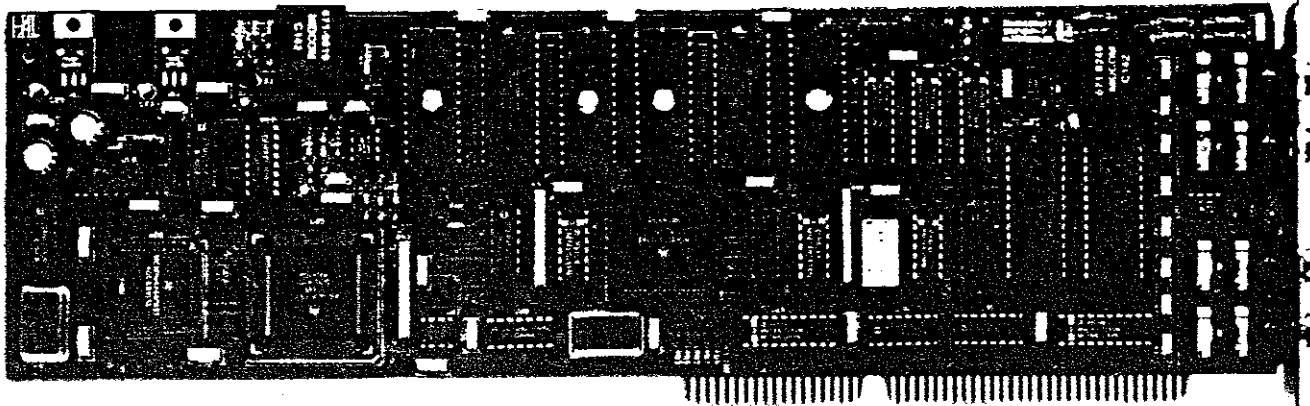




HAL COMMUNICATIONS CORP.  
1201 West Kenyon Road  
Post Office Box 365  
Urbana, Illinois 61801-0365  
Phone: (217) 367-7373 FAX (217) 367-1701

# PCI-4000 / PC-CLOVER



## CLOVER MODEM FOR HF DATA COMMUNICATION

PC-CLOVER is a hardware and software implementation of CLOVER modulation (patent pending). The modem provides bandwidth-efficient and high data rate transmission of error-corrected data in a format that is specifically tailored to meet the challenges of HF radio propagation. In ARQ modes, CLOVER modulation format is adaptively adjusted to maximize data throughput.

\* **HIGH THROUGHPUT AND BANDWIDTH EFFICIENT:** Data pulses are amplitude shaped to produce a data signal that has a -50 dB bandwidth of 500 Hz. Error-corrected data throughput as high as 500 bps is available. The CCIR emission designator for all CLOVER modes is "500HJ2DEN".

\* **MODULATION FORMATS:** The four CLOVER tone pulses are modulated using BPSK, QPSK, 8PSK, 16PSK, and up to 4-level ASK. Modulation modes may be manually or automatically selected via adaptive control (ARQ modes only).

\* **ERROR-CORRECTION:** In addition to checksum protection of each data transmission, CLOVER uses Reed-Solomon encoding which permits repair of most data errors without requiring a repeat transmission. CLOVER uses a true "error-correction" protocol rather than an "error-detect and repeat" protocol (AMTOR and packet).

\* **ADAPTIVE TRANSMISSION:** In ARQ mode, modulation, block length, and coder efficiency are adaptively chosen to produce the highest data throughput that can be supported by existing ionospheric conditions. A total of 128 unique combinations may be selected. CLOVER data throughput varies from 5 characters-per-second (cps) under poor conditions to 80 cps in very good conditions. Typical HF "speed" is approximately ten times that of AMTOR/SITOR or HF packet.

\* **DATA TRANSMISSION MODES:** CLOVER may be used in FEC mode to send data to multiple stations and ARQ mode for linked adaptive communications between two stations. Monitor mode allows listening by unconnected stations.

\* **HARDWARE:** PC-CLOVER is a plug-in circuit board that can be used in any "IBM-compatible" PC-286 or higher level PC. PC-CLOVER does not require use of any PC Serial or Parallel I/O port. Convenient rear panel jacks provide direct connection between PC-CLOVER and radio equipment. Split-screen, menu-driven PC application software is furnished with each PC-CLOVER unit.

# PCI-4000/ PC-CLOVER

## SPECIFICATIONS

### SIGNAL FORMAT:

Each 32 mSec data frame consists of 4 Dolph-Chebychev pulses interleaved in time and frequency. Each pulse is 32 mSec long and is displaced in time from the preceding pulse by 8 mSec. The first pulse in a frame is centered at an odd multiple of 62.5 Hz and the remaining 3 pulses are centered at the next three higher odd multiples of 62.5 Hz, respectively. Each pulse occupies a bandwidth of 125 Hz, measured at the -60 dB points. The composite -50 dB bandwidth of a CLOVER emission is 500 Hz. The crest factor of CLOVER modulation is 2.0.

### MODULATION FORMATS:

All modulation formats convey data in the differences between phase and/or amplitude of successive pulses at each of the 4 pulse frequencies.

**BDFV:** 4-Pulse diversity, Binary phase, 31.25 bits/sec

**BPSK:** 4-Pulse Binary Phase, 125 bits/sec

**QPSK:** 4-Pulse Quad Phase, 250 bits/sec

**8PSK:** 4-Pulse Eight Phase, 375 bits/sec

**16PSK:** 4-Pulse Sixteen Phase, 500 bits/sec

**8P2A:** 4-Pulse Eight Phase, Two Amplitude, 500 bits/sec:

Similar to 8PSK except that 8-dB amplitude shifts also occur, providing one more bit of data per pulse.

**16P4A:** 4-Pulse Sixteen Phase, 4 Amplitude, 750 bits/sec:

Similar to 16PSK except that amplitude shifts to one of four values (4 dB per step) provide 2 extra bits per pulse.

### ECC FORMATS:

Reed-Solomon codes on GF(2<sup>8</sup>) are generated and decoded with fast transform methods. The Massey-Berlekamp Algorithm synthesizes the feedback shift register which corrects the errors. Block sizes of 17, 51, 85, and 255 bytes with code rates of 60%, 75%, 90%, and 100% are used.

### DATA FORMAT:

CLOVER modulation is bit transparent. Data supplied via the PC bus is demodulated at the receiving station in exactly the same bit order. Data compression and/or encryption may be used in PC-based application software.

### DATA TRANSMISSION MODES:

FEC mode is used to send data from one station to one or more CLOVER-equipped stations. Modulation, block size, and coder rate are set manually by the transmitting station. Adaptive mode control is not available in FEC mode.

ARQ mode connects one CLOVER station to a second station. Data flow may be in either direction without the use of an "OVER" command. This is the radio analog of "full duplex" and maximizes data flow on the radio channel when large amounts of data must flow in both directions simultaneously. Automatic adaptive control of CLOVER modulation is provided in ARQ mode.

MONITOR mode allows any unconnected station with a CLOVER modem to listen to FEC and ARQ radio transmissions. Error correction is limited to the capacity of the Reed-Solomon encoder and code rate chosen by the sending station(s). Adaptive mode changes by the sending station will be followed as closely as possible by the monitoring modem, but adaptive feedback to the sending station(s) is not available in this mode.

### MODEM SIGNAL PROCESSING:

DSP56001 DSP 24-bit processor, 8Kx24 bit RAM; software downloaded from host processor.

### HOST AND PROTOCOL PROCESSOR:

68EC000 16-bit processor, 32Kx16 bit RAM, 16Kx16 bit ROM; software downloaded from PC bus.

### PC INTERFACE:

16-bit interface to "PC-AT" bus; FIFO data buffers for all transmit and receive data. PC interface may be set via option jumpers to use I/O Address mapped, poll-select access or to use PC I/O Interrupt access. CLOVER operating software is downloaded via the PC-bus.

### RADIO INTERFACE:

16-bit Sigma-Delta A/D converter for received data; dynamic range exceeds 90 dB. Audio input is 10K ohms, -60 to +10 dBm (.7 mV to 2.8 V rms). 16-bit D/A converter generates transmit modulation; spurious signals are at least 60 dB below peak output. Audio output is 600 ohms, adjustable from -40 to 0 dBm (7 mV to .7 V rms). Push-To-Talk (PTT) relay output (+50V, 100 ma). NPN open-collector SEL-CAL output (+50V, 100 ma). Tuning Indicator output ( $\pm$  1 ma). All rear panel connectors are 1/4" "stereo" jacks (AF IN, AF OUT, PTT & SEL-CAL, TUNING).

### RADIO REQUIREMENTS:

Radio equipment must be tunable in 10 Hz steps and be sufficiently stable to remain within  $\pm$ 25 Hz of the operating frequency while in communications.

### FURNISHED ACCESSORIES:

Three 1/4" "stereo" plugs and tuning meter with cable and plug; Operator's Manual, HAL PC-CLOVER software diskette.

### SOFTWARE:

**HAL PC-CLOVER SOFTWARE:** PC compatible software on one 5.25" diskette. Software features include split-screen, menu-driven commands, save-to-disk, send disk files, edit in transmit buffer, set CLOVER configuration, MYCALL entry and storage, HERE IS programmable messages.

**THIRD-PARTY SOFTWARE:** All network software authors are encouraged to write drivers for PC-CLOVER. A complete command protocol definition document is available free of charge to interested authors. Information regarding available "third-party" software will be provided to all CLOVER customers.

A written copy of the applicable warranty may be obtained free of charge upon request. Specifications subject to change without notice.



**HAL COMMUNICATIONS CORP.**

1201 W. Kenvon Road

P.O. Box 365

Urbana, Illinois 61801-0365

Phone: (217) 367-7373 FAX (217) 367-1701