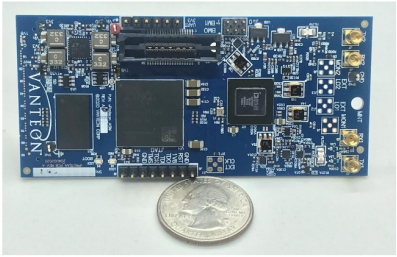

VANTEON vProtean Software Defined Radio User Manual

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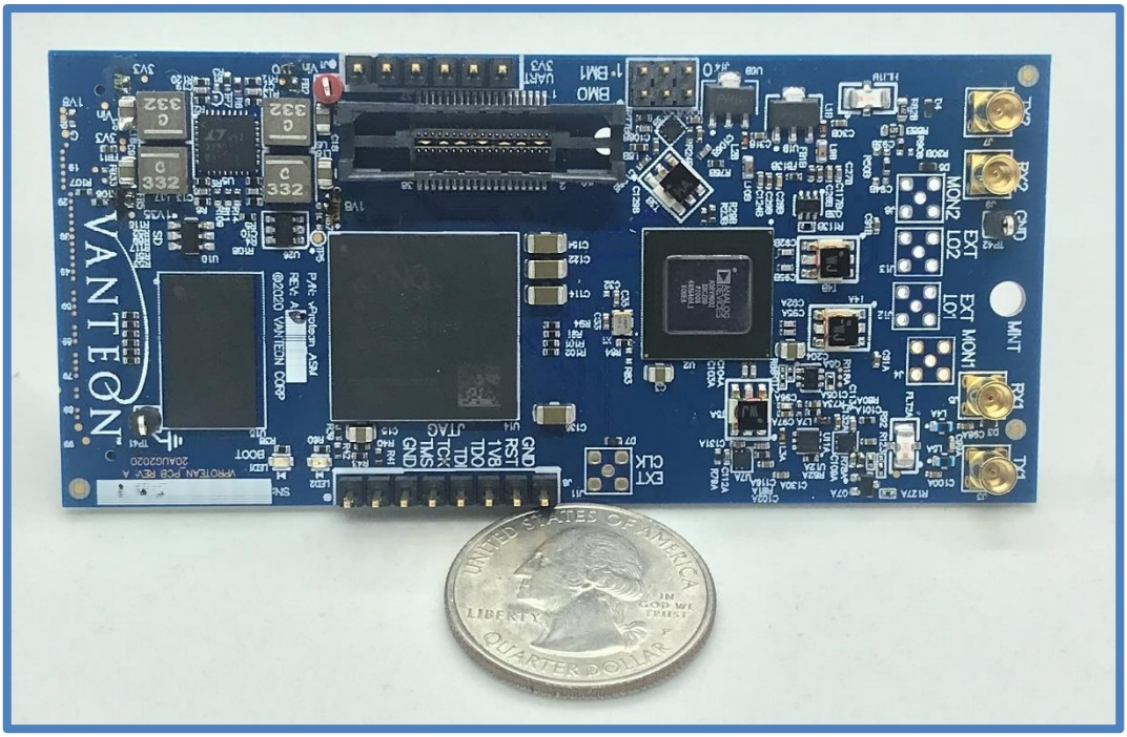
30+ Years

vProtean Software Defined Radio
User Manual



User Manual

Version 3.1
vProteanTM Software Defined Radio
Vanteon 99 Garnsey Road, Suite 200 Pittsford, NY 14534 585.419.9555
www.vanteon.com

Contents

Introduction

The Vanteon vProteanTM is a 2×2 software-defined radio (SDR) that targets communications, signal intelligence, and other 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 protean SDR has a custom RF front end that is highly flexible, allowing its frequency range to be configured from 30 to 6000 MHz.
Each vProtean SDR is pre-loaded with the vProtean SDR Evaluation Kit (VPROKIT-21) firmware. The VPROKIT-21 firmware includes Vanteon proprietary, programmable logic cores and executable code to perform transmit and receive functions via a menu-based UI over USB enabled com port from a host computer (host not included). An encrypted Vivado Project of the VPROKIT-21's FPGA firmware, along with the source code of the User Interface (UI) firmware is available under a free license agreement. The vProtean schematic and layout design files, and Vanteon-proprietary DSP cores are available with a paid license. Contact Vanteon Sales for more information.

Proper Care and Handling

All Vanteon products are thoroughly tested before shipment. The protean 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 that can prevent damage to the unit:

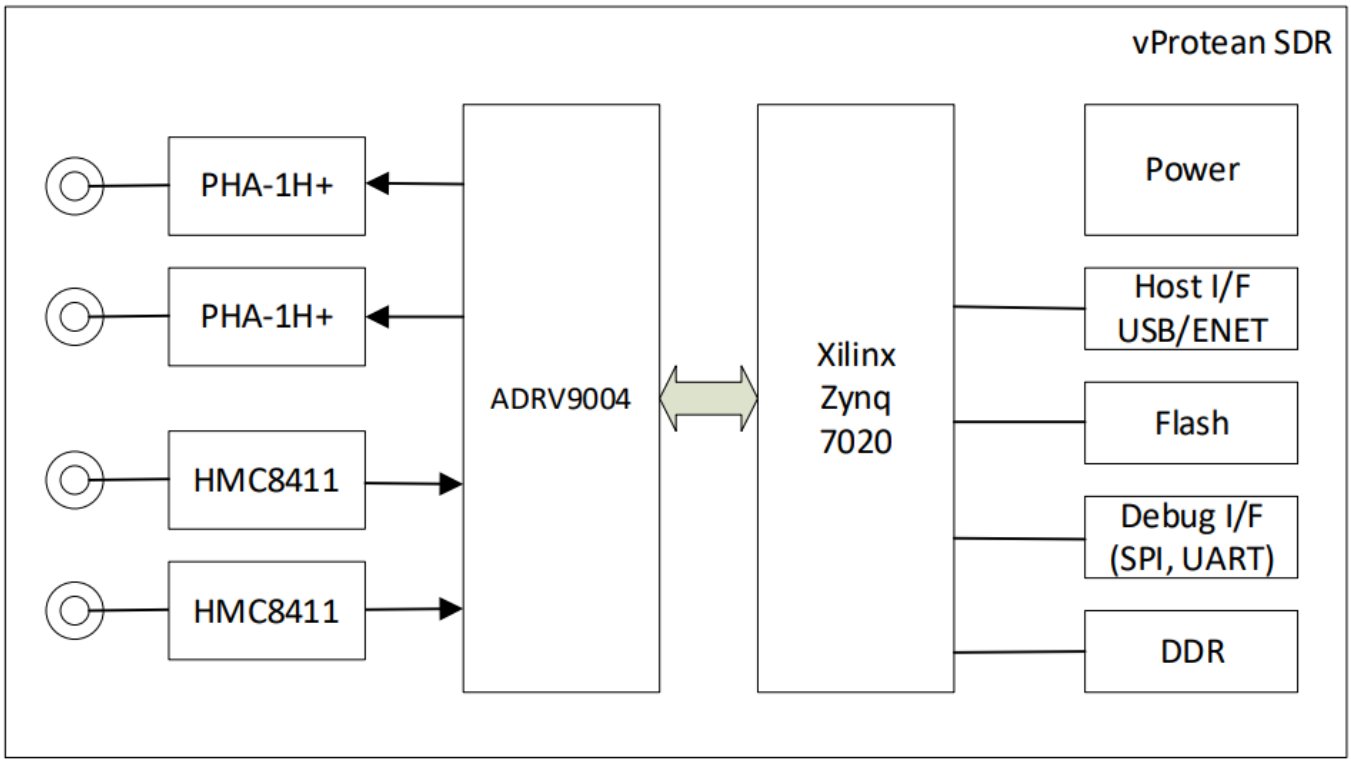
1. Never allow metal objects to touch the circuit board while powered.
2. Always properly terminate the transmit port with an antenna or 50 loads.
3. Always handle the board with proper anti-static methods.
4. Never allow the board to directly or indirectly come into contact with any voltage spikes.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

The protean 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

3.1 Block Diagram



3.2 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

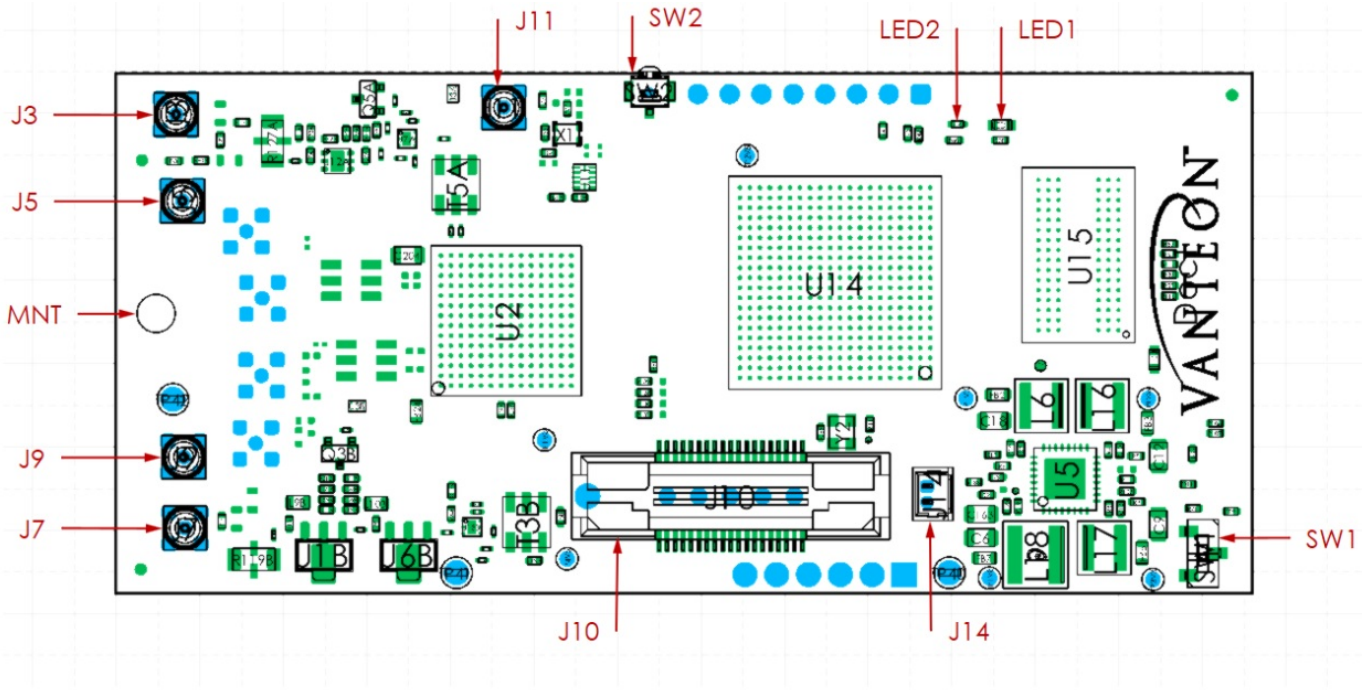


Figure 1: vProtean RevC, Top View

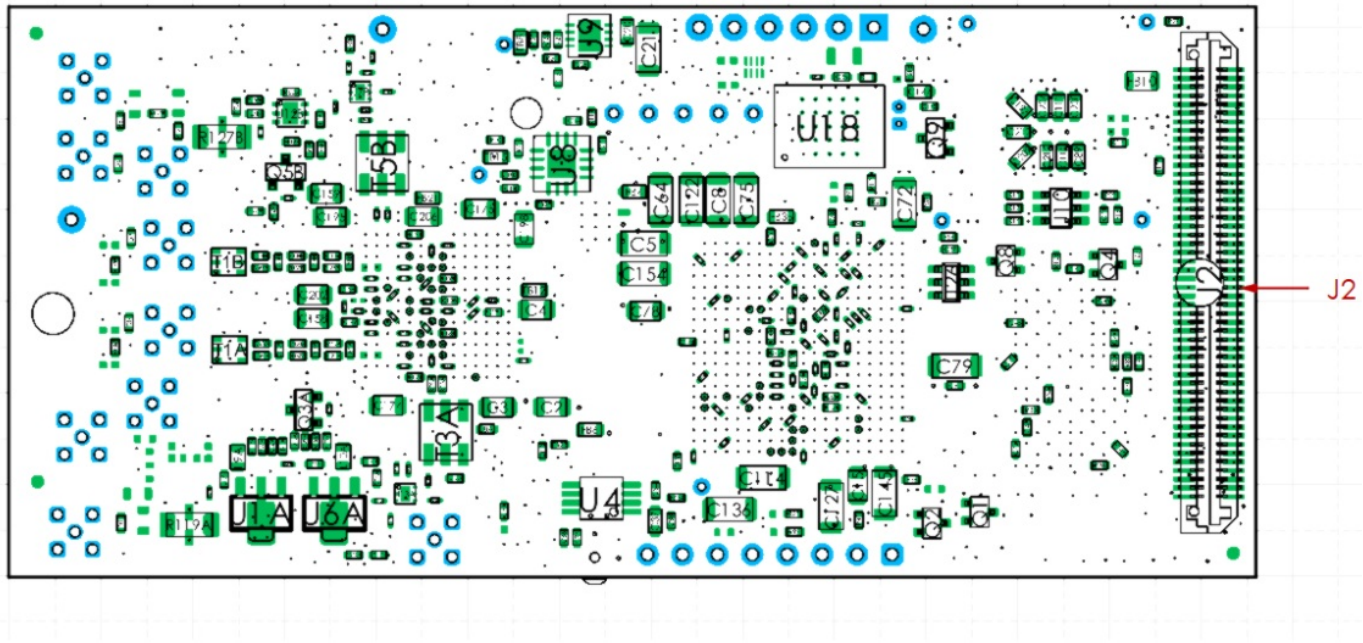


Figure 2: vProtean RevC, Bottom View

4.1 Connectors

The vProtean SDR has a number of connectors that allow it to be interfaced to a host carrier board and connectors for antennas. The table below lists all of the connectors and their associated functions. Refer to Figure 1 and Figure 2 for connector locations

Connector	Type	Function
J2	2×50 100-pin header	JTAG, UART, Boot Mode, Power, Reset, USB, Ethernet, SD Card, I2C, GPIO
J3	MMCX	Transmit 1
J4	MMCX	Monitor 1 (DPD models only)
J5	MMCX	Receive 1
J7	MMCX	Transmit 2
J8	MMCX	Monitor2 (DPD models only)
J9	MMCX	Receive 2
J10	MICTOR	Debug
J11	MMCX	External Clock
J12	SMP	External LO1 (not fitted)
J13	SMP	External LO2 (not fitted)
J14	2-pin PicoBlade header	Fan Connector

4.1.1 J2 Connector

The J2 connector is a 100-pin header that 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, the minimum voltage for all signals is PCB ground.
Note that the connector is hermaphroditic, and pin numbers on the carrier are mirrored against the vProtean.
USB host interface pins 26-40 may be configured as ETH1 by the host carrier board with firmware support.
Unused interfaces may be configured as GPIO.

vProtean Pin	Carrier Pin	Signal Name	Type	Description
22	21	VCC_1P0V	Power	1.0 V nominal core voltage
1, 3, 5, 7	2, 4, 6, 8	VCC_1P8V	Power	1.8 V nominal IO level
14, 16	13, 15	VCC_3P3V	Power	3.3 V nominal IO level
2, 4, 6, 8	1, 3, 5, 7	VCC_SYS	Power	5 to 6.5VDC System power input
9, 10, 11, 12, 18, 20, 24, 39, 42, 53, 62, 71, 76, 81, 82, 87, 88, 93, 94, 95, 96, 97, 98, 99, 100	9, 10, 11, 12, 17, 19, 23, 40, 41, 54, 61, 72, 75, 81, 82, 87, 88, 93, 94, 95, 96, 97, 98, 99, 100	GND	Power	PCB Ground
27	28	USB_CTL.CLOUD	Out	USB Clock

29	30	USB_CTL.DIR	In	USB Control
31	32	USB_CTL.NXP	In	USB Control
35	36	USB_CTL.RESET_n	In	USB Reset
33	34	USB_CTL.STEP	In	USB Control
40	39	USB_DATA0	In/Out	USB Data
38	37	USB_DATA1	In/Out	USB Data
26	25	USB_DATA2	In/Out	USB Data
30	29	USB_DATA3	In/Out	USB Data
36	35	USB_DATA4	In/Out	USB Data
34	33	USB_DATA5	In/Out	USB Data
28	27	USB_DATA6	In/Out	USB Data
32	31	USB_DATA7	In/Out	USB Data
60	59	ETH0.MDC	Out	MII Management Data Clock
52	51	ETH0.MDIO	In/Out	MII Management Data I/O
44	43	ETH0.RESET_n	In	MII Reset
46	45	ETH0.RX.CLK	In	MII Clock Receive
48	47	ETH0.RX.CTRL	In	MII Receive Enable
56	55	ETH0.RX.D0	In	MII Data Receive
50	49	ETH0.RX.D1	In	MII Data Receive
58	57	ETH0.RX.D2	In	MII Data Receive
54	53	ETH0.RX.D3	In	MII Data Receive
41	42	ETH0.TX.CLK	In	MII Clock Transmit
51	52	ETH0.TX.CTRL	Out	MII Transmit Enable
43	44	ETH0.TX.D0	Out	MII Data Transmit
45	46	ETH0.TX.D1	Out	MII Data Transmit
47	48	ETH0.TX.D2	Out	MII Data Transmit
49	50	ETH0.TX.D3	Out	MII Data Transmit
74	73	SD_CARD.CLK	Out	microSD Card Clock
66	65	SD_CARD.CMD	Out	microSD Card Data

72	71	SD_CARD.D0	In/Out	microSD Card Data
68	67	SD_CARD.D1	In/Out	microSD Card Data
64	63	SD_CARD.D2	In/Out	microSD Card Data
70	69	SD_CARD.D3	In/Out	microSD Card Data
23	24	SDCARD_CD	In	microSD Card Detect
78	77	I2C_SDA	In/Out	I2C Serial Data
80	79	I2C_SCL	Out	I2C Serial Clock
13	14	UART0_TXD_1P8V	Out	UART transmit
25	26	UART0_RXD_1P8V	In	UART Receive
15	16	PS_BOOT_MODE0	In	Boot Mode Logic
17	18	PS_BOOT_MODE1	In	Boot Mode Logic
37	38	PS_SRSTn	In	System Reset. Open-drain wi re-or. Drive with open-drain o r switch closure to GND.
19	20	DEV_CLK_B2B._N	In/Out	The external transceiver cloc k input (not connected in stan dard build)
21	22	DEV_CLK_B2B._P	In/Out	External transceiver clock inp ut (not connected in standard build)
55	56	MCS_B2B._N	In/Out	Multi-Chip Synchronization (n ot connected in a standard build)
57	58	MCS_B2B._P	In/Out	Multi-Chip Synchronization (n ot connected to standard buil d)
73	74	J_TMS	In	JTAG Test Mode Select
75	76	J_TDO	Out	JTAG Test Data Output

77	78	J_TDI	In	JTAG Test Data Input
79	80	J_TCK	In	JTAG Test Clock

90	89	SPARE_PAIRS.CLK._P	In/Out	Differential I/O Pairs, 2.5 V nominal
92	91	SPARE_PAIRS.CLK._N	In/Out	Differential I/O Pairs, 2.5 V nominal
89	90	SPARE_PAIRS.0._P	In/Out	Differential I/O Pairs, 2.5 V nominal
91	92	SPARE_PAIRS.0._N	In/Out	Differential I/O Pairs, 2.5 V nominal
84	83	SPARE_PAIRS.1._P	In/Out	Differential I/O Pairs, 2.5 V nominal
86	85	SPARE_PAIRS.1._N	In/Out	Differential I/O Pairs, 2.5 V nominal
83	84	SPARE_PAIRS.2._P	In/Out	Differential I/O Pairs, 2.5 V nominal
85	86	SPARE_PAIRS.2._N	In/Out	Differential I/O Pairs, 2.5 V nominal
67	68	SPARE_PAIRS.3._P	In/Out	Differential I/O Pairs, 2.5 V nominal
69	70	SPARE_PAIRS.3._N	In/Out	Differential I/O Pairs, 2.5 V nominal
63	64	SPARE_PAIRS.4._P	In/Out	Differential I/O Pairs, 2.5 V nominal
65	66	SPARE_PAIRS.4._N	In/Out	Differential I/O Pairs, 2.5 V nominal
59	60	SPARE_PAIRS.5._P	In/Out	Differential I/O Pairs, 2.5 V nominal
61	62	SPARE_PAIRS.5._N	In/Out	Differential I/O Pairs, 2.5 V nominal

The following J2 pinout Table lists those pins that are different in the older vProtean HW revisions A2. All other pins are the same as vProtean HW Revisions B0 and C0 above.

vProtean Pin	Carrier Pin	Signal Name	Type	Description
61	62	J1_GPIO0	In/Out	General Purpose I/O, 1.8 V nominal
69	70	J1_GPIO1	In/Out	General Purpose I/O, 1.8 V nominal
63	64	J1_GPIO2	In/Out	General Purpose I/O, 1.8 V nominal
65	66	J1_GPIO3	In/Out	General Purpose I/O, 1.8 V nominal
57	58	J1_GPIO4	In/Out	General Purpose I/O, 1.8 V nominal
59	60	J1_GPIO5	In/Out	General Purpose I/O, 1.8 V nominal
67	68	J1_GPIO6	In/Out	General Purpose I/O, 1.8 V nominal
83	84	SPARE_PAIRS.0._N	In/Out	Differential I/O Pairs, 2.5 V nominal
85	86	SPARE_PAIRS.0._P	In/Out	Differential I/O Pairs, 2.5 V nominal
91	92	SPARE_PAIRS.1._N	In/Out	Differential I/O Pairs, 2.5 V nominal
89	90	SPARE_PAIRS.1._P	In/Out	Differential I/O Pairs, 2.5 V nominal
92	91	SPARE_PAIRS.2._N	In/Out	Differential I/O Pairs, 2.5 V nominal
90	89	SPARE_PAIRS.2._P	In/Out	Differential I/O Pairs, 2.5 V nominal
86	85	SPARE_PAIRS.3._N	In/Out	Differential I/O Pairs, 2.5 V nominal
84	83	SPARE_PAIRS.3._P	In/Out	Differential I/O Pairs, 2.5 V nominal

4.1.2 J14 Connector

Pin	Description
1	FAN –
2	FAN +

The J14 connector is a fan connector to provide cooling for the system. It can deliver 5V up to 200mA and can be speed controlled using PWM in software. Connect a suitable fan using a Molex PicoBlade connector, e.g. #15134-0200

4.2 Switches

The vProtean software defined radio has two switches, whose function is described in the table below.

SW1	DIP Switch	Boot Mode. Move to position J (towards the Vanteon logo) for JTAG boot mode, position Q for QSPI or SD card booting. Can be overridden by the carrier jumper s.
SW2	Pushbutton	Reset. Can also be driven from the carrier board.

4.3 LEDs

The vProtean software defined radio has two LEDs, whose function is described in the table below. This is

followed by a board diagram showing the location of each LED.

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

4.4 Mounts
The vProtean software defined radio has one mounting point. In the standard configuration, it is designed for a standoff height from the carrier PCB of 9.5mm (3/8″).

MNT	Standoff	Use threaded spacer, screws, and locking washer (supplied in kit). The smaller hea d screw is intended for the top side, to avoid collision with RF connectors

Software versions and Support HW

Version	**Supported vProtean HW**
Version 1.x	vProtean HW Rev A1 with B0 Silicon
Version 2. x	vProtean HW Rev A2 with C0 Silicon
Version 3. x	vProtean HW Rev B0 with C0 silicon

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. Note that the evaluation kit application does not provide access to the full capabilities of the vProtean SDR platform.

6.1 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.

6.2 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 RSS	Display of RX1 RSSI
–	RX2 RSS	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

6.2.1 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 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 and 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), the value ca n 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.

6.2.2 TX1 and TX2 Waveform Select Menu

The TX Waveform Select Menu configures the wave form that is transmitted when the TX is toggled on. When the transmit is enabled, the selectthe ed 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

6.2.3 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 p air) 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 and 3. 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.

6.2.4 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 a ".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 t o 9 characters. The filename extension can be up to 2 characters. It is rec ommended 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 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

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Vanteon Corporation provides a One-Year Limited Warranty for all products sold. Should this product, in Vanteon Corporation’s opinion, fail to be in good working order during the warranty period, Vanteon Corporation will, at its option, repair or replace this product at no charge, provided 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.
Should the product prove to be irreparable, Vanteon reserves the right to substitute an equivalent product if available.
See accompanying “Vanteon Corporation Terms and Conditions of Product Sales” for additional information regarding this warranty.
The above warranty is the only warranty authorized by Vanteon for this product. Under no circumstances will Vanteon be liable in any way for any damages, including any lost profits, business revenue, special, indirect, incidental, exemplary, punitive, or consequential damages arising out of the use of, or inability to use such product.

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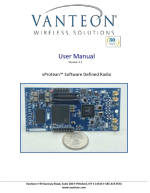	**VANTEON vProtean Software Defined Radio** [pdf] User Manual vProtean, Software Defined Radio, vProtean Software Defined Radio

References

- **Vanteon Wireless Solutions and Hardware Design Services**