**Learning Unit 11**

# Clover

***Objectives:***

Obtaining an introduction of this efficient, error-free HF digital mode.

***Student Preparation Required:***

An HF SSB transceiver.

**What is Clover?**

Clover is an advanced HF digital communication system developed in a joint venture with HAL Communications of Urbana, Illinois. Clover uses a four-tone modulation scheme. An enhanced version using improved DSP technology came along later and was officially christened Clover II, but I'll refer to the mode simply as "Clover" throughout this lesson for the sake of clarity.

Depending on signal conditions, several different modulation formats can be selected manually or automatically. Each tone is phase- and/or amplitude-modulated as a separate, narrow-bandwidth data channel. As you might guess, the resulting Clover signal is very complex.

For example, when the tone pulses are modulated using quadrature phase-shift modulation (QPSM), the differential phase of each tone shifts in 90° increments. Two bits of data are carried by each tone for a total of eight bits in each 32-ms frame. The resulting block data rate is about 250 bits per second. Clover is capable of even higher data rates when using 16-phase, four-amplitude modulation (16P4A). In this format, Clover perks along at 750 bit/s.

The complex, higher-speed modulation systems are used when conditions are favorable. When the going gets rough, Clover automatically brings several slower (but more robust) modes into play.

Even with these ingenious adaptive modulation systems, errors are bound to occur. That's where Clover's Reed-Solomon coding fills the gaps. Reed-Solomon coding is used in all Clover modes. Errors are detected at the receiving station by comparing check bytes that are inserted in each block of transmitted text. When operating in the ARQ (automatic repeat request) mode, Clover's damaged data can often be reconstructed without the need to request repeat transmissions (sort of a nonARQ type of ARQ). This is a major departure from the techniques used by PACTOR. Of course, Clover can't always repair data; repeat transmissions--which Clover handles automatically--are sometimes required to get everything right.

With the combination of adaptive modulation systems and Reed-Solomon coding, Clover boasts remarkable performance--even under the worst HF conditions. The only Amateur Radio digital mode with the potential to match Clover's performance is PACTOR II.

**Clover Handshaking**

As you may recall, PACTOR uses an *over* command to switch the link so that one station can send while the other receives. Clover links must be switched as well, but the switching takes place *without* using *over* commands.

When two Clover stations make contact, they can send limited amounts of data to each other (up to 30 characters in each block) in what is known as the *chat mode*. If the amount of data waiting for transmission at one station exceeds 30 characters, Clover automatically switches to the *block data mode*. The transmitted blocks immediately become larger and are sent much faster. The other station, however, remains in the chat mode. Because of precise frame timing, all of this takes place without the need for either operator to change settings, or send *over* commands. The Clover controllers at both stations "know" when to switch from transmit to receive and vice versa. And what if both stations have large amounts of data to send at the same time? Then they *both* switch to the data block mode. This high degree of efficiency is transparent to you, the operator. All you have to do is type your comments or select the file you want to send--Clover takes care of everything else.

Clover features an FEC mode similar to that used by PACTOR and G-TOR. You use the Clover FEC to call CQ, or to send transmissions that can be received by several stations at once. (In the Clover ARQ mode, only two stations can communicate at a time.)

**What Do You Need to Run Clover?**

The requirements for a Clover station differ somewhat from those of other HF digital modes. They are:

- An SSB transceiver. The transceiver must be stable (less than 30 Hz drift per hour). It should also include a frequency display with 10-Hz resolution. The audio output from the Clover controller is fed to the audio input of the transceiver (Clover uses AFSK, not FSK). Receive audio is supplied to the controller from the external speaker jack or other source.

- An IBM-PC computer or compatible. The computer must be at least a 286-level machine.

- A P-38 Clover controller board or a DXP38 HF modem. All Clover products are available exclusively from HAL Communications. The HAL P-38 Clover controller is installed *inside* the computer using any available expansion slot. The board uses a dual-microprocessor design and digital signal processing to achieve signal modulation and demodulation. The DXP38 HF modem, on the other hand, is an external device.

- HAL PC-Clover software. This is supplied by HAL Communications and is included with every P-38 and DXP38. It is *not* a terminal program. The PC-Clover software is the instruction set of the controller itself. It's loaded into the controller's memory each time you decide to operate. This approach makes it easy to update the controller in the future. You simply buy a new diskette or download

the software. There are also third-party programs that will function with either product.

The original Clover controllers cost approximately $1000. In the late '90s HAL introduced the P-38 with a selling price of less than $400. Then, in early 1999, the external DXP38 appeared, also selling at under $400. Both products are multimode processors. That is, they offer RTTY, AMTOR, PACTOR (HAL refers to it as "P-Mode") and Clover.

**Clover on the Air**

Most Clover-equipped stations are dedicated to relaying high-volume message traffic, often functioning as HF/Internet e-mail gateways. Although the WinLink 2000 system is primarily based on PACTOR, some stations accept Clover connections. Casual Clover operating is the exception rather than the rule, although you will find occasional keyboard-to-keyboard "live" chats.

Clover signals are relatively easy to recognize. The data bursts vary in length. Some are short, while others can last several seconds. The signals make a staccato *brrrrrr* sound rather than the chirping rhythms of PACTOR. Click here to listen to a Clover signal.

**Clover Conversations**

When it comes to on-the-air operating, Clover is different from any of the modes we've discussed so far. To call CQ, for example, you switch to the **MODE**menu, highlight **CQ** and press **ENTER**. The Clover controller sends a CW identification followed by a raucous stream of data. Unlike other digital modes, you do not see "CQ CQ CQ" flowing across your screen. In fact, you see nothing at all.

The controller sends CQ in the form of data signals that appear as CQ "flags" to other Clover stations. When another Clover operator tunes in your signal, all he sees is a statement on his screen announcing that you are calling CQ. At that point he can ignore you or press a single key to establish a Clover connection.

Once the conversation has started, you need to let the other station know when you've completed a statement. Remember that there are no *over* commands. For example:

**Hello! My name is Steve and I live in Wallingford, Connecticut. I am new to Clover. What do you think of it? >>>**

Without >>>, BTU, K or a similar symbol at the end of my statement, the other operator might inadvertently jump in after the end of the first line. This can be very confusing for everyone.

While you're watching the conversation, it's easy to get distracted by the receive/transmit status table in the upper right corner of the screen (if you're using the HAL software). The table displays the modulation format in use at the moment, the signal-to-noise ratio, tuning error, phase dispersion, error-correction capacity and transmitter output power (as a percentage of full output). The table is split into horizontal rows labeled "MY" and

"HIS." Not only do you see your own parameters changing, you see the changes taking place *at the other station.* (Clover accomplishes this feat by periodically swapping station data.) Who is enjoying the best receive conditions? Which station is doing the greatest amount of error correcting at the moment? Just look at the table!

**Clover Bandwidth**

As we've already discussed, space is a premium in the HF digital subbands. That's why it's important for any HF digital mode to be as *narrow* as possible.

With a 2-kHz bandwidth, an HF packet signal is nearly as wide as a voice transmission. You can't squeeze too many packet signals onto the band before serious interference begins.

As remarkable as it may seem, Clover manages to conduct extremely efficient communications while using only 500 Hz of spectrum. *Four* Clover signals could fit in the same amount of spectrum required for a one HF packet signal.

This narrow bandwidth is yet another prominent feature of Clover. Of course, a narrow-bandwidth signal requires more careful tuning. You can also understand why your transceiver must be very stable to operate Clover. With a 500-Hz wide signal, all it takes is a little bit of drift and you're way out of the ballpark.

For further reading on Clover, go to http://www.halcomm.com/clover2.htm