

Hudson Valley Digital Network | www.hvdn.org /presentations

Build a Amateur Radio Digital (Repeater)
Hotspot for less than \$100

About Hudson Valley Digital Network (HVDN)

Subpart A—General Provisions

§ 97.1 Basis and purpose.

The rules and regulations in this part are designed to provide an amateur radio service having a fundamental purpose as expressed in the following principles:

(a) Recognition and enhancement of the value of the amateur service to the public as a voluntary noncommercial communication service, particularly with respect to providing emergency communications.

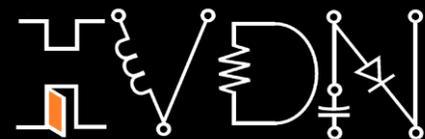
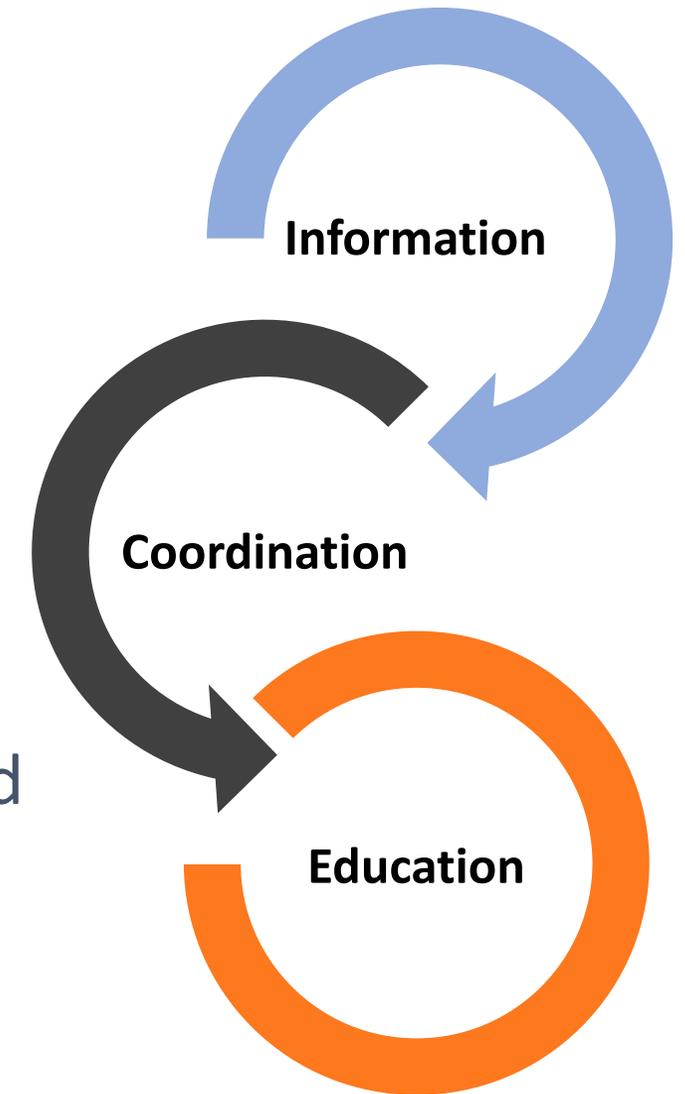
(b) Continuation and extension of the amateur's proven ability to contribute to the advancement of the radio art.

(c) Encouragement and improvement of the amateur service through rules which provide for advancing skills in both the communication and technical phases of the art.

(d) Expansion of the existing reservoir within the amateur radio service of trained operators, technicians, and electronics experts.

(e) Continuation and extension of the amateur's unique ability to enhance international goodwill.

- HVDN founded 2017
- Uphold FCC Part 97.1
- 3 pillar approach
- Club call sign N2HVD
- Digital meets physical world

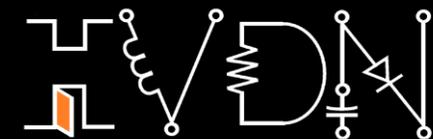


The “Biography” Slide....



Joseph Apuzzo
N1JTA, Co-Founder HVDN

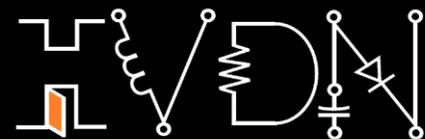
Name:	Joseph Apuzzo
Day Job:	IBM: Quantum Mechanic & HPC Admin
Amateur Radio License Since:	1993 (26 Years Ago)
Accomplishments	Two patents, two books, taught on three continents
Fun Fact:	Creator of the Hudson Valley “Mad Science Fair”



Presentation Goal



Focus on **MMDVM open hardware**, it's parts and how to acquire and assemble them. We hope you are inspired and pursue further learning. **Hand held digital radios** and **Pi-Star** are mentioned but not fully discussed. Thus this is only one small part of the greater digital voice mode adoption, migration and growth.



FCC Amateur License

- The Technician class license has full privileges in all possible digital voice bands (2m, 70cm, 1.25m, 33cm & 23cm)
- Got the license!! Now what? Join a local radio club!
- A VHF/UHF repeater is the **crown jewel** of many clubs.
 - It will likely be remote but centrally located.
 - They are expensive to own and hard to maintain.
 - FM voice is common, and Digital Voice is growing in popularity.
- Use of the club repeater is usually open to all even non-club members but is a shared resource.
- Opportunities to learn will most likely be constrained.



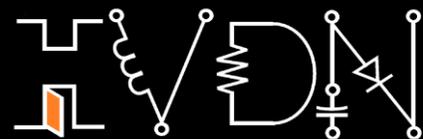
Digital Voice Modes supported by MMDVM

Digital Mode Name	Digital Mode Origin	Open Digital Standard	Key Interesting Feature	Current Amateur Radio Users
	<ul style="list-style-type: none"> Icom in 2004 Amateur radio only 	No	<ul style="list-style-type: none"> Most mature mode but older GFSK technology Only two vendors 	
	<ul style="list-style-type: none"> Yaesu in 2011 Amateur radio only 	No	<ul style="list-style-type: none"> FDMA based Better audio Only one vendor 	
	<ul style="list-style-type: none"> Motorola in 2005 Early amateur adoption in 2007 in NY/NJ area. 	Yes	<ul style="list-style-type: none"> TDMA based 2 streams per channel Many vendors 	
	<ul style="list-style-type: none"> Vendor agnostic. Introduced phase 2 in 2012 globally. 	???	<ul style="list-style-type: none"> First responders 53 countries globally Less latency than DMR 	
	<ul style="list-style-type: none"> Introduced by Icom & Kenwood in 2005 for commercial use. 	???	<ul style="list-style-type: none"> FDMA based Narrower channels Lower cost than P25 	



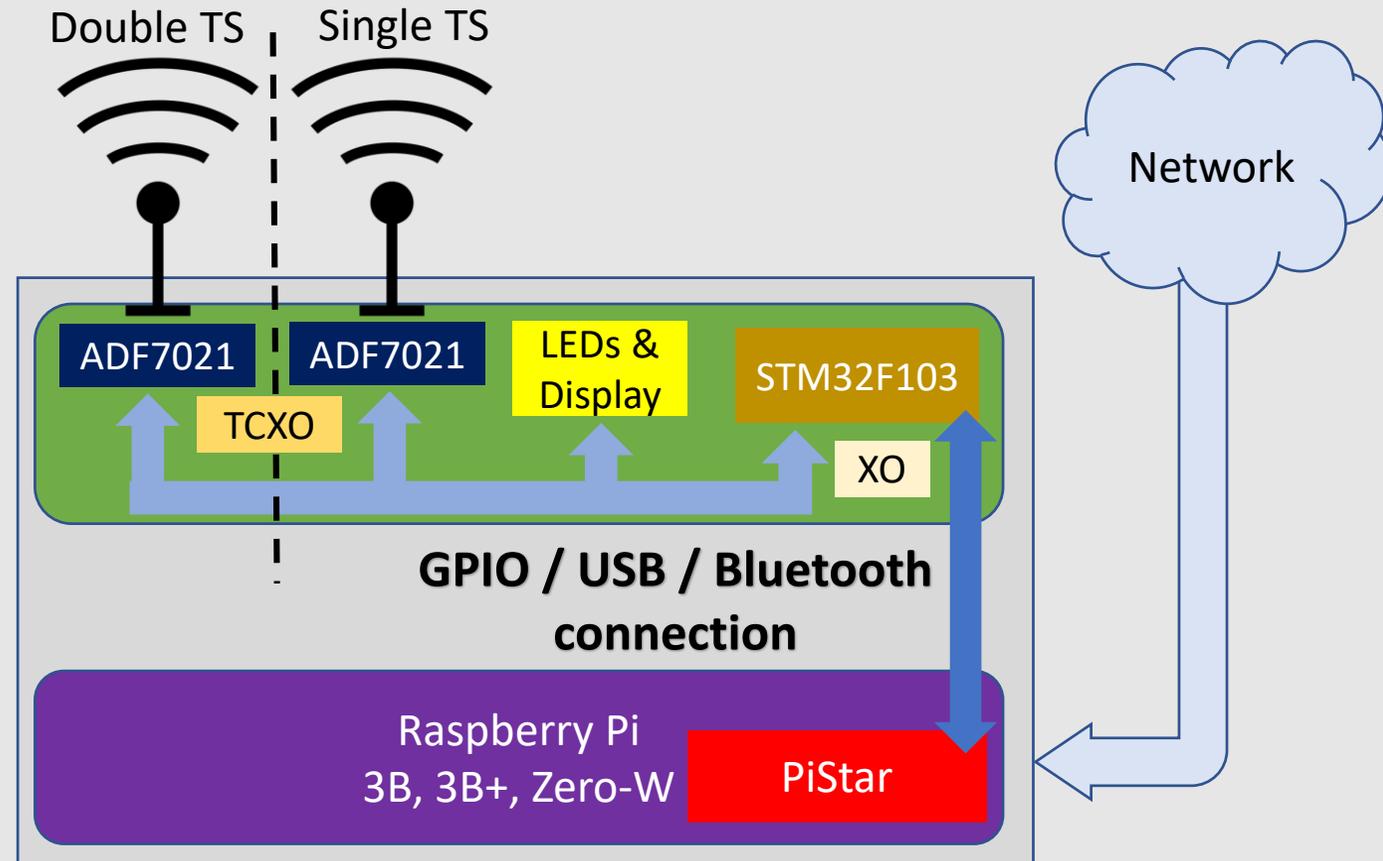
A Radio for Digital Voice

- Your radio should support at least 2m and 70cm FM voice.
- The mode your radio supports is where you will spend most of your time
- DMR is widely used and currently the most affordable
- When picking a DMR Radio:
 - Make sure it support **Tier 2**
 - It has ID database support of 100K or more
 - That you are happy with the **SCREEN** and can read it
 - **Code Plug Software** is different for each radio, make sure you like it **BEFORE** you buy!



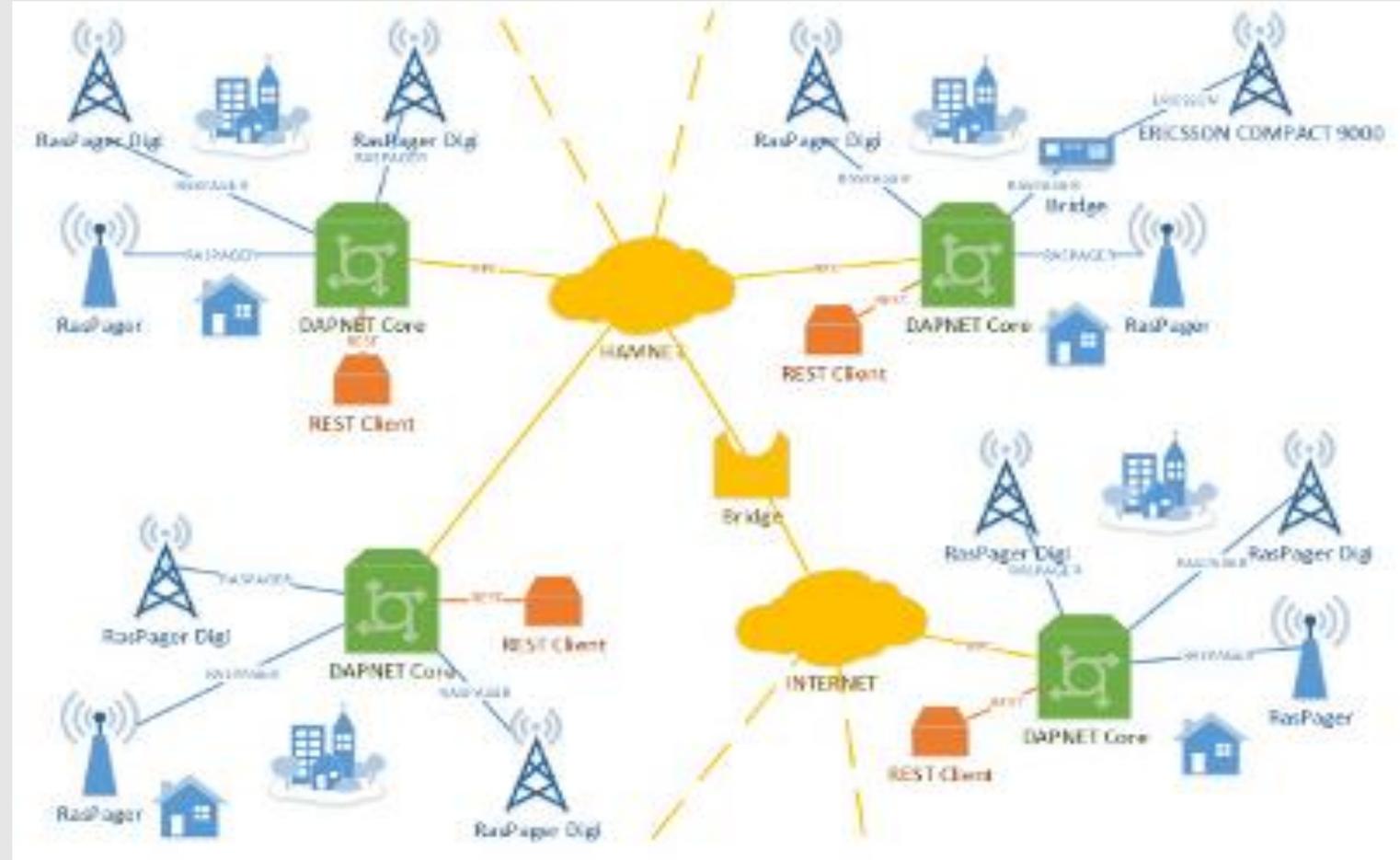
MMDVM = MultiMode Digital Voice Modem

- Main parts of the MMDVM board:
 - STM32F103C8 MCU @ 72MHz
 - ADF7021 2FSK/3FSK/4FSK RF Transceiver
 - Timing is important (TCXO & XO)
 - Supports 2m, 70cm and 33cm
- Effective output is 10-16mW = .016 W
Range is not the goal. Learning is.
- Pi-Star is the software stack to run on this hardware <https://www.pistar.uk/>
- MMDVM boards require soldering (GPIO and/or SMA antennas)



Digital Non-Voice MMDVM Modes (DAPNET)

- The MMDVM modem & Pi-Star supports other use cases other than digital voice communication

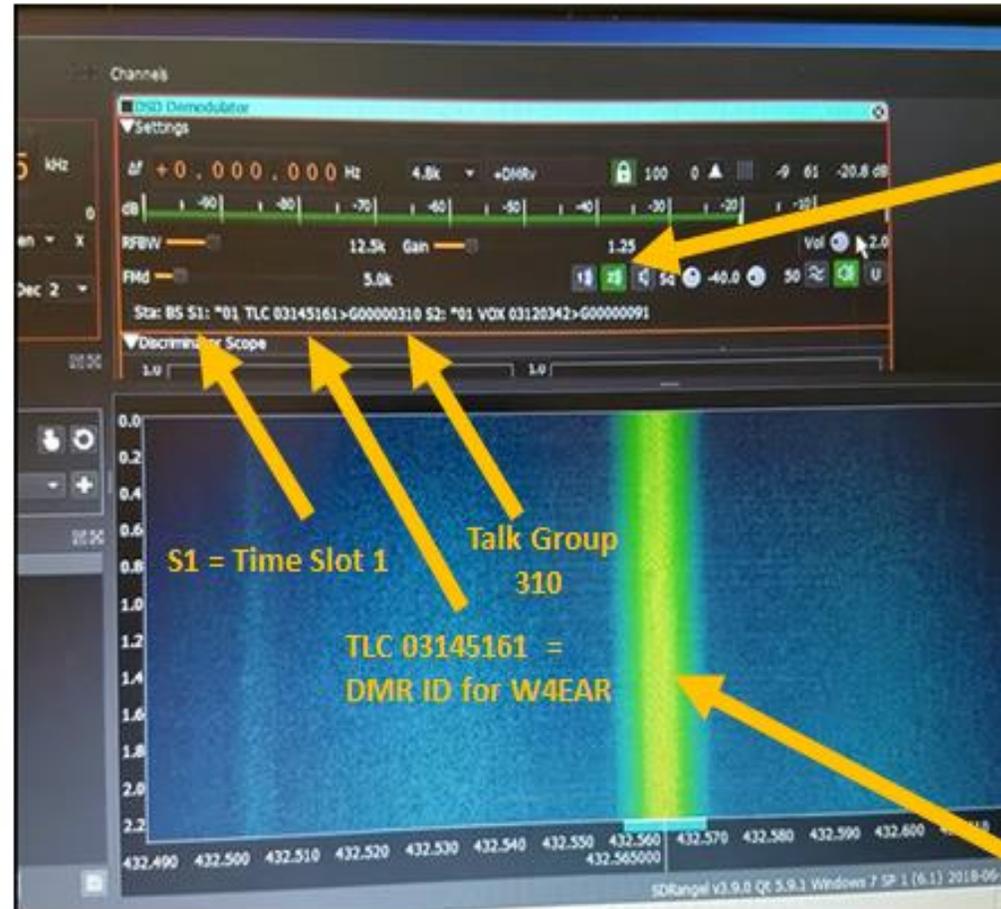


- POCSAG is an open paging standard that is not encrypted
- Still in use by many users....



Digital Non-Voice MMDVM Modes (Decoding)

- Use inexpensive USB SDR receiver to:
 - Decode GPS location sent over DMR
 - Decode POCSAG pages
 - Decode voice traffic on all modes
 - Stream decoded data over internet



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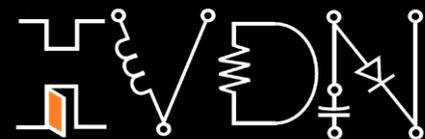
SDRangel software allows the decoding of one or both timeslots at the same time

The green illuminated indicator shows which time slot is currently active

Either can be muted from one another.

Audio on your computer can be routed for time slot 1 to be heard in the right speaker and time slot 2 in the left speaker or both slots at the same time from both speakers

One 12.5 kHz wide channel can be used for two separate discussions at the same time



Buy vs Building a Hotspot

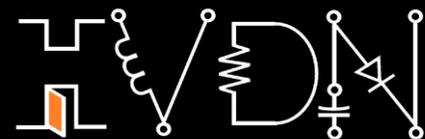
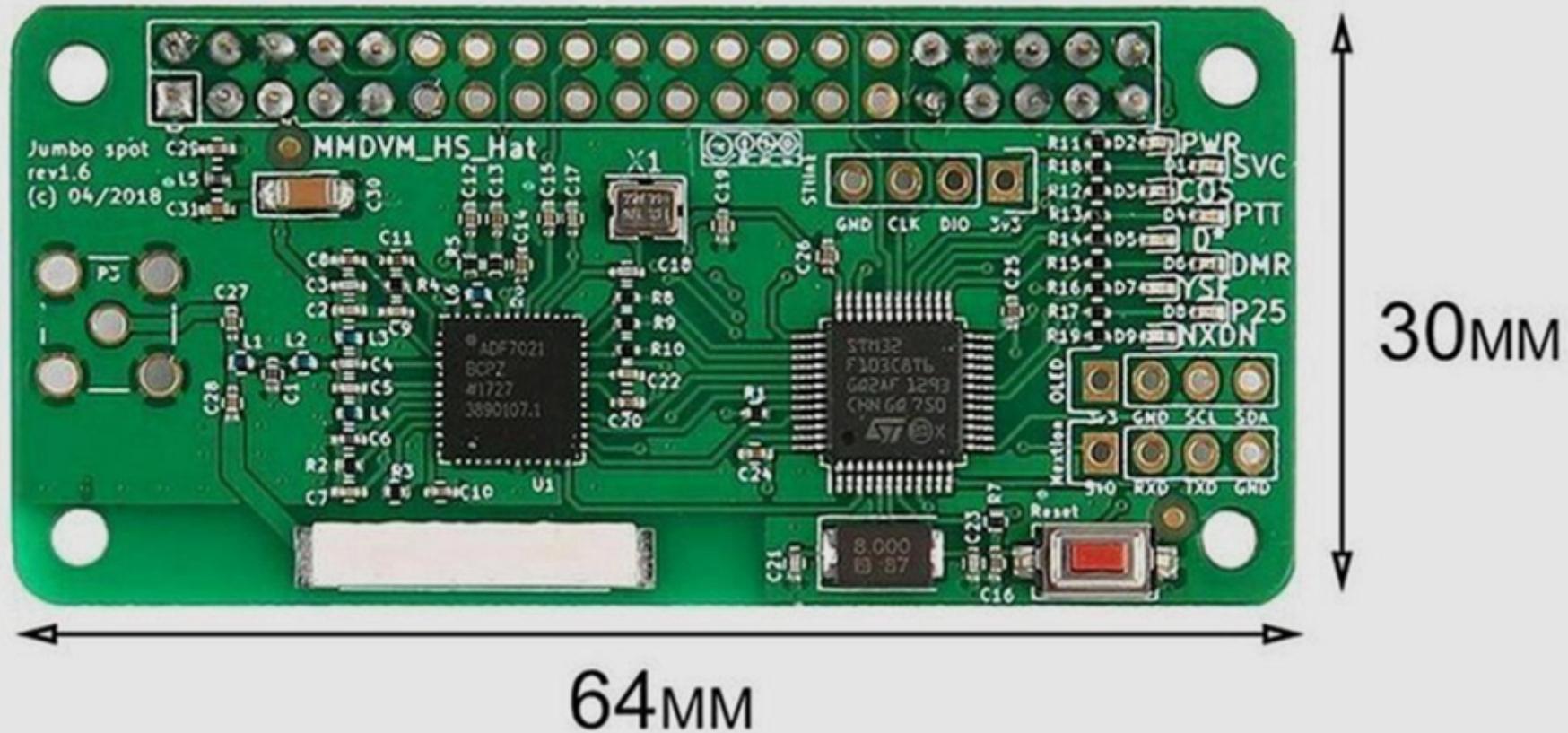
- Using a hotspot supplements your access to digital voice resources found on the internet. You should use and support local digital repeaters if there are any.
- **Buy a hotspot: suggest the “SharkRF Openspot” Original**
 - * Don't want complexity, don't like computers.
 - * Get easily frustrated or confused by technology. It's a hobby NOT a job for me!
 - * Don't want to troubleshoot, need a person to call or email for support.
- **Build a hotspot: Support Open Hardware & the Amateurs that created it**
 - * Want to learn! I need my equipment to break and not be a burden on others
 - * Learn by “Hands on” want to understand the intersection of RF and Digital
 - * Like the idea of building it yourself, being self sufficient. Want to work through issues



MMDVM Single Time Slot

- https://github.com/mathisschmieder/MMDVM_HS_Hat

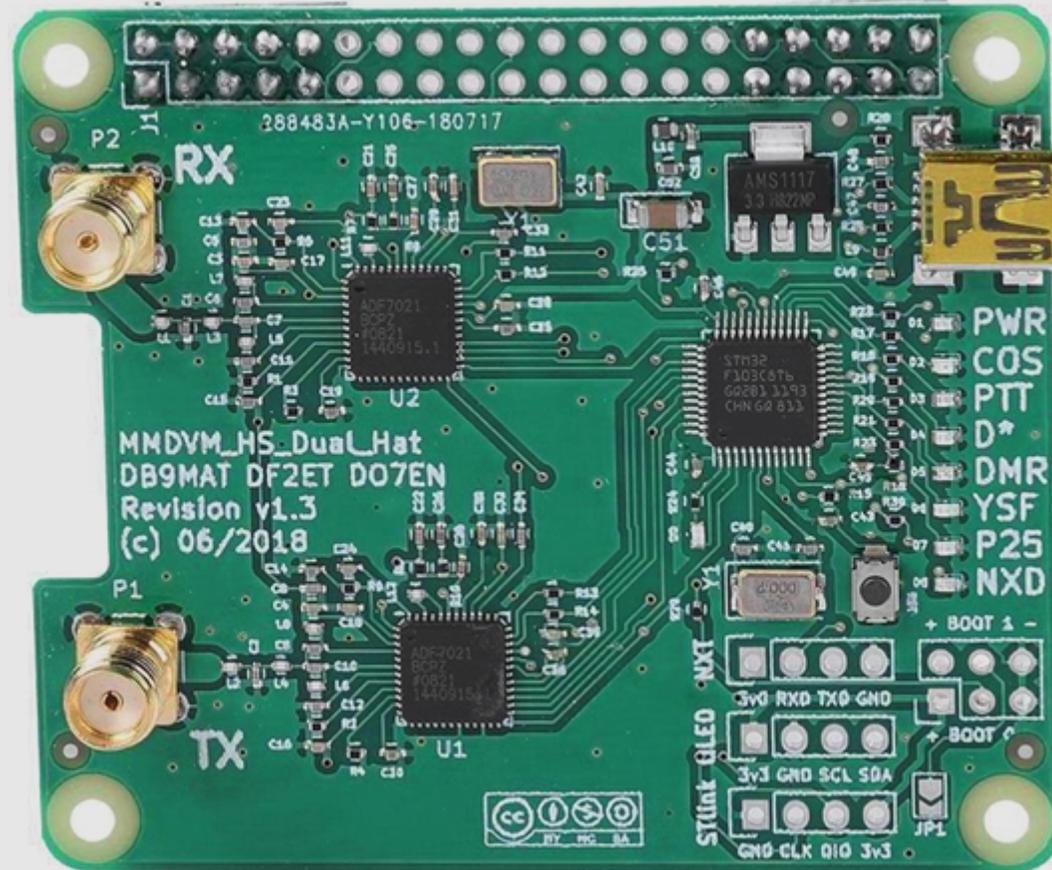
Key words to search with: MMDVM Hotspot raspberry pi v1.6 {latest version}



MMDVM Duplex / Dual time slot

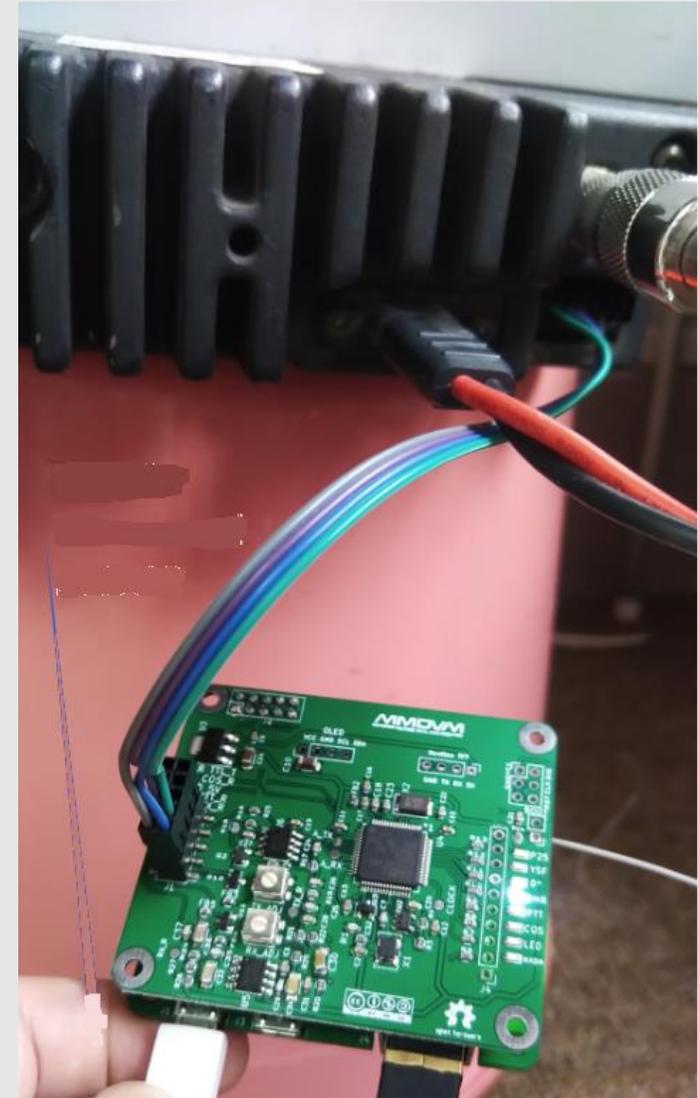
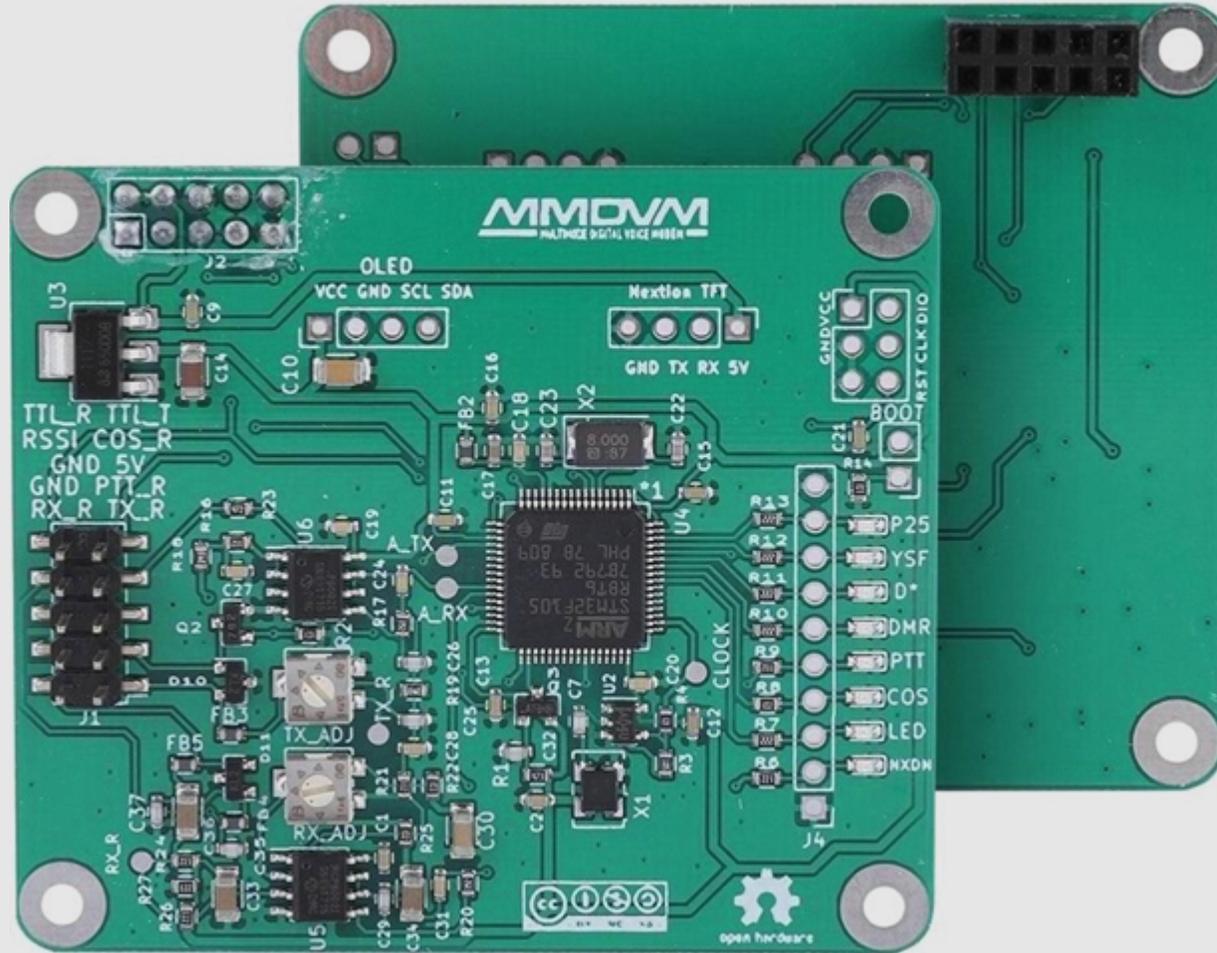
- https://github.com/ph10/MMDVM_HS_Dual_Hat

Key words to search: MMDVM duplex Hotspot raspberry pi v1.3 {latest version}



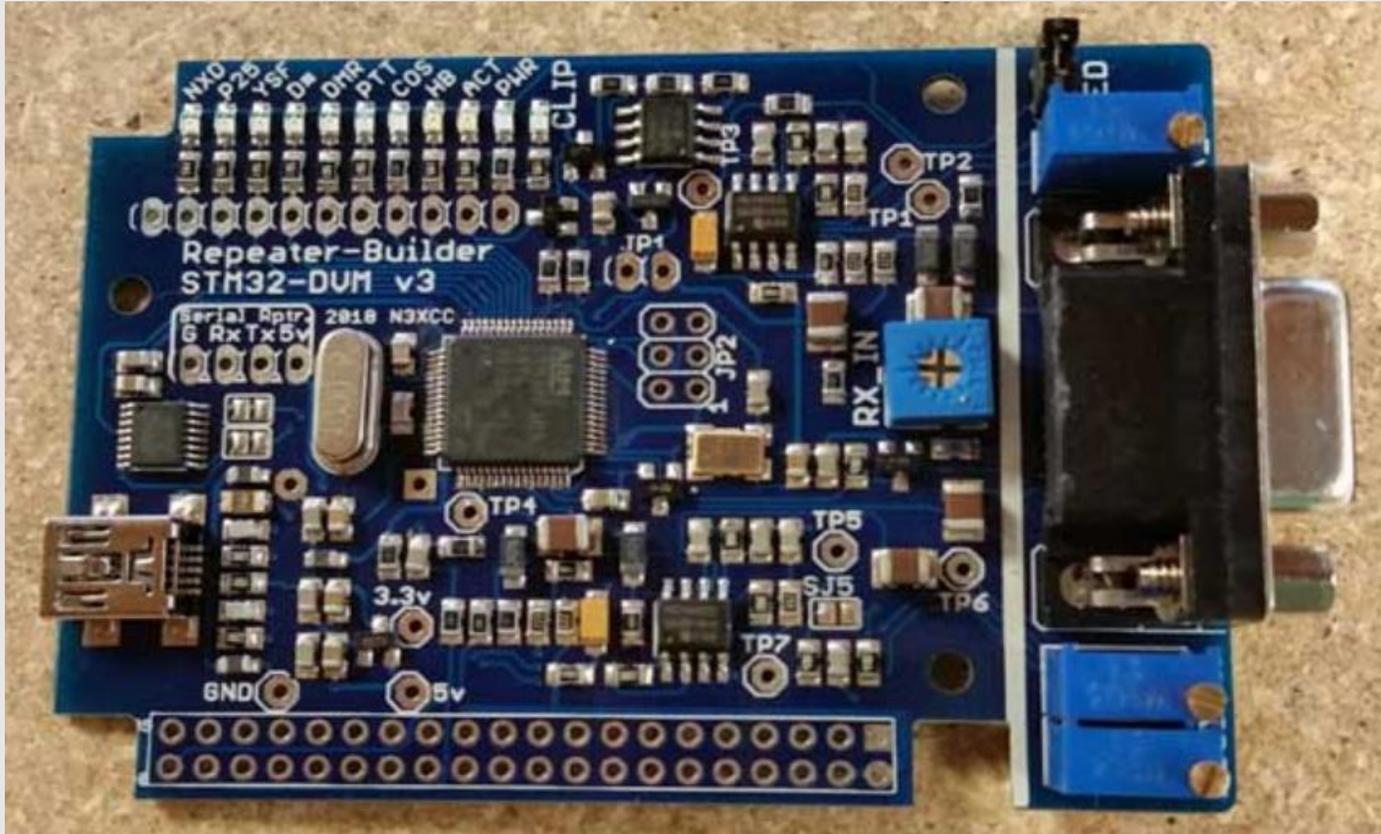
MMDVM via External Radio

- Key words to search with: MMDVM latest repeater



MMDVM Repeater

- Beyond the hotspot: a real repeater controller that uses PiStar and thus all the knowledge you acquired!



<http://www.repeater-builder.com/products/stm32-dvm.html>

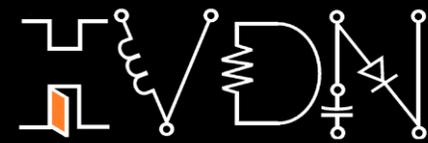
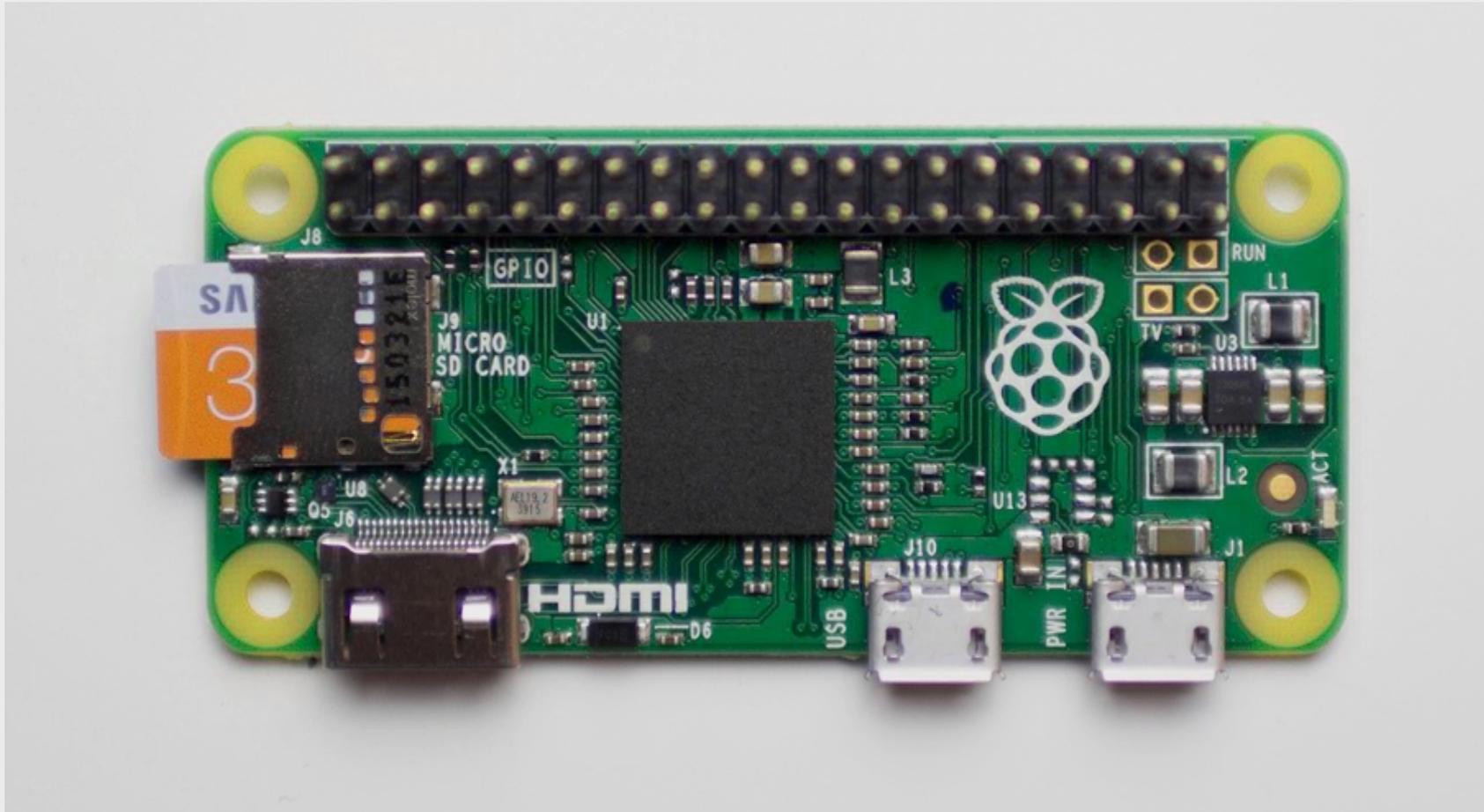


<http://www.micro-node.com/store>



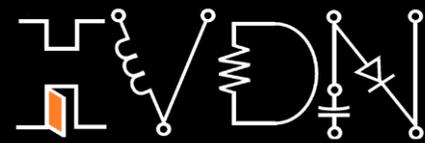
Hotspot Parts: Raspberry Pi

- Recommend a Raspberry Pi Zero since that's all you really need



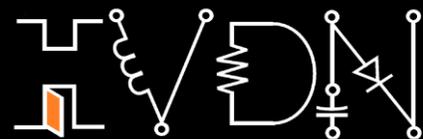
Hotspot Parts: SD Card

- SD card: 8gb is all that is needed. Get a C10 or better. Brand name COUNTS!



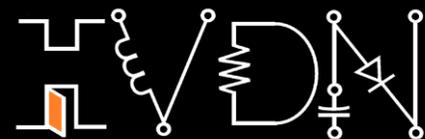
Hotspot Parts: UHF antenna

- Search for “433 MHz 6DBi Antenna SMA”



Hotspot Parts: Ethernet Adapter

- Search for “Micro USB 2.0 to Ethernet 10/100”
About \$2-3 do not add MMDVM to the search to avoid the \$15 or more price tag
- One per household!
Their MAC address is the same on each unit !!!



Hotspot Parts: miscellaneous

- **Display:**

Not needed for home use, maybe advantageous for a real repeater or more visually beneficial implementations. Keyword: Nextion Display

- **Case:**

Only needed to make things look pretty. If you work on your hardware, the case tends to get in the way. The metal case is very hard to fit around both boards. Keywords: C4Labs, Thingiverse

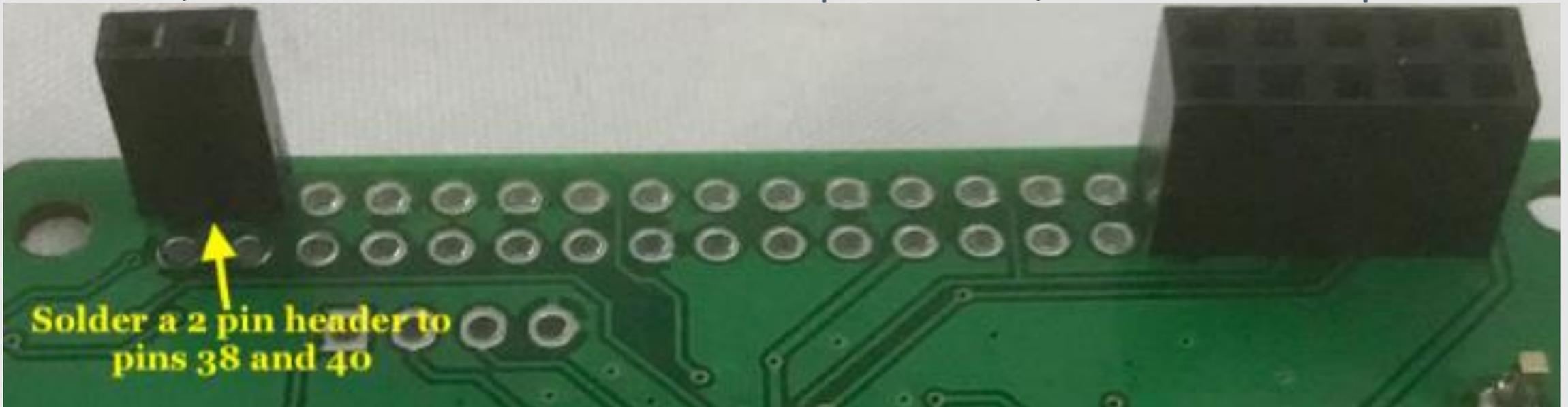
- **Power supply:**

Use the best power supply you can afford! 2 Amp or more!! Do not use that ten year old USB 500mA charger you found in the draw. The output “must absolutely be 5V”, “NO low voltage”, “NO noise”.



MMDVM Firmware: What you need to know

- <http://hvdnnotebook.blogspot.com/2018/08/mmdvm-firmware-why-update-how-to-update.html>
- GPIO pins need to be connected to Raspberry Pi. Some boards already have this done, others do not. Some use a 10 pin header, others use a 2 pin header.



PiStar Information

- **PiStar**

- <http://www.pistar.uk/>

- <https://forum.pistar.uk/>

- Start learning PiStar <https://amateurradionotes.com/pi-star.htm>

- W1MSG's YouTube video's

- <https://www.YouTube.com/channel/UCcjYjtognBaSAa-ZLk3EU2A/videos>

- **Other sites you need to setup PiStar**

- DMR ID database <https://www.radioid.net>

- Brandmeister <https://brandmeister.network/>



Where to go for more information

- <http://www.northstardigitalnet.us/>

Every Tuesday night at 9:00 PM EST on Brandmeister STEM talkgroup

- Hudson Valley Digital Network – Not your normal “amateur radio club”

Main site => <https://hvdn.org/>

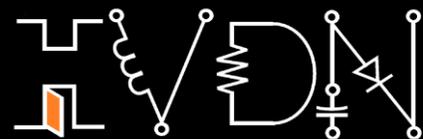
News and more => <https://hvdn.org/notebook>

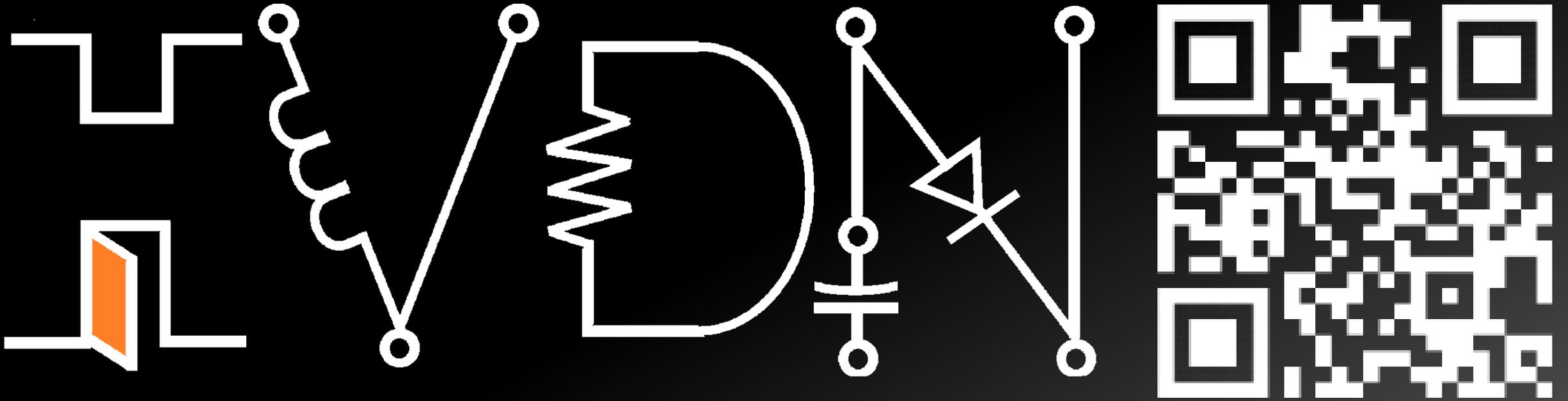
- **Your Local Clubs**

Support your local Radio Club

Support your local Makers/Hacker Club

Support your local Open Source / Open Hardware Organizations!





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Hotspot for less than \$100