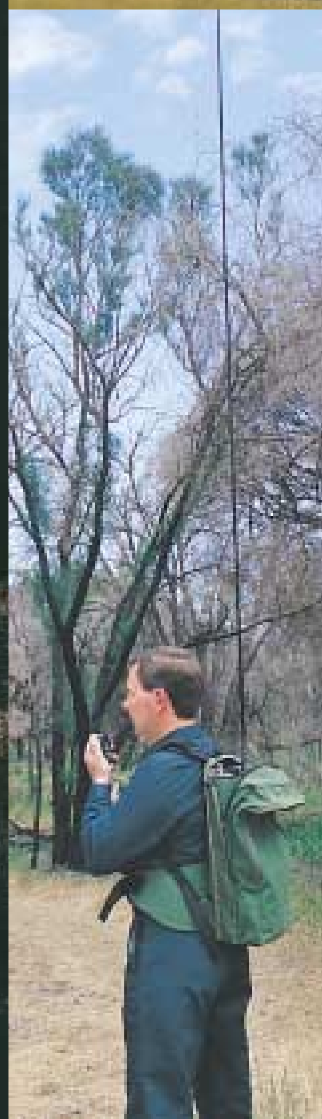
Q-MAC HF-90 FREQUENCY HOPPING OPTION



The HF-90 Frequency Hopping Option is an integral module within the HF-90 Transceiver. This option enables secure, jam-resistant HF communications to a military standard.

The development of the HF-90 Frequency Hopping Option represents a significant breakthrough in the field of military HF communications. For the first time, end users have access to a product which is affordable, yet offers a very high grade of voice security.

This new option builds on the HF-90's established reputation as the world's smallest high specification HF SSB transceiver. The addition of the frequency hopping option makes the HF-90 an attractive alternative to full Mil-Spec HF transceivers which can cost around 4 to 5 times more.

A detailed description of the HF-90 Transceiver, together with technical specifications, is provided on a separate brochure.

WHAT IS FREQUENCY HOPPING AND HOW DOES IT WORK?

Conventional fixed frequency radios are designed to transmit and receive on a single channel. This fact makes them vulnerable to Electronic Warfare (EW) techniques such as interception and jamming. Interception is the unauthorized monitoring of radio traffic, which may place the operator at a severe disadvantage. Jamming is the deliberate disruption of communication, by operating a transmitter (jammer) on the same frequency as the radio traffic. Whilst scramblers and speech encryption devices may provide some degree of resistance to the threat of interception, they are ineffective against jammers. Frequency hopping is the only effective counter measure to both forms of electronic attack.

A frequency hopping transceiver is capable of hopping its operating frequency over a given bandwidth several times a second. Synchronization data is periodically transmitted and decoded to ensure that the transmitter and receiver keep hopping in synchronism with each other, thereby maintaining intelligible communication whilst under severe electronic attack. The hopping sequence follows a pseudo random pattern, which has an extremely long repeat time. This renders the hopping network virtually impossible to intercept or jam. Only the network users who have programmed their radios with the same frequency, sideband, and hopping code can communicate.

In a frequency hopping network, one station is designated as Master (or Base). This station is responsible for transmitting the synchronization data to the Slave stations. There can be any number of Slaves within a network.

APPLICATIONS

Military and paramilitary users who require HF communications for Long Range Reconnaissance Patrol (LRRP) and Rear Link applications, are frequently faced with enemies which are capable of deploying EW systems.

Aid/relief organizations and peace-enforcement agencies may be seriously compromised in their operations, through interception and jamming of radio traffic from elements within a technically aware population.

A growing problem for military and aid organizations alike is the proliferation of low cost amateur HF radios, which can be easily modified for interception and jamming.

The HF-90 Transceiver, fitted with the frequency hopping option, presents an immediate, cost effective solution to these problems.

FEATURES

HOPPING RATE AND BANDWIDTH

The HF-90 Frequency Hopping Option has a hop rate of 5 hops per second and operates within a 256kHz bandwidth (hop band). There are 103 contiguous hop bands within the range 2 – 30MHz. The reference frequency which is selected for use by the operator determines which of the hop bands is selected. Several individual hopping networks can operate effectively (and with minimal interference to other networks) within the same hop band.

The hop speed and bandwidth have been rigorously tested and optimized for the following parameters: voice security, voice clarity, antenna bandwidth and propagation.

PSEUDO-RANDOM HOPPING

A pseudo-random (DES) frequency hopping algorithm provides the user with 7.2×10^{16} different hopping codes. This results in a sequence repeat time of 457 million years, ensuring a high level of security.

ROBUST ANTI-JAM ALGORITHM

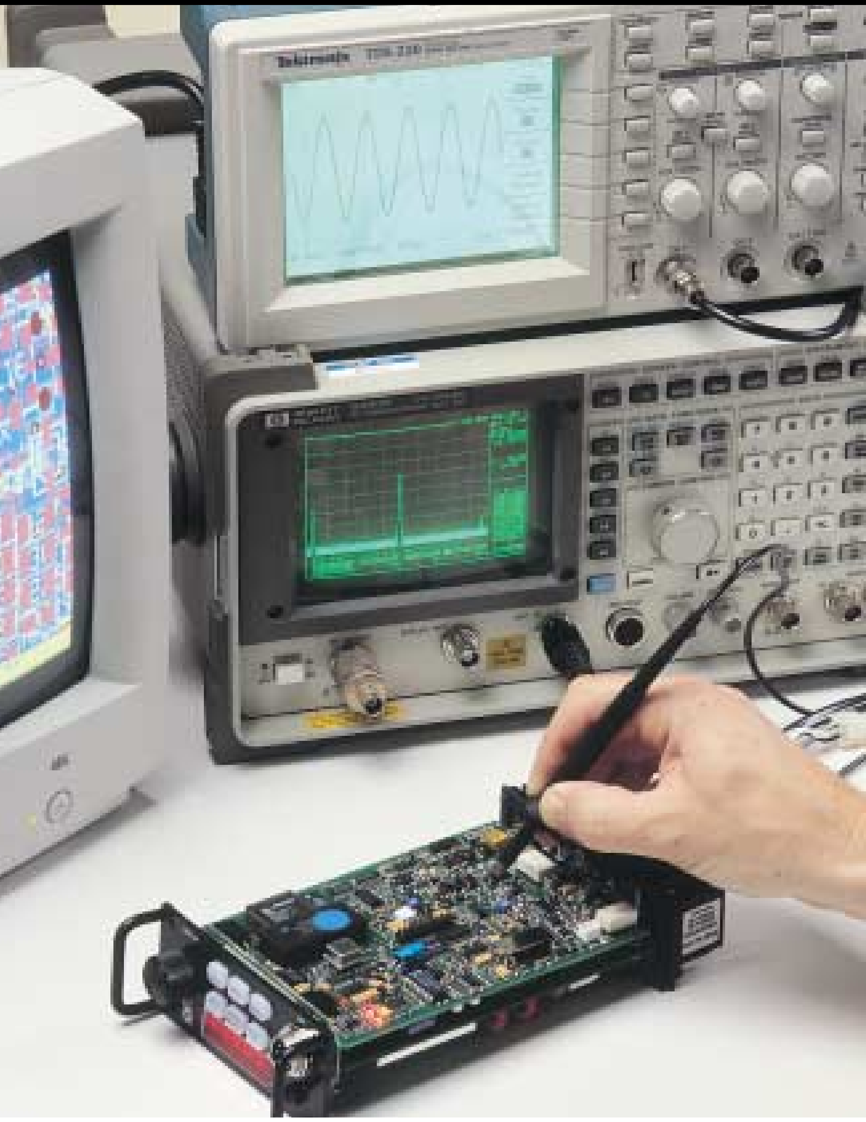
All EW techniques (such as detection, direction finding, unauthorized monitoring and jamming) are effectively countered by the HF-90's frequency hopping algorithm. Even in the presence of badly corrupted synchronization data, the demodulation algorithm, combined with the FEC coding and time frequency diversity, provides a robust anti-jam capability.

RAPID SYNCHRONIZATION

The HF-90 Frequency Hopping Option offers rapid synchronization on late entry – ie. where a network is already communicating in frequency hopping mode and an additional operator wishes to join the network. Synchronization time varies between 6 and 53 seconds (with an average of 26 seconds). Synchronization time on start-up is even more rapid, given that between 3 and 4 synchronization bursts are transmitted within the first 60 seconds of start-up. Synchronization time varies due to the pseudo random time and frequency allocation of synchronization data (bursts) sent from the Master to the Slaves.

SECURE CODE ENTRY

A unique hopping code, comprising 11 digits, must be entered by the operator from the DTMF microphone/handset keypad. The same code must be entered for each HF-90 Transceiver operating within the network. The same reference frequency and sideband (USB/LSB) must also be selected. Once entered, there is no way to retrieve the 11-digit code, thus making the code fully secure. Typically this code would be changed on a regular basis (eg. once every month during peace time and once every week during combat).



INCREASED SECURITY THROUGH USE OF SSB VOICE

In order to mount an electronic attack on a frequency hopping network, an Electronic Counter Measures (ECM) Unit must first identify the presence of the hopping network within a defined frequency range. The ECM Unit must then attempt to determine the geographic location of the hopping network and either crack the hop code or follow and jam the transmissions.

The HF spectrum is typically very crowded and contains a myriad of signals and noise (refer Fig. 3). Therefore, in identifying a hopping network, the task is made easier if the transmissions have a coherent or characteristic signature. For example, frequency hopping transceivers which use digitized voice transmissions employ Phase Shift Keying (PSK) or Frequency Shift Keying (FSK). Such transmissions are well defined and readily identifiable (refer Fig. 4).

The HF-90 (unlike many other HF frequency hopping transceivers) uses SSB voice as opposed to digitized voice transmissions. The instantaneous spectrum of an SSB voice transmission is characteristically 'noise' like (refer Fig. 5). Furthermore, there is no output whatsoever between syllables. This renders the HF-90 extremely difficult to intercept.

These differences become more apparent when observing transmissions over time (using a spectrum analyzer set to Peak Hold or Accumulate). With a digital voice hopper, the hop channels are easily identified since the output is nearly constant (refer Fig. 6). In comparison, the hop channels of an SSB hopper are more difficult to identify, since on many channels there is no output due to the voice cadence (refer Fig. 7). Synchronization channels may appear as discrete line spectra (also refer Fig. 7), given that the synchronization bursts are sent in random timeslots over a number of channels using FSK.

SMART HOPPING

When using HF on sky-wave circuits at night, many channels are blocked by strong broadcasting and fixed stations. This factor, combined with fading and multi-path propagation, leads to a very hostile HF environment. Enemy jamming within the hop set further compounds this problem. The HF-90 Frequency Hopping Option overcomes these difficulties through "Smart Hopping".

Smart Hopping enables avoidance of blocked channels (refer Fig. 1 & 2). The network acquires information on the signal strength of each channel within the hop set. All network members receive this data automatically and consequently blocked channels are avoided. Continuous updating occurs in order that changing band conditions are accommodated.

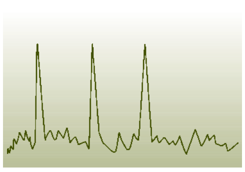


Figure 1
Spectrum display of congested hop band 256kHz wide. Broadcast stations and jammers present.

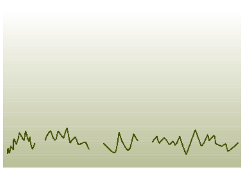


Figure 2
Display shows effect of Smart Hopping ie.conjestion removed from hop set. Blocked channels avoided.

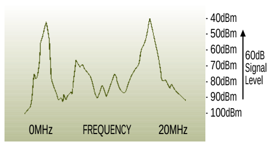


Figure 3
Typical HF spectrum occupancy.

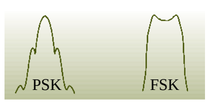


Figure 4
Instantaneous spectrum view of HF digital voice hopper.

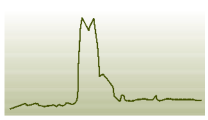


Figure 5
Instantaneous spectrum view of HF SSB voice hopper.

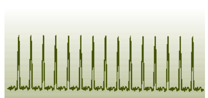


Figure 6
Wideband spectrum of HF digital voice hopper, accumulated over time.

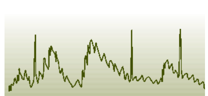


Figure 7
Wideband spectrum of HF SSB voice hopper (inc. FSK sync bursts), accumulated over time.

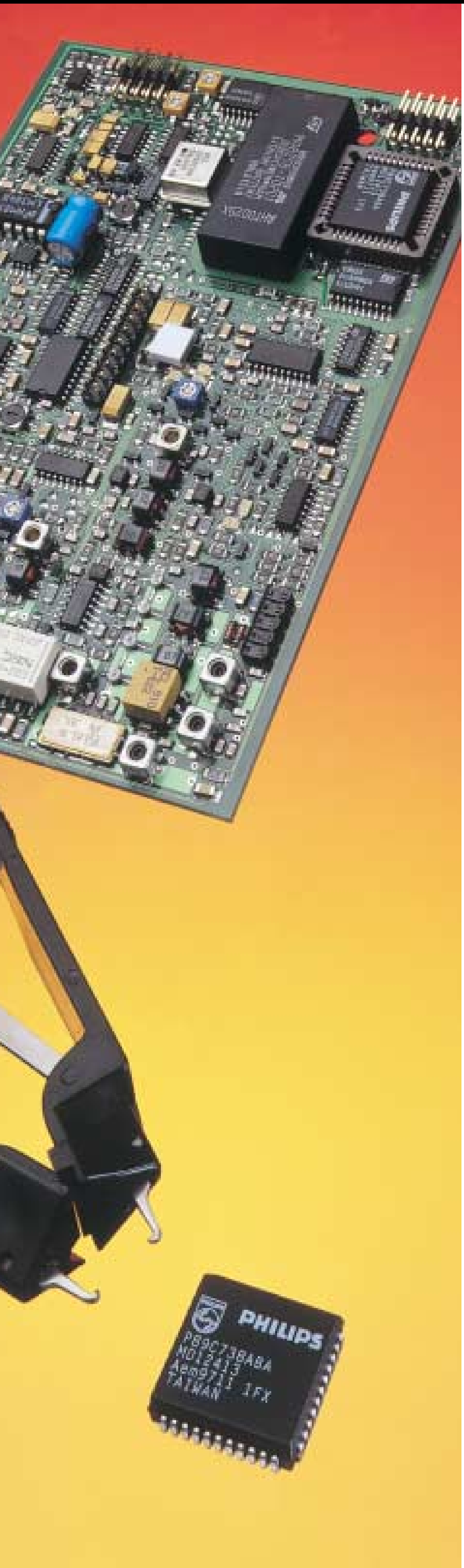
SIMPLE OPERATION

Despite its complex design, the hopping function within the HF-90 Transceiver is extremely simple to operate. It is accessed from a single key on the front panel.

The transceiver display clearly indicates fixed/hopping status at all times. The following modes are differentiated:

- Fixed frequency mode
- Hopping mode – not synchronized
- Hopping mode – synchronized (receiving sync bursts)
- Hopping mode – synchronized (no longer receiving sync bursts)

Setup parameters (including Slave/Base setting, Smart Hopping status and the 11-digit hopping code) are entered via the DTMF microphone/handset keypad.



SELCALL FACILITY IN HOPPING MODE

The HF-90 Transceiver incorporates a Selcall facility which can be used in frequency hopping mode, as well as on a fixed channel. When operating in frequency hopping mode, Selcalls may only be sent/received between transceivers within the hopping network.

LOW POWER CONSUMPTION

The HF-90 Transceiver is very power efficient in frequency hopping mode, given that it employs SSB for voice transmissions. With SSB there is no output between speech syllables, whereas alternative digital methods produce output continuously on speech. The low power consumption of the HF-90 Transceiver means it is ideally suited to manpack/portable roles.

RETROFITTING TO EARLY VERSION HF-90

The HF-90 Frequency Hopping Option may be ordered together with the HF-90 Transceiver, in which case it is provided as an integral module within the transceiver. Upgrade kits are also available for retrofitting this option to existing HF-90 Transceivers.

TECHNICAL SPECIFICATIONS

A detailed description of the HF-90 Transceiver, together with technical specifications, is provided on a separate brochure.

HF-90 FREQUENCY HOPPING OPTION

Mode:	SSB (J3E) speech plus FSK sync.
Hop rate:	5 hops per second
Hop channels per hop band:	256
Hop Bandwidth:	256kHz (approx 1/4 MHz)
Number of hop bands:	103 contiguous bands in the range 2-30MHz.
Hop band selection possible:	Yes (reference frequency determines which pre-set hop band is utilized).
Hop sequence:	Pseudo-random
Sync burst length:	0.9 sec (extended dwell)
Sync burst repetition rate:	Pseudo-random
Late entry & sync time:	Minimum 6 seconds Maximum 53 seconds Average 26 seconds*
Number of sync channels:	8
Sync channel allocation:	Random at time of code selection.
Hop code entry:	11 decimal digits, via DTMF mic/handset keypad.
Hop code binary size:	56 bits
Number of code combinations:	7.2×10^{16}
Hop algorithm:	Modified DES

**Synchronization time on start-up is even more rapid. Typically 3 or 4 synchronization bursts are transmitted within the first 60 seconds of start-up.*

Specifications are subject to change without notice.

Represented by:

Q-MAC Electronics Pty Ltd (ACN 054 566 684)

PO Box 1334, Osborne Park Business Centre, Western Australia 6916
Phone +61 8 - 9242 2900 **Fax** +61 8 - 9242 3900
Email sales@qmac.com **Web** http://www.qmac.com