Valhalla Wireless
High Quality RF Telemetry Systems

Preliminary Document

VikingX

OEM User Manual

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1 Introduction To The VikingX OEM Module

The VikingX has been engineered to enable long-range wireless communications for various industrial, scientific, and medical applications without requiring the end-user to obtain a special license to operate. The module has been designed to ensure that power consumption is reduced to a minimum for battery-powered applications and includes on on-board 6V lead-acid battery charger circuit. The module integrates many advanced features including multi-hop repeater functionality, Ethernet interface, TCP/IP/UDP/ICMP protocol support, DHCP server support with auto-client configuration, dynamic routing table updates, fast synchronization times, analog and digital sensor measurements, infield wireless firmware updates, automatic network-wide digital frequency drift compensation, and power management capabilities.

1.1 Specifications

1.1.1 RF

Parameter	Typical	Notes / Conditions
Peak RF Output Power	28.1dBm	>2 Watts Effective Isotropically Radiated Power (EIRP) With 5 dBi Antenna
Receiver Sensitivity	-101 dBm	PER < TBD, acceptable performance
System Gain	139 dB	With 5dBi antenna, PER < TBD
Antenna Gain	5 dBi	Omni-directional whip antenna
RF Data Bit-Rate	230 kbps	Specified rate is actual throughput. (no additional overhead from Manchester encoding, etc.)
Modulation	Frequency Shift Keying	
Channel Dwell Time	5 milliseconds	Fixed
20dB Channel Bandwidth	480Khz	
Channel Spacing	480Khz	
Synchronization Time	< 1 second typical	In severly bad conditions with combined close-in interference, multi-path fading, and marginal signal levels of <-100dBm, up to 30 seconds may be required.
Number Of Frequencies Used	50	
Network Topology	Hybrid Star (Star-of-Stars)	See figure 1 for a visual representation.
Repeater Chaining Limit	Up To 16 Hops Per Chain-of-Stars	Repeaters may be in RF Line-of-sight with each other. Data transport is synchronous.
MAX payload per channel hop	64 bytes total including header	200 hops per second
Receiver Selectivity	Adjacent Channel: TBD In-Band: TBD Out-of-Band: TBD	Multiple front-end bandpass filters provide excellent blocking performance.

1.1.2 Electrical

Parameter	Typical	Notes / Conditions
RF Receive Current Slave	60 mA @ 6 Volts	Synchronized
RF Transmit Current Peak	TBD	All operating modes
RF Transmit Current Master	TBD	Network Synchronization Only
RF Transmit Current Master	TBD	Heavy Network Traffic
RF Transmit Current Repeater	TBD	Network Synchronization Only
RF Transmit Current Repeater	TBD	Heavy Network Traffic
Sleep Current (Not Synced)	2.9 mA	From 6V battery source
Solar / Power Supply Voltage In	4 to 25 Volts	30 Volts Absolute Maximum
6V Battery Voltage Input	5.5 to 8 Volts	6V Lead Acid Battery Only

1.1.3 Mechanical

Parameter		
Product Dimensions	3.91" x 4.68" x 0.81"	(excluding antenna connector protrusion) The device is compatible with the Hammond Manufacturing 1455 and 1457 series of enclosures.
Product Weight	TBD	

1.1.4 Networking Interfaces and Protocols

| Interface / Protocol	Implementation / Features	Notes / Conditions
Ethernet / DHCP	Server-side implemented Sets MTU size	Temporarily disables MS Netbios On Ethernet Interface under Windows to reduce un-necessary network traffic.
All / Internet Protocol (IP)	Duplicate packet suppresion on wireless interface. MSS option TIMESTAMP option	IP Fragmentation implemented on local RF Network only. Endpoints perform re-assembly.
All / Transmission Control Protocol (TCP)	MAC layer retransmission mechanism modeled after Berkeley SNOOP protocol for reliable TCP transfers. Enables data upload/download over TCP stream from micro SD card. Enables remote firmware updates. Enables remote configuration.	Currently, delayed acknowledgements are not implemented.
All / User-Defined Protocol (UDP)	micro SD card sector read/write Sensor Measurements Configuration by MAC address / Broadcast	Primarily used for single-channel-hop data collection and remote control, but supports datagrams up to MTU as well.
All / Internet Control Message Protocol (ICMP)	ECHO Time-To-Live exceeded Source Quench Do Not Fragment	Traceroute utility supported for querying wireless routes.

1.1.5 Sensor Measurements

Connection Header	Type	Notes
JP102,JP103,JP104	DC Voltage Measurements	
JP107	Not Used	
JP105	Thermistor Measurement	PN: VW-410-0001-00
JP106,JP108	Normally Open Contact	
JP100,JP101	Switched B+	
RS-485	Not Used	

2 VikingX Operation

2.1 Networking Topology

The VikingX modem has three general modes of operation: Master, Repeater, and Slave with roaming option. A VikingX network is comprised of exactly one Master and one or more Repeaters and Slaves configured in a hybrid-star topological configuration. Please refer to Figure 1 for an example of one possible network configuration utilizing the hybrid-star topology.
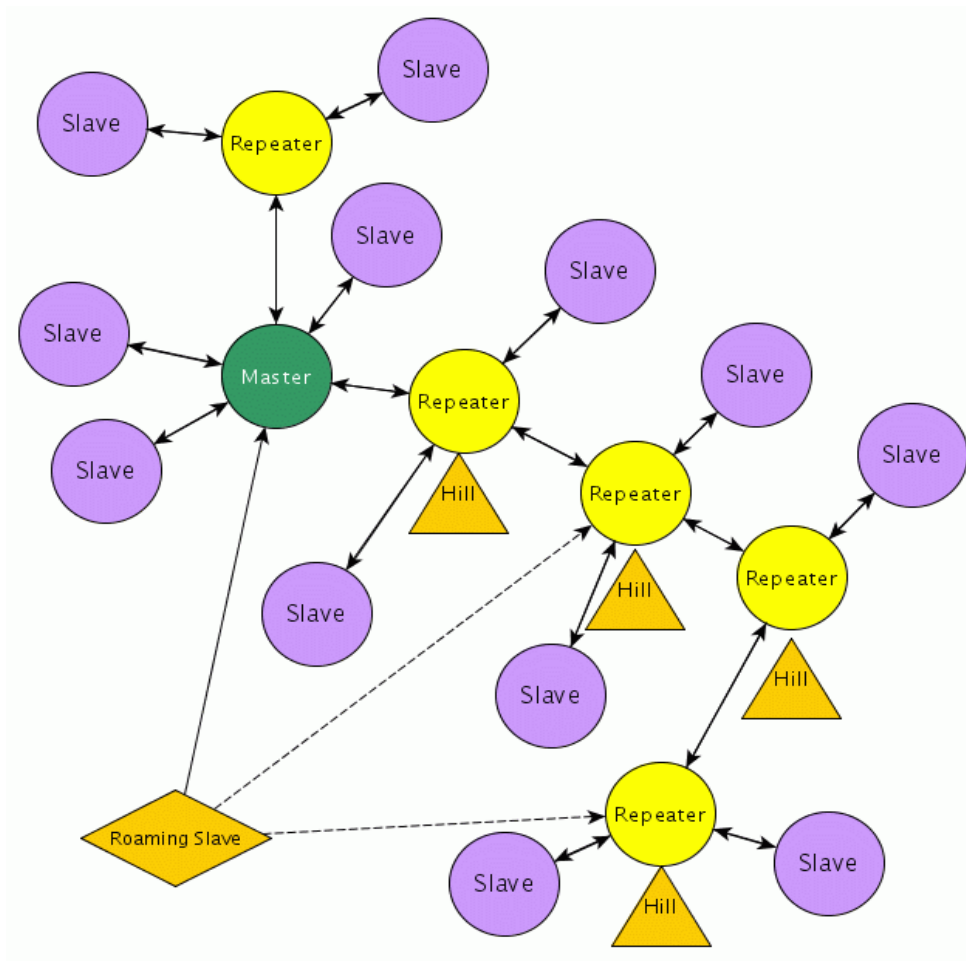
Figure 1: Example Hybrid-Star Network Deployment

2.2 Master / Base Operation

The Master provides synchronization and frequency reference for the entire network.

2.3 Repeater Operation

Repeaters alternate between serving as Master when communicating with downstream modems, and a Slave when communicating with their configured upstream Master.   For this reason, the throughput rate for data being routed through one or more repeaters is half the rate of direct Master-to-Slave communications. Data being routed through multiple repeaters in a multi-hop chain configuration does not result in further reduction of the data throughput, but adds one channel dwell period of latency for each repeater in a chain of repeaters. This additive latency has minimal impact on communications throughput for multi-packet data transfers when delayed acknowledgments are implemented in the higher-level protocols such as TCP/IP.

2.4 Slave Operation

Slave devices synchronize with their configured upstream Master.   This may be a device operating the Master or a Repeater mode of operation.   Due to the dynamic routing capabilites of the VikingX, Slave-to-Slave communications at the IP datagram level are routed through the **shortest** network path and do not require that Datagrams are necessarily all routed through the network Master.

2.5 Roaming Operation

Slave devices may also be configured as "Roaming" stations.   In this case, the Slave device will search for a new Repeater or Master upon loosing synchronization.   This allows Roaming devices to synchronize to any Repeater or the Master while being mobile. This mode also provides support for link redundancy in the case that an upstream Repeater becomes unavailable.

2.6 Sensor Measurements

3 VikingX Configuration

4 FCC Related Requirements For OEM's

4.1 Requirements For Antenna Orientation

The VikingX OEM RF Module and antenna must be mounted vertically as shown in Figure 2. If the antenna must be mounted in a non-vertical orientation, further certification will be required. The approved antenna for use with the VikingX is the Valhalla Wireless PN: VW-410-0002-00 5dBi Fixed RPSMA Whip Antenna.
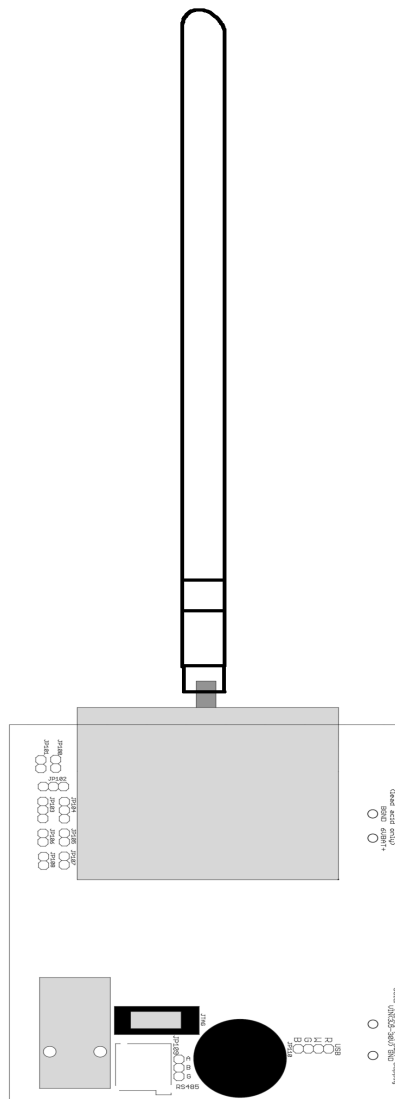
Figure 2: Vertical Module And Antenna Orientation

4.2 Labeling and Antenna Requirements

The VikingX OEM RF Module complies with Part 15 of the FCC rules and regulations. Compliance with the following labeling, antenna, and FCC notice requirements are required for operation in the United States.

In order to operate under Valhalla Wireless's FCC Certification, the OEM customer must comply with the following regulations:

- The OEM must ensure that an exterior label with the following text is clearly visible on the outside of their final device:

> Contains FCC ID: W4OVIKINGX
>
> The enclosed device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:
>
> (1) this device may not cause harmful interference and
>
> (2) this device must accept any interference received, including interference that may cause undesired operation.

- The VikingX OEM RF Module may only be used with the included antenna that has been tested and approved for use with the module. The OEM must take steps to ensure that the end-user will not remove or replace the antenna with a non-compliant one.

> Approved Antenna: Valhalla Wireless PN: VW-410-0002-00, 5dBi omni-directional with Reverse-Polarity SMA connector.

This statement must be included as a WARNING statement in OEM product manuals.

- WARNING: This equipment is approved only for the mobile classification of transmitting devices. The antenna used for this transmitter must be installed in a manner that will ensure a separation distance of greater than 20cm from all persons and must not be co-located or operated in conjunction with any other antenna or transmitter.

4.3 IMPORTANT FCC NOTICES

- The VikingX OEM RF Module has been certified by the FCC for use with other products without any further certification (as per FCC section 2.1091). Modifications of the module not expressly approved by Valhalla Wireless could void the user's authority to operate the equipment.

- The OEM must test their final product to comply with unintentional radiators (FCC section 15.107 and 15.109) before declaring compliance of their final product to Part 15 of the FCC rules.

- The VikingX OEM RF Module has been approved for the mobile classification only. A distance of greater than 20cm separation from any person is required for mobile operation. Additional certification for Specific Absorption Rate (SAR) will be required if the device is to be used in portable applications (applications with 20cm or less separation from nearby persons).

This equipment has been tested and found to comply with the limits for a class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

The user is cautioned that changes and modifications made to the equipment without the approval of manufacturer could void the user's authority to operate this equipment.

5 Document History

Rev 01, 2010-03-03   Added section regarding antenna orientation and Figure 2 - t.elliott

Rev 01, 2010-03-31 Modified manual cover and language repeater operation section. - t.elliott

Rev 01, 2010-04-02 Removed language regarding shielded cables. - t.elliott

Rev 01, 2010-04-11 Added Thermistor and Antenna part numbers. Added table describing sensor connection types available. - t.elliott