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JODY-W2

Antenna reference design

Application Note

Abstract

This application note describes the test set-up used in JODY-W2 module certification.

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Document Information

Title	**JODY-W2**	
Subtitle	Antenna reference design	
Document type	Application Note	
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Disclosure Restriction		

This document applies to the following products:

Product name
JODY-W2 series

Contents

1 Scope

This document defines the essential specifications necessary to implement the JODY-W2 antenna reference designs as used in certification. It is part of the equipment certification application issued to FCC and ISED. The information contained herein and its references should be sufficient to guide a skilled person to implement the design on a host carrier. It will provide the designer with PCB layout details and expected performance specifications.

This document supports a connector-based design for the use of external antennas (one for each antenna pin of the module).

2 General description and requirements

JODY-W2 series modules provide two RF interfaces for connecting external antennas. The antenna ports ANT0 and ANT1 have a nominal characteristic impedance of 50 Ω and must be connected to the related antenna through a 50 Ω transmission line to allow proper impedance matching along the RF path. A bad termination of the pin may result in poor performance or even damage the RF section of the module.

For optimal performance in multiradio mode, the isolation between the antennas shall target the requirements as specified in Table 1 and Table 2 in order to ensure good performance.

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 and Bluetooth. For 802.11a/n/ac.
Return loss	S11 < -10 dB (VSWR < 2:1) recommended S11 < -6 dB (VSWR < 3:1) acceptable	The return loss or the S11, as the VSWR, refers to the amount of reflected power, measuring how well the primary antenna RF connection matches the 50 Ω characteristic impedance of antenna pins. The impedance of the antenna termination must match as much as possible the 50 Ω nominal impedance of antenna pins over the operating frequency range, to maximize the amount of power transferred to the antenna.
Efficiency	> -1.5 dB (> 70%) recommended > -3.0 dB (> 50%) acceptable	The radiation efficiency is the ratio of the radiated power to the power delivered to antenna input: the efficiency is a measure of how well an antenna receives or transmits.
Maximum gain		The maximum antenna gain must not exceed the value specified in type approval documentation to comply with regulatory agencies radiation exposure limits.

Table 1: Summary of antenna interface requirements

Item	Requirements	Remarks
Isolation (in-band)	S_{21} > 25 dB recommended S_{21} > 20 dB acceptable	The antenna to antenna isolation is the S_{21} parameter between the two antennas in the band of operation.
Isolation (out-of-band)	S_{21} > 35 dB recommended S_{21} > 30 dB acceptable	Out-of-band isolation is evaluated in the band of the aggressor to ensure that the transmitting signal from the other radio is sufficiently attenuated by the receiving antenna to avoid saturation and intermodulation effect at the receiver's port.
Envelope correlation Coefficient (ECC)	ECC < 0.1 recommended ECC < 0.5 acceptable	The ECC parameter correlates the far field parameters between antennas in the same system. A low ECC parameter is fundamental to improve performance in MIMO-based systems.

Table 2: Summary of MIMO and Wi-Fi/Bluetooth coexistence requirements. MIMO is not applicable for JODY-W2.

3 Reference design of RF path

JODY-W2 is certified with a set-up including **JODY-W2 module board** with it's RF paths connected to the **carrier board** with RF coaxial cables. The antennas are connected to the carrier board through SMA connectors. Below are the relevant components listed.

- **Module board** including U.FL connectors with JODY-W2 mounted.
- **Carrier board** including U.FL connectors to interface the module board and SMA connectors to connect antennas.
- **Coaxial cables** with U.FL connectors connecting the module board's RF traces to the carrier board's RF traces.
- **Antennas** connected to the carrier board's SMA connectors.

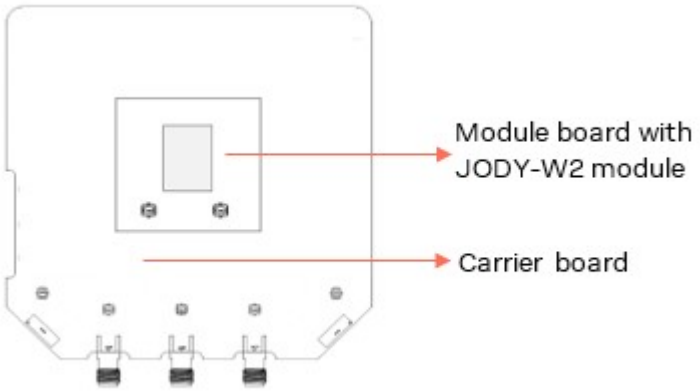


Figure 1. Definition of Module board and Carrier board

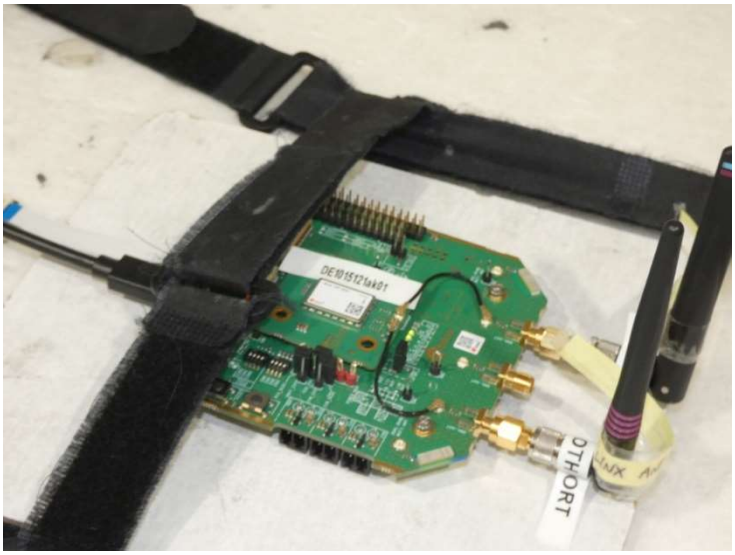


Figure 2. Test set-up.

3.1 RF trace PCB routing

The PCB routing connecting the module's antenna pins to module board U.FL connectors are designed with coplanar microstrips. Coplanar microstrips are also used on the carrier board connecting the U.FL connectors with the SMA connectors to which the external antennas or test

equipment are connected. Figure 3 and Table 3 shows the design stack-up including dimensions of the 50 Ω coplanar microstrips implemented.

Regarding the coplanar microstrips the ground planes beside the signal trace are connected to the inner layer ground plane using vias. The vias are placed with a maximum distance of 0.5 mm to the coplanar ground edge and a maximum pitch of 2 mm. The top layer is coated with generic LPI solder stop mask.

The SMA connectors on the carrier board are used for mounting antennas. For Bluetooth and Wi-Fi operation in the 2.4 GHz band and Wi-Fi operation in the 5 GHz band, the module has been tested and approved for use with antennas up to 2 dBi antenna gain.

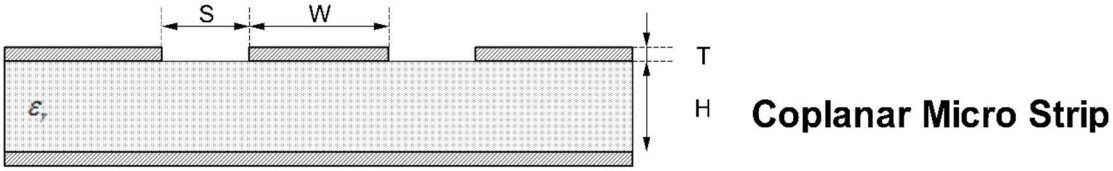


Figure 3: Coplanar micro-strip dimension specification

Item	Value
S	200 µm
W	700 µm
T	35 µm
H	800 µm
ε_r	4.3

Table 3: Coplanar micro-strip specification

The mechanical dimensions of the module board's microstrips and position of the pi network impedance matching components are shown in Figure 4. Figure 6 shows the components used for the PI network impedance matching. Here only series 0 ohm resistors are used. The inner layers have the same dimensions and are filled with ground. No RF traces are routed in these layers.
The antenna ports shown in Figure 4 on the right hand side are from top to bottom: ANT1, ANT0, and ANT2. ANT2 is not used and shall be left unconnected.

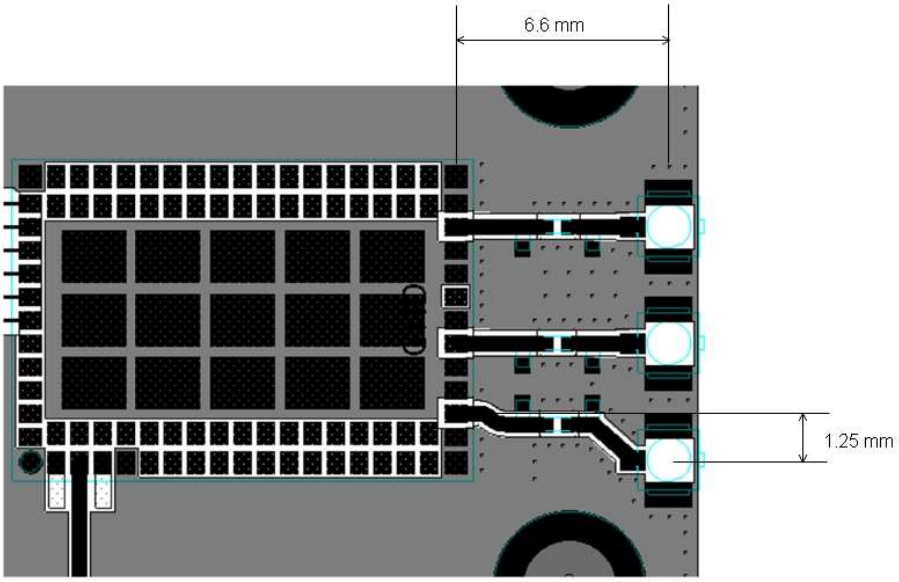


Figure 4. Module board Antenna micro strip implementation.

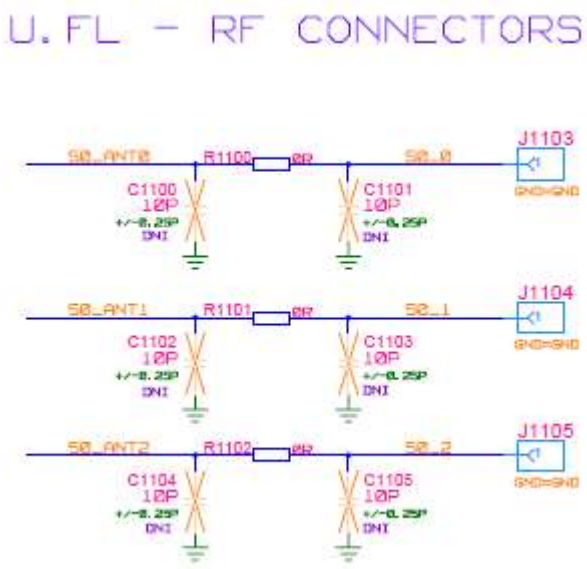


Figure 5. Component selection for RF matching network on module board using 0 ohm series resistor.

The carrier board RF traces includes pi network matching components and are routed as coplanar microstrips. Here 10 pF capacitors in series are implemented.

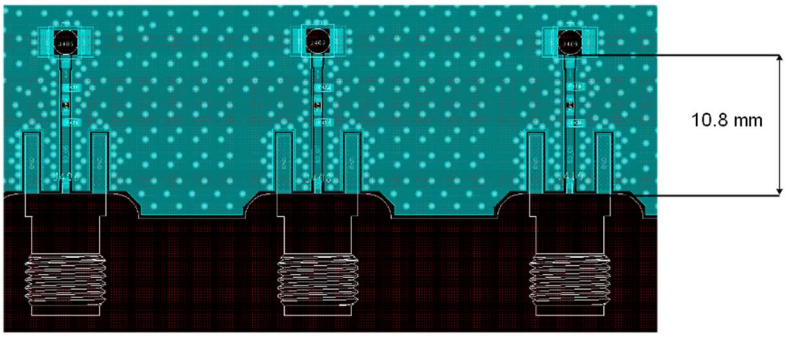


Figure 6. Carrier board Antenna micro strip implementation.

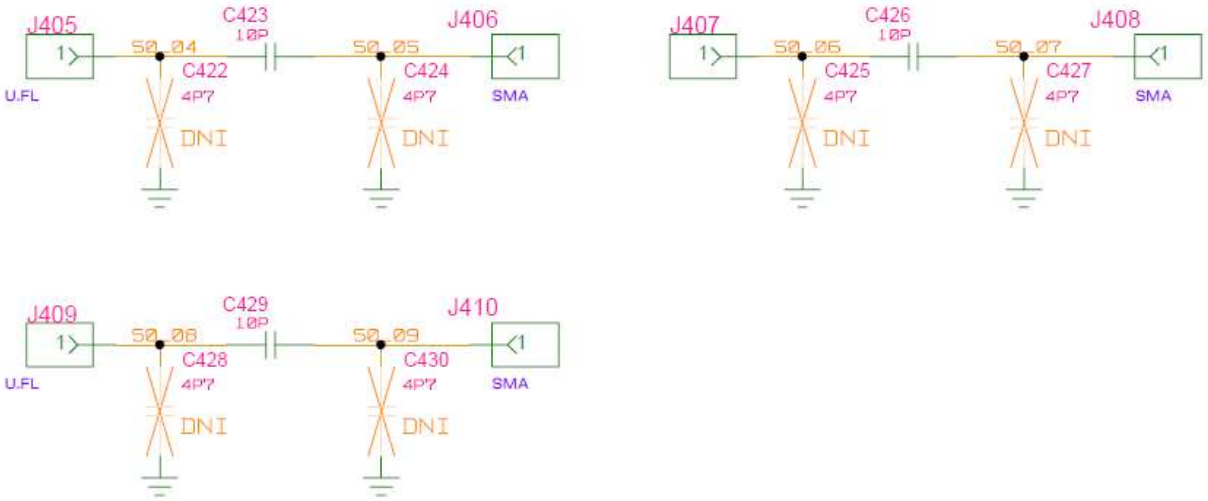
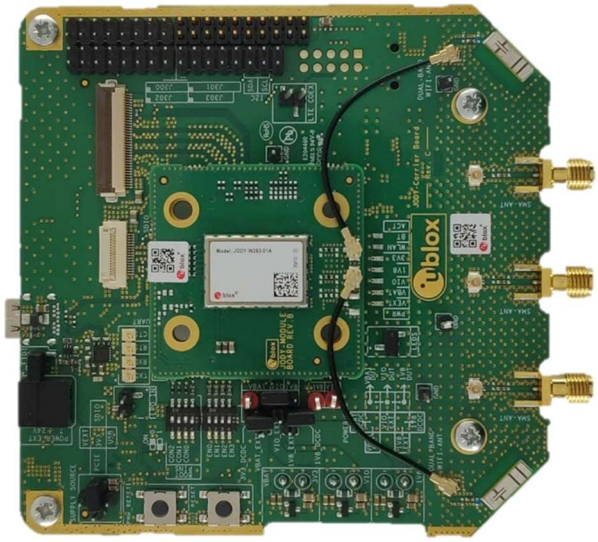


Figure 7. Component selection for RF matching network on carrier board using 10 pF series capacitors.

4 Parts

Part	Description	Outline

Evaluation board (EVB)	Evaluation board for JODY-W263 series modules. The board includes SMA antenna connectors that connect to external antennas for Wi-Fi and Bluetooth. It has two internal dual-band Wi-Fi/Bluetooth antennas.	
External Antennas (2)	1 x dual band Wi-Fi/Bluetooth antenna, Linx Technologies ANT-DB1-RAF-SMA	
Coax RF cable	U.FL-2LP(V)-04N1-A-(40)	

Revision history

Revision	Date	Name	Comments
R01	TBD	lber	Initial release.

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