

Improved TNC Interconnections

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Abstract:

Hardware for interconnecting TNCs to form a TheNET or ROSE network hub has been further refined for greater convenience. An updated version of the well-known Diode Matrix Board for RS-232 network hub backbones is introduced. The new board has been re-packaged into a backplane-line configuration, eliminating the need and expense of cables for the RS-232 signals. Additionally, a new circuit is described which allows multiple TNCs to be interconnected at high speed via their modem disconnect headers, with full flow control, using only two signal wires.

For effective Packet Radio networks, it is essential that a three-dimensional network topology be utilized. This means that user access and data transport must be not performed on the same radio channel. Generally, this is done by having a network user access channel on the 2 meter band and a second network TNC sending the data into the network on a backbone channel using a different band, such as 440 MHz. In small or lightly loaded networks, a number of 2-port network hubs may be effective. However, as the data loading increases, it becomes necessary to rely upon point-to-point links. This creates a need for network switching hubs of three or more TNCs, which must be interconnected on a Local Area Network, or Matrix. Traditionally, the lowest cost implementation for such a matrix has been the Diode Matrix Board.

The Diode Matrix Board was originally produced by John Painter, N0NDO, in 1989 as the TJP Octopus. It had eight ports, and the wires to the TNC connectors were soldered directly to the PC Board. The Octopus, with its twisted maze of cables emanating from the tiny PC board, was the best solution available at that time.

In early 1991, the North East Digital Association' began selling the NEDA Hexiyus, a six-port version of the Octopus. The Hexiyus was built mostly for NEDA's use in their growing TheNET network, since Octopus boards were no longer available and hand-made matrices built on perfboard were not consistently reliable. The redesigned PC Board addressed two of the Octopus' biggest problems: the soldered-in cables and RS-

232 fan-out problems with some TNCs. The Hexipus used 9-pin sub-D connectors, allowing the use of commonly available, removable cables. Limiting the number of ports to six resolved the fan-out situation (where some TNCs could not provide sufficient RS-232 drive current, stopping communications), as well as reducing the backbone contention at busy sites (where there is more data to be handled than time in which to handle it, causing slowdowns and data collisions). The Hexipus is no longer being produced.

At approximately the same time, the ROSE networking software was upgraded to support diode matrix interconnection, unfortunately using a different pin-out from the Hexipus, which had been designed with TheNET in mind. Previously, ROSE networks had to use the relatively expensive Active RS-232 LAN designed by Tom Moulton, W2VY. Bill Slack, NX2P, designed the five-port EZ-Matrix², mostly because he needed an inexpensive, easy to build circuit to implement a ROSE network in northwestern New Jersey. The EZ-Matrix, which used "HPFM Technology", was the first to be compatible with both ROSE and TheNET networks. It used DIP diode arrays, as opposed to the 60 discrete diodes in the Hexipus, allowing it to be assembled in a few minutes. The networking software type was selected by soldering the DE-9 connectors into different sets of holes in the PC Board.

Recently, the diode matrix board concept has been further refined, as the NETRIX Diode Matrix Board³. This six-port circuit was designed with a backplane-like PC board, allowing the TNCs to be connected directly to the matrix, eliminating cables. The Netrix

is compatible with both TheNET and ROSE networking software, which is selected by DIP shorting jumpers. The extremely short data path adds less capacitance to the RS-232 lines, permitting higher speeds. The unique stacking method, with all of the TNCs placed on their side, contributes to better cooling airflow, allowing TNCs to run cooler and therefore more reliably.

An added benefit to the elimination of the cables is a neat, professional appearance for the network hub. The Netrix is endorsed by NEDA, RATS⁴ and NAPRA⁵, leading packet networking organizations.

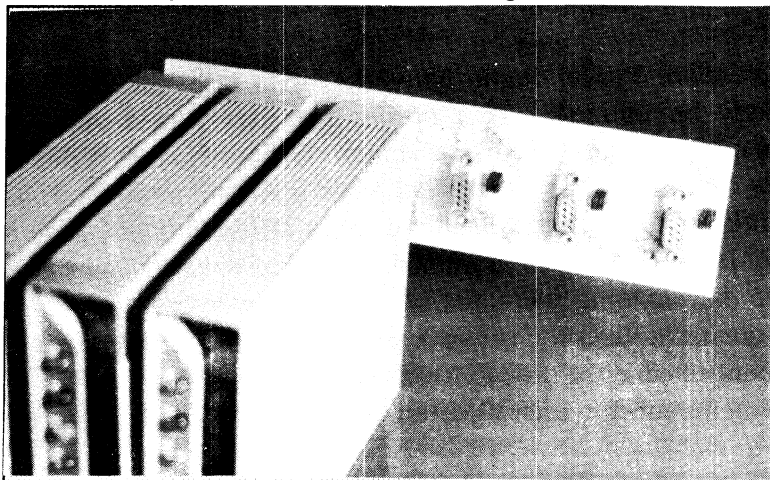


Photo 1: The NETRIX Diode Matrix Board, shown with three TNCs attached.

The Netrix is offered with 9-pin female sub-D connectors, spaced on 1.625 inch centers, allowing any brand of TNC-2 compatible to be used. Commonly available 9 to 25 pin

adapters are used to attach TNCs with 25-pin RS-232 connectors, while a 9-pin gender changer is used to connect TNCs with female DE-9 connectors. TNCs with male DE-9 connectors attach directly to the Netrix board.

The Netrix, like the original TJP Octopus, consists of a matrix of diodes, connected such that signals may flow in only one direction. TNCs are designed to be connected to a computer using a straight-through RS-232 cable (TXD to TXD, RXD to RXD, etc.), like most telephone modems, making it a DCE (Data Communications Equipment) device. DCE devices send data on the RXD pin, and receive data on the TXD pin - just the opposite of what you'd expect. The opposite of a DCE device is a DTE (Data Terminal Equipment) device - a computer or terminal - which sends data on the TXD pin and receives data on the RXD pin.

To connect same-type (DTE or DCE) devices together, you use a "null-modem" cable, where all pins on one end are connected to their opposites on the other end to the cable - e.g., TXD is connected to RXD, and so on. A Diode Matrix is therefore wired somewhat like a null-modem, except with diodes having reversed polarity, making the diode matrix a "null-terminal". This permits more than two devices to share the data and control lines.

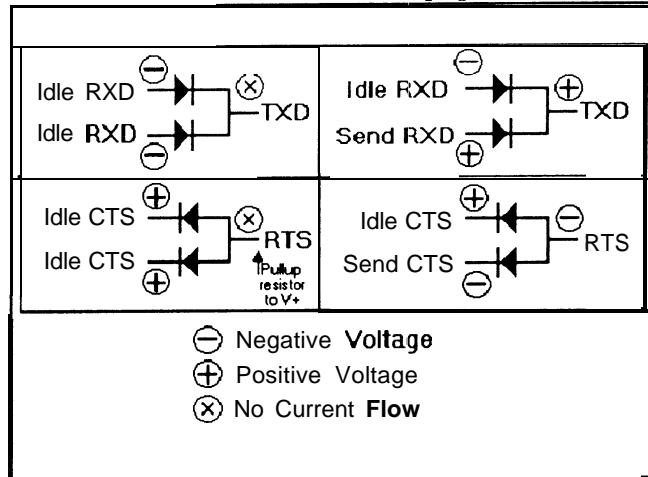


Figure 1: The simplified 2-port diode matrix.

Diode matrix operation is easiest to explain in terms of idle states and voltage levels. The purpose of the diodes is to allow ANY active (non-idle) line to override ALL idle lines. Some important things to understand:

- 1) RS-232 signals may have either of two voltage levels, + 12 volts and - 12 volts.
- 2) Data signals go through the diodes in the opposite direction from the Flow control signals.
- 3) Current flows through a diode only when the voltage at the cathode (the side with the line or band) is lower than the anode voltage.

For DATA lines:

Idle = Mark = 1 = V- **Data = Space = 0 = V+** **One V+ must override many V-**

For FLOW lines:

Idle = Space = 0 = V+ **Flow = Mark = 1 = V-** **One V- must override many V+**

So, to cover all four possible cases (all Data idle, all Flow idle, one Data active, one Flow active), the simple 2-port diode matrix must look like the circuit shown in Fig. 1.

Occasionally, two or more co-located TNCs must be connected via their modem ports. This was often done at audio levels, using a null radio cable. This method is limited by the modem in the TNC, usually 1200 baud. Two TNCs could be connected via the modem disconnect header signals, but adding a third TNC created significant problems.

A simple, inexpensive circuit, designed by Bill Slack, NX2P, is now available to connect six or more TNCs together via their modem disconnect headers. This circuit, dubbed a WireModem Adapter[?], operates independently of the type of software running on the TNC and uses only two wires for data and flow control. It is easily (and reversibly) installed into the TNC, and the TNC remains removable from the network hub with the WireModem installed.

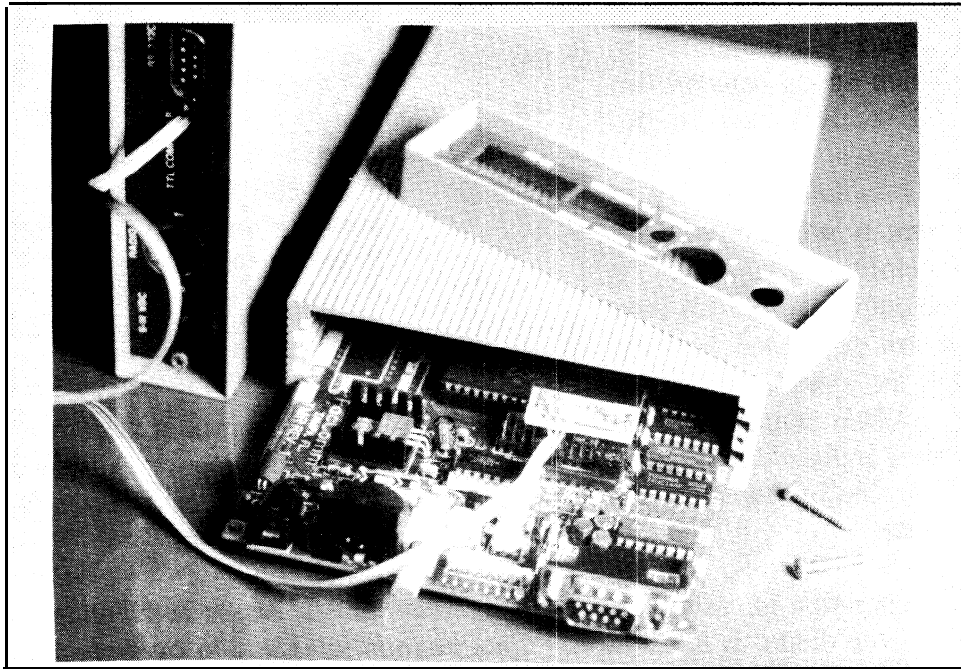


Photo 2: The WireModem Adapter, shown installed in a TNC.

Applications for the WireModem include the creation of a gateway between ROSE and TheNET networks; connection of two diode matrices together for a site with more than six radio ports, allowing high-speed connectivity while maintaining isolation to avoid matrix contention; the addition of a TNC- or computer-based data server (e.g., BBS, Weather Server, DX Cluster, Crowd Node, Callbook Server, etc.); and allowing an easy method of monitoring site activity, as well as site testing and maintenance.

The WireModem adapter is available in kit form, which consists of a small (0.5 x 1.1 inch) PC board, components and connectors. A DIP header is fashioned into a simple interconnecting matrix, permitting a TNC to be easily disconnected for service or inspection. The PC board mounts directly onto the 20-pin modem disconnect header, and the signal and ground wires of each WireModem are all connected in parallel.

The function of the circuit is as follows:

FLOW CONTROL: When the transmitting TNC asserts RTS (Request To Send output, Pin 5, active low), the diode conducts, and the signal is imposed upon CD (Carrier Detect input, Pin 1, active low). The signal is also sent, via the FLOW wire, to the receiving TNCs. In the receiving TNCs, CD is asserted, but the diode blocks the signal from reaching RTS. Thus, the transmitting TNC lights both the PTT (RTS) and DCD (CD) indicators, while in the receiving TNCs only DCD is indicated.

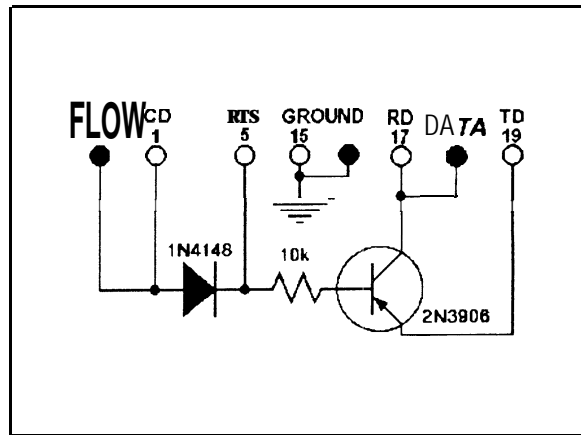


Figure 2: Schematic of the WireModem Adapter.

DATA: The RD input (Receive Data, pin 17) is directly connected to RD in the other TNCs. If RTS is inactive (high), it biases the PNP transistor off, effectively cutting TD. When the transmitting TNC asserts RTS, the transistor is biased on through the resistor, connecting TD to RD. The RD of the receiving TNCs and the transmitting TNC also hears its own data.

In conclusion, the NETRIX is an updated version of the familiar diode matrix board, use. The WireModem Adapter simplifies a once difficult task, offering a new solution to a number of networking problems.

Endnotes:

1. PO Box 563, Manchester NH 03 105. NEDA operates a TheNET network spanning from Maine to
2. Available from NX2P Electronics, 321 East Shore Trail, Lake Mohawk NJ 07871
3. Available from Amateur Networking Supply, PO Box 219, Montvale NJ 07645.
4. The Radio Amateur Telecommunications Society, PO Box 93, Park Ridge NJ 07656. RATS is the distributor of the ROSE X.25 Packet Switch networking software, as well as other packet-related software.
5. The Northwest Amateur Packet radio Association, PO Box 70405, Bellevue WA 98007. NAPRA operates a TheNET network in the northwestern United States.
6. Available from Amateur networking Supply, address above.