

NANO - DV

World's Smallest Plug & Play Personal Hotspot
for D-Star, DMR, C4FM, P25 and dPMR



User's Manual

REVISION 1.03

Micro-Node International, Inc. - Henderson, Nevada



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1.0 CAPABILITIES OF THE NANO-DV PERSONAL HOTSPOT

The Nano-DV is a small stand alone personal hotspot that allows linking with D-STAR DCS, XRF, REF, DMR as well as Fusion C4FM, APCO-P25 and dPMR reflectors.

Nano-DV is a complete Plug and Play embedded solution that only requires an internet connection (Wired CAT5 or WiFi) and a 5VDC@500ma maximum power source.

The Nano-DV incorporates a simple to use and comprehensive software package developed by DG8FAC (Stefan Reimann), DG1HT (Torsten Schultze) and DJ0ABR (Kurt Moraw). In addition, the above software was customized for use with the internal 320x480 LCD touch screen by DL5KV of KW-Soft.

2.0 OPERATING MODES

Digital ham radio repeaters are connected via reflectors allowing for worldwide connections from one repeater to another. With the Nano-DV hotspot you create your own connection to a particular digital reflector network and gain access to all connected ham radio repeaters. When connected all voice communications on the connected reflector will be transmitted and received by the hotspot's built-in 70cm transceiver.

The Nano-DV hotspot is the ideal solution for mobile operation or when you don't have access to a local digital repeater. e.g. inside buildings or traveling in remote locations. When using the hotspot you use your own call sign and reduce your transmit power to just enough to cover your living area for reliable communication.

3.0 DIGITAL MODES OF OPERATION

The Nano-DV can be used with five different digital modes.

D-Star

D-Star was developed in Japan 1999/2000 especially for ham radio and due to its clear and relative simple user interface the worldwide leading system. Voice is being transformed by the AMBE Vocoder into a compressed digital data stream of 3600 bits/s. In addition there is a data channel with 1200 bits/s for a total data rate of 4800 bits/s. This data signal modulates a carrier, so that a logical 0 is one frequency and a logical 1 a second frequency. This is called 2FSK (two frequency shift keying) or GMSK (which is the same, however the signal is utilized with a Gauss curve). This signal can be used to modulate most FM transceivers (via the packet radio socket). This is the reason why there are many homemade D-Star solutions.

There are three D-Star reflector systems in use today.

- DCS Reflectors (the system with widest use)

- D-Plus REF reflectors (mostly in the English speaking countries)

- X-Reflector system which plays a minor role.

Nano-DV enables communication with all three systems.

DMR

DMR is a system designed for commercial applications. This is evident in the user interface where numbers are used in lieu of call signs. DMR modulates with 4FSK, indicating that it uses 4 frequencies (compared to D-Star with 2 frequencies). This allows to double the data rate to 9600 bit/s. This higher rate allows the transmission of 2 channels at the same time (2 time slots). The DV4mini always operates in time slot 2 and in simplex mode. The radios must be configured accordingly. Today there are two DMR networks in use. One based on Hydra technology and the other on Motorola. The Nano-DV checks in to the Hytera network. However if Motorola repeaters have installed the appropriate software they can also be reached. DMR reflectors have numbers in the range of 4000 to 5000, each region has its own reflector which can be selected in the Nano-DV menu.

C4FM-Fusion

C4FM-Fusion is a system developed by YAESU It is similar to DMR as it uses 4FSK, and transmits using 4 frequencies with a total data rate of 9600 bits/s. It also uses the same AMBE+ Codec as DMR, but needs only 3600 bits/s. The extra bits are used in C4FM-Fusion in a different way. They can be utilized for data transfer (e.g. GPS) but also for additional error correction to make the speech more robust during interference. There is also a mode for high speech quality which uses all bits for speech only.

C4FM -Fusion reflectors are named FCS001 etc. All Nano-DV's connected to a reflector can hear each other.

It is very easy to connect a C4FM-Fusion repeater to the FCS reflector system. Just put a Nano-DV next to the repeater and enter the reverse RX/TX frequencies.

dPMR

dPMR is a system adopted by the ETSI (the European Telecommunications Standards Institute) and developed into a European Standard. dPMR became an open, non-proprietary EU standard and was published under the reference TS 102 490 (License-free) and TS 102 658 (Licensed).

dPMR uses FDMA to divide the 12.5kHz channel in to two 6.25kHz sub-channels. dPMR uses 4FSK modulation at a rate of 2400 symbols/second where the dibits mapped to +1050 Hz, +350 Hz, -350 Hz and -1050 Hz deviations of the carrier in relation to the center frequency.

dPMR supports different levels of functionality, Mode 1: Peer-to-peer direct mode (communication without infrastructure), Mode 2: Centralized repeater network and Mode 3: Managed centralized repeater network (trunking).

The Nano-DV operates using Mode2 conventional (repeaters and infrastructure).

APCO-P25

In the USA Motorola repeaters are in use that utilize this mode. Because of the similarity with C4FM we included this mode in the Nano-DV. There is also a reflector for it in "reflector.net"

4.0 REFLECTORS

A reflector is a server connected to the Internet and is linked to a number of digital Ham Radio repeaters. If one of these repeaters is active it will send the voice data stream to the reflector. The reflector sends a copy of the voice data to all of the connected repeaters. This means that a QSO can be heard on all connected repeaters simultaneously.

Thus the chance to find a QSO partner is considerably increased - which is one of the reasons reflectors are so popular.

The following system reflectors are in operation.

DCS (Digital Call Server)

DCS is the most modern D-STAR reflector system and in worldwide use. Many countries use their own reflectors which differ from each other by their 3 digit number. (DCS001, DCS002 etc). Each DCS reflector has 26 rooms which are allocated to various regions of a country or continent. These rooms (A to Z) have been given names to make their identification easier and are shown on the user surface of the DV4mini.

FCS

FCS reflectors are similar to DCS reflectors but planned for the Yaesu C4FM system. FCS001 and rooms 0-99.

PCS

PCS reflectors are also similar to DCS reflectors but used by the P25 system. PCS001 and rooms 0-99.

Xreflectors

Xreflectors are the second generation of D-STAR reflectors and no longer widely in use. However in some countries like Italy they are still used as the hams have not yet agreed to a uniform concept. Also Xreflectors have less ports over which simultaneous QSOs be run. Xreflectors are named XRF001, XRF002 etc.

D-Plus reflectors

They were the first generation D-STAR reflector system. Although it is getting old it is still used intensively in a number of countries (mostly English speaking ones like USA, UK and Canada). D-Plus reflectors are named REF001, REF002 etc. They also use a number of ports allowing for simultaneous QSOs.

DMR reflectors

DMR reflectors consist of several regional servers that are connected with each other via a super ordinate network. Two nets exist, One based on Hytera and the other based on Motorola technology. The Hytera network is open and friendly to Ham Radio operators using the Nano-DV hotspot. The DMR-MARC network by design will ONLY allow Motorola repeaters to connect because of the proprietary IPSEC that Motorola has that lets the repeaters communicate through the C-bridges.

Net organization (CCS7)

The many reflectors, repeaters and also Dongle users (the Nano-DV is considered a Dongle too) require a structured organization, so that the network technology works properly.

D-Star works with call signs to identify a station. DMR however uses numbers. That is why it is necessary that an amateur radio station gets a number assigned in addition to its call sign and that this call sign - number combination is known to the network.

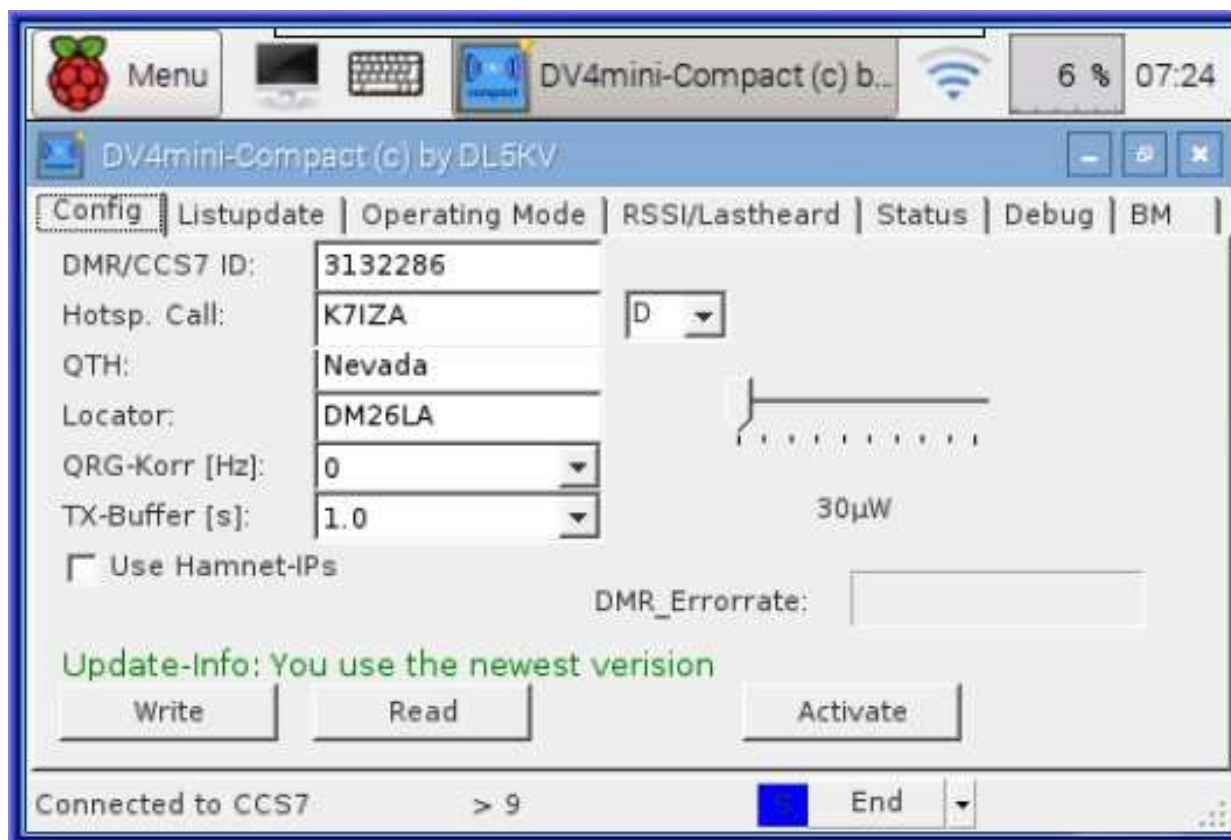
Go to the web site <http://dmr-marc.net/cgi-bin/trbo-database/register.cgi> and request a 7 digit number to be assigned. This number is then entered into the DMR/CCS7 field of the Nano-DV configuration menu. This facilitates reporting into the network and conduct worldwide contacts in D-Star or DMR and the use of D-Star/DMR bridges.

5.0 SYSTEM CONFIGURATION AND SETUP

In the following menu tabs you will be configuring your personal data, frequency and power level of the internal radio and mode of operation. Your call sign and location data will be resolved from your DMR-ID. It could be changed manually if needed.

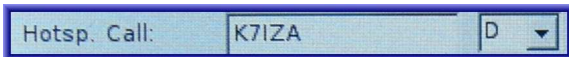
If there are pending software updates available for the Nano-DV there will be a message in **RED** lettering just above the **Write** and **Read** buttons on the configuration screen below. By clicking on this message a software update dialog box will appear allowing you to perform the update.

6.0 "CONFIG" MENU

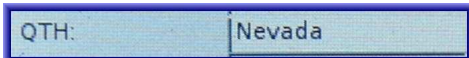


DMR/CCS7 ID: 3132286

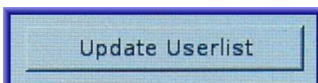
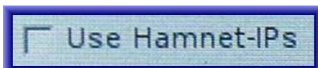
Enter your 7 digit DMR/CCS7 ID number . If you don't have one yet or have forgotten yours go to the <http://dmr-marc.net> website and query under the "Database" tab or apply for new one.




If you entered your DMR/CCS7 ID your call sign will be automatically loaded from the DMR database along with the letter D designator. If you have several Nano-DV hotspots then a different letter must be used for each node.



If you entered your DMR/CCS7 ID your QTH will be automatically loaded from the DMR database.



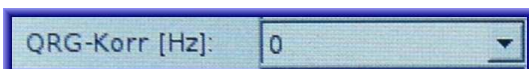
Clicking on **Update Userlist** will refresh the list of DMR/CCS7-ID's and their call signs.



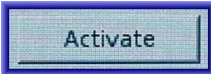
Slide the bar to the preferred transmitter power level. Available power levels are 0.03, 0.4, 1.2, 2.4, 3.9, 5.5, 7.1, 8.8, 10.5 and 12 mW



This display is used for frequency adjustment. This feature is used to verify the block error rate (BER) during decoding and encoding of incoming radio voice data.



Click the down arrow and select the frequency offset that optimizes the DMR Error Rate (BER) to its lowest possible percentage keeping it mainly in the green zone.



When initially setting up your node you can temporarily test the entered parameters by clicking the **Activate button**.

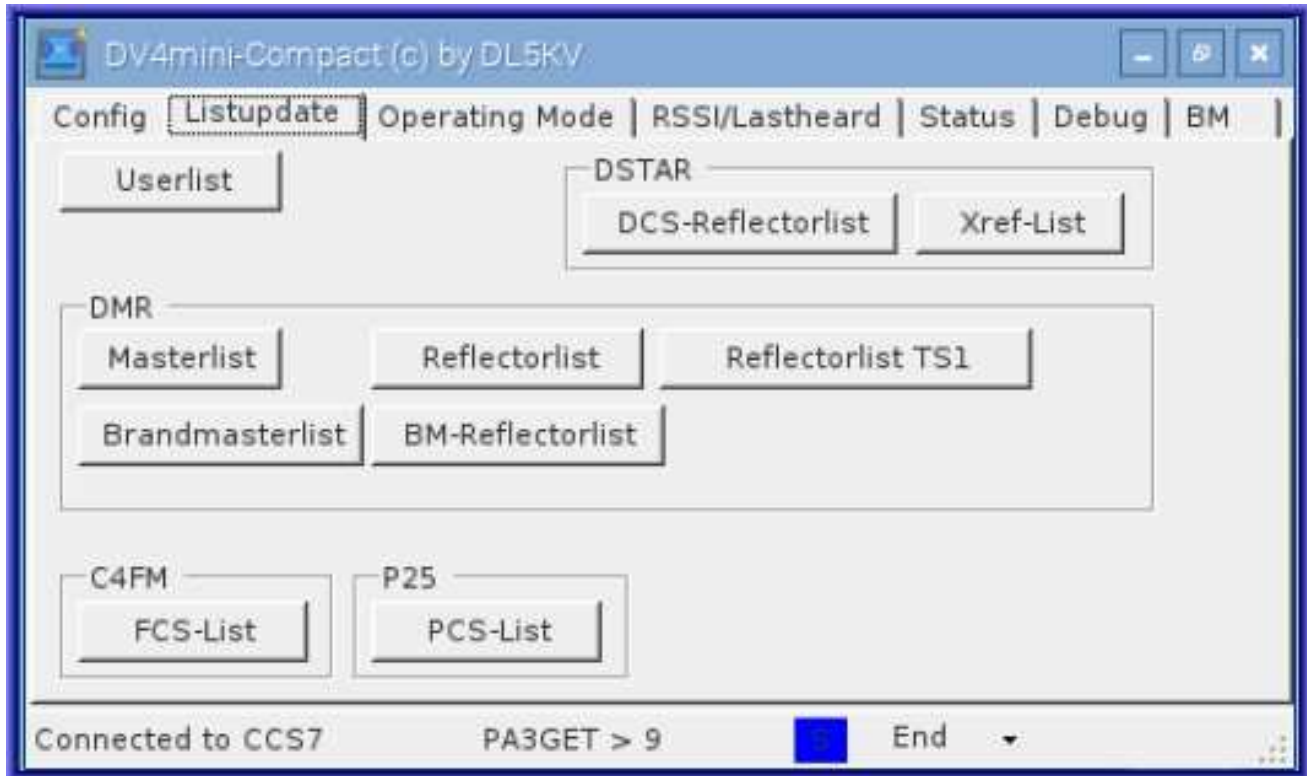


When you are satisfied your node configuration is correct save the configuration permanently by clicking the **Write** button. The stored configuration will be loaded every time the node is booted or by clicking on **Read button**.

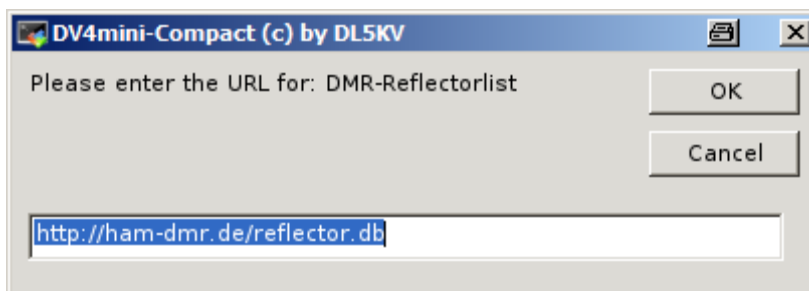


The Status bar provide information about the operational state of the hotspot. Within the status bar there three fields of information: If a CCS7 or reflector-linking exists, Call sign that is actually transmitting or was transmitting last, Radio state (GREEN receiving , RED transmitting, BLUE standby). You can also exit the program by touching the END button.

7.0 "LIST UPDATE" MENU

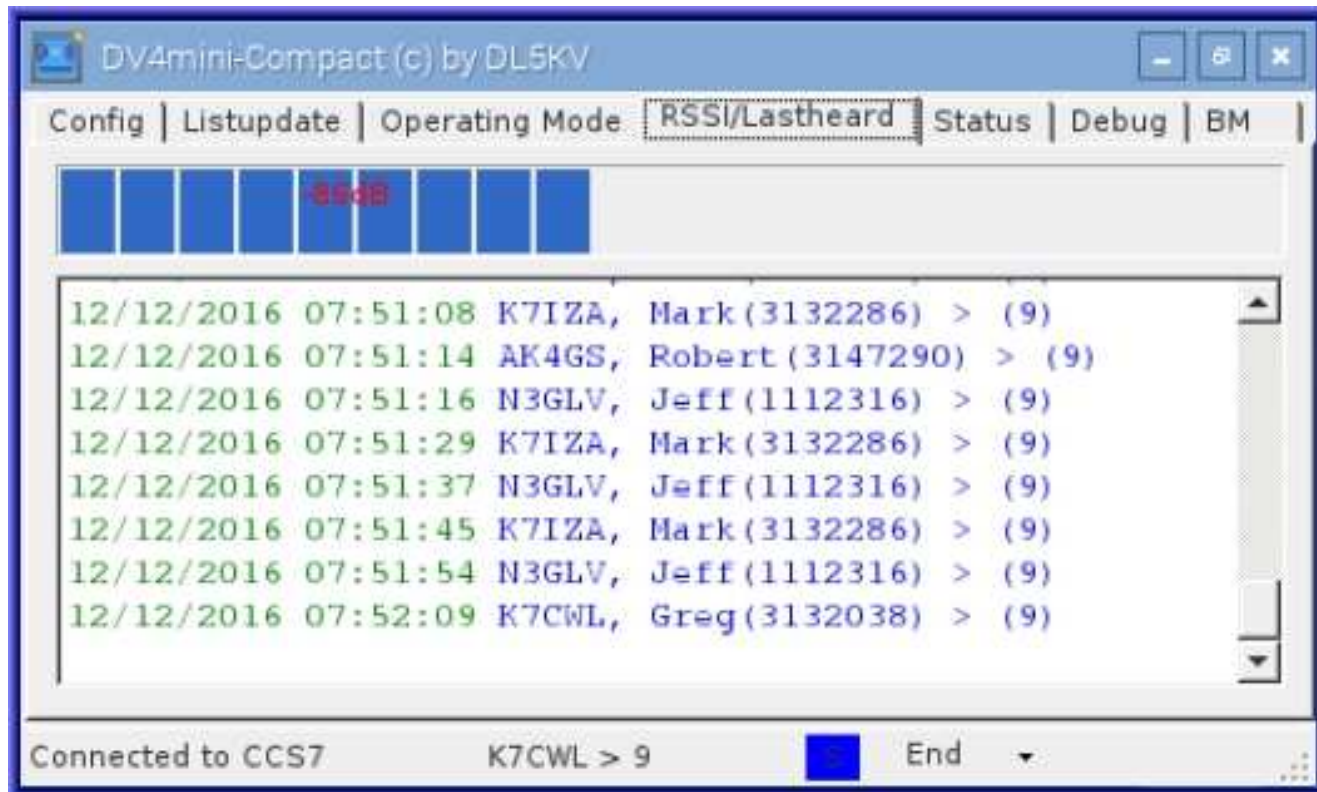


There are ten buttons for updating the various Reflector and master lists. Pressing a button updates the list or reflector. Press and hold the button enables a dialog to change the Download-URL for each individual list.



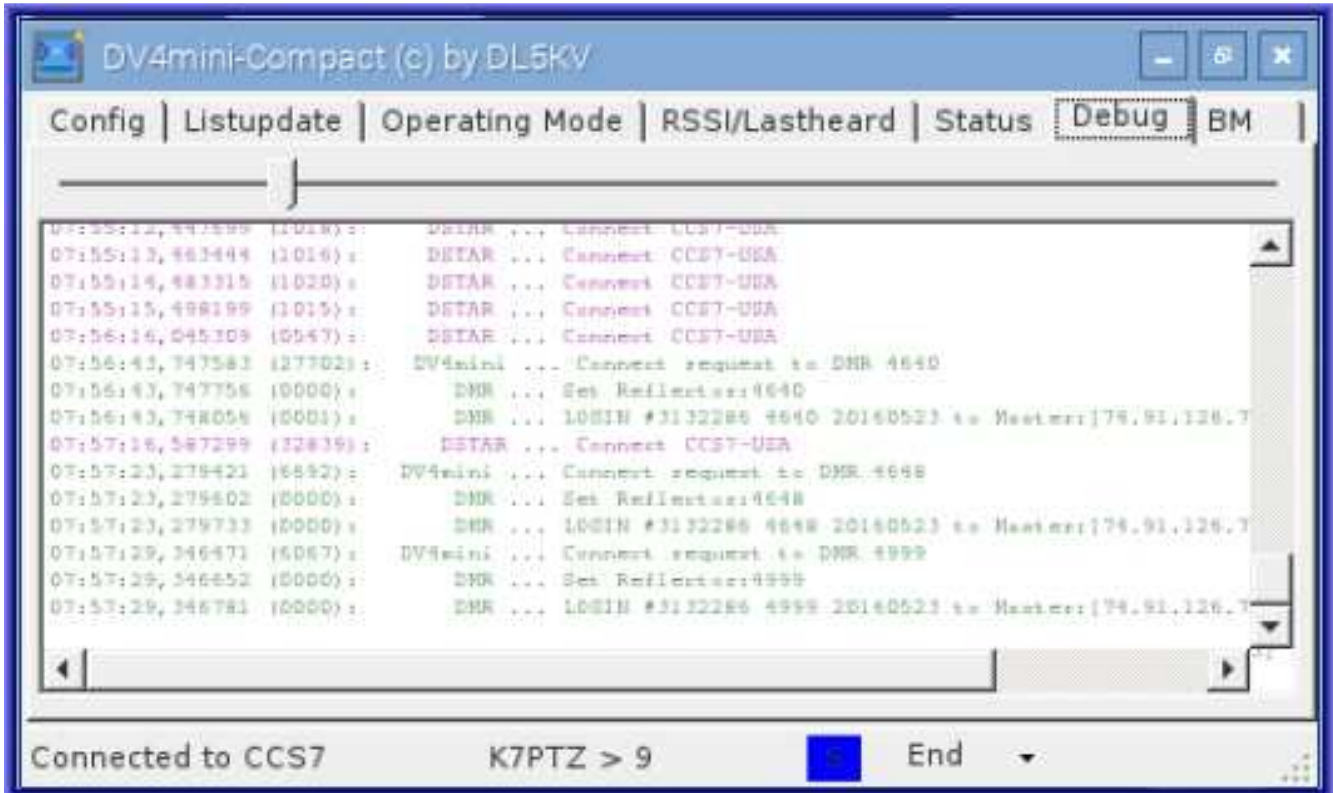
8.0 "RSSI / LASTHEARD" MENU

This tab display a signal strength bar indicating the RX-level of the received signal. Below that is a list of the stations last heard on the actual mode and reflector. In DMR-mode the Call Sign, Name and the DMR-ID in brackets is shown. Also changes in mode or configuration are shown with three stars. Reflector-entries are colored in red, entries concerning persons are shown in blue.



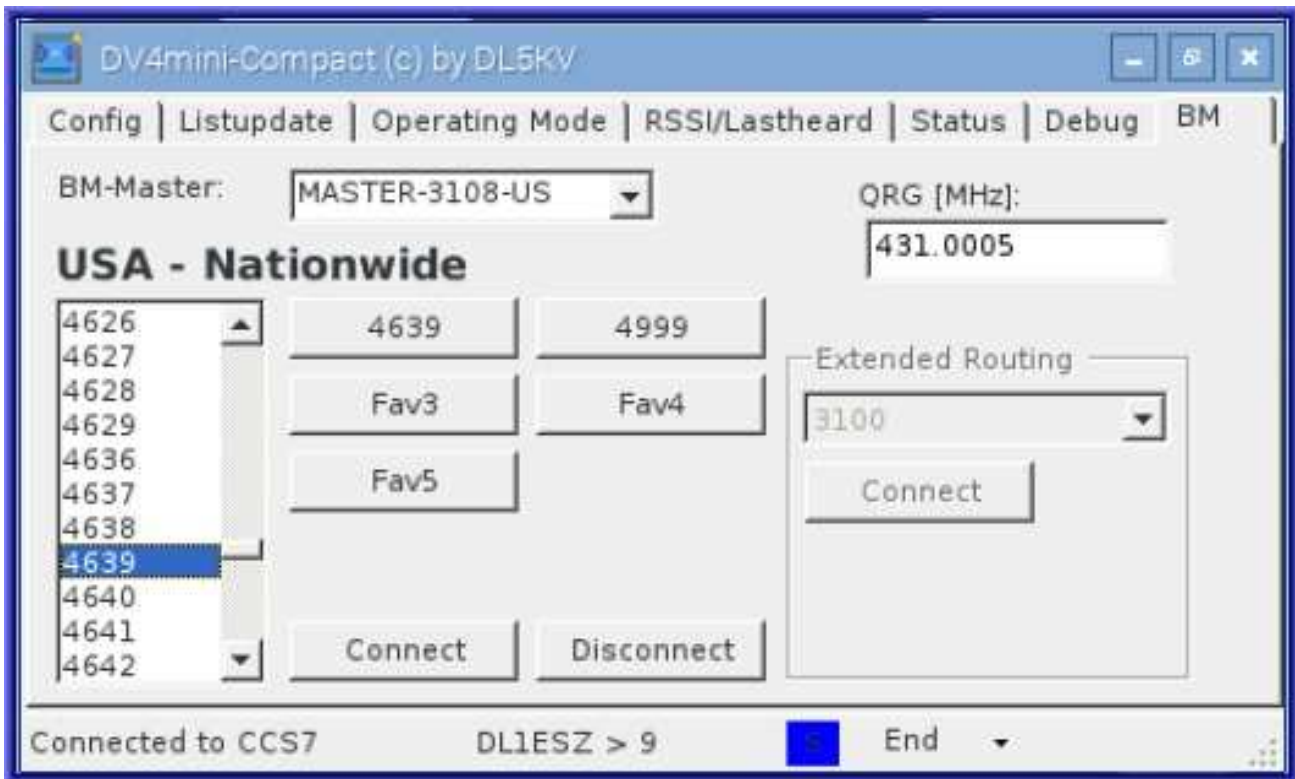
9.0 "DEBUG" MENU

The **Debug** menu tab displays logged information about the operation of the node. The font-size is configurable via the slider at the top of the text-window box. Changes will only take effect on the following entries into the log. Previous messages existing in the text-window will not be resized.



10.0 "DMR / BRANDMASTER" MENU

Due to the fact that the tabs for the different modes are very similar only the configuration of the DMR / Brandmaster mode will be described in detail.



Here you can configure the DMR-Master and the reflector you want to connect to. Changes to DMR-Master take effect immediately, selection of a reflector is activated by clicking the **Connect** Button.

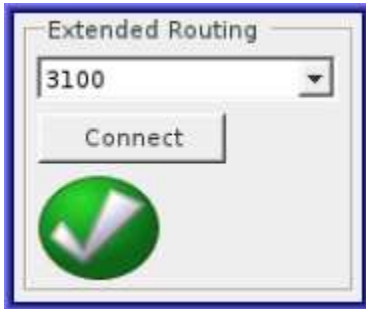
In the middle you will find 5 favorite buttons. Once a reflector is selected pressing and holding the button for 2-3 seconds will open a dialog box allowing you to change, delete or assign the selected reflector to this button. In the caption of the button, Brandmaster favorites will be labeled with "BM" preceding the reflector number.

On the right you can configure the operating-frequency for the specific mode that is enabled. Frequency changes are activated 3 seconds after last number is entered..

DMR Extended Routing

Another way to change talk groups is using the Extended Routing feature of the BrandMaster mode. On the Brandmaster menu connect to talk group 4999

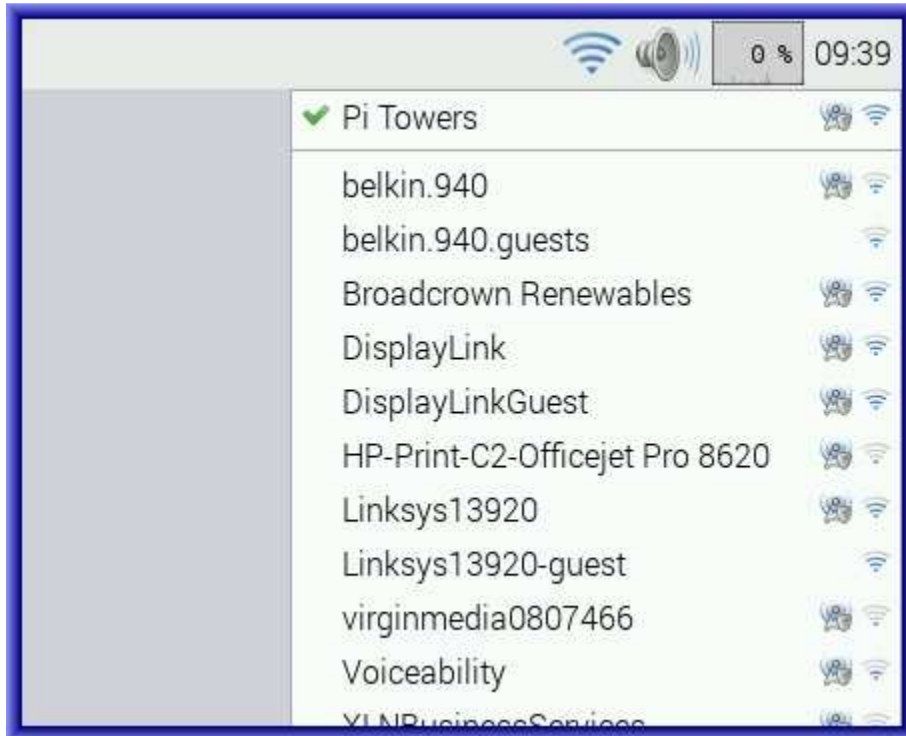
which will enable the “Extended Routing” dialog box.



Using the drop down arrow select the extended talk group you want to connect, If the talk group you want is not listed in the drop down menu you can enter the talk group directly in the entry box and click the "Connect" button. When the connection is complete a green check will appear in the extended routing box.

11.0 WIFI NETWORK SETUP

WiFi connections can be made via the network icon at the right-hand end of the menu bar. If the optional WiFi dongle is plugged in, touching this icon will bring up a list of available WiFi networks, as shown below. If no wireless networks are found, it will show the message "No APs Found - Scanning..." just wait a few seconds without closing the menu, and it should find your network.



The icons on the right show whether a network is secure or not, and its signal strength. Touch the network that you want to connect to, If it is a secured network, a dialogue box will appear prompting you to enter the network key.



Enter the key and touch OK, then wait a couple of seconds. The network icon will flash briefly to show that a connection is being established, once it is ready, the icon stops flashing and shows the signal strength.

12.0 EXTERNAL CONNECTIONS

420-450 MHz Internal Radio Antenna

The Nano-DV is a low power device and operates from any +5VDC power source capable of providing 1 amp of current (typically less than 500ma). Most USB cell phone chargers, cigarette lighter adapters or charging batteries will power the hotspot..



Dual USB Connectors for optional devices

- 802.11bg Wireless Network Adapter.
- Wireless Keyboard and Mouse
- GPS Receiver

10/100 Mbit/s Ethernet Port

13.0 MAIN PROCESSING SUBSYSTEM SPECIFICATION

The main operating system is based on Debian Linux 3.18.5-v7+ running on a ARM Cortex A7, V7 Quad Core 32 bit Processor architecture with 1gb Ram and 8gb Flash.

14.0 RF SUBSYSTEM TECHNICAL SPECIFICATIONS

The Nano-DV Hotspot internally utilizes DV4Mini technology consisting of a powerful 64 bit microcontroller based GMSK, 4FSK modulator/demodulator 70cm transceiver.

Frequency Range: 420-450 MHz
Resolution: ca 250 Hz

RX/TX D-Star: Duplex +/- any shift RX/TX
DMR: Simplex (TX=RX QRG)

Modulation
D-Star: GMSK (Gaussian 2FSK) Modulation
DMRPLUS: 4FSK Raised Cosine

Antenna Connector: SMA female 50 Ohm

S-Meter Sensitivity 1 dBm Resolution (Accuracy +/- 1 dBm)

Nano-DV TX Power Steps:

- 0 = 0.03 mW
- 1 = 0.4 mW
- 2 = 1.2 mW
- 3 = 2.4 mW
- 4 = 3.9 mW
- 5 = 5.5 mW
- 6 = 7.1 mW
- 7 = 8.8 mW
- 8 = 10.5 mW
- 9 = 12 mW

NANO - DV Personal Hotspot

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