VERA-P1 series antenna reference design

Topic :	**VERA-P1 antenna reference design**		
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1 Scope

This document defines the essential specifications necessary to implement the VERA-P173 / VERA-P174 antenna reference designs. The information contained herein and its references should be sufficient to guide a skilled person in an attempt to implement the design on a host carrier. It will provide the designer with PCB layout details and expected performance specifications.

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

2 FCC ID reference

Model	FCC ID
VERA-P173-00A	XPYVERAP174
VERA-P174-00A	XPYVERAP174

Table 1: FCC IDs for different models of VERA-P1 series modules

3 General description and requirements

The antenna reference design provides two RF interfaces for connecting the external antennas. Antenna ports **ANT1** and **ANT2** 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 to the RF section of the module.

For optimal antenna performance in multi-radio mode, the isolation between the antennas must be maximized; the designer must follow the requirements specified in Table 2 and Table 3 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 **ANTx** pin.
Frequency Range	5850 - 5925 MHz	For 802.11p.
Return Loss	S_{11} < -13 dB (VSWR < 1.5:1) Abs. Max.	The return loss or the S_{11}, 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 the **ANTx** pin. The impedance of the antenna termination must match as much as possible the 50 Ω nominal impedance of the **ANTx** pin over the operating frequency range thus, maximizing the amount of the 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 the antenna input. The efficiency is a measure of how well an antenna receives or transmits.

Table 2: Summary of antenna interface requirements

Item	Requirements	Remarks
Isolation (in-band)	$\|S_{21}\|$ > 50 dB recommended $\|S_{21}\|$ > 43 dB minimum	The antenna to antenna isolation is the loss between the primary and the secondary antenna; high isolation results from low coupled antennas.
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 effects at the receiver's port.

Table 3: Summary of antenna isolation requirements

4 Reference design of RF path

The reference design of the 50 Ω path to connect the modules antenna pins with a SMA connector is displayed in **Figure 1** and the dimensions concerning the board stack-up (**Table 4**) are specified in **Table 5**. An SMA connector is used to mount the antenna from Table 6.

PCB Layer	Material	Thickness
Solder mask top	General LPI solder mask	20 µm
Top	Copper Foil	35 µm
Dielectric	Pre-preg	600 µm
L2	Copper Foil	35 µm
Dielectric	Core	240 µm
L3	Copper Foil	35 µm
Dielectric	Pre-preg	600 µm
Bottom	Copper Foil	35 µm
Solder mask bottom	Generic LPI Soldermask	20 µm

Table 4: Stack-up of VERA-P1-EVK with standard FR4 substrate (ε_r = 4.6)

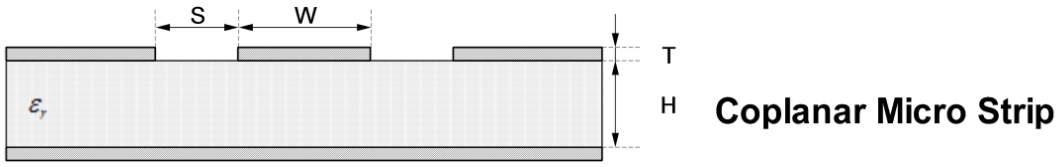

Figure 1: Coplanar waveguide with ground dimension specification

Item	Value
S	400 µm
W	900 µm
T	35 µm
H	600 µm
Spacing between ANT1 and ANT2 waveguides	16 mm

Table 5: Coplanar waveguide with ground specification

5 Antenna

The module has been approved for use with any dipole antenna with less or equal to 6 dBi peak gain. An example of an approved antenna is listed in **Table 6**.

Model name	Manufacturer and description	Gain [dBi] (peak)
TD.10.5113	Taoglas, Dipole Terminal Antenna SMA Connector	5.88 dBi

Table 6: Approved antenna example