Building a 10Mhz GPS Disciplined Oscillator

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Here is the one I will be discussing today

What it is - Why you may need one – How to Build one!

What in the world is a "10Mhz GPS Disciplined Oscillator"

- Basically a combination of a GPS receiver and a stable (Usually quartz or rubidium based) oscillator whose output is controlled/disciplined to agree with the signals broadcast by GPS satellites

- Since GPS satellite time signals must be very accurate in order to provide positional accuracy for GPS in navigation, this makes a great known reference source

- These signals are accurate to nanoseconds and provide a good reference for timing applications as well as a frequency standard, in this case the common 10Mhz standard

- Also known as GPSDO for short
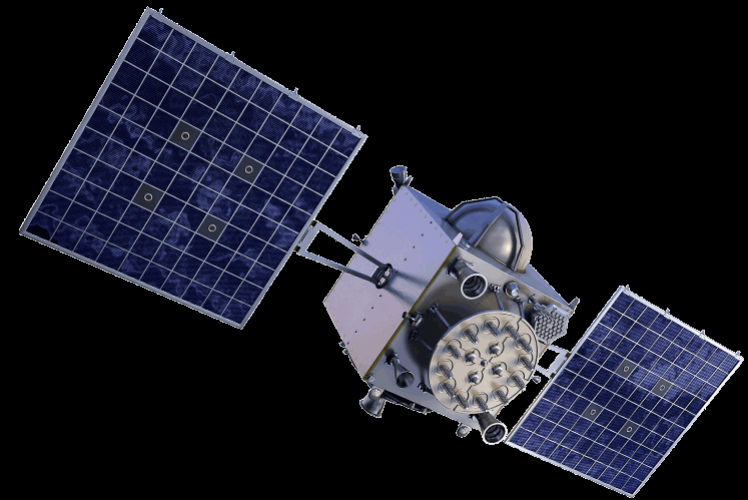
Where do you find these?

- Cell Towers – would be a mess without them

- Some Coordinated Universal Time (UTC) sources

- Lab equipment needing an accurate 10Mhz source for calibration or reference

Why would I want one?

- **Your ham shack** – Keep your radio frequency accurate and stable

- Great source for transverters, mainly used in gigahertz range, sometimes EME

- Many higher end radios have input for 10mhz source, etc.

Where do you find these 10Mhz connectors?

Down East Microwave (DEMI) Transverters as well as many other Brands especially high frequency have the option

Higher end USB receivers like the Airspy as well as some other units

How about Electraft Radios? -> Yes

Electraft K3
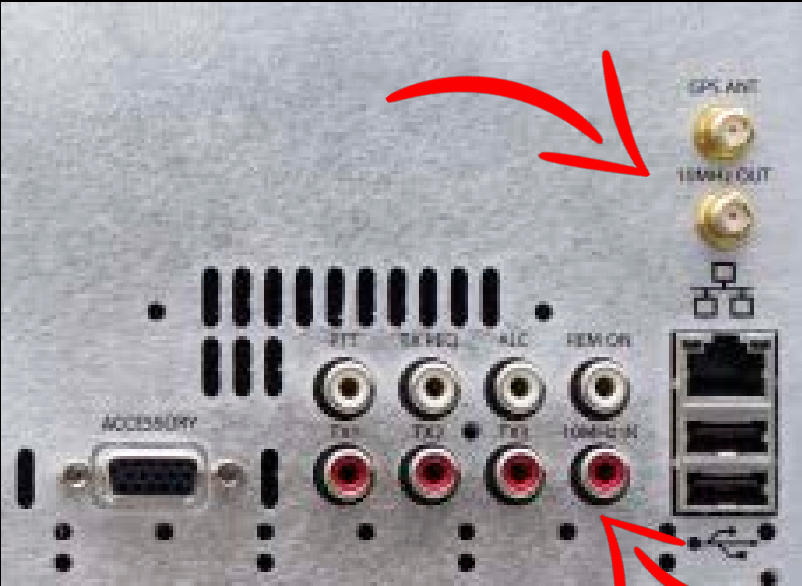*(Picture from Elecraft website)*

It is an option for the K3 but some do not order it I noticed.

How about Flex Radios? -> Yes

Newer Flex Radios like the 6600M
(Picture from Flex Radio Website)

10Mhz reference input or option for internal GPSDO reference with an extra output

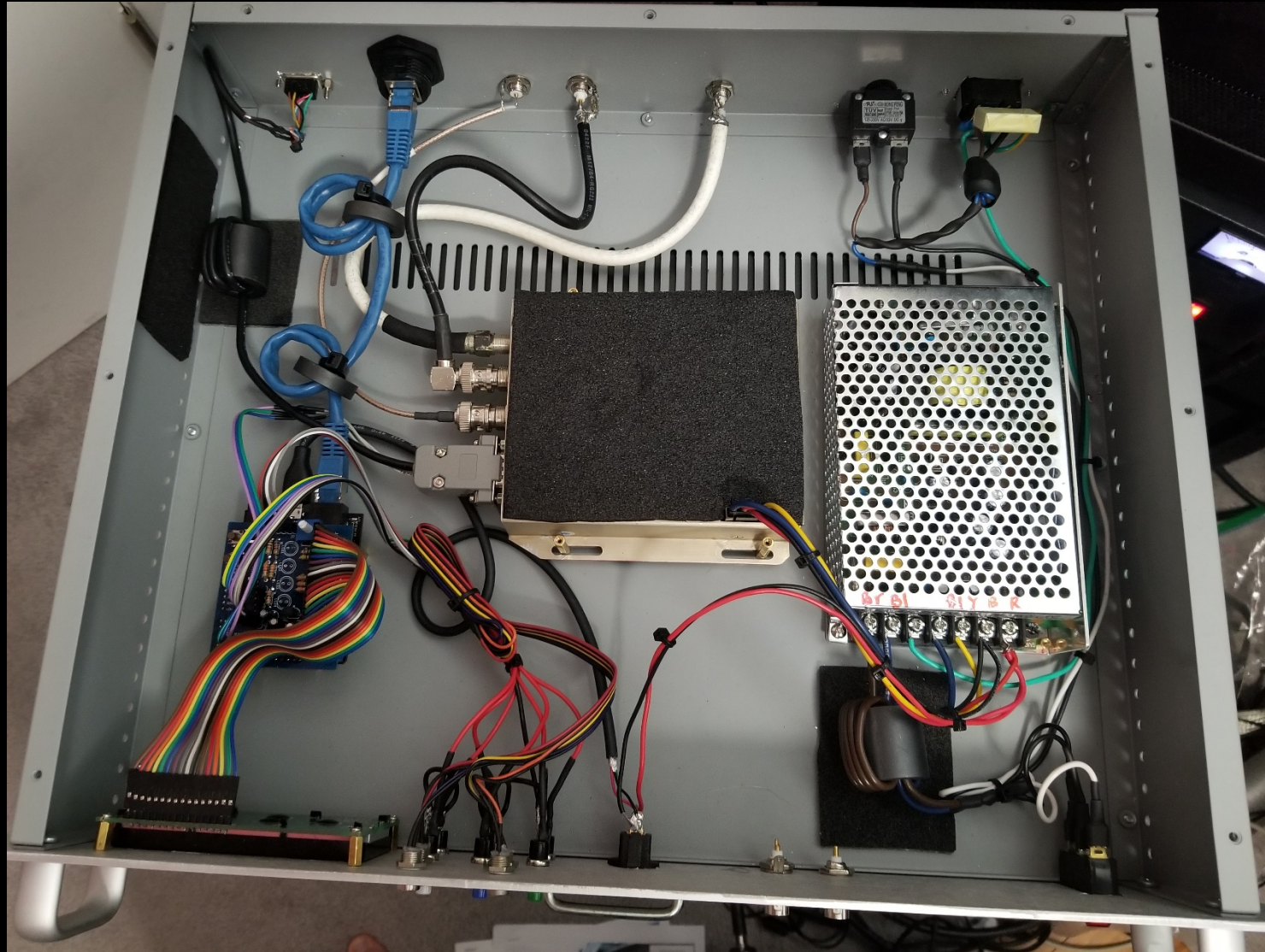# Where else do you see these?

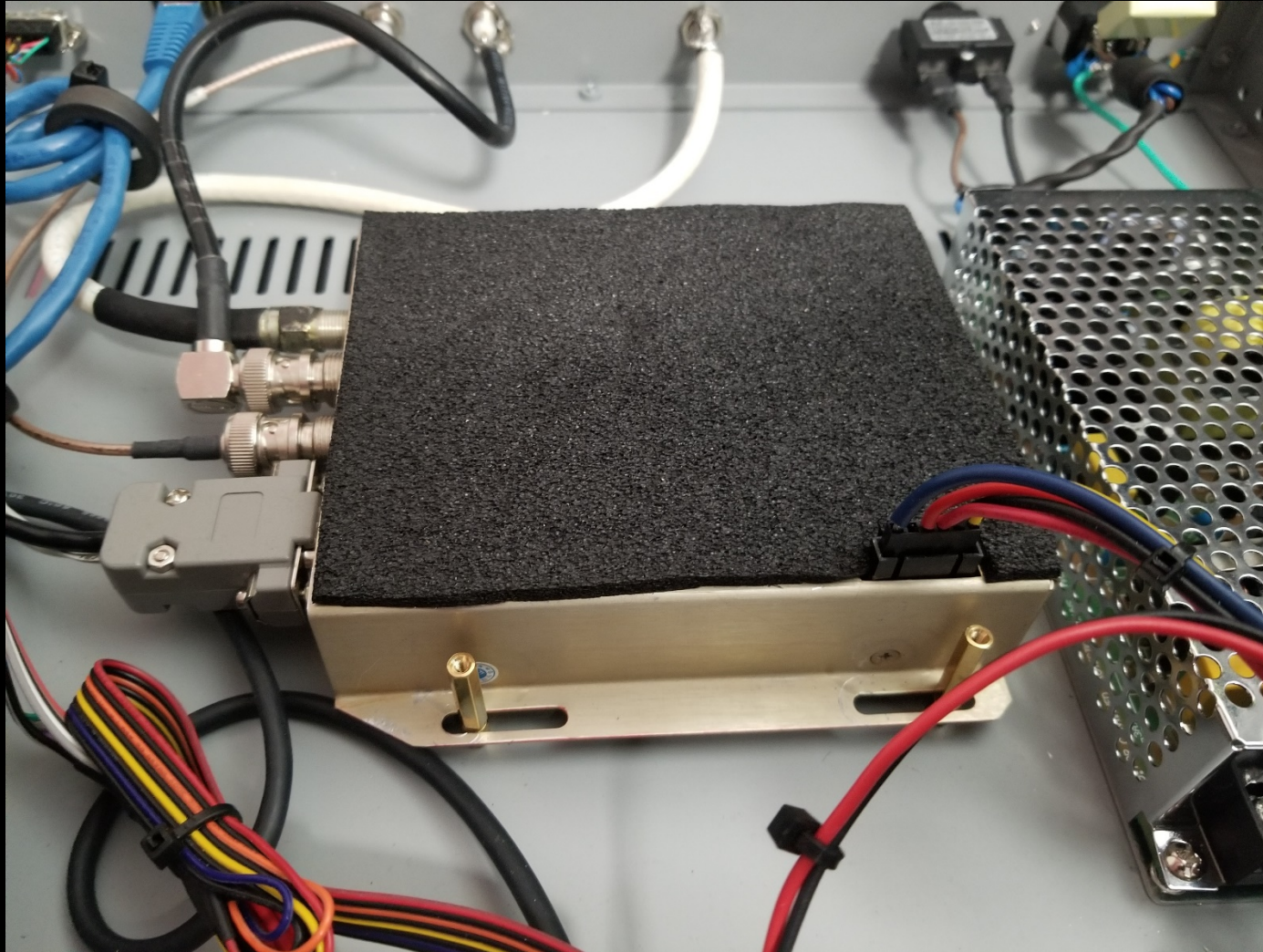Even older model Flex radios had these like the Flex 5000

Can be used to calibrate Frequency Counters

Let's take a virtual Tour Inside

The Trimble Thunderbolt GPSDO

Foam is used to help with temperature control/stability (optional) Some use Styrofoam, etc.

- GPS in
- 10Mhz Out
- 1PPS Out
- Serial Data Out
- Power (top)

Connected GPSDO Close Up View

- GPS in (F-Type)
- 10Mhz Out (BNC)
- 1PPS Out (BNC)
- Serial Data Out (9 pin)

GPSDO Close Up View Unplugged

Before construction

- GPS in (F-Type)
- 10Mhz Out (BNC)
- 1PPS Out (BNC)
- Serial Data Out (9 pin)

The GPSDO "Naked" (Metal case removed)

Picture Found on Internet (not mine)

- The main clock unit is in metal case

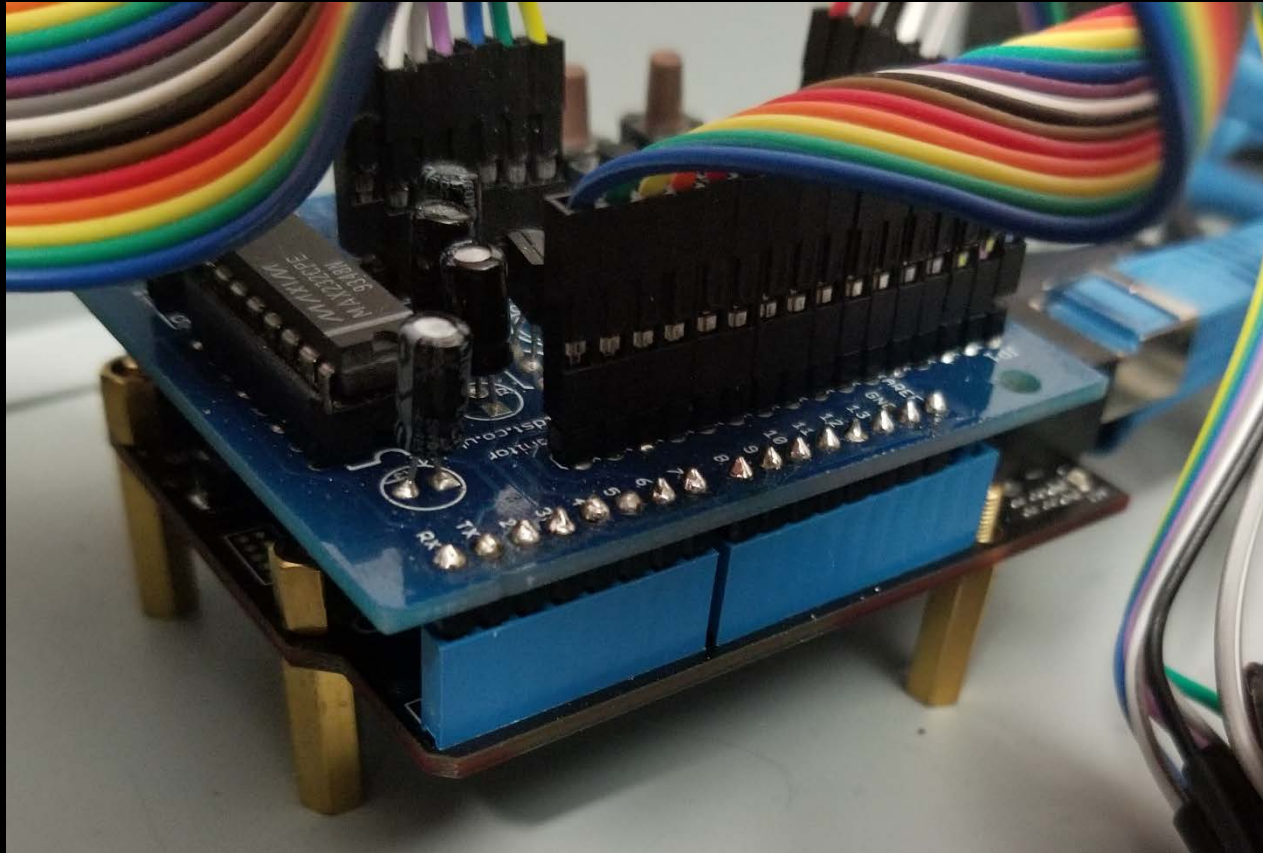- Rest is basically for GPS disciplining and for serial reporting

Example of an eBay "Bundle"

This will get you going just add a few components, case of your liking, etc.

I opted not to go this route, but if you are not familiar with this tech, I do recommend it. You will pay a little premium for convenience though.
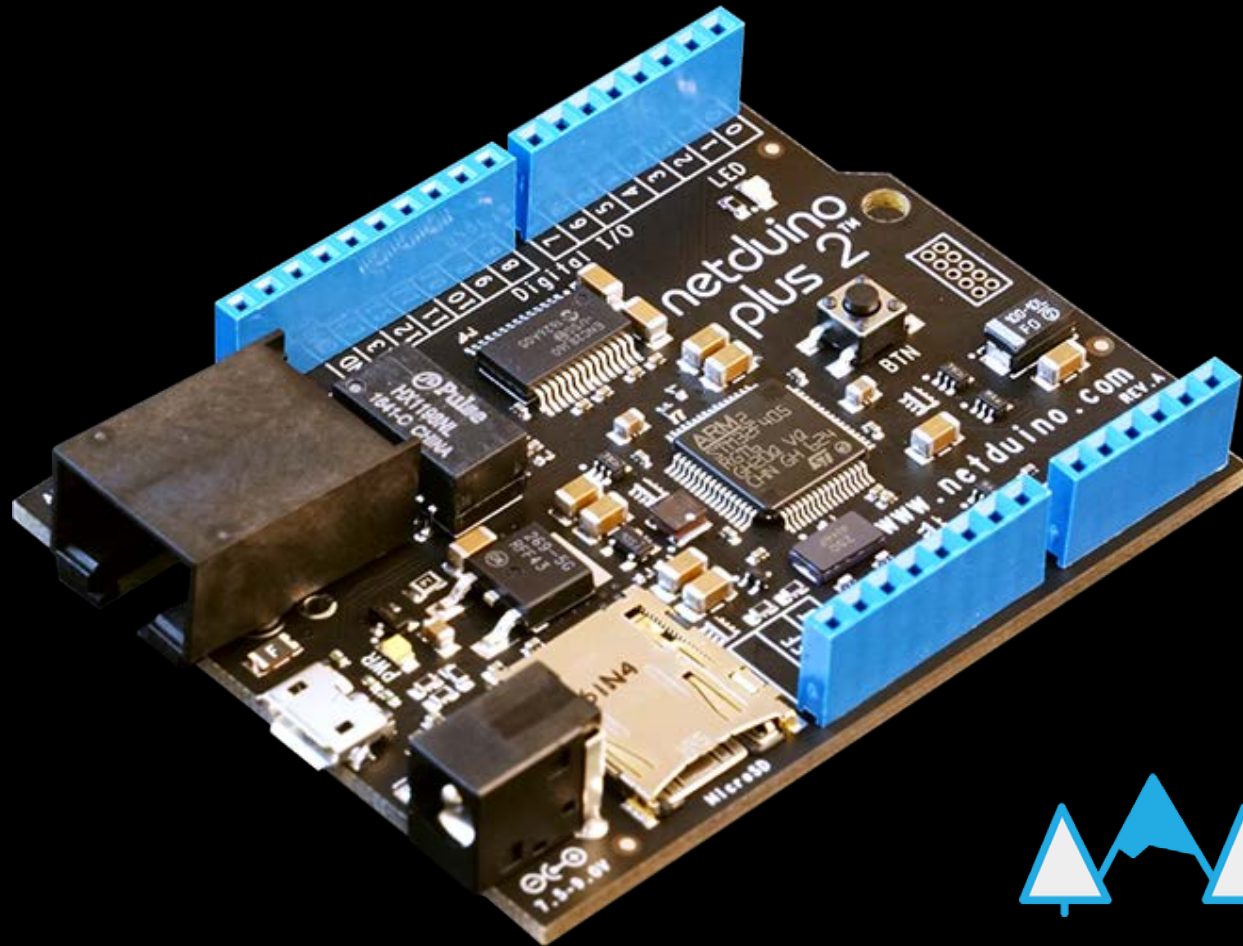
"Reporting Unit" Side View

Uses a Netdrino with the M1DST header as pictured, Header is top

- Serial In from GPSDO
- Ribbon cable to LCD
- Wires to front buttons
- 5V power in
- Uses Max232 chip for serial data translation
- Hardware & PCB designed by M1DST

Netduino N2 Plus

(Picture from their website)

Cortex-M4 @ 168Mhz
384 KB Code Flash Storage
100 KB RAM
10 Mbps Ethernet
Micro SD Slot (up to 2GB)

There are other options but I choose this one, see website for details

WILDERNESS LABS

"Reporting Unit" feeding the front panel and the LCD Unit


LEDs and buttons are wired to Netduino Plus 2

- Power switch to Netduino was salvaged from a broken hair dryer
- Ribbon cable to LCD
- Wires to front buttons
- Ribbon cables are from a Raspberry PI Kit Leftover

(Almost) Everything needs power!

- AC in on top left

- DC -12/+12 & +5/Ground to Thunderbolt

- +5V split off to other hardware

- AC main power and DC ONLY to keep GPSDO on

AC to DC – Fairly basic but filtered
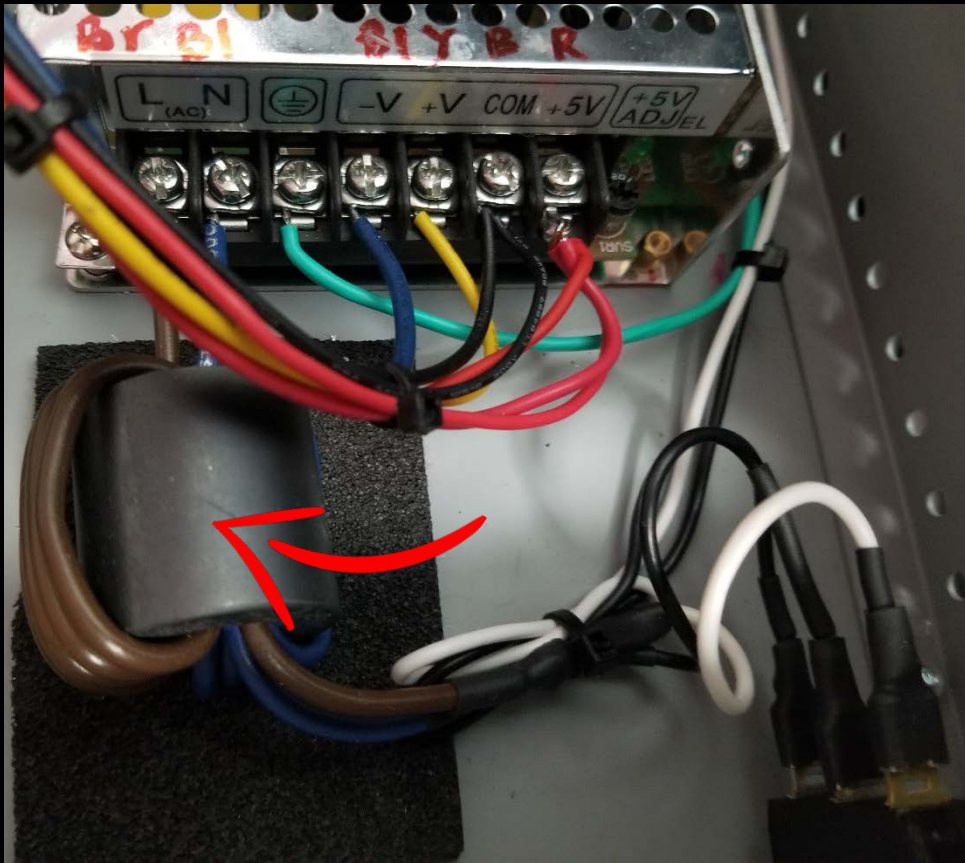
AC comes in via inline circuit breaker and power cord, note the filter capacitors and the ferrites!

Material costs and part sources

- With Patience you can get most on eBay and/or your junk box

- I saved some money with parts I already had

- Total cost if you start with **nothing**: $300-500

- **Why Build?** Flex version (While a lot smaller but not as well featured) costs 2x as much, other commercial version can run in the thousands!

Item	Source	Cost
GPSDO	eBay	$95-250
Rack Mount/Case	eBay, etc	$35+
Power Supply	Jameco, Mouser	$40
NetDuino Plus 2	Wilderness Labs	$60
LCD Display	eBay	$18
Cover for LCD	eBay	$6
Buttons	Jameco, Mouser	$10
GPS Antenna	eBay	$10-60
BNC Connectors	Jameco, Mouser	$10
Header Board	M1DST	$12-14
Misc. Cables	Jameco, Mouser	$20
Misc. Comp.	Jameco, Mouser	$15

Why did I use a Netduino N2 Plus and not an Arduino?

NTP Server

- The Netduino has an ethernet jack, allows me to run a super accurate NTP (time) server on my LAN to use by my PCs, etc. thanks to code from James M1DST

- Set to Static IP on the LAN

Software from M1DST

- M1DST was already nice enough to share his code with the world and it was proven to work with this unit.

- Uses C# vs Wiring Language

As for the Software

Here is where you get it:

- https://www.m1dst.co.uk/category/projects/trimble-thunderbolt-monitor/

- For monitoring via serial port use Thunderbolt Monitor and/or Lady Heather

Thank you James, M1DST
For the code and the board!

The LCD overview

- Buttons select view up/down

- Time is UTC

- Shows Grid

- Lat/Lon and Altitude in Meters (software from UK)

- Temperature reading is from Oscillator and is heated

GPS Upgrade (Outside vs. Inside)

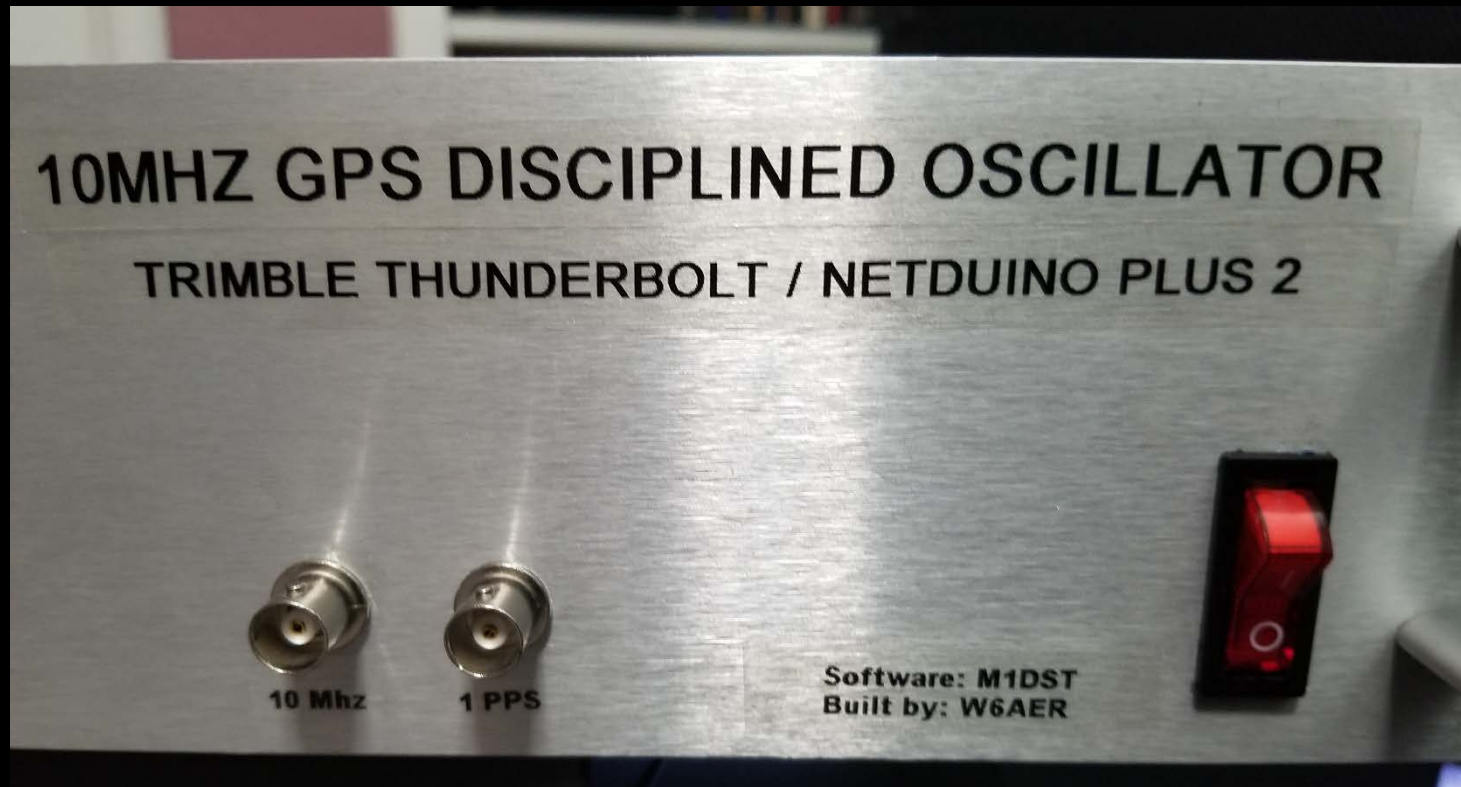5V External GPS from Ebay   Backyard Location, low loss coax

The "sort of" Finished Product Installed

Why "soft of" finished? - The GPSDO Future!

- Looking to add a 10Mhz Distribution system (aka Splitter)

- Front Connectors not yet implemented

- Some surprises to be announced later

This "Beta" Presentations Future

- Will include Lady Heather demo
- Trimble Thunderbolt Monitor demo
- More construction details, edited for time here
- Some Hardware Modifications
- Cover mistakes I made, lessons learned
- Future Development

Anything else you would like to see?

Any Questions?

You will find this presentation as well as many others on my website:

www.w6aer.com