

# VANTEON ADRV9002 vProtean Software Defined Radio User Manual

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## VANTEON ADRV9002 vProtean Software Defined Radio



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## Introduction

The Vanteon vProtean™ is a 2×2 MIMO software defined radio (SDR) that targets signal intelligence and multi-band processing applications. It is based on the Analog Devices ADRV9004 highly integrated wideband RF transceiver and the Xilinx Zynq-7020 All Programmable System-on-Chip (SoC). The vProtean SDR has a custom RF front end that is highly flexible, allowing its frequency range to be configured from 30 to 6000 MHz, and its instantaneous bandwidth from 12 kHz to 40 MHz.

## Proper Care and Handling

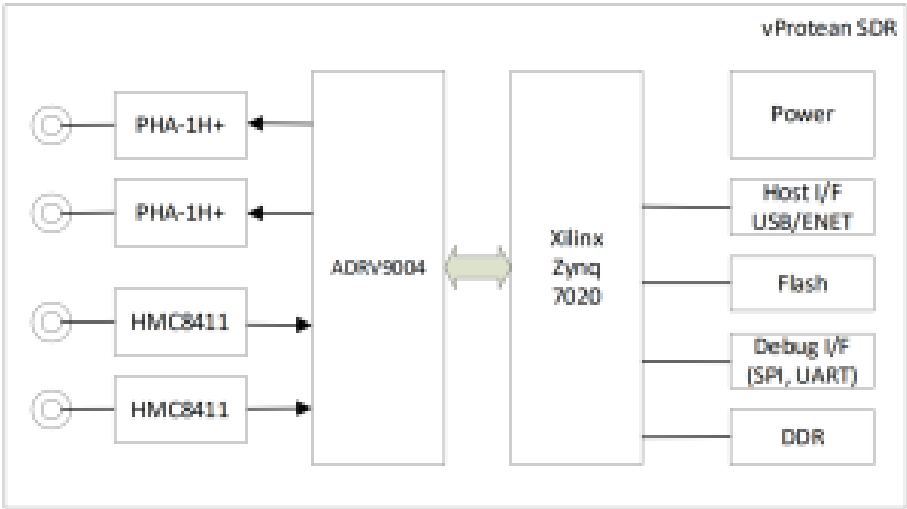
All Vanteon products are thoroughly tested before shipment. The vProtean SDR is guaranteed to be functional at the time it is received by the customer. Improper use or handling of the vProtean SDR can easily cause the device to become non-functional. Listed below are some examples of actions which can prevent damage to the unit:

1. Never allow metal objects to touch the circuit board while powered.
2. Always properly terminate the transmit port with an antenna or 50 load.
3. Always handle the board with proper anti-static methods.
4. Never allow the board to directly or indirectly come into contact with any voltage spikes.
5. Never allow any water, or condensing moisture, to come into contact with the boards.
6. Never apply more than 0 dBm of power into any RF input.
7. Always use at least 30dB attenuation if operating in a loopback configuration.

The vProtean SDR is sold for evaluation purposes and test equipment. If you choose to use your vProtean and Carrier to transmit using an antenna, it is your responsibility to make sure that you are in compliance with all laws for the country, frequency, and power levels in which the device is used. Additionally, some countries regulate reception in certain frequency bands. Again, it is the responsibility of the user to maintain compliance with all local laws and regulations.

## Technical Overview

Block Diagram



High Level Specifications

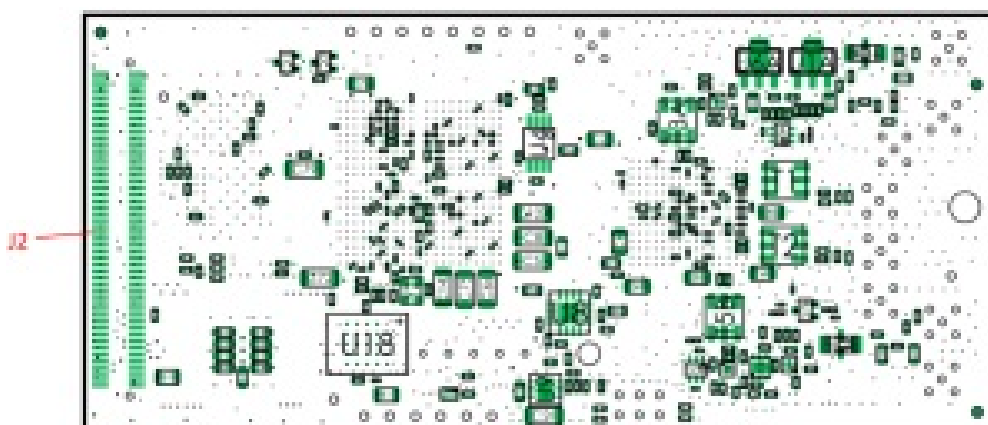
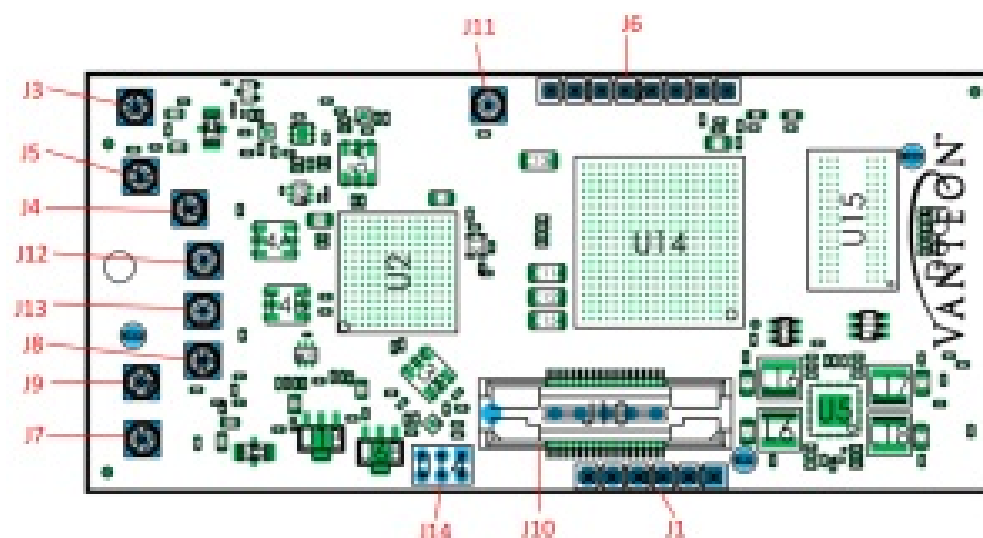
Frequency Band 1	30 to 6000 MHz
Instantaneous Bandwidth	12 kHz to 40 MHz
Number of transmitters	2
Number of receivers	2
Output Transmit Power	Variable up to 19 dBm
Dimensions	9.0 cm x 4.2 cm
Host interface	UART, USB, Ethernet, I2C and SD Card
Antenna connections	MMCX RF connectors
Power control	Wide range of output power from –20 dBm to +19 dBm
Flash	512 Mb
DDR SDRAM	4 Gb
Input Voltage	2.0 VDC to 3.6 VDC
Front End Module Voltage	3.3 VDC to 4.5 VDC

Hardware Interfaces

Connectors

The vProtean SDR has a number of connectors that allow it to be interfaced to a host carrier board, and connectors for antennas. That table below lists all of the connectors and their associated functions. This is followed by board diagrams showing the location of each connector.

Connector	Type	Function
J1	1×6 6 pin header	UART
J2	2×50 100 pin header	JTAG, UART, Boot Mode, Power, Reset, USB, Ethernet, SD Card, I2C, GPIO
J3	Antenna	Transmit 1
J4	Antenna	Unused
J5	Antenna	Receive 1
J6	1×8 8 pin header	JTAG
J7	Antenna	Transmit 2
J8	Antenna	Unused
J9	Antenna	Receive 2
J10	MICTOR	Debug
J11	Antenna	External Clock
J12	Antenna	External LO1
J13	Antenna	External LO2
SW1	2×3 6 pin header	Boot Mode



## J1 Connector

The J1 connector is a 6 pin header which provides a serial console interface.

Pin	Description
1	GND
2	Unused
3	VCC_SYS
4	FTDI_TXD_3P3V
5	FTDI_RXD_3P3V
6	Unused

## J2 Connector

The J2 connector is a 100 pin header which may be used as an interface to a host carrier board, such as the Vanteon Carrier board. The connector provides signals for several peripheral interfaces including JTAG, UART, USB, Ethernet, SD Card, I2C and GPIO. Unless otherwise noted, minimum voltage for ground (GND) is PCB ground.

Pin ID	Mnemonic	Type	Description
1, 3, 5, 7	VCC_1P8V	Power	1.8 V nominal to GND
2, 4, 6, 8	VCC_SYS	Power	
9, 10, 11, 12	GND	Power	PCB Ground
13	UART0_TXD_1P8V	Output	UART transmit
14, 16	VCC_3P3V	Power	3.3 V nominal to GND
15	PS_BOOT_MODE0	Input	Boot Mode Logic
17	PS_BOOT_MODE1	Input	Boot Mode Logic
18	GND	Power	PCB Ground
19	PS_GPIO	Input/Output	General Purpose I/O, 1.8 V nominal
20	GND	Power	PCB Ground
21	PS_GPIO1	Input/Output	General Purpose I/O, 1.8 V nominal
22	VCC_1P0V	Power	1.0 V nominal to GND
23	SDCARD_CD	Input	If SD Card used, will be input. Otherwise can be used for 3.3V GPIO.

24	GND	Power	PCB Ground
25	UART0_RXD_1P8V	Input	UART Receive
26	USB_DATA2	Input/Output	USB Data
27	USB_CTL.CLKOUT	Output	USB Clock
28	USB_DATA6	Input/Output	USB Data
29	USB_CTL.DIR	Input	USB Control
30	USB_DATA3	Input/Output	USB Data
31	USB_CTL.NXP	Input	USB Control
32	USB_DATA7	Input/Output	USB Data
33	USB_CTL.STP	Input	USB Control
34	USB_DATA5	Input/Output	USB Data
35	USB_CTL.RESET_n	Input	USB Reset
36	USB_DATA4	Input/Output	USB Data
37	PS_SRSTn	Input	Open-drain wire-or. Drive with open- drain or switch closure to GND.
38	USB_DATA1	Input/Output	USB Data

39	GND	Power	PCB Ground
40	USB_DATA0	Input/Output	USB Data
41	ETH0.TX.CLK	Input	MII Clock Transmit
42	GND	Power	PCB Ground
43	ETH0.TX.D0	Output	MII Data Transmit
44	ETH0.RESET_n	Input	MII Reset
45	ETH0.TX.D1	Output	MII Data Transmit
46	ETH0.RX.CLK	Input	MII Clock Receive
47	ETH0.TX.D2	Output	MII Data Transmit
48	ETH0.RX.CTRL	Input	MII Receive Enable
49	ETH0.TX.D3	Output	MII Data Transmit
50	ETH0.RX.D1	Input	MII Data Receive
51	ETH0.TX.CTRL	Output	MII Transmit Enable
52	ETH0.MDIO	Input/Output	MII Management Data I/O
53	GND	Power	PCB Ground



54	ETH0.RX.D3	Input	MII Data Receive
55	J1_GPIO7	Input/Output	General Purpose I/O, 1.8 V nominal
56	ETH0.RX.D0	Input	MII Data Receive
57	J1_GPIO4	Input/Output	General Purpose I/O, 1.8 V nominal
58	ETH0.RX.D2	Input	MII Data Receive
59	J1_GPIO5	Input/Output	General Purpose I/O, 1.8 V nominal
60	ETH0.MDC	Output	MII Management Data Clock
61	J1_GPIO0	Input/Output	General Purpose I/O, 1.8 V nominal
62	GND	Power	PCB Ground
63	J1_GPIO2	Input/Output	General Purpose I/O, 1.8 V nominal
64	SD_CARD.D2	Input/Output	microSD Card Data
65	J1_GPIO3	Input/Output	General Purpose I/O, 1.8 V nominal
66	SD_CARD.CMD	Output	microSD Card Data
67	J1_GPIO6	Input/Output	General Purpose I/O, 1.8 V nominal
68	SD_CARD.D1	Input/Output	microSD Card Data

69	J1_GPIO1	Input/Output	General Purpose I/O, 1.8 V nominal
70	SD_CARD.D3	Input/Output	microSD Card Data
71	GND	Power	PCB Ground
72	SD_CARD.D0	Input/Output	microSD Card Data
73	J_TMS	Input	JTAG Test Mode Select
74	SD_CARD.CLK	Output	microSD Card Clock
75	J_TDO	Output	JTAG Test Data Output
76	GND	Power	PCB Ground
77	J_TDI	Input	JTAG Test Data Input
78	I2C_SDA	Input/Output	I2C Serial Data
79	J_TCK	Input	JTAG Test Clock
80	I2C_SCL	Output	I2C Serial Clock
81, 82	GND	Power	PCB Ground
83	SPARE_PAIRS.0._N	Input/Output	Differential I/O Pairs, 2.5 V nominal
84	SPARE_PAIRS.3._P	Input/Output	Differential I/O Pairs, 2.5 V nominal

85	SPARE_PAIRS.0._P	Input/Output	Differential I/O Pairs, 2.5 V nominal
86	SPARE_PAIRS.3._N	Input/Output	Differential I/O Pairs, 2.5 V nominal
87, 88	GND	Power	PCB Ground
89	SPARE_PAIRS.1._P	Input/Output	Differential I/O Pairs, 2.5 V nominal
90	SPARE_PAIRS.2._P	Input/Output	Differential I/O Pairs, 2.5 V nominal
91	SPARE_PAIRS.1._N	Input/Output	Differential I/O Pairs, 2.5 V nominal
92	SPARE_PAIRS.2._N	Input/Output	Differential I/O Pairs, 2.5 V nominal
93, 94, 95, 96, 97, 98, 99, 100	GND	Power	PCB Ground

## J6 Connector

The J6 connector is a 8 pin header which provides a JTAG interface.

Pin	Description
1	GND
2	JTAG_TMS
3	JTAG_TCK
4	JTAG_TDI
5	JTAG_TDO
6	VCC_1P8V
7	PS_SRSTn
8	GND

## J14 Connector

The J14 connector is a 6 pin header that defines the boot mode for vProtean

Pin	Description
1	GND
2	JTAG_TMS
3	JTAG_TCK
4	JTAG_TDI
5	JTAG_TDO
6	VCC_1P8V
7	PS_SRSTn
8	GND

The boot mode settings are defined by pins 3 and 4.

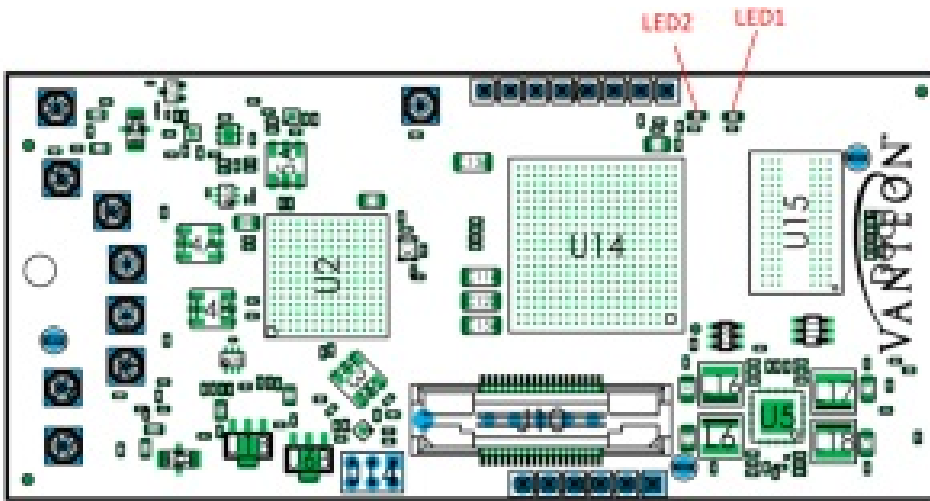
Mode	PS_BOOT_MODE0	PS_BOOT_MODE1
JTAG	0	0
QSPI	0	1
SD Card	1	1

The boot mode jumpers are provided on the vProtean SDR and the Carrier board. The vProtean SDR boot mode jumpers should only be used when the vProtean SDR is used without the Vanteon Carrier board. Otherwise, the Carrier board vProtean jumpers should be used.

## LEDs

The vProtean software defined radio has two (2) LEDs, whose function is described in the table below. This is followed by a board diagram showing the location of each LED.

LED1	Blue	On when Zynq 7020 programmable logic has been programmed
LED2	Green	Software control



## User Console

If the vProtean SDR was purchased as part of an evaluation kit, it is preloaded with a menu-based application that allows a user to perform transmit and receive functions. This section explains how to use the vProtean SDR evaluation application.

### UART

The simplest method to access the preloaded test application on the vProtean SDR is to mount it to a the Vanteon Carrier board. The Carrier board provides a serial console interface via the Type-C USB connector. Connect the vProtean Carrier Board to a PC using the appropriate USB cable. Use a terminal emulator program on the PC to open a terminal session using the virtual COM port associated with the vProtean Carrier Board. The serial port parameters are: 115200 baud, 8 bits, no parity, 1 stop bit, no handshaking.

### Main Menu

The vProtean software defined radio has a hierarchical menu structure that allows you to configure the radio and to transmit and receive test waveforms. The main menu consists of the following status and commands:

Item	Name	Function
–	TX RX Sample Rate	Display of the pre-configured sample rate (not user changeable)
–	FPGA Temperature	Display of the FPGA temperature
–	ADRV Temperature	Display of the RF IC temperature
–	RX1 RSSI	Display of RX1 RSSI
–	RX2 RSSI	Display of RX2 RSSI
1	TX1 RX1 Settings	Configure TX1 and RX1
2	TX2 RX2 Settings	Configure TX2 and RX2
3	Capture RX	Initiate RX capture according to RX capture settings
4	RX Capture Waveform Settings	Configure the RX capture parameters
5	Recalibrate System	Force a transceiver recalibration

### **TX1/RX1 and TX2/RX2 Settings Menu**

There are two submenus for configuring the TX1/RX1 and TX2/RX2 pairs. This section covers both submenus, and refers to TX1 and TX2 as a generic TX\_, and RX1 and RX2 as a generic RX\_.

Item	Name	Function
1	TX_/RX_ Frequency	Set the TX_/RX_ frequency (30 MHz to 6000 MHz)
2	Toggle TX_	Toggles transmit for TX_ on/off
3	TX_ Waveform Select	Go to TX_ waveform select menu
4	Digital Attenuation (dB)	Attenuation that is applied digitally to the transmit waveform (0 to 100 dB)
5	TX_ Front End Atten (dB)	Sets the attenuation in the ADRV9004 (0 to 41.5 dB), value can only be changed when TX is enabled
6	TX_ BOOST	Adds an additional 3 dB to the transmit
7	Toggle RX_	Toggles receive for RX_ on/off

**Note:** The vProtean SDR may require external cooling, should both transmit channels be used continuously. The FPGA and ADRV temperatures displayed on the main menu should be monitored by the user, and external cooling (i.e. directed fan) should be applied as needed.

### TX1 and TX2 Waveform Select Menu

The TX Waveform Select Menu configures the waveform that is transmitted when the TX is toggled on. When the transmit is enabled, the selected waveform is transmitted repeatedly.

Item	Name	Function
–	Current Waveform	Display the current selected waveform
1	Zeros	Fills transmit buffer with zero waveform
2	CW	Single tone at carrier frequency
3	USB Tone, Offset=FS/32	Upper side band waveform, FS=sample rate
4	Dual Tone, Offset=FS/32+FS/8	Dual tone waveform, FS=sample rate
5	File	Go to file select menu to load waveform file from SD card

### TX1 and TX2 File Select Menu

The File Menu allows the user to select a user defined file that specifies the transmit waveform.

The file must exist on the SD card to be listed in this menu. The format of the filename must have a “.iq” extension to show up in the file list.

The format of a transmit waveform is a .CSV file with one sample (IQ pair) per line with I and Q values separated by a comma.

### For Version 1.x Software

The TX waveform file must contain between a minimum of 256 samples and a maximum of 2,097,150 samples, inclusive.

### For Version 2.x Software

The TX waveform file must contain between a minimum of 512 samples and a maximum of 4,194,304 samples, inclusive. The number of samples should be a multiple of 512. If the number of samples is not a multiple of 512, the TX waveform will be zero padded to the next multiple of 512.

**Note:** The vProtean SDR and Carrier board should be powered down whenever mounting or removing the SD card.

### RX Waveform Capture Settings Menu

The RX Waveform Capture Settings Menu allows the user to set the number of samples captured and the file to which the samples are saved. It also allows the user to configure which RX channel will be captured.

The format of a captured waveform is a .CSV file with one sample (IQ pair) per line with I and Q values separated by a comma.

If the captured waveform filename has an “.iq” extension it will show up in the TX waveform list if the capture was



successful.

### For Version 1.x Software

The number of RX samples to capture must be between a minimum of 256 samples and a maximum of 2,097,150 samples, inclusive.

### For Version 2.x Software

The number of RX samples to capture must be a multiple of 512. If it is not a multiple of 512 the capture will fail.

Item	Name	Function
1	Filename	The name of the file to save the RX samples to. The filename can be up to 9 characters. The filename extension can be up to 2 characters. It is recommended that the filename extension be ".iq"
2	Samples	The number of samples to capture.
3	RX Channel [1,2]	Configure which RX channel the capture should be performed on.

## Customer Support

If you experience difficulty after reading the manual and/or using the product, please feel free to contact [support@vanteon.com](mailto:support@vanteon.com) for additional assistance.

Vanteon offers contract engineering services and can assist you in implementing the vProtean SDR into your system.

## Terms and Conditions of Sale

All sales of product are subject to the terms and conditions described in "Vanteon Corporation – Terms and Conditions of Product Sales". Unless explicitly agreed to in writing, Vanteon rejects all modifications to these standard terms and conditions.

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that the product has not been subject to abuse, misuse, accident or unauthorized modification or repair. Products returned to Vanteon must be pre-authorized by Vanteon and sent prepaid, insured, and packaged for safe shipment. Vanteon will return this product by prepaid ground shipment service.

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## Documents / Resources

	<p><a href="#"><b>VANTEON ADRV9002 vProtean Software Defined Radio</b></a> [pdf] User Manual ADRV9002, vProtean Software Defined Radio, ADRV9002 vProtean Software Defined Radio, D efined Radio, Radio</p>
	<p><a href="#"><b>VANTEON ADRV9002 vProtean Software Defined Radio</b></a> [pdf] User Manual ADRV9002 vProtean Software Defined Radio, ADRV9002, vProtean Software Defined Radio</p>

## References

- [\*\*V Vanteon Wireless Solutions and Hardware Design Services\*\*](#)

