Using a NUC ("Brick") CPU to Run RMS Trimode with Pactor and VARA HF

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(additional inputs from Phil Sherrod, W4PHS Winlink Development Team)

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1.0 Overview

This writeup summarizes a Winlink Trimode HF setup using a modern miniature low-cost NUC (Next Unit of Computing) [often called "brick"] Win 11 computer to run Winlink RMS Trimode with VARA HF and Pactor. This can be a low-cost approach to creating a simpler, more reliable software environment and computer configuration that can run unattended. The approach taken here (primarily for long term reliability) is to separate the near real- time requirements of these HF protocols from a computer doing many other tasks. This is one way you can achieve near real-time capability from a non-real-time OS like Windows, Linux, or Mac. This writeup is not a detailed step-by-step instruction guide…those details are normally covered in the specific setup instructions for the specific brick computer and associated Winlink and VARA software programs.

2.0 The NUC or "Brick" Computer

"Brick" computers (because of their small size and typical brick shape) have become popular for many cost-sensitive applications and unattended, stand-alone systems. These 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 for many functions and environments. Typically, these run between $100 to $300 depending on number and type of cores, Operating System, "Hard Drive" size (usually internal flash memory chips), dynamic RAM, 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 GMKtek Mini PC Intel N100 Windows 11 pro (3.4 GHz) with 16GB DDR4 RAM with 1TB PCIe M.2 NVMe SSD. It supports Dual 4K HDMI displays and has 4 USB ports, WiFi 6, and a quad core processor (Amazon $210 12/30/2024). Various versions of this or similar computers are usually available with more or less RAM or SSD storage and sometimes different processor speed, number of cores, cooling, and case options. These are available from AMAZON or other retailers with typical costs of $100 - $300. The GMKtek Mini PC came complete with one AC to 12v DC power supply, 2 USB 3.0, and 2 USB 2.0 ports, a RJ45 Ethernet port, 2 HDMI display ports, 1 Audio in/out port, HDMI cables, and mounting hardware. There is fan cooling that is virtually inaudible. Some suppliers may also provide fan-less cooling and metal case options.

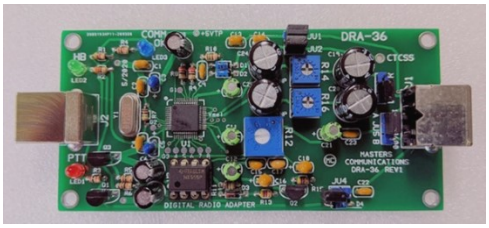
Unless cost is the over-riding parameter I would recommend using a higher end Quad core brick configuration with at least 8 GB RAM.

Windows 11 Pro 64 bit was pre-installed but needed 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 "virgin" Win 11 setup procedure walks you through the simple configuration process. Complete and verify this OS setup and registration before trying to load or configure any VARA or Winlink code. Windows 11 comes with an 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 software 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 interfaces 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.

Phil Sherrod W4PHS chief software developer on the Winlink team points out one of the pitfalls that can lead to an unstable system is loading it up with 3rd party programs that do "system optimization," registry cleaning, driver updating, etc. Phil recommends using only Windows Defender as the anti-virus utility rather than some other program and to stick with Microsoft system tools and install only certified driver updates that Microsoft offers.

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 PTT timing with software. Also new higher performance Ham Radios (e.g. Icom 7300) may contain internal "sound cards" that can interface directly to the computer via USB ports. If an external modem is used be aware of the important critical PTT timing and audio bandwidth requirements. There are other popular "sound card" modems like the SignaLink pictured at right or the Masters Communication DRA-36 (or similar) below that are also useable. One caution here is that some of these "sound card" interfaces may 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 a significant part of the transmitted or received packet is not delayed or truncated. Also, because some of these products may contain audio isolation transformers they may not have the flat frequency response required by some higher bandwidth or baud rate protocols (e.g. 9600 baud packet and VARA FM or HF 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 protocol timing requirements may require

timing precision that will be degraded when the CPU is heavily loaded with other applications. 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 an Icom 7300 model all-mode transceiver was selected. The Icom 7300 is a modern 12 V powered radio and provides 100 Watts PEP Sideband and covers all frequencies 1.8 to 70 MHz The radio has a USB control interface and supports external modems like the DR-7400 SCS Pactor modems shown below. The 7300 radio, P4 Modem, and Brick CPU have been operating HF reliably 24/7 for over 12 months.

5.0 Powering the Brick for Reliable operation.

Most "Brick" CPUs operate off a 12 V DC supply which is usually provided with the computer. For the best reliability you should have a Brick power mechanism that protects against short term power transients. One solution is a larger 12V storage battery that is kept "topped up" by a small 12-13v charger. Another simple alternative is to plug the supplied AC to12v DC Brick power supply into a 120/240 V AC power backup (UPS). The idea is to minimize any chance of a power glitch causing a full Windows and operational code restart.

Phil Sherrod, (W4PHS) primary software developer on the Winlink team also suggests for a stable Windows system avoid 3rd party programs that mess with the system. This includes "system optimizers," "registry cleaners," disk defragmenters, and driver updating programs. Install only Windows updates, and don't install "optional updates" offered with Windows updates. Also, ***don't*** sign up to be a Windows beta tester!

6.0 The Dark Side of the "Brick"

There is however a dark side to the Brick CPU story. A quick look at the customer feedback on Amazon of the above and similar CPUs reveals that these relatively simple CPUs often have two primary bins of customer feedback. Excellent and Good are usually the major rating but there is too often a relatively significant number of problems/complaints. Examples include:

a) Problems activating or installing/re installing the Windows 11 or 10 OS.

b) Early failure of one or more major components or features.

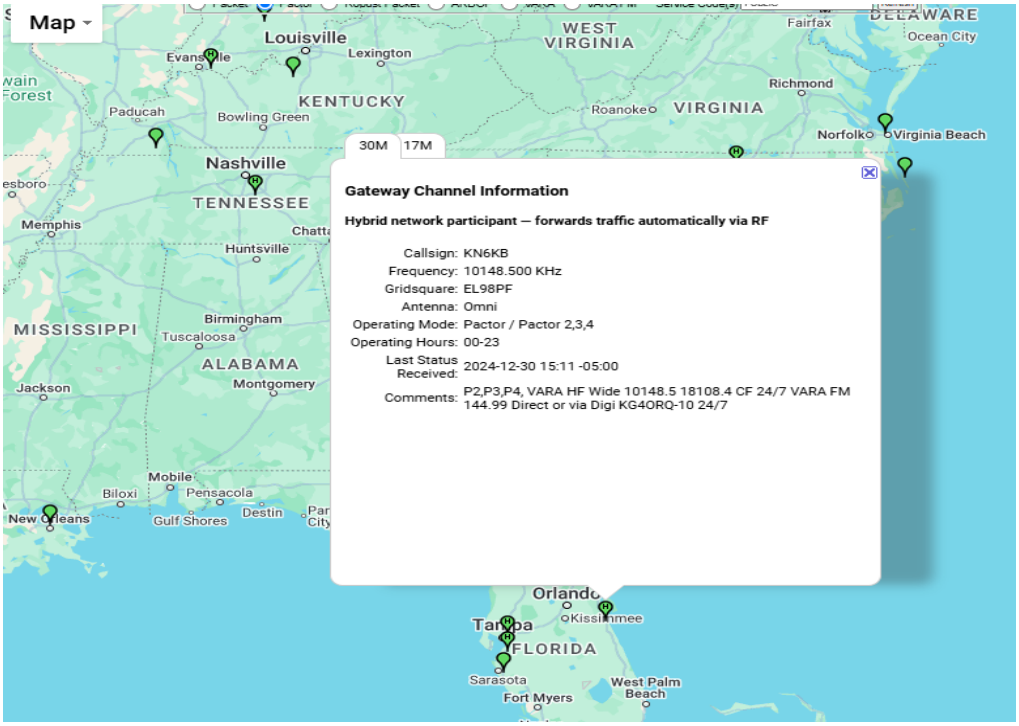
c) Poor manufacture's support with respect to fixing issues or handling returns.

The causes of this could be several things: Use of “seconds”, or untested components. Poor or minimal instructions. Attempts to “piggy back” on a prior Wind 10 or 11 install. My experience has been once the brick CPU has a proper Win 10/11 install and has run several days without problems the CPUs are reliable. One bit of advice is to avoid dealing with unreliable, unskilled, or come-and-go venders and to carefully read reviews along with the return policy of the seller. My personal experience over 4 or 5 brick CPU projects suggests a failure or issue rate of about 10-20%.

7.0 Setting Up the Software:

Once the basic OS is fully 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 HF Pactor and a VARA HF network node (The same RMS Trimode software can support ARDOP or robust packet) . These protocols can accept HF user connections and handle forwarding messages to/from the Winlink system. The two software server modules used are RMS Trimode and VARA HF. The fairly straight forward setup instructions for the software (which may vary with software version) are contained in the software downloads and are not included here. If you have questions or need help configuring the software sign up for one or more of the Winlink support groups: https://winlink.org/content/user_support_and_help The Winlink Live System Information can show you what other users will see about your station (Position, Frequencies, Modes, Schedule etc.)

The screen capture below shows Pactor maps and frequencies for KN6KB’s modes P2, P3, P4, VARA HF Wide and VARA FM VHF. Use the comment field to supply whatever additional info you wish.

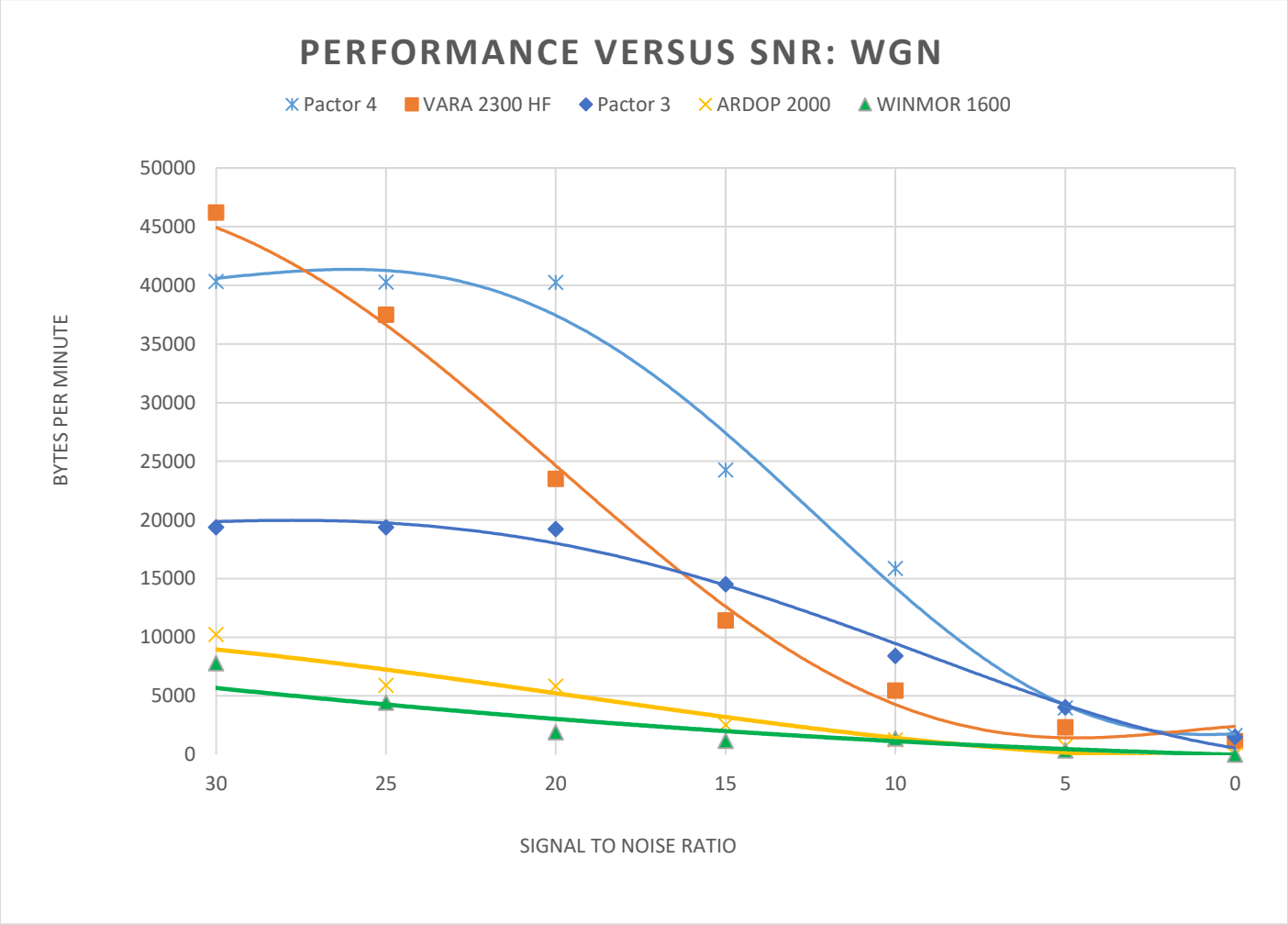


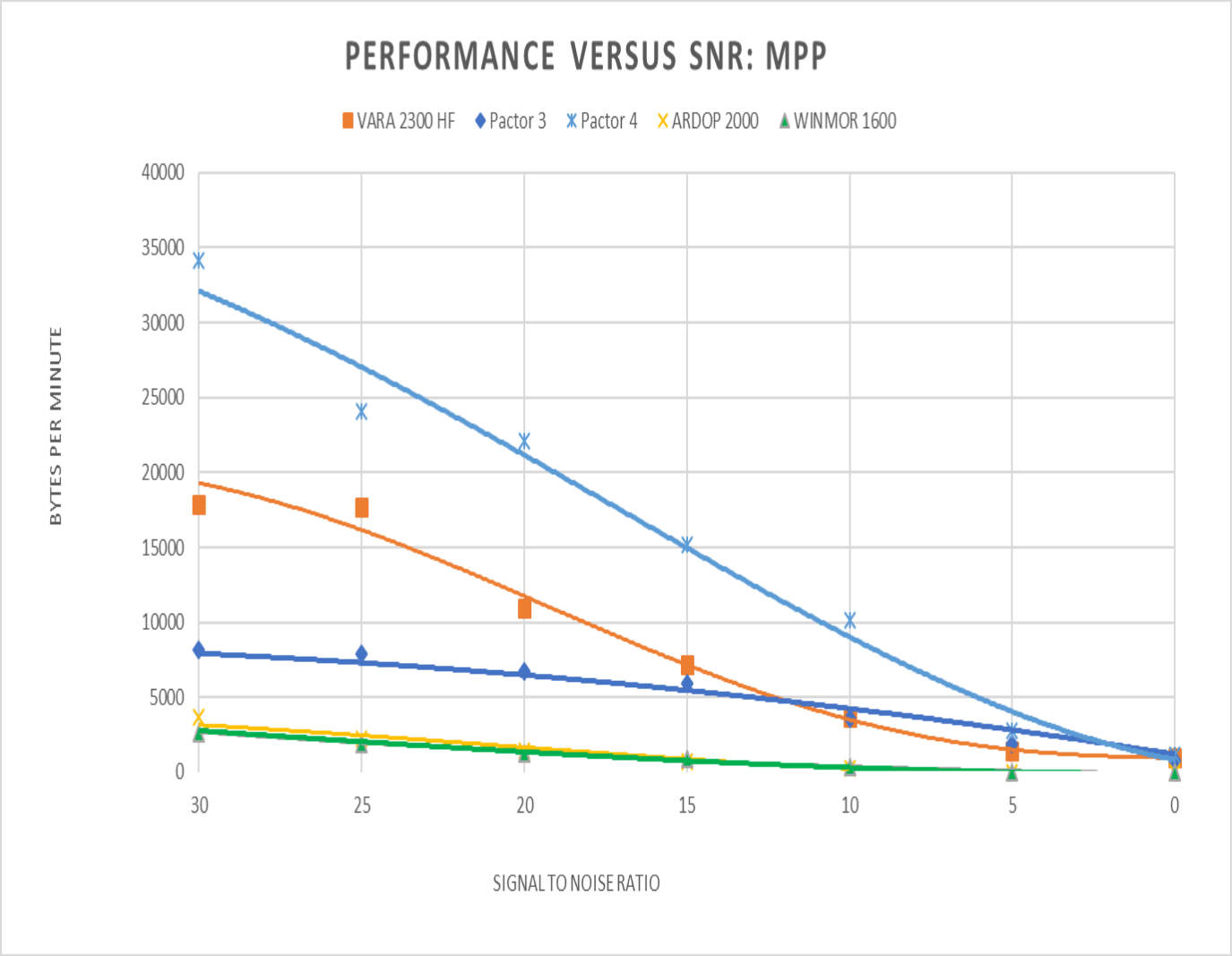
The Winlink RMS Channels utility (https://winlink.org/RMSChannels?qtlive_winlink_information=1#qt-live_winlink_information)

The Winlink web site also has a number of HOW-TO Recipes for setting up and optimizing Winlink HF and VHF/UHF installations. See (https://winlink.org/content/how_recipes)

8.0 What performance can you expect from some of Winlink HF modes?

As part of a Winlink project on developing a low-cost open-sourced HF/VHF channel simulator (See ARRL's QEX 2022 March/April page 9 or https://github.com/ARSFI/HFSimulator) the Winlink development team ran extensive simulations on various HF and VHF protocols. These tests averaged several long simulation runs (> 10 minutes/run) using the appropriate modems over a wide range of S:N and standardized CCIR/ITU channel types. The Winlink Teensy CPU HF/VHF simulator (with Arduino OS) was verified and calibrated against other available simulators over the same standardized channels and S:N ranges. The QEX article contains several of the simulation runs for multiple protocols and standard CCIR/ITU channels but the following two give some perspective on what one might expect from each Winlink supported HF protocol over a simple White Gaussian Noise (WGN) channel and a CCIR standard Multipath Poor HF channel (MPP). The horizontal axis are in dB and vertical in bytes/min.





Hopefully you will find this article helpful and encourage you to look into a dedicated NUC ("brick") CPU to run your Winlink HF or VHF station.

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