A Packet Controller for the Revolution

by Lyle Johnson, WA7GXD
co/ Tucson Amateur Packet Radio
PO Box 22888
Tucson Arizona 85734-2888

Tucson Amateur Packet Radio (TAPR), an Amateur-based, volunteer organization, is dedicated to the advancement of Amateur digital communications. Its first wide-spread TNC design, now called TNC 1, is in use throughout the world.

In spite of its wide acceptance, the high cost of the TNC 1 (about $300 as a kit and $500 assembled> discouraged many Amateurs from entering the exciting world of packet radio.

The TNC 2 project was launched with two primary objectives: reducing the cost of entry into Amateur packet radio while maintaining the high standards set by the TNC 1.

Any list of high-cost items used in the TNC 1 must include the WD1933/1935 HDLC controller, the XD2212 NOVRAM (tm) and the cabinet. Together, these items represent nearly $100 of the $320 cost of the TAPR TNC 1 kit.

In addition to eliminating the above corn - ponents, careful attention was directed to parts or features that could be deleted from the new TNC design without seriously affecting performance. As a result of this, TNC 2 lacks a software-programmable baud rate generator, user parallel ports and a programmable memory map ROM.

Finally, ways were explored to enhance the operation of TNC 2. Hundreds of letters have been received by TAPR since the beta testing of the original TNC design, and many of the suggestions contained in those letters were implemented in the new unit.

TNC 2 is based on the Z80 (tm) micropro-cessor (uP). In addition to its efficient interrupt structure, the wide availability of software tools for this device make the TNC 2 more suitable for the experimentally inclined Amateur than TNC 1, which is based on the less common 6809 processor.

TNC 2 uses an SIO dual channel serial controller: one channel serves as the user asynchronous port, while the other serves as the HDLC controller. Both serial ports are full-duplex. The user port output is buffered to RS-232 compatible levels by a low-power op amp. Incoming RS-232 level data is translated to TTL logic levels by a CMOS Schmitt trigger IC.

In order to use the SIC1 on Amateur packet channels, a means had to be devised to convert the NRZ (Non Return to Zero> for-mat of the SIO's HDLC data to and from title NRZI (Non Return to Zero-Inverted> format. This problem was solved by use of a single flip-flop on transmit and a two-chip state machine for the receive side,

As with other logic on the TNC 2, the NRZ-NRZI circuitry was implemented with ICs readily available in CMOS technology. CMOS ICs typically consume far less power and have much greater tolerance to noise than other types, and are now speed and cost competitive with earlier, less opti-mal ICs.

The TNC 1 has six byte-wide memory sites mapped for 8k byte parts. This results in 48k of available memory without reprogram-ming the address decoder. The release software (pre-version 4.0) utilized only 40k of this memory space. TNC 2, on the other hand, has only three bytewide soc-kets. In the final configuration, one socket is mapped for a 32k byte EPROM and the other two sockets can use either a pair of 8k byte RAMs or a single 32k byte RAM. Thus, TNC 2 normally supports 48k bytes of memory and can easily accomodate 64k bytes, the entire address capability of the processor used.

To solve the problem of memory volatility (the loss of data upon the interruption of power), a battery-backed RAM (bbRAM) scheme is employed for all RAM on TNC 2. This not only eliminates the need for NOVRAM, as used on TNC 1, it provides greatly expanded nonvolatile storage.

To simplify the visual interface, the number of LEDs on the TNC front panel was reduced from eight to five. At the same time, more useful information is presen-ted. LEDs are provided for POWER, PTT (indicating transmitter activation>, DCD (data carrier detect - indicating that the modem has detected incoming data), STA (status - indicating unacknowledged frames in the TNC's buffers) and CON (connected -- indicated the TNC is in the connected or disconnecting states).

An effort was made to enable TNC 2 to operate from a single source of DC power Cnominally 12 volts with negative common1 for portable and emergency use. However, a decision was made early on to assure that the RS-232 serial port output was capable of driving a standard RS-232 load to below -3 volts. This meant a negative voltage source was required.

This was provided by means of a full-wave charge pump circuit based on a dual 555 timer IC. Unregulated +12 and -V are used for the RS-232 driver. Regulated +5 and -5 voltas are derived from the regulated sources. The modem ICs, which require more than 9 volts of DC and are somewhat voltage sensitive, are driven from the +5 and -5 volt sources. Simple bipolar transistor level shifters are then employed to interface the modem to the TTL levels required by the SIO chip and NRZ-NRZI conversion circuitry. Not coincidentally, the MF-10 switched-capacitor filter IC used in the receive portion of the modem requires +5 and -5 volt sources.

As with the earlier TNC, TNC 2 includes on-board circuitry to aid in modem calibration. The modem parameters are configurable via plug-in DIP headers. Switch selectable data rates for the radio channel include 300 and 1200 baud, which are the current HF and VHF packet standards. A higher-speed clock for 9600 baud operation is also included, but requires the use of an off-board modem. The modem disconnect is virtually identical to that of TNC 1, and the K9NG 9600 bps modem has been successfully interfaced to both TNC 1 and TNC 2.

The TNC 2 was introduced at the 1985 Dayton Hamvention at a cost of well under $200. Available to the general Amateur community in August of the same year, the intial production run of 1200 units was quickly exhausted.

At that time, TAPR determined to step out of the TNC marketplace. Production rights were licensed to several commercial firms, allowing TAPR to concentrate its efforts on development of otherwise unavailable packet devices, including a networking controller and high speed RF deck.

Licensed versions of TNC 2 are now available from various sources at prices between $100 and $200. Truly, participating the packet revolution is now within the financial grasp of virtually every radio Amateur.

Acknowledgmenta

While a complete list of all the volunteers who helped with suggestions or testing of the TNC 2 would be quite lengthy, it is appropriate to include the names of the prime movers of the project, without whose help TNC 2 would not have occurred.

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