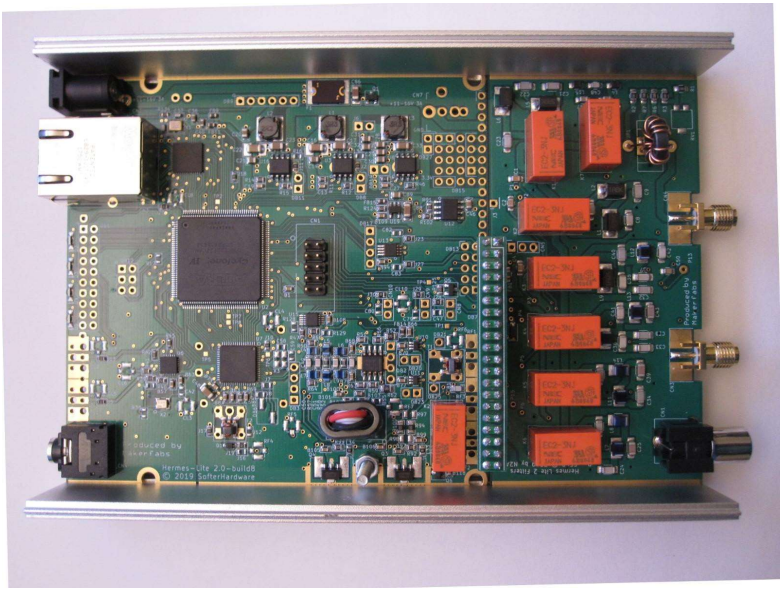


Hermes-Lite

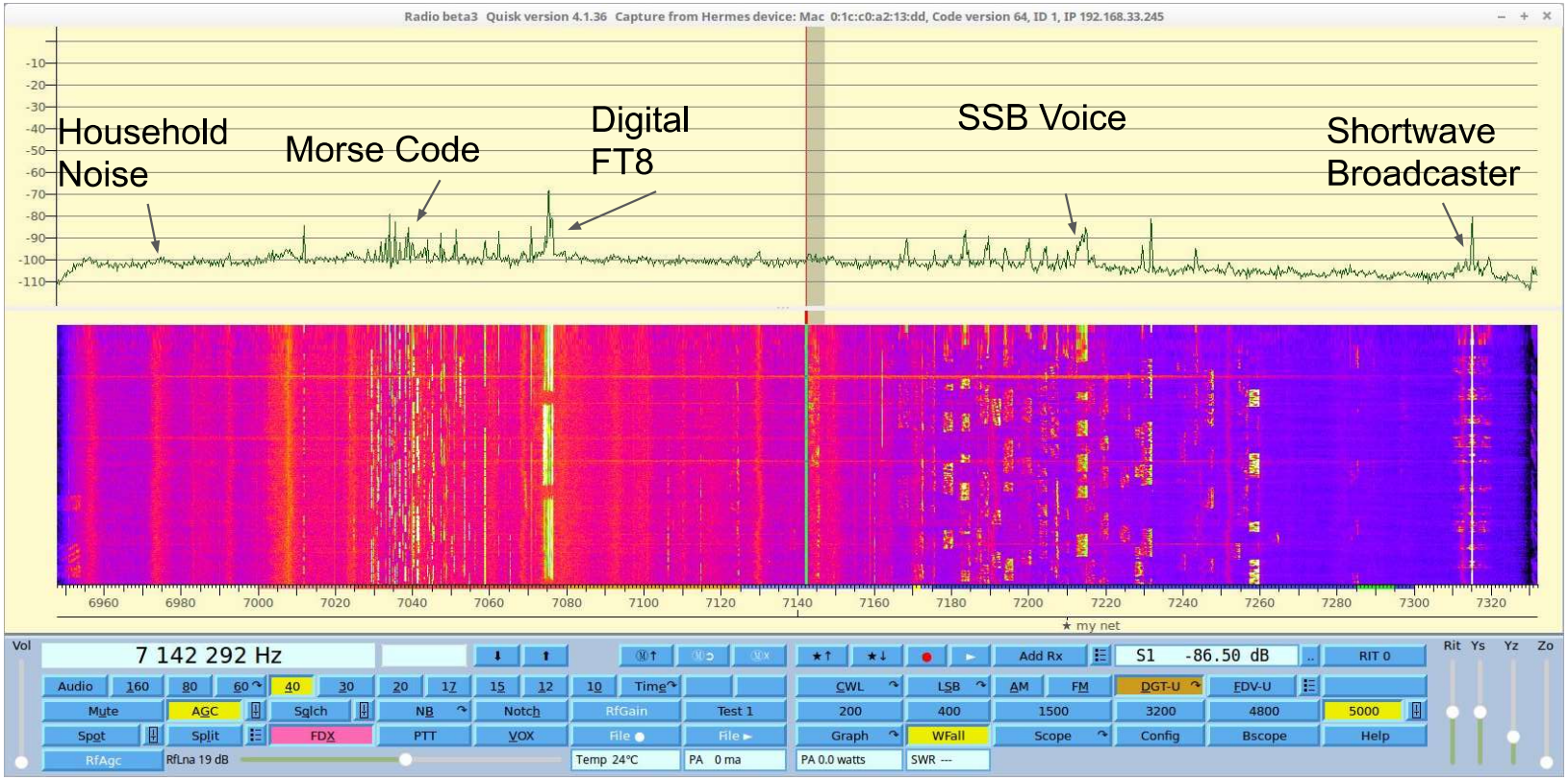
Open-Source Software Defined Amateur Radio

Steve Haynal, KF7O

What Is The Hermes-Lite?

- DDC/DUC HF Transceiver
  - Direct Down/Direct Up Conversion SDR
  - No Analog IF: ADC/DAC covers full HF
  - 0.1 to 38MHz RX and TX
  - 5W QRP PA and Filters
  - Target use mainly digital modes: FT8/WSPR
- Evolution of OpenHSPDR's Hermes
  - Independent effort, inherits PureSignal
- Decent Performance at Low Cost
  - Commodity Broadband Chip
- Fully Open Source and Hardware
  - KiCAD for PCB
  - Makerfabs for small batch production

Software Required, Wideband 48-384kHz Receivers

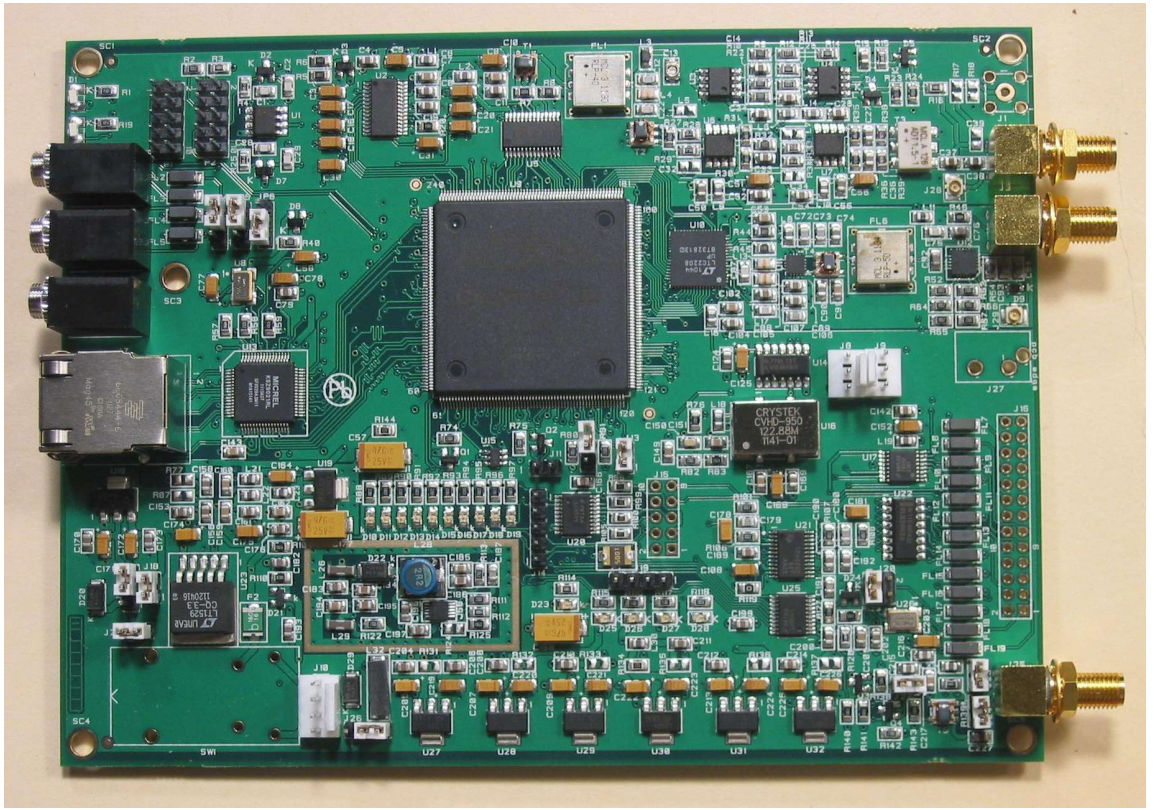


A Brief History

- 1/2014 - Discovered AD9866 Broadband Modem Mixed Signal Front End
- 4/2014 - First Prototype Done and Google Groups Started
- 12/2014 - PCBs for Hermes-Lite 1 Available
- 2015 - Partially Assembled Hermes-Lite 1 Kits
- 2017 - Hermes-Lite 2beta3 Group Buy
- 2018 - Partially Assembled Hermes-Lite 2 from Elecrow
- 2019 - Enclosure and End Plates Finalized, Small Batch Runs by Makerfabs
- 2020-2022 - Refinements, 10 receivers
- 2022 - Retired from Active Development and Support
- Current - Over 1000 Units Sold by Makefabs, Over 1100 Group Members, Production Slowed by Supply Chain

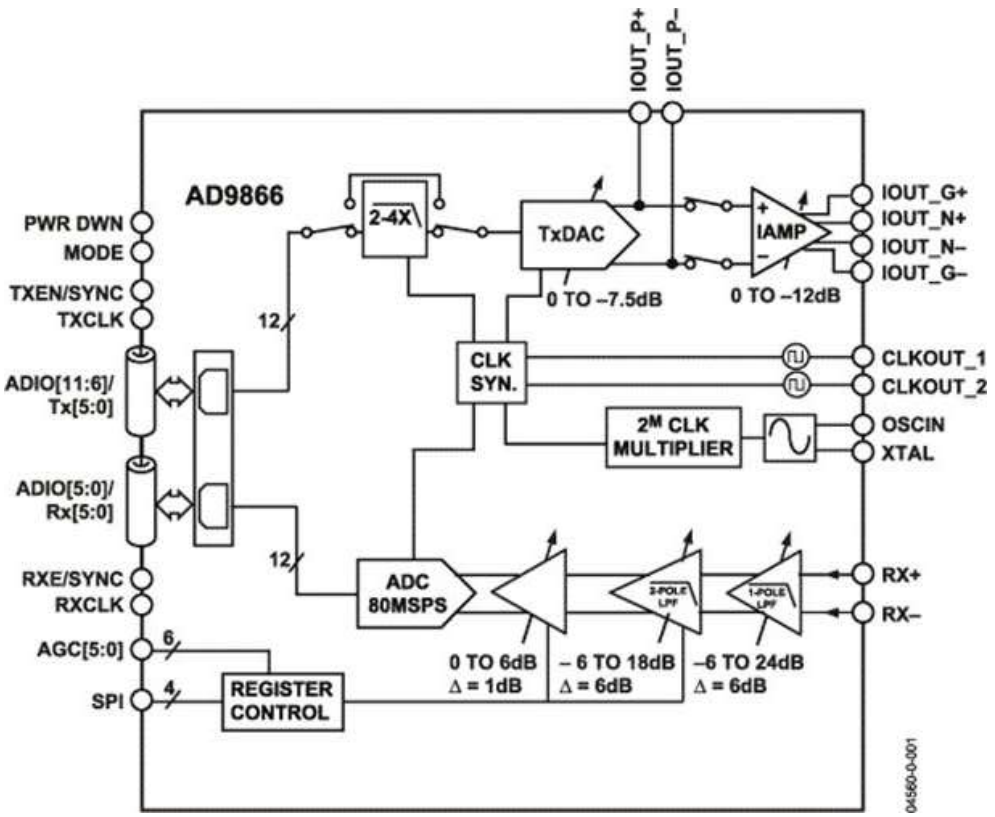
Evolution of OpenHPSDR Hermes

- Circa 2009
- Costly at $700+
- Required Filters and PA
- Code was Complete
  - FPGA RTL
  - Software
  - PureSignal
- Partially Opensource
- Good Starting Point



AD9866: Heart and Inspiration of the Hermes-Lite

- Commodity Broadband Modem
  - Introduced 2003
  - $35
- Combines ADC/DAC/LNA
- 12-Bit
  - Further reduces cost
  - Simplifies clocking

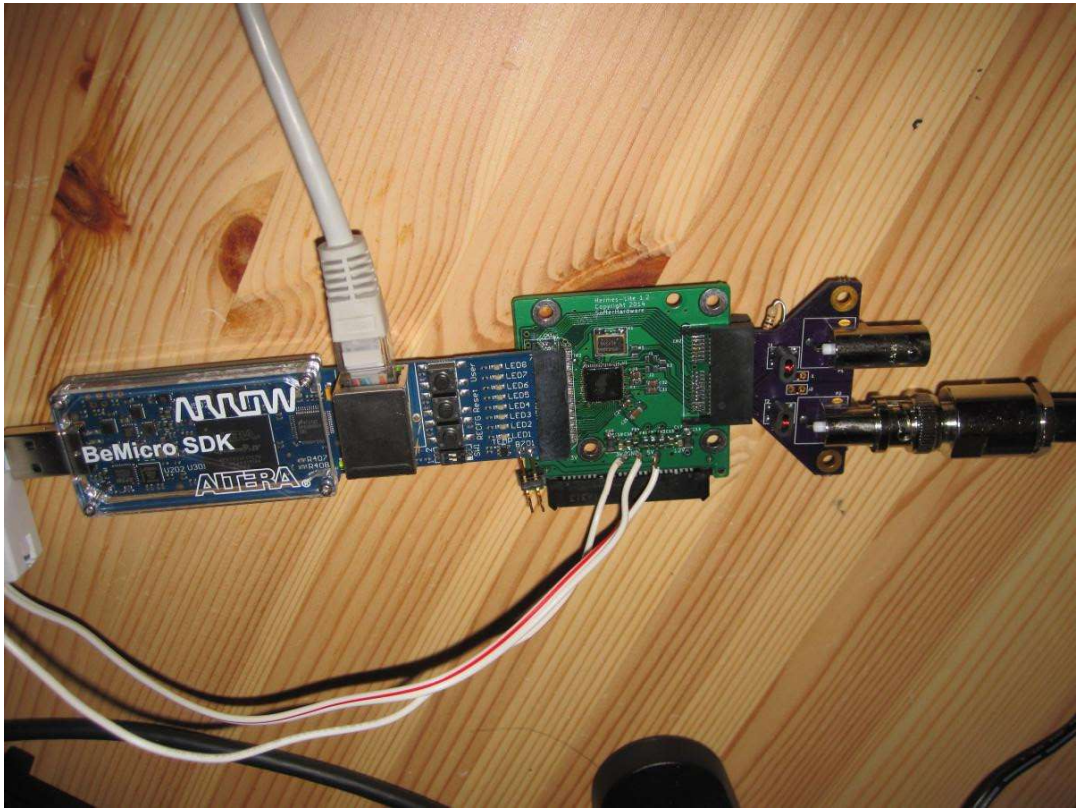


Lower Cost But Decent Performance

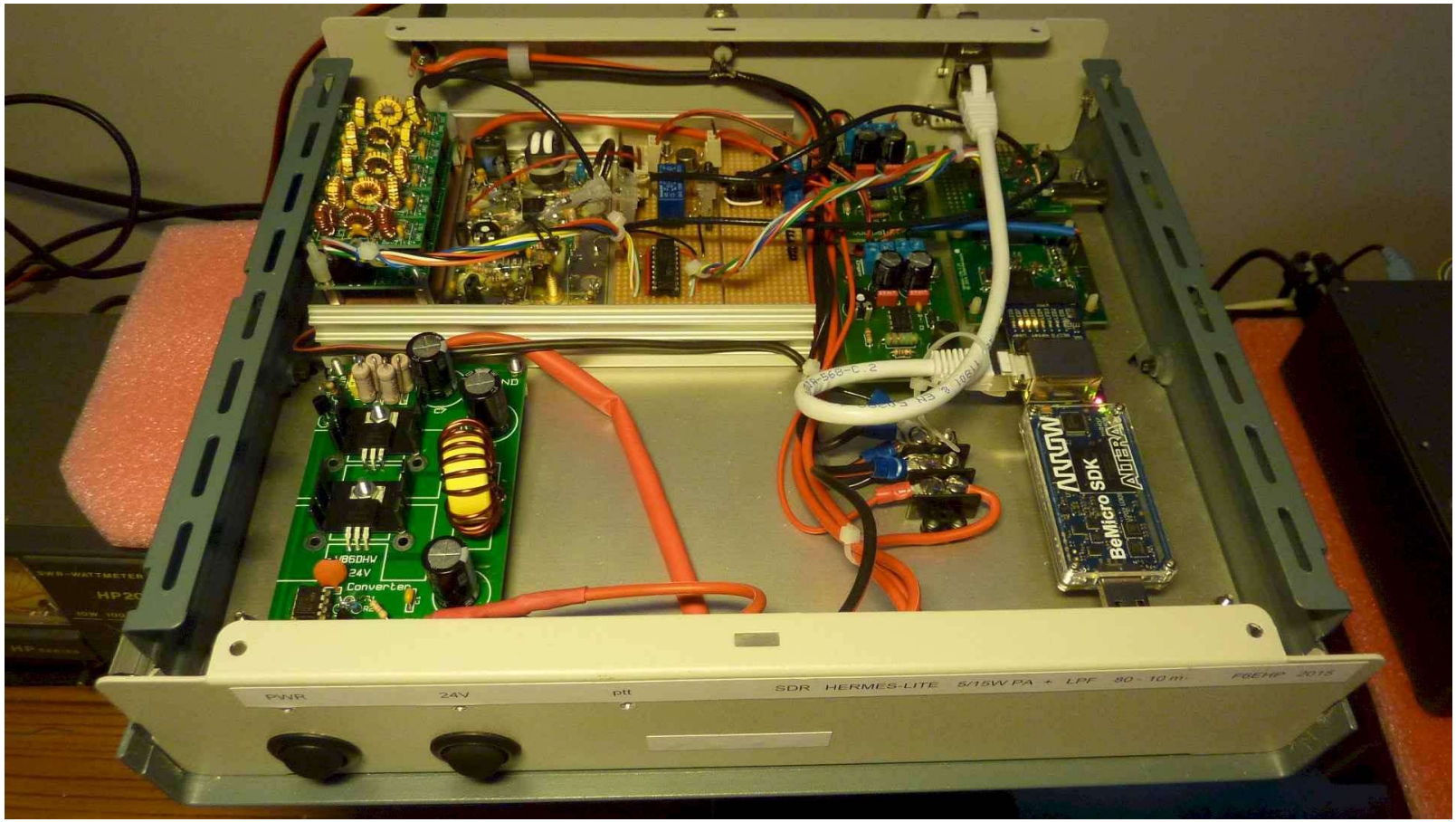
Hermes	**Hermes-Lite**
160M-6M	160M-10M
16-Bit ADC LTC2208	12-Bit ADC AD9866
14-Bit DAC AD9744	12-Bit DAC AD9866
External RX LNA/Attenuator	Internal LNA/Attenuator AD9866
40K Cyclone III FPGA	25K Cyclone IV FPGA
Gigabit Ethernet	Gigabit Ethernet
Onboard Linear Power Supply	Onboard Low Noise Switching Power Supply
Low Phase Noise Crystal Oscillator	Low Phase Noise Modern PLL, Commodity XTAL
Local Audio	
	5W PA and 6 LPFs

Hermes-Lite 1

- Frankenstein
  - 3 Boards
- Very Experimental
- Reuse of BeMicro
- No Filters and PA



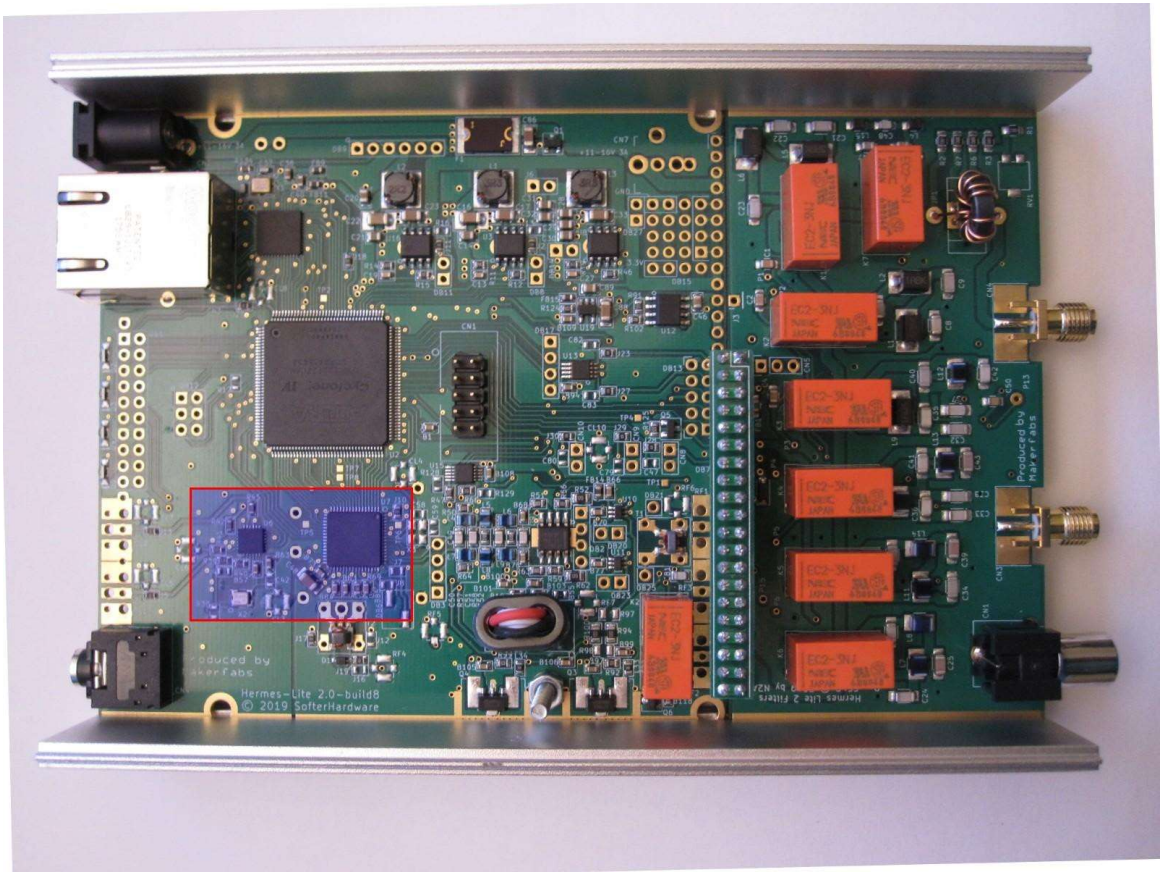
Hermes-Lite 1 Complete Rig - F6EHP



Hermes-Lite 2

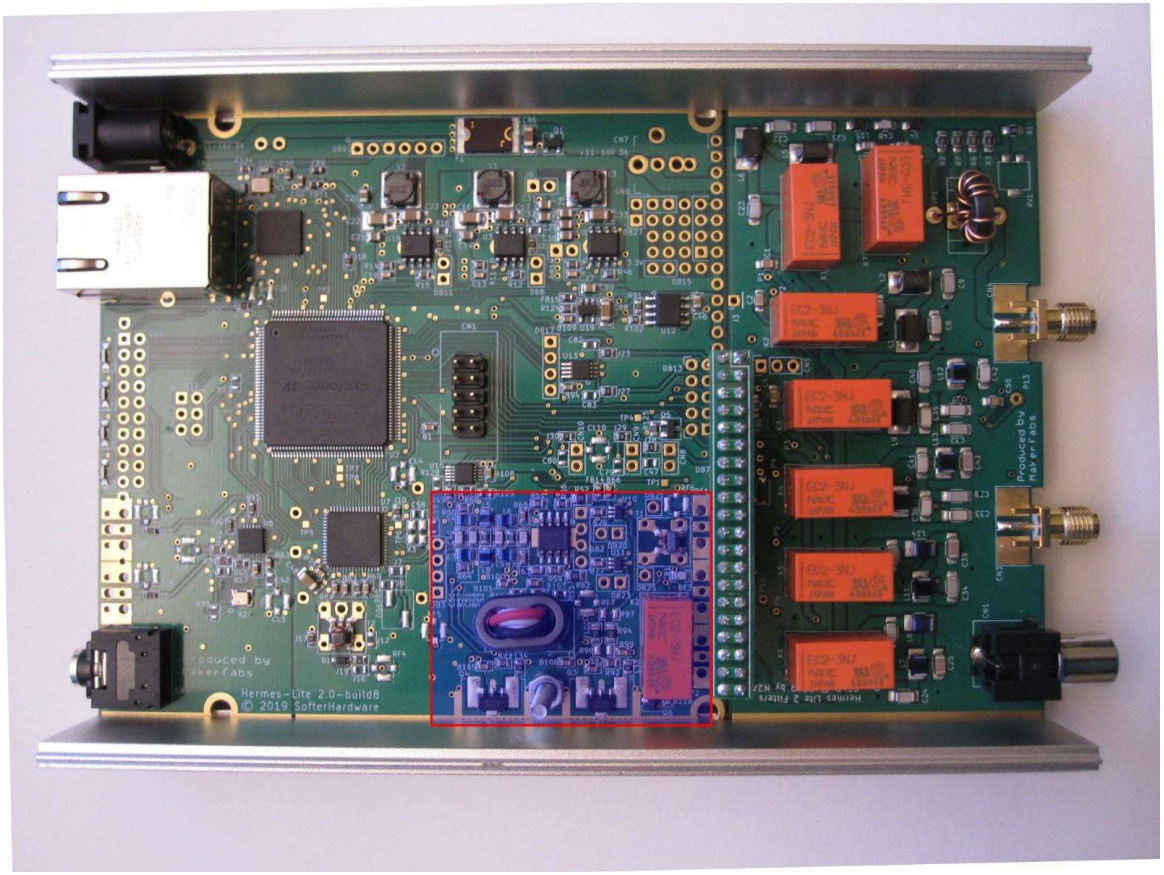
Repurposed Cable Modem Mixed Signal Frontend

- AD9866
  - 12-bit 80 MHz ADC and DAC
  - Integrated low noise amplifiers
  - **Integration in commodity part significantly reduces cost**
- Direct Down/Up Conversion
  - Baseband only
  - 0.1 to 38 MHz
  - No analog mixer ⇒ Less distortion and noise
  - RTL-SDR, Lime SDR cover more spectruem but use an analog mixer



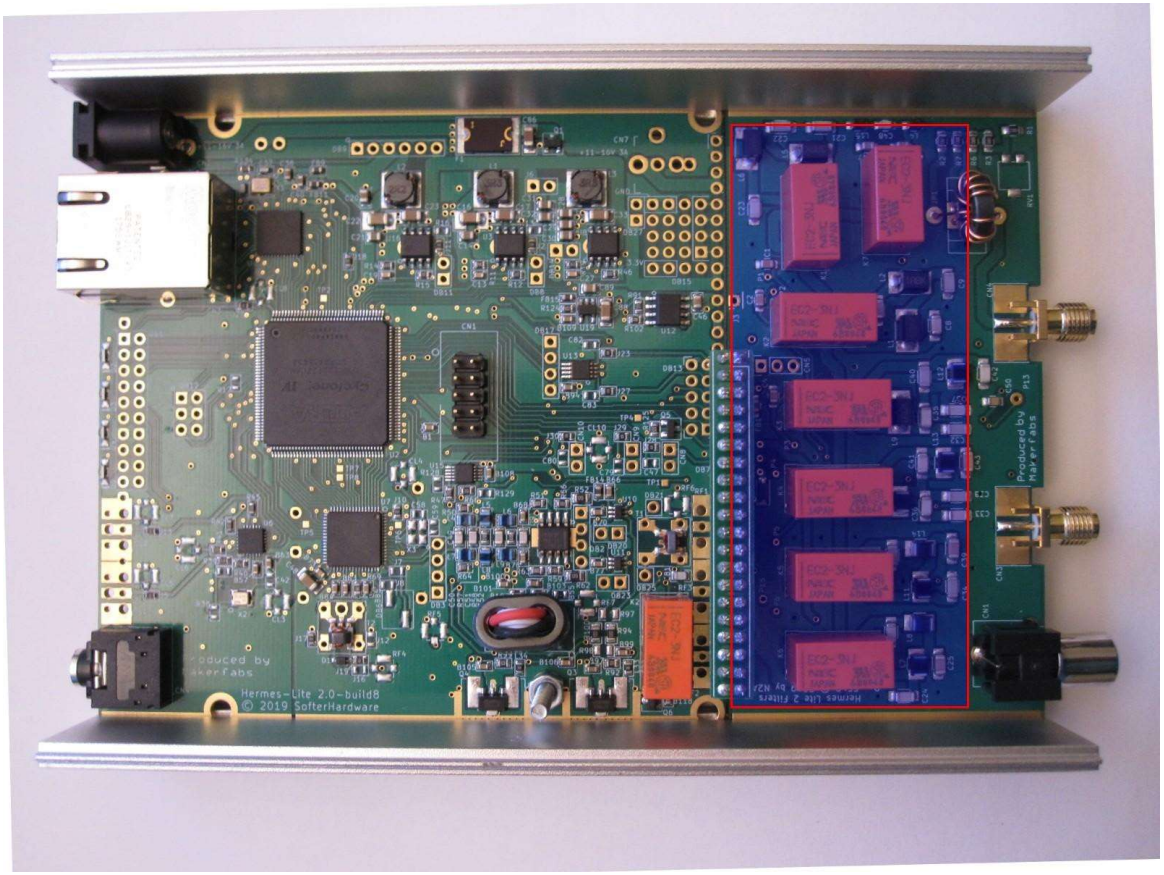
A Complete Amateur Radio Transceiver

- RF Subsystem
  - Low power RF filtering
  - Instrument quality RF preamp
  - RF switching
  - 5W RF power amplifier



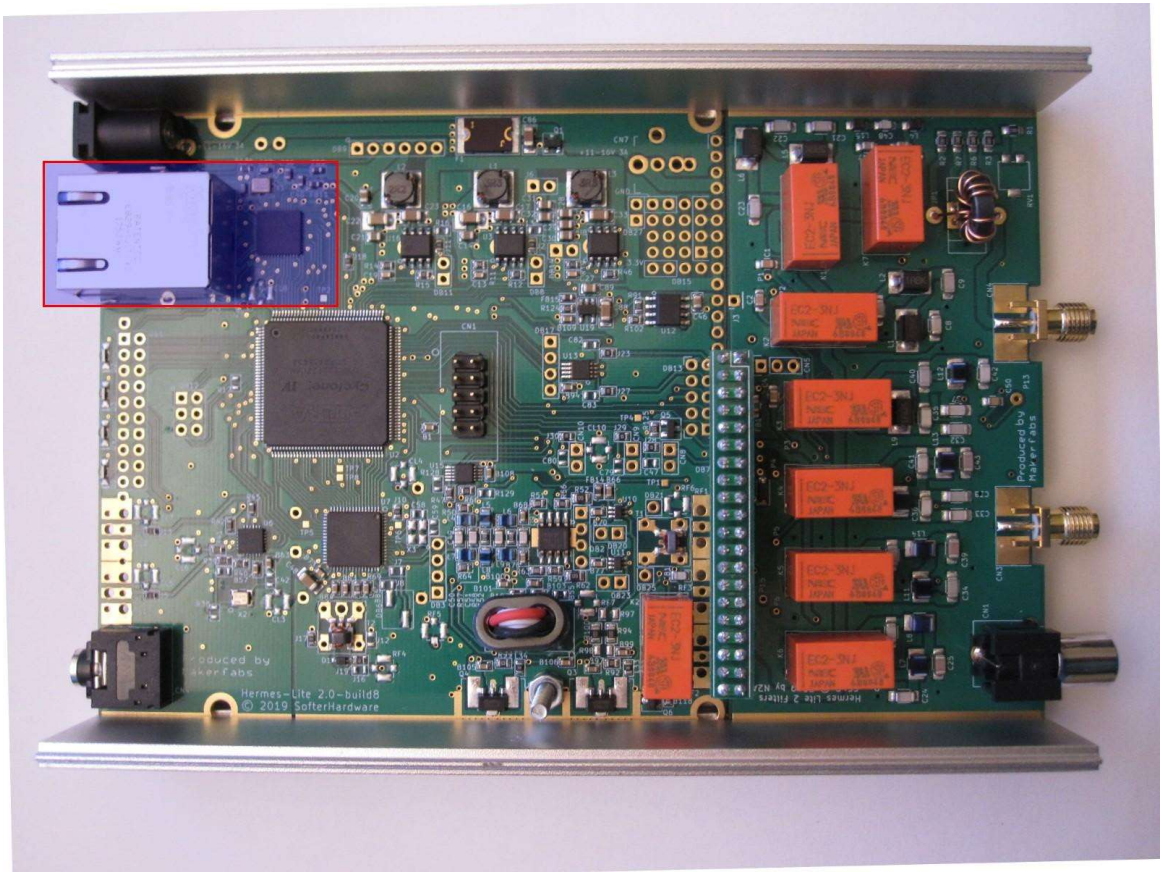
A Complete Amateur Radio Transceiver

- 5W RF Switched Filters
  - Meets international regulations for harmonic suppression



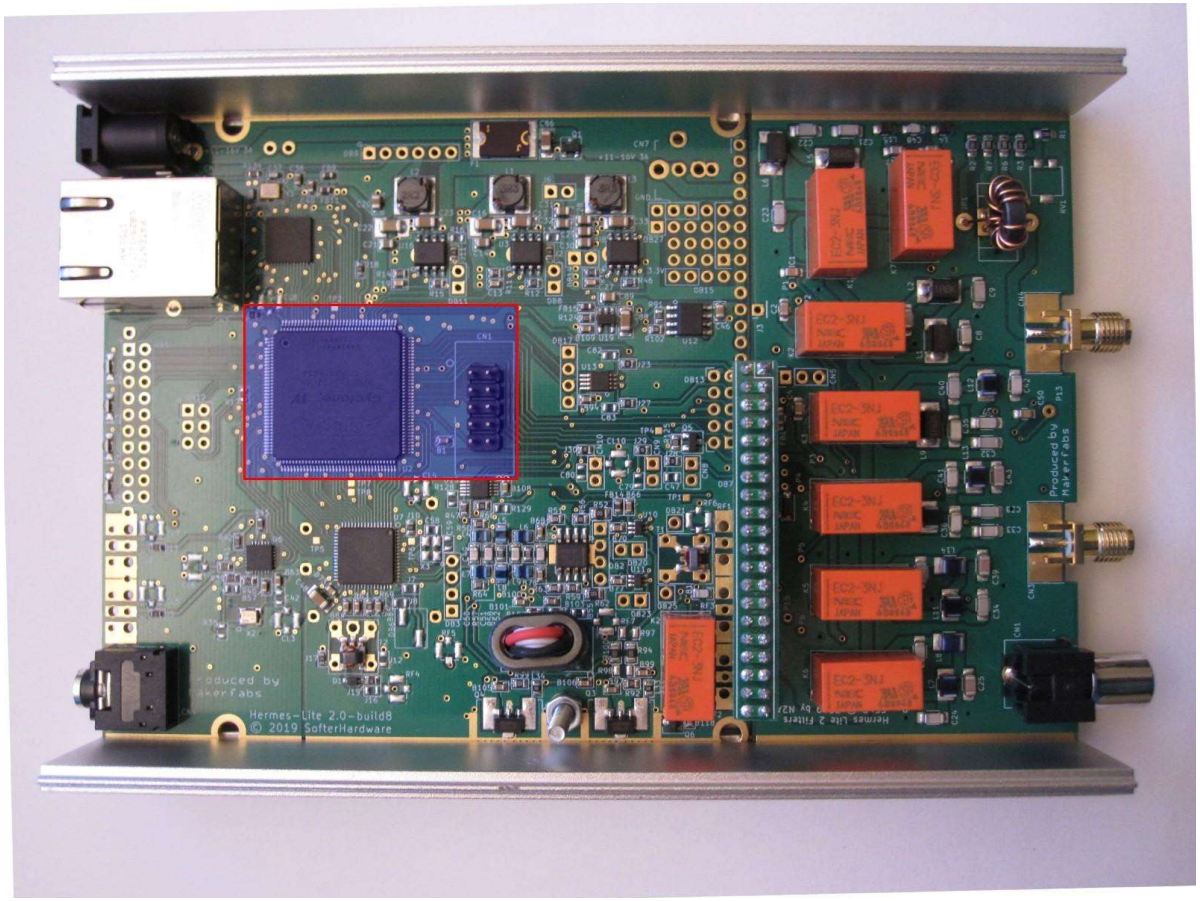
1 Gbs Ethernet

- Autosense, switch 100Mbs/1Gbs
- Permits radio to be far from host computer



FPGA

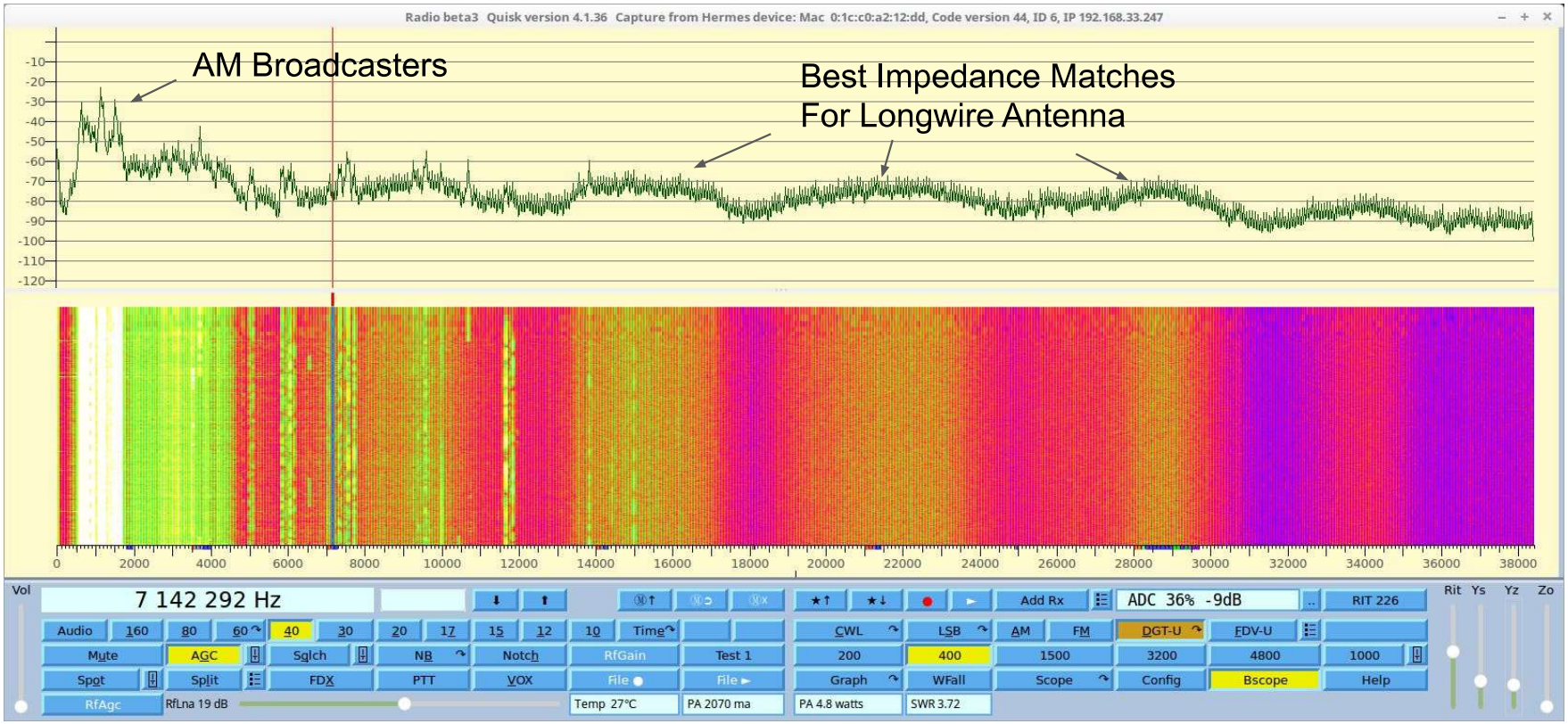
- Cyclone IV
- 25K LE



Software

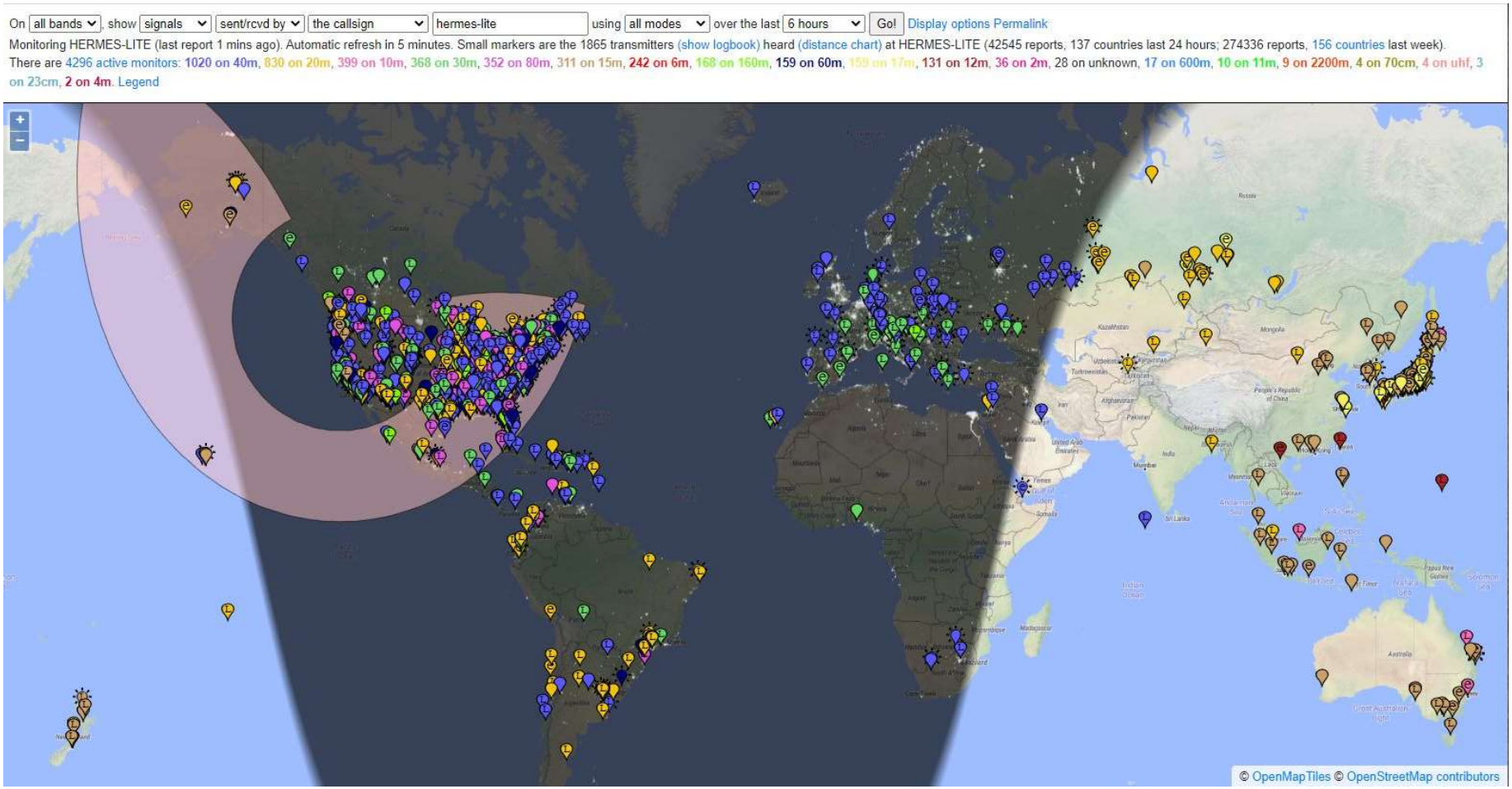
- Quisk - Jim N2ADR
- SparkSDR - Alan M0NNB
- SDR Console - Simon G4ELI
- Thetis - Reid MI0BOT (Fork of Doug W5WC)
- LinHPSDR - Matthew M5EVT (Fork of John G0ORX)
- PiHPSDR - Christoph DL1YCF (Fork of John G0ORX)
- hl2_tcp - Ron N6YWU
- OpenWebRX - Jim N1ADJ Hermes-Lite Support
- GNU Radio - Daniel EA4GPZ Hermes-Lite Support
- CW Skimmer - Robin G7VKQ
- Hermes-Lite Python Module - Steve KF7O
- SDR++ - Alexandre ON5RYZ (New effort, donated HL2 to support effort)

Visualize Entire HF Spectrum



10 Band Digital Skimming, Multiple Slice Receivers

PSK Reporter Logs All Spots



Remote QTH
In Gresham

- Sister’s House
- Good NE Exposure
- 80M EFHW
- Icom AH-4

Regularly in Top 10-20 Bracket on PSK Reporter

Top Monitors by reports over last 24 hours

Monitor	Reports over 24 hours	Reports over 7 days
EA8BFK	113817	693940
DL0PF	92435	526874
WZ7I	89438	681250
KM3T	76757	530415
K1RA-4	72776	500301
K1RA-PI	71751	496976
MM3NDH	66988	449222
K9IMM	64039	412188
OE9GHV	59450	443528
W2AXR	56395	271105
W3OA	56337	375478
DL9GTB	54407	392291
G0KTN	53991	361246
HB9TMC	53470	392223
AA7NM	49661	316148
SparkSDR v2.0.33.0 with antenna 160-10 meter multiband dipole		
WF8Z	48075	269440
LZ4UX	47354	343998
HERMES-LITE	47134	274390
SparkSDR v2.0.33.0 with antenna longwire		
WE9V	46878	326881
DK1MAX	46693	348465
ON3URE	44861	348885
SM2GHI	42442	281600
ES5PC	41839	294494

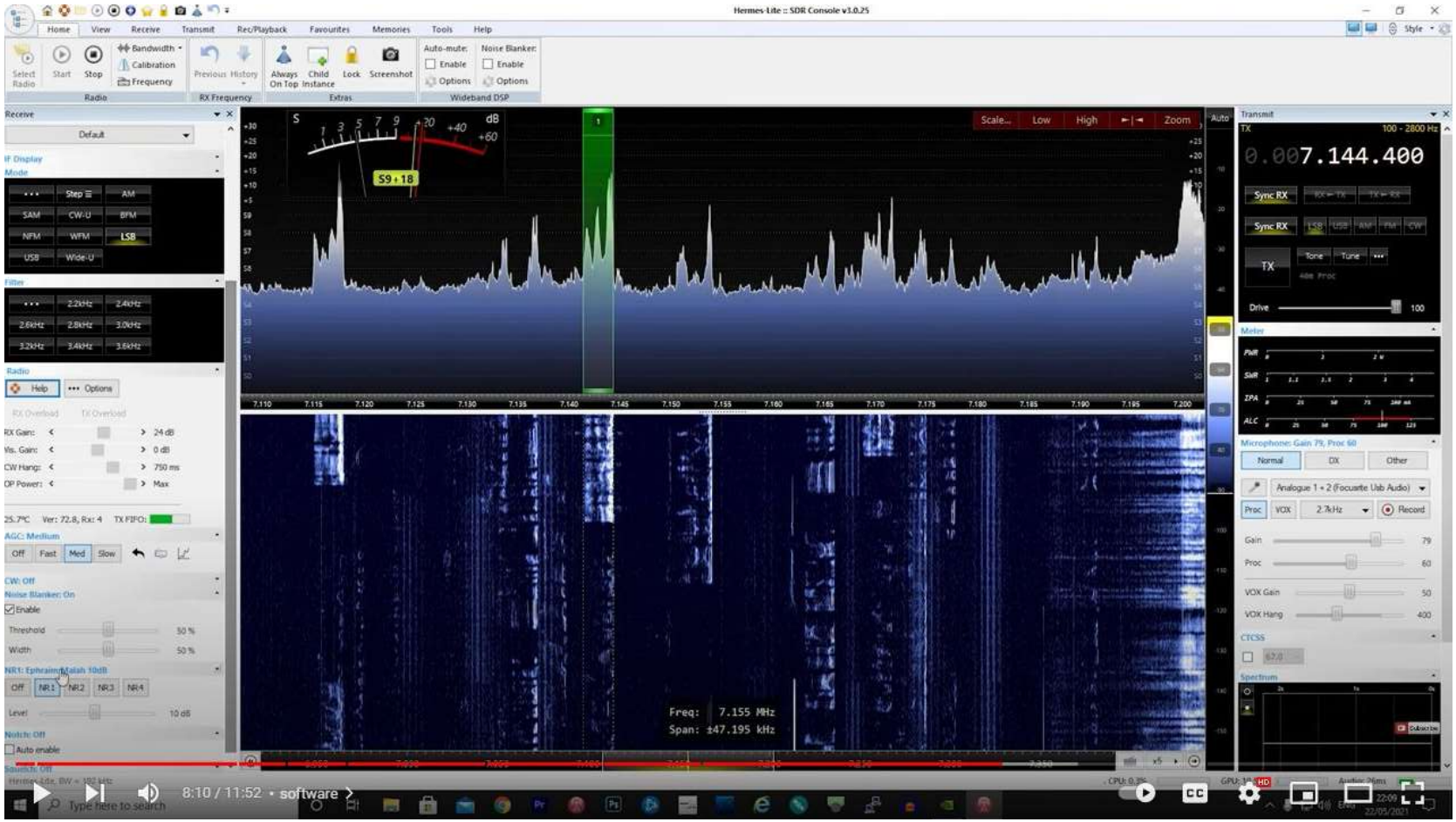
- (•) All
- ( ) invalid
- ( ) vlf
- ( ) 4000m
- ( ) 2200m
- ( ) 600m
- ( ) 160m
- ( ) 80m
- ( ) 60m
- ( ) 40m
- ( ) 30m
- ( ) 20m
- ( ) 17m
- ( ) 15m
- ( ) 12m
- ( ) 11m
- ( ) 10m
- ( ) 8m
- ( ) 6m
- ( ) 5m
- ( ) 4m
- ( ) 2m
- ( ) 1.25m
- ( ) 70cm
- ( ) 33cm
- ( ) 23cm
- ( ) 2.4Ghz
- ( ) 3.4Ghz
- ( ) 5.8Ghz
- ( ) 10Ghz

PureSignal


LSB 2.7k
VFO A: 3.605000
VFO B: 14.010000
24.1C 842mA
Zoom
Pan:
AF:
AGC:
RX-GAIN:
Mic:
Drive:
Squelch:
Mox
Band
BStack
Mode
Filter
Noise
AGC
Function
piHPSDR - Pure Signal
Close
Enable PS
Two Tone
Auto Attenuate
OFF
Restart
MON
PS FeedBk ANT:
Internal
EXT1
ByPass
Feedback Lvl
Correcting
feedbk
160
corr.cnt
7566
sln.chk
0
dg.cnt
0
status
RESET
GetPk
0.000
SetPk
0.230
TX ATT
16


LSB 2.7k
VFO A: 3.605000
VFO B: 14.010000
22.4C 860mA
Zoom
Pan:
AF:
AGC:
RX-GAIN:
Mic:
Drive:
Squelch:
Mox
Band
BStack
Mode
Filter
Noise
AGC
Function
piHPSDR - Pure Signal
Close
Enable PS
Two Tone
Auto Attenuate
OFF
Restart
MON
PS FeedBk ANT:
Internal
EXT1
ByPass
Feedback Lvl
Correcting
feedbk
158
corr.cnt
2458
sln.chk
0
dg.cnt
0
status
CALC
GetPk
0.234
SetPk
0.230
TX ATT
16

SDR Console - YouTube

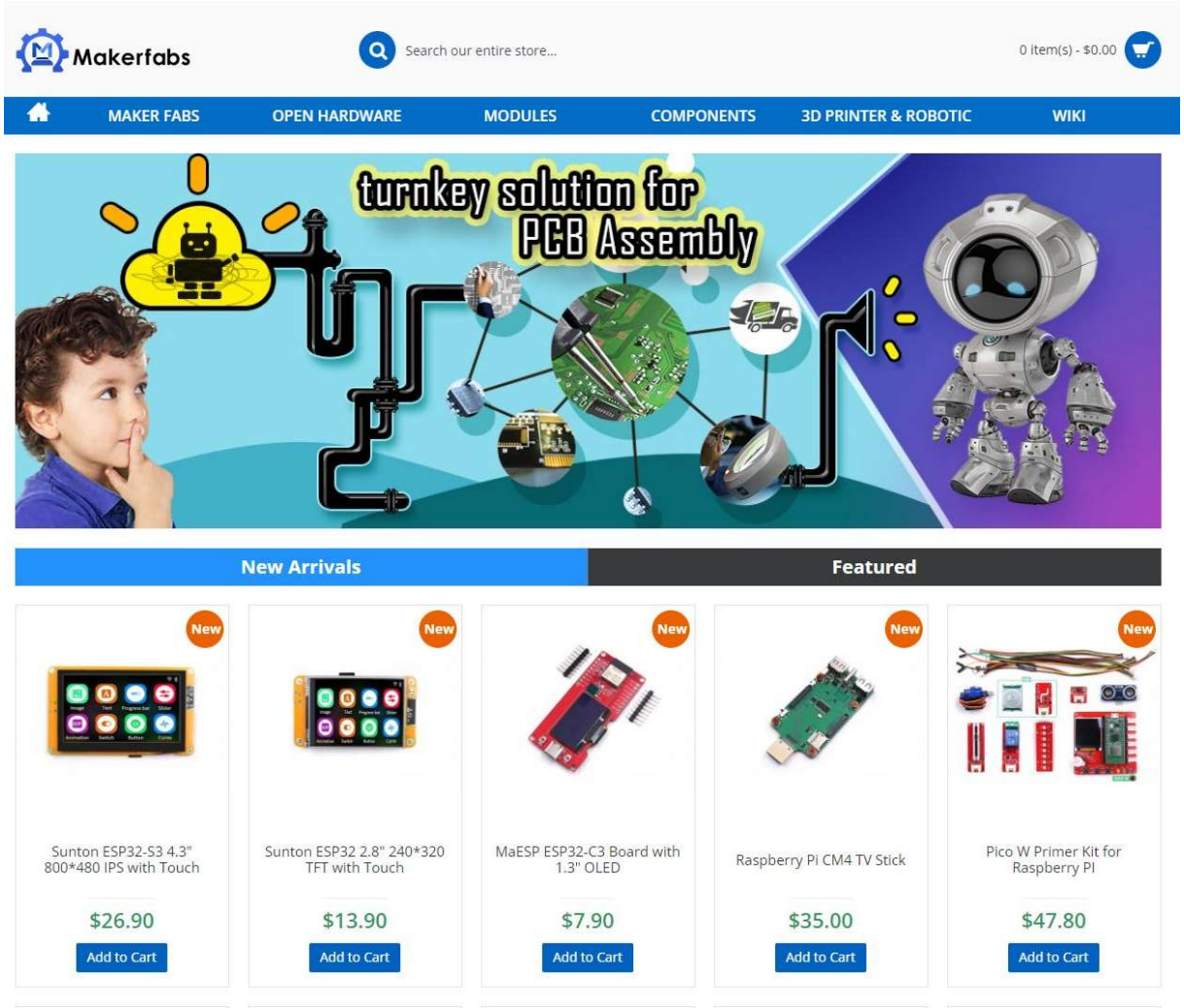


Opensource Software, Hardware, Tools & Production

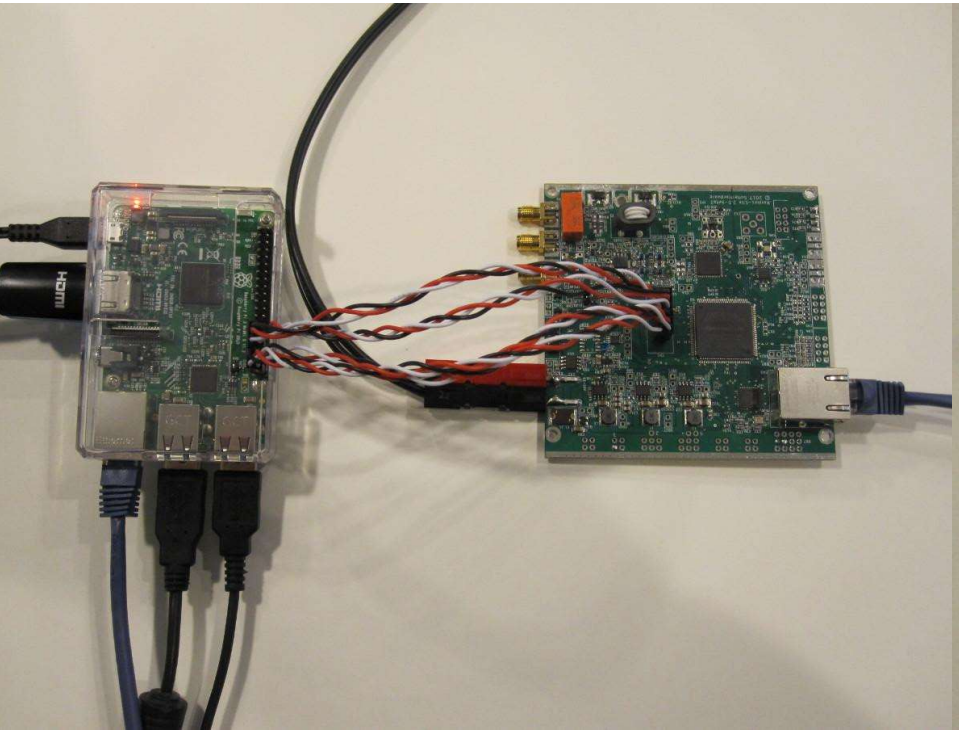
- Gateware - FPGA Verilog RTL
  - Forked from OpenHPSDR project, one of oldest open hardware licenses, similar to GPL
  - No soft CPU, No proprietary IP
  - Small, standalone UDP stack, including DHCP
  - High performance NCOs, filters, DSP
  - Co-simulation of portions with MyHDL, Icarus Verilog and Cocotb
  - Free version of Quartus Lite used for Synthesis, Place & Route
- Hardware - Schematics, PCBs and BOM
  - KiCAD Schematics and 4-Layer PCB
  - BOM & PCB Gerber files on github
  - Anyone can send gerbers to a PCB production house, over 50 homebrew builders
- Production - Small Batch Assembly with Open Hardware Makers in China
  - www.makerfabs.com (1000+ units shipped over the past 4 years)
  - Raspberry Pi based production testing

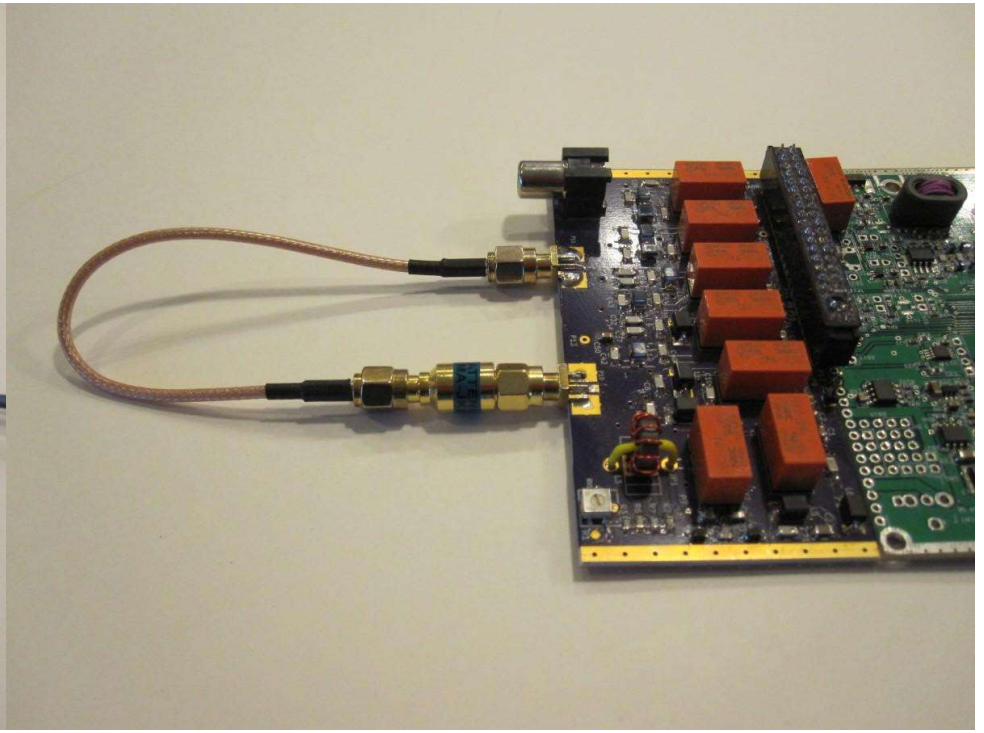
Makerfabs

- Great turnkey small batch production
- Based in the “silicon delta”
- Specializes in open hardware
- $10 per unit sold goes to Hermes Lite R&D fund



Production Screening Tests





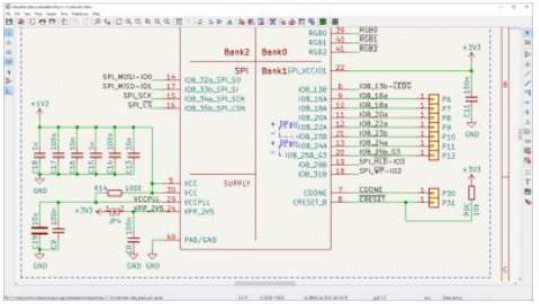
KiCAD

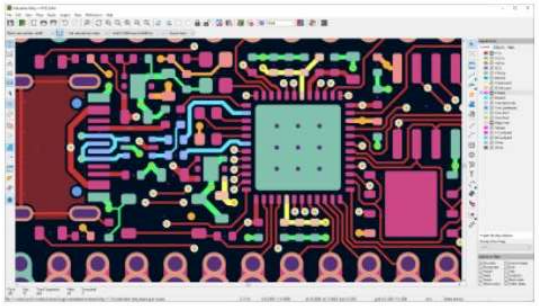
- Popular Opensource
- Sponsored by CERN
- Financial contributions from Hermes-Lite fund

Schematic Capture

KiCad's Schematic Editor supports everything from the most basic schematic to a complex hierarchical design with hundreds of sheets. Create your own custom symbols or use some of the thousands found in the official KiCad library. Verify your design with integrated SPICE simulator and electrical rules checker.

Learn more





PCB Layout

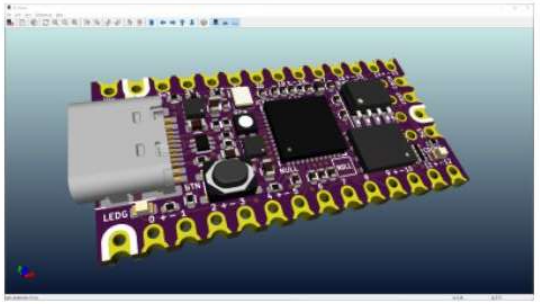
KiCad's PCB Editor is approachable enough to make your first PCB design easy, and powerful enough for complex modern designs. A powerful interactive router and improved visualization and selection tools make layout tasks easier than ever.

Learn more

3D Viewer

KiCad's 3D Viewer allows easy inspection of your PCB to check mechanical fit and to preview your finished product. A built-in raytracer with customizable lighting can create realistic images to show off your work.

Learn more



Open Community Projects

Community Projects

m5evt edited this page on Oct 27, 2021 · 33 revisions

Hardware

- N2ADR's Companion Filter Board
  - Production Release
  - KiCAD Design Files
- DB9MAT's HL2-MRF101
- M5EVT's HL2_XVTR
- M5EVT's HL2 external PA monitoring
- DL9LJ's HL2 with 300W PA
- EA3IGT's HL20PA70
- PA3GSB's Radioberry with tight Raspberry Pi integration
- ZL2APV's Diode-Switched Filter Board
- EA4GPZ's Hardrock-50 Amp Setup
- Hardrock-50 interface kits from AK3Q
- Alex Pressl's HL2 Breadboard
- Alex Pressl's HL2 I2C Extender
- 5B4AMO's HL2 to EB300/EB500 Interface
- Various Efforts at Electrolab in France
  - Alexandrie Filter Board
  - EER and ET
- N6QW's blog with Hermes-Lite review and enhancements

Softerhardware CW Keyer

- HL2 soundcard+keyer
- Based on Teensy 4
- Low-latency key to ear
- Low cost construction
- Multiple keyer software

2021 ARRL Technical Innovation Award

There are many people who are essential to the realization of the Hermes-Lite:

- Jim N2ADR, who designed the filter board, preamp and added support to his Quisk software.
- Claudio IN3OTD, who made many guiding measurements with deep analysis and also designed the PA.
- Phil VK2PH, and other openhpsdr RTL coders who provided most the initial Hermes-Lite gateware.
- Alan M0NNB, who wrote SparkSDR with great Hermes-Lite support.
- John G0ORX, Matthew M5EVT, Christoph DL1YCF who wrote and added Hermes-Lite support to LinHPSDR and piHPSDR.
- Doug W5WC, other openhpsdr software developers and Reid Gi8TME/Mi0BOT, who wrote and added Hermes-Lite support to PowerSDR and Thetis.
- Simon G4ELI, who wrote SDR Console and added Hermes-Lite support.
- Zeqing, CEO of Makerfabs, who has provided stellar small batch production, testing and fulfillment of over 1000 Hermes-Lite orders
- Others mentioned in Google Groups and on Wiki

Thank You!

- Main Page With All Links:
  - http://www.hermeslite.com
- Google Groups ~1100 Members:
  - https://groups.google.com/forum/#!forum/hermes-lite
- Github:
  - https://github.com/softerhardware/Hermes-Lite2
- Github Wiki:
  - https://github.com/softerhardware/Hermes-Lite2/wiki
- Makerfabs:
  - $289 HL2 Main Board (out of stock) https://www.makerfabs.com/hermes-lite-2.html
  - $52.70 Filter Board https://www.makerfabs.com/hermes-lite-2-n2adr.html
  - $16.90 Enclosure https://www.makerfabs.com/hermes-lite-2-enclosure.html