PacComm

Amateur Radio Products Catalog
Autumn-Winter 1994-5 Edition

The World's Smallest Packet Station using the STANDARD C108A

MINIATURE PAC by PacComm
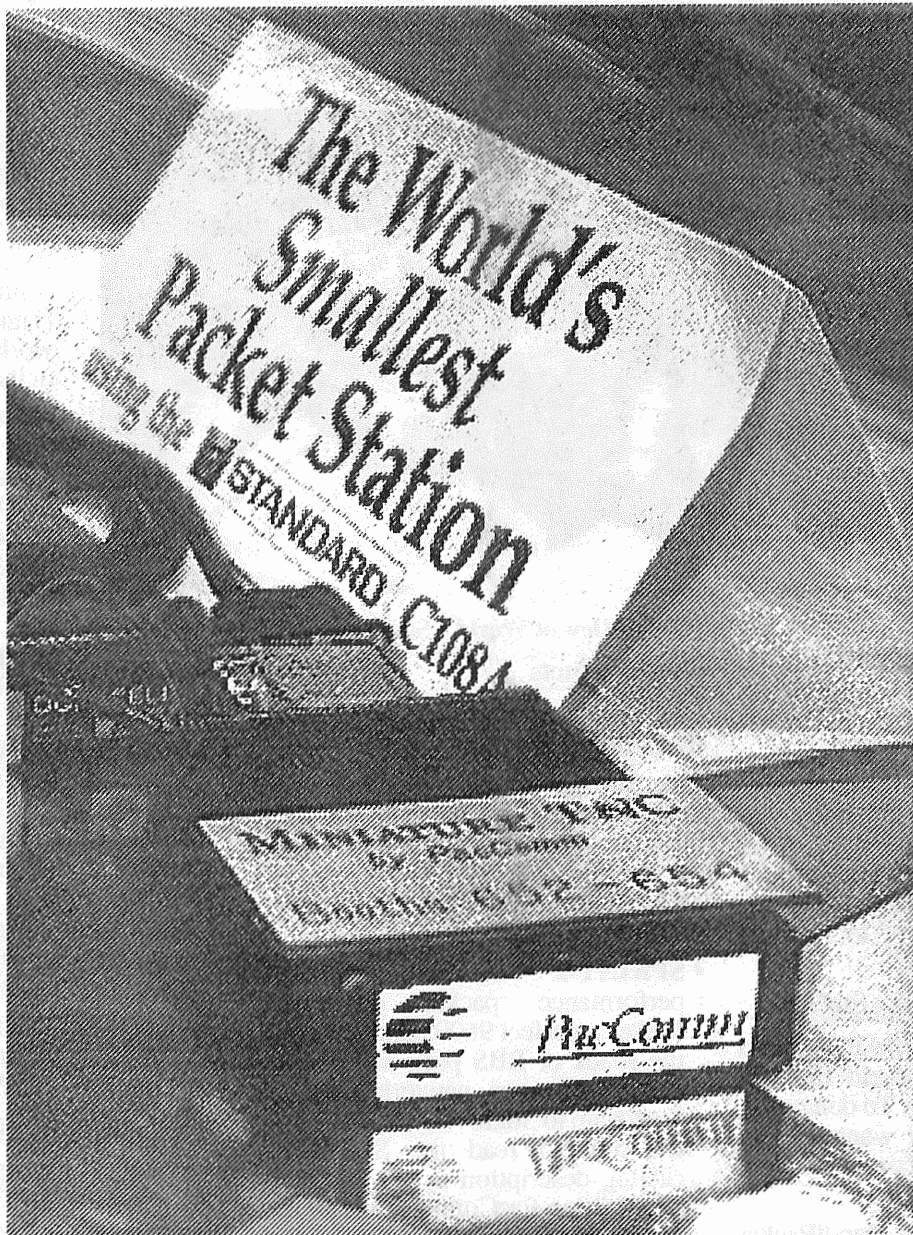
PacComm

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Thank you for your interest in PacComm amateur radio products.

PacComm Packet Radio Systems has been designing and manufacturing a wide variety of wireless data communications equipment for the amateur radio and commercial markets since 1985. Tens of thousands of units are in use around the world in many diverse applications.

Some Interesting Stories

Tough Enuf!

David Chesser, KA9NHL, tells this fascinating story about a PacComm HandiPacket.

Seems David's group likes to launch high altitude balloons - big ones. Recently they launched one which had the lift to carry an 8mm video camcorder, GPS receiver, 440 MHz radio and packet TNC (the HandiPacket).

The balloon was tracked well by the MacAPRS program to an altitude of 86,000 feet, whereupon it burst and decended some 14 miles at terminal velocity.

What was left? The camcorder was smashed, the 440 MHz radio was badly battered. The GPS circuit board was broken in half.

As for the HandiPacket: Upon removing the case the EPROM body was found with the pins sheared off. After removing the pins from the socket a new EPROM was installed and the HandiPacket came right to life and worked perfectly.
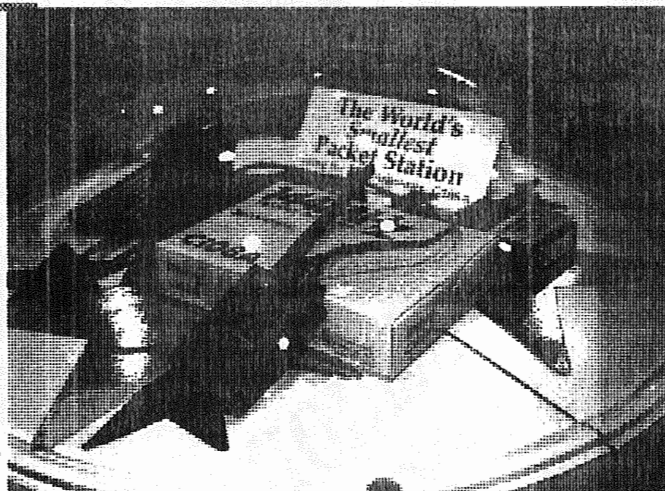
World's Smallest Packet Station

Standard Communications introduced a super-miniature handheld radio at Dayton this past Spring. To demonstrate how small it is, they wanted to put together a very compact packet station.

They were aware of the HandiPacket on the MIR Space Station and called PacComm to see if a HandiPacket would be available for use in their display.

Instead Bob Klock in our Engineering shop custom built a 1200 baud AX.25 TNC in a case only 2.5 x 4.0 x .75 inches using some of our commercial surface mount boards.

Standard teamed it with a Hewlett-Packard HP-100 palm-top computer and their new C108A radio and put the entire thing under a plastic dome in their display.

In order to better identify our TNC, we had a callsign badge vendor make a nameplate with the words, 'Minaiture TNC by PacComm.' As you see in the cover photo, the name badge was larger than the TNC!

Total View of World's Smallest Packet Station

New Products

Continuous product improvement is the policy at PacComm.

Since our last catalog we have re-written several product manuals in a new, clearer style, updated the circuit boards for the TINY-2, MC-NB96, AD-4, SPRINT-2, as well as bringing out new products.

- **SPRINT-2** - A low cost, high performance packet controller. Makes a perfect 9600 baud TNC for the shack or BBS port, and can be configured as a network node at speeds up to 56kb.
  Be sure to read the SPRINT-2 catalog description to see just how much value PacComm offers in the lowest priced 9600 baud TNC!
- **SPRINT-2/RF** - A SPRINT-2 with built-in radio. 9600 and 19.2 kb off the shelf. (Available soon).
- **PacketPet for Windows** - A flexible, friendly Windows program for packet and PacTOR.
- **TINY-2/GPS** - A TINY-2 MK-2 TNC with GPS receiver mounted

internally. Ready to take on your sailboat! Now switchable between GPS and terminal.

- **AD-4** analog-to-digital converter board to fit TheNet X1J Node sites and all PacComm TNCs with Release 3.3 firmware. Measure received signal deviation and strength, voltage, temperature, etc. and transfer the readings over the packet network.
- The **CoaxLAN** is now available in two models to better support both ROSE and TheNet nodes. An RS-232 model to connect to the DataEngine ® is in the works for release later in the year.
- An accesssory is now provided for APRS users: the **APRS hardware single port switch.** This allows both a TNC and GPS to be attached to the same port of a laptop computer and controlled by the APRS program on the computer.
- The **TINY-2 MK-2** has been updated. A few of the new features are: Jumper selection of bank switching for TheNet and ROSE, mounting holes and connection pads for an integral GPS receiver, EPROM switch may be configured to switch the serial port between GPS and terminal functions.
- The **MC-NB96** has been redesigned to allow operation up to 57,600 bd just like the SPRINT-2.

New Firmware Features

- Expanded GPS support works with all NMEA- 0183 capable GPS receivers. Any NMEA string may be selected and transmitted by a variety of methods.
- Users of ROSE networks will find a new connection macro very convenient. Simply enter (one time) the call of your local ROSE switch into MYROSE, then a connect command will take the form C callsign @ address.

- PacComm firmware is now available for upgrading the **Heathkit Pocket Packet.** See the PacComm Firmware page for more details.

PacComm commercial products of interest to amateurs

- Automatic Vehicle Location Modems. With PacComm's extended GPS command set in commercial firmware releases, automatic vehicle location systems are increasingly using PacComm commercial products. TNCs with built-in GPS receivers and radios are our speciality.

- The _new_ PacComm Wireless Modem- Our new Super TNC. Features fast 80182 processor, multiple serial ports (one dedicated to a GPS receiver), and MX-589 LSI high speed radio modem chip with software selectable baud rates from 300 to 38400 baud. The optimum filter is switched in circuit for each data rate. A low power/sleep mode cuts standby power to almost zero.

- Minimum Shift Keying (MSK) adapter, model -24M. The most convenient way to higher speed packet without doing radio modifications. Not compatible with previous 2400 baud modem designs by other manufacturers. PacComm now offers the latest MSK technology on a simple modem disconnect header board to fit your TNC-2 clone.

- Dumb modems - Sometimes all that's required is the transition from RS-232 signals to audio tones (with the protocol handled in the host computer(s)). PacComm has a range of modems for both RS-232 and TTL, both encased and circuit board-only models giving you radio control over the port. Models for AFSK & MSK, TTL, RS-232, & RS-422, and both asynchronous and synchronous serial connections.

- DGPS - PacComm now supplies many dedicated Differential GPS links to the commercial world. Watch for DGPS to come down into the amateur price bracket!

PacComm's New Telephone BBS

PacComm's landline BBS is now running Wildcat version 4 software. We have a number of product files, help files, and interesting shareware programs available.

You may place credit card orders via our BBS.

Ordering Information

We gladly accept telephone orders during normal business hours, Monday through Friday, 6 am to 6 pm Eastern Time. Our numbers are listed below, and on the catalog order form and on the back of the catalog.

We accept the following major credit cards:

- MasterCard
- VISA
- Discover
- American Express
- Diners Club.

Credit card orders must include card number, card holder's name, card type and expiration date.
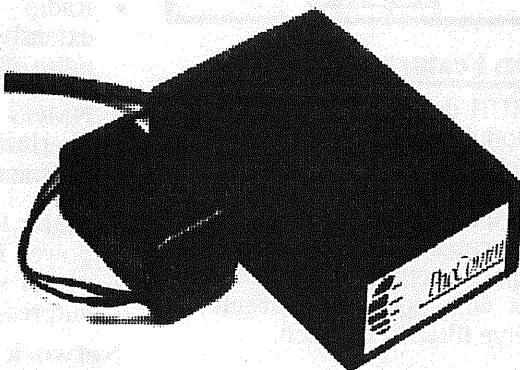
Bank checks, money orders, and direct wire transfers are also accepted.

We are happy to ship COD within the United States.

International Orders

PacComm will gladly ship orders to any country (other than those prohibited by US government technology regulations). The following international terms apply:

All orders must be pre-paid by money order, wire transfer or credit cards listed above. For information on wire transfers, please contact the PacComm Sales Office.

For international orders we normally ship via Express Mail or Air Parcel Post. Shipping costs are on an order-by-order basis. Federal Express or DHL shipping on special request.

PacComm TNC and 9 Volt Battery
Used in the Standard Communications's Ezhibit

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The SPRINT-2 High Performance Packet Controller

PacComm announces the SPRINT-2 High Performance Packet Controller, a new third-generation packet controller designed for the second decade of packet.

The SPRINT-2 is the ideal TNC for the modern (9600 bps & faster) packet station & for BBS, satellite and NODE use.

The SPRINT-2 is built for reliable high performance, yet is very affordable.

Uses reliable, tested technology (G3RUH modem, TNC-2 CPU architecture) with large-scale programmable logic circuits to reduce cost for solid, reliable performance.

Firmware Features

PacComm firmware uses TAPR style commands with many PacComm extensions and improvements, including KISS (see PacComm firmware page for more details).

- Special command set to support Global Positioning System (GPS) receivers. APRS compatible.

- Special commands support Deviation meter and Signal Strength accessory board (see AD4 page).

- Personal Message System features forwarding, reverse forwarding to other PMS & to BBS. Forwards via network connections or directly. Many powerful features.

Digital Section Features

- 512kbit (64k Byte) EPROM.

- 128k RAM provides 64k of Personal Message System storage and large send and receive buffers.

- TNC-2 compatible design works with any TNC-2 EPROM.

- Bank-switching circuit for TheNet. Ready to run TheNet X1J or later EPROM.

  » No wiring modifications required, just set jumpers.

- 9.8 MHz CPU clock speed and 10 MHz rated parts are standard. 20 MHz CPU option.
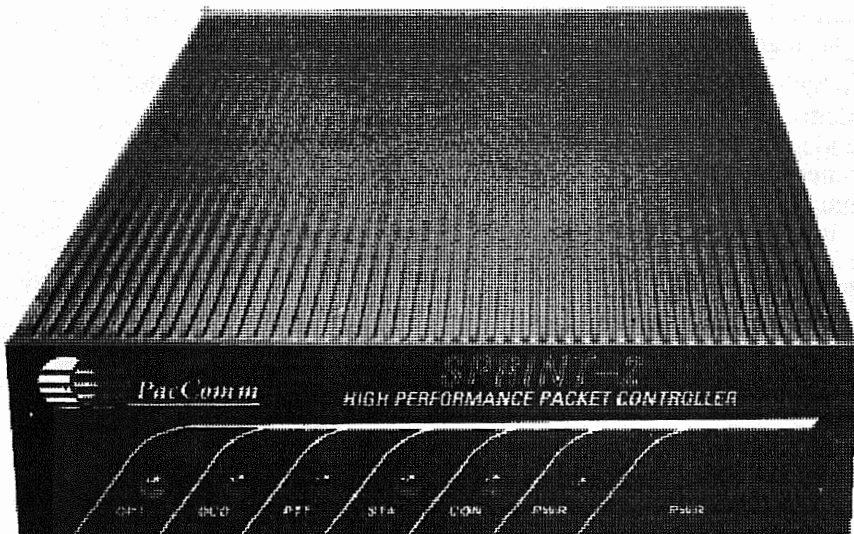
The PacComm SPRINT-2 Packet Controller

- Terminal baud rates from 9.6 kb up to 57.6 kb for satellite file downloads without dropped frames.

> FAST
> POWERFUL
> RUGGED
> RELIABLE
> QUIET
> SENSITIVE
> EXPANDABLE
> INEXPENSIVE
> **THIS IS NOT A TOY TNC!**

Modem Features

- G3RUH design modem with PLL demodulation for outstanding performance.

- Two independent modem transmit and receive filter sections to allow jumper selection of two radio baud rates with optimum transmit and receive filtering for each.

- Radio baud rates from 4.8 kb up to 57.6 kb are supported for fast satellites and network node use.

User Features

- Six LEDs. Power (red), Connect (green), Status (yellow), Push to Talk (red), DCD (green) and OPT (a multi-purpose dual color LED).

  » When used with the CoaxLAN, red and green indicate transmit and receive data on the LAN.

- Black anodized aluminum case; rugged, attractive, and RFI/EMI resistant.

- Extensive RFI/EMI filtering. This is a quiet TNC!

Reliability Features

- Radio and serial port lines extensively filtered against RF and noise effects.

- NMOS (not CMOS) RS-232 interface ICs for increased resistance to voltage spikes.

- Major RS-232 and radio lines and power feed are protected against power spikes with on-board surge surpressors (Transorbs).

Network Features

- TNC-2 EPROM compatible, TheNET X1 ready, Processing

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power and modem performance for serious throughput.

- PacComm's CoaxLAN circuit is built in for easily interconnecting multiple SPRINT-2s for node stacks. Works with NET/ROM, TheNET, and ROSE. No more need for diode matrices!

  » Interconnect the SPRINT-2 to TINY-2 and MFJ node units by adding CoaxLAN adapters to those TNCs' TTL ports.

Standard and Optional Accessories

The SPRINT-2 is delivered with:

- Operating Manual and 'Quick-Start Card' (Standard and Satellite models only).

- Hardware Manual with all schematics

- Computer cable to fit 9 pin PC serial port.

- Unterminated radio cable.

- Power supply (120vac to 12vdc) and cable.

- Accessory socket cable plug.

SPRINT Models

The SPRINT-2 is offered in four configurations: Standard model for ham shack and BBS use, Satellite model, Node model, and a 20 MHz Backbone model.

Standard Model

- 128k RAM.

- PacComm firmware including PMS.

- Main modem filters configured for 9600 bps and auxiliary modem filters unconfigured.

Satellite Model

- 128k RAM.

- PacComm Firmware.

- Modem configured for 9.6 and 38.4 kbps.

Node Model

- 32k RAM.

- Blank 27C512 EPROM (factory burned TheNet X1J or ROSE at $15 extra - please specify all parameter defaults required).

- Modem configured for 9.6 and 38.4 kbps. Other speeds upon request.

Backbone Model

- 32 k 70 nanosecond RAM.

- Blank 27C512 55 nanosecond EPROM.

- 20 MHz CPU running at 19.6 MHz.

- Modems configured for 38.4 and 57.6 kb.

Custom RAM sizes, CPU speed and modem filters available on special order.

RF Baud Rate vs. Bandwidth in the SPRINT-2 implementation of the G3RUH Direct FM Modem

4.8 kb	8 kHz
9.6 kb	15 kHz
19.2 kb	30 kHz
38.4 kb	60 kHz
57.6 kb	90 kHz

Product -> Feature	SPRINT-2 (Standard)	TINY-2 MK-2	MICRO PWR-2	TNC-NB96	Handi Packet	TNC-320	PC-320	PSK-1T	PSK-1	PacTOR	PC-120/PC
Purpose	High Speed DFM Packet	1200 Bd AFSK	Low Power 1200 Bd AFSK	1200 AFSK & 9600 DFM	Portable 1200 Baud AFSK	300, 1200 Baud AFSK	300, 1200 Baud AFSK	1200 Baud PSK & AFSK	1200 Baud PSK	100-200 Bd PACTOR AMTOR	1200 Baud AFSK
CPU/Speed	84C00/10 (20 MHz opt)	86C00/5 (10 MHz opt)	84C00/5 (10 MHz opt)	84C00/5 (10 MHz opt)	84C00/5 (10 MHz opt)	85C00/5 (10 MHz opt)	84C00/5 (10 MHz opt)	84C00/5 68HC11	68HC11	84C00/5	None
HDLC	84C40	84C40	84C40	84C40	85C30	8530	8530	84C40	-	MK3801	8530
Base RAM (battery backed)	128k	32k	32k	32k	32k	32k	32k	32k	32k	32k	None
RAM Expandable	No	MEM EXP	MEM EXP	No	No	MEM EXP	MEM EXP	No	No	No	N/A
Personal Message System	64k	12k	4k w/printer	12k	15k	11k	11k	No	12k	Mailbox	N/A
GPS Firmware Support	Yes	Yes	Yes	Yes	Yes	Partial	Partial	Yes	N/A	No	N/A
Modem Disconnect	Yes	Yes	Yes	Yes	Non-TAPR	Yes	Yes	No	N/A	No	Yes
Printer Port	No	No	Option	No	No	No	No	No	No	No	N/A
TTL Serial Port	No	Yes	Yes	No	No	No	N/A	No	No	No	N/A
Serial Port Speeds	4800-57600	300-38400	300-38400	300-38400	300-19200	300-19200	300-19200	300-38400	1200-9600	1200-9600	N/A
Radio Port Speeds (standard modem bypassed)	4800-57600	300-38400	300-38400	300-38400	300-19200	300-19200	300-19200	300-38400	300-1200	N/A	300-115300
Internal Battery Pack	No	No	No	No	10 Hrs	No	No	No	No	No	N/A
Cables & PS Provided	Yes	No	No	Yes	Yes	No	No	Yes	Yes	Yes	Cable
AD-4 Option	Yes	Yes	Yes	No	No	Yes	Yes	No	No	No	No
CoaxLAN	Built-In	Yes	Yes	No	No	No	No	No	No	No	No
Real Time Clock	Yes	Yes	Yes	No	No	Yes	Yes	No	No	No	N/A
Internal GPS Available	No	Yes	No	No	No	No	No	No	No	No	N/A
GPS Firmware Support	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	N/A
TheNet Firmware Compatible	Yes	Yes	Yes	Yes	No	No	No	Yes	N/A	N/A	Yes
ROSE Firmware Compatible	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	N/A	Yes
KISS for TCP/IP, PB, PG	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No
WA8DED Host Mode	No	Yes	Yes	Yes	No	No	Yes	Yes	Yes	No	No
Size (mm)(HxWxL)	33,125, 236	33,125, 188	33,125, 188	45,150, 188	33,65, 118	45,150, 188	19,127, 273	45,150, 188	45,150, 188	45,150, 188	Half-card
Size (inches)(HxWxL)	1.3,4.9, 9.3	1.3,4.9, 7.4	1.3,4.9, 7.4	1.8,5.9, 7.4	1.3,2.55, 4.65	1.8,5.9, 7.4	0.8,5, 10.8	1.8,5.9, 7.4	1.8,5.9, 7.4	1.8,5.9, 7.4	"
Weight (grams)	737	510	510	935	340	765	255	963	793	652	180
Weight (Ounces)	26	18	18	33	12	27	9	34	28	23	7
Power Consumption (mA)	350	55	40	100	50	320	100	220	180	200	0.5W
Price	$225	$149	$175	$295	$229	$195	$195	$375	$235	$285	$99

PacComm's Family of G3RUH Modems

PacComm has been producing modems based on the famous G3RUH design since 1988. This modem is used on many of the amateur satellites and is the standard for amateur radio 9600 bd operation. The G3RUH design is compatible with the K9NG design pioneered by TAPR and with recent single chip modems using the same modulation scheme.

For years we have called our line of direct FM (DFM) modems "The PacComm Narrowband 9600 Packet Radio System," or NB-96 Series.

So while our system name refers to a particular data rate, please keep in mind that the G3RUH design is highly effective from 4800 baud to 64kb and above.

Times are changing. You can now get several "off-the-shelf" 9600 baud capable radios from major amateur manufacturers, and higher speed radios can't be far away. The Phase 3D satellite will offer up to 56kb digital channels!

Bandwidth

The NB-96 modem operated at 9600 baud complies with FCC bandwidth limitations on the 6 and 2 meter amateur bands as well as higher frequencies.

Digital generation of the transmit audio waveform allows very tight control of the transmit audio bandwidth.

Bandwidth at various Data Rates

Baud Rate	Deviation	Bandwidth
4800	+/- 1.5 kHz	8 kHz
9600	+/- 3 kHz	15 kHz
19200	+/- 6 kHz	30 kHz
38400	+/- 12 kHz	60 kHz
57600	+/- 18 kHz	90 kHz
64000	+/- 20 kHz	100 kHz

Technical Specifications

* NOTE: The modem connects directly to the radio's varactor and discriminator and may not be suitable for all radios.

* The transmit modulator uses an 8 bit digital F.I.R. transversal filter in EPROM for waveform generation. Typically -6 dB at 4800 Hz, -50 db at 7500 Hz.

* Deviation of +/- 3kHz gives a bandwidth under the 20 kHz required by the FCC at the -60dB point.

* Output adjustable 0-8V p-p.

* 17 bit maximal length LFSR scrambler, jumper selectable data or bit error rate test mode.

* Discriminator audio input, 50mV to10V peak-to-peak. 3rd order Butterworth filter, 6kHz. Data Detection (DCD) circuit. Independent un-scrambler.

* Clock recovery circuit average lock time is 5 ms (50 bits.)

* The only set-up adjustment is Transmit Audio level.

MC-NB96 Internal DFM Modem Card

The MC-NB96 internal modem card is designed to attach directly to the TAPR style modem disconnect found on all PacComm and other quality TNCs.

Combine it with the TINY-2 MK-2 Node for an economical 9600/19200 bps network link.

Also fits all all PacComm TNCs, all TNC-2 derivatives and TNC-2 compatibles with a modem disconnect header.

The low cost alternative for upgrading existing 1200 baud network links to 9600 bps or 19200 bps or higher.

The MC-NB96 has been engineered to offer the features shown below. It has been tested with excellent results at over 100k bps.

* All baud rate sensitive components mounted on a plug-in header. **NEW!** Header now contains 14 components for optimum operation up to 56kb.

* Transmit and receive sections are isolated for superior full duplex performance.

* Transmit and receive voltage references are separated and Zener diode stabilized.

* **NEW!** Transmit audio may be enabled or disabled during receive operation.

* An on-board DCD LED makes troubleshooting convenient.

* The DCD signal may be jumpered to be active high or low.

* DCD circuitry provides a stable DCD indication.

* **NEW!** Receive audio may be gated by the DCD signal or run continuously.

* Comprehensive bypassing and a large ground plane make the board very quiet.

Radios and Filters

PacComm offers TEKK KS-900 and KS-960 telemetry radios with optimum filters installed for 9600 or 19,200 bd. These perform better than the standard units.

* KS-900L-D96 w/'D' filter, wide 21.4 filters

* KS-900L-D192 w/'C' filter, wide 21.4 filters

* KS-960L-D96 w/'D' filter, wide 21.4 filters

* KS-960L-D192 w/'C' filter, wide 21.4 filters

We also sell separately the good digital filters used in the above radios for those amateurs who wish to modify their own radio.

* Digital 'C' filters for 19.2 kb
  +/- 12.5 kHz @ -6 dB; +/- 30 kHz @ -50 dB
        Part # SFH455C

* Digital 'D' filters for 9.6 kb
  +/- 10 kHz @ -6dB; +/- 25 kHz @ -50 dB
        Part # SFH455D

* Monolithic 21.4 MHz digital filters
        Part # MCF21.4F30B

The TNC-NB96 is PacComm's dual speed TNC - it does both 1200 baud AFSK and 9600 baud DFM. The ideal TNC for the modern packet station.

The TNC-NB96 is a TINY-2 MK-2 TNC with open squelch adapter mounted in the same case with PacComm's DFM-SA modem board. All connections between the two units are made inside the case, so only the connections to the radio and computer are needed.

9600 baud signalling over an RF circuit is not 'a piece of cake' and care must be taken to use the best circuit possible. The modem uses the G3RUH design for outstanding performance.

The modem board in the TNC-NB96 also provides a radio and modem switching circuit which makes operation in the shack very convenient. A front panel push button switch selects between 1200 AFSK, 9600 DFM, 1200 baud PSK (if PSK-1 is attached) and the fourth selection is whatever modem is connected to the rear-panel modem accessory connector. Once you make up and install the cables, only a button push is needed to switch between modes.

PacComm The TNC-NB96 is the perfect companion to the PSK-1 Satellite Modem. The switching circuitry in the TNC-NB96 and the PSK-1 operate together to allow access to the 1200 bps Microsats and the 9600 bps PacSats through the same multimode transceiver. No cable changing is required with most radios to change between 1200 bps AFSK or 1200 bps PSK terrestrial packet and 9600 bps or 1200 bps AFSK/PSK satellite operation. A photo of the pair appears on the PSK-1 page.

Rear panel accessible enhanced TAPR modem disconnect header allows all TAPR and PacComm compatible expansion cards to be fitted in moments. 9600/19.2kBd modem cards, for example.

The TNC-NB96 has all of the features specified in the TINY-2 MK-2 description elsewhere in this catalog.

More information about the modem performance is presented on the previous page.

GPS (Global Positioning System)
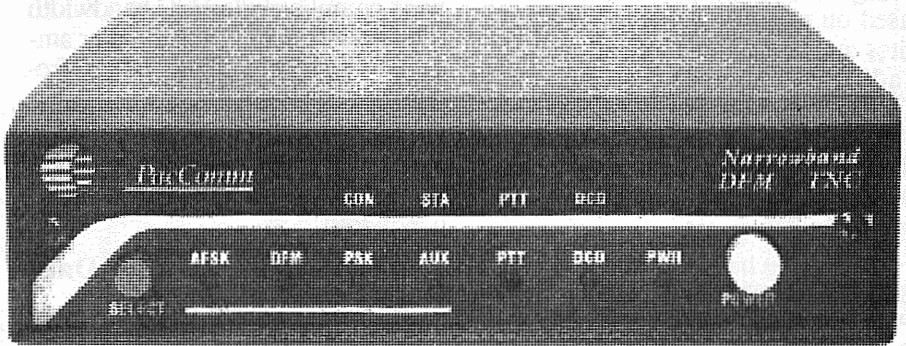
firmware supplied as standard. Switch from using your TINY-2 as a regular TNC to a remote vehicle tracker by executing one simple command. NMEA command structure compatible. Uses any NMEA GPS output string to place latitude, longitude and satellite availability into CText, PText, SText, etc.

- 32k non-volatile RAM. Provides over 14k message storage. LED Message waiting indicator.

- Rugged extruded case -The TNC-NB96 case measures 6 x 7 x 1 7/8 inches. Grey epoxy finish. Weight 35 oz. (1kg).

- Serial rates of 300 to 38.4k baud, jumper selected.

Shipped with all interconnecting cables, power cube, new User's Manual, Command Reference Card, and complete schematic diagrams.
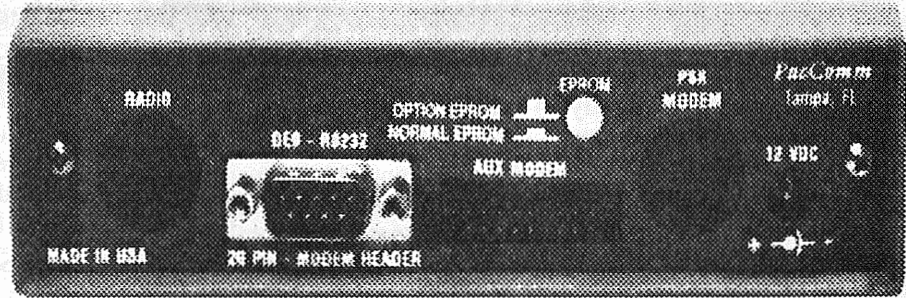
- 64kB EPROM contains two 32kB EPROM images (selectable by rear panel switch).

- PacComm's latest firmware including PacComm's famous Personal Message System local mailbox.

- WA8DED host mode or second language option (French, Spanish, etc. on special order).

- Multicolored LED's - PWR (Power), CON (Connect), STA (Status), Push-to-talk (PTT), Data Carrier Detect (DCD).

TNC-NB96 Review in QST

QST published a review of PacComm's TNC-NB96 in the September 1994 issue.

The review emphasized the good performance of the TNC and the features offered which are not available on other units.

There was only one negative comment - the manual was not clear and helpful.

So, we have completely rewritten the manual and think you will find it to be most helpful and easy to read.

IPR-NB96 Packet Radio

The IPR-NB96 is the most convenient way to begin 9600 bps operation. The TINY-2 MK-2 TNC, EM-NB96 modem and RF transceiver are already interfaced and tested. It is only necessary to attach power, computer cable, and antenna.

The IPR-NB96 consists of a TNC-NB96 (TINY-2 MK-2 and EM-NB96) packaged with a 70 cm. RF data transceiver.

You get 9600 baud on 70 cm, and can select 1200 baud operation using your existing 2 meter radio with the push of a button.

The TINY-2 MK-2 TNC in the IPR-NB96 has all of the features specified in the TINY-2 MK-2 description elsewhere in this catalog, including the dual-image EPROM and Personal Message System.

The 'Open Squelch' DCD is included as a standard feature (except the NODE model).

The IPR-NB96 case measures 7 x 7.3 x 2.4 inches.

- Can be configured for 1200 or 9600 bps at power-on.

- Uses the TEKK KS-900L 2 watt 70 cm data transceiver

- Ready to attach to computer or terminal and antenna

- Commercial Grade, Type accepted for commercial use

- Crystal Controlled - 70 cm

- Two watts output @ 9.6 vdc

- 0.35 dB SINAD Sensitivity

- Rise time < 8 ms

- Operating temperature range: -30 to +60 degrees Celsius
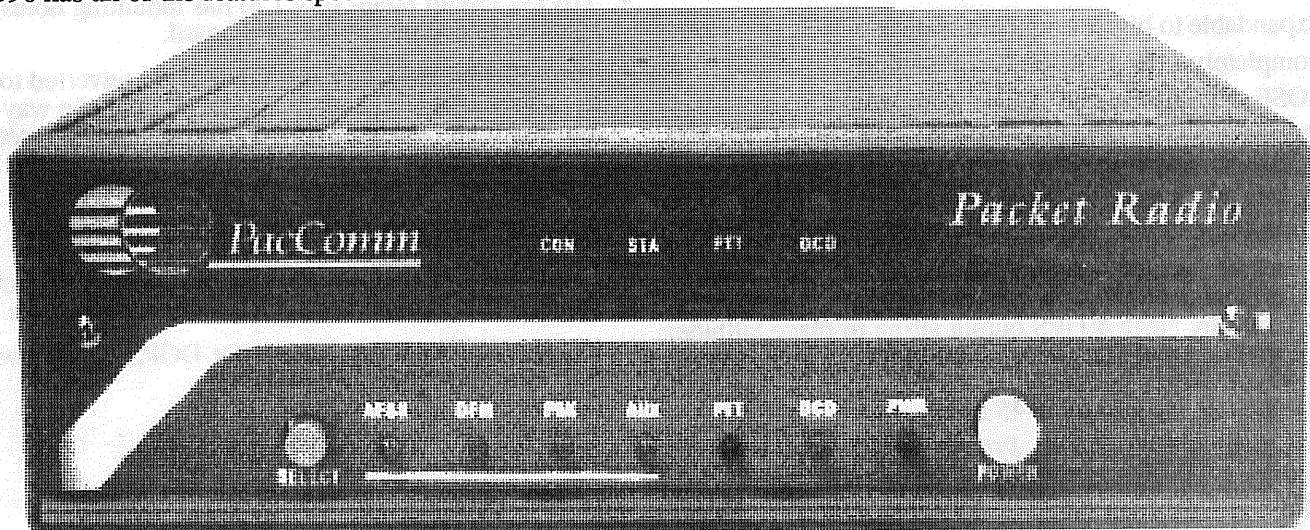
Packet Radio (approximately actual size)

'Open Squelch' Digital DCD Adapter

The PacComm DCD Board is based on a design by Eric S. Gustafson, N7CL. This digital DCD circuit allows the radio to be operated unsquelched by generating a DCD signal only when a packet signal is present.

Unsquelched radio operation is useful when the radio has slow, insensitive squelch action or poor hysteresis. Weak signals are sometimes lost due to a slow opening squelch, and link throughput is reduced because longer transmit delay times must be used to wait for the squelch to open. Some squelch circuits can be fooled by even moderate amounts of noise or hash present in the IF.

The PacComm DCD is a surface mount card that measures 1.85" x 1.25" (47 x 38 mm) and can be ordered in three styles:
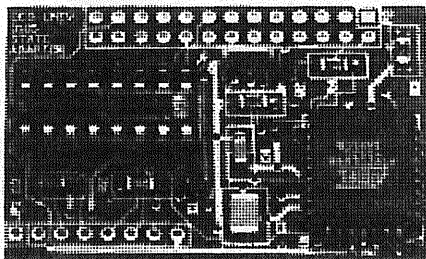
- DCD-3105. Plugs into the socket of a TCM3105 modem IC and carries the DCD-3105.

- DCD-Header. Plugs directly into the pins of a TAPR-style modem disconnect header (20 or 26 pin).

- DCD-Universal. May be integrated into other packet controllers (not limited to the TCM 3105 modem IC) by directly wiring to the circuit board and modem IC.

The DCD circuit is included in the HandiPacket, IPR-NB96, TNC-NB96 and PSK-1T.

- The most flexible, fully equipped low-cost TNC on the market. Over 18,000 in use worldwide.

- Ideal for the newcomer, but with expansion capability to grow.

- Easy to install. Setup and begin operation with less than 10 commands.

- Expandable to high throughput node use.

- Completely TNC-2 EPROM compatible.

- ROSE, NET/ROM and TheNet compatible.
  » Bankswitch jumper allows for no-soldering installation of network firmware.

- GPS (Global Positioning System) firmware supplied as standard.
  » Switch from using your TINY-2 as a regular TNC to a remote vehicle tracker by executing one simple command. NMEA command structure compatible. Uses any NMEA GPS output string to place latitude, longitude and satellite availability into CText, LText, SText, etc.

- Low power consumption: 45 mA.

- 32k non-volatile RAM. Provides over 14k message storage. LED Message waiting indicator.

- 64kB EPROM contains two 32kB EPROM images (selectable by rear panel switch).

- PacComm's latest firmware including PacComm's famous Personal Message System local mailbox.

- WA8DED host mode or second language option (French, Spanish, etc. on special order).

- Factory installed enhanced TAPR modem disconnect header allows all TAPR and PacComm compatible expansion cards to be fitted in moments. 9600/19.2kBd modem cards, for example.

- Higher speed clock options. When channel occupancy is high (Node use) or data speed is 9600Bd+, the TNC may be simply upgraded to 9.8MHz from 4.9MHz (parts available).

- Optional Open Squelch (Digital DCD) Adapter, Hardware (Real Time) Clock, 9600 (and higher) bps DFM modem. RAM Expansion available with firmware release 3.3.

- Multicolored LED's - PWR (Power), CON (Connect), STA (Status), Push-to-talk (PTT), Data Carrier Detect (DCD).

- Rugged extruded case - 5 x 7 x 1 3/8 ins (130x180x35mm). Grey epoxy finish. Weight 18 oz. (500g).

- Both TTL level and RS-232 level serial ports to computer/terminal. An eight pin push-on connector is provided for TTL connections.

- Serial rates of 300 to 38.4k baud, jumper selected.

- Comprehensive User's Manual, Quick Start Card, Command Reference Card, Complete Schematic Diagrams.

TINY-2 MK-2/GPS

Want to experiment with Automatic Position Reporting System (APRS) tracking of your boat or vehicle? The TINY-2 MK-2/GPS integrates a Trimble SVeeSix OEM GPS module inside the TINY-2 case for convenient and troublefree operation.

Note: Brand and model of GPS receiver in the TINY-2 MK-2/GPS is subject to change without notice or obligation.

- TINY-2 circuit board (rev 1.8) has mounting holes and signal connections for the GPS board.

- The EPROM switch on the TINY-2 is converted to use as a Terminal/GPS switch. Set the switch one way and you can program the TINY-2 with commands, set the switch the other way and the GPS is connected and automatically updating the TINY-2 buffers.

- A differential GPS version available at extra cost.

- Comes with active 45 dB gain antenna (mag-mount) which makes it more sensitive than hand-held units.

- Unit monitors packet channel for DGPS updates while also transmitting its own position.
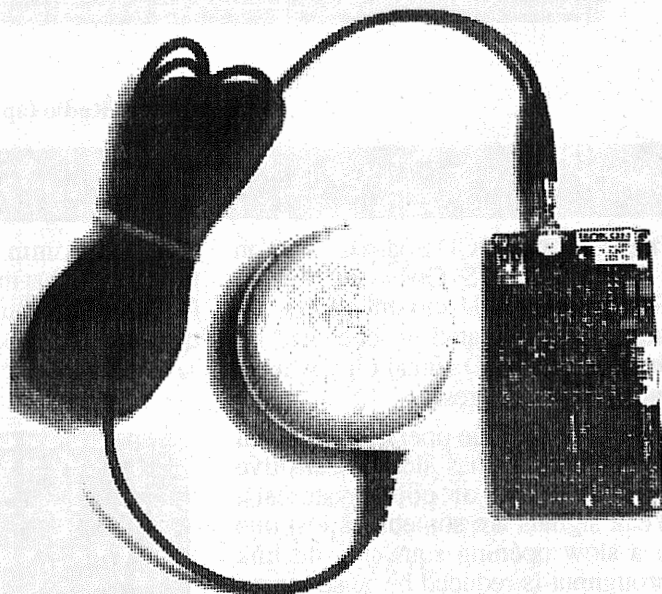
Trimble OEM GPS unit as used in TINY-2 MK-2/GPS

MICROPOWER-2 Features

- Extremely low current draw - 35-40 mA. @ 7.5-9 VDC
- Optional Printer port w/cable

Operates any parallel printer

Also serves at remote I/O port

- Optional Real-time hardware clock
- OptionalOpen Squelch DCD adapter
- Optional low power memory expansion increases PMS to 64k
- Standard PacComm firmware

TAPR style commands

KISS mode

WA8DED host mode

Personal Message System with reverse and manual message forwarding

- TNC-2 EPROM Compatible
- ROSE, NET/ROM, TheNet compatible, no modifications
  » TheNet bankswitch ready
- 6 MHz CMOS Z-80 CPU and SIO (HDLC), 4.9 MHz clock
- 64K EPROM and 32K RAM
- Modem disconnect for use with external modems is factory installed
- Subminiature red LEDs
  » Power, Connect, Status, PTT, Carrier Detect
- RS-232 and TTL computer ports
- Extruded aluminum case with baked-on gray wrinkle finish.
  » 5 x 7 x 1 3/8 inches, 18 oz.
- 30 day return privilege
- One year factory warranty
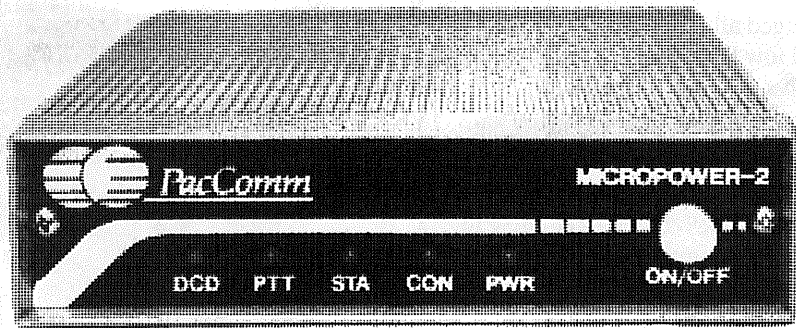
The MICROPOWER-2 is a 1200 baud AFSK packet controller optimized for very low power consumption.

It is ideal for use as a solar powered digipeater or node, or for any type of portable operation where power consumption is an important factor. It will operate from less than 9 VDC at under 40 milliamperes. It can be modified to operate from 5 VDC at about 30 mA.

A MICROPOWER-2 with the printer port option is ideal for dedicated use in emergency operations centers, emergency shelters, etc. It can attach directly to a parallel printer to provide error free printed messages without the need for a trained operator or a computer terminal.

The parallel port of the MICROPOWER-2 equipped with the PRINTER-REMOTE I/O option provides the capability for remote control of attached devices using packet commands. For example, this powerful feature may be used to monitor and control battery voltage at a repeater site and to reset a repeater controller.

The PacComm Personal Message System (PMS) is a self-contained message system which is completely contained in the MICROPOWER-2 EPROM. The PMS allows the packet controller to support all standard packet functions while simultaneously allowing messages to be entered or read by an over-the-air user.

The Original TNC Powered by a 9V Battery
Gwyn Reedy, W1BEL

These days at Hamfests, when someone asks if PacComm has a 9V battery powered TNC, I tell them about our show display back in 1988 when the MICROPOWER-2 was introduced.

We put the MICRO-2 running on a 9V battery, and a hand-held radio and battery powered printer on an island in the isle by our booth. We printed messages from our booth base station. We had to change the radio and printer batteries, but the 9V on the MICROPOWER lasted the full two days.

The MICRO-POWER-2 is fully ROSE, TheNet, NET/ROM ©, and all TNC-2 compatible firmware. No trace cuts or additions, or component value changes are needed. Jumper settings allow implementation of bank switching without any modifications.

The KISS module in the EPROM supports TCP/IP, packet satellite programs, etc.

Each MICROPOWER-2 comes with a comprehensive Operating Manual, a Command Reference Card, and a Technical Reference Manual, and complete circuit schematics. Mating connectors for both the RS-232 and TTL computer connectors and the radio and power connectors are provided.
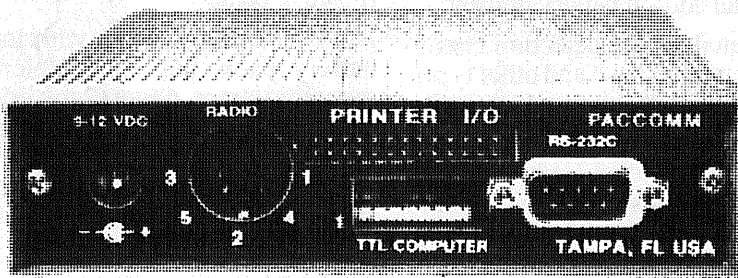
MICROPOWER-2 Rear View Showing Printer Port Connection

HandiPacket Features

- Rugged all-metal case for durability and low RF noise;
  1.28 x 2.55 x 4.15 inches.

- Built in heavy-duty 500 mAH battery pack. Up to 10 hours of operation between charges.

- LEDs and RS-232 voltages may be disabled for even longer battery endurance.

- Modem circuit features 'open squelch' operation for better performance in noisy conditions.

- Advanced Personal Message System with 15K Bytes of battery maintained message storage.

- GPS support - six GPS commands.

- Belt clip, Velcro (TM) mounting strap, and computer and un-terminated radio cables included at no charge. Battery charger is also included with North American models.

- Six LEDs - DCD, PTT, STA, CON, PWR, and Message Waiting. Standard DE-9 RS-232 connector.

- Eight pin MiniDIN radio/ external modem connector.

- Built-in circuitry to support hand held radio PTT circuits.

- AX.25 firmware including KISS and the advanced PacComm Personal Message System.

- 32K battery backed RAM, 4.9 MHz CPU clock speed, 6 MHz rated low power CMOS ICs.

Do you have a **Heathkit Pocket Packet** and wish you could get up-to-date firmware?

You Can! PacComm offers our latest firmware for the Pocket Packet.

The Russian Cosmonauts have been using an unmodified PacComm HandiPacket from the MIR space station since January 18, 1991.

When you connect to the MIR Station, just give the V command and see the PacComm message!

PacComm HandiPacket, approximately actual size

The popular truly portable packet controller.

- Ideal for portable or mobile operation.

- Take a self-powered packet controller wherever you go.

- A personal message system right on your belt!

- Set up an instant digipeater for emergencies.

- A reporting station at public service events.

- Use with a handheld GPS receiver and APRS software for an automatic position reporting system (see QEX February 94).

The HandiPacket provides unequalled performance and flexibility. Just compare the features of the HandiPacket with any other unit and you'll clearly see the superiority of the HandiPacket design. This is NOT a small desktop unit with an add-on battery holder!

Sophisticated carrier detection circuit ignores computer hash and other types of noise and interference which is the plague of portable packet operation.

Self-contained Nickel-Cadmium battery pack provides continuous operation of 10 hours on a single charge. Top panel DIP switches disable LEDs and RS-232 drivers for even longer battery life.

Externally accessable controls on the HandiPacket allow Microprocessor RESET and Transmit Level Adjustment. You should never need to open the case.

Uses CMOS 6MHz Z80 CPU and CMOS 8530 HDLC IC. EPROM is socketed to allow easy firmware upgrades. Modem uses TCM3105 modem IC.

The Personal Message System (PMS) is an advanced personal mailbox/mini-BBS. About 15k bytes of battery backed RAM are allocated for message storage in the HandiPacket. See the PacComm Firmware specifications page of this catalog.

Rugged all-metal case. DE-9 male connector for connection to computer or terminal. Eight pin Mini-DIN connector for radio interface cable. Battery charger & external power connector is a 2.1 mm coaxial socket (positive center).

All HandiPackets come with internal battery pack, belt clip, Velcro(TM) mounting straps, 6 foot (2 meter) radio cable with tinned leads, computer cable and battery charger. (Note: Battery charger is not included in export shipments due to varying line voltages and electrical codes).

Also included are a comprehensive Operating and Technical manual, circuit schematic and Command Reference Card.

PacketCluster ™ Support

PacketCluster has become one of the major amateur radio users of packet radio technology, along with BBS store and forward systems and network linking.

Historically the preferred PacketCluster set-up has most frequently been PacketCluster software, BPQCODE (G8BPQ network node software), DEDHOST (G8BPQ host mode driver), and a DRSI PC-PA card.

However, you'll note that G8BPQ says that a PacComm PC-120 can be used equally as well. (In fact, the 'BPQ' code was developed on the PC-120 and later ported to the PC-PA).

The PacComm PC-100

PacComm introduced the first PC plug-in card called the PC-100 back in 1986 . Later, the PC-PA came out based on the same concept.

Subsequently various models of the PC-100 series were marketed (PC-105, PC-110, PC-120), but never became as well known in the PacketCluster community as the PC-PA card.

The PacComm PC-120/PC

The PC-120/PC is a new variant of the PC-120 card especially configured for PacketCluster use. The HF modem is not fitted but the external modem connector is maintained for upgrading to 9600Bd radio ports. The VHF modem used is a TCM-3105 which has worked so well in the popular TINY-2.

The PC-120/PC card may be configured to use IRQ2-7 and will appear as a comm port to the PC. The card address may be set as needed for compatibility.

PacketCluster and BPQ see the card simply as a single incoming port of data.

BPQCODE, SYSOPH, DEDHOST and PACKCLUS are loaded in that order when the PC is booted.

As with other plug-in cards, you'll need one PC-120/PC per radio port of your PacketCluster installation.
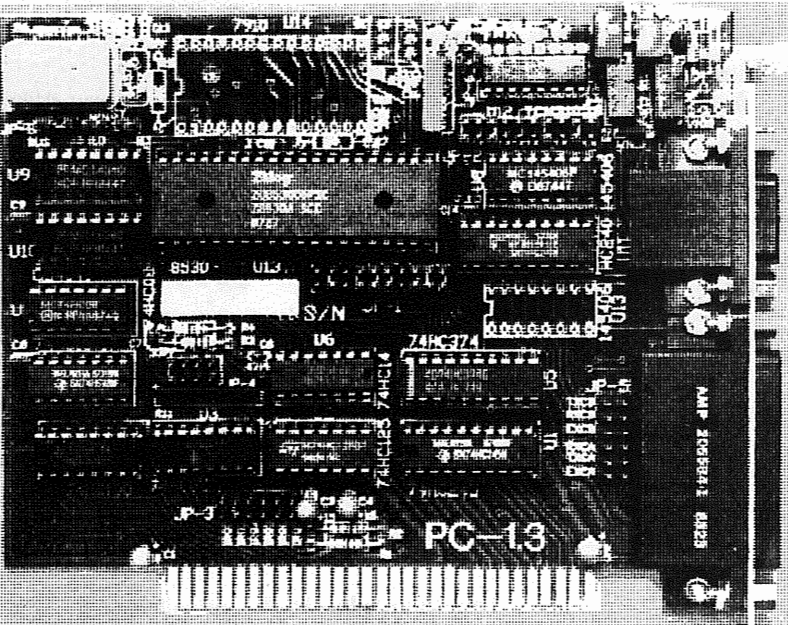
Availability

The PC-120/PC is in production now and there will not be any delivery delays.

Support

Each PC-120/PC comes with complete step-by-step instructions for first-time installation (alone or with a PC-PA card) or substitution for a PC-PA.

If you still have questions, call PacComm Technical Support for assistance.

Other Configurations

PacketCluster & BPQCODE can be used to talk KISS through serial ports to an external TNC (with suitable KISS code installed). Therefore, you may also use any of the following TNC's with PacketCluster ports:

SPRINT-2, TINY-2 MK-2, MICROPOWER-2, TNC-NB96, HandiPacket, etc.

Getting started - Packet Books.

We all know the initial excitement and frustrations of getting on packet radio. Here's a list of sources that might be able to help you:

Basic Packet Radio
Joe Kasser, W3/G3ZCZ) Software for Amateur Radio, POB 3419, Silver Spring, MD 20918 $29.95

PRIME-Packet Radio is made Easy
Buck Rogers, K4ABT $ 9.95

PROH -Packet Radio Operators Handbook
Buck Rogers, K4ABT $17.00

The Packet Radio Operators Manual
Buck Rogers, K4ABT $15.95

Getting started in Packet Radio
VHS Video $19.95

Your Packet companion
Steve Ford, WB8IMY ARRL $ 8.00

Your RTTY/AMTOR Companion
Steve Ford, WB8IMY ARRL $ 8.00
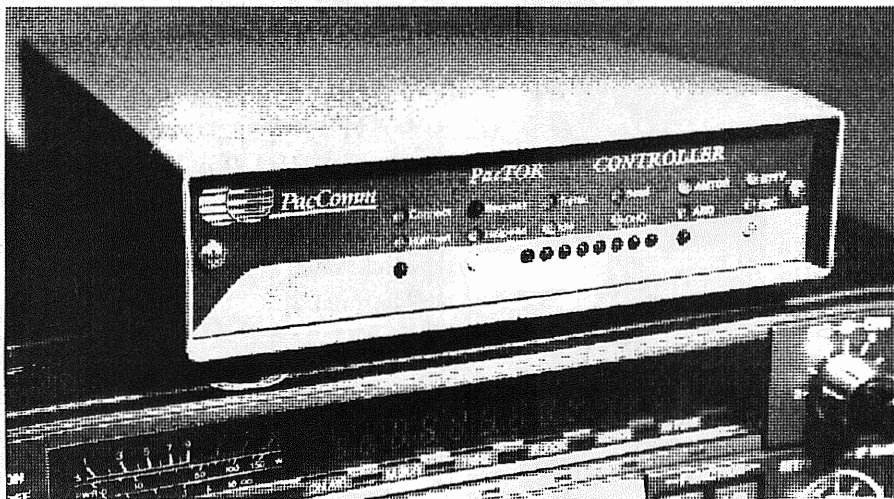
Your Gateway to Packet Radio
Steve Ford, WB8IMY ARRL $12.00

NOSintro: TCP/IP over Packet Radio
Ian Wade, G3NRW RSGB $23.00

We make no particular recommendations here on these sources. Try asking your friends which they feel is the best for your particular need.

PacComm's PacTOR Controller

What is PACTOR?

PACTOR is a robust ARQ radio-teletype mode developed by German amateurs, in particular DL6MAA and DF4KV. It was designed to overcome the shortcomings of packet and AMTOR in HF operation.

The AX.25 packet protocol works very well on VHF FM but suffers badly on HF. The 300 bps rate and large frame sizes commonly used by amateur packet operators are very succeptible to distortion by fading, multipath propagation and QRM. Secondly, the amount of non-data overhead in each packet transmission reduces efficiency.

AMTOR (based on SITOR) was specifically developed for HF radio text communication. Even during very poor signal-to-noise conditions a useable connection can be maintained when a packet connection would be impossible. However, 5-level code is used making binary data difficult to send and error detection is rather weak leading to 12% chance of bad characters. Effective throughput is only 35 baud.

PACTOR provides a more robust error correction scheme and better throughput than AMTOR. The synchronous transmission format and short frame size of AMTOR are retained for excellent performance under poor propagation. The result of this new protocol design is a hardware/software system which gives a four-fold throughput increase over AMTOR while continuing to be useable for typical ham QSOs as RTTY and AMTOR operators have become accustomed to.

PACTOR requires an HF radio capable of changing between transmit and receive modes in 130 ms. Any AMTOR capable radio will operate properly with PACTOR.

Call or write for additional technical information on PACTOR.

PacComm's PacTOR Controller

The PacComm PacTOR Controller is produced under license from the German developers. It uses the German firmware with all commands and messages in English.

The PacTOR unit also supports AMTOR and RTTY operation making it ideal for all data modes of HF operation. PacTOR will accept a call in either PACTOR or AMTOR and automatically respond in the correct mode.

PacTOR commands are similar to packet commands and are easy to learn and use. Complete amateur callsigns are supported.

An internal mailbox is accessible from either PACTOR or AMTOR modes. Many file and message handling functions are supported.

PacComm's PacTOR unit is capable of either 'high tones' or 'low tones.' Tone

- PACTOR, AMTOR, and RTTY modes, Packet option.
- Error-free data transmission including binary files.
- Up to four times faster than AMTOR.
- Complete ASCII character set, 8 bit data.
- Memory-ARQ <u>with analog to digital converter</u> restores bad data packets.
- On-line data compression.
- Automatic speed adaptation 100 or 200 baud data rates.
- UNPROTO mode (FEC).
- Listen mode to monitor PACTOR QSOs.
- CW Identification capability.
- Built in Message System.
- Automatic logbook function which is accessible over the air and locally.
- LED digital tuning display.
- 16 status LEDs.
- Selectable for either 'High Tones' or 'Low Tones' with proper filters.
- MeisterTerm terminal program included.
- VHF packet card may easily be added internally at low cost.
- <u>New, lower price!</u>

pairs are user selectable by internal jumper settings. <u>All</u> filters are adjustable for optimum performance at the tone frequencies selected.

PacComm's PacTOR however, is not an exact reproduction of the German hardware. In fact it is a complete redesign of that unit. Our unit has received excellent reviews from QST, QEX, Ham Radio Today (UK), RTTY Digital Journal, etc.

The modem section of our unit performs exceptionally well because of careful groundplane layout and lack of proximity to the digital section of the unit. This results in superior signal-to-noise performance and extended connects under adverse band conditions. PacComm's unit beats the others by at least 6dB in this respect.
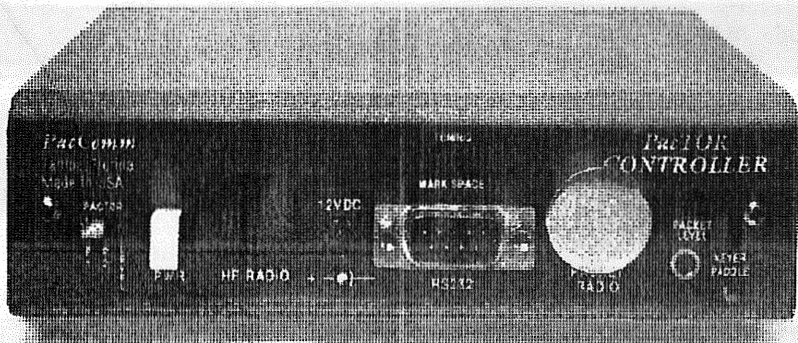
Terminal Program

PacTOR is designed to be used with conventional RS-232 ASCII terminals or personal computers running terminal emulator software.

PacComm supplies a diskette with each PacTOR unit which contains the Meister Term (MT) public domain terminal program specifically designed for the PacComm PacTOR unit.

PacComm's PacketPet for Windows terminal program also supports PacTOR usage. See the PacketPet page elsewhere in this catalog.

Packet Adapter

PacComm's PacTOR Controller may be fitted with an optional packet modem card to allow VHF packet operation as well as the HF modes.

The packet upgrade kit consists of a pre-assembled and tested packet modem card and a new PacTOR front panel (and new switch cap). Installation requires only a #2 Phillips screwdriver, and no soldering. (Early PacTOR boards require trace cuts).

The packet adapter provides a separate radio connector for a VHF FM radio. A push button selects packet or PacTOR operation. No cable changing is required.

See the following reviews of PacComm's PacTOR Controller.

– January 1993 issue of QST, New Product Review.

– February 1993 issue of Ham Radio Today (UK)

– November 1993 issue of the RTTY Digital Journal, page 18. "Review" by Phil Sussman, KB8LUJ

– March 1994 QST, page 67. "Plug into PacTOR".

Call or write PacComm for a reprint of these articles.

Memory ARQ

One of the key features of the PAC-TOR mode is Memory-ARQ. Copies of corrupted frames are saved and are correlated with frames received later.

The key to proper Memory-ARQ operation is having an analog to digital converter (ADC) - an item of hardware.

The ADC converts the actual strength of each received bit into an 8 bit value which is stored in memory for later comparison. Thus each bit can have an exact representation of its received value. If Memory-ARQ is attempted without the ADC, the value of each bit must be rounded down to a zero or up to a one to be stored and the 'marginal value' of the signal is lost.

Beware of cheap 'software only' PACTOR implementations. These include EPROM upgrades to older multimode TNCs. They are NOT recommended by the German inventors of PACTOR. Most anyone's implementation of PACTOR will work fine under good conditions. When the QRM is tough and the band is fading, the PacComm PACTOR will continue to decode signals too weak to hear. The 'software PACTOR' units will have long since lost the connection.

Doing it 'right' costs more, but the performance improvement is worth the cost.

PACTOR-II

PACTOR-II is a powerful protocol being developed by the developers of PACTOR. It will offer up to four times the throughput of PACTOR on HF using a sophisticated DSP modem.

The PACTOR-II Controller is a top-of-the-line multiport-multimode unit which can operate three ports simultaneously. PACTOR-II, PACTOR, AMTOR, RTTY, and both 1200 and 9600 baud packet are supported.

PacComm is licensed to produce the PACTOR-II design. Look for it to be available early in 1995. Cost will be in the $900-$1000 class.
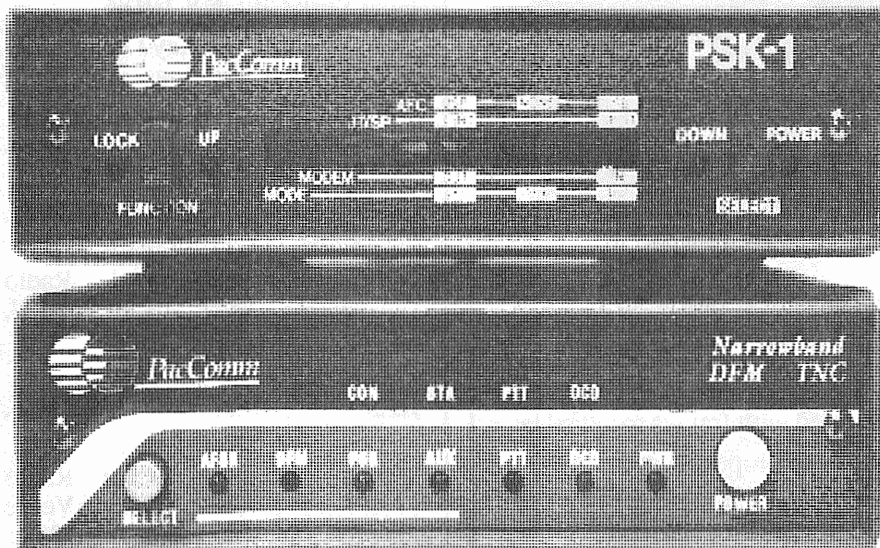
The PacComm PSK-1 Packet Satellite Modem

PSK-1 with Companion TNC-NB96

PSK-1 Features

– Converts standard 1200 baud AFSK TNCs to operate with packet satellites.
– Provides 1200 baud Manchester encoded AFSK output for satellite uplink.
– Decodes 1200 baud PSK signals downlink signals and 400 baud telemetry.
– Transmits and receives 1200 baud PSK for terrestrial use.
– All modes and functions selected by front panel push buttons, or by menus if computer control port is used.
– Switching between standard packet and satellite operation by push button or computer command.
– Assembled, tested, ready to use. All cables provided.
– Excellent sensitivity, wide range Automatic Gain Control circuit.

PSK-1 with companion TNC-NB96, showing easy interfacing.

– Automatically tunes downlink radio via UP/DOWN control lines to compensate for Doppler frequency shift. LEDs show signal lock and step-up, step-down pulses.
– LED bargraph displays proper signal tuning, also shows mode and functions selected.
– Rear panel connections: Uplink radio, Downlink radio, TNC radio port, TNC modem disconnect header, Telemetry and control port, power.
– Operating manual contains detailed installation and interface instructions.
– One year factory parts and labor warranty, 30 day return privilege.
– Power supply provided (North America only).

The PSK-1 Satellite Modem allows you to add packet satellite capability to your existing station. It can be used with most 1200 baud TNCs to provide access to the 1200 baud MicroSats and FUJI satellites.

Used with PacComm's TNC-NB96 (shown above) the PSK-1 allows access to all the current satellites, both 1200 and 9600 bps.

When the PSK-1 is attached to the PacComm TNC-NB96, 1200 bps AFSK (conventional packet), 9600 bps DFM (terrestrial or satellite), and 1200 bps Manchester AFSK/PSK (satellite) are each available at the push of a button (no cable swapping required).
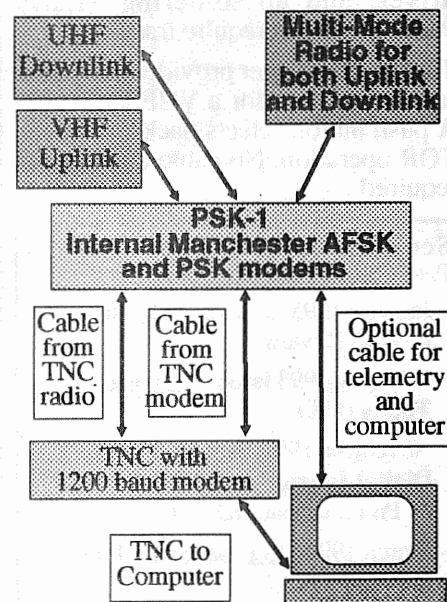
Cabling for PSK-1 and TINY-2 or other 1200 baud TNC

The PacComm PSK-1T Satellite TNC

Supports separate cables to receiver and transmitter, or one combined cable to a multimode radio.

UHF Radio → | Multi-Mode Radio ←
VHF Radio → | PSK-1T

Single cable for both packet data and commands and satellite modem control

Optional second cable for full-time telemetry.

The PacComm PSK-1T Satellite TNC provides the most convenient way to add 1200 baud packet satellite operation to your station. The PSK-1T supports conventional 1200 baud AFSK, PSK for point-to-point operation, and the Manchester encoded AFSK uplink/PSK downlink combination for the MicroSats.

The PSK-1T consists of a TINY-2 MK-2 TNC and a PSK-1 modem interconected and installed in the same case. (See individual descriptions of each product on other pages.) A single RS-232 cable connects to the computer and allows access to both the TNC and satellite modem control menus.

PSK-1T Features

- TINY-2 MK-2 TNC and PSK-1 Satellite Modem in one case.
- Assembled, tested, ready to use. All cables provided.
- Provides conventional 1200 baud AFSK packet operation and 1200 baud PSK modes in addition to satellite functions.
- Requires only one computer serial port.
- "Open Squelch" digital DCD.
- Personal Message System.
- Excellent sensitivity, wide range AGC.
- Pulses microphone UP/DOWN lines for Doppler compensation.
- Decodes 400 baud telemetry.
- All functions selected by push buttons or computer control port.
- Supports GPS position reporting for the Automatic Position Reporting System (APRS).
- A convenient way to build a terrestrial PSK link.

Satellite corner

1200 Baud PSK: (FM uplink 2m., SSB downlink 70cm.)

AO-16 (OSCAR 16)
LO-19 (LUSAT OSCAR 19)
FO-20 (Fuji OSCAR 20)
IO-26 (ItamSat)

9600 DFM: (FM uplink 2m., FM downlink 70cm.)

UO-22
KO-23 (KITSat A)
KO-25 (KITSat B)

Others:

AO-27 (EyeSat 1), PO-28 (PoSAT), UO-11, UO-15, DO-17 (DOVE), WO-18 (WeberSat).

Up-coming Launches:

UN-AMSAT, RS-15, CEsar-1, SUNSAT, HUTSAT, GUerwin-1, Techsat and SEDsat.

For complete information, see either lastest AMSAT publications or the CQ Beginner's Guide to Amateur Radio which has an excellent section on the satellites in orbit.
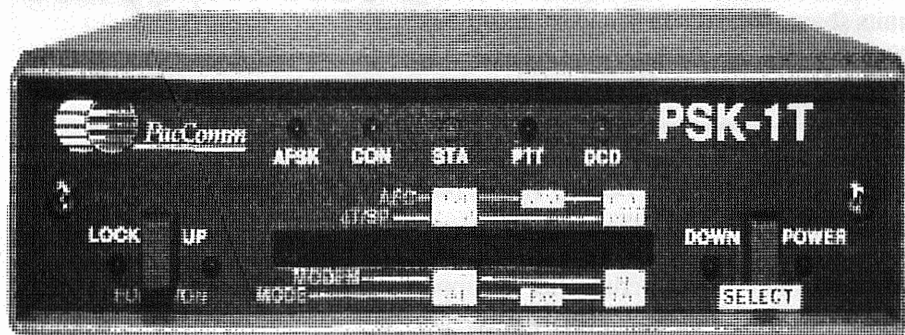
PacComm is currently working with several of the vehicle builders to provide both ground station hardware and satellite hardware. The latest request is for a re-build of Spartan, the Space Shuttle payload experiment which is allowed to orbit three days at a time.

PacComm has a hints file on our BBS for newcomers to packet satellites, along with copies of PB/PG software, etc. PB/PG is provided free of charge with PSK-1 and TNC-NB96 combinations.

Remember! To work most of the packet satellites you must use the PB/PG protocols or else all you'll receive is junk on your screen (these satellites do NOT use AX.25).

The '320' Series dual-modem HF/VHF Packet Controllers

The PacComm '320' series consists of two dual-modem HF/VHF packet controller models. The units share many features, including excellent HF packet performance.

The PC-320 is configured as a 3/4 size plug-in card for PCs and compatibles.

The TNC-320 is a conventional stand-alone TNC.

Features Common to Both 320 Series Models

- Separate modem circuits for optimum VHF and HF operation
- Uses the EXAR 2206/2211 PLL modem and 6 pole active filter for superb HF operation. Excellent HF carrier detection performance. The HF modem filter may be bypassed and the modem retuned to support VHF tones
- Expanded auxiliary modem header supports PacComm's G3RUH 9600/19200 baud modem and PSK-1 satellite modem
- Radio port selection is by a single keyboard command which also selects a separate heard log, radiolink and many other parameters
- The AX.25 firmware uses the TAPR command set with numerous additional commands to support

- PacComm features and enhancements. Supports TCP/IP via the built-in KISS module.
- Personal Message System (PMS) with manual and reverse forwarding. The PMS allows the packet controller to support all standard packet functions while allowing messages to be entered or read by an over-the-air user.
- PMS message space expandable to 128k via installation of the PacComm Memory Expansion Adapter.
- Each unit comes with a comprehensive Operating/ Technical Reference Manual, a Command Reference Card, and a circuit schematic. Mating connectors for the RS-232 computer connector (TNC-320 only) and the radio and power connectors are provided.

PC-320 PC Packet Controller Card

- Extensive filtering for quiet operation.
- Appears as regular PC serial port (COM 1-4). Multiple PC-320 cards may be installed in a PC
- Uses any terminal program, just like an external TNC
- TSR Program provides on-screen tuning and 'simulated LED' display
- Dual powered - operates from PC power or external power. Continues full operation even when the PC is turned off!
- 10 inches long, 4.13 inches high, 5/8 inch thickness
- Nine pin (DE-9S) radio connector allows both HF and VHF radios to always remain connected.
- Options: Dual radio cable, Hardware clock, External power supply, Open Squelch DCD, 9600 bps DFM modem.
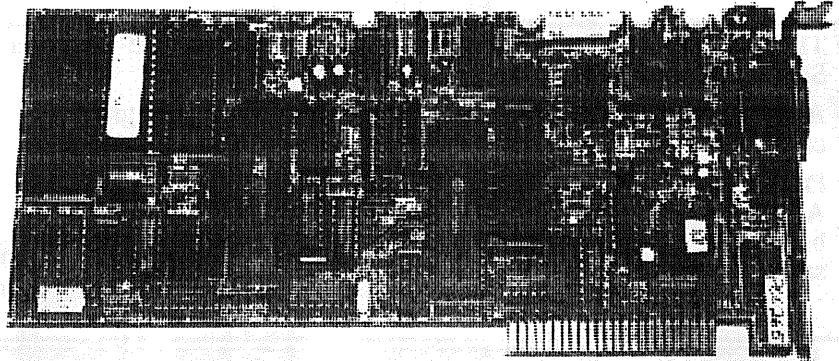
PC-320 On Screen Tuning Display

TNC-320 Stand-alone Packet Controller

- The TNC-320 front panel features a horizontal LED bargraph HF tuning display, HF threshold control, and 14 multicolored status LEDs grouped for instant recognition.
- LEDs display activity on the RS-232/TTL data in and data out lines.
- The TNC-320 requires 12-16 volts DC at 280 mA. The 'low power' option reduces current draw to 150 mA.
- Options: Hardware clock, Open Squelch DCD adapter, 9600 bps DFM modem.
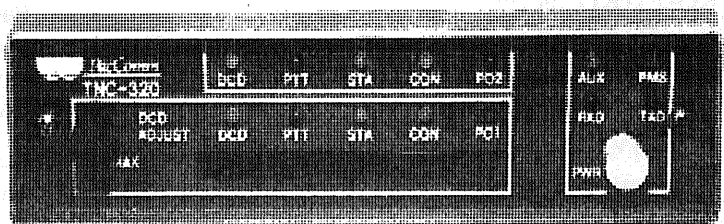
BayCom V1.60

The complete guide to Packet Radio
with BayCom Packet Radio

for IBM PC with MS-DOS

The official manual for the software release V1.60 of BayCom

Software by Florian Radlherr, DL8MBT
Hardware by Johannes Kneip, DG3RBU

English Manual by Ulrich Günther, ZL1DDL (DL1NDB)

BayMod-9 Modem

BayCom V1.60

The complete guide to Packet Radio
with BayCom Packet Radio

for IBM PC with MS-DOS

The official manual for the software release V1.60 of BayCom
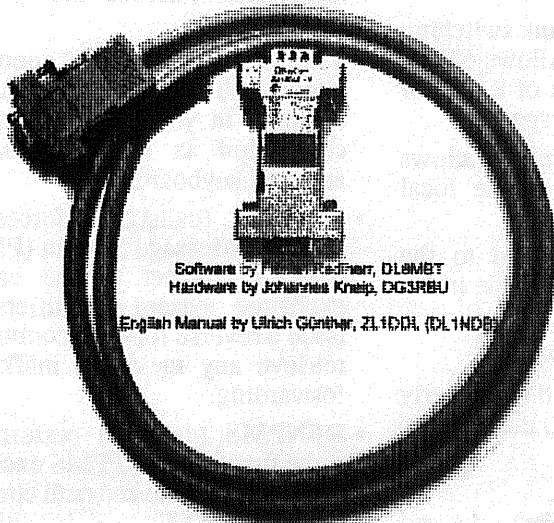
Software by Florian Radlherr, DL8MBT
Hardware by Johannes Kneip, DG3RBU

English Manual by Ulrich Günther, ZL1DDL (DL1NDB)

BayMod-25 Modem

PacComm's VHF serial port modems are the simplest and easiest way to get started on packet. The entire modem is contained in the serial cable housing, either 9 or 25 pin.

Simply plug the modem into the computer's serial port, attach the cable to your radio, and load the BayCom software. Power to operate the modem is obtained from the serial port itself.

PacComm's serial port modems were designed by the BayCom software developers, so you can be sure they properly interface to the BayCom software in every respect. The TCM3105 modem IC is used.

Both the BayMod-9 and BayMod-25 are provided with the latest BayCom software diskette and cable materials for constructing the radio interface cable.

The BayMod-9 is contained in a 9 to 9 pin gender changer housing. Just plug the BayMod-9 into your 9 pin serial port, or at the end of a 9-to-9 cable and attach a radio cable to the other end.

The radio connector has provision for applying external power to operate the BayMod-9 in case the serial port of your computer cannot supply enough voltage.

> BayCom is the creative group of amateurs from Bavaria, Germany. PacComm manufactures and distributes BayCom products under license.
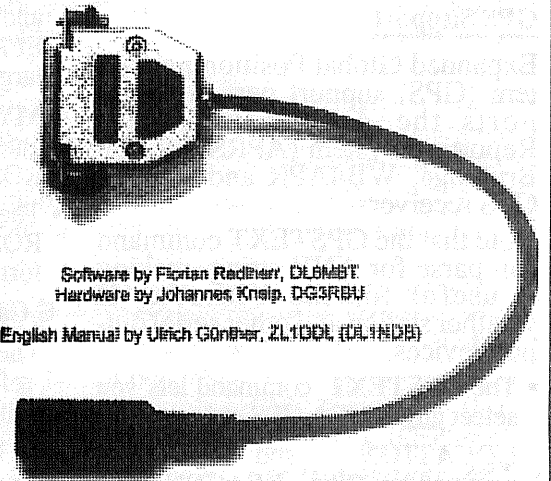
BayCom Software

A BayCom software diskette and extensive page manual is included with each modem. A 5.25 inch 360k diskette is provided, and a 3.50 inch 720k diskette may be substituted if requested. The manual is not available on disk. The software and manual are also available for purchase separately (not shareware).

- New version: 1.60a.
- Simple and easy to learn.
- Easy to use installation program.
- Separate windows for:
  - Command and Transmit, Receive, and Monitor.
- Six simultaneous connections.
- A separate display buffer for each connection.
- Save data to disk or printer.
- Stations heard log.
- Supports the Broadcast BBS Capability now popular in Europe.
- 9600 baud parallel port modem (available soon).

PacComm firmware is based on code licensed from Tucson Amateur Packet Radio Corp. (TAPR).

PacComm firmware supports most TAPR commands, but internally it is much, much different than TAPR code. There are many additional commands and features and we are continually expanding the functionality of the code.

In addition, the PacComm code has been extensively re-written for faster execution and greater reliability.

GPS Support

Expanded Global Positioning System (GPS) support perfectly supports the Automatic Packet Reporting System (APRS) by Bob Bruninga, WB4APR and 99% of GPS receivers.

Note that the GPSTEXT command can parse for ANY string, making it useful for the Ultimeter-II weather station and other serial output devices.

- The **GPSTEXT** command lets you select any NMEA GPS string.

- **LOCATION** and **LTEXT** commands (like BEACON and BTEXT) for GPS position information. Lets you use Beacon function for traditional purposes and beacon at a different rate than you send position reports.

- **LPATH** command allows POSITION reports to be sent via a unique path, different than UNPROTO path.

- **GPSITEXT** allow a user specified initialization string to be automatically sent to an attached GPS after power-up. GPSITEXT is only sent if the GPS command is turned on.

- **UIMODE** command puts the TNC into CONmode automatically at power-up without operator commands.

When operating in GPS mode, the PacComm firmware now allows the Monitor command to be used to select whether any received UI frames are forwarded out the serial port. When Monitor is on, the TNC can be receiving differential GPS corrections and passing them to the GPS reciever, while also updating all the GPS related transmit buffers with the latest GPS fix data.

PacComm's AD-4 analog-to-digital (deviation meter/ S Meter) board.

- Puts relative deviation and 'S-meter' reading of received signal in the Heard Log.

- Allows alarm thresholds to be set for A-to-D channels which cause an alarm beacon to be sent.

Other New Features

- Support for EPROM bank switching and expanded RAM. Allows 64k of EPROM space and 64k of RAM for larger message storage space.

- **MYROSE** Command allows entering the callsign of the local ROSE switch.

- Then a connect command to the ROSE network may be made in the form

C Call @ Destination Switch

The connect request will be properly reformatted and sent to the local switch.

The PacComm Personal Message System

The PacComm Personal Message System (PMS) is a self-contained message system (mailbox) which is a standard feature on all of PacComm's packet controllers.

- The PacComm PMS EPROM may also be used in most MFJ, TAPR TNC-2 and DRSI TNCs to upgrade the performance of those models.

PacComm's PMS is completely compatible with current BBS message standards.

Automatic forwarding by the PMS is NOT supported to reduce channel congestion. Messages may be manually forwarded from the PMS to other PMS or BBS systems, either by direct connection, digipeater, or node.

Message headers may be turned on or off and message headers may be edited and re-addressed by the sysop.

If the PMS is installed on a PacComm controller which is equipped with a printer port, messages may be printed directly to the printer at keyboard command.

When the **GPS** command is ON, the NMEA-0183 data (Latitude, Longitude, etc.) from the GPS receiver is inserted in the STEXT field of the PMS. Each connection to the PMS will be initiated with the standard LOGON Message (if enabled) and the position data from the STEXT field.

- **MSGRoute**: Allows deletion of forwarding path entries in messages. When MSGR is ON only the first and last entries of the forwarding list are retained.

- **The REMote** sysop command allows you to manage the message database in your PMS via a radio connection as well as from the attached keyboard.

- **RFPMS** (callsign) forces the Personal Message System (PMS) to issue a connect to the callsign, exchange system identifiers, and issue a reverse forward command to retrieve any messages marked for forwarding.

- **RFNPMS** (callsign) performs the same function as RFPMS except via the network node and path contained in NODETEXT.

- **RENUmber** Allows the sysop to renumber PMS messages in memory.

- **TKILLOK:** When set to ON by the sysop, allows traffic handler users to kill messages of type "T" which are not addressed to them.

PacComm Firmware Support

PacComm welcomes problem reports when our firmware does not appear to function properly. Call, fax, or write for a software discrepancy form which will help you record all the information necessary for us to research the problem.

PacComm supports the current firmware release, and the most recent prior release for a period of six months after it is superceded.

Bug reports on earlier releases are solicited, but the bug fixes will only be applied to the current release and previous release.

PacComm policy is to constantly improve the performance and features of our firmware, but to limit the frequency of firmware releases to a modest rate.

PacketPet for Windows

Now, a Windows packet terminal program written by an experienced packet user. Chuck Harrington, WA4GPF, has been active in packet since the the days when the TNC-1 was still just called the TAPR TNC.

Chuck is the author of the widely known Packet-Term program for the Atari. Several years ago he turned his attentions to the PC and the Windows platform. Now he has released this powerful program, PacketPet for Windows. Chuck distributes his program as shareware, and PacComm sells a special version with unique features to support PacComm TNCs.

This is quality professional software, but at a price that doesn't cost you an arm and a leg.

PacketPet Features

- Standard Windows SETUP program for trouble free installation.

- Excellent on-line help and documentation.

- Supports multiple simultaneous packet or other digital mode sessions each using its own window.

- Excellent on-screen editor. Compose and edit messages while operating several connections in other windows.

- Supports all PacComm TNCs and the TNC-1, TNC-2 and compatibles, as well as AEA and Kantronics units.

- Operate hassle-free multiple connections on a single packet controller. This function provided for all PacComm TNCs, and MFJ, PK-88, PK-232, PK-900, KPC-3, KAM and KAM+.

- PacketPet Macro language supports multiple mode operation, and various other kinds of enhanced automatic and command line operations.

- Macro recorder automatically creates Macro files from your keystrokes.

- Macro Player permits automatic (robot) operations at set times or intervals and at PacketPet startup and shutdown. This can be used for automatic connections such as to your local PBBS.

- Binary transfers with simultaneous CHAT between operators.

- Support for .WAV sound files. Connect and Disconnect messages and many other events may be set to cause spoken output.

- 27 definable menus for personal customization.
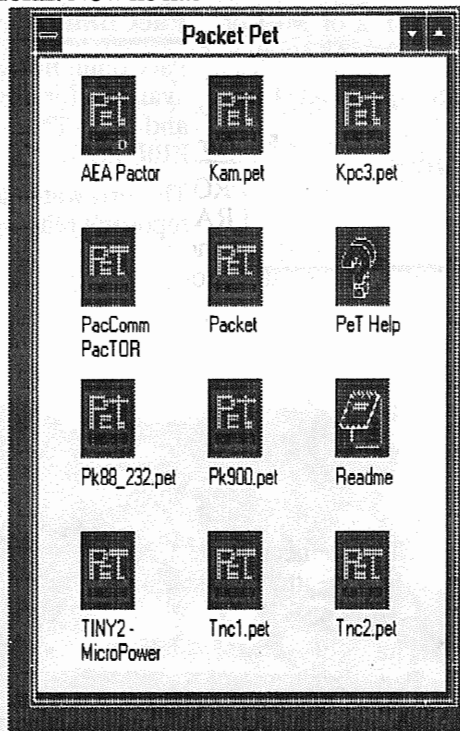
- Support for multiple TNCs at the same time. Attach up to four TNCs. Each TNC has its own main window and configuration. Use the same terminal program to access your TINY-2, your TNC-NB96 and PSK-1 satellite combo, your PacComm PacTOR, and your trusty old PK232! All at the same time!

- A File menu and File Delete Utility allows cleaning unwanted files from disk without leaving PacketPet to access File Manager.

- Sets TNC clock from PC clock.

- Runs in background while other windows programs are being used. Connect alarm notifies you to switch to PacketPet task.

- Font sizes and colors selectable. Ideal for those people who see best with large type.

- Support for files formatted with ANSI color graphics.

- Printed Users Manual and help line support.

System Requirements

- Some kind of hardware TNC. (Will not work with BayCom modems).

- Microsoft Windows 3.1 or later, or OS/2 release 2.1 or later. (Contact the author if you have Windows 3.0).

- A mouse or trackball is highly recommended.

- A hard disk with at least 2mb free space.

- One serial port on your PC for each TNC.

- A sound card and speakers if you wish to use the .WAV fiiles to produce spoken text.

PacComm Warranty Policy

PacComm products are carefully designed, built, and tested to provide good value and long service.

All amateur radio products carry a 30 day money-back guarantee to allow you to return a unit which does not meet your requirements. Returned units must be in 'like-new' condition or a restocking fee will be applied.

All amateur products carry a 12 month factory warranty. This warranty does not apply to units used in commercial applications or which have been damaged by misuse or accident.

PacComm will repair or replace, at its option, any unit in warranty which is returned to the factory and found to be defective.

Repair service is available for units not in warranty.

An optional service contract and/or extended warranty is available for amateur products used in commercial service.

The AD4 is PacComm's licensed implementation of the Suffolk (UK) Data Group's design for an analog-to-digital board. The design started out simply to be able to measure received signal deviation (hence it was known as the TheNet Deviation Meter Board). PacComm expanded it to use four A-to-D channels and is supporting it in our standard TNC code (beginning with Release 3.3).

- Use with any network node TNC (TINY-2 or MFJ or DRSI) which uses TheNet X1J or later network code.

- Use with the TINY-2 or SPRINT-2. (Sorry, the AD4 will not fit into a HandiPacket).

- Use with the SPRINT-2/RF or IPR-NB96.

It's the ideal experimenter's toy!

AD4 Capabilities

The AD4 has four channels of analog-to-digital conversion. These channels may be used in a variety of ways as desired by the user. The factory setup is as follows. Note that the S-Meter function is optional and requires connection to the reciever IF.

- Channel 1 used for relative deviation measurement of received signals from receiver audio.

- Channel 2 used for voltage measurements or S-meter reading of received signals (with optional radio interface installed).

- Channel 3 used for voltage measurement (normally used with solid-state sensor for temperature measurement).

- Channel 4 used for voltage measurement (typically humidity using the appropriate sensor, or a second temperature reading, or supply voltage).

When fitted to existing TNC-2 compatible TNCs using TheNet X1J firmware, these measurements become available to the end-user in the MHeard list.

Suggested Applications

- Install at X1J node sites to identify overdeviated signals hindering network performance.

- Monitor ambient site temperature and final amplifier temperature at node sites.

- Monitor node site supply voltage and backup battery voltage.

- Download signal strength readings over a period of time and plot network weak spots and interfering signals.

In the ham shack, use the AD4 for a variety of remote telemetering and alerting uses such as:

- Monitor wind speed, temperature and other weather conditions (with appropriate sensors) at a remote site.

- Test and adjust antennas by checking the signal strengths received as they are turned.

- Help local friends get their transmitter deviation adjusted properly.

PacComm Firmware Support

PacComm firmware (Version 3.3) makes the AD4 features available for use in amateur stations on all PacComm TNCs and any TNC-2 compatible TNC using a PacComm EPROM.

The firmware supports calibrating the AD-4 channels and reporting readings in the Heard Log.
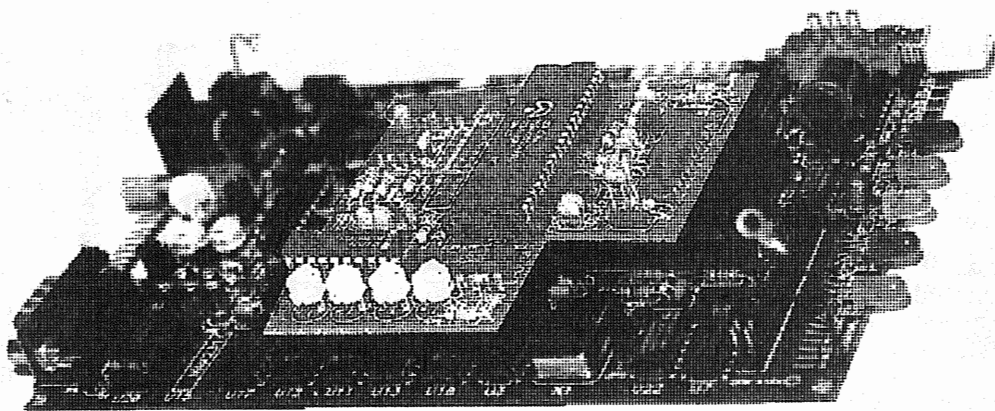
AD-4-CPU/S installed on a TINY-2

Ordering Information

There are two models of the AD4 based on the method of mounting to the TNC.

- The AD-4-CPU mounts into existing TNC-2 compatible TNCs (TINY-2, MFJ 1270, etc.) by removing the CPU, pushing in the AD4 and putting the CPU back into a socket on the AD4.

- The AD-4-HDR mounts on newer PacComm products (SPRINT-2) by fitting to a single header on the TNC board.

The standard AD4 is NOT equipped with the received signal strength (S Meter) function since this requires a direct connection to the receiver IF.

To order this option installed, add /S to the AD4 part number, e.g. AD-4-CPU/S or AD-4-HDR/S. Make sure you can perform the needed radio installation before ordering the S-Meter model.

Note: The AD-4 will not fit into the PacComm PSK-1T, Handi-Packet, TNC-NB96, or a TINY-2 equipped with an MC-NB96 modem or a memory expansion adapter.

TNC Memory Expansion

The PacComm Memory Expansion Adapter installs in most PacComm TNCs and many other Z-80 based TNCs to provide additional battery backed RAM message storage for use by PacComm's Personal Message System.

- The adapter board plugs into the TNC Z80 CPU (8400 or 84C00) socket to provide access to the data and address lines. No soldering required.
- The CPU chip mounts on the adapter, along with the additional RAM IC and decoding logic.

A special version EPROM replaces the original. The EPROM provides PacComm's latest version of AX.25 firmware and Personal Message System and automatically manages the additional memory space.

- No changes in commands or operation are needed to access the additional memory.
- Models are available for all PacComm TNCs except the HandiPacket (no space!): TNC-200, TNC-220, TNC-320, PC-320, TINY-2, TINY-2 MK-2, MICROPOWER-2. The SPRINT-2

incorporates expanded memory circuitry on the main board.

- The TNC-200 adapter is designed to fit any TAPR-2 "EPROM compatible" TNC. Use for the TNC-2, TNC-200, TNC-2A, PK-80, MFJ-1270, MFJ-1274, DPK-2, etc.

Note: The Memory Expansion adapter cannot be used in conjunction with the MC-NB96 modem accessory card or the AD-4 Analog-to-Digital converter accessory because all three occupy the same physical location.

APRS Port Switch
(Used in Hardware Single Port [HSP] mode of APRS)

The APRS port switch is used when only a single comm port is available on a computer such as a notebook PC.

It allows APRS to access a TNC for receiving broadcast APRS frames and sending display status messages to other stations. It also allows a local GPS receiver to be attached and it's output data sampled. The sequence of events is as follows:

Select HSP mode of APRS and re-save the configuration (CFIG) file. You'll need the extra GPS registration ($9) from Bob Bruninga to enable local GPS mode.

The computer will now transmit and receive data to the TNC for most of the time. Every now and then the computer toggles the DTR serial line which will "pause" the TNC (allowing data to gather in the buffers - no data will be lost) and the software looks for good, complete NMEA strings coming from the LOCAL GPS receiver.

When it sees one, after only a couple of seconds, the computer switches back to continue conversing with the TNC. In this way, APRS packet operations continue as normal and your GPS derived position is placed on the map. This is most useful when driving along and you

need your position on a map as well as all the other stations locally. It's not very useful at home - not many shacks move around unless they're in California!

The APRS Switch is built as a Y cable. One end goes to the notebook computer, one side of the Y goes to the TNC and the other side of the Y goes to your GPS receiver data port. Connections to GPS's vary tremenously - you will almost certainly need to get a special data connector from your GPS manufacturer.
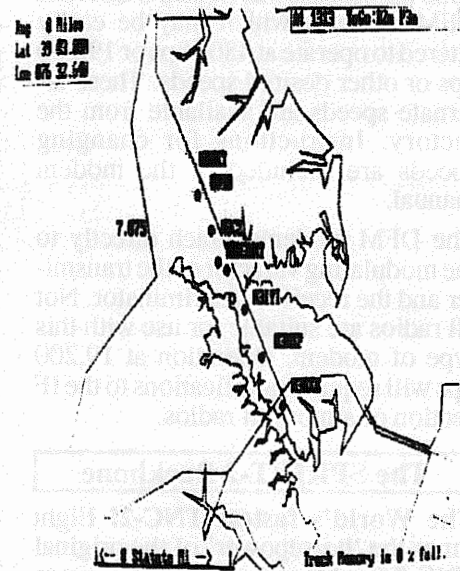
Typical Automatic Position Reporting System Map
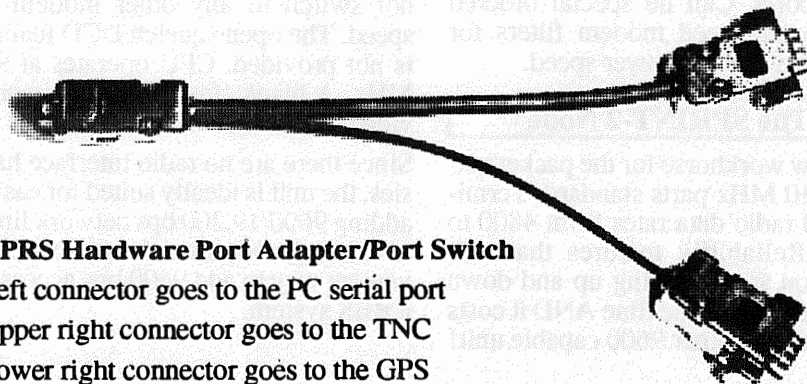
APRS Hardware Port Adapter/Port Switch

Left connector goes to the PC serial port

Upper right connector goes to the TNC

Lower right connector goes to the GPS

PacComm offers a variety of products for service in the amateur packet network to enable the node operator to select the most cost effective approach regardless of whether a node is being upgraded or a new one is being built.

The PacComm 'Node Series'

The NODE series of packet controllers are specially priced to stretch the network budget.

All models support RS-232 port data rates of at least 38.4 kbps for efficient communication between units in a 'node stack.' Running the 'wire side' of the node stack at that speed can significantly improve response and throughput.

1200 baud units use the TCM 3105 modem which is not affected by changes in temperature on high sites.

9600 models use PacComm's G3RUH DFM modems which may be easily altered to operate at 4800 bps or 19,200 bps or other desired speeds. These alternate speeds are available from the factory. Instructions for changing speeds are included in the modem manual.

The DFM modems attach directly to the modulating varactor of the transmitter and the receiver discriminator. Not all radios are suitable for use with this type of modem. Operation at 19,200 bps will require modifications to the IF section of almost all radios.

The SPRINT-2 Backbone

The World's fastest TNC-2! Eight times the 'horsepower' of the original TNC-2 (and it costs about the same as the original TNC-2!)

Runs 56kb easily on both the radio and serial ports. Can be special ordered with lower speed modem filters for temporary use at a lower speed.

The SPRINT-2 Node

The new workhorse for the packet network. 10 MHz parts standard, Terminal and radio data rates from 4800 to 56kb. Reliability features that will keep you from running up and down the mountain all the time AND it costs less than any other 9600 capable unit!

The TINY-2 / NODE and TINY-2/ 10MHz/ NODE

The TINY-2/NODE is the workhorse of the amateur 1200 baud packet network. It is shipped without an EPROM to reduce the cost and is ready to accept the customer's NODE EPROM. The unit is based on the TINY-2 MK-2 TNC which supports serial and radio port speeds up to 38,400 bps.

The unit is available from the factory with the 10 MHz option installed. User upgrade to 10 MHz operation requires only the replacement of four socketed ICs and resetting of a push-on jumper. The 10 MHz model is supplied with a blank 'fast' EPROM since customer supplied EPROMs may be too slow for the 9.8 MHz processor.

The MC-NB96 Modem Card

The TINY-2/MC-NB96 DFM modem card combination has been the most popular 9600 baud network unit prior to the introduction of the SPIRNT-2.

If you have a 1200 baud node that needs to be upgraded to a higher speed, adding the MC-NB96 is the most economical way to go.

The MC-NB96 has recently been redesigned to match the modem performance provided by the SPRINT-2 modem. The modem filters (14 components!) are mounted on a parts carrier for easy changing to other data rates.

The IPR-NB96/10MHz/NODE

The IPR-NB96/NODE is a special model of the IPR-NB96. The modem switching features of the standard IPR-NB96 have been eliminated. The unit operates only at 9600 bps and cannot switch to any other modem or speed. The open squelch DCD feature is not provided. CPU operates at 9.8 MHz. A blank 'fast' EPROM is provided.

Since there are no radio interface hassles, the unit is ideally suited for easily adding 9600/19,200 bps network links to existing node sites. It is also a convenient way to add 9600 bps access to a BBS system.

10 MHz Upgrade Kits

For busy high traffic packet nodes, the installation of 10 MHz CPU, SIO, and fast EPROM offers faster radio response and increased throughput.

The NX2P EZ-Matrix

The EZ-Matrix is a diode matrix board for connecting multiple NODE TNCs together. It uses DIODE arrays in DIP packages which greatly simplify construction. Node cables are attached to board mounted connectors.

RF Data Transceivers

PacComm is an authorized dealer for E.F. Johnson, Maxon, Motorola, Repco, Standard, TEKK, etc.

PacComm IPR-NB96 UHF models use the TEKK KS-900L Data Transciever. Units are stocked on frequencies of 441.050, .075, and .100 MHz.

Proper digital filters are available. See the G3RUH and MC-NB96 page.

TheNet and ROSE Network Firmware

TheNet and ROSE are the most popular networking systems for AX.25 and IP frame transport. They are for AMATEUR use only and copyright is with the authors. Please contact PacComm for details of alternative Commercial firmware.

PacComm offers an EPROM programming service for TheNet X1J2 (or current release). The programming of this code is labor intensive and PacComm offers this service at cost. Included is an operational check in a TNC to ensure that the code does run correctly.

You will receive a 27C512 EPROM with the code pre-installed and a 720kb 3.5" disc with the X1J2 code and software tools (does not include source code).

To use this service, please provide (at minimum) the following information:

* Official callsign of the switch, alias of the switch, TX delay required and Sysop verification password.

You may wish to provide other parameter settings, otherwise TheNet distribution defaults will be programmed.

The CoaxLAN replaces complex diode matrices in Node/Switch stacks with a system which communicates among numerous units with just a signal and ground wire.

The CoaxLAN detects data on the 'bus' or LAN and flow-controls the attached TNC serial port off. Transmit drivers are tri-stated except when transmitting.

The CoaxLAN is now built into the PacComm SPRINT-2 TNC, providing simple inter-linking for TheNet node stacks/ROSE switches.

- Small size - in a DE-9 cable housing.
- Connects directly to the TTL serial port of TINY-2 or MFJ TNC.
- Uses RCA Phono connectors for easy availability.
- Connects like EtherNet - but without terminations.

- LEDs monitor data in and out of each Node or Switch.
- Increased fan-out. Run more TNCs in the stack.
- Convenient, shielded connections.
- Lengthy cable runs (3000 ft.) between node TNC's possible.
- Allows 38.4 kb data rate when used with the TINY-2 MK-2 Node. Rapid inter-processor communications for protocoled links.

The CoaxLAN adapter connects directly to the TTL port of the TINY-2 MK-2. Older TINY-2 and MICROPOWER-2 and MFJ TNCs can also be used if 5VDC is jumpered onto the TTL connector to power the CoaxLAN.

CoaxLAN Adapter

There are two CoaxLAN models (please specify when ordering):
- TheNet model
- ROSE model.

The RADIO MULTIPLIER-II (RM-II)

The RM-II lets you take maximum advantage of your dedicated packet station. Designed by Bill Slack, NX2P. The RM-II:

- Allows up to four TNCs or TNC-like devices to share one radio. Each TNC can transmit and receive packets over the air.
  - » When any one of the TNCs is transmitting data, audio feedback asserts DCD on the other TNCs preventing collisions.
- Distributes power to all TNCs
- Allows communication between all TNCs.
- Uses the standard 5 pin DIN cable connection from radios.

The RM-II is ideal for multiplexing numerous functions onto a single radio. It overcomes many incompatibility issues between various sets of hardware and software.

Take advantage of hams who live at good locations to provide those necessary network links by putting a network NODE/SWITCH in parallel with their dedicated packet radio and antenna.
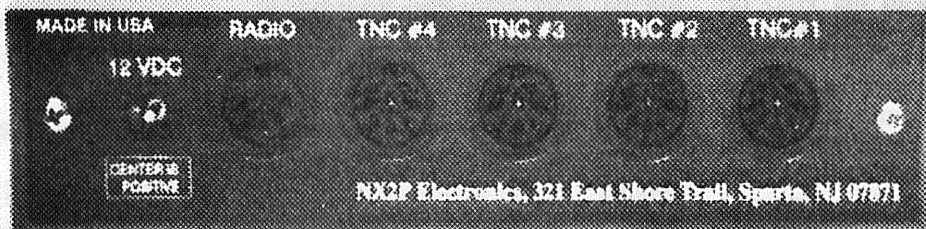
Experiment with new networking protocols in a real networking environment while still using your existing network.

Place a monitor TNC and terminal in parallel with your BBS for monitoring and personal packet operation without having to take the BBS off the air.

Run TCP/IP and AX.25 simultaneously through the same radio.

The RM-II is very handy around the shack. Use it to compare the performance of a TNC with a 'known-good' unit using a radio and real-world signals.

The RM-II allows up to four TNCs to share one radio by diode OR-ing the PTT control signal from each TNC and combining their audio outputs. This combined audio signal is then fed to the transceiver's microphone input as well as being amplified and combined

with the transceiver's receive audio before being fed to each of the TNC's receive audio input. The audio feedback prevents more than one TNC from keying the radio at the same time and provides the means for all the TNCs to communicate between each other.

All the audio inputs are high impedance and all the audio outputs are a relatively low impedance. The RM-II connects to the radio via a 5 pin DIN socket using the standard pin-out found on most TNCs. Each TNC is connected to the RM-II via its own cable (cable not supplied) to its own connector on the back of the RM-II.

The RM-II requires a single 12V supply for operation. Unswitched 12V from the RM-II's input is available at each of the TNC connectors to make supplying power to the TNCs easier.

The RM-II works fine at both 1200 and 9600 baud without modification.

The Global Positioning System has been developed by the US DoD to provide a continuous precise position fixing service anywhere on Earth. 24 satellites make up the constellation, ensuring that four satellites should always be in view at any point on the Earth. The orbits are at 11,000 miles and there are two orbits per day of each satellite. Achieving precision of about 100 feet or better requires many factors to be taken into account - GPS has to make allowances for six types of relativistic effects, for example. Each satellite carries a very accurate and stable clock which can be corrected by the ground control stations to allow for any small changes in system performance.

The system works on the principle of triangulation. Two satellites would give a fix as the intersection of two spheres (a circle). Three resolve to two points and a fourth will resolve to one point. Therefore, three satellites will give a 2D fix and four satellites will give a 3D fix and you can select which mode is acceptable in the GPS receiver. To work, the distance to the satellite must be measured. The satellites and the ground receiver generate an identical pseudo random code at precisely the same time. When a signal is received from a satellite, a look back is made to see when that code was generated by the receiver and the time difference measured. The distance is then simply calculated by multiplying time by speed of light.

The satellites are very stable in their orbits and therefore can be predicted well in advance. The ground receiver holds an almanac which predicts where each satellite will be at a given time. Small corrections to account for gravitational pull (ephemeris data) are broadcast by the satellites along with system health messages and the pseudo-random rangeing codes.

Other factors affecting system accuracy are delays caused by the ionosphere and atmospherics. Corrections to account for average ionospheric delays are applied, but cannot be completely successful due to the highly variable nature of the ionosphere. Likewise, constantly changing weather patterns cannot be corrected for in the basic system.

Two "schemes" operate in GPS - for commercial and military users. The military system uses seperate data channels and has a high security data encryption scheme, making it almost impossible to break into the higher accuracy system. The accuracy of the military system is guaranteed, whereas the commercial one is not. In fact, selective availability (SA) is applied to the commercial system at times of national emergency. This spoils the accuracy of the commercial system, making it impossible for other military powers to use commercial grade receivers in their armament systems. SA can be applied for only partial orbits, therefore affecting only one hemisphere of the Earth.

PacComm Amateur Radio GPS Products

All PacComm amateur radio products feature the GPS function for use by the amateur digital experimenter. For details of the latest TNC GPS commands, see the "PacComm Packet Firmware" page.

Our primary GPS product is the TINY-2 MK-2/GPS which is an OEM GPS receiver board fitted into the TINY-2 case. See the TINY-2 catalog page for details.

GPS may also be retro-fitted into existing units. Call the factory for estimates of costs.

PacComm GPS units are fully compatible with APRS (Automatic Packet Reporting System) and commercial mapping programs which will plot positions of a large variety of objects on a map on a PC screen.

You may download the APRS program from PacComm's BBS. At least a 9.6kb modem is recommended as the file is greater than one megabyte.

PacComm units are the only ones available which can be used on remote vehicles without the need for a PC being connected.

Please note that PacComm amateur units are not normally warranteed for use in commercial service. If you are interested in business use, contact PacComm for information on our broad line of commercial-grade units.

Modulation Methods Used In PacComm Products

Audio Frequency Shift Keying (AFSK)

AFSK is a simple, reliable, and low-cost method for transmitting data through unmodified voice grade radios. 1200 baud signals will be easily handled by almost all radios through connections to the microphone and speaker connectors.

Manchester encoded AFSK, sometimes called Manchester modulation, is used on the transmit modulator of the PSK-1 Satellite Modem. This consists of AFSK modulation as described above with a clock bit interspersed between each data bit.

Minimum Shift Keying (MSK)

MSK modulation allows higher data rates to be used on conventional voice radios via microphone and speaker connections.

PacComm does not offer an MSK product in the amateur product line.

Direct Frequency Modulation (DFM)

DFM is used where higher data rates are required.

Direct Frequency Modulation is similar to frequency shift keying since the frequency of a carrier is moved to carry data. It is not the same as FSK, however, which switches between two frequencies similar to AFSK.

The DFM modem design digitally generates a transmit audio waveform which varies the carrier frequency. Precise shaping limits the signal bandwidth. Deviation of +/- 3kHz gives an RF spectrum 20 kHz wide (-60db).

Using a DFM modem entails direct connection to both the modulation varactor and receiver discriminator. These connection points are normally brought out to the data connector of a "telemetry" radio module.

Phase Shift Keying (PSK)

The receive section of the PSK-1 Satellite Modem decodes PSK. As the name indicates, data is encoded by phase changes in a continuous frequency signal.

Paul Evans, W4/G4BKI, PacComm Technical Sales

The Latest on APRS & GPS

Well, the hot topic in packet radio continues to be APRS and GPS. In the few months since our last catalog there's been explosive growth on the air in the number of users. Our sales of amateur and commercial integrated TNC and GPS Rx combinations continue to grow. Using separate units, Garmin are dominating the field with nearly 100% of amateur callers using either the Garmin 45 or 50 receiver.

We communicate frequently with Bob Bruninga, the author of APRS, about new ideas for his program. Bob works with us commercially as well. PacComm now offers a commercial mapping program called PPRS which works with CD-ROM mapping systems.

DX spot mapping

One such conversation with Bob was to add the ability to monitor PacketCluster activity and to take spots, process them and put them on a map of the world. Bob added this swiftly and it is now a standard part of APRS and DXers love it. (It's particularly useful for newcomers to see just where the DX is).

Weather via packet

The functionality of the weather support in APRS has been added to greatly by using PacComm TNCs in "GPS" mode with the ULTIMETER-II home weather center. Simply set GPSTEXT to look for the start of the weather string and connect the ULTIMETER-II 's serial line to the TNC. The TNC will regularly report the weather from a remote site for you. Several of these stations are running around the Washington DC area and provide really effective real-time weather data. A network of such stations could be very useful in YOUR area.

Making 9600 work ...... General Connection Points

Many modern rigs use true FM and it's simple to add a 9600Bd port.

Most modern rigs use receiver chips such as the TA7761F, TA7761P, LA5006M, LC7532M, TK10420, TK10424, MC3357P. All of these use pin 9 for the discriminator output, making connection very easy.

Transmitter connection should normally be made directly to the varactor in the main VCO circuit (at the top of the deviation pot is the most often used point).

To show how easy it can be, here's a list of known popular amateur rigs which can be easily modified

AKD ALR72, ALR709, AMR1000;

Standard C58, C140, C450, C500, C528, C558, C628, C5608D;

Alinco DJ560, DR510, DR570, DR590, DR1200;

Yaesu FT211, FT212, FT221, FT227R, FT230, FT280R, FT470, FT480R, FT73R, FT711, FT712, FT726, FT730R, FT736R, FT767, FT780R, FT790R, FT5100, FT5200;

Icom IC02, IC04, IC22A, IC25, IC27H, IC28, IC211, IC228, IC251, IC260, IC271, IC290, IC32, IC38, IC451, IC471, IC490, IC1201, IC2500, IC2400, IC3220;

Maxon MC80, 4020;

Pye 400, Olympic M212;

Kenwood TH77, TH405, TM211, TM212, TM221, TM231, TM241, TM321, TM421, TM431, TM441, TM531, TM621, TM701, TM721, TM731, TM741, TR751, TR7500, TR7700, TR7800, TR7850, TR8400, TS700, TS770, TS790, TS711, TS811

APRS Introduction

Tracking of position by using the Global Positioning System (GPS) is becoming increasingly popular and inexpensive. There are many hams out there who are experimenting with GPS and packet radio. The most famous and easy to use system is APRS (Automatic Packet Reporting System) written by WB4APR. A detailed description appears in CQ Magazine, December 1993 and QEX February, 1994, p9. You can now take a regular PacComm TNC, attach a GPS receiver with NMEA-0183 data output with antenna and mount it externally or even internally in the TNC and use it to send position data through any radio to a base station and/or other users. The APRS software places a variety of different types of objects on a map screen (anywhere in the world) and tracks their movements.

It's ideal for public events, disasters, emergency prepareness exercises, etc.

A typical system: TINY-2, GPS Receiver, radio, antenna on mobile unit TINY-2, radio, PC with APRS on base unit

The GPS equipped TNC can be used in two modes: broadcast beacons and/or polling by connecting to the remote unit. APRS uses beacon mode only.

Connecting the GPS Rx. Take the TXD (data out) of the GPS to pin 5 of the TTL serial port on the TNC and connect grounds together. Match the baud rate of the GPS serial output (normally 4800) to that of the TNC (using jumpers/switches).

Make sure that your GPS antenna is in the clear and not near such things as florescent lights which generate high noise levels.

Remember, APRS can be worked in a listen only mode at the base, with only the mobile units transmitting. This means that if you are out sailing, for example, your position can be monitored by anybody without the need for an amateur license. All we need to do now is convince the Coastguard to set aside a clear VHF marine channel and the way is clear for a superb low-cost emergency tracking system!

Network Nodes

Many backbone links are now using 9600 bd or faster. The SPRINT-2 TNC is proving very popular for hilltop sites with multiband high throughput node stacks.

The CPU loops parameter in TheNet which counts the number of unused CPU cycles as an indication of reserve capacity says it all: regular TNC = 400; 10 MHz SPRINT-2 Node Model= 1400; 20 MHz SPRINT-2 Backbone model = 2850! That's horsepower!

TheNet author Dave Roberts nearly choked when we told him how fast the SPRINT-2 is!

We have included this short section about our commercial products for the interest of our amateur customers. Anyone desiring more information about our commercial products should call and request our commercial product literature.

PacComm realises that many hams work in the electronics and data-comms industry. We get many calls and eventual orders from companies who have been enlightened on how to do radio data communications by one of their staff engineers who's into packet radio.

We often find that customers call in a last attempt to solve a problem that they've been trying to get off the ground for up to a year, only to have a couple of minutes conversation with our sales staff and find that the solution is off-the-shelf or very close to it.

Typically, a small number of trial/demonstrator units will be purchased and slightly modified, if necessary, to fulfill the task. Once the accountants have been satisfied that all is viable (the main hurdle), the main production run will follow with the hardware customised to exactly suit the application.

It depends upon the value of the units, but typically the level of order to suit complete customisation is around 100 units, although in some cases it will be less.

Although PacComm is small, we maintain the flexibility to design the product as you want it and yet keep the price low. You'll find our customisation very flexible and helpful and able to get you through that important trials stage at low budget.

Surprisingly, you'll find our units in many, many diverse applications (some of which are listed below) up against and frequently beating the performance of units made by giants in the telecommunications industry.

We are particularly strong in the GPS and DGPS datalink industry right now and proud that we are displacing other commercial systems provided by very respected industrial names simply on performance and customer support.

It's also nice to have the major GPS receiver and radio manufacturers beat-ing a path to your door for telecommunication solutions.

Some of Our Applications

- Bar code data collection systems
- Paging site interconnection (saves $)
- Remote computer access terminals
- Remote printing
- Police licence plate enquiry systems
- Telemetry from:
  » Ocean buoys
  » Oil and water wells
  » Lift stations
  » Gas Pipelines
  » High altitude balloons (NASA)
  » Military munitions
- Satellite terminals
- HF circuits
- AVL automatic vehicle location systems
- GPS position data
- Differential GPS data broadcasts (MSK and AFSK)

PacComm GPS magazine features / advertisements

GPS World Showcase, August 1994. Applications Competition

Of the ten prizes awarded, two involved wireless data transmission. Both used PacComm equipment.

Second Place Prize Winner: "Preventing Crane Crashes"

End customer, Weyerhaeuser.

Systems Integrator: Challenger Surveys.
Local Representative: TD Communications.

Equipment: 9600Bd differential correction and position data links.

Honorable Mention

"Tracking Oil Spills with GPS"

End customer, Chevron.

Systems Integrator: Radio Satellite Integrators.

OEM manufacturer: PacComm.

Also Entered

"Low-Cost Airborne Interim Tracking System"

End customer: Redstone Technical Test Center

Equipment: PacComm 9600 bd miniature Wireless Modems.

Advertisements

GPS World Showcase, August 1994, p46.

Ashtech - differential correction data links with PacComm (UMPAD).

NavSymm - DR5-96S 9600Bd DGPS data link with time slot code (UMPAD)

Who's Who in GPS Equipment - Differential link features & advertisement.

Customers in GPS:

Ashtech, NavSymm, Rockwell International, Qualcomm, TransTrak, Challenger Surveys, KARA, St.Joseph's Hospital system, InterFerometrics, General Railway Signal, Robson & Parsons Ltd., InfoTrade, Holst-Webster, Oceantronics, Avionicare, Everett Avionics, Aqua-Tech, Ham Radio Outlet, Global Electronics, Coastal Systems Station, Data-Com, Greenfield Assoc., Geonav, Integrated Systems Research Corp., KiloWatt, MITRE, MacCormack Inversiones, Stennis Space Center (NRL), Custom Software, Scientech, Satelite C.A., UEL, Vinncler, Trimble Navigation, Optimal Golf Solutions, Agrelo, Orbital Sciences, Civil Air Patrol, US Coastguard, US Army, US Navy, US Army Corps. of Engineers, Unitech, DeKalb Agra, Opalfire Int'l., University of California Berkeley Dept. of Particle Physics.

Applications

AVL, Troop monitoring, Ocean buoy tracking, balloon flights, aircraft, Differential correction broadcast, satellite systems, golf course monitoring, pilotless vehicle monitoring, agricultural guidance systems, surveying, EMS, medical helicopters, search & rescue.

Packet and PacTOR Controllers

SPRINT-2 Standard model _____ $225
  Power supply (US only), Operating and Technical manuals,
  schematic, cables
  Satellite Model... $235
  Node and Backbone models - see Network Products

TINY-2 MK-2 _____ $149
  Operating and Technical manuals, schematic, TNC connectors
  10 MHz option, factory installed ....add $ 25
  'Open Squelch DCD' option............................add $ 25
  TINY-2 to C-64 TTL cable.. $ 20
  Node model - see Network Products

TINY-2 MK-2/GPS _____ $675
  Power Supply (US only), TNC manuals, schematics, cables
  TINY-2 /10 MHz with internal GPS and antenna
  'Open Squelch DCD' option............................add $ 25
  GPS Manual .... $ 40

TNC-NB96 Switchable 1200/9600 TNC _____ $295
  Power supply (US only), Operating and Technical manuals,
  schematics, cables

MICROPOWER-2 _____ $175
  Operating & Technical manuals, schematics, cable connectors
  Hardware Real Time Clock option, ...add $ 30
  Printer Port option, with 3 ft cable, ...add $ 45
  'Open Squelch DCD' option............................add $ 25
  MICROPOWER-2 to C-64 TTL Cable .... $ 20

PacTOR Controller (PACTOR, AMTOR, RTTY) _____ $285
  Power supply (US only), Operating manual, schematics, cables
  Packet Adapter .... $ 99
  'Open Squelch" DCD on Packet Adapter...........add $ 25

HandiPacket with all accessories _____ $229
  Power supply (US only), Operating and Technical manuals,
  schematics, cables,
  belt clip, Velcro ™ straps
  Extra unterminated radio cables - See Cable Section

PSK-1 Packet Satellite Modem _____ $235
  Power supply (US only), Operating manual, schematics,
  serial, radio, and telemetry cables

PSK-1T Satellite TNC/Modem _____ $375
  Power supply (US only), Operating and Technical manuals,
  schematics, serial, radio, and telemetry cables

IPR-NB96 Integrated Packet Radio _____ $495
  Power supply (US only), Operating and Technical manuals,
  schematics, cables
  Specify exact frequency between 430 and 450 MHz.

TNC-320 HF/VHF Packet Controller _____ $195
  Operating and Technical manuals, schematics, TNC connectors
  'Open Squelch DCD' option............................add $ 25
  Hardware Real-time clock option ....add $ 30

PC-320 HF/VHF Internal PC Controller _____ $195
  Operating and Technical manuals, schematics, TNC connectors
  'Open Squelch DCD' option............................add $ 25
  Dual radio cable (6 ft pigtails for radios)................ $ 13
  Hardware Real-time clock option ....add $ 30

PC-120/PC Single port PC card for PacketCluster __ $ 99
  Installation & operating instructions, schematic, cable.
  connector

TNC-200 Bare board, EPROMs, Manual_____ $ 40
  Cabinet (case, bezels, end plates, etc.) .... $ 30
  Call for special quantity price - only 100 circuit boards left

BayMod-9 1200 bps modem w/BayCom Software _____ $ 65
  Manual and diskette. Specify 3.5" or 5.25" disk

BayMod-25 1200 bps modem w/BayCom Software _____ $ 65
  Manual and diskette. Specify 3.5" or 5.25" disk

Network Products

SPRINT-2/Node_____ $225
  Technical manual, schematic, cables, TNC connectors

SPRINT-2/Backbone_____ $260
  Technical manual, schematic, cables, TNC connectors

IPR-NB96/Node_____ $475
  Technical manual, schematics, TNC connectors

TINY-2 / Node *without* EPROM _____ $125
  Technical manual, schematics, TNC connectors
  'Open Squelch DCD' option ....add $ 25

TINY-2/10MHz/Node _____ $145
  Technical manual, schematic, TNC connectors
  'Open Squelch DCD' option ....add $ 25

TINY-2/9600/Node *without* EPROM_____ $240
  Technical manual, schematics, TNC connectors

TINY-2/9600/10MHz/Node_____ $260
  Technical manual, schematics, TNC connectors

MC-NB96 Internal DFM Modem Card _____ $115
  Technical manual, schematic, connectors

NX2P EZ-MATRIX _____ $ 33
  Complete diode matrix kit

NX2P Radio Multiplier-II_____ $125
  Schematic

CoaxLAN Adapter, For use with TINY-2 or MFJ TTL port__ $ 25
  Assembled. Schematic. Quantity pricing available.
  Must specify ROSE or TheNet model

Radios and Filters

TEKK KS-900 70 cm data transceiver (factory version) _$179
  KS-900 without crystals $165

TEKK KS-960 70 cm data transceiver (factory version) _$199

TEKK KS-900L-D96 (9600)_____ $230
  Modified with Digital 'D' and Monolithic 21.4 filters

TEKK KS-900L-D192 (19200)_____ $235
  Modified with Digital 'C' and Monolithic 21.4 filters

TEKK KS-960L-D96 (9600)_____ $250
  Modified with Digital 'D' and Monolithic 21.4 filters

TEKK KS-960L-D192 (19200) _____ $255
  Modified with Digital 'C' and Monolithic 21.4 filters

Digital 'C' filters for 19.2 kb (each) _____ $ 19
   Part # SFH455C

Digital 'D' filters for 9.6 kb (each) _____ $ 15
   Part # SFH455D

Monolithic 21.4 MHz filters (pair) _____ $ 20
   Part # MCF21.4F30B

Accessories and Upgrades

PacketPet for Windows _____ $ 79
   Delivered on two 3.5 inch HD diskettes, plus manual
   Must supply callsign to be used for password generation

BayCom Version 1.60 Software (without modem) __ $ 25
   Software diskette and manual.
   Specify 3.5" or 5.25" disk

Memory Expansion Provides 64k PMS _____ $ 49
   Fits TINY-2, MICROPOWER-2, TNC-200, TNC-320, PC-320
   Requires PacComm Release 3.3 EPROM (not included)

AD-4 Analog-to-Digital Converter _____ $ 39
   Specify if Header model (SPRINT-2) or 40 pin CPU
   plug-in model

AD-4 with S Meter Function _____ $ 49
   Specify if Header model (SPRINT-2) or 40 pin CPU
   plug-in model

'Open Squelch DCD' adapters (specify model) ____ $ 28
   DCD-3105 model (TINY-2/MICROPOWER-2)
   DCD-Header model (TNC/PC-320, TNC-200, any TNC
            with TAPR modem disconnect header)
   DCD-Universal model (has wire leads for connection)

10 MHz Upgrade Kit for TINY-2/TNC-200 _____ $ 25
   CPU, SIO, 100 ns EPROM, misc.
   Please specify model and version number of TNC

APRS Port Switch (HSP Mode Switch) _____ $ 25
   Fits PC with DE-9P, and TNC & GPS with DE-9S

Audio AGC Kit by K7NM (AGC-4) _____ $ 28

Heath Pocket Packet EPROM Upgrade _____ $ 50
   Latest PacComm firmware, Installation Instructions,
   EPROM, Operating Manual, Command Reference Card

Latest PacComm EPROM as upgrade to PacComm TNC
   Must furnish TNC model .... $ 25

Monitor EPROM (with source listing) _____ $ 35

32k RAM (memory) chip for user upgrade _____ $ 12

128k RAM (memory) chip for user upgrade _____ $ 20

Manual set (any product) _____ $ 10
   Operating/Technical Manual(s), schematic(s)

TheNet X1J EPROM programmed with your parameters __ $ 25
   Includes cost of EPROM. Diskette copy of X1J included

Cables, Power Supplies

All RS-232 cables are $12 unless otherwise marked.

CBL-232M/M 25 pin male to 25 pin male , 8 conductor for TNC-200, MFJ etc. to dumb terminal with female DB-25.

CBL-232M/F 25 pin male to 25 pin female, 8 conductor for TNC-200, MFJ to PC/XT male DB-25, or as 'extension cable.'

CBL-925F/M 9 pin female to 25 pin male for TINY-2/ MICRO-2/ TNC-320 to dumb terminal female DB25.

CBL-925F/F 9 pin female to 25 pin female TINY-2/MICRO-2/ TNC-320 to PC/XT male DB-25.

CBL-925M/M 9 pin male to 25 pin male for SPRINT-2 to dumb terminal female DB25.

CBL-925M/F 9 pin male to 25 pin female for SPRINT-2 to PC/XT male DB-25.

CBL-99F/F 9 pin female to 9 pin female for TINY-2/ MICRO-2/ TNC-320 to PC/AT or laptop male DE-9.

CBL-99M/F 9 pin female to 9 pin female for SPRINT-2 to PC/AT or laptop male DE-9 or as 'extension cable.'

CBL-99M/M 9 pin female to 9 pin female for SPRINT-2 to female DE-9.

CBL-64-320 TNC-320 to C-64/128 with TTL/RS-232 converter _____ $ 20

CBL-64-TMR TINY-2/MICRO-2 to C-64/128 _____ $ 15

HandiPacket unterminated radio cable (6 ft.) _____ $ 6
   8 pin MiniDIN connector

TNC to radio unterminated cable (5 ft.) _____ $ 6
   Specify 5 pin DIN or 8 pin DIN connector

120v to 12v dc wall power cube _____ $ 12
   0.5 or 0.8 Amp., 2.1 mm coaxial plug, 4-5 ft. cord

Custom radio and Node interconnection cables: $35/hour labor plus parts.

Repair Service

$35/hr plus parts and shipping.

Prices do not include applicable taxes and shipping charges.

Public Service and Commercial Pricing

Discounts for ARES, CAP, MARS, and other volunteer public service groups are available upon presentation of proof of membership and activity.

Call for information about service contracts and/or extended warranties for amateur products used in commercial service. Amateur units used in commercial service are not subject to any quantity discounts.

Form PR-AR (10/28/94)

PacComm Amateur Products Order Form

If you live outside the United States, please submit your order to the nearest dealer or distributor in your country or area. Sending your order direct to Pacomm causes delivery delays. Orders placed from overseas for delivery within the USA may be sent to PacComm. All prices subject to change without notice. Dealer prices may vary.

Send this form with your check, money order, or credit card information (including expiration date) to:

PacComm Packet Radio Systems, Inc.
4413 N. Hesperides Street
Tampa, FL 33614-7618 USA

Note: Personal checks require 5-10 working days to clear before goods are shipped.

Credit card or COD orders may be placed via:
- Telephone Switchboard (813) 874-2980
- Facsimile (813) 872-8696
- BBS (813) 874-3078
- Orders (Toll Free) (800) 486-7388
- CompuServe Mail 76576,2003

(When telephoning orders, be sure to have your credit card number ready!)

Name: _____

Address: _____

City, State/Province: _____

ZIP/Postal Code: _____ Country: _____

Telephone (circle whether Day or Evening): (Area Code) (_____) _____

Payment: COD (USA only)(COD payment must be in cash, cashier's check, or money order. **NO personal checks**)_____

CHECK   MONEY ORDER   Date: _____ Amount: _____

VISA   MASTERCARD   DISCOVER   AMEX   Card No: _____

Expiration date_____ : _____ Signature:_____

Quantity Ordered	Product Description	Price Each	Extended Price

- Florida and Ohio residents must add sales tax.
- **$6.00 Shipping fee** is for UPS surface within the Continental U.S. If you prefer another method, Circle your choice below and we will add the extra shipping charge to your total.
- **COD - $5.00** additional charge. **You must be available to accept and pay for a COD shipment. We will bill you for shipping charges on returned COD shipments!** Payments for COD must be in cash or cashier's check or money order. Personal checks not accepted without prior approval.

Total for Goods: _____

Credit from prior order: _____

Sales Tax (FL = 6 or 6.5%)(Ohio = 6.5 %): _____

Shipping Charges (see note at left): _____

Total : _____

Shipping Instructions	UPS Surface	Express Mail	Standard Air Freight	Airborne Next Day
	UPS 2nd Day Air	Priority Mail	Rush Air Freight	Airborne Economy
	UPS 3rd Day	Parcel Post	FedX P1	Other (specify)
- Circle One	UPS Overnight	Surface Freight	FedX Economy	_____

Australia: Blamac Pty. Ltd. 26B Bombala St., Cooma, NSW 2630 Australia Telephone: 64-523-112 Facsimile: 63-524-317	**Australia:** Kevin Cavanagh, VK4SP 222 Brisbane Valley Hwy. Wanora, Queensland 4306 Australia Telephone: (074) 643-954 Facsimile: (074) 643-954	**Argentina:** Laboratorio Electronica Digital Moreno 1989 2000 Rosario, Argentina Telephone: +54 41 823-824	**Argentina:** RDS, Radio Data Systems San Lorenzo, 1841 1636 Olivos BS.AS Argentina Telephone: 541-790-1166 Facsimile: 541-790-1166
BENELUX: RYS Electronics De Kuil, 12 1911 TP Uitgeest, Holland Telephone: 02-513-11934 Facsimile: 02-513-14032	**Chile:** Federhit S.A./Reximco, Ltd. Quillota 853, Casilla 803 Vina Del Mar, Chile Telephone: 02-972-104 Facsimile: 02-660-294	**Colombia:** Servicio de Comunicaciones Radiales (SCR), P.O. Box 50405 Calle 30C No. 72 A 23 Medellin, Colombia Tel: 235 13 24, 40 or 57. Facsimile: 235 71 56	**Italy & France:** A.B. MIS (HYPERTEAM) Via Monte Corono 29 10127 Torino, Italy Telephone: 11-317-3529,-3579 Facsimile: 11-618-782
New Zealand: RT Communications Sys Ltd. P.O. Box 29-167 (19 Mandeville Street, Unit 2 Riccarton) Christchurch 1, New Zealand Telephone: (03) 343-3273 Facsimile: (03) 348-8294	**South Africa:** V.I.P. Radio CC Midline Business Park, Richards Drive, Halfway House P.O. Box 5365, Halfway House 1685 South Africa Telephone: (011) 315-4493 Facsimile: (011) 0315-4494	**Sweden:** Inge Eklund, A.B Box 442, S-851 06 Sundsvall, Sweden Telephone: 46-60-151-715 Facsimile: 46-60-117-970	**United Kingdom:** Siskin Electronics, Ltd. PC Builders, 2 South St, Hythe, Southampton, England SO4 6EB Telephone: 0703-207-155 Facsimile: 0703-847-754
Canada: IES Communications, Ltd. 500 12th St. West Cornwall, ON K6J 3E4 Telephone: (613) 930-2165 Facsimile: (613) 930-4838	**British Columbia:** Burnaby Radio Comms, Ltd. 4257 E. Hastings St. Burnaby, BC V5C 2J5 Telephone: (604) 298-5444 Facsimile: (604) 298-5455	**Maritimes:** R & S Electronics 306 Prince Albert Road Dartmouth, NS B2Y 1N2 Telephone: (902) 464-0464 Facsimile: (902) 464-0090	**Maritimes:** Spectrum Amateur Sales 302 Keswick Ridge Road Mouth of Keswick, NB E0H1N0 Telephone: (506) 363-3627 Facsimile: (506) 458-9741
Ontario: Norham Radio Supply 4373 Steeles Avenue West North York, ON M3N 1V7 Telephone: (416) 667-1000 Facsimile: (416) 667-9995	**USA:** Anderson Communications 69 Page Drive Oakland, NJ 07436 Telephone: (201) 331-6945	**USA:** The Country Ham 5 Shoo Fly Circle Givhans, SC 29472 Telephone: (803) 821-8100 Facsimile: (803) 821-7019	**USA:** Den-Tronics 6102 Deland Road Flushing, MI 48433 Telephone: (313) 659-1776 Orders: 1-800-PAC-KITT Facsimile: (313) 659-1280

Here is PacComm's Latest Amateur Radio Catalog