

Building A Project: A Learning Adventure

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AMRAD

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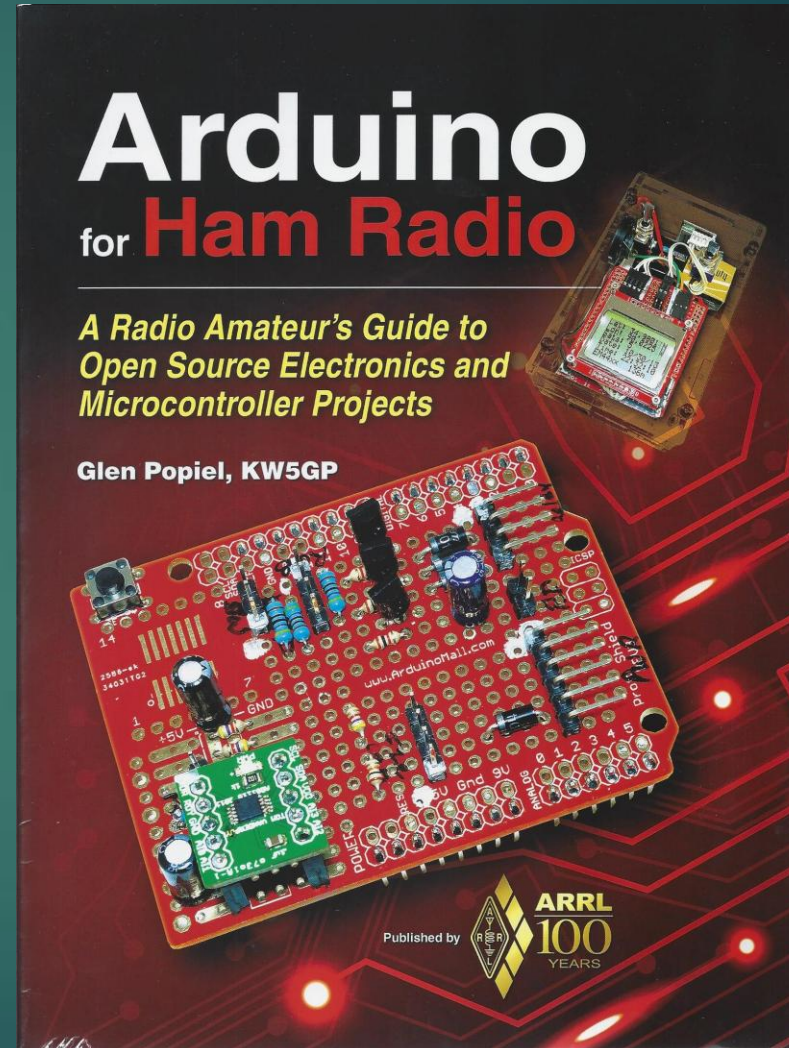
Objective

- ▶ Find an interesting and useful project in a published source
- ▶ Buy the specified parts
- ▶ Build the project “by the book”
- ▶ Design an enhanced project
- ▶ Build an enhanced version
- ▶ Compare side-by-side

Arduino for Ham Radio

Glen Popiel, KW5GP

- ▶ Recent ARRL Publication (Aug '14)
- ▶ Complement to “Ham Radio for Arduino and PICAXE”
- ▶ Excellent practical resource for Arduino hardware
- ▶ Great place to start with Arduino
- ▶ 19 useful projects for the ham station
- ▶ Full schematics for every project
- ▶ Complete code packages on-line
- ▶ Author support very responsive



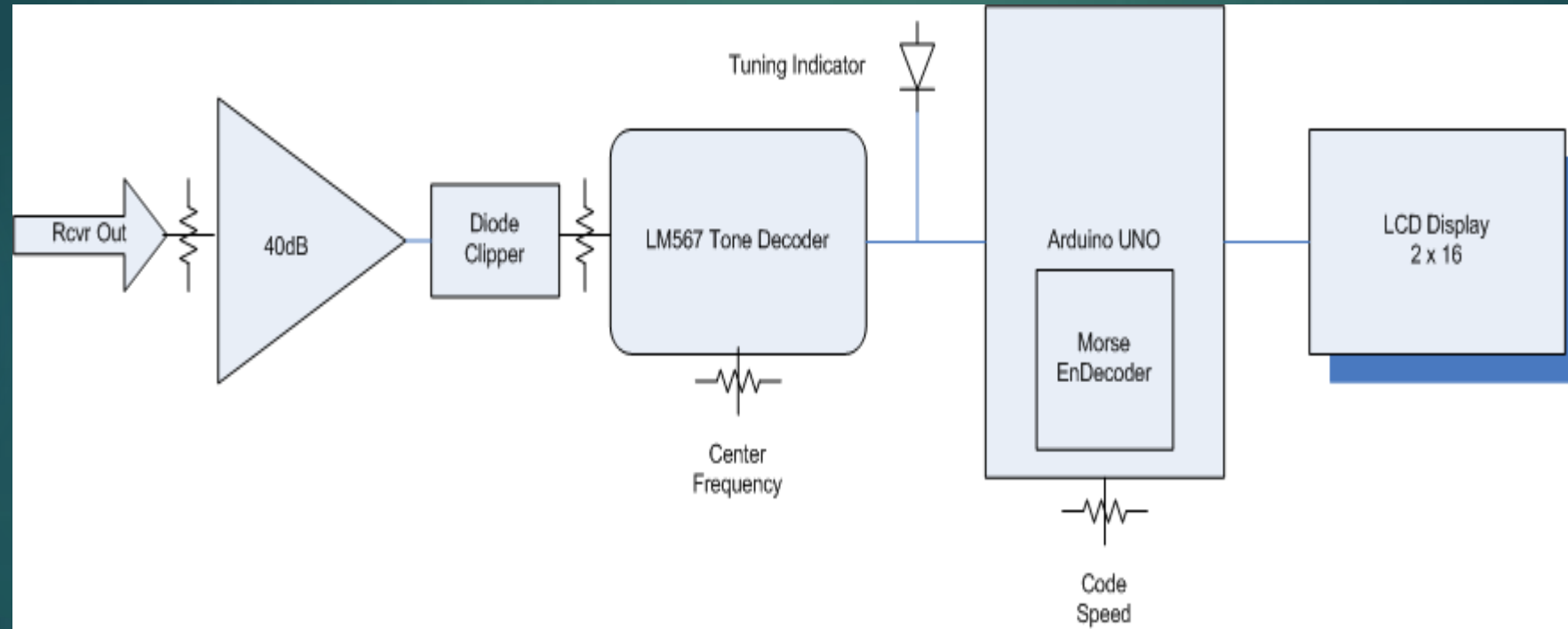
Arduino for Ham Radio

- ▶ Introduction to the Arduino
- ▶ Random Code Practice Generator
- ▶ CW Beacon and Foxhunt Keyer
- ▶ RF Probe with LED Bar Graph
- ▶ On-Air Indicator
- ▶ Talking SWR Meter
- ▶ Iambic Keyer
- ▶ Waveform Generator
- ▶ Field Day Satellite Tracker
- ▶ Azimuth/Elevation Rotator Controller
- ▶ CW Decoder

Morse Decoder

- ▶ Decodes Morse from receiver audio output
- ▶ Displays decoded Morse on 2 line by 16 character LCD display
- ▶ Uses the MorseEnDecoder library by “raronoff”
- ▶ All code available in one package with good commenting
- ▶ Built with an Arduino UNO and a protoshield
- ▶ Provides a schematic (useful) and a Fritzing Diagram (less useful)
- ▶ No protoshield layout
- ▶ Some ambiguities and contradictions in the description
- ▶ Requires manual adjustment of speed
- ▶ Ticker style scrolling is not ideal

KW5GP Morse Decoder Block Diagram



Work Log Part 1

- ▶ Order parts for this and enhanced project:
 - ▶ eBay - LCD 4-line display \$11 (enhanced)
 - ▶ Micro Center - Arduino Pro Mini \$8 (enhanced)
 - ▶ Tayda Electronics - LM567, stripboard, trimpots, misc. \$5
- ▶ Experimented with Digital Signal Processing - Goertzel Algorithm
- ▶ Found adaptive Morse decoder software by Budd Churchward, WB7FHC
- ▶ Breadboarded the WB5KUP Project "by the book" – did not work
- ▶ Built protoboard version – did not work
- ▶ Built tone decoder datasheet example - worked

Schematic Errors

Fritzing Diagram

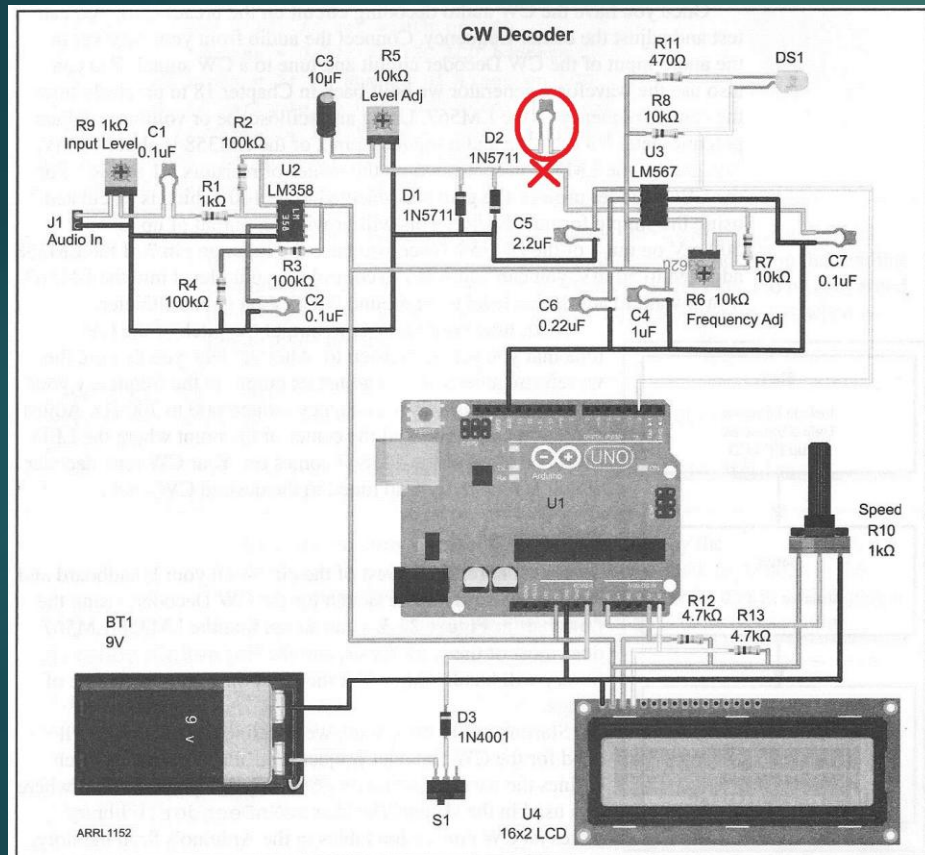


Figure 22.2 — CW Decoder Fritzing diagram.

Schematic

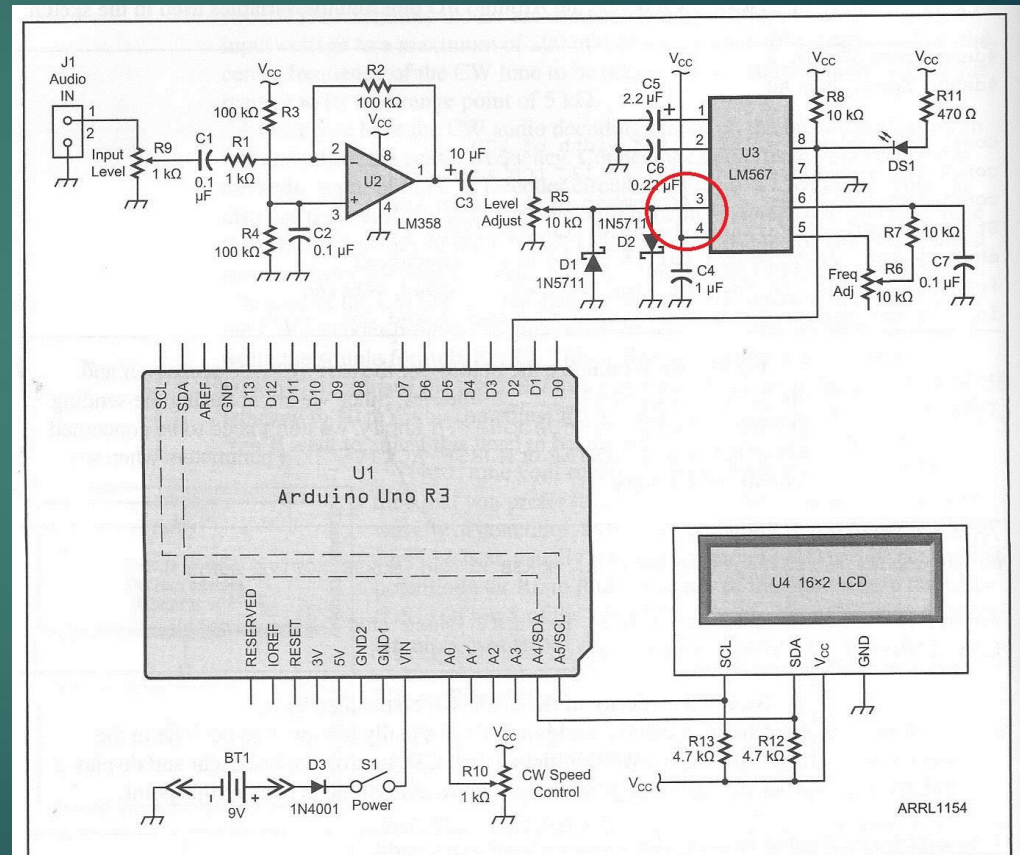
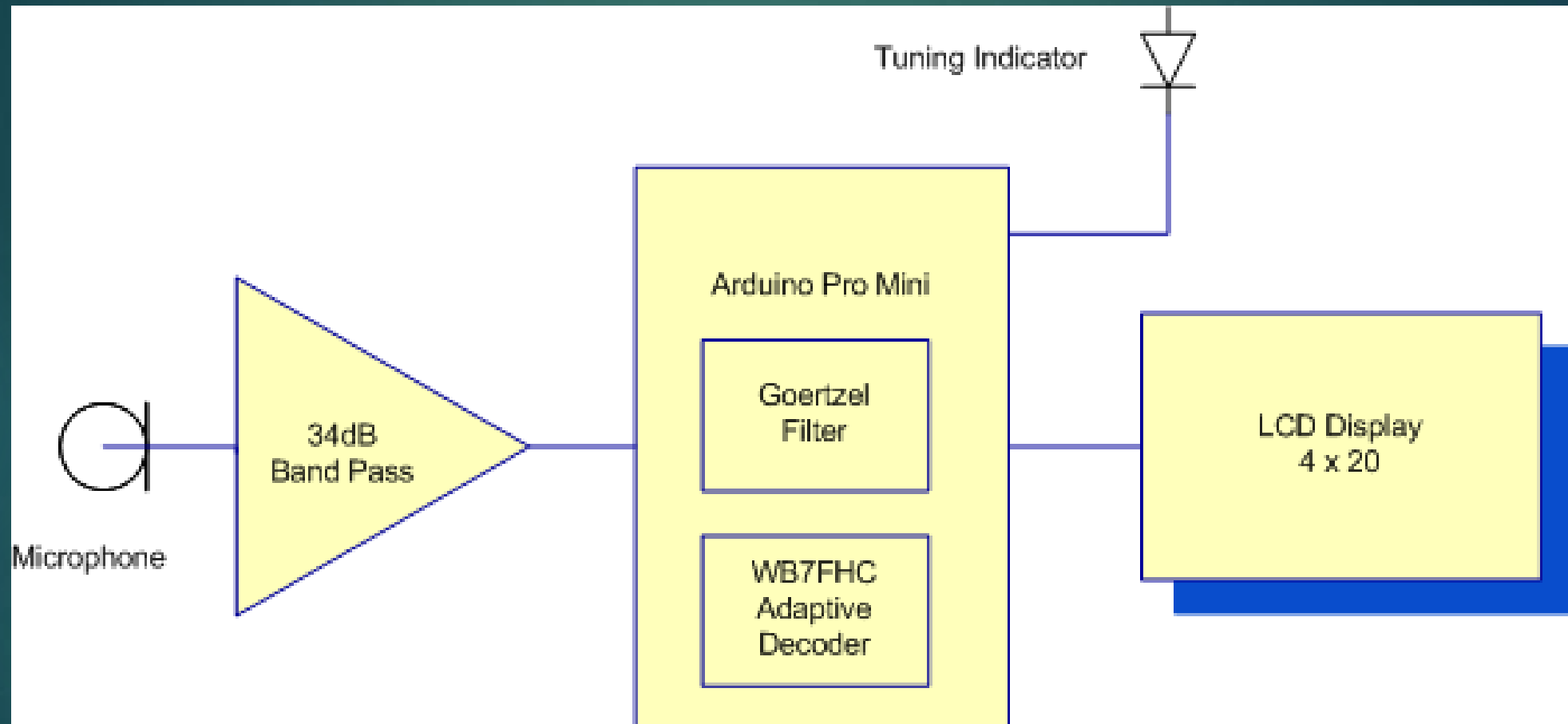


Figure 22.4 — CW Decoder schematic diagram.

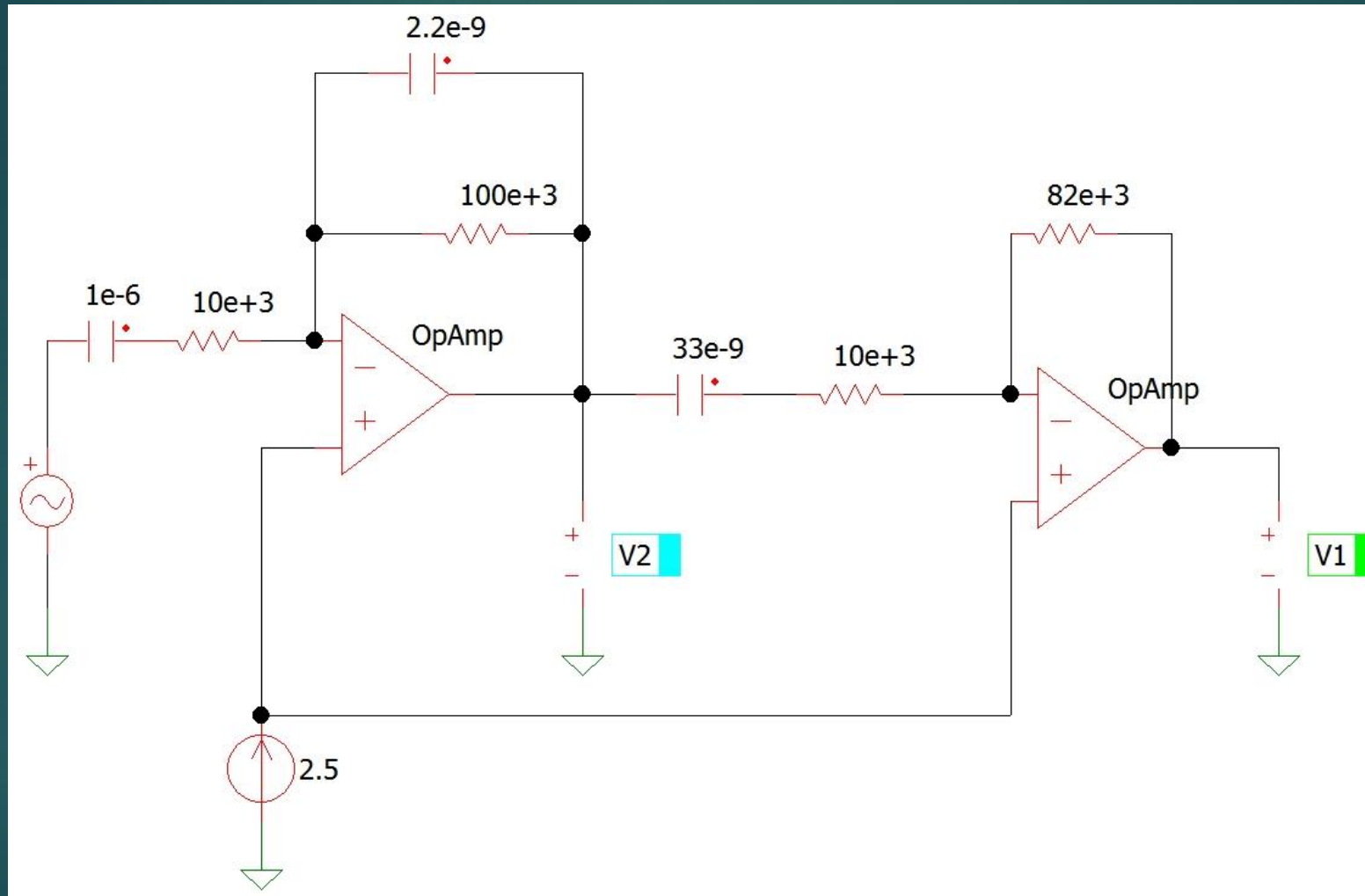
Problems/Resolutions

- ▶ Could not get good output from amplifier stage on breadboard
- ▶ Could not get the tone decoder to work until adding a decoupling capacitor
- ▶ Fixed protoboard version - worked – confirmed with author
- ▶ Author also reduced gain of amp from 100:1 to 10:1. Suggested it could be eliminated.
- ▶ Didn't like the limitations of the software
- ▶ Proceeded with an enhanced version

Enhanced Decoder

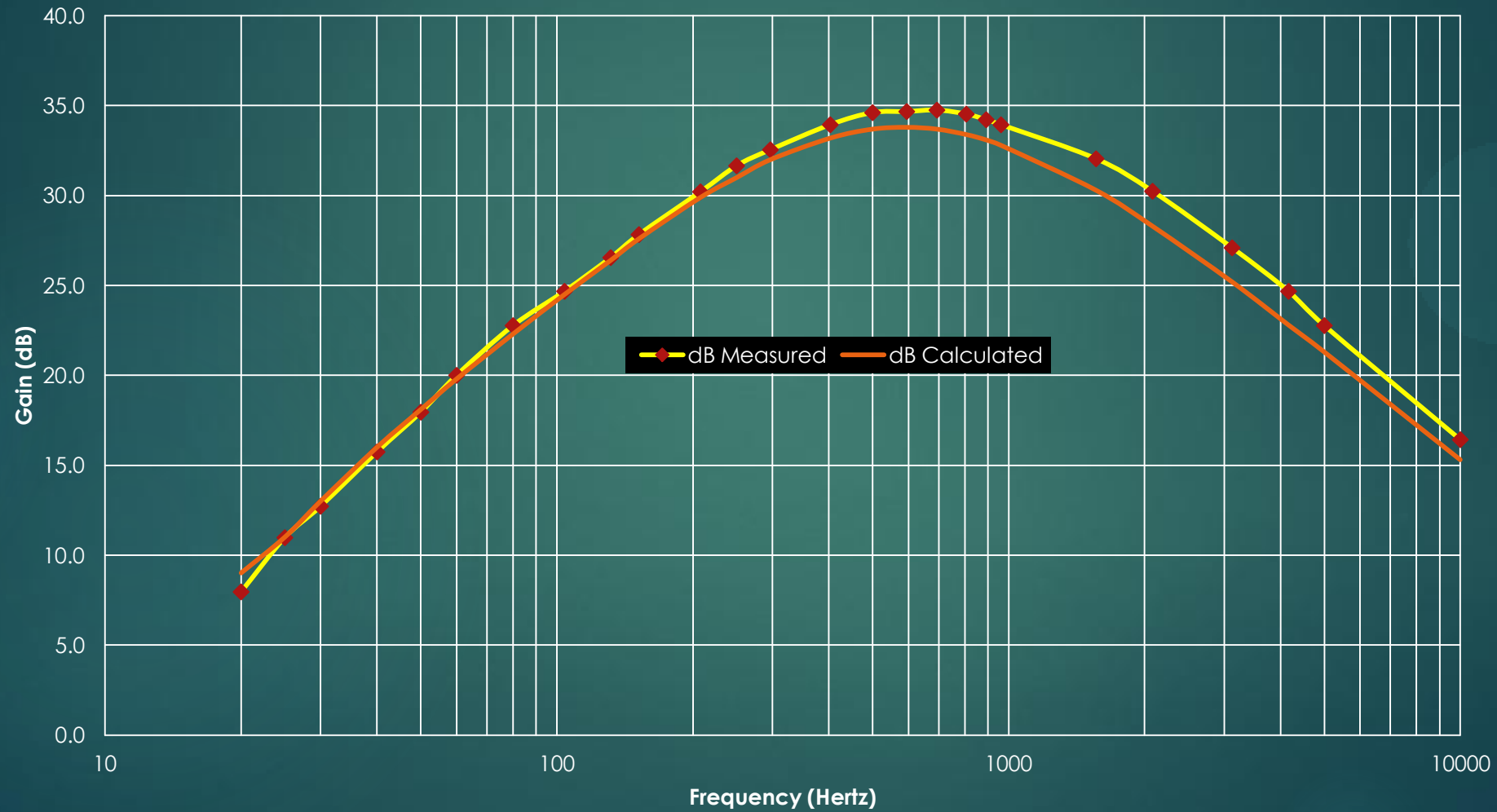


Microphone/Band Pass Amplifier

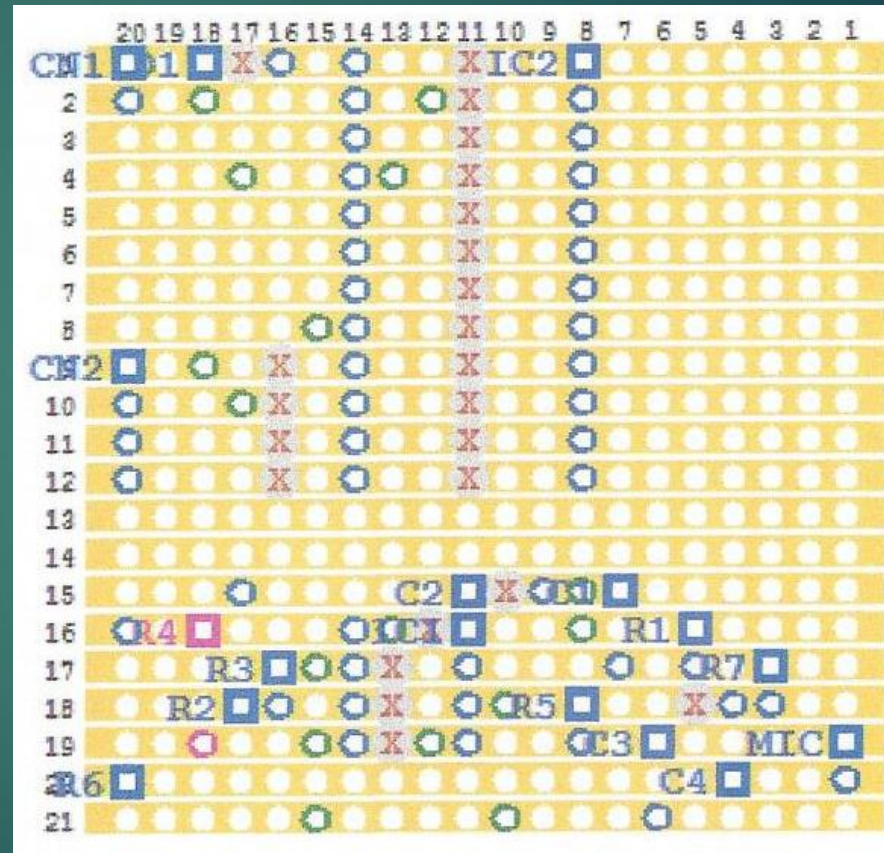
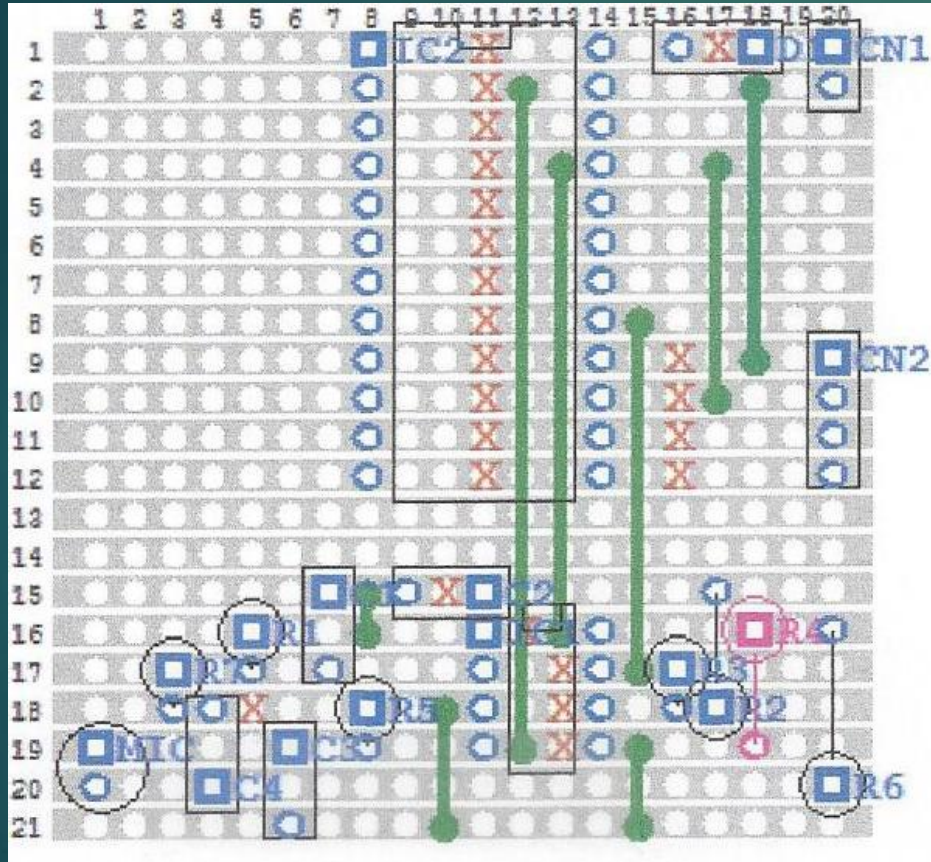


Filter Response

2-Stage Filter Response



Stripboard Layout

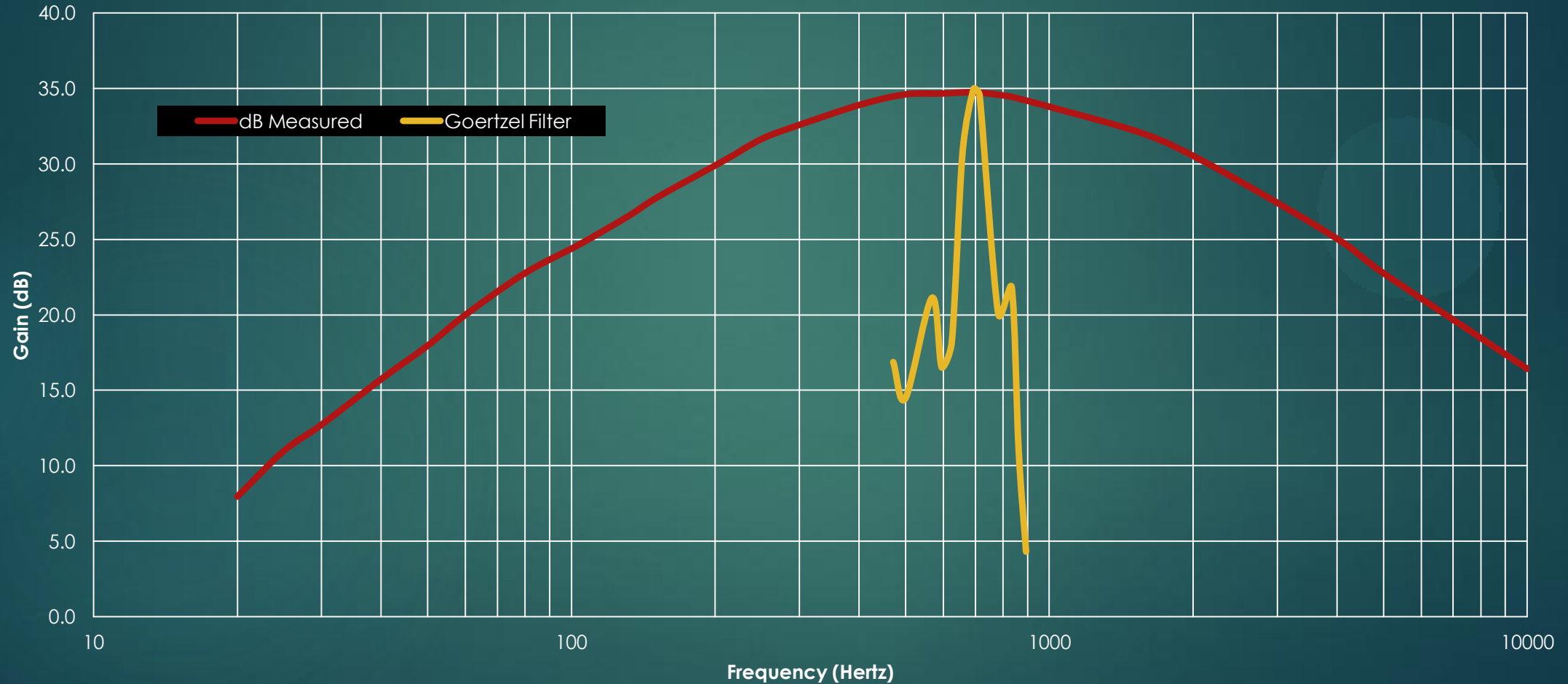


Goertzel Algorithm

- ▶ **Gerald Goertzel** (18 August 1919 – 17 July 2002) was an American theoretical physicist who worked on the Manhattan Project. He developed the algorithm in 1958 while an employee of IBM's Research Division.
- ▶ Analyzes one selectable frequency from a sampled signal. It is widely used for DTMF decoding.
- ▶ More efficient than the Fast Fourier Transform for a small number of frequencies. Uses only real arithmetic.
- ▶ "The simple structure of the Goertzel algorithm makes it well suited to small processors and embedded applications." – Wikipedia
- ▶ Arduino implementation thanks to Jacob Rosenthal.

Filter Response (Measured)

Active Filter and Goertzel Response



Next steps

- ▶ Better adaptive decoding
- ▶ Play around with Goertzel bandwidth
- ▶ Spectrum or multiple LED tuning indication
- ▶ Push ON/OFF
- ▶ Develop kit

References

- ▶ Arduino: www.arduino.cc
- ▶ Goertzel Algorithm Explanation: <http://www.embedded.com/design/configurable-systems/4024443/The-Goertzel-Algorithm>
- ▶ Goertzel Arduino Code: <https://github.com/jacobrosenthal/Goertzel>
- ▶ Ideal Circuit: <http://ic.sidelinesoft.com/>
- ▶ VeroDes: <http://www.heyrick.co.uk/software/verodes/>
- ▶ WB7FHC Morse Decoder: <http://tinyurl.com/wb7fhc-morse>