HRA142 Antenna Datasheet

Revision 0.1.2020

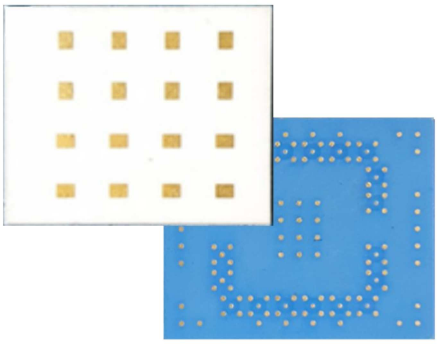
18 Aug 2020

Miliwave Co.,Ltd.
Suite 423, 105 Gwanggyo-ro
Yeongtong-su, Suwon-si, Gyeonggi-do, 16229 KOREA.

1. Introduction

1.1 Summary

The HRA142 antenna is Miliwave's dual-polarized phased array antenna, designed for Consumer Electronic (CE) applications. The dual-polarized antenna addresses both vertical and horizontal polarizations with 2x4 patch arrays for each polarization. This antenna is optimized for use with Peraso's PRS1145 radio transceiver for 802.11ad (WiGig) applications.



1.2 Features Summary

- Operates in the unlicensed 57 to 66 GHz band
- Overall size: 13 mm x 15 mm x 0.565 mm
- Array size: 2x4 for each polarization
- Broadside radiation
- Beam-steering of ±50° and ±50° for horizontal and vertical polarization respectively

1.3 Applications and Use Cases

- Wireless Virtual Reality
- High speed point-to-point data transfer
- Mobile "sync-and-go"
- Wireless docking and I/O
- In-room wireless display (including full HD/4K video streaming and secondary display)

1.4 Application Diagram

1.5 Abbreviations and Acronym Definitions

Acronym	Definition
CE	Consumer Electronic
WiGig	Wireless Gigabit Alliance

1.6 Common Parameters

Table 1-1: IEEE 802.11ad Channels

IEEE 802.11ad Channel #	Carrier Frequency
1	58.32GHz
2	60.48GHz
3	62.64GHz
4	64.80GHz

2. Product Overview

The antenna element for the designed antenna array is a 2x4 array of patch antenna for each polarization. The overall dimension of the antenna is 13 mm x 15 mm x 0.565 mm.

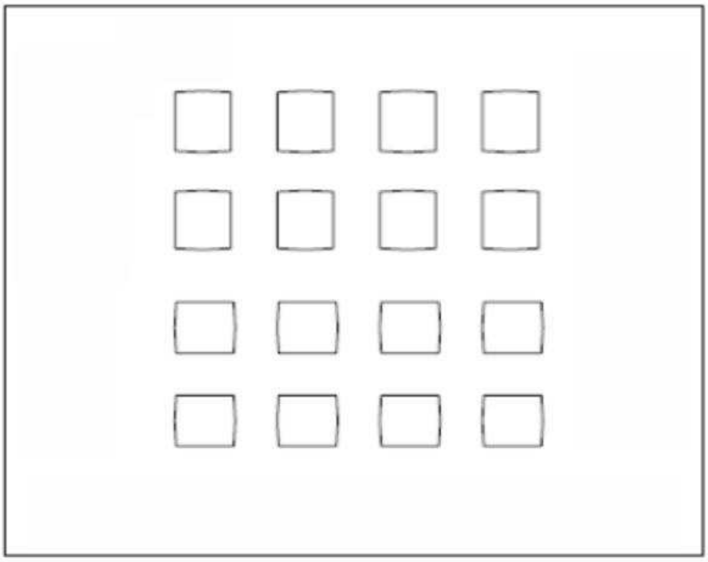


Figure 2-1: Top view of HRA142

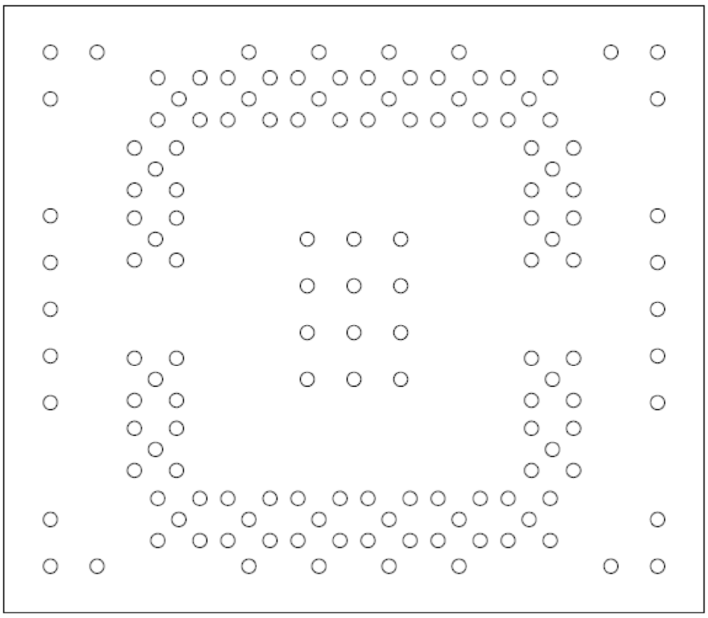


Figure 2-2: Bottom view of HRA142

3. Signal Descriptions and Pin Assignment

Table 3-1 and Figure 3-1 shows the signal names and the pin assignment for the HRA142.

Table 3-1: Signal Descriptions

Signal Name	Pin Name	I/O	Signal Type Interface	Supply Reference	Description
RF0A	0A	I/O	60 GHz RF	GND	Tx/Rx RF Antenna Port (50 Ω)
RF0B	0B	I/O	60 GHz RF	GND	Tx/Rx RF Antenna Port (50 Ω)
RF1A	1A	I/O	60 GHz RF	GND	Tx/Rx RF Antenna Port (50 Ω)
RF1B	1B	I/O	60 GHz RF	GND	Tx/Rx RF Antenna Port (50 Ω)
RF2A	2A	I/O	60 GHz RF	GND	Tx/Rx RF Antenna Port (50 Ω)
RF2B	2B	I/O	60 GHz RF	GND	Tx/Rx RF Antenna Port (50 Ω)
RF3A	3A	I/O	60 GHz RF	GND	Tx/Rx RF Antenna Port (50 Ω)
RF3B	3B	I/O	60 GHz RF	GND	Tx/Rx RF Antenna Port (50 Ω)
RF4A	4A	I/O	60 GHz RF	GND	Tx/Rx RF Antenna Port (50 Ω)
RF4B	4B	I/O	60 GHz RF	GND	Tx/Rx RF Antenna Port (50 Ω)
RF5A	5A	I/O	60 GHz RF	GND	Tx/Rx RF Antenna Port (50 Ω)
RF5B	5B	I/O	60 GHz RF	GND	Tx/Rx RF Antenna Port (50 Ω)
RF6A	6A	I/O	60 GHz RF	GND	Tx/Rx RF Antenna Port (50 Ω)
RF6B	6B	I/O	60 GHz RF	GND	Tx/Rx RF Antenna Port (50 Ω)
RF7A	7A	I/O	60 GHz RF	GND	Tx/Rx RF Antenna Port (50 Ω)
RF7B	7B	I/O	60 GHz RF	GND	Tx/Rx RF Antenna Port (50 Ω)
GND	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 0A1, 0A2, 0A3, 0A4, 0B1, 0B2, 0B3, 0B4, 1A1, 1A2, 1A3, 1A4, 1B1, 1B2, 1B3, 1B4, 2A1, 2A2, 2A3, 2A4, 2B1, 2B2, 2B3, 2B4, 3A1, 3A2, 3A3, 3A4, 3B1, 3B2, 3B3, 3B4, 4A1, 4A2, 4A3, 4A4, 4B1, 4B2, 4B3, 4B4, 5A1, 5A2, 5A3, 5A4, 5B1, 5B2, 5B3, 5B4, 6A1, 6A2, 6A3, 6A4, 6B1, 6B2, 6B3, 6B4, 7A1, 7A2, 7A3, 7A4, 7B1, 7B2, 7B3, 7B4, G1, G10, G11, G12, G13, G14, G15, G16, G17, G18, G19, G2, G20, G21, G22, G23, G24, G25, G26, G27, G28, G29, G3, G30, G31, G32, G4, G5, G6, G7, G8, G9				Ground Connection for Electrical and Mechanical Integrity

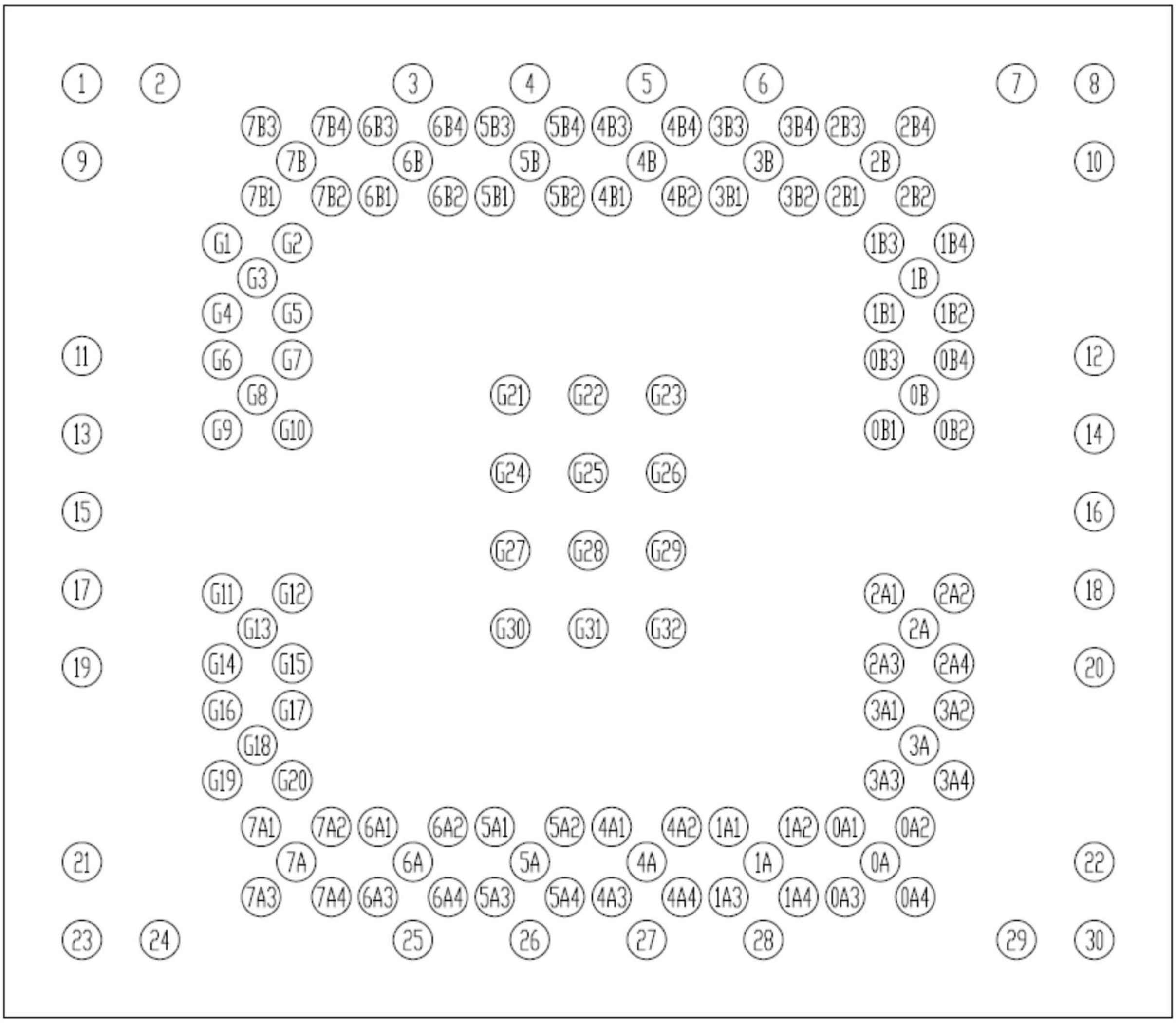


Figure 3-1: Pin assignment for HRA142

4. Specifications

4.1 Antenna Specifications

The antenna has a characteristic impedance of 50 Ω. Unless otherwise specified all parameters are referenced to 50 Ω.

Table 4-1: Specifications for Broadside Radiation of 2x4 Horizontal Polarized Array

Parameter	Achieved Value
RF Chains	8
Peak Gain (@using 8 elements)	14.5dBi
Scan range	±50°

Table 4-2: Specifications for Broadside Radiation of 2x4 Vertical Polarized Array

Parameter	Achieved Value
RF Chains	8
Peak Gain (@using 8 elements)	15.5dBi
Scan range	±50°

5. Theory of Operation

5.1 General Description

The dual linearly-polarized phased array antenna is inteded to address the requirement of a high data rate short range wireless communciations within the 57-66 GHz operating band. For some applications, such as virtual/augmented reality (VR/AR), the beam needs to have a stable gain over all channles for each scanned angle. In addition, the scan loss needs to be as minimum as possible to have a uniform range coverage for the deisred covered angles.

The general block diagram of the designed dual-polaried phased array antenna is shown in Figure 6-1. Each element (unit cell) includes an L-shape probe fed patch antenna which is excited by a strip-line transmission line through Peraso's PRS1145 RF chip. The antenna has been designed based on substrate fabrication design rules provided by Kyocera.

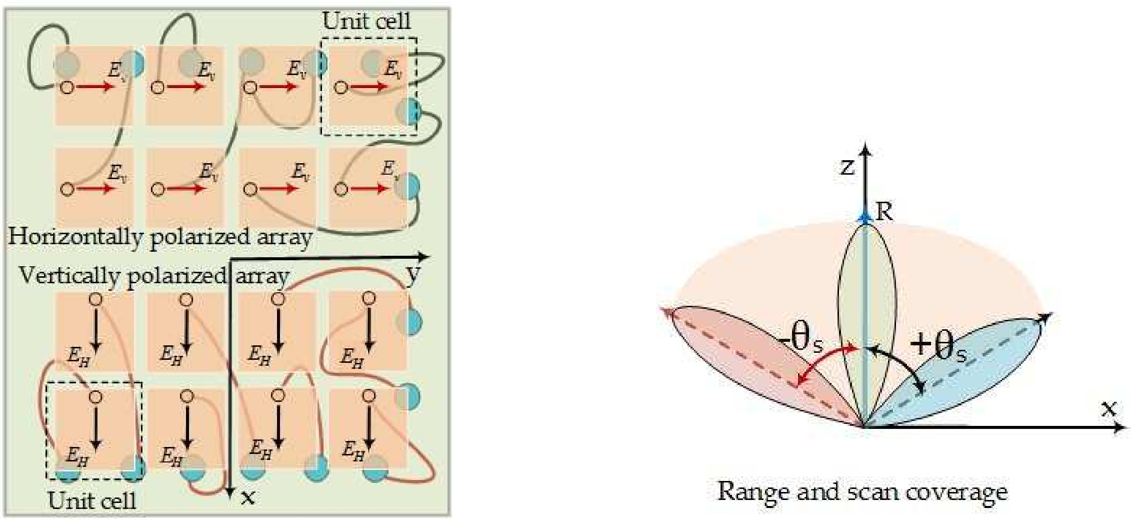


Figure 6-1. Dual Polarized 2×4-element phased array antenna

5.2 Antenna and PRS1145 interface

PRS1145 pin map is shown in Figure 6-2. Table 6-1 lists the HRA142 RF port mapping to PRS1145 RF ports.

Table 6-1: HRA142 port mapping to PRS1145 RF port

	Ant. 1 (horizontally polarized array)								Ant. 2 (vertically polarized array)							
Antenna ports	RF1B	RF0B	RF4B	RF6B	RF2B	RF3B	RF5B	RF7B	RF0A	RF1A	RF5A	RF7A	RF3A	RF2A	RF4A	RF6A
RF ports	RF2B	RF3B	RF5B	RF7B	RF1B	RF0B	RF4B	RF6B	RF3A	RF2A	RF4A	RF6A	RF0A	RF1A	RF5A	RF7A

TOP VIEW

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
A	GND	GND	RF7A	GND	GND	RF6A	GND	GND	RF5A	GND	GND	RF4A	GND	GND	RF1A	GND	GND	RF0A	GND
B	VDD25_TX_FE	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND
C	VDD12_TX_FE	VDD12_TX_FE	GPIO_9	GND	VDD25_BG	GND	GND	XREF1	TEMP_DIODE	RSET	ATST1	ATST0	GND	GND	GND	GND	GND	GND	GND
D	GND	GND	GPIO_8														GND	GND	RF3A
E	RX_LM	GND	GPIO_7														GND	GND	GND
F	RX_LP	GND	GPIO_6			GND	GND	GND	GND	GND	GND	GND	GND	GND			CPF_P	GND	GND
G	GND	GND	GPIO_5			GND	GND	GND	GND	GND	GND	GND	GND	GND			CPF_M	GND	RF2A
H	RX_Q_P	GND	VDD25			GND	GND	GND	GND	GND	GND	GND	GND	GND			VDD12_VCO	GND	GND
J	RX_Q_M	GND	GND			GND	GND	GND	GND	GND	GND	GND	GND	GND			VDD_REG_VCO	GND	XIN
K	GND	GND	VDD12_REG_PLL			GND	GND	GND	GND	GND	GND	GND	GND	GND			VDD12_PLL	GND	VDD18_XO
L	TX_Q_M	GND	VDD12_DIG			GND	GND	GND	GND	GND	GND	GND	GND	GND			VDD18_PLL	GND	VDD18_REG_PLL
M	TX_Q_P	GND	GND			GND	GND	GND	GND	GND	GND	GND	GND	GND			VDD18_RX_COMMON	GND	GND
N	GND	GND	GPIO_4			GND	GND	GND	GND	GND	GND	GND	GND	GND			VHV	GND	RF0B
P	TX_LP	GND	GPIO_3			GND	GND	GND	GND	GND	GND	GND	GND	GND			BB_RST_N	GND	GND
R	TX_LM	GND	GPIO_2														GND	GND	GND
T	GND	GND	GPIO_1														GND	GND	RF1B
U	VDD12_RX_FE	VDD12_RX_FE	GPIO_0	GND	VDD25_IO	GND	GND	XREF2	MISO	MOSI	CS_N	SCK	GND	GND	GND	GND	GND	GND	GND
V	VDD25_RX_FE	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND
W	GND	GND	RF7B	GND	GND	RF6B	GND	GND	RF5B	GND	GND	RF4B	GND	GND	RF3B	GND	GND	RF2B	GND

Figure 6-2: PRS1145 pin map

5.3 Beam steering and look up table

TBD

6. Applications Information

The connection between the radio and the antenna is extremely sensitive, and care must be taken so as not to reduce the RF performance of the system.

In general, this connection can be optimized when it done solely through a via with specific parameters. Thus, the radio IC is mounted on one side of the PCB, and the antenna is mounted on the other side. (Refer to Figure 7-1.)

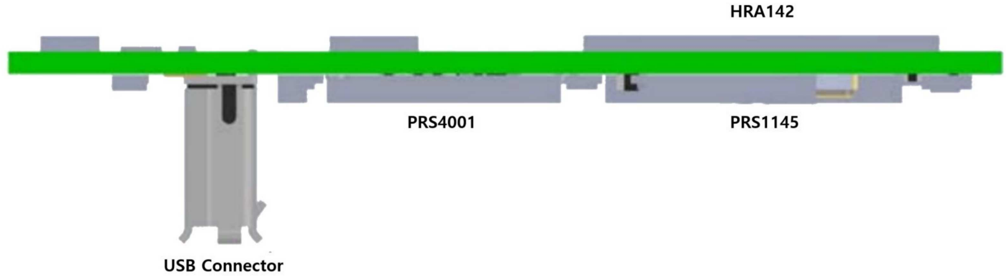


Figure 7-1: Conceptual Cross Section of PCB with radio IC and antenna attached

6.1 Antenna Assembly

Figure 7-2 shows the PCB footprint with information to illustrate a process for assembling the antenna onto the PCB. Most of the bump pads on the antenna substrate are ground pins which help secure the package onto the radio PCB.

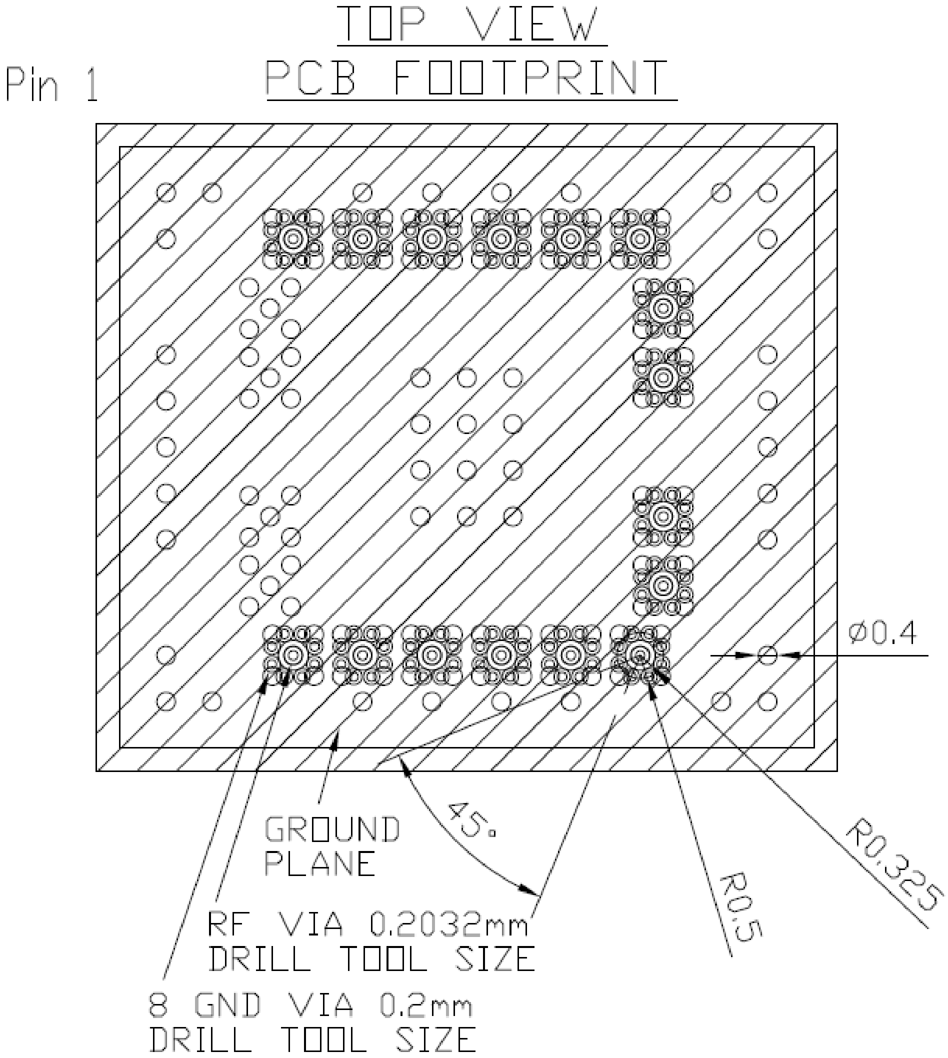


Figure 7-2: Antenna assembly guide

As shown in , Figure 7-3, and Figure 7-4, the antenna RF pins need to connect well electrically between the Peraso radio RF pins (TX and RX) and the mating RF solder bumps of the antenna for optimal RF performance. The RF via on the radio PCB must be mechanically drilled with an 0.2032mm (8 mill drill) and over or under sizing for the drill tool will compromise performance. The reason for this is that the outer diameter of the outer plated barrel of the RF via hole must be 0.2032mm (8 mil) in diameter. This is the critical dimension that should not be deviated from. The RF pad must be 0.4mm in diameter (including RF via pad diameter for via in pad) on the radio side and opposite side in the design of the modular antenna PCB footprint.

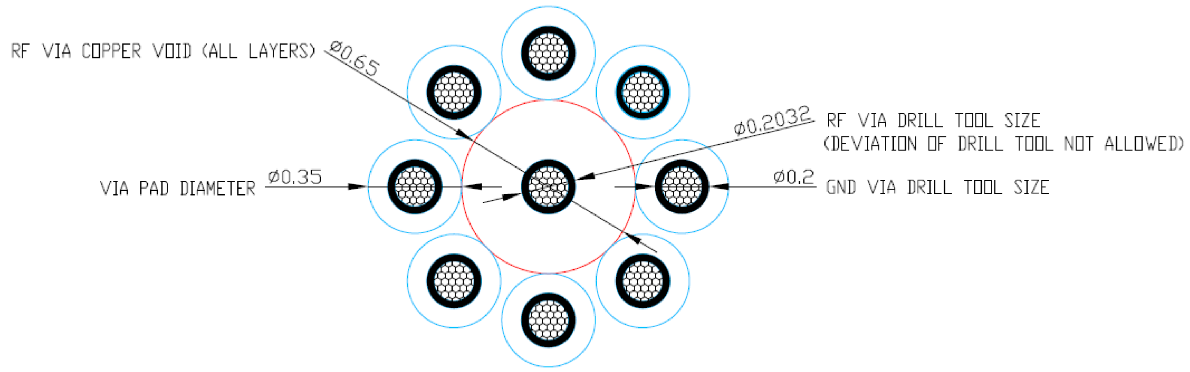


Figure 7-3: Inner layer RF/GND pad/via detail

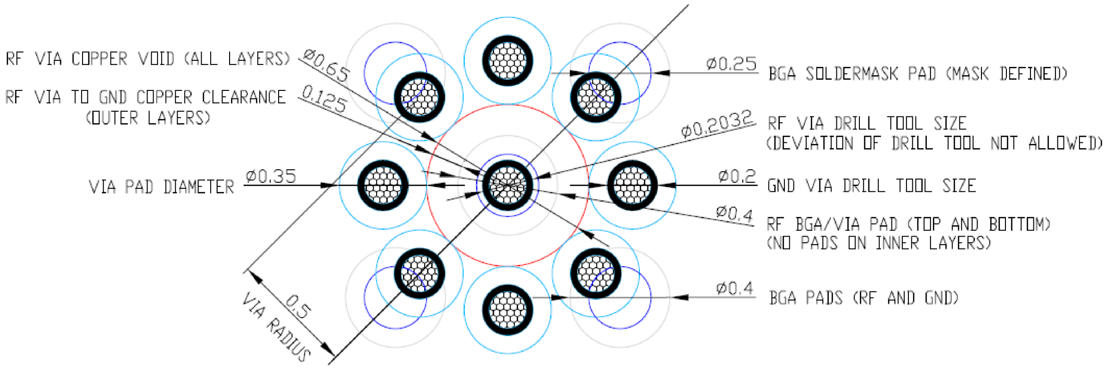


Figure 7-4: Antenna side RF/GND pad/via detail

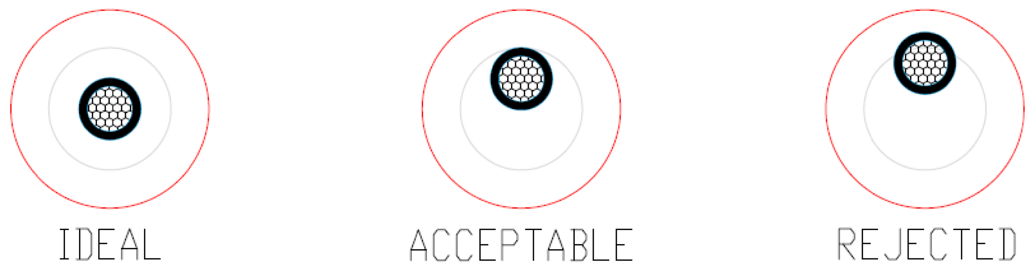


Figure 7-5: RF Via Annular Ring

Figure 7-5 shows the RF via annular ring and while offset is acceptable within the 0.4 mm pad, breakout from the boundary is not allowed. Figure 7-6 shows the RF pad cross-section detail of the PCB footprint.

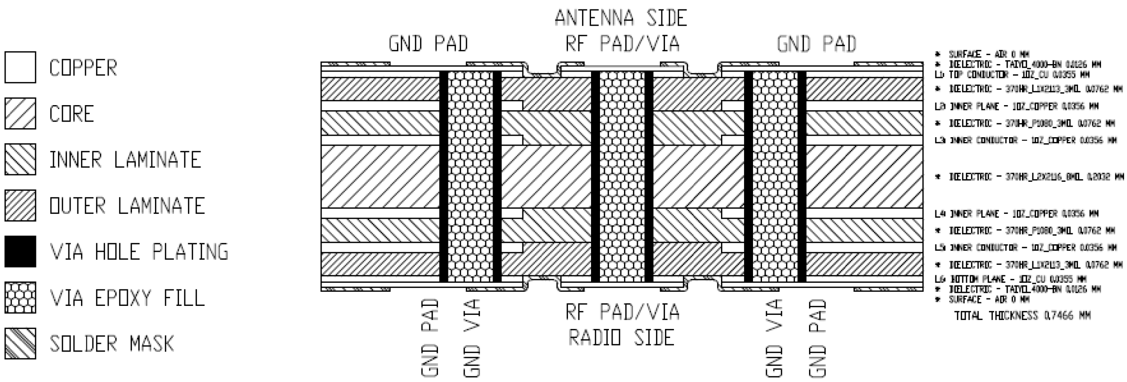


Figure 7-6: PCB footprint RF pad cross-section detail

Figure 7-7 shows the solder and paste mask to be used on the PCB. Solder mask for ground pads are the same size as the PCB footprint pads and RF pads are to be 0.25 mm in diameter.

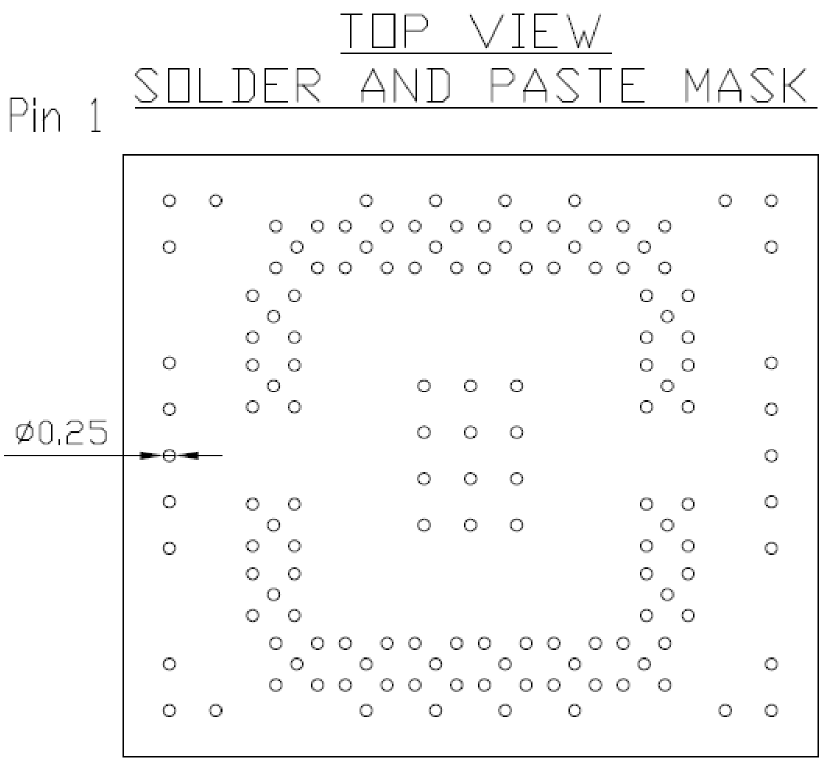


Figure 7-7: HRA142 solder and paste mask

7. Mechanical Characteristics

7.1 Package Outline and Geometry

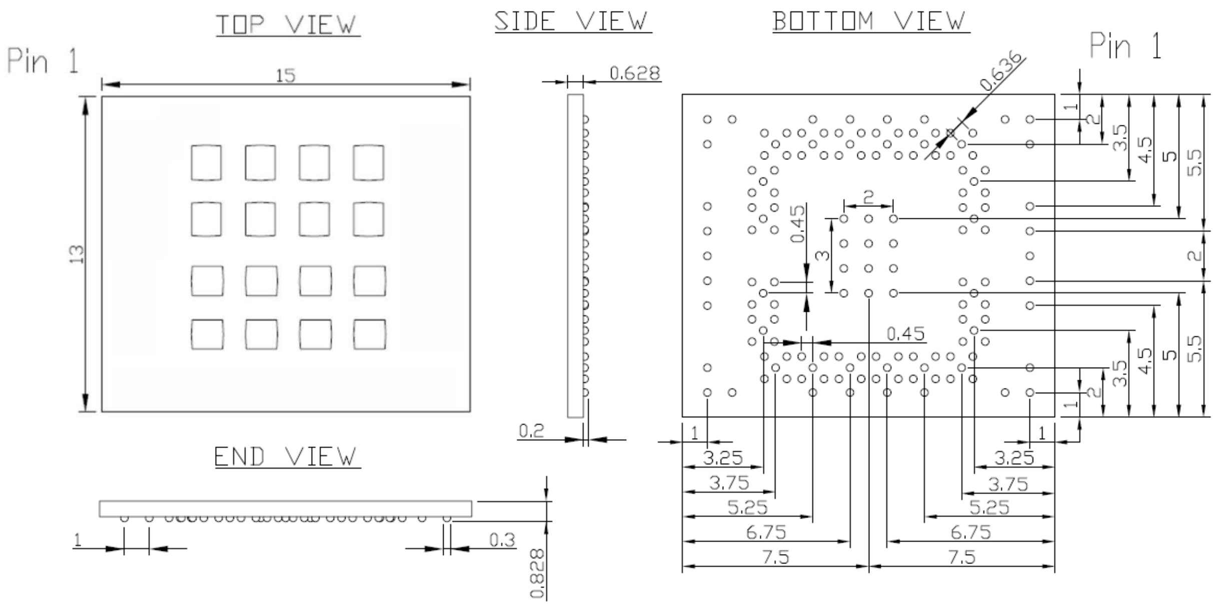


Figure 8-1: Package drawing for HRA142

7.2 Soldering Profile

The modular antenna uses lead-free solder balls. The recommended reflow profile and critical parameters are shown Figure 8-2 and can be adjusted based on the experience of the assembly supplier, their equipment and process.

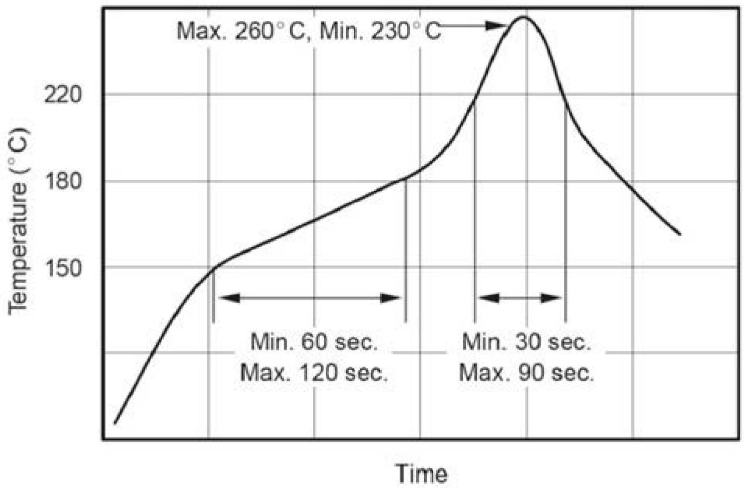


Figure 8-2: Solder Reflow Profile

Table 8-1: Solder Reflow Process Key Parameters

Process Step	Lead-Free Solder
Ramp Rate	*3 °C/sec*
Pre-Heat	*150 °C to 180 °C, 60 to 120 seconds*
Time above Liquidus, 220 °C	30 to 90 seconds
Peak Temperature	*245 °C +/- 15 °C*
Time within 5 °C of Peak Temperature	10 to 20 seconds
Ramp Down Rate	*6 °C/sec Maximum*

8. Appendix

8.1 Errata

8.2 Revision History

Revision	Date	Comments
0.1.2020	2020/08/18	First Created