Using a "Brick" CPU to Run RMS Packet with VARA FM (rev 2.0)

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1.0 Overview

This writeup summarizes a simple setup using a modern miniature low-cost "brick" Win 11 computer to run Winlink RMS Packet with VARA FM. This is a reliable, low-cost approach to creating a simpler software environment and computer configuration that can run reliably unattended. A similar approach can be used to run programs like Winlink RMS Packet 1200/9600 baud, Winlink RMS Trimode, RMS Express or other Ham programs. This writeup is not a detailed step by step instruction guide…those details are normally covered in the specific setup instructions for the computer and associated software programs. There is a good writeup on setup details of RMS Packet and VARA FM by Scott NS7C at https://winlink.org/sites/default/files/RMSE_FORMS/rms_packet_dual_mode_single_radio_setup_0.pdf

2.0 The "Brick" Computer

Brick computers have become popular for many cost-sensitive applications and unattended, stand-alone systems. These brick computers are often used in office settings where the brick computer is mounted on the back of the monitor. The computer is small (typically 5"x5"x2") and can be quite suitable in many environments. Typically these run between $100 to $250 depending on OS, "Hard Drive" size (internal flash memory chips), dynamic RAM, and CPU chip and clock rate. This article covers an implementation using Windows 11 but the same brick computers can normally be used on Windows 10, Linux or other Operating systems. The computer selected for this project was a KAMRUI Mini PC with Intel Celeron N5105 2GHz quad core processor, Windows 11 Pro, 8GB DDR4 RAM and a 256 GB SSD ($150-$200). The KAMRUI various versions of this or similar computers are usually available with more or less RAM or SSD storage and sometimes different processor speed, cores, cooling, and case options. These are available from AMAZON or other retailers. The KAMRUI Mini PC came complete with 1AC to 12v DC power supply, 2 USB 3.0, and 2 USB 2.0 ports, a RJ45 Ethernet port, 2 HDMI display ports and 1 Audio in/out port. There is fan cooling that is virtually inaudible. Some suppliers also provide fan-less cooling and metal case options.

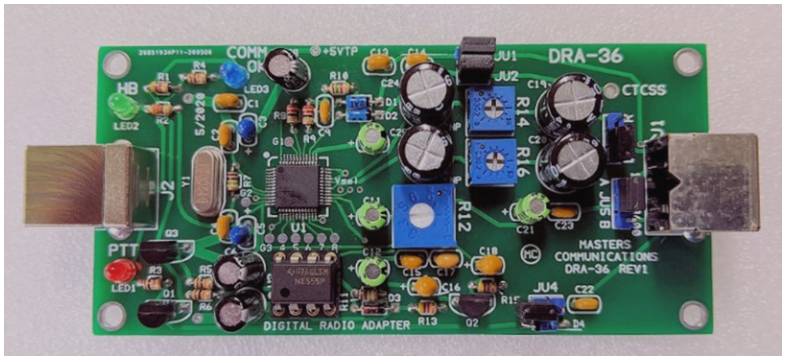
A second lower cost (~$100) BMAX "brick" CPU was also evaluated for comparison. This was the same Win 11 Pro OS with an older dual core Celeron N4020 Series B25, 1.1 GHz base processor frequency and 6 GB DDR4 RAM with 128 GB SSD. It also came with a similar AC to 12V DC supply, 4USB ports, 1 Ethernet Port, 1 HDMI monitor port, 1 Audio in/out port and quiet internal fan. This brick computer worked on VARA FM Wide but the VARA reported CPU usage (42%) was considerably more than the 4% reported for the KAMRUI quad core. Unless cost is the over-riding parameter I would recommend using a higher end Quad core brick with at least 8 GB RAM.

On both brick computers Windows 11 Pro 64 bit was pre-installed but needs to be configured (personalized, login password etc.) prior to Installing operational software. There is minimal documentation on this that is included with the computer but the Win 11 setup customizing procedure walks you through the simple configuration process. Complete this setup and registration before trying to load or configure any VARA or Winlink code. The Windows 11 comes with a basic Internet browser and utility programs that should be sufficient. These of course can be customized to your choice but keep in mind you are going to be supporting time-critical communications protocols, software, and hardware (e.g. Sound card based modems). One important setting for Windows 11 running unattended is the System/Power setting which should be set for "Best Performance" which will keep the OS from going to sleep or timing out. The cornerstone of reliable high-performance operation is keeping any other "real time" or heavy CPU/Memory demanding applications to a minimum. You will also need to provide some basic operator/setup interface consisting of a keyboard, mouse, and monitor. These can range from conventional full size to smaller, cheaper or older accessories. The normal graphics demands of most ham radio protocol software is modest so a smaller display and keyboard is probably fine.

3.0 The Modem

The modem for most ham radio digital applications can either be a true dedicated HF/VHF modem like an SCS Packet or Pactor modem or it can be a higher performance sound card with support software to do the modulation, encoding/decoding and timing with software. The preferred and more reliable approach is to use a *dedicated* "sound card with keying" hardware such as the DRA series available from Masters Communications. http://www.masterscommunications.com/products/radio-adapter/dra/

In the example in this writeup a MC DRA-36 "high performance" sound card with keying was used with the VARA FM software to implement the sound generating and receiving tasks along with accurately timed radio PTT keying. This USB sound card provides flat response, wide bandwidth audio, and manual audio level adjustments for transmit and receive along with software controlled non-relay transmitter PTT keying. To reach full performance with VARA FM or 9600 baud AX.25 packet it is necessary to use the higher baud rates and bandwidths permitted on VHF/UHF frequencies and radios that can support the higher bandwidths of these modes. Other similar MC modems may have different connectors, levels, or adjustments.



There are other popular "sound card" modems like the SignaLink pictured below that are also useable. One caution here is that often these "sound card" interfaces often use the audio input with filtering to generate the internal PTT relay (transmitter keying) function. While this approach can be used on some ARQ protocols it requires careful adjustment of the PTT "hold" or "DLY" time to insure part of the transmitted or received packet is not delayed or truncated. Also, because these products often contain

audio isolation transformers they may not have adequate flat frequency wider response required by some higher baud rate protocols (e.g. 9600 baud packet and VARA FM wide).

Trying to share one "sound card" across multiple *concurrent* running protocols is ***NOT*** recommended especially for unattended operation. The "sound card" should be a dedicated resource for each protocol supported to avoid timing or resource conflicts. Keep in mind that while Windows may report fairly low *average* CPU utilization (e.g. < 20%) to maintain accurate timing requirements of the protocol may require timing precision that will be degraded when the CPU is heavily loaded with other real-time applications. In my RMS Packet/VARA Wide setup I am running only VARA FM and my KAMRUI Mini PC utilization (reported by VARA) was typically under 4% with occasional higher peaks. Running too many high CPU demanding applications is probably the most common mistake in setting up and maintaining *reliable unattended* sound card -based modems and protocols. Tracking down the causes of such transient problems is a difficult or to-often impossible debugging task.

4.0 The Radio

The Radio is of course an important part of the system and must be designed for and configured for reliable stand-alone operation. For this project a 2 meter Alinco DR-135T was selected to provide 50 watts of output on 2 meters and supports a wide bandwidth 9600 baud capability. Accessing the high bandwidth audio in/out and PTT keying is set up with the radio's packet menus and uses the 9 pin "D" connector at the back of the radio. This and the radio's 9600 bps packet mode (wider bandwidth) supports the bandwidth for VARA FM Wide. The D connector is wired directly to the ground, audio out, audio in, and PTT connections of the DRA- 36 modem. The radio is set up for Wide band data transfer. The similar models for the Alinco 220 MHz or 440 MHz radios can be used for other bands. I also had good success with the 2 meter TYT TH-9000D radio which *may* be made in the same factory as the DR-135T. The 60 watt TH-9000D is available for 2Meter or 220 MHz but will require adding the wiring and radio rear panel mounted 9 Pin D connector wired into a small header in the radio. Make sure the radio's 12 volt power supply is rated with some reserve to handle long sessions. Extended operation at full power may require a small fan for the radio. Lowering the output power (20-25W) of the radio will improve reliability but of course reduces S:N by about 3 dB (which can lower data throughput somewhat at the receiving end…see throughput vs S:N graphs in section 6).

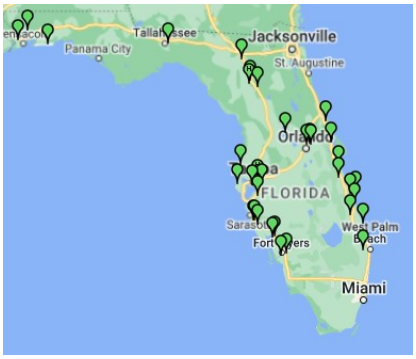
5.0 Setting Up the Software:

Once the basic OS is configured and the support hardware obtained the required software can be installed. For this project this consisted of two software modules that create a Winlink VHF/VARA FM network node that can accept user connections and handle messages to/from the Winlink system. The VARA software also allows the (licensed) VARA FM station to perform as a one or two hop "digi" to relay connections (at the expense of message throughput) to other similar nodes. This is one way to obtain message forwarding when a station loses internet connectivity. The two modules used are RMS Packet

and VARA FM. These two modules should be configured as per the setup instructions first with RMS Packet and then VARA FM. The fairly strait forward setup instructions for the software (which may vary with software version) are contained in the software downloads and are not included here.

The Winlink RMS Channels utility

(https://winlink.org/RMSChannels?qtlive_winlink_information=1#qt-live_winlink_information)

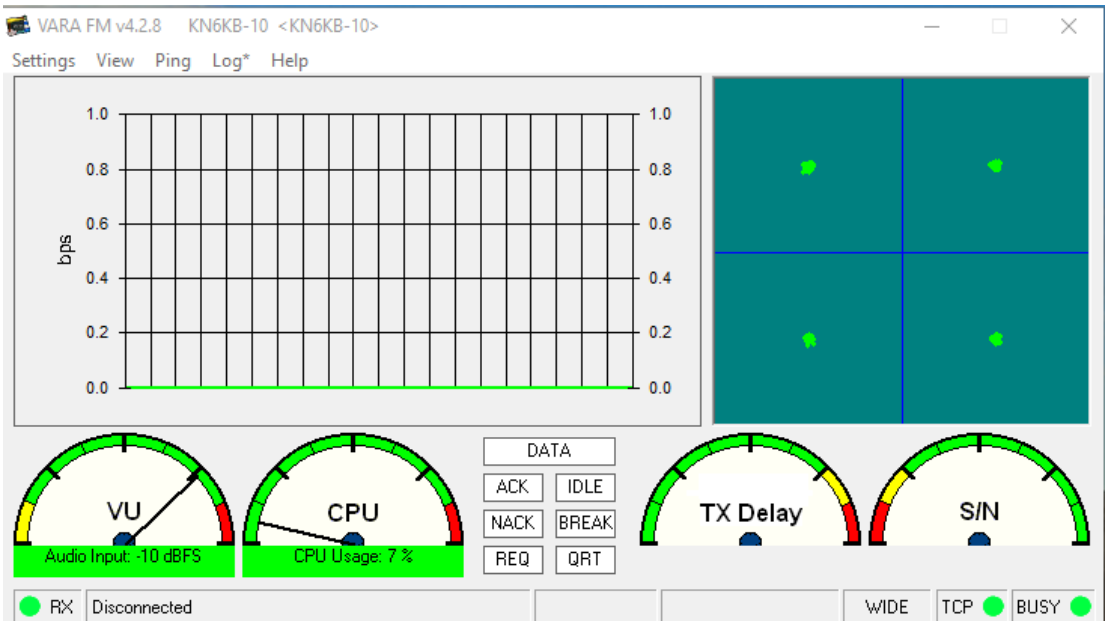


shows similar nearby Winlink/VARA FM stations operating in the Winlink network. Clicking on a specific location provides details (at right) on the station (callsign, frequency, gridsquare, antenna, modes, operating hours and operational status).

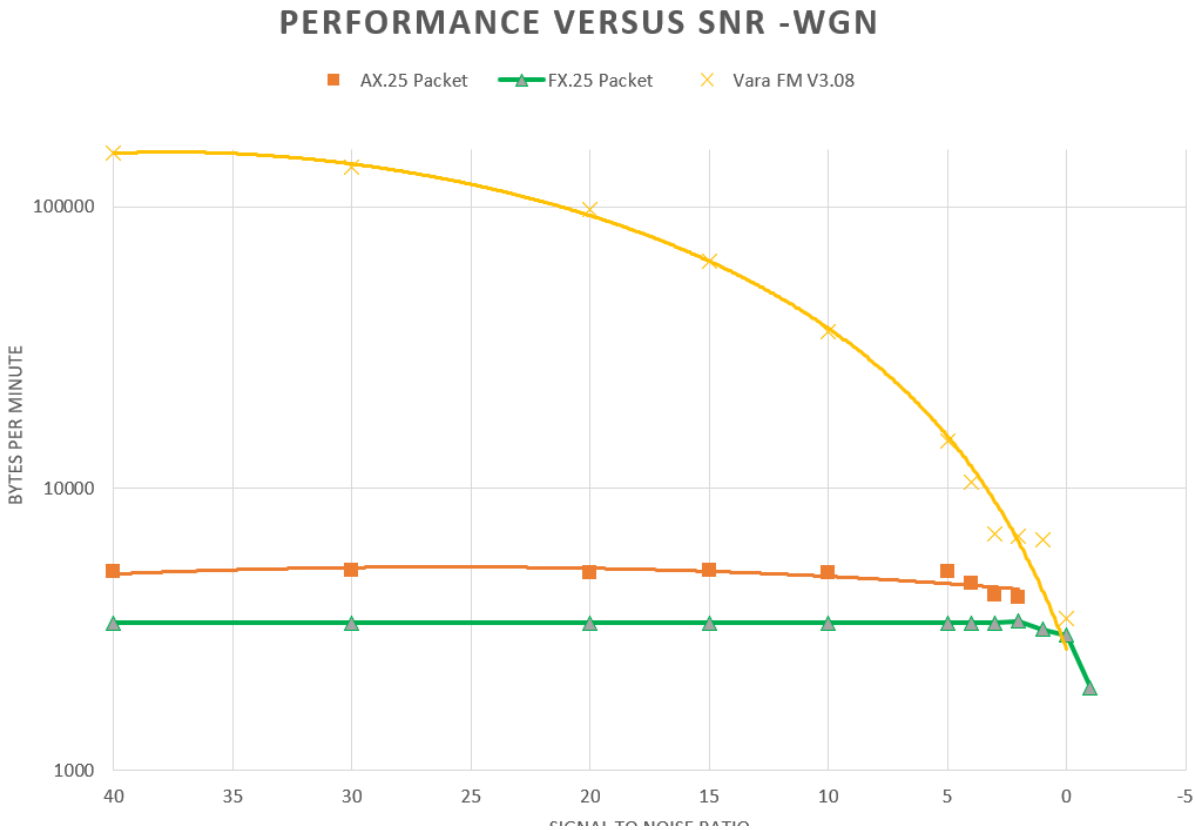
Gateway Channel Information

Callsign:	KN6KB-10
Frequency:	144.990 MHz
Gridsquare:	EL98PF
Antenna:	Omni
Operating Mode:	VARAFM / VARA FM WIDE
Operating Hours:	00-23
Last Status Received:	2023-03-19 11:25 -04:00
Comments:	Connect direct or Digi through K4DCS-10

VARA FM operation requires a VARA license code for full speed performance and use as a digi. The VARA FM setup and "PING" features provide a simple mechanism for automatically adjusting drive levels for the radio and audio levels for the received audio for the sound card. Below are a couple of screen shots showing readouts from a VARA FM Ping through a connecting DIGI through 2 stations within the Florida East coast VARA FM network. The tight grouping of the 4 PSK constellation confirms good signal strength and proper audio levels at the sending and receiving stations.



6.0 Simulated Performance VARA FM Wide vs 1200 baud AX.25 and FX.25 Packet



Evaluating the throughput of a protocol as a function of radio path (S:N or multipath) requires the consistent statistical duplication of radio path or using a propagation simulator. As part of an article in the Mar/April 2022 issue of QEX that described a self-contained open source Teensy 4.0 CPU HF and VHF channel simulator we ran extensive performance simulations (courtesy of Tom Whiteside N5TW) of VARA FM Wide compared to AX.25 Packet and FX.25 packet showing net throughput of large files through a White Gaussian Noise channel at various S:N Ratios (0-40dB). The Chart above shows the throughput (averaged over several large file transfers). VARA FM Wide substantially outperformed conventional 1200 baud AX.25 or FX.25 packet at all useable WGN S:N environments.

Feel free to contact me via the email address above with any questions or results of your “Brick Computer”, Winlink /VARA Setup, or usage help on the open source IONOS HF/VHF simulator.