HC908 VFO

Operator's Manual

(Firmware version 3)

HC908 VFO mounted in optional Ten-Tec TPC-49 enclosure

*The **HC908 VFO** is a full-featured VFO capable of high-quality signal generation up to 60 MHz, with features making it uniquely capable within Amateur Radio markets: a high-contrast back-lighted display, a single encoder control, multiple memories, flexible IF offset and multiplier settings to accommodate a wide number of radio design architectures, modular controller (HC908 Daughtercard) and signal generator (DDS-60 Daughtercard), 40 bits of available digital and analog I/O for custom use, an advanced menu system for easy access to all features, and a built-in serial port providing field upgradeability by allowing the owner to download and update the VFO with improved software versions when available. The **HC908 VFO** is available as a single printed circuit board that may be used with an optionally-purchased standard enclosure or in a custom project chassis. The software source code is freely available for developers to modify and extend the VFO capabilities using a free and powerful development suite from P&E Micro.*

Features

- Continuously-adjustable VFO from 400 kHz to 60 MHz

- Displays frequency digits: two for megahertz, three for kilohertz, hundreds and tens. (Display of single Hertz digit in next release.)

- Flexible cursor movement to digit desired for changing via Dial

- Four easily set and programmable memory buffers available

- IF Offset buffer provided to add to or subtract from the active frequency buffer;

- 1x (direct), 2x or 4x frequency multiplier allows scaled use with SoftRock and other over-clocking architectures

- Currently displayed frequency stored in EEPROM after 20-second dial press, and displayed at next power-up.

- Backlight timeout logic for auto power saving

- 17 preset frequency bands may be selected via menus to conveniently establish initial dial frequency, and Start and End frequencies for subsequent frequency Sweep operation

- Additional Custom Band may be programmed to establish user-defined Start frequency, End frequency and Step Size for subsequent frequency Sweep operation

- Frequency Sweep function automatically and repeatedly sweeps the frequency generated by the VFO from the Start frequency, to the End frequency, in increments of Step Size. (e.g., useful as input to a filter for automated frequency response measurements.)

- High-precision, low power DDS signal generation by the DDS-60 daughtercard (default) for operation up to 60 MHz, or the DDS-30 (menu-selectable) for operation up to 30 MHz

- VFO may be calibrated against known 10 MHz reference (or WWV);

- Powerful 8-bit microcontroller controls all aspects of the operation

- Automatic scanning results displayed as frequencies with lowest SWR

- Configurable frequency scanning limits and step sizes

- Serial port connects to PC for field-upgradeable software

- Features in development: frequency display to units Hertz digit, dual VFOs, A/B split operation, IF-VFO, Rx and Tx frequency scaling, increased frequency memory buffers, remote control and data collection via serial port;

- Source code freely available and downloadable from website.

- SDK available describing software architecture and development guidelines per the P&E Micro WinIDE development environment (also freely available).

Menu Organization

The HC908 VFO user interface is represented by the Menu Organization diagram below, wherein two separate levels of menus are available (MEM and MAIN) as controlled by the tuning dial. The dial is a rotary encoder that also contains a pushbutton, such that two basic functions (turn CW/CCW, and pushbutton) are present with this control.

The VFO powers up into the MEM "memory buffer" menus, shown in blue on the left, and when first turned on the Frequency Display shows the contents of MEM buffer 0, as indicated by the number shown at the left end of line 1. The initial contents of MEM 1 is 7,030.00 kHz, unless it is changed (and saved) in subsequent operations. (More on this in a bit.) Whenever power is again applied to the VFO, the display will show the contents of whatever memory buffer was last saved.

And of course, whatever is showing in the Display is the frequency of the signal being generated by the VFO.

At power-up, the user interface "focus" is in the frequency Display, and when the dial is turned the digit with the cursor beneath it (i.e., the underline) is the digit that changes. See the next section "Adjusting the Frequency" for more details regarding the tuning operation.

In order to change the interface focus to the menus, a simple tap of the dial pushbutton is needed. When this is done, the menu item is shown on line 2 of the display.

The first menu item to appear after tapping the dial is MEM 0, assuming we are starting from the default power-on state. Rotating the dial counter clockwise (CCW), will sequentially show the other available memory buffers, as well as two special menu items that we'll describe in a moment.

Whenever a MEM number is displayed on line 2, the user may activate that buffer by tapping the dial. This action

moves the contents of that buffer to the frequency Display and the VFO immediately generates that new frequency. The new memory buffer number is also displayed on the left end of line 1.

So in this way, you may quickly move to a new memory with a tap, rotate and tap operation.

Adjusting the Frequency

Frequency is changed by adjusting a single digit indicated at the point in the display where the cursor (underline) is. Upon power-up of the VFO, the 10 kHz digit is the adjustment point, as shown by the digit with the cursor in the MEM Menu diagram.
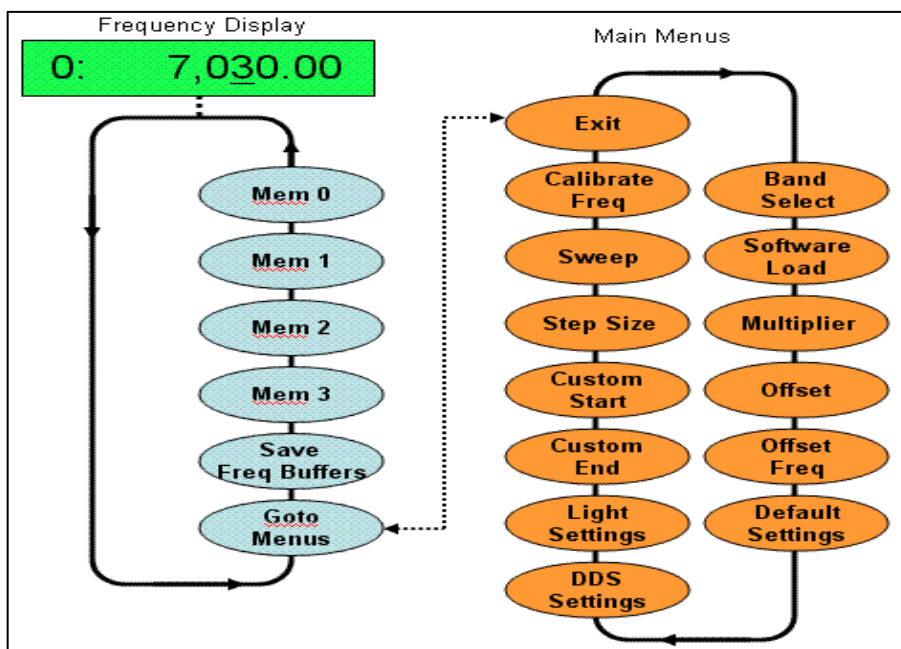
To move the cursor to a different digit to be adjusted, press the dial pushbutton while simultaneously turning the dial. The cursor will move to any of the seven available digits, allowing subsequent up/down adjustment of that digit with the dial pushbutton is released.

Rotating the dial clockwise will increase the digit value and, correspondingly, the signal generated by the VFO. Counter-clockwise rotation will decrease the digit and the generated signal.

When the digit is incremented past 9, or when it is decremented past 0, the digits above the selected adjustment point are rolled up or down, respectively. The digits lower than the digit at the cursor will not change.

Using this frequency adjustment scheme, the user can conveniently pick an "increment" digit and manually change frequencies with the desired granularity. Rough changes can manually be done by positioning the cursor under the 100 kHz digit or the 1 MHz digit, giving a wide and course change of the frequencies with a quick twist of the dial. The signal frequency can then be set to the area of

interest and the cursor set to a lower granular digit (e.g., 10 kHz or 1 kHz) in order to adjust to a more specific value.

Setting the Frequency into a Buffer

Once you have adjusted a given MEM buffer to a frequency of interest, you may wish to "set" it more permanently into that buffer. "Setting" a frequency will save it in that buffer while you remain in the MEM buffer menus, and this is done by pressing-and-holding of the dial pushbutton for about 3 seconds, at which point the display will indicate "Frequency set!".

You could then move on to each of the other MEM buffers and set those in a similar manner, perhaps setting up each buffer to be the QRP frequency for different bands. You can quickly check all memories using the tap-rotate-tap method described previously.

Saving the Frequency Memory Buffers

Before you exit the MEM menus, you should save the frequency buffers away to nonvolatile memory so they will be present when you turn the VFO on next time. You can do this by selecting the menu item called Save Freq Buffers. Once you tap the dial to select this operation, a "saving …" message will be displayed for about five seconds while the controller put the contents of the memory buffers to nonvolatile EEPROM. (Note: This time will be reduced in future software releases, as the delay is annoying after you experience it several times.)

Accessing the MAIN Menus

As described thus far, most of the normal, everyday actions take place in the BAND Menus: setting frequencies into the memories, changing the display (and generated) frequency, and saving the memory buffers away to nonvolatile storage.

But there are many more less-often-used functions in the HC908 VFO, and these operations are located in the MAIN Menu. This is the orange stack of menu items shown on the right side of the Menu Organization diagram on the previous page.

To access the MAIN menus, dial up the menu item called Go To Menus in the BAND Menu, tap the dial to select it and control will then be transferred to the MAIN Menu with Exit shown on line 2. At this point you will have the ability to turn the dial and rotate the menu stack as indicated in the Menu diagram.

Exit

The first item to show in MAIN Menus is Exit, which is the exit portal to get back to the MEM menus.

Setting the Band

Turning the dial the the Band Select position and selecting it by tapping the dial will bring up a BAND sub-menu of choices: 1-10 MHz, 10-20 MHz, 20-30 MHz, 1-30 MHz,

160m, 80m, 60m, 40m, 30m, 20m, 15m, 10m, and "Custom Band". The idea is that selecting a given band, or a preset range of frequencies will allow you to more quickly go to a given frequency when you exit back to the MEM menus. In this case the starting point of that band segment is placed into MEM 0 and is displayed and generated. This is a convenient way to go to your favorite band, no matter where it is, with a couple taps of the dial.

And if you have a special frequency range you wish to use on a regular basis you can select Custom Band, and then set the Start and End frequencies for this band segment, as described in the next sections.

Sweep Freq

A special feature of the HC908 is its ability to continuously sweep the generated frequency across a specified band segment. On an oscilloscope or spectrum analyzer, you would see the fundamental signal quickly moving from the band Start frequency to the band End frequency, at an increment frequency Step of 10 kHz. This type of function can be useful when providing a varying input frequency to a filter, crystal or front end of a receiver while simultaneously monitoring the target's output … thus one dimension of its transfer function may be easily determined using the HC908 VFO.

The Start frequency, End frequency and Step size are all specified in their own menu functions (described next), thus giving you the flexibility of how much granularity to use in sweeping across the given band segment.

Start Freq

Just select Start Freq and then dial-in the desired starting frequency using the same techniques as used when setting the main frequency.

End Freq

Just select End Freq and then dial-in the desired ending frequency using the same techniques as used when setting the main frequency.

Step Size

Just select Step Size and then dial-in the desired digit to increment upon each automatic frequency change when the Sweep Freq function is in effect.

Set Scan Step Size
This function allows the user to select the step size to be used for the Scan operation. Available step sizes are 100 kHz, 10 kHz, 1 kHz (default), and 100 Hz.

BackLight Settings

You have the ability to have the LCD backlight automatically turn off after a present number of minutes, thus lowering the current load on your power supply, which can be a useful feature for field applications of the VFO.

When you select the Backlight Settings menu, you are able to set the timeout period, in minutes. If the timeout is set to 00, the backlight will never come on. If the period is set to anything else up to 19 minutes, the backlight will turn off after than many minutes of quiet activity (i.e., untouched dial).

As long as the backlight time period is greater than zero, the timer gets reset every time the VFO dial is touched. So in this way with regular interactive operation on the bench, the backlight will always stay on. Only when the dial has been untouched for the period of time set in this timeout control, the backlight will turn off.

Default Settings

This menu function restores the default settings of all data stored in nonvolatile EEPROM memory. It is essential to perform this function each time that a new software version is loaded into the VFO.

Calibrate Frequency

This feature allows you to adjust the internal DDS reference clock. When properly calibrated, the frequency dial will indicate very accurately the frequency being generated by the VFO. The VFO frequency is set to 10,000.00 kHz and the dial is used to vary an internal calibration factor that moves the actual frequency up/down in 1-Hz increments. Thus when the signal being generated by the VFO is read by a high-quality frequency counter, or when the signal is zero-beat against WWV (for example), you can adjust the generated signal to be as accurate as possible compared to the reference. Once the best setting is achieved, pressing the dial will save the frequency correction factor to nonvolatile memory and the VFO frequency display will forevermore reflect that same accuracy throughout its operational range.

DDS Selection

This menu item allows you to change from the default use of the DDS-60 Daughtercard and specify that the VFO should use the older (but still popular) DDS-30 Daughtercard. The only difference in operation is that the maximum usable frequency is 30 MHz instead of 60 MHz.

Frequency Offset

This menu item allows you program the IF Offset frequency buffer, much in the same way that you set the main frequency display during VFO use.

Once the Offset frequency is set, you are presented with the choice to apply the offset as …

- **PLUS** – i.e., Displayed freq + Offset buffer

- **MINUS** – i.e., Displayed freq – Offset buffer

- **OFF** – no offset operation

Freq Multiplier

This menu item allows you to scale the displayed frequency in order to, for example, more easily drive the popular SoftRock over-clocking type of radio architectures.

When selected, you are given the choice to select …

- **4x** – 4 times the displayed frequency is generated

- **2x** – 2 times the displayed frequency is generated

- **1x** – The displayed frequency is generated (default)

Appendix A – Loading New Software Into the HC908 VFO

This appendix overviews a way you can load an updated software program into the HC908 VFO, as provided on the Midnight Design Solutions website.

BACKGROUND

Increasingly today, microcontrolled projects have an ability to be "field updated" with new capabilities and software updates made available by the designer. So instead of needing to send your instrument back for re-programming to get these new features, you can now simply download the program update from the Midnight Design Solutions website and send it to the VFO, and the instrument will automatically update its internal memory with the new program. What a great way to keep your project completely up to date with the latest features!

PC REQUIREMENTS

- Computer (at least 33 MHz Intel 486)
- Windows 95, 98, 2000, or XP. (Windows Vista may work.)
- RS-232 serial port. A USB-to-Serial converter may not work for computers having only this type of serial port.
- Terminal emulator program. You can freely download TeraTerm at http://hp.vector.co.jp/authors/VA002416/teraterm.html. It's easy to install the program. We will assume this terminal program is being used in the following discussion on usage.

USAGE

1. Download the latest VFO software from the Palstar website located at www.palstar.com/zm30. Save the S19 file to a known location on your PC (like in your desktop folder.) The S19 file is the file with the ".s19" extension to its filename. This is a text representation of the binary image to be loaded onto the VFO.

2. Connect your VFO to the PC using a standard, straight-through male-female DB9-type serial cable. Do not use a null modem cable that swaps pins 2 and 3 from end-to-end.

3. Start up the TeraTerm program on your PC. If not already set up, configure the communications as 9600 8N1, no flow control (in the Setup ➔ Serial Port menu).
    Very important: You must have the line delay set to at least "40ms/line".
    Make sure that you have TeraTerm configured to be using the active serial port in your PC. Be certain that no other program has control of the serial port – e.g., if your Palm HotSync program is running, as evidenced by its icon in the system tray in the lower right of the screen, you must quit that program by right-clicking the icon and select "exit".)

4. Issue the **Software Load** command in the VFO menus. The program called "HCmon" will display its sign-on message on the PC screen.

5. Type **C** to clear out memory on the VFO. See the C character echoed to the screen and the HCmon> prompt displayed again.

6. Type **L** to load new program. See message "…waiting …"

7. Pull down **the File ➔ Send File** menu.

8. Navigate to where you saved the *.s19 file.

9. Once in the folder that contains **hc908vfovX.s19** file, select that file and click the Open button. ***Very Important: Be careful to only load S19 files!*** If you mistakenly select any other file extension, it is very likely that you'll mess up the bootstrap loader program.)

10. See line after line of ASCII data displayed in short one-second bursts. This will continue for about 2 minutes until the entire program has been sent to the VFO and has been flashed into its memory. **DO NOT INTERRUPT THIS PROCESS!!** When it is complete, the **HCmon >** command prompt will be displayed again.

11. Disconnect the serial cable and power-cycle the VFO to start the newly-loaded program. You will see the new version number presented in the LCD sign-on message.

12. ***Very Important:*** The first thing you must do after loading new software is to go into the SETUP menu and select the Default Settings item. This will synchronize the internal nonvolatile EEPROM memory in your VFO with the new software you just loaded. (If this step is omitted, strange things are likely to happen, like the beeper sounding when it shouldn't, or some unusual impedance results being shown.)

IN CASE OF SOFTWARE LOADING PROBLEMS

The normal indication of new software being successfully sent to the VFO is seeing line-after-line of nicely-formatted text data being displayed to the PC terminal screen, as indicated in Step #10 above.

However if this process is interrupted for some reason (such as your computer accessing the Internet in the background, or you task switching over to another program), the PC data
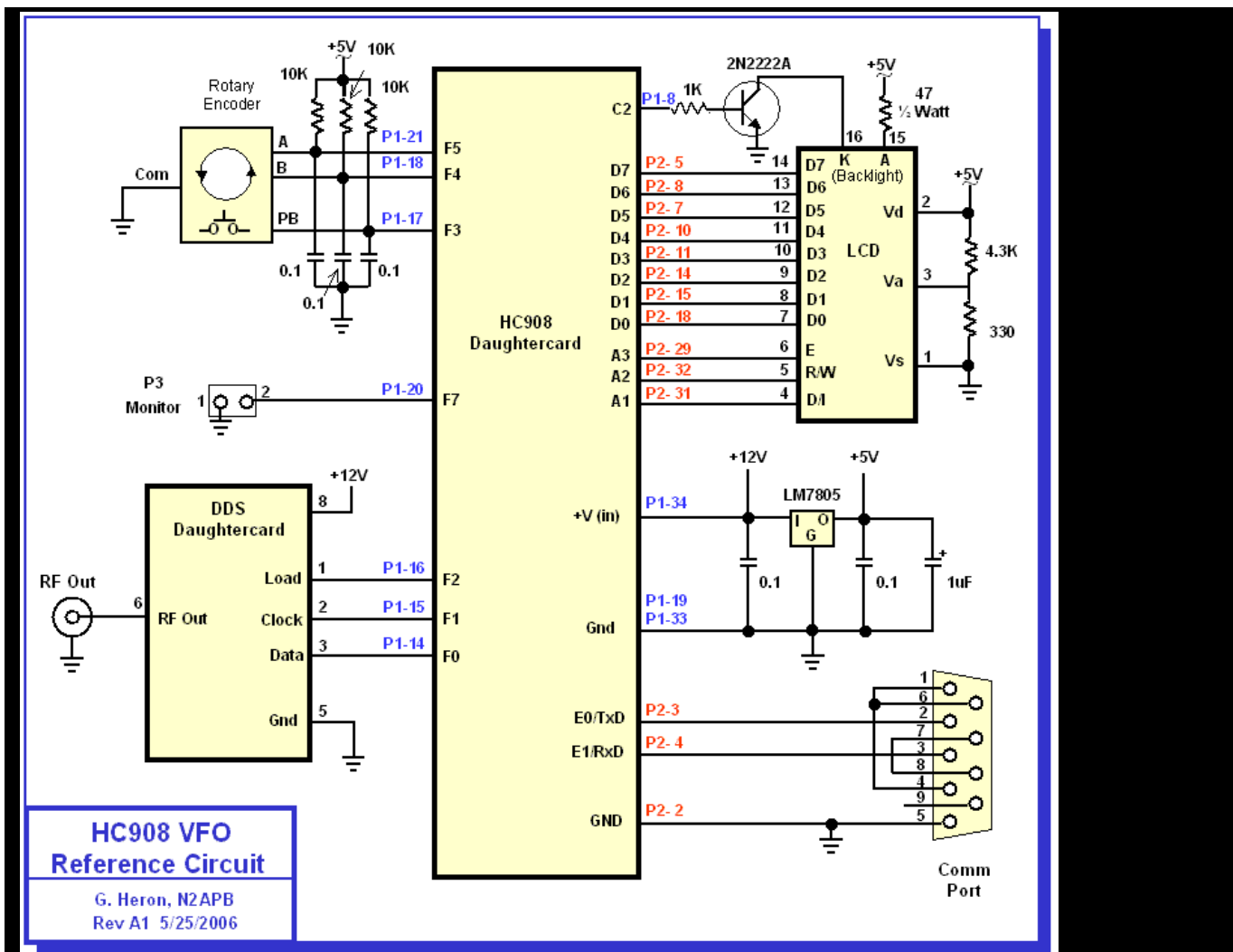
link to the VFO can get out of sync, resulting in either a complete stopping of the scrolling data lines, or unusual and unformatted data continually being displayed to the screen. Neither of these conditions will end in a successful display of the HCmon prompt and the software memory of the VFO will be left blank … brain dead.

But all is not lost! There is an alternate way to load new software into your VFO.

ALTERNATE LOADING METHOD

1. Remove power from the VFO.

2. Locate the two 2-position pinheader on the pc board labeled "P3/Mon"

3. Place a shunts (small jumper) across this pinheader, ensuring that each of the two pinheader pins are shorted.

4. Connect your VFO to the PC using a standard, straight-through male-female DB9-type serial cable. Do not use a null modem cable that swaps pins 2 and 3 from end-to-end.

5. If not already running, make sure that TeraTerm (or some other terminal program) is running on your PC.

6. Power-up the VFO again by plugging in the external power cable, or by inserting the battery that was previously removed.

7. You should immediately see the HCmon program display its sign-on message to the PC screen.

8. Proceed as before in steps 5-11 above, copied below for easy reference …

    a. Type **C** to clear out memory. See the C character echoed to the screen and the HCmon> prompt displayed again.

    b. Type **L** to load new program. See message "…waiting …"

    c. Pull down **the File ➔ Send File** menu.

    d. Navigate to where you saved the *.s19 file

    e. Once in the folder that contains **hc908vfovX.s19** file, select that file and click the Open button. (Be careful to only load S19 files! If you mistakenly select any other file extension, it is very likely that you'll mess up the bootstrap loader program.)

    f. See line after line of ASCII data displayed in short one-second bursts. This will continue for about 2 minutes until the entire program has been sent to the VFO and has been flashed into its memory. DO NOT INTERRUPT THIS PROCESS!! When it is complete, the **HCmon >** command prompt will be displayed again.

9. Disconnect the serial cable and power down the VFO.

10. Remove the P3/Mon jumper.

11. Power the VFO on again to start the newly-loaded program. You will see the new version number presented in the LCD sign-on message.

HC908 VFO Reference Circuit

G. Heron, N2APB
Rev A1 5/25/2006

PARTS LIST

Description	Vendor / Part Number
Resistor, 330, 1/8 W	Mouser: 270-330
Resistor, 4.3K, 1/8 W	Mouser: 270-4.3K
Resistor, 10K, 1/8 W	Mouser: 270-10K
Resistor, 4.3K, 1/8 W	Mouser: 270-4.3K
Resistor, 1K, 1/8 W	Mouser: 270-1K
Capacitor, 1 uF, Electrolytic, SMT	DK: PCE3045CT-ND
Capacitor, 10 uF, Electrolytic	Mouser: 140-XRL16V10
Voltage regulator, 3-terminal, 7805	Mouser: 511-L7805 ABV
Transistor, NPN, 2N3904, TO92	DK: 2N3904D26ZCT-ND
BNC, pcb mount	Mouser: 523-31-5538-10-RFX
Serial port connector, DB9F	Jameco 104951
Coaxial power connector, 2.1mm	Mouser: 163-5004
Socket, 1x8 pos'n	Excess Solutions
Pinheader, 2x34 (HC908) (cut 2 from 2x72 strip)	Mouser: 517-710-03-36
Display, LCD, Hantronix, 16x2 STN, GRAY	Mouser: HDM16216H-5-S00S
shunt, 0.1", 2 pos'n	Mouser: 571-3828115
Rotary Encoder	Cam RPC Electronics 100-1166-191

Appendix D -- Specifications

- **Frequency Generation & Control:**
  - 400 kHz to 60 MHz (may extend down to 1 Hz by changing coupling cap on DDS-60 card)
  - Source Impedance: 50 Ohms
  - Stability: +/- 50 ppm
  - Spectral Purity: Harmonics down >-35 dB beyond 60 MHz
  - Step Size: User configurable increments of 10 Hz, 100 Hz, 1 kHz, 10 kHz, and 100 kHz

- **RF Output:**
  - Adjustable, 0-4 Volts p-p (typical)

- **Power Supply:**
  - External: 9-to-16.0 Volts DC
  - Internal: Eight AA-cells, alkaline or NiMH
  - Current Requirements: 200 ma (typical)

- **User Interface:**
  - Rotary Encoder: "Tuning", 24-position/rotation, with built-in pushbutton
  - 2-line x 16-character LCD display, with optional backlight under software control, configurable in menus. Backlight may be configured to turn off after user-set period of inactivity. If enabled, backlight turns on again when any of the controls are touched.

- **Connectors:**
  - External Power: 2 pin header
  - RF Out: 2 pin header
  - Serial Port: 3 pin header
  - Bootloader: 2 pin header

- **Environmental**
  - Temperature: 0-70C
  - Humidity: 0-100% RH

- **Dimensions**
  - PCB: 3" x 2"

- **Weight**
  - 4 oz

- **Frequency Memories**
  - 4, user programmable

- **IF Offset**
  - 0 to 60 MHz

- **Frequency Prescale factors**
  - 1x, 2x or 4x

- **Supported Bands**
  - 1-10 MHz, 10-20 MHz, 20-30 MHz, 1-30 MHz, VHF (30-60 MHz)
  - 160m, 80m, 60m, 40m, 30m, 20m, 17m, 15m, 12m, 10m, 6m, Direct

- **Field Programmability**
  - Via RS-232C serial port: 9600 baud, N81, with standard terminal emulator on PC

- **Controller**
  - Standard HC908 Daughtercard

- **Signal Generator**
  - Standard DDS-30 Daughtercard (for VFO operation up to 30 MHz)
  - Standard DDS-60 Daughtercard (for VFO operation up to 60 MHz)

Appendix E -- Support, Service and Warranty

Technical Support

If you experience any problems with the HC908 VFO, or if you have any questions relative to its operation or specifications, please contact Midnight Design Solutions at support@midnightdesignsolutions.com. Be sure to visit the HC908 VFO product website at www.midnightdesignsolutions.com to check for product updates and other technical information**.**

Limited Warranty

Midnight Design Solutions LLC warrants products manufactured by it to be free from defects in material and workmanship under normal use and service **for a period of one (1) year from the date of delivery to the buyer** (the "Warranty Period"). Midnight Design Solutions LLC's obligation under this warranty is limited to repair or replacement of the product at its option at the factory in Baltimore, MD.

Effective only when the product is returned to the factory with all transportation charges prepaid and examination of the product discloses in Midnight's judgment, to have been defective during the Warranty Period.

The Warranty Period shall not extend beyond its original term with respect to interim in-warranty repairs by Midnight. This Warranty Period shall not apply to any product which has been repaired or altered by anyone other than Midnight without prior written authorization.

Warranty does not extend to any products which have been subject to damage from improper installation, application or maintenance in accordance with the operating specification.

Midnight Design Solutions neither assumes nor authorizes any person to assume for it any obligation or liability other than herein stated.

Repair Policy

When sending in a product for service, please "double" box it carefully and ship it insured for your protection. Please include a note clearly describing the problem, how you wish the item returned and how you wish to pay for the service. Package your radio properly. Midnight Design Solutions LLC is not responsible for merchandise damaged in shipment. Our service rate is $30 per hour (1/2 hr. minimum).

Return Policy

All returns must receive prior authorization from Midnight. Returned items must be received in original— AS SHIPPED– condition including the original box, manuals, accessories, and copy of sales receipt. Returns must be within 14 days of purchase. Returned items are subject to a 25% restocking fee. Shipping is not refundable.