Low Cost
Personal Space Weather Station
Grape Gen 2 Receiver

by
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Review of Receiver Basic Operation

ANT → A → Gilbert Cell Mixer → Gain (G) & BPF → Low IF Output

B → Local OSC

G(A + B)

G(A – B)
Gilbert Cell Frequency Mapping

If you place the Local OSC below the Beacon Frequency you get the Positive Doppler Shift Spectrum (Denoted in Red)
A positive Shift in Beacon Freq Maps into positive shift in the Mixed Signal Output.
If you place the Local OSC Above the Beacon Frequency you get the Mirror Image of the Doppler Shift Spectrum (Denoted in GREEN). A positive Shift in Beacon Freq Maps into a mirrored negative shift in the Mixed signal Output.
In either case, the Doppler shift deviation moves the same amount in frequency from the 1KHz “Zero” position, but just in opposite directions creating either a direct or mirrored measured frequency deviation.
For the Grape 1 & 2 Receivers, we chose to place the LO below the Measured Beacon so that the measured Doppler shift frequency is in the same direction as the measured frequency shift of the Carrier Mixed Signal.

\[
\text{ANT} - \text{LO} = \text{IF} \\
2.5 \text{ MHz} - 2.499 \text{ MHz} = 1 \text{ KHz} \\
5 \text{ MHz} - 4.999 \text{ MHz} = 1 \text{ KHz} \\
10 \text{ MHz} - 9.999 \text{ MHz} = 1 \text{ KHz} \\
15 \text{ MHz} - 14.999 \text{ MHz} = 1 \text{ KHz}
\]
Grape Gen 1 PCB

PCB is a 2 layer board - 1.50" x 0.88" (38.1 x 22.4 mm)

Top

Bottom
Grape Gen 2 Receiver

- Basing new design on Grape Gen 1 Receiver
- 4 Channels will be running simultaneously
- Sampling will be synchronized on all 4 Channels
- Will Measure 2.5, 5.0, 10 & 15 MHz WWV
- Can also measure 3.33, 7.85 & 14.67 MHz CHU
Low Cost PSWS (Grape Gen 2) Radio Receiver (x4)

GPS Amplified Antenna

Multi-Output GPS Disciplined Oscillator
3.3Vp-p @ 8Ma output

Grape 2 PSWS
External Antenna

Buffer / 2nd Order BPF

Mixer
SA612

BPF
160Hz - 1600Hz

22dB Gain
LT6202

BPF
160Hz - 2000Hz

Audio Output
To A/D Input
Typical Quiet WWV 2.5 MHz Day Plot
Typical Quiet WWV 5 MHz Day Plot

WWV 5 MHz Doppler Shift Plot
Node: N0000001 Gridsquare: EN91th
Lat= 41.3219273 Long= -81.5047731 Elev= 285 M
2021.02.11 UTC
Typical Quiet WWV 10 MHz Day Plot
Questions?