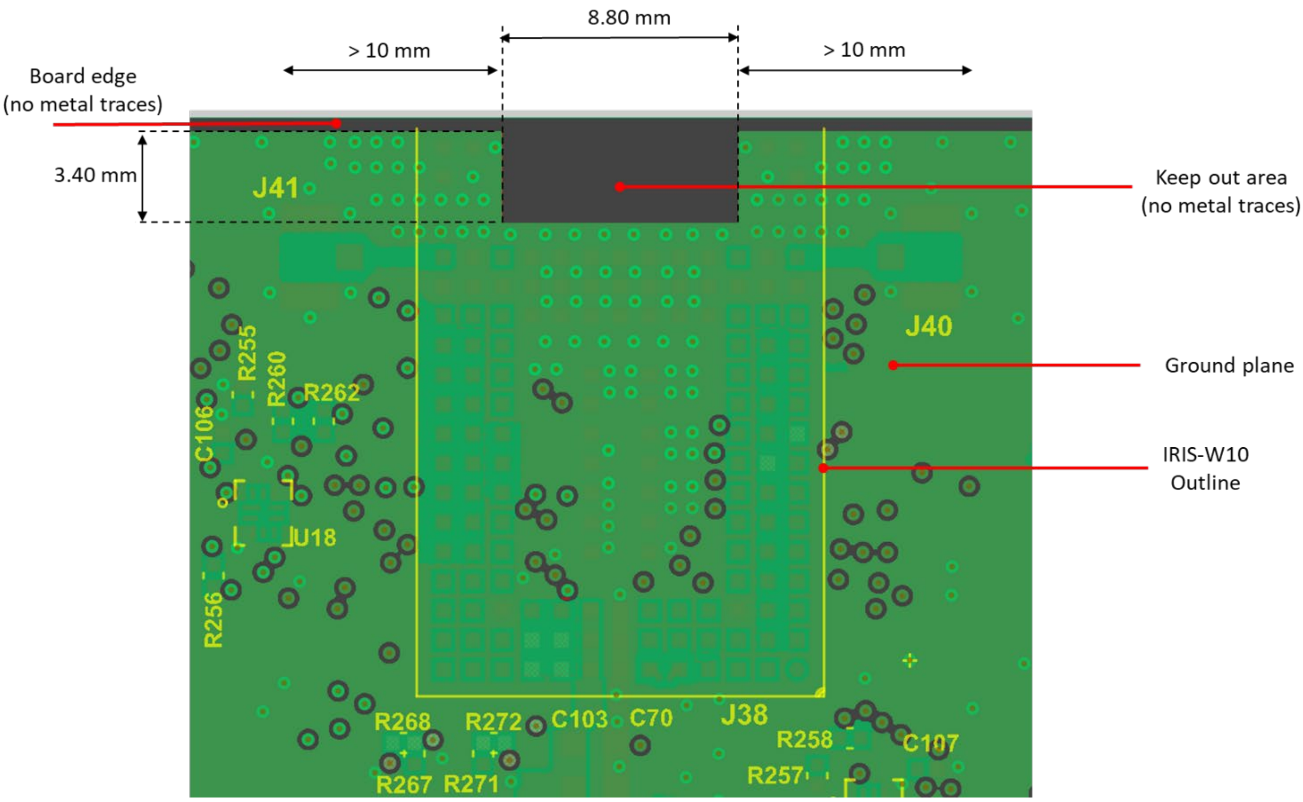


Figure 6: Antenna keepout area and GND plane design

3.3 Data communication interfaces

3.3.1 SDIO 3.0

The design of the SDIO 3.0 bus demands special attention to meet signal integrity requirements and minimize electromagnetic interference (EMI) issues. Route these signals with a single ended impedance of 50 Ω.

Route all signals in the bus with the same length and have appropriate grounding in the surrounding layers. Also minimize the total bus length. Layout the SDIO bus so that crosstalk with other parts of the circuit is minimized. This provides adequate isolation between the signals, clock, and surrounding busses/traces. Also include an undisrupted return current path in close vicinity to the signal traces.

Figure 7 shows the suggested application schematic for the SDIO bus. The electrical requirements of the bus are described in Table 14.

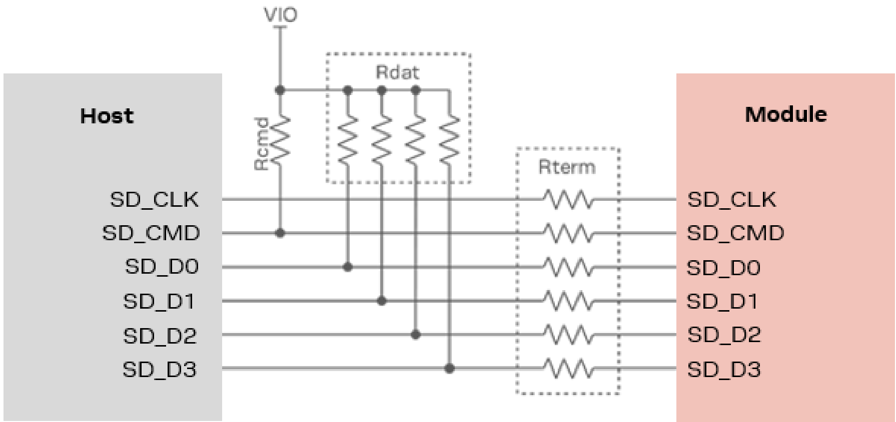


Figure 7: SDIO application schematic

☞ As an EMI debug option and signal termination for **SDIO_CLK**, consider using a small-value capacitor in the range of few picofarads to GND. Place the capacitor as close as possible to the clock input pin on the module. Mount the capacitor only if it is needed for EMI protection. The capacitor increases the total line capacitance which must not be so great that it violates the clock rise time and the timing specifications.

Signal Group	Parameter	Min.	Typ.	Max.	Unit
CLK, CMD, DAT[0:3]	Single ended impedance, Z_0		50		Ω
CLK, CMD, DAT[0:3]	Impedance control	$Z_0 - 10\%$	Z_0	$Z_0 + 10\%$	Ω
DAT[0:3]	Pull-Up range, Rdat	10	47	100	kΩ
CMD	Pull-Up range, Rcmd	10	10	50	kΩ
CLK, CMD, DAT[0:3]	Series termination (Host side), Rterm[2]	0	0		Ω
CLK, CMD, DAT[0:3]	Bus length[3]			100	mm
CMD, DAT[0:3]	Bus skew length mismatch to CLK	-3		+3	mm
CLK	Center to center CLK to other SDIO signals[4]	4*W			
CMD, DAT[0:3]	Center to center between signals[11]	3*W			

Table 14: SDIO bus requirements

[2] Series termination values larger than typical recommended only for addressing EMI issues.
[3] Routing should minimize the total bus length.
[4] Center to center spacing requirement can be ignored for up to 10 mm of routed length to accommodate BGA escape.

3.3.2 USB 2.0

The USB bus supports Hi-Speed connectivity with a transfer rate of 480 Mb/s. USB 2.0 offers a controlled impedance bus that uses a single differential pair (D+ and D-). The main parameters to consider when calculating the track impedance are shown in Figure 8.

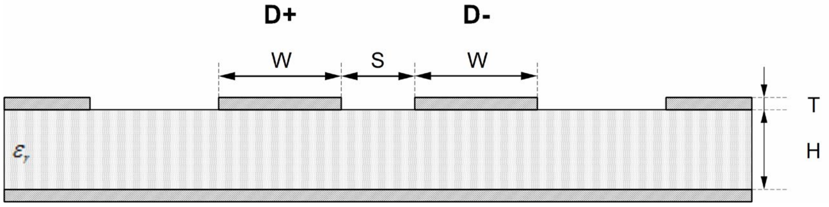


Figure 8: USB differential pair, controlled impedance parameters

To ensure bus signal integrity and avoid EMI issues, the USB data lines, follow the recommendations described in Table 15.

Signal Group	Parameter	Min.	Typ.	Max.	Unit
USB differential data	Single Ended impedance, Z_{SE}	45			Ω
	Differential impedance, Z_{diff}		90		Ω
	Common mode impedance, Z_{CM}		30		Ω
	Impedance control, Z_{SE}, Z_{diff}, Z_{CM}	$Z_0 - 10\%$	Z_0	$Z_0 + 10\%$	
	Shunt capacitance to GND			5	pF
	Bus skew length mismatch between differential pair[5]		0	15[5]	mm
	Isolation to other signals	4 w			

Table 15: USB bus requirements

☞ USB data signals routed on the host board can influence RF performance. So, shunt capacitors or an ESD protection filter connected to GND might be needed to reduce any possible in-band noise caused by USB harmonics.

If the USB data link is routed on a connector, consider the use of a common mode choke with ESD protection on USB lines. To avoid signal degradation, only use common mode chokes to avoid possible EMI issues. For more information about proper ESD protection, see also the ESD guidelines.

3.3.3 Ethernet RMII

It is advisable to route all signals on the RMII bus with the same length. The signals should have appropriate grounding in the surrounding layers, and the total bus length should be minimized. Arrange the RMII bus layout to minimize crosstalk with other parts of the circuit, and provide adequate isolation between the signals, the clock, and the surrounding buses/traces.

Termination resistors are recommended for the RX and TX lines on the RMII bus.

A pull-up resistor is required for **RMII_MDIO** and **RMII_CRSDV**.

[5] Total mismatch includes skew introduced by cable and host-side routing. Keep the routing to a minimum if USB bus is routed on a connector.

3.4 General layout guidelines

This section describes the best practice for the schematic design and circuit layout of the application.

3.4.1 Considerations for schematic design and PCB floor-planning

- Low frequency signals are generally not critical to the layout and designers should focus on the higher speed buses. One exception to this general rule is when high impedance traces, such as signals driven by weak pull resistors, might be affected by crosstalk. For these and similar traces, a supplementary isolation of **4w** (four times the line width) from other buses is recommended.
- Verify which interface bus requires termination and add series resistor terminations to these buses.
- Carefully consider the placement of the module with respect to the antenna position and host processor.
- Verify the controlled impedance dimensions of the selected PCB stack-up. The PCB manufacturer might be able to provide test coupons.
- Verify that the power supply design and power sequence are compliant with module specifications, as described in the IRIS-W10 series data sheet [2].

⚠ Take particular care not to place components close to the antenna area and follow the recommendations from the antenna manufacturer to determine the safe distance between the antenna and any other part of the system. Designers should also maximize the distance between the antenna and high-frequency buses, like DDRs and related components, or consider the use of an optional metal shield to reduce the potential interference picked up by the module antenna.

3.4.2 Component placement

- Place the module such that it provides optimum RF performance. This includes short low loss antenna connections and unobstructed antenna placement. For more information about the module placement and other antenna considerations, see also Antenna integration.
- Place bypass capacitors as close as possible to the module. Prioritize the placement of capacitors with the least capacitance so that these are closest to module pads. The supply rails must be routed through the capacitors from the power supply to the supply pad on the module.
- Do not place components close to the antenna area. Follow the recommendations of the antenna manufacturer to determine distance of the antenna in relation to other parts of the system. Designers should also maximize the distance of the antenna to High-frequency buses, like DDRs and related components. Alternatively, consider an optional metal shield to reduce interferences that might otherwise be picked up by the antenna and subsequently reduce module sensitivity.

3.4.3 Layout and manufacturing

- Avoid stubs on high-speed signals which might adversely affect signal quality. Test points or component pads should be placed over the PCB trace.
- Verify the recommended maximum signal skew for differential pairs and length matching of buses.
- Minimize the routing length. Ensure that the maximum allowable length for high-speed buses is not exceeded. Longer traces generally degrade signal performance.
- For impedance matched traces, consult with your PCB manufacturer early in the project for proper stack-up definition.
- Separate the RF and digital sections of the board.
- Don’t split ground layers under the module.
- Couple all traces (including low speed or DC traces) with a reference plane (GND or power), and reference all hi-speed buses against the ground plane. If any ground reference needs to be changed, add an adequate number of GND vias in the area in which the layer is switched. This is necessary to provide a low impedance path between the two GND layers for the return current.

- Don't change the reference plane for Hi-Speed buses. If changes in the reference plane are unavoidable, add capacitors in the transition area of the reference planes. This is necessary to ensure that a low impedance return path exists through the different reference planes.
- Following the "**3w rule**", keep traces at a distance no less than three times that of its own width from the routing edge of the ground plane.
- For EMC purposes and the need to shield against any potential radiation, it is advisable to add GND stitching vias around the edge of the PCB. Traces on the PCB peripheral are not recommended.

3.5 Module footprint and paste mask

Figure 9 and Figure 10 show the pin layout of IRIS-W10 series module. The proposed land pattern layout complements the pin layout of the module. Both Solder Mask Defined (SMD) and Non Solder Mask Defined (NSMD) pins can be used with adherence to the following considerations:

- All pins should be Non-Solder Mask Defined (NSMD)
- To help with the dissipation of the heat generated by the module, GND pads must have good thermal bonding to PCB ground planes.

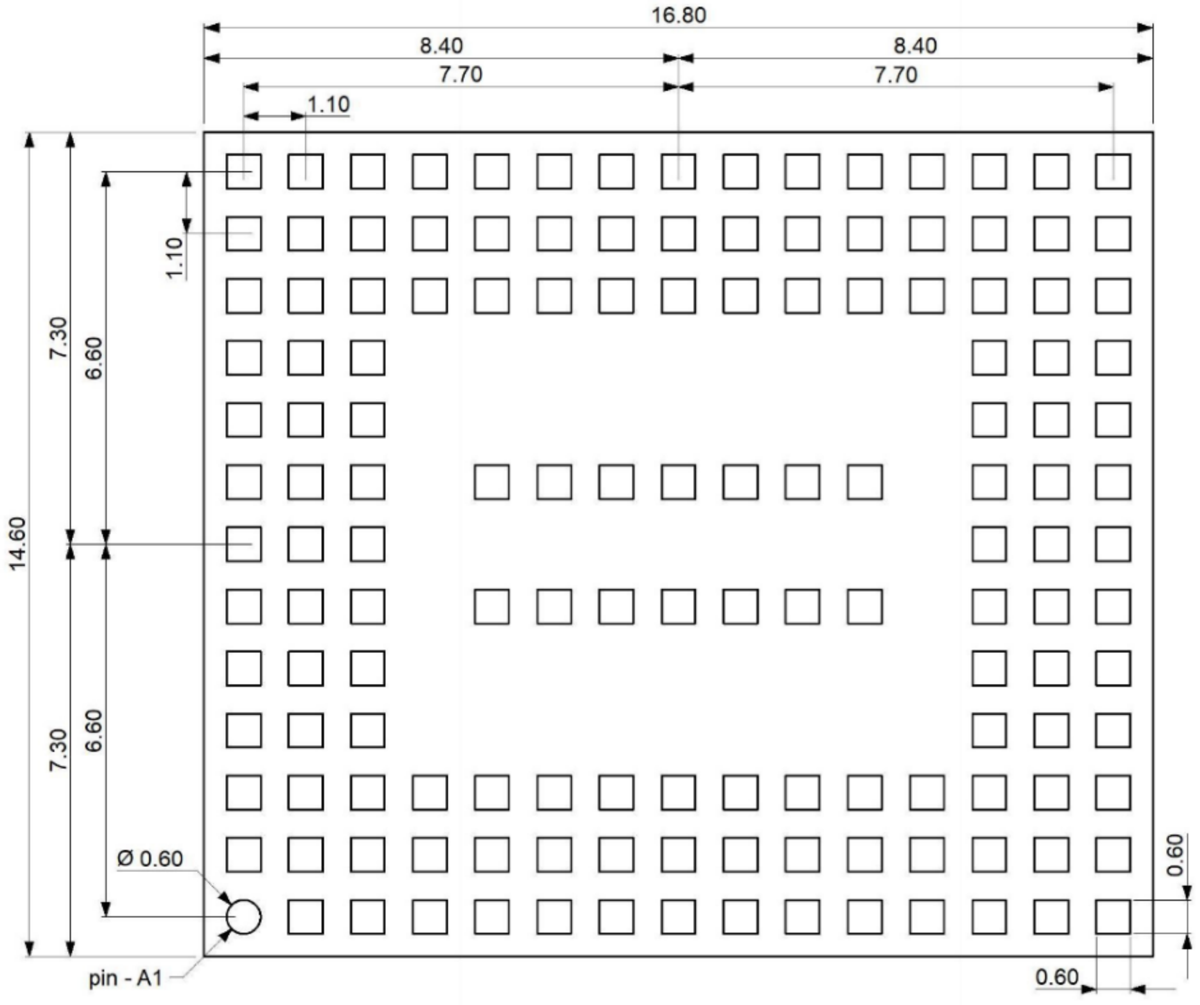


Figure 9: IRIS-W101 recommended PCB footprint (top view)

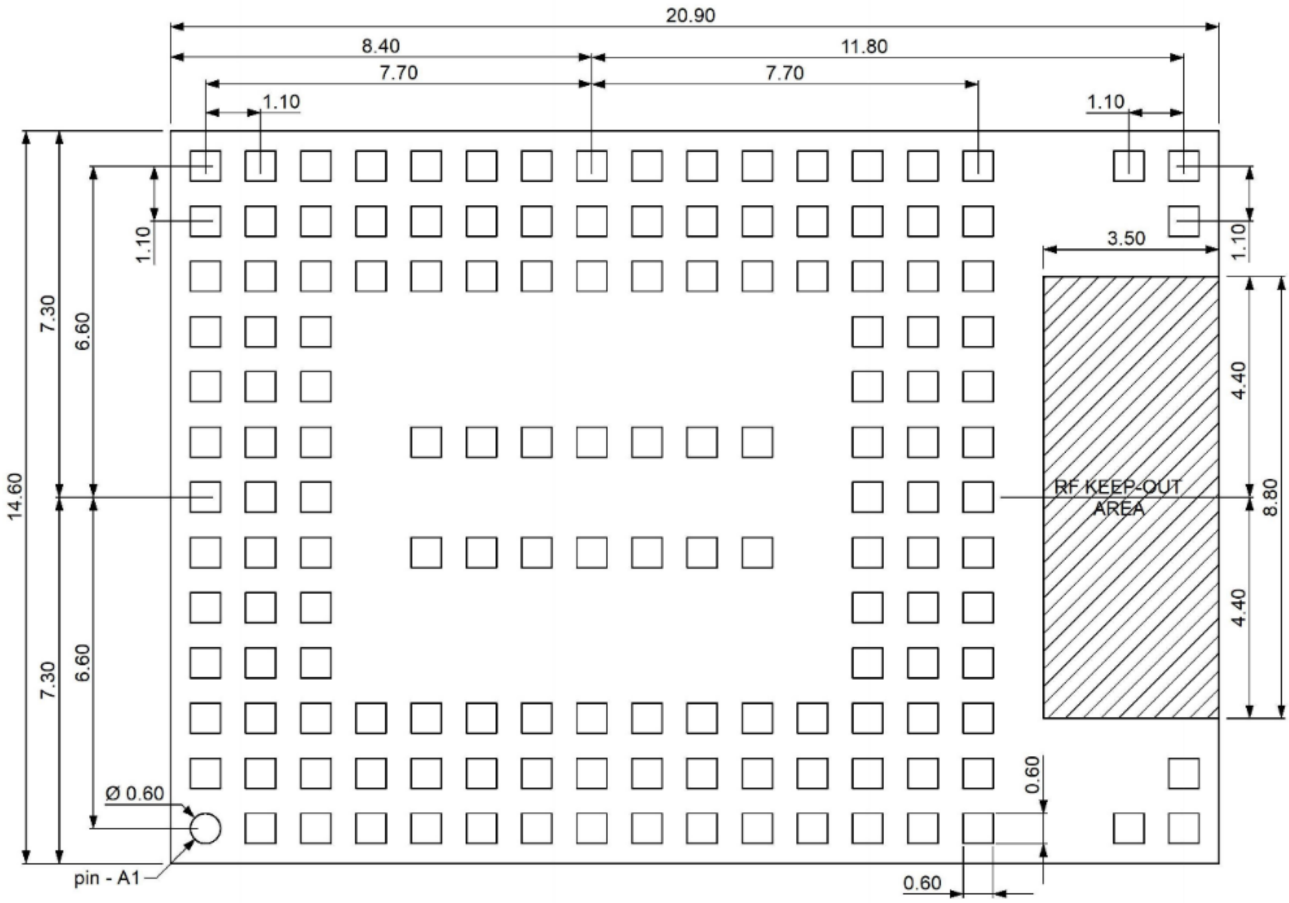


Figure 10: IRIS-W106 recommended PCB footprint (top view)

The suggested stencil layout for the IRIS-W10 series modules should follow the copper pad layout, as shown in Figure 9 and Figure 10. The assembly house should determine the thickness of the solder paste stencil based on the entire host PCB, typically 100-120 µm.

☞ The RF keep-out area is not required for IRIS-W101.

3.6 Thermal guidelines

IRIS-W10 series modules are designed to operate in a specified temperature range at an ambient temperature inside the enclosure box. The PCB generates heat during high loads that must be dissipated to sustain the lifetime of the components.

The improvement of thermal dissipation in the module decreases its internal temperature and consequently increases the long-term reliability of device applications operating at high ambient temperatures.

For best performance, layouts should adhere to the following guidelines:

- Vias specification for ground filling: $300/600\mu m$ with no thermal reliefs allowed on vias.
- Ground via densities under the module: $50\ vias/cm^2$. Place thermal vias in the gaps between the thermal pads of the module.
- Minimum layer count and copper thickness: $4\ layers, 35\ \mu m$.
- Minimum board size: $55x70\ mm$.
- To optimize the heat flow from the module, avoid crossing the layers of power planes and signal beneath the module.

Use the following hardware techniques to further improve thermal dissipation in the module and optimize its performance in customer applications:

- Maximize the return loss of the antenna to reduce reflected RF power to the module.
- Improve the efficiency of any component that generates heat, including power supplies and processor, by dissipating it evenly throughout the application device.
- Provide sufficient ventilation in the mechanical enclosure of the application.
- For continuous operation at high temperatures, particularly in high-power density applications or smaller PCB sizes, include a heat sink on the bottom side of the main PCB. The heat sink is best connected using electrically insulated / high thermal conductivity adhesive[6].

3.7 ESD guidelines

Device immunity against Electrostatic Discharge (ESD) is a requirement for Electromagnetic Compatibility (EMC) conformance and use of the CE marking for products intended for sale in Europe. To bear the CE mark, all application products integrating u-blox modules must be conformance tested in accordance with the R&TTE Directive (99/5/EC), EMC Directive (89/336/EEC), and Low Voltage Directive (73/23/EEC) issued by the Commission of the European Community.

Compliance with the above directives also implies conformity to the following European norms for device ESD immunity: ESD testing standard CENELEC EN 61000-4-2 and radio equipment standards ETSI EN 301 489-1, ETSI EN 301 489-7, ETSI EN 301 489-24. The ESD immunity requirements for each of these standards are summarized in Table 16.

The ESD immunity test is performed at the enclosure port, which is defined by ETSI EN 301 489-1 as the physical boundary through which the electromagnetic field radiates. If the device implements an integral antenna, the enclosure port is seen as all-insulating and includes conductive surfaces to house the device. If the device implements a removable antenna, the antenna port can be separated from the enclosure port. The antenna port includes the antenna element and its interconnecting cable surfaces.

Any extension of the ESD immunity test to the whole device is dependent on the device classification, as defined by ETSI EN 301 489-1. Applicability of the ESD immunity test to the related device ports, or the interconnecting cables to auxiliary equipment, depends on the device-accessible interfaces and manufacturer requirements, as defined by ETSI EN 301 489-1.

Contact discharges are performed on conductive surfaces, while air discharges are performed on insulating surfaces. Indirect contact discharges are performed on the measurement setup horizontal and vertical coupling planes as defined in CENELEC EN 61000-4-2.

For the definition of integral antenna, removable antenna, antenna port, and device classification, refer to the *ETSI EN 301 489-1*. For the contact and air discharges definitions, refer to *CENELEC EN 61000-4-2*.

Parameter	Min.	Typical	Max.	Unit	Remarks
ESD immunity. All exposed surfaces of the radio equipment and ancillary equipment in a representative configuration			8	kV	Indirect discharge according to IEC 61000-4-2
ESD sensitivity, tested for all pins except ANT and NC pins			2.0	kV	Human body model according to JEDEC JS001

Table 16: Electromagnetic Compatibility ESD immunity requirements

IRIS-W10 is manufactured with consideration to specific standards that minimize the occurrence of ESD events; the highly automated process complies with IEC61340-5-1 (STM5.2-1999 Class M1

[6] Typically, not required

devices) standard, and designers should subsequently implement proper measures to protect any pin that might be exposed to the end user from ESD events.

Compliance with the standard protection level specified in EN61000-4-2 is achieved by including ESD protection close to any areas that are accessible to the end user.

3.8 Design-in checklists

3.8.1 Schematic checklist

- ☐ All module pins have been properly numbered and designated on the schematic (including thermal pins) as shown in the pin list of the data sheet [2].
- ☐ Power supply design comply with the voltage supply requirement, as described in data sheet [2].
- ☐ Adequate bypassing has been included in front of each power pin, as described in data sheet [2].
- ☐ Each signal group is consistent with its own power rail supply or proper signal translation has been provided, as described in data sheet [2]
- ☐ Configuration pins are properly set at bootstrap, as described in data sheet [2].
- ☐ SDIO bus includes series resistors and pull-ups, if needed.
- ☐ Unused pins are properly terminated.
- ☐ When using an external antenna, A pi-filter is provided in front of each antenna for final matching. See Antenna design.

3.8.2 Layout checklist

- ☐ PCB stack-up and controlled impedance traces follow the recommendations given by the PCB manufacturer. See RF transmission line design.
- ☐ All pins are properly connected, and the footprint follows u-blox recommendations for pin design. See the solder mask information in the IRIS-W10 data sheet [2].
- ☐ Proper clearance has been provided between the RF section and the digital section.
- ☐ Proper isolation has been provided between Antennas for co-location RF systems.
- ☐ Bypass capacitors are placed close to the module. See Layout and manufacturing.
- ☐ Low impedance power path or power plane has been provided to the module.
- ☐ Controlled impedance traces are properly implemented on the layout (both RF and digital) and follow PCB manufacturer recommendations. See RF transmission line design.
- ☐ 50 Ω RF traces and connectors follow the rules described in RF connector design.
- ☐ Antenna design has been reviewed by the antenna manufacturer.
- ☐ Proper grounding has been provided to the module for low impedance return path. See Layout and manufacturing.
- ☐ Reference plane skipping has been minimized for high frequency buses.
- ☐ All traces and planes are routed inside the area defined by the main ground plane.
- ☐ u-blox has reviewed and approved the PCB[7].

[7] This is applicable only for end-products based on u-blox reference designs.

4 Open CPU software

This section describes how to download and setup the software for different applications. The MCU software development toolkit, MCUXpresso SDK [17], currently supports the following environments:

- MCUXpresso IDE
- IAR Embedded Workbench
- Arm GCC
- Keil MDK/µVision

The customer can develop the applications with support of FreeRTOS or Zephyr OS. This chapter describes the steps necessary to configure, compile, debug, flash, and run the Wi-Fi and Bluetooth sample applications included in the MCUXpresso SDK and Zephyr OS. It also covers the configuration and required tool setup for the Integrated Development Environment (IDE).

☞ The SDK must be modified to align with the memory and variant of IRIS-W1 module before building and flashing on IRIS-module. Refer to the GitHub repository [13] or Contact your local u-blox support team for more information.

4.1 Software options

IRIS-W10 module provides software implementation with an open-CPU configuration.

- Includes a MCU host that enables customers to easily develop applications using the MCUXpresso SDK [17] in an open-CPU configuration out of the box. This feature is also referred to Open CPU.
- Zephyr SDK can also be used to develop applications [30].
- Additionally, the IRIS-W10 software can be programmed using various development methods/environments that are supported by the MCUXpresso SDK [17]:
  - MCUXpresso IDE [19]
  - IAR Embedded Workbench [22]
  - Arm GCC [23]

4.1.1 Open CPU

The Open CPU architecture of IRIS-W10 series module allows module integrators to build their own applications. Table 17 describes the possible connectivity and application support in recommended MCUXpresso SDK environments for IRIS-W10 hardware.

Feature	Support
Development environment	MCUXpresso SDK (including basic example application)
Hardware interfaces	5 x universal serial interface modules (FlexComm, configurable as SPI/I2C/I2S/UART)
	1 x SDIO 3.0
	IEEE 1588 RMII/Fast Ethernet interface
	OTG (USB2.0)
	QVGA LED Support (8080 interface)
	16-bit ADC and 10-bit ADC
	32-bit General purpose timers/PWM
	4 x digital microphone support
Security	NXP EdgeLock™ Assurance
	Trusted execution environment (TEE) based on Arm TrustZone®-M
	Wi-Fi WPA2/WPA3 security
	OTP-based device configuration and life cycle management
	Cryptography accelerators (symmetric, asymmetric, secure hash, KDF)
	Bluetooth LE secure connections

Table 17: Open CPU software support

4.2 Application Development

The IRIS-W1 series modules serve as Open CPU platforms, allowing developers to execute applications built with **NXP's MCUXpresso SDK or Zephyr.** This section outlines the guidelines for developing applications, focusing on essential setup steps, modifications, and resource references

For detailed information about NXP SDK APIs and related documentation, refer to the **NXP website** or the SDK's bundled documentation[29].

4.2.1 Pre-setup Requirements

To compile applications for IRIS-W1, it is essential to update the `flash_config`, `mflash_drv`, and `RF calibration control` parameter files in the SDK. These updates are important for the IRIS-W1 module to work seamlessly with NXP's SDK. You have the option to either modify these files in the SDK once or update them in every example project.

To align with the IRIS module Hardware, essential files in the SDK need to be updated to ensure proper functionality with the IRIS module . These updates include:

- **Flash configuration**: Update the flash_config file to match the module vendor and memory size. This configuration is a must.
- **Flash driver**: Modify the `flash_drv` file for compatibility with the IRIS-W1 module. This configuration is must, when you're using Radio Application.
- **Calibration Files and Transmit power limits**: If the application involves radio functionalities (Wi-Fi or Bluetooth), update the corresponding files related to calibration and transmit power limits in the SDK with the files available in the following folders: `wifi_calibration`, `BT_802_15_4_calibration_files`, `wifi_txpower_cfg`. For more details refer README.md on u-blox openCPU Github repository [13].
- **Board Support Files**: Update the Board Support Files for the EVK-IRIS-W1. This is necessary when the application involves GPIO or mikroBUS functionalities on EVK-IRIS. Modify the `pin_mux` files to ensure proper pin assignments and configurations for the IRIS-W1 Evaluation Kit (EVK).

Detailed information about the configuration files, along with examples, can be found on u-blox openCPU GitHub repository [13]. This repository includes code snippets, examples, and further guidance on these setup steps.

4.2.2 Zephyr Support

Zephyr RTOS is supported for application development with the IRIS module. Unlike FreeRTOS-based setup, Zephyr does not require separate pre-configuration steps. The build system handles the necessary setup through a defined set of commands and configuration files, in line with standard Zephyr workflows.

While core configuration concepts remain similar, the SDK structure (including directory layout and integration) follows Zephyr-specific conventions. Current support is available via a downstream local repository, with upstream integration planned. For build instructions and source access, refer to the GitHub repository [30].

4.2.3 MCUXpresso SDK

NXP Semiconductor provides the MCUXpresso IDE [19] and SDK [17] for development using the FreeRTOS. MCUXpresso is supported by NXP chipsets, including the RW61x chip integrated in the IRIS-W10 module.

4.2.3.1 Download MCUXpresso SDK

To get MCUXpresso SDK:

1. Go to MCUXpresso SDK Builder page [18].
2. Click **Select Development Board**
   - RD-RW612-BGA
   - Define the **Developer Environment Setting** (Select Host OS and IDE)
   - Build MCUXpresso SDK
   - Download the SDK Archive (includes documentation)
3. Import the SDK archive into either the MCUXpresso IDE [19] GCC setup [23], or IAR Workbench setup [22].

☞ Another way to get SDK is from GitHub, Go to GitHub nxp-mcuxpresso/mcux-sdk web page [32].

4.3 Building applications

Use this guide to import, configure, build, debug, and run the IRIS-W10 demo in the supported IDEs.

4.3.1 Building for IRIS-W10 with MCUXpresso IDE setup

To build a demo application:

1. Download the MCUXpresso SDK [17]
2. Download and open the MCUXpresso IDE [19]
3. From the “Installed SDKs” tab is located at the bottom of the central window, drag-and-drop the SDK into the designated area or use import archive option.
4. Select the evaluation board (RW612)
5. Select a Wi-Fi or Bluetooth LE example and verify default project option
6. Check Pre-setup condition
7. Build the application
8. To flash the software, select Debug from the menu (make sure IRIS-W1x is connected)
   By default, the project is configured to use the WIFI_BOARD_AW_RW610 in `app_config.h` from the source code directory.

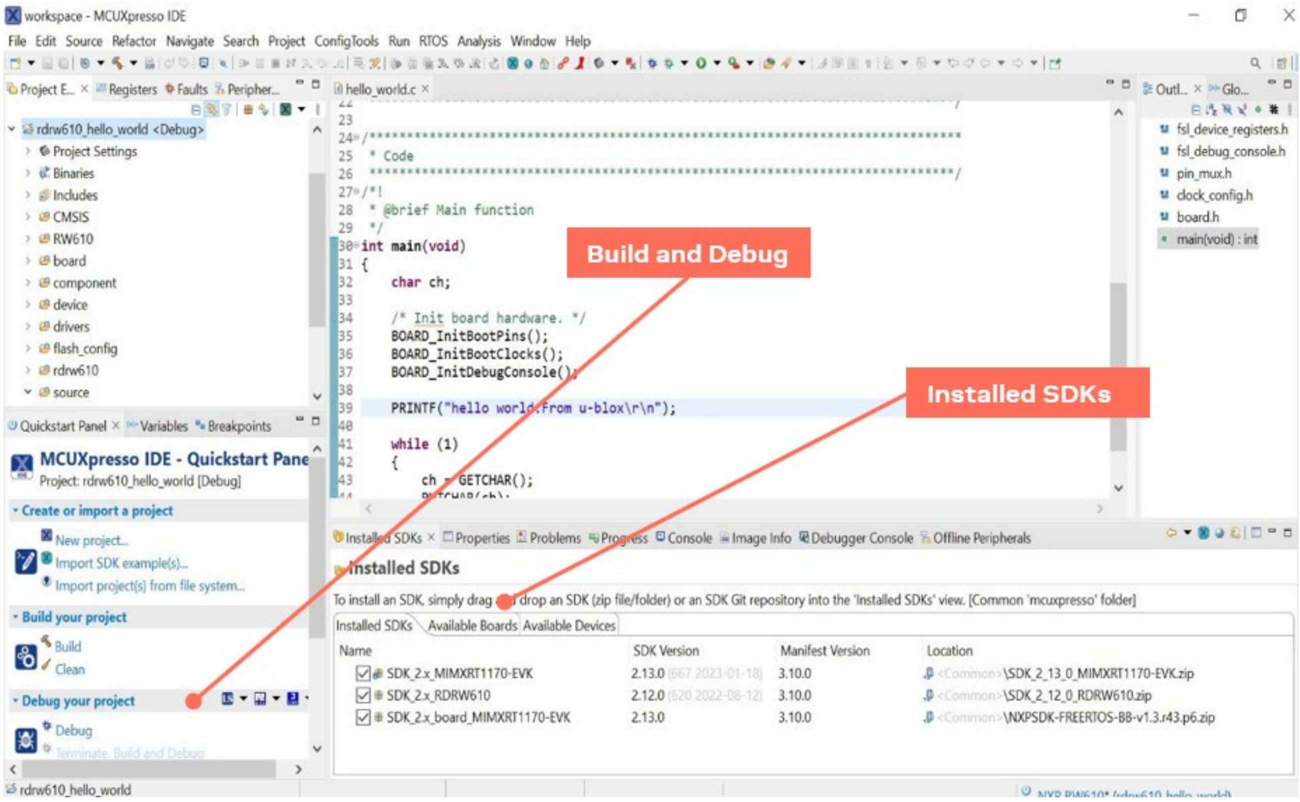


Figure 11: MCUXpresso IDE

☞ All instructions are based on MCUXpresso IDE version v11.6.0 and pre-release SDK.

4.3.2 Building for IRIS-W10 with Arm GCC setup

This section outlines the process of configuring the command-line Arm® GCC tools for building and running demo applications, with the `wifi_cli` application serving as an example. This procedure can be applied to any example application available through the MCUXpresso SDK [17]. The instructions are based on the use of Linux, which is one of the operating systems supported by Arm GCC tools. For additional information on setting up the Arm GCC Toolchain [20].

☞ To get started with the MCUXpresso SDK, see MCUXSDKGSUG [26].

4.3.2.1 Install Arm GCC toolchain

To install the toolchain:

1. Download the toolchain [20] for Linux x86_64 system and cmake [21].

```
gcc-arm-none-eabi-XXXXXX-x86_64- linux.tar.bz2 (Linux x86_64 tarball)

tar -xf gcc-arm-none-eabi-10-2020-q4-major-x86_64-linux.tar.bz2
```

2. Export the `ARMGCC_DIR`

```
export ARMGCC_DIR=/toolchain-dir/gcc-arm-none-eabi-XXXXXX
```

3. Add toolchain path to **PATH** environment

```
export PATH=$PATH:/toolchain-dir/gcc-arm-none-eabi-XXXXXX/bin/
```

4.3.2.2 Build the application

To build the application using the Arm GCC toolchain [20]:

1. Go to the `armgcc` directory of the application.

```
cd /boards/rdrw610/wifi_examples/wifi_cli/armgcc
```

2. Build the application binary

```
 sh build_flash_debug.sh

[100%] Linking C executable flash_debug/wifi_cli.elf
[100%] Built target wifi_cli.elf
```

3. The application image `sdk20-app.bin` is autogenerated.

```
ls ./flash_debug
sdk20-app.bin wifi_cli.elf
```

☞ Given commands are based on `SDK_2_12_0_RDRW610`. See also the latest NXP User Manual or SDK documentation [24].

4.3.2.3 Flash the application program

To flash the binary on the RW61x EVK board:

1. Connect the board to the Windows host system.
2. Open J-Link commander and connect to IRIS-W10.

```
J-Link> con
Device> RW610
TIF>S
Speed> enter
```

3. Flash the application image `sdk20-app.bin` to RW61x EVK FlexSPI NOR flash

```
J-Link>loadbin sdk20_app.bin, 0x08000000
```

4.3.3 Building for IRIS-W10 with IAR Workbench IDE

The software development process for the IRIS-W10 module can be accomplished using the IAR Embedded Workbench IDE.

To build a demo application:

1. Download MCUXpresso SDK [17]
2. Download and open IAR Embedded Workbench IDE [22]
3. Import SDK
4. Open the SDK and select the *.eww* extension file into workspace IDE
5. Select a Wi-Fi or Bluetooth LE example and verify default project option
6. Check pre-setup condition
7. Build the application
8. To flash the software, press Debug from the menu (make sure IRIS-W1x is connected)
9. By default, the project is configured to use the `WIFI_BOARD_AW_RW610` in `app_config.h` from the source code directory.

☞ The guidelines given in this section are specific to version 9.10.2 of the IAR Embedded Workbench IDE [22]. See also the latest NXP User manual [24].

4.4 Flashing open CPU software

IRIS-W10 open CPU modules are flashed using various utility programs over the SWD or JTAG interface.

Use SEGGER J-Link version v7.96o or later, which includes support for the IRIS-W10 device.

To flash the IRIS-W10 module:

1. Connect the USB-3 MCULINK port (**J101**) of the EVK-IRIS-W10 board to the host computer.

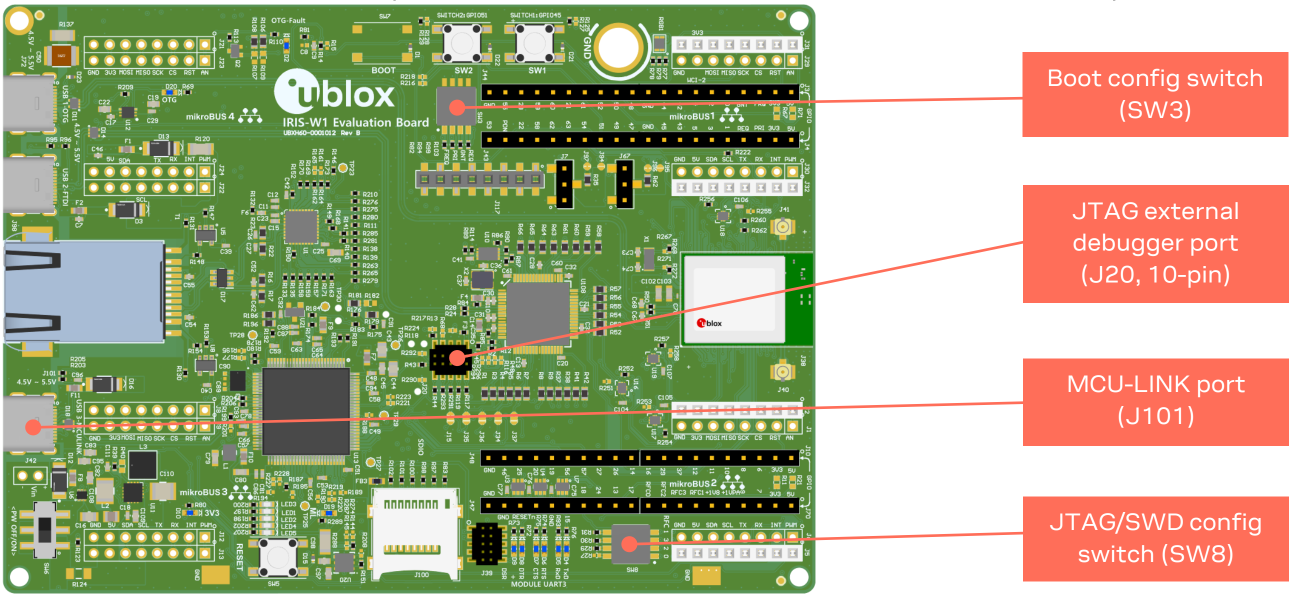


Figure 12: EVK-IRIS-W1 MCU-Link debugger pins

2. Launch the flashing tool on the computer. For example, J-Link Commander or J-Flash Lite.
3. Select the SWD interface on the flashing tool to flash the IRIS-W10 without an external debugger.

☞ For more information about connecting the external debugger, see the EVK-IRIS-W10 user guide [3].

Flashing examples using the SEGGER J-link Lite Software flashing tool running on the host computer are shown in Figure 13 and Figure 14.

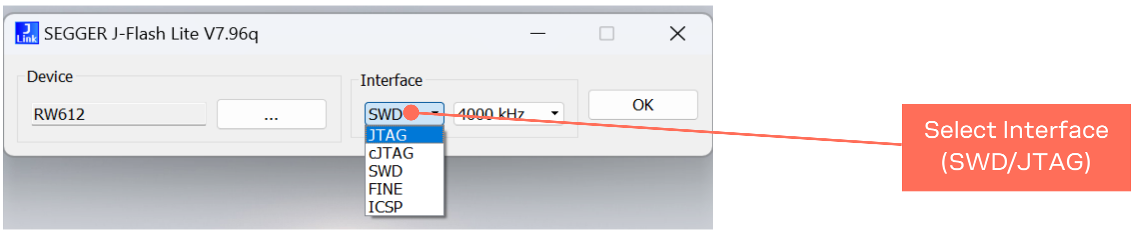


Figure 13: J-Flash Lite device SWD interface

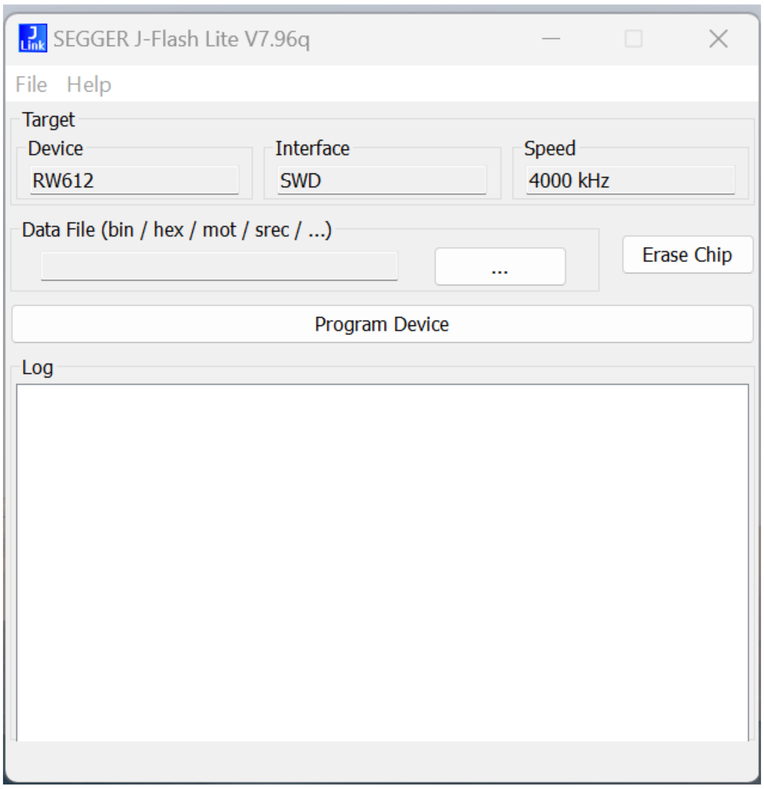


Figure 14: J-Flash Lite program target device over SWD interface

4.4.1 Flashing over the JTAG interface using an external debugger

To flash IRIS-W10 over the JTAG interface:

1. Connect an external debugger to the JTAG interface of the module (**J20**).
2. Launch the flashing tool on the computer (e.g., J-Link Commander or J-Flash Lite).
3. Set SW8 DIP switch to JTAG interface mode.
4. Select the JTAG interface on the flashing tool to flash the IRIS-W10 with an external debugger. Flashing examples using the SEGGER J-link Lite Software flashing tool running on the host computer are shown in Figure 13 and Figure 14. For information about connecting the external debugger to the 10-pin port, see the EVK-IRIS-W10 user guide [3].

☞ SEGGER J-Link BASE or NXP MCU-link Probe external debugger works with IRIS-W10 module.

☞ To generate a `.bin/.hex` application, it is necessary to utilize an internal feature of the MCUXpresso IDE during the application building process.

☞ EVK-IRIS-W10 incorporates an onboard debugger, which means that it can be flashed via SWD without an external debugger.

4.5 blhost application

The `blhost` application is a command-line utility used on the host computer to initiate communication and send commands to the IRIS-W1 bootloader. `blhost` supports multi-platforms like Windows, Linux (x86-based), macOS, and Linux (arm-based) and can be downloaded from the NXP website [28]. The host computer can communicate directly with the IRIS-W1 bootloader over the UART (serial port) or USB connection. The `blhost` application is specifically used for recovering and flashing firmware on the IRIS-W1 module.

4.5.1 Module recovery with blhost

The `blhost` tool is used to recover hardware from a bad or unknown state to normal mode. By using `blhost`, users can diagnose and resolve software-related issues and restore the hardware to a stable and functional state. Use `blhost` for flashing the firmware on IRIS-W1. Recovering hardware can be done using our Windows batch script. Refer to NXP blhost User Manual [12] for the blhost application.

To use `blhost`, the IRIS-W10 must be in ISP boot (bootloader mode) during the start-up of the module.

After successfully recovering the board from an unknown state, proceed to switch the EVK back to QSPI Flash mode and initiate a restart of the IRIS-W10. This restores the board to its original out-of-the-box condition.

For more information about boot mode configuration, see also Configuration pins.

Use the following example to update the IRIS-W1 bootloader.

```
blhost [options] -- [command]
```

For further information about `blhost` use cases, see the NXP blhost User Manual [12].

4.5.2 Flashing firmware with blhost on USB-IRIS-W1

The `blhost` application allows you to flash firmware on the USB-IRIS stick via UART in ISP boot mode. (without an external debugger). See u-blox openCPU GitHub repository [13] for Instructions and guidelines.

4.6 Reading OTP memory data.

This section outlines the process for accessing parameters stored in memory during production, explaining their significance and how to retrieve them for various applications. Data can be accessed by integrating example application.

To retrieve production data parameters, execute the following commands:

- **Read Wi-Fi MAC Address:** MAC address
- **Type Number:** It is the ID of the product used for ordering e.g. IRIS-W101-00B-00.
- **Serial Number:** It is the MAC address in decimal format.

☞ To verify the MAC Address, ensure that the Wi-Fi firmware `.bin` file is pre-flashed at the specified address, and then build the example application and notes available on u-blox openCPU GitHub repository [13].

☞ For detailed information about the MAC address, refer to the IRIS-W10 datasheet [3].

4.7 Output power configuration

To ensure compliance with regulatory output power limits, the module must be configured according to the guidelines given in this section.

4.7.1 Wi-Fi output power configuration

To configure transmission power for a specific region, you need to include a u-blox-specific Wi-Fi transmit power limits header file in the SDK example. The procedure for setting output power levels, along with illustrative examples, is outlined in the product subfolder of the GitHub repository [13].

5 Handling and soldering

No natural rubbers, hygroscopic materials, or materials containing asbestos are employed.

⚠ IRIS-W10 series modules are Electrostatic Sensitive Devices that demand the observance of special handling precautions against static damage. Failure to observe these precautions can result in severe damage to the product.

5.1 ESD handling precautions

⚠ As the risk of electrostatic discharge in the RF transceivers and patch antennas of the module is of particular concern, standard ESD safety practices are prerequisite. See also Figure 15.

Consider also:

- When connecting test equipment or any other electronics to the module (as a standalone or PCB-mounted device), the first point of contact must always be to local GND.
- Before mounting an antenna patch, connect the device to ground.
- When handling the RF pin, don't touch any charged capacitors. Be especially careful when handling materials like patch antennas (~10 pF), coaxial cables (~50-80 pF/m), soldering irons, or any other materials that can develop charges.
- To prevent electrostatic discharge through the RF input, don't touch any exposed antenna area. If there is any risk of the exposed antenna being touched in an unprotected ESD work area, be sure to implement proper ESD protection measures in the design.
- When soldering RF connectors and patch antennas to the RF pin on the receiver, be sure to use an ESD-safe soldering iron (tip).

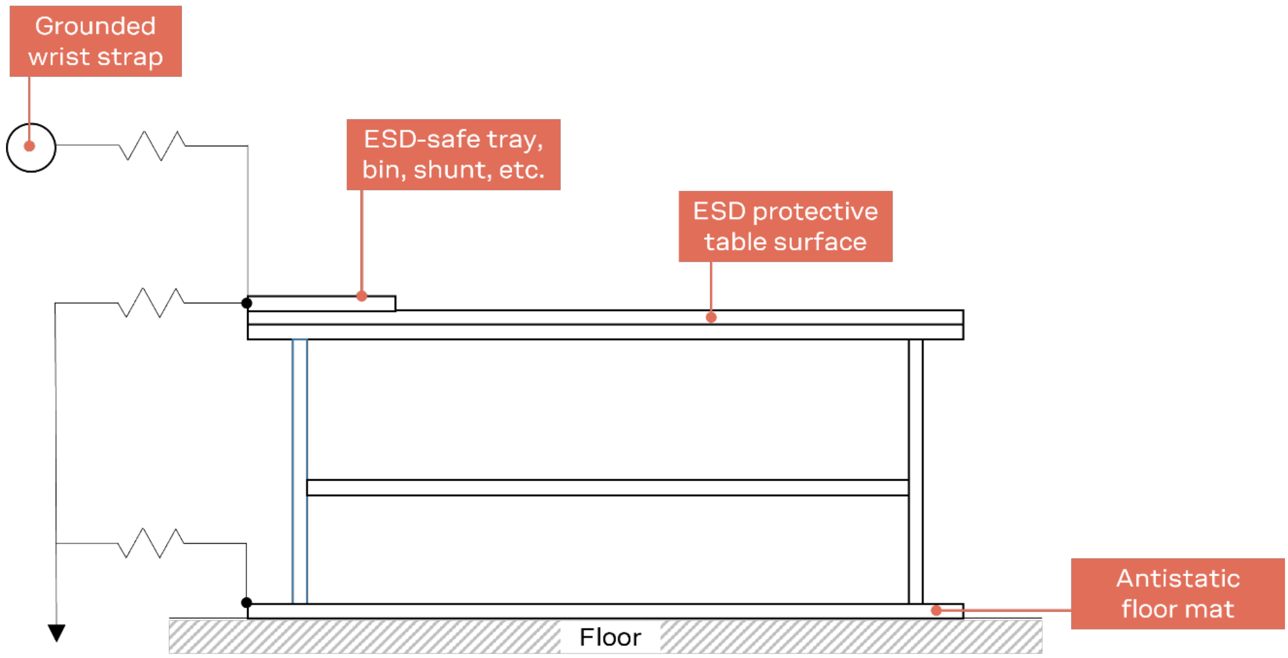


Figure 15: Standard workstation setup for safe handling of ESD-sensitive devices

5.2 Packaging, shipping, storage, and moisture preconditioning

For information pertaining to reels, tapes or trays, moisture sensitivity levels (MSL), shipment and storage, as well as drying for preconditioning, refer to the IRIS-W10 data sheet [2] and Packaging information reference guide [13].

5.3 Reflow soldering process

IRIS-W10 series modules are surface mount devices supplied on a FR4-type PCB with gold plated connection pads and are produced in a lead-free process with a lead-free soldering paste. The thickness of solder resist between the top side of host PCB and the bottom side of IRIS-W10 series modules must be considered for the soldering process.

IRIS-W10 series modules are compatible with the industrial reflow profile for common SAC type RoHS solders. No-clean soldering paste is strongly recommended. The reflow profile is dependent on the thermal mass of the fully populated host PCB, the heat transfer efficiency of the oven, and the type of solder paste that is used. The optimal soldering profile that is used must be trimmed for each case depending on the specific soldering process and layout of the host PCB.

⚠ The target parameter values shown in Table 18 and Figure 16 are only general guidelines for a Pb-free process and all given values are tentative and subject to change. For further information, see also the JEDEC J-STD-020C standard [4].

Process parameter		Unit	Value
Pre-heat	Ramp up rate to T_{SMIN}	K/s	3
	T_{SMIN}	°C	150
	T_{SMAX}	°C	200
	t_S (from 25 °C)	s	110
	t_S (Pre-heat)	s	60
Peak	T_L	°C	217
	t_L (time above T_L)	s	60
	T_P (absolute max)	°C	245
	t_P (time above T_P -5 °C)	s	10
Cooling	Ramp-down from T_L (absolute max)	K/s	6
General	$T_{to\ peak}$	s	300
	Allowed reflow soldering cycles	-	2

Table 18: Recommended reflow profile

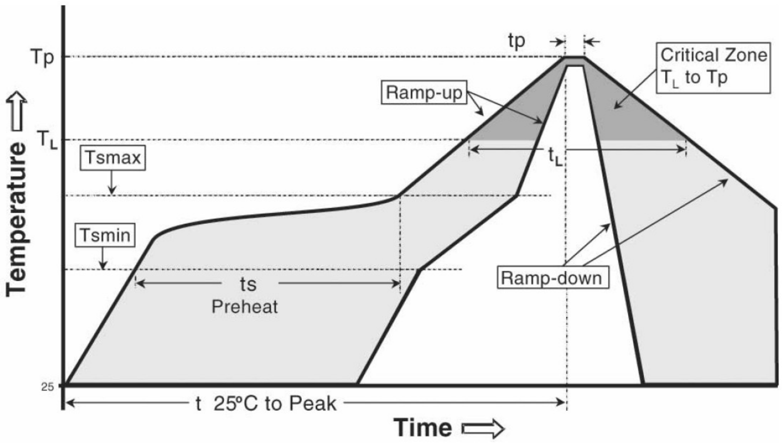


Figure 16: Reflow profile

☞ The lower value of T_P and slower ramp down rate (2–3 °C/sec) is preferred.

5.3.1 Repeated reflow soldering

For application boards with components on both sides, a two-reflow process may be required. In such cases, IRIS-W10 can be mounted in both reflow cycles. To reduce the risk of detachment due to its relatively higher weight compared to other components on the board, it is advisable to place the module on the side of the board that undergoes the final cycle. This reduces the risk of detachment due to its relatively higher weight compared to other components.

Mounting the module in an upside-down position (with the module on the underside of the board during reflow) is not recommended, as this increases the likelihood of detachment.

⚠ u-blox does not provide warranty coverage for damages to IRIS-W10 modules caused by performing more than two total reflow soldering processes (one for mounting the module and one for mounting other components).

5.3.2 Cleaning

Cleaning the module is not recommended. Residues underneath the module can't be easily removed with a washing process.

- Cleaning with water will lead to capillary effects where water is absorbed in the gap between the baseboard and the module. The combination of residues of soldering flux and encapsulated water leads to short circuits or resistor-like interconnections between neighboring pads. Water will also damage the label and the ink-jet printed text.
- Cleaning with alcohol or other organic solvents can result in soldering flux residues flooding into areas that are not accessible for post-wash inspections. The solvent will also damage the label and the ink-jet printed text.
- Ultrasonic cleaning will permanently damage the module and the crystal oscillators in particular.

For best results use a "no clean" soldering paste and circumvent the need for a cleaning stage after the soldering process.

5.3.3 Other remarks

- Boards with combined through-hole technology (THT) components and surface-mount technology (SMT) devices might require THT components to be wave soldered.
- Miniature Wave Selective Solder processes are preferred over traditional wave soldering processes.
- Hand soldering is not recommended.
- Rework is not recommended.
- Conformal coating can affect the performance of the module, which means that it is important to prevent the liquid from flowing into the module. RF shields don't provide protection for the module from coating liquids with low viscosity; therefore, care is required while applying the coating. Conformal coating of the module will void the warranty.
- Grounding metal covers: Attempts to improve grounding by soldering ground cables, wick, or other forms of metal strips directly onto the EMI covers is done so at the customer's own risk and will void the module warranty. The numerous ground pins on the module are adequate to provide optimal immunity to interferences.
- The modules contain components that are sensitive to Ultrasonic Waves. Use of any ultrasonic processes, like cleaning and welding, might damage the module. Use of ultrasonic processes on an end product integrating this module will void the warranty.

6 Regulatory compliance

This chapter describes the current approval status of certification in each country and the regulatory requirements that must be met when using IRIS-W10 modules in an end product.

6.1 General requirements

IRIS-W10 series modules are designed to comply with the regulatory demands of Federal Communications Commission (FCC), Innovation, Science and Economic Development Canada (ISED)[8] and the CE mark. This chapter contains instructions on the process needed for an integrator when including the IRIS-W1 module into an end-product.

- Any deviation from the process described may cause the IRIS-W10 series modules not to comply with the regulatory authorizations of the module and thus void the user's authority to operate the equipment.
- Any changes to hardware, hosts or co-location configuration may require new radiated emission and SAR evaluation and/or testing.
- The regulatory compliance of IRIS-W1 does not exempt the end-product from being evaluated against applicable regulatory demands; for example, FCC Part 15B criteria for unintentional radiators [9].
- The end-product manufacturer must follow all the engineering and operating guidelines as specified by the grantee (u-blox).
- IRIS-W1 is for OEM integrators only.
- Only authorized antenna(s) may be used. For the list of authorized antennas, see the IRIS-W1 data sheet [2].
- In the end-product, the IRIS-W10 module must be installed in such a way that only authorized antennas can be used.
- The end-product must use the specified antenna reference design as described in RF interface and Antenna reference designs. A custom trace design can be approved and submitted through a C2PC. See Adding a new antenna for authorization.
- Any notification to the end user about how to install or remove the integrated radio module is NOT allowed.
- Electromagnetic interference compatibility (EMI / EMC) and spurious emissions tests are required for end-products targeted for most world regions.
- Region codes must be properly set to comply with regulatory RF output power requirements.

⚠ If these conditions can't be met or any of the operating instructions are violated, the u-blox regulatory authorization will be considered invalid. Under these circumstances, the integrator is responsible for re-evaluating the end-product including the IRIS-W1 module. The integrator is then also responsible for obtaining their own regulatory authorization, or u-blox may be able to support updates of the u-blox regulatory authorization.

6.2 European Union (CE)

For information about the regulatory compliance of IRIS-W10 series modules against requirements and provisions in the European Union, see also the IRIS-W1 Declaration of Conformity [15].

[8] Formerly known as IC (Industry Canada).

6.2.1 CE end-product regulatory compliance

6.2.1.1 Safety standard

In order to fulfill the safety standard EN 60950-1 [8], the IRIS-W10 module must be supplied with a Class-2 Limited Power Source.

6.2.2 ETSI Equipment classes

In accordance with Article 1 of Commission Decision 2000/299/EC[9], IRIS-W10 is defined as either Class-1 or Class-2 radio equipment, the end-product integrating IRIS-W10 inherits the equipment class of the module.

☞ Guidance on end product marking, according to the RED, can be found at: http://ec.europa.eu/

⚠ The EIRP of the IRIS-W10 module must not exceed the limits of the regulatory domain in which the module operates. Depending on the host platform implementation and antenna gain, integrators must limit the maximum output power of the module through the host software. For information about the corresponding maximum transmit power levels, see Approved antennas.

6.2.3 Radio Equipment Directive (RED) 2014/53/EU

IRIS-W1 series modules comply with the essential requirements and other relevant provisions of Radio Equipment Directive (RED) 2014/53/EU.

6.2.4 Compliance with the RoHS directive

IRIS-W1 series modules comply with the Directive 2011/65/EU (EU RoHS 2) and its amendment Directive (EU) 2015/863 (EU RoHS 3).

6.3 Great Britain regulatory compliance (UKCA)

For information about the regulatory compliance of IRIS-W10 series modules against requirements and provisions in Great Britain, see also the IRIS-W10 UKCA Declaration of Conformity [16].

6.3.1 UK Conformity Assessed (UKCA)

☞ The United Kingdom is made up of the Great Britain (including England, Scotland, and Wales) and the Northern Ireland. Northern Ireland continues to accept the CE marking. The following notice is applicable to Great Britain only.

IRIS-W10 series modules have been evaluated against the essential requirements of the Radio Equipment Regulations 2017 (SI 2017 No. 1206, as amended by SI 2019 No. 696).

For guidance about using the UKCA marking: https://www.gov.uk/guidance/using-the-ukca-marking

[9] 2000/299/EC: Commission Decision of 6 April 2000 establishing the initial classification of radio equipment and telecommunications terminal equipment and associated identifiers.

6.4 US / Canada (FCC / ISED)

u-blox represents that the modular transmitter fulfills the FCC/ISED regulations when operating in authorized modes on any host-product given that the integrator follows the instructions as described in this document. Accordingly, the host-product manufacturer acknowledges that all host-products referring to the FCC ID or ISED certification number of the modular transmitter and placed on the market by the host-product manufacturer need to fulfil all of the requirements mentioned below. Non-compliance with these requirements may result in revocation of the FCC approval and removal of the host products from the market. These requirements correspond to questions featured in the FCC guidance for software security requirements for U-NII devices, FCC OET KDB 594280 D02 [11].

⚠ The modular transmitter approval of IRIS-W10, or any other radio module, does not exempt the end product from being evaluated against applicable regulatory demands.

The evaluation of the end product shall be performed with the IRIS-W10 module installed and operating in a way that reflects the intended end product use case. The upper frequency measurement range of the end product evaluation is the 5th harmonic of 5.8 GHz as described in KDB 996369 D04.

The following requirements apply to all products that integrate a radio module:

- Subpart B - UNINTENTIONAL RADIATORS
  To verify that the composite device of host and module comply with the requirements of FCC part 15B, the integrator shall perform sufficient measurements using ANSI 63.4-2014.
- Subpart C - INTENTIONAL RADIATORS
  It is required that the integrator carries out sufficient verification measurements using ANSI 63.10-2013 to validate that the fundamental and out of band emissions of the transmitter part of the composite device complies with the requirements of FCC part 15C.

When the items listed above are fulfilled, the end product manufacturer can use the authorization procedures mentioned in Table 1 of 47 CFR Part 15.101, before marketing the end product. This means the customer has to either market the end product under a Suppliers Declaration of Conformity (SDoC) or to certify the product using an accredited test lab.

The description is a subset of the information found in applicable publications of FCC Office of Engineering and Technology (OET) Knowledge Database (KDB). We recommend the integrator read the complete document of the referenced OET KDB's.

- KDB 178919 D01 Permissive Change Policy
- KDB 447498 D01 General RF Exposure Guidance
- KDB 594280 D01 Configuration Control
- KDB 594280 D02 U-NII Device Security
- KDB 784748 D01 Labelling Part 15 18 Guidelines
- KDB 996369 D01 Module certification Guide
- KDB 996369 D02 Module Q&A
- KDB 996369 D04 Module Integration Guide

6.4.1 United States compliance statement (FCC)

IRIS-W10 series modules have modular approval and comply with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

1. This device may not cause harmful interference, and
2. This device must accept any interference received, including interference that may cause undesired operation.

⚠ Any changes or modifications NOT explicitly APPROVED by u-blox could cause the IRIS-W10 series module to cease to comply with FCC rules part 15 thus void the user's authority to operate the equipment.

The internal / external antenna(s) used for this module must provide a separation distance of at least 20 cm from all persons and must not be co-located or operating in conjunction with any other antenna or transmitter.

Table 19 shows the FCC IDs allocated to IRIS-W10 series modules.

Model	FCC ID
IRIS-W101-00B	XPYIRISW1
IRIS-W106-00B	XPYIRISW1
IRIS-W101-10B	XPYIRISW1
IRIS-W106-10B	XPYIRISW1
IRIS-W101-30B	XPYIRISW1
IRIS-W106-30B	XPYIRISW1
IRIS-W101-40B	XPYIRISW1
IRIS-W106-40B	XPYIRISW1

Table 19: FCC IDs for different variants of IRIS-W10 series modules

☞ For FCC end-product labeling requirements, see End product labeling requirements.

6.4.2 Canada compliance statement (ISED)

IRIS-W10 series modules are certified for use in accordance with Innovation, Science and Economic Development Canada (ISED) Radio Standards Specification (RSS) RSS-247 Issue 2 and RSS-Gen. Table 20 shows the ISED certification IDs allocated to IRIS-W10 series modules.

Model	ISED certification ID
IRIS-W101-00B	8595A-IRISW1
IRIS-W106-00B	8595A-IRISW1
IRIS-W101-10B	8595A-IRISW1
IRIS-W106-10B	8595A-IRISW1
IRIS-W101-30B	8595A-IRISW1
IRIS-W106-30B	8595A-IRISW1
IRIS-W101-40B	8595A-IRISW1
IRIS-W106-40B	8595A-IRISW1

Table 20: ISED IDs for different variants of IRIS-W10 series modules

IRIS-W10 complies with ISED (Innovation, Science and Economic Development Canada)[10] license-exempt RSS(s). Operation is subject to the following two conditions:

1. This device may not cause interference, and

[10] Formerly known as IC (Industry Canada).

2. This device must accept any interference, including interference that may cause undesired operation of the device.

☞ Any notification to the end user of installation or removal instructions about the integrated radio module is NOT allowed. Unauthorized modification could void authority to use this equipment.

This equipment complies with ISED RSS-102 radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20 cm between the radiator and your body.

This radio transmitter IC: 8595A-IRISW1 has been approved by ISED to operate with the antenna types listed in Approved antennas with the maximum permissible gain indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

☞ Operation in the band 5150–5250 MHz is only for indoor use to reduce the potential for harmful interference to co-channel mobile satellite systems.

☞ Operation in the 5600-5650 MHz band is not allowed in Canada. High-power radars are allocated as primary users (i.e., priority users) of the bands 5250-5350 MHz and 5650-5850 MHz and these radars could cause interference and/or damage to LE-LAN devices.

Le présent appareil est conforme aux CNR d'ISED applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes:

(1) l'appareil ne doit pas produire de brouillage, et

(2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Cet émetteur radio, IC: 8595A-IRISW1 été approuvé par ISED pour fonctionner avec les types d'antenne énumérés ci-dessous avec le gain maximum autorisé et l'impédance nécessaire pour chaque type d'antenne indiqué. Les types d'antennes non inclus dans la liste des antennes approuvées et ayant un gain supérieur au gain maximum indiqué pour ce type sont strictement interdits pour une utilisation avec cet appareil.

☞ Le dispositif de fonctionnement dans la bande 5150-5250 MHz est réservé à une utilisation en intérieur pour réduire le risque d'interférences nuisibles à la co-canal systèmes mobiles par satellite

☞ Opération dans la bande 5600-5650 MHz n'est pas autorisée au Canada. Haute puissance radars sont désignés comme utilisateurs principaux (c.-à utilisateurs prioritaires) des bandes 5250-5350 MHz et 5650-5850 MHz et que ces radars pourraient causer des interférences et / ou des dommages à dispositifs LAN-EL.

For ISED end-product labeling requirements, see End product labeling requirements.

☞ The approval type for all IRIS-W10 series variants is a single modular approval. Due to ISED Modular Approval Requirements (Source: RSP-100 Issue 10), any application which includes the module must be approved by the module manufacturer (u-blox). The application manufacturer must provide design data for the review procedure.

6.4.3 RF exposure statement

6.4.3.1 ISED compliance

All transmitters regulated by ISED must comply with RF exposure requirements listed in RSS-102 - Radio Frequency (RF) Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands). This module is approved for installation into mobile and/or portable host platforms and must not be co-located or operating in conjunction with any other antenna or transmitter except in accordance with Innovation, Science and Economic Development Canada (ISED) multi-transmitter guidelines. End-users must be provided with transmitter operating conditions to satisfy RF Exposure compliance.

To fulfil the requirements of the SAR evaluation Exemption limits defined in RSS-102 issue 5, an OEM integrator implementing IRIS-W10 series modules into an end-product must ensure a separation distance of 45 mm between the user (or bystander) and the antenna (or radiating element).

6.4.3.2 FCC compliance

All transmitters regulated by FCC must comply with RF exposure requirements. KDB 447498 General RF Exposure Guidance provides guidance in determining whether proposed or existing transmitting facilities, operations or devices comply with limits for human exposure to Radio Frequency (RF) fields adopted by the Federal Communications Commission (FCC).

IRIS-W10 modules are approved for installation into mobile and/or portable host platforms and must not be co-located or operating in conjunction with any other antenna or transmitter – except in accordance with FCC multi-transmitter guidelines.

To ensure that the max output power of IRIS-W10 series modules remains below the SAR Test Exclusion Threshold defined in KDB 447498 D01v06, an OEM integrator integrating IRIS-W10 series modules into an end-product must ensure a separation distance of 40 mm between the user (or bystander) and the antenna (or radiating element).

6.4.4 Referring to the u-blox FCC/ISED certification ID

If the General requirements, FCC/ISED End-product regulatory compliance and all Antenna requirements are met, the u-blox modular FCC/ISED regulatory authorization is valid and the end-product may refer to the u-blox FCC ID and ISED certification number. u-blox may be able to support updates to the u-blox regulatory authorization by adding new antennas to the u-blox authorization for example. See also Antenna requirements.

⚠ To use the u-blox FCC / ISED grant and refer to the u-blox FCC ID / ISED certification ID, the integrator must confirm with u-blox that the all requirements associated with the software configuration and Software configuration and control are fulfilled.

6.4.5 Obtaining own FCC/ISED certification ID

Integrators who do not want to refer to the u-blox FCC/ISED certification ID, or who do not fulfil all requirements to do so may instead obtain their own certification. With their own certification, the integrator has full control of the grant to make changes.

Integrators who want to base their own certification on the u-blox certification can do so via a process called “Change in ID” (FCC) / “Multiple listing” (ISED). With this, the integrator becomes the grantee of a copy of the u-blox FCC/ISED certification. u-blox will support with an approval letter that shall be filed as a Cover Letter exhibit with the application.

⚠ It is the responsibility of the integrator to comply with any upcoming regulatory requirements.

6.4.6 Antenna requirements

In addition to the general requirement to use only authorized antennas, the u-blox grant also requires a separation distance of at least 20 cm from the antenna(s) to all persons. The antenna(s) must not be co-located with any other antenna or transmitter (simultaneous transmission) as well. If this cannot be met, a Permissive Change as described in Adding a new antenna for authorization must be made to the grant.

☞ To support verification activities that may be required by certification laboratories, customers applying for Class-II Permissive changes must implement the setup described in Software configuration and control.

6.4.6.1 Separation distance

If the required separation distance of 20 cm cannot be fulfilled, a SAR evaluation must be performed. This consists of additional calculations and/or measurements. The result must be added to the grant file as a Class II Permissive Change.

6.4.6.2 Co-location (simultaneous transmission)

If the module is to be co-located with another transmitter, additional measurements for simultaneous transmission are required. The results must be added to the grant file as a Class II Permissive Change.

6.4.6.3 Adding a new antenna for authorization

If the authorized antennas and/or antenna trace design cannot be used, the new antenna and/or antenna trace designs must be added to the grant file. This is done by a Class I Permissive Change or a Class II Permissive Change, depending on the specific antenna and antenna trace design.

- Antennas of the same type and with less or same gain as those included in the list of Approved antennas can be added under a Class I Permissive Change.
- Antenna trace designs deviating from the u-blox reference design and new antenna types are added under Class II Permissive Change.
- For 5 GHz modules, the combined minimum gain of antenna trace and antenna must be greater than 0 dBi to comply with DFS testing requirements.

⚠ Integrators intending to refer to the u-blox FCC ID / ISED certification ID must contact their local support team to discuss the Permissive Change Process. Class II Permissive Changes are subject to NRE costs.

6.4.7 Software configuration and control

☞ "Modular transmitter" hereafter refers to IRIS-W10 series (FCC ID XPYIRISW1).

As the end product must comply with the requirements addressed by the OET KDB 594280 [10], the host-product integrating the IRIS-W10 must comply with the following requirements:

- Upon request from u-blox, the host-product manufacturer will provide all of the necessary information and documentation to demonstrate how the requirements listed below are met.
- The host-product manufacturer will not modify the modular transmitter hardware.
- The configuration of the modular transmitter when installed into the host-product must be within the authorization of the modular transmitter at all times and cannot be changed to include unauthorized modes of operation through accessible interfaces of the host-product. The Wi-Fi transmit output power limits must be followed. In particular, the modular transmitter installed in the host-product will not have the capability to operate on the operating channels/frequencies referred to in the section(s) below, namely the following channels: 12 (2467 MHz), 13 (2472 MHz)). The channels 120 (5600 MHz), 124 (5620 MHz), and 128 (5640 MHz) are

allowed to be used in the US in client mode only. IRIS-W10 use is certified as supporting DFS client functionality.

- The host-product uses only authorized firmware images provided by the host-product manufacturer, u-blox, and/or by the manufacturer of the RF chipset used inside the modular transmitter.
- The configuration of the modular transmitter must always follow the requirements specified in Operating frequencies and cannot be changed to include unauthorized modes of operation through accessible interfaces of the host-product.
- The modular transmitter must, when installed into the host-product have a regional setting that is compliant with authorized US modes and the host-product is protected from being modified by third parties to configure unauthorized modes of operation for the modular transmitter, including the country code.
- The host-product into which the modular transmitter is installed does not provide any interface for the installer to enter configuration parameters into the end product that exceeds those authorized.
- The host-product into which the modular transmitter is installed does not provide any interface to third parties to upload any unauthorized firmware images into the modular transmitter and prevents third parties from making unauthorized changes to all or parts of the modular transmitter device driver software and configuration.

☞ OET KDB 594280 D01 [10] lists the topics that must be addressed to ensure that the end-product specific host meets the Configuration Control requirements.

☞ OET KDB 594280 D02 [11] lists the topics that must be addressed to ensure that the end-product specific host meets the Software Security Requirements for U-NII Devices.

6.4.8 Operating frequencies

IRIS-W10 802.11b/g/n operation outside the 2412–2462 MHz band is prohibited in the US and Canada and 802.11a/n operation in the 5600–5650 MHz band is prohibited in Canada. Configuration of the module to operate on channels 12–13 and 120–128 must be prevented accordingly.

The channels allowed while operating under the definition of a master or client device[11] are described in Table 21.

Channel number	Channel center frequency [MHz]	Master device	Client device	Remarks
1 – 11	2412 – 2462	Yes	Yes	
12 – 13	2467 – 2472	No	No	
36 – 48	5180 – 5240	Yes	Yes	Canada (ISED): Devices are restricted to indoor operation only and the end product must be labelled accordingly.
52 – 64	5260 – 5320	No	Yes	
100 – 116	5500 – 5580	No	Yes	
120 – 128	5600 – 5640	No	Yes	USA (FCC): Client device operation allowed under KDB 905462 Canada (ISED): Operation is prohibited in this band
132 – 144	5660 – 5720	No	Yes	
149 – 165	5745 – 5825	Yes	Yes	

Table 21: Allowed channel usage under FCC/ISED regulation

[11] 47 CFR §15.202

☞ 15.407 (j) Operator Filing Requirement:
Before deploying an aggregate total of more than one thousand outdoor access points within the 5.15–5.25 GHz band, parties must submit a letter to the Commission acknowledging that, should harmful interference to licensed services in this band occur, they will be required to take corrective action. Corrective actions may include reducing power, turning off devices, changing frequency bands, and/or further reducing power radiated in the vertical direction. This material shall be submitted to Laboratory Division, Office of Engineering and Technology, Federal Communications Commission, 7435 Oakland Mills Road, Columbia, MD 21046. Attn: U-NII Coordination, or via Web site at https://www.fcc.gov/labhelp with the subject line: "U-NII-1 Filing".

6.4.9 End product labeling requirements

For an end-product using the IRIS-W10, there must be a label containing, at least, the following information:

This device contains FCC ID: XPYIRISW1 IC: 8595A-IRISW1

"XPY" represents the FCC "Grantee Code" for u-blox AG, this code may consist of Arabic numerals, capital letters, or other characters, the format for this code will be specified by the Commission's Office of Engineering and Technology[12]. "8595A" is the Company Number for u-blox AG registered at ISED. "IRISW1" is the Unique Product Number decided by the grant owner.

The label must be affixed to an exterior surface of the end product such that it will be visible upon inspection in compliance with the modular labeling requirements of OET KDB 784748. The host user manual must also contain clear instructions on how end users can find and/or access the FCC ID of the end product.

The label on the IRIS-W10 module containing the original FCC ID acquired by u-blox can be replaced with a new label stating the end-product's FCC/ISED ID in compliance with the modular labeling requirements of OET KDB 784748.

FCC end product labeling

In accordance with 47 CFR § 15.19, the end product shall bear the following statement in a conspicuous location on the device:

Contains FCC ID: XPYIRISW1 This device complies with part 15 of the FCC rules. Operation is subject to the following two conditions: 1. This device may not cause harmful interference, and 2. This device must accept any interference received, including interference that may cause undesired operation.

[12] 47 CFR 2.926

The following statement must be included in the end-user manual or guide:

> Changes or modifications to this unit not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.
> This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:
> - Reorient or relocate the receiving antenna.
> - Increase the separation between the equipment and receiver.
> - Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
> - Consult the dealer or an experienced radio/TV technician for help.

ISED end product labeling

The end product shall bear the following statement in both English and French in a conspicuous location on the device:

> Contains transmitter module IC: 8595A-IRISW1
> This device contains licence-exempt transmitter(s)/receiver(s) that comply with Innovation, Science and Economic Development Canada's licence-exempt RSS(s). Operation is subject to the following two conditions:
> 1. This device may not cause interference.
> 2. This device must accept any interference, including interference that may cause undesired operation of the device.

> Contient le module émetteur IC: 8595A-IRISW1
> L'émetteur/récepteur exempt de licence contenu dans le présent appareil est conforme aux CNR d'Innovation, Sciences et Développement économique Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes:
> 1. L' appareil ne doit pas produire de brouillage;
> 2. L'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre lefonctionnement.

Labels of end products capable of operating within the band 5150–5250 MHz shall also include:

> For indoor use only

> Pour usage intérieur seulement

When the device is so small or for such use that it is not practicable to place the statements above on it, the information shall be placed in a prominent location in the instruction manual or pamphlet supplied to the user or, alternatively, shall be placed on the container in which the device is marketed. However, the FCC/ISED ID label must be displayed on the device as described above.

In cases where the final product will be installed in locations where the end-consumer is unable to see the FCC/ISED ID and/or this statement, the FCC/ISED ID and the statement shall also be included in the end-product manual.

6.5 Japan radio equipment (MIC)

⚠ This regulatory compliance is pending for variants IRIS-W101-40B and IRIS-W106-40B.

6.5.1 Compliance statement

IRIS-W10 series modules comply with the Japanese Technical Regulation Conformity Certification of Specified Radio Equipment (ordinance of MPT N°. 37, 1981), Article 2, Paragraph 1:

- Item 19 "2.4 GHz band wide band low power data communication system".
- Item 19-3 "Low power data communications system in the 5.2/5.3 GHz band"

- Item 19-3-2 "Low power data communications system in the 5.6 GHz band"

The IRIS-W10 series modules are restricted on the Japanese market to be used indoors only if the product is operating in the 5.2/5.3 GHz band.

Table 22: Giteki IDs for different variants of IRIS-W10 series modules shows the Giteki certification IDs allocated to IRIS-W10 series modules.

Model	Giteki ID
IRIS-W101-00B, IRIS-W101-10B	MIC ID: [R] 022-250009, MIC ID: [T] P250007022
IRIS-W101-30B	MIC ID: [R] 022-250010, MIC ID: [T] P250008022
IRIS-W106-00B, IRIS-W106-10B	MIC ID: [R] 022-250021, MIC ID: [T] P250009022
IRIS-W106-30B	MIC ID: [R] 022-250022, MIC ID: [T] P250010022
IRIS-W101-40B	Pending
IRIS-W106-40B	Pending

Table 22: Giteki IDs for different variants of IRIS-W10 series modules

6.5.2 End product labelling requirement

End products based on IRIS-W10 series modules and targeted for distribution in Japan must be affixed with a label with the "Giteki" marking, as shown in Figure 17, Figure 18, Figure 19 and Figure 20. The "Indoor use only" information translated into Japanese below is mandatory if the product is operating in the 5.2/5.3 GHz band. The product marking must be visible for inspection.

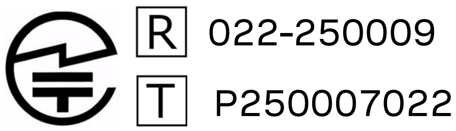


Figure 17: Giteki [R] and [T] marks with the IRIS-W101-00B and IRIS-W101-10B MIC certification numbers

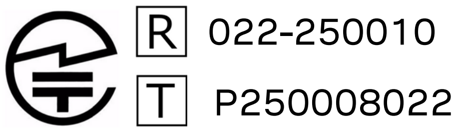


Figure 18: Giteki [R] and [T] marks with the IRIS-W101-30B MIC certification numbers

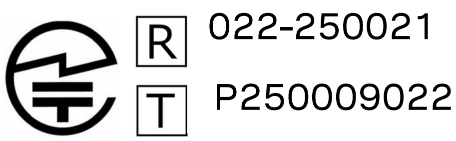


Figure 19: Giteki [R] and [T] marks with the IRIS-W106-00B and IRIS-W106-10B MIC certification numbers

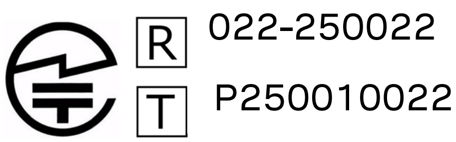


Figure 20: Giteki [R] and [T] marks with the IRIS-W106-30B MIC certification numbers

6.5.3 End product user manual requirement

As the MIC ID is not included on the IRIS-W10 marking, the end product manufacturer must include a copy of the IRIS-W10 Japan Radio Certificate in the end product technical documentation.

6.6 Taiwan (NCC)

⚠ This regulatory compliance is pending for variants IRIS-W101-40B and IRIS-W106-40B.

6.6.1 Taiwan NCC Warning Statement

取得審驗證明之低功率射頻器材，非經核准，公司、商號或使用者均不得擅自變更頻率、加大功率或變更原設計之特性及功能。
低功率射頻器材之使用不得影響飛航安全及干擾合法通信；經發現有干擾現象時，應立即停用，並改善至無干擾時方得繼續使用。前述合法通信，指依電信管理法規定作業之無線電通信。低功率射頻器材須忍受合法通信或工業、科學及醫療用電波輻射性電機設備之干擾。

系統廠商應於平台上標示「本產品內含射頻模組： XXXyyyLPDzzzz-x」字樣

Statement translation:

- Without permission granted by the NCC, any company, enterprise, or user is not allowed to change frequency, enhance transmitting power, or alter original characteristic as well as performance to an approved low power radio-frequency device.
- The low power radio-frequency devices shall not influence aircraft security and interfere legal communications; If any interference is found or suspected, the user shall immediately cease operating the equipment until the interference has been prevented. The said legal communications means radio communications is operated in compliance with the Telecommunications Act. The low power radio-frequency devices must be susceptible with the interference from legal communications or ISM radio wave radiated devices.

應避免影響附近雷達系統之操作。
Statement translation:
The operations near the radar system shall not be influenced.

6.6.2 Labeling requirements for end product

End products based on IRIS-W10 series modules and targeted for distribution in Taiwan must carry labels with the textual and graphical elements shown in Figure 21, Figure 22, Figure 23, Figure 24, Figure 25 and Figure 26.

For IRIS-W101-00B:

Contains Transmitter Module

內含發射器模組: CCAK25Y10070T8

Figure 21: Labeling or end-products containing IRIS-W101-00B

For IRIS-W101-10B:

Contains Transmitter Module

內含發射器模組: CCAK25Y10080T1

Figure 22: Labeling or end-products containing IRIS-W101-10B

For IRIS-W101-30B:

Contains Transmitter Module

內含發射器模組: CCAK25Y10090T1

Figure 23: Labeling or end-products containing IRIS-W101-30B

For IRIS-W106-00B:

Contains Transmitter Module

內含發射器模組: CCAK25Y10100T4

Figure 24: Labeling or end-products containing IRIS-W106-00B

For IRIS-W106-10B:

Contains Transmitter Module

內含發射器模組: CCAK25Y10110T7

Figure 25: Labeling or end-products containing IRIS-W106-10B

For IRIS-W106-30B:

Contains Transmitter Module

內含發射器模組: CCAK25Y10120T0

Figure 26: Labeling or end-products containing IRIS-W106-30B

Other wording can be used, but only if the meaning of original messaging remains unchanged. The label must be physically attached to the product and made clearly visible for inspection.

6.7 KCC South Korea compliance

IRIS-W10 series modules are certified by the Korea Communications Commission (KCC).

⚠ This regulatory compliance is pending for variants IRIS-W101-40B and IRIS-W106-40B.

End products based on IRIS-W10 series modules and targeted for distribution in South Korea must carry labels containing the KCC logo and certification number, as shown in Figure 27. This information must also be included in the product user manuals.

R-R-ULX-IRIS-W106

Figure 27: Sample label of an end product that includes IRIS-W10

☞ The height of the KCC logo must be at least 5 mm.

6.8 Brazil compliance

⚠ This regulatory compliance is pending for variants IRIS-W101-40B and IRIS-W106-40B

End products based on IRIS-W10 series modules and targeted for distribution in Brazil must carry labels that include the ANATEL logo, IRIS-W10 Homologation number: 07282-25-05903 and a statement claiming that the device may not cause harmful interference but must accept it (Resolution No 506).

ANATEL
07292-25-05903

"Este equipamento opera em caráter secundário, isto é, não tem direito a proteção contra interferência prejudicial, mesmo de estações do mesmo tipo, e não pode causar interferência a sistemas operando em caráter primário."

Statement translation:

"This equipment operates on a secondary basis and, consequently, must accept harmful interference, including from stations of the same kind, and may not cause harmful interference to systems operating on a primary basis."

When the device is so small or for such use that it is not practicable to place the statement above on the label, the information shall be placed in a prominent location in the instruction manual or pamphlet supplied to the user or, alternatively, shall be placed on the packaging in which the device is marketed.

In cases where the final product is to be installed in locations where the end user is unable to see the ANATEL logo, IRIS-W10 Homologation number and/or statement, these graphical and textual elements must be included in the end product manual.

6.9 Australia and New Zealand (ACMA)

IRIS-W10 modules are compliant with the standards made by the Australian Communications and Media Authority (ACMA).

⚠ This regulatory compliance is pending for variants IRIS-W101-40B and IRIS-W106-40B.

The modules are compliant with AS/NZS 4268:2012 standard – Radio equipment and systems – Short range devices – Limits and methods of standard measurement. The test reports for IRIS-W10 modules can be used as part of the product certification and compliance folder. Contact your local support team for more information.

To meet the overall Australian and/or New Zealand end product compliance standards, the integrator must create a compliance folder containing all the relevant compliance test reports such as RF, EMC, electrical safety and DoC (Declaration of Conformity). It is the responsibility of the integrator to know what is required in the compliance folder for ACMA compliance.

For more information on Australia compliance, refer to the Australian Communications and Media Authority web site http://www.acma.gov.au/.

For more information on New Zealand compliance, refer to the New Zealand Radio Spectrum Management Group web site www.rsm.govt.nz.

6.10 South Africa (ICASA)

⚠ This regulatory compliance is pending for variants IRIS-W101-40B and IRIS-W106-40B

IRIS-W10 series modules are compliant and certified by the Independent Communications Authority of South Africa (ICASA). End products that are made available for sale or lease or supplied in any other manner in South Africa shall have a legible label permanently affixed to its exterior surface. The label shall include the ICASA logo and the ICASA issued license number, as shown in the figure below. The minimum width and height of the ICASA logo shall be 3 mm. The approval labels must be purchased by the customer's local representative directly from the approval authority ICASA.

A sample of an IRIS-W10 ICASA label is shown in Figure 28.

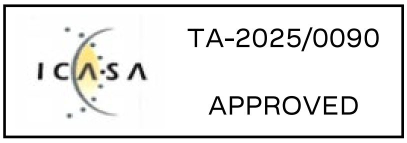


Figure 28: ICASA label

More information on registration as a Responsible Integrator and labeling requirements can be found at the following website: Independent Communications Authority of South Africa (ICASA) web site - https://www.icasa.org.za

6.11 Approved antennas

This chapter describes an overview of the different antennas that can be used together with the modules.

☞ Note that not all antennas are approved for use in all markets/regions. For each antenna, the "Approvals" field defines in which test reports the antenna is included.

6.11.1 Antenna accessories

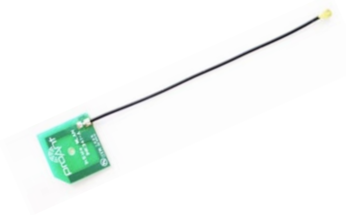
Name	U.FL to SMA adapter cable	
Connector	U.FL and SMA jack (outer thread and pin receptacle)	
Impedance	50 Ω	
Minimum cable loss	0.5 dB, The cable loss must be above the minimum cable loss to meet the regulatory requirements. Minimum cable length 100 mm.	
Comment	The SMA connector can be mounted in a panel. For information describing how to integrate the U.FL connector,	
Approval	RED, UKCA, MIC, KCC, ANATEL, RCM, and ICASA	

Name	U.FL to Reverse Polarity SMA adapter cable	
Connector	U.FL and Reverse Polarity SMA jack (outer thread and pin)	
Impedance	50 Ω	
Minimum cable loss	0.5 dB. The cable loss must be above the minimum cable loss to meet the regulatory requirements. Minimum cable length 100 mm.	
Comment	The Reverse Polarity SMA connector can be mounted in a panel. This reference design must be followed to comply with the IRIS-W10 FCC/IC modular approvals.	
Approval	FCC, ISED, RED, UKCA, MIC, KCC, ANATEL, RCM, NCC, and ICASA	

6.11.2 Dual band antennas

IRIS-W106 internal antenna	
Manufacturer	Abracon
Gain	1.74 dBi (2.4 GHz), 1.63 dBi (5 GHz)
Impedance	50 Ω
Size (HxWxL)	Embedded into the PCB
Type	PIFA
Comment	Embedded PCB antenna on IRIS-W106. Should not be mounted inside a metal enclosure.
Approval	FCC, ISED, RED, UKCA, MIC, KCC, ANATEL, RCM, NCC, and ICASA

PRO-IS-432	
Manufacturer	Abracon
Gain	0.8 dBi (2.4 GHz), 3.4 dBi (5 GHz)
Impedance	50 Ω
Size	22 x 20 x 0.8 mm
Type	Patch
Cable length	100 mm
Connector	U.FL. connector
Comment	Should be attached to a plastic enclosure or part for best performance.
Approval	FCC, ISED, RED, UKCA, MIC, KCC, ANATEL, RCM, NCC, and ICASA



ANTX100P002B24553	
Manufacturer	Pulse Electronics / Yageo
Gain	0.7 dBi (2.4 GHz), 1.9 dBi (5 GHz)
Impedance	50 Ω
Size	40 x 43 x 0.55 mm
Type	PCB patch
Cable length	100 mm
Connector	U.FL. connector
Comment	Should be attached to a plastic enclosure or part for best performance.
Approval	FCC, ISED, RED, UKCA, MIC, KCC, ANATEL, RCM, NCC, and ICASA

W1039B030	
Manufacturer	Pulse Electronics / Yageo
Gain	+1.5 dBi (2.4 GHz), +3.2 dBi (5 GHz)
Impedance	50 Ω
Size	104.8 mm (Straight)
Type	¼ wave monopole dual-band antenna
Cable length	76 mm
Polarization	Vertical
Connector	U.FL
Comment	For optimal performance this antenna should be mounted on a metal ground plane.
Approval	FCC, ISED, RED, UKCA, MIC, KCC, ANATEL, RCM, NCC, and ICASA

GW.59.3153		
Manufacturer	Taoglas	
Gain	2.37 dBi (2.4 GHz), 2.93 dBi (5 GHz)	
Impedance	50 Ω	
Size	156 mm (Straight)	
Type	½ wave monopole dual-band antenna	
Polarization	Vertical	
Connector	Reverse Polarity SMA plug (inner thread and pin receptacle)	
Comment	To be mounted on the U.FL to Reverse Polarity SMA adapter cable. For optimal performance this antenna should be mounted on a metal ground plane. This antenna may only be used for host devices subject to professional installation or the integrator permanently attaches this external antenna to the adaptor cable plug in the host device by loctite, super glue etc. so that the antenna cannot be replaced by the end user.	
Approval	FCC, ISED, RED, UKCA, MIC, KCC, ANATEL, RCM, NCC, and ICASA	

6.12 Output power compliance

To maintain regulatory compliance, Wi-Fi RF power limits must be set in the SDK when compiling the application. See Appendix A for regulatory domain power limits by channel and mode. For information about setting the power tables in the SDK, see also Output power configuration.

7 Product testing

7.1 u-blox in-line production testing

As part of our focus on high quality products, u-blox maintain stringent quality controls throughout the production process. This means that all units in our manufacturing facilities are fully tested and that any identified defects are carefully analyzed to improve future production quality.

The Automatic test equipment (ATE) deployed in u-blox production lines logs all production and measurement data – from which a detailed test report for each unit can be generated. Figure 29 shows the ATE typically used during u-blox production.

u-blox in-line production testing includes:

- Digital self-tests (firmware download, MAC address programming)
- Measurement of voltages and currents
- Functional tests (host interface communication)
- Digital I/O tests
- Measurement and calibration of RF characteristics in all supported bands, including RSSI calibration, frequency tuning of reference clock, calibration of transmitter power levels, etc.
- Verification of Wi-Fi and Bluetooth RF characteristics after calibration, like modulation accuracy, power levels, and spectrum, are checked to ensure that all characteristics are within tolerance when the calibration parameters are applied.

Figure 29: Automatic test equipment for module test

7.2 OEM manufacturer production test

As all u-blox products undergo thorough in-series production testing prior to delivery, OEM manufacturers don’t need to repeat any firmware tests or measurements that might otherwise be necessary to confirm RF performance. Testing over analog and digital interfaces is also unnecessary during an OEM production test.

OEM manufacturer testing should ideally focus on:

- Module assembly on the device; it should be verified that:
  - Soldering and handling process did not damage the module components
  - All module pins are well soldered on application board
  - There are no short circuits between pins
- Component assembly on the device; it should be verified that:
  - Communication with host controller can be established
  - The interfaces between module and device are working
  - Overall RF performance test of the device including antenna

In addition to this testing, OEMs can also perform other dedicated tests to check the device. For example, the measurement of module current consumption in a specified operating state can identify a short circuit if the test result deviates from that taken against a “Golden Device”.

The standard operational module firmware and test software on the host can be used to perform functional tests (communication with the host controller, check interfaces) and perform basic RF performance testing. Special manufacturing firmware can also be used to perform more advanced RF performance tests.

7.2.1 “Go/No go” tests for integrated devices

A “Go/No go” test compares the signal quality of the Device under Test (DUT) with that of “Golden Device” in a location with a known signal quality. This test can be performed after establishing a connection with an external device.

A very simple test can be performed by just scanning for a known Bluetooth LE device and checking that the signal level (Received Signal Strength Indicator (RSSI) is acceptable.

☞ Tests of this kind may be useful as a “go/no go” test but are not appropriate for RF performance measurements.

Go/No go tests are suitable for checking communication between the host controller and the power supply. The tests can also confirm that all components on the DUT are well soldered.

A basic RF functional test of the device that includes the antenna can be performed with standard Bluetooth LE devices configured as remote stations. In this scenario, the device containing IRIS-W1 and the antennas should be arranged in a fixed position inside an RF shield box. The shielding prevents interference from other possible radio devices to ensure stable test results.

7.3 Radio test

This chapter provides guidance on the usage of NXP manufacturing software (Labtool) application. Labtool is a software application used to control and run various RF and regulatory compliance tests.

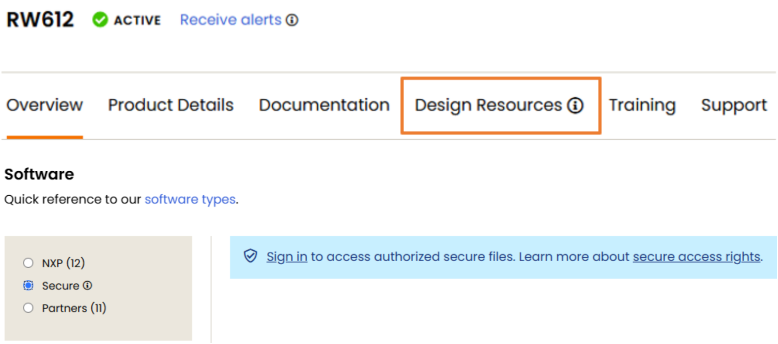
Labtool enables RF testing for IRIS-W10 series modules. Labtool is used for the following:

- Measurement of RF parameters such as transmit power, error vector magnitude (EVM), and receiver sensitivity
- *Regulatory compliance testing (EMC/EMI)*

7.3.1 Download and setup

To download and set up the Labtool, follow these steps:

1. Go to RW610 and RW612 product pages on NXP website.
2. Navigate to Design Resources and select Secure files under Software.



3. Sign in to access software.
4. Look for the manufacturing software release package. For example, *MFG-RW61X-MF-BRG-U16-WIN-X86-2.0.0.20.0-18.80.2.pXX*
5. Download the zip file and extract the content.
6. Below table shows the content of the manufacturing (MFG) software package:

Type	Name	Description
Directory	Calibration data	Sample calibration files in .conf file and .txt file formats Driver source code (.tgz)
Directory	FWImage	MFG firmware binary files
Directory	Labtool	Precompiled Labtool application • SetUp.ini • Labtool application *DutApiMimoApApp_LABTOOL_UNIFIED.exe*
Directory	License	

7. The IRIS-W10 series modules come in versions that use two different memory types. Check the date code on the module label to understand what type is being used.
   - For build versions to and including 23/45 (meaning week 45 of 2023), type is Macronix.
   - For build versions from 23/46, type is Fidelex.

   Based on the integrated memory type in your module, select the appropriate UART bridge binaries and replace them in the FreeRTOS folder as mentioned in table below.

Memory type	IRIS-W10 Variant	Replace binaries
Fidelix (8/16 MB)	IRIS-W10x-00B/10B	• Replace **uart_wifi_ble_15d4_bridge.bin** located in the folder **MFG-RW61X-MF-BRG-U16-WIN-X86-x.x.x.xx.x-xx.xx.x.xxx\FwImage\FreeRTOS** (Table in Step 6) with **uart_wifi_ble_15d4_bridge_fi8.bin**. • Rename the binary to **uart_wifi_ble_15d4_bridge.bin**.
	IRIS-W10x-30B/40B	• Replace **uart_wifi_ble_bridge.bin** located in the folder **MFG-RW61X-MF-BRG-U16-WIN-X86-x.x.x.xx.x-xx.xx.x.xxx\FwImage\FreeRTOS** (Table in Step 6) with **uart_wifi_ble_bridge_fi8.bin**. • Rename the binary to **uart_wifi_ble_bridge.bin**.
Macronix (8 MB)	IRIS-W10x-00B	• Replace **uart_wifi_ble_15d4_bridge.bin** located in the folder **MFG-RW61X-MF-BRG-U16-WIN-X86-x.x.x.xx.x-xx.xx.x.xxx\FwImage\FreeRTOS** (Table in Step 6) with **uart_wifi_ble_15d4_bridge_mx8.bin**. • Rename the binary to **uart_wifi_ble_15d4_bridge.bin**.

☞ The replaced binaries are compiled using the uart_wifi_bridge application from SDK version 25.06.00 and have been tested with Labtool version MFG-RW61X-MF-BRG-U16-WIN-X86-2.0.0.35.0-18.80.6.p34 for various memory models. With newer Labtool versions, these binaries may or may not function properly.

☞ If the binaries fail to work, recompile them using the uart_wifi_bridge application with the latest SDK release available. As a general guideline, always use the latest SDK version to compile uart_wifi_bridge binaries when working with the latest Labtool version. Alternatively, refer README.md on u-blox openCPU Github repository [13] for building UART bridge binaries specific to IRIS-W10 modules.

8. Figure 30 shows the RF test set-up for IRIS-W10.

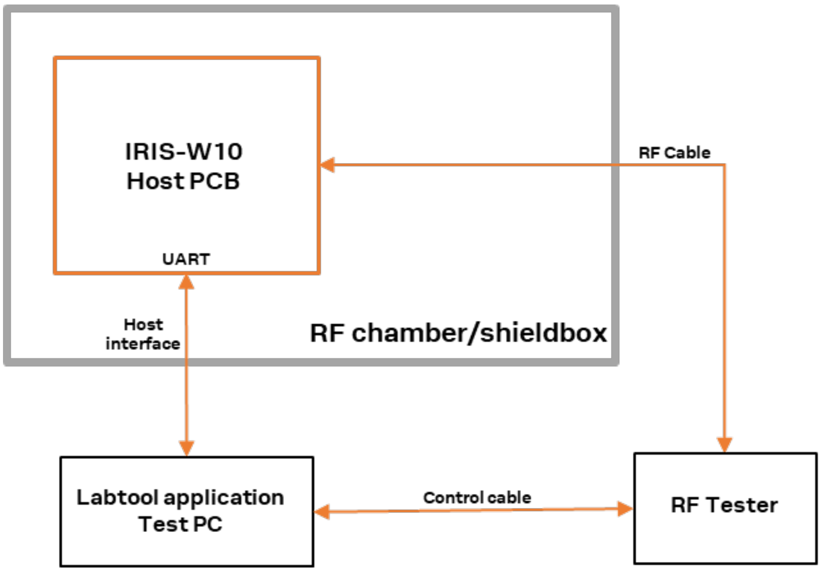


Figure 30: RF test steup

7.3.2 Flash the application and firmware

To flash the labtool application and firmware:

1. Ensure IRIS-W10 is set to boot from QSPI flash (default) and SWD interface is enabled.
2. Go to *FwImage\FreeRTOS* folder in labtool software package and run **prog_flash_RW610_A2.bat** script. This file includes:

```
Device RW612
SelectInterface SWD
//SelectInterface JTAG
Speed 1000
JTAGConf -1,-1
Connect
Sleep 1000
Halt
loadbin rw61xw_sb_mfg_fw_cpu1_a2.bin,0x08400000
Sleep 1000
loadbin rw61xn_sb_mfg_fw_cpu2_combo_a2.bin,0x085E0000
Sleep 1000
loadbin uart_wifi_ble_15d4_bridge.bin,0x08000000
Sleep 2000
Reset
Exit
```

3. Wait for the flashing to complete. Then, power cycle the board.

7.3.3 Labtool setup on PC

Labtool must run on 64-bit Windows. Follow these steps to set up labtool environment.

1. Power up the IRIS-W10 host board and connect it to the PC via USB port.
2. Look for **JLink CDC UART** port number in Device Manager.

3. Edit the *SetUp.ini* file located in the Labtool folder and update the COM port value to match JLink CDC UART port number.
4. IRIS-W10 requires calibration data for optimal RF performance. Refer to README.md on u-blox openCPU Github repository [13] for loading u-blox specific calibration data onto the module via Labtool.
5. Run *DutApiMimoApApp_LABTOOL_UNIFIED.exe* application to start Labtool.

```
Name: Dut labtool Version: 2.0.0.20
Date: Feb 03 2025 (10:57:58)
Note:
1. =========WiFi tool=============
2. =========BT tool=============
3. =========15_4 tool=============
Enter CMD 99 to Exit Enter option:
```

6. Enter **1** at the command prompt to start operating the Wi-Fi radio. Enter **2** to start operating Bluetooth LE radio. Enter **3** to start operating 802.15.4 radio.
7. Refer Manufacturing Software User Manual for RW61x (UM11801) [13] for commands and sequences to run RF tests on Wi-Fi, BLE and 802.15.4 radio.

Appendix

A Wi-Fi transmit output power limits

All power settings apply to the IRIS-W101 and IRIS-W106 unless otherwise noted.

A.1 FCC / ISED regulatory domain

Table 23 and Table 24 list the maximum allowable conducted[13] output power limits for operation in the FCC/ISED regulatory domains.

A.1.1 FCC / ISED Wi-Fi output power for 2.4 GHz band

The output power limits are for use with a max allowed antenna gain of 3 dBi.

Mode	Channel	Maximum Tx power [dBm] IRIS-W101	Maximum Tx power [dBm] IRIS-W106
802.11b	1	17	17
	2 – 8	18	18
	9 – 10	17	17
	11	16	16
802.11g	1	14	14
	2 – 8	16	16
	9 – 10	14	14
	11	13	13
802.11n	1	12	12
	2 – 8	16	16
	9 – 10	14	14
	11	12	12
802.11ac	1	12	12
	2 – 8	16	16
	9 – 10	14	14
	11	12	12
802.11ax	1	12	12
	2 – 8	16	16
	9 – 10	14	14
	11	12	12
802.11ax RU	1	11	11
	2 – 8	15	15
	9 – 10	14	14
	11	11	11

Table 23: FCC / ISED Wi-Fi power table for operation in the 2.4 GHz band

[13] Output power at the antenna connector, without antenna gain

A.1.2 FCC / ISED Wi-Fi output power for 5 GHz band

The output power limits are for use with a max allowed antenna gain of 3.4 dBi.

Mode	Channel	Maximum Tx power [dBm] IRIS-W101	Maximum Tx power [dBm] IRIS-W106
802.11a	36 – 48, 52 – 60	15	15
	64, 100	14	14
	104 – 136	17	17
	140	15	15
	149 - 165	16	16
802.11n	36 – 48, 52 – 60	15	15
	64, 100	14	14
	104 – 136	17	17
	140	15	15
	149 – 165	16	16
802.11ac	36 – 48, 52 – 60	15	15
	64, 100	14	14
	104 – 136	17	17
	140	15	15
	149 – 165	16	16
802.11ax	36 – 48,52 – 60	15	15
	64, 100	14	14
	104 – 136	17	17
	140	15	15
	149 – 165	16	16
802.11ax RU	36 – 48	12	12
	52 – 64	12	12
	100 – 136	12	12
	140	11	11
	149 – 165	16	16

Table 24: FCC/ISED Wi-Fi power table for operation in the 5 GHz band

A.2 RED and UKCA regulatory domains

Table 25 and Table 26 describe the maximum allowable conducted[14] output power limits for operation in the RED and UKCA regulatory domains.

A.2.1 Wi-Fi output power for 2.4 GHz band

The output power limits are for use with a max allowed antenna gain of 3 dBi.

Mode	Channel	Maximum Tx power [dBm] IRIS-W101	Maximum Tx power [dBm] IRIS-W106
802.11b	1	15	17
	2 – 12	16	18
	13	16	18
802.11g	1	16	18
	2 – 12	17	19
	13	17	19
802.11n	1	16	18
	2 – 12	17	19
	13	17	19
802.11ac	1	16	18
	2 – 12	17	19
	13	17	19
802.11ax	1	16	18
	2 – 12	17	19
	13	17	19
802.11ax RU	1	7	9
	2 – 12	8	10
	13	8	10

Table 25: RED Wi-Fi power table for operation in the 2.4 GHz band

[14] Output power at the antenna connector, without antenna gain

A.2.2 Wi-Fi output power for 5 GHz band

The output power limits are for use with a max allowed antenna gain of 3.4 dBi.

Mode	Channel	Maximum Tx power [dBm] IRIS-W101	Maximum Tx power [dBm] IRIS-W106
802.11a	36 – 48	18	18
	52 – 64, 100 – 136	15	15
	140	11	11
	149 – 163	10	10
	165	9	9
802.11n	36 – 48	18	18
	52 – 64, 100 – 136	15	15
	140	11	11
	149 – 163	10	10
	165	9	9
802.11ac	36 – 48	18	18
	52 – 64, 100 – 136	15	15
	140	11	11
	149 – 163	10	10
	165	9	9
802.11ax	36 – 48	18	18
	52 – 64, 100 – 136	15	15
	140	11	11
	149 – 163	10	10
	165	9	9
802.11ax RU	36 – 48	16	16
	52 – 64, 100 – 136	14	14
	140	11	11
	149 – 165	10	10

Table 26: RED Wi-Fi power table for operation in the 5 GHz band

B Antenna reference designs

Designers can take full advantage of IRIS-W10's Single-Modular Transmitter certification approval by integrating the u-blox reference design into their products. This approach requires compliance with the following rules:

- Only listed antennas can be used. See also Approved antennas.
- Schematics and parts used in the design must be identical to the reference design. Use only parts validated by u-blox for antenna matching.
- PCB layout must be identical to the one provided by u-blox. Implement one of the reference designs described in this section or contact u-blox.
- The designer must use the PCB stack-up provided by u-blox. RF traces on the carrier PCB are part of the certified design.

When using the IRIS-W101 with this antenna reference design, the circuit trace layout must be made in strict compliance with the antenna reference design described in this appendix.

B.1 Reference design for external antennas (U.FL connector)

The reference design uses a U.FL micro-coaxial connector to connect the external antenna via a 50 Ω coaxial cable. Figure 31 shows the placement of the connector in relation and module footprint. The components connected to the RF trace must be kept as shown in the reference design.

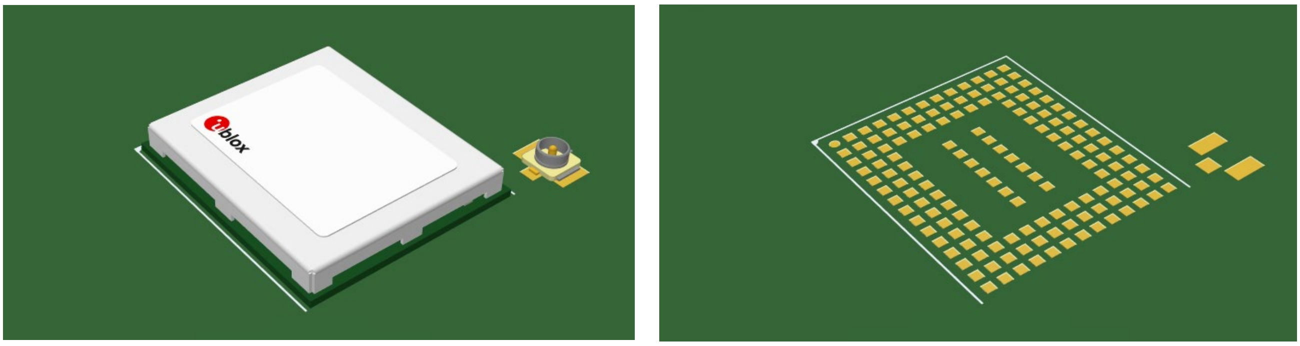


Figure 31: U.FL connector placement (left) and module footprint (right)

B.1.1 Floor plan

Figure 32 shows the critical components and positioning of the copper traces in the reference design. The itemized references are described in Table 27.

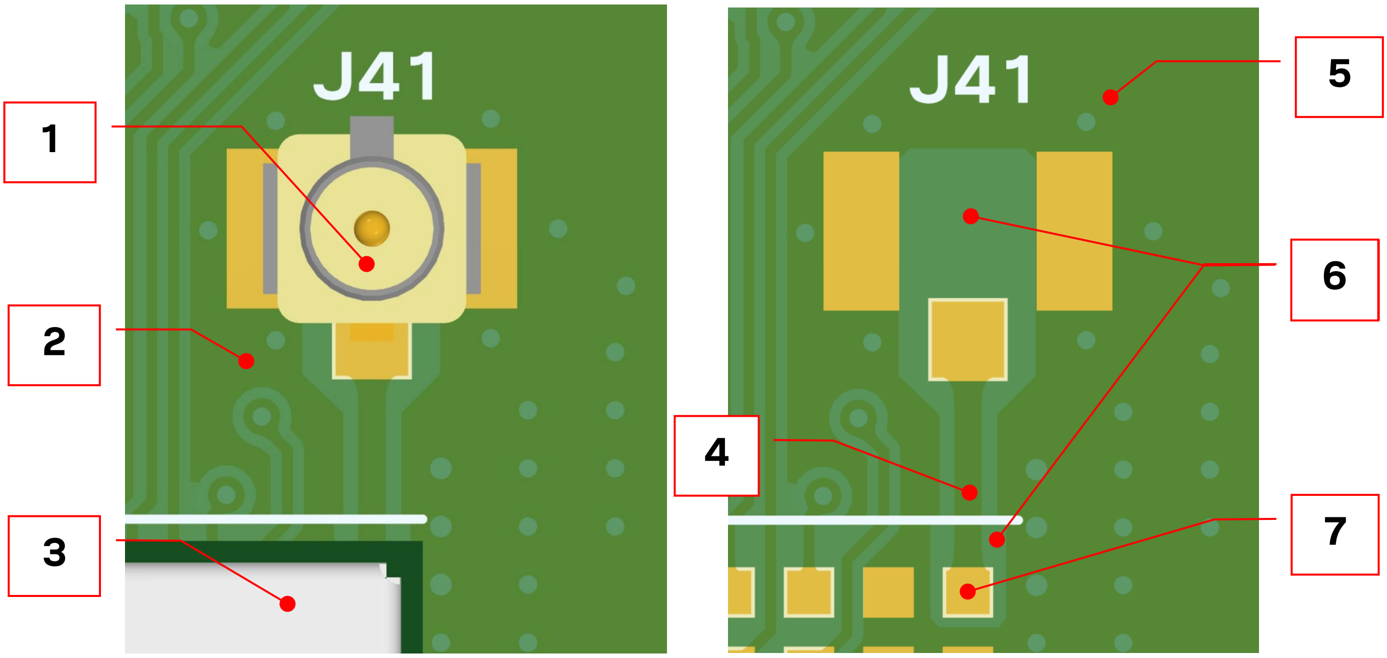


Figure 32: IRIS-W101 antenna reference design

Reference	Part	Manufacturer	Description
1	U.FL-R-SMT-1(10)	u-blox	Coaxial connector, 0 – 6 GHz, for external antennas
2	Carrier PCB		Should have a solid GND inner layer underneath and around the RF components (vias and small openings are allowed)
3	IRIS-W101	Hirose	IRIS-W10 module with antenna pin
4	RF trace		Antenna coplanar microstrip, matched to 50 Ω
5	GND copper pour		Minimum required top layer GND copper pour. Minimum 1.3 mm surrounding U.FL connector and RF traces. See also Figure 34.
6	Copper keep-out		Keep this area free from any copper on the top and second layer.
7	RF pin		RF pin on IRIS-W10 footprint

Table 27: Antenna reference design – item descriptions

B.1.2 RF trace specification

The dimensions of the 50 Ω coplanar microstrip used in the reference design are shown in Figure 33 and described in Table 28. GND stitching vias should be used around the RF trace to ensure a proper GND connection. No other components are allowed within this area.

The solid GND layer beneath the “top layer” shall surround at least the entire RF trace and connector. No signal traces are allowed to be routed on the GND layer within this area but vias and small openings are allowed.

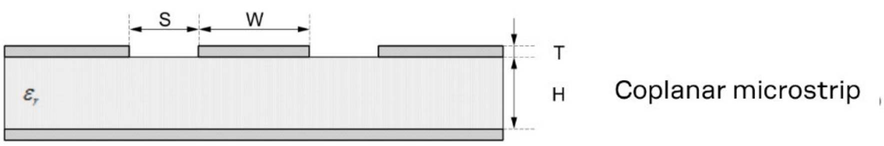


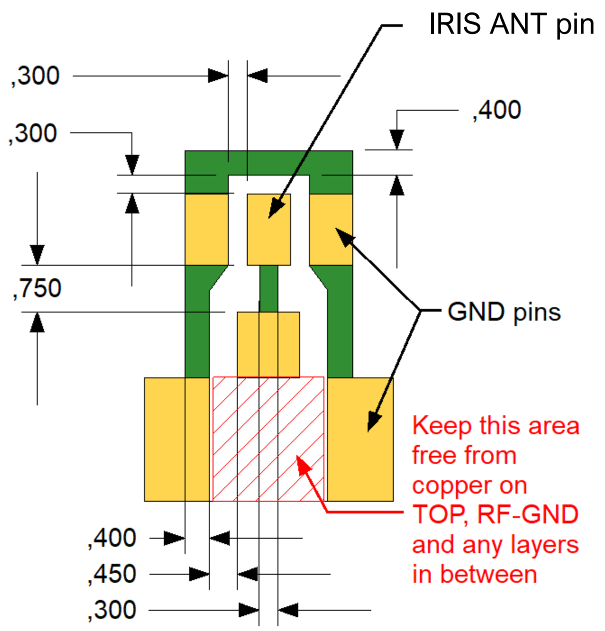
Figure 33: Coplanar microstrip dimension specification

Reference	Item	Value
S	Spacing	200 +/- 50 µm
W	Conductor width	300 +/- 30 µm (match as close to 50 Ω as possible)
T	Copper and plating/surface coating thickness	35 +/- 15 µm
H	Conductor height	150 +/- 20 µm
ε_r	Dielectric constant (relative permittivity)	3.77 +/- 0.5 @ 2 GHz

Table 28: Coplanar microstrip specification

☞ The GND spacing requirements of the IRIS ANT and U.FL connector RF pins are greater than the spacing requirement of a 50 Ω coplanar microstrip. However, when using the conductor width and height specified in Figure 34, the increased spacing to GND does not significantly affect the trace impedance for short trace lengths. Therefore, the impedance is still close to 50 Ω.

Figure 34 shows the **ANT** and **GND** pins, with the dimensions of the U.FL connector, and the copper-free area on RF-GND.



All dimensions are shown in mm

Figure 34: RF trace and minimum required GND trace of the U.FL antenna connector reference design

C Glossary

Abbreviation	Definition
ABS	Acrylonitrile butadiene styrene
ADC	Analog to Digital Converter
ATE	Automatic Test Equipment
LE	Bluetooth Low Energy
CTS	Clear To Send
DCX	Data/Command Signal
DFU	Device Firmware Update
DDR	Dual-Data Rate
DUT	Device Under Test
EMC	Electro Magnetic Compatibility
EMI	Electro Magnetic Interference
ESD	ElectroStatic Discharge
FCC	Federal Communications Commission
GATT	Generic ATTribute profile
GND	Ground
GPIO	General Purpose Input/Output
I2C	Inter-Integrated Circuit
I2S	Inter-IC sound interface
IDE	Integrated Development Environment
IEEE	Institute of Electrical and Electronics Engineers
LDO	Low Drop Out
LED	Light-Emitting Diode
MAC	Media Access Control
MISO	Master Input, Slave Output
MOSI	Master Output, Slave Input
MSL	Moisture Sensitivity Level
NFC	Near Field Communication
NSMD	Non Solder Mask Defined
PCB	Printed Circuit Board
PIFA	Planar Inverted-F Antenna
PC	Polycarbonate
QDEC	Quadrature DECoder
QSPI	Quad Serial Peripheral Interface
RF	Radio Frequency
RoHS	Restriction of Hazardous Substances
RSSI	Received Signal Strength Indicator
RTS	Request to Send
RXD	Receive Data
SCL	Signal Clock
SWD	Serial Wire Debug
SDL	Specification and Description Language
SMA	SubMiniature version A
SMD	Solder Mask Defined

Abbreviation	Definition
SMPS	Switching Mode Power Supply
SMT	Surface-Mount Technology
SPI	Serial Peripheral Interface
SWD	Serial Wire Debug
Thread	Networking protocol for Internet of Things (IoT) "smart" home automation devices to communicate on a local wireless mesh network
THT	Through-Hole Technology
TRP	Total Radio Power
TXD	Transmit Data
UART	Universal Asynchronous Receiver/Transmitter
UICR	User Information Configuration Registers
USB	Universal Serial Bus
VCC	IC power-supply pin
VSWR	Voltage Standing Wave Ratio
Zigbee	Open standard protocol, full-stack solution for a majority of large smart home ecosystem providers

Table 29: Explanation of the abbreviations and terms used

Related documentation

[1] IRIS-W10 product summary, UBX-23000279
[2] IRIS-W10 data sheet, UBX-23002331
[3] EVK-IRIS-W1 user guide, UBX-23007837
[4] JEDEC J-STD-020C - Moisture/Reflow Sensitivity Classification for Non Hermetic Solid State Surface Mount Devices
[5] IEC EN 61000-4-2 - Electromagnetic compatibility (EMC) - Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test
[6] ETSI EN 301 489-1: Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 1: Common technical requirements
[7] IEC61340-5-1: Protection of electronic devices from electrostatic phenomena, General requirements
[8] ETSI EN 60950-1:2006: Information technology equipment – Safety – Part 1: General requirements
[9] FCC Regulatory Information – Title 47 - Telecommunications
[10] FCC guidance 594280 D01 Configuration Control v02 r01
[11] FCC guidance 594280 D02 U-NII Device Security v01r03
[12] NXP blhost User Manual https://www.nxp.com/docs/en/user-guide/MCUBLHOSTUG.pdf
[13] u-blox openCPU Github repository https://github.com/u-blox/u-blox-sho-OpenCPU
[14] Product packaging guide, UBX-14001652
[15] IRIS-W10 EU Declaration of Conformity, UBXDOC-465451970-3451
[16] IRIS-W10 UKCA Declaration of Conformity, UBXDOC-465451970-3452
[17] MCUXpresso SDK, https://www.nxp.com/design/designs/mcuxpresso-software-development-kit-sdk:MCUXpresso-SDK
[18] MCUXpresso SDK Builder, https://mcuxpresso.nxp.com/en/welcome
[19] MCUXpresso IDE, https://www.nxp.com/design/software/development-software/mcuxpresso-software-and-tools-/mcuxpresso-integrated-development-environment-ide:MCUXpresso-IDE
[20] Arm GNU Toolchain, https://developer.arm.com/Tools%20and%20Software/GNU%20Toolchain
[21] CMake software, https://cmake.org/download/
[22] IAR Embedded Workbench for ARM: https://www.iar.com/products/architectures/arm/iar-embedded-workbench-for-arm/
[23] GNU Compiler Collection (GCC): https://gcc.gnu.org/install/
[24] NXP Wi-Fi and Bluetooth Demo Applications for RW61x - User manual (UM11799) (login required)
[25] Manufacturing Software User Manual for RW61x (UM11801) https://www.nxp.com/docs/en/user-manual/UM11801.pdf
[26] Getting Started with MCUXpresso SDK, MCUXSDKGSUG
[27] NXP RW612 Data sheet (login required): https://www.nxp.com/webapp/Download?colCode=RW612-DS&appType=license
[28] blhost application (login required): https://www.nxp.com/design/design-center/software/development-software/mcuxpresso-software-and-tools-/mcu-bootloader-for-nxp-microcontrollers:MCUBOOT
[29] MCUXpresso SDK Documentation https://mcuxpresso.nxp.com/mcuxsdk/latest/html/index.html
[30] Zephyr SDK Documentation https://docs.zephyrproject.org/latest/boards/u-blox/ubx_evk_iris_w1/doc/index.html
[31] Zephyr downstream repo (u-blox-zephyr) https://github.com/u-blox/u-blox-zephyr

[32] Github mcuxpresso-sdk/mcux-sdk
https://github.com/nxp-mcuxpresso/mcuxsdk-manifests
https://github.com/nxp-mcuxpresso/mcux-sdk

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Revision history

Revision	Date	Name	Comments
R01	28-Mar-2023	lber, tpat	Initial release
R02	21-Sep-2023	lber, tpat	Deleted pin list, product features list, and table data describing country code approvals status (with all relevant content now maintained in data sheet). Added General requirements for qualification and approval. Moved information describing the potting and conformal coating to Other remarks. Updated module configuration ordering codes in 1.1 Module architecture . Revised flashing instructions to describe EVK-IRIS-W10 flashing over MCULINK (USB-C) port using the SWD interface. Added Flashing over the JTAG interface, and blhost application sections. Revised number of USARTs in Universal synchronous asynchronous serial interface (USART) and updated design recommendations in Antenna interface.
R03	16-Oct-2023	lber, hisa, ovik	Updated the Approved antennas. Updated the regulatory statements for EU. Moved Internal antenna (IRIS-W106) chapter to section 2. Added Antenna reference design (IRIS-W101) and Module footprint and paste mask sections. Updated table data describing Boot strapping pins and options in Configuration pins section. Removed country code approvals status and pending Bluetooth statement (maintained in data sheet). Added General requirements for qualification and approval. Included other minor editorial changes throughout the document. Removed figure in section 2.9 and referenced EVK User guide instead.
R04	23-Oct-2023	hisa	Updated document status to Public. Added note about MCUXpresso SDK and tools support for RW612 in Open CPU software.
R05	24-Jul-2024	hisa, ovik, kbhi, lkis	Updated IRIS-W1 images. Updated Approved antennas. Added ordering codes for 10B and 30B in Document information and other related sections. Added Antenna reference designs. Added Wi-Fi transmit output power limits. Updated several sections to reflect support for Bluetooth LE version 5.4.
R06	26-Jun-2025	lkis, tpat	Removed Chapters 1.1.1 Block diagrams, 1.2 Software options, 1.2.1 Open CPU, and 2.2.1Digital I/O interfaces reference voltage, VCCIO. Table 1 and Table 2 updated. Updated related documentation and references. Moved UART, SPI, I2C chapters under Data interfaces. Chapter Clock source updated. Flexcomm pin assignments added in Table 5. U.fl connector layout updated in RF connector design. QSPI signals and pins updated in Table 6. Chapters USB 2.0, RMII, SDIO 3.0, Debug interface updated. Added chapters Repeated reflow soldering and Radio test. Renamed chapter GPIO pins to Digital interfaces and added chapter Analog interfaces. Added NCC certification, Japan radio equipment (MIC) and South Africa (ICASA).
R07	24-Nov-2025	ovik, fkru, tpat, mhan	Updated output power limit values in Wi-Fi transmit output power limits. Added IRIS-W10x-40B as variants. Added Brazil certification.

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