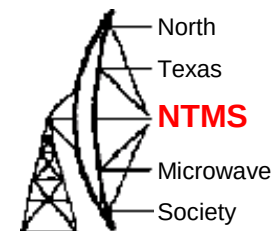


The Spectracom 8194B Ageless Master Oscillator and other wannabe oscillators

Jim McMasters KM5PO

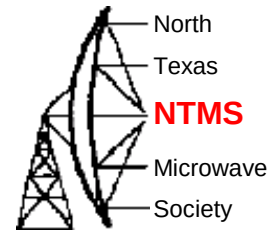
October 12th, 2024

Spectracom 8194B



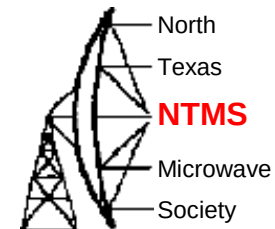
- Highly accurate frequency source available in oven-stabilized crystal oscillator (OCXO) and Rubidium versions.
- Its outputs are locked to the United States Naval Observatory via the NAVSTAR Global Positioning System (GPS).
- Spectracom's field-proven Ageless Oscillator technology provides continual automatic frequency control.
- A long-term averaging algorithm compensates for oscillator aging and temperature drift.
- Units were available January 2024 from Jim McClellan at Cowtown Hamfest.
- Al Ward performed a modification which removed a factory mod and restored 10 MHz outputs.

Spectracom 8194B

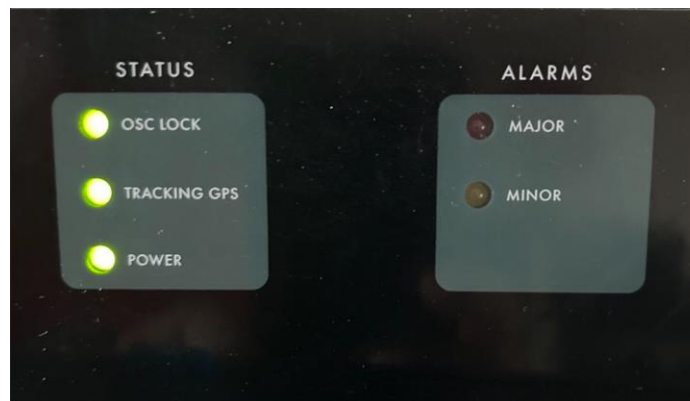


- Accuracy: Continuous self-calibration to GPS provides $\pm 1.0 \times 10^{-11}$ frequency accuracy with the OCXO versions and $\pm 1.0 \times 10^{-12}$ frequency accuracy for Rubidium version.
- Front panel
 - (1) 10 MHz output
 - (1) PPS output
 - Leading edge synchronized to UTC typically within ± 30 nanoseconds with SA off and in Position Hold
 - (1) RS-232 Comm port
- Rear panel
 - (4) 10 MHz output
 - (1) Data Clock Output (including disciplined 1 PPS)

Spectracom 8194B

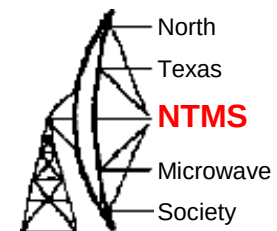


- Front panel of rack mounted instrument



- Happy state – all green lights

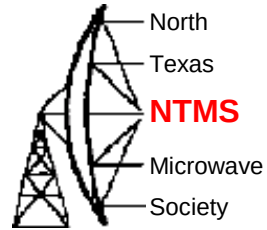
Spectracom 8194B



- OCXO center, GPS receiver on the right



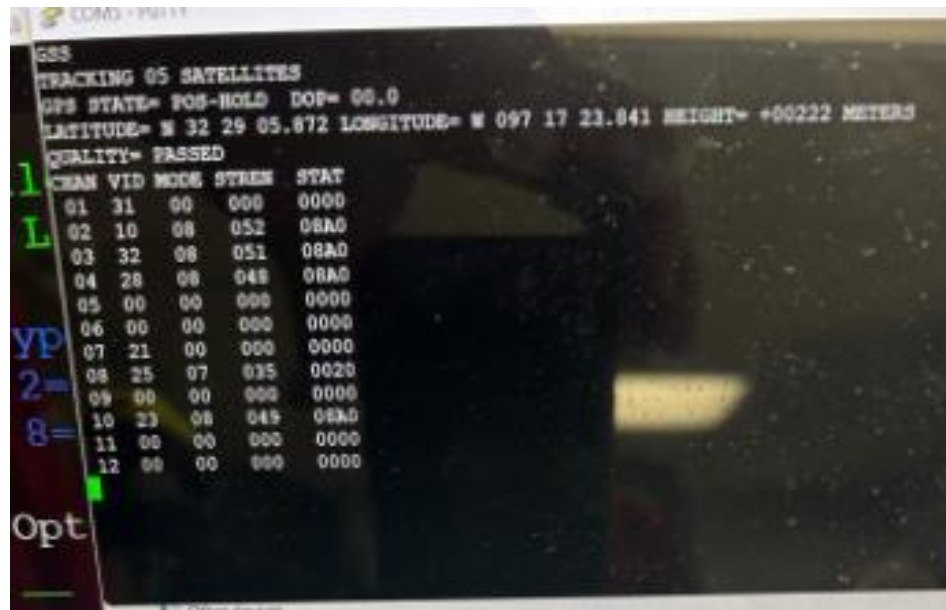
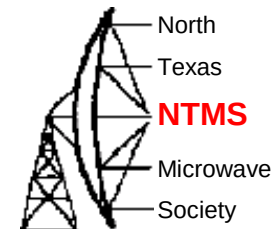
Active GPS Antenna



- Provides 30 dB of gain and requires +5 VDC at 27 milliamps

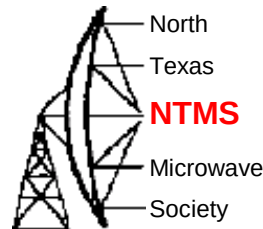


RS232 Comms



- GSS Command (GPS Signal Status)
- GPS STATE= POS-HOLD DOP=00.0 (Dilution of Precision)
- Satellite Mode must be 08 to be acceptable

RS232 Comms



- DH Command (Display Tracking Histogram)
- Between 1200 and 1300 UTC yesterday
 - 4 Sats tracked for 883 seconds
 - 5 Sats tracked for 1,305 seconds
 - 6 Sats tracked for 1,392 seconds

```
COM5 - PuTTY
DH
TIME=13:00:00 DATE=2024-10-11
0=00000 1=00000 2=00000 3=00020 4=00883
5=01305 6=01392 7=00000 8=00000 9=00000
10=00000 11=00000 12=00000 Q=03580

TIME=14:00:00 DATE=2024-10-11
0=00000 1=00000 2=00000 3=00002 4=00143
5=01713 6=01694 7=00048 8=00000 9=00000
10=00000 11=00000 12=00000 Q=03598

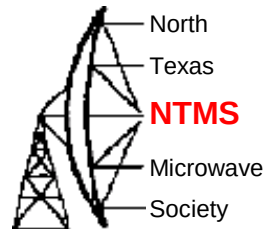
TIME=15:00:00 DATE=2024-10-11
0=00000 1=00000 2=00000 3=00000 4=00001
5=00835 6=01985 7=00779 8=00000 9=00000
10=00000 11=00000 12=00000 Q=03600

TIME=16:00:00 DATE=2024-10-11
0=00000 1=00000 2=00000 3=00029 4=00410
5=01718 6=01435 7=00008 8=00000 9=00000
10=00000 11=00000 12=00000 Q=03571

TIME=16:51:42 DATE=2024-10-11
0=00000 1=00000 2=00000 3=00069 4=02658
5=00338 6=00036 7=00000 8=00000 9=00000
10=00000 11=00000 12=00000 Q=03032

END OF LOG
```

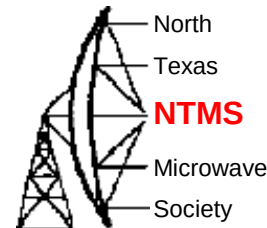
RS232 Comms



- DAL Command (Display Alarm Log)
- OUTPUT FAULT
- No output is detected from one or more of the four-rear panel Frequency Outputs. Fault could be caused by a shorted cable, reflections due to an un-terminated cable or removed by a Major Alarm when Signature Control is enabled.

```
TIME= 18:55:44 DATE= 2024-10-11 STATUS CHANGE <TEMP= +45.5>
COOLING FAN= OFF
ALARM RELAYS: MAJOR= OFF MINOR= ON
ACTIVE ALARMS: MINOR
OUTPUT FAULT
TIME= 18:55:47 DATE= 2024-10-11 STATUS CHANGE <TEMP= +45.5>
COOLING FAN= OFF
ALARM RELAYS: MAJOR= OFF MINOR= OFF
ACTIVE ALARMS: NONE
TIME= 18:55:47 DATE= 2024-10-11 STATUS CHANGE <TEMP= +45.5>
COOLING FAN= OFF
ALARM RELAYS: MAJOR= OFF MINOR= ON
ACTIVE ALARMS: MINOR
OUTPUT FAULT
TIME= 18:55:47 DATE= 2024-10-11 STATUS CHANGE <TEMP= +45.5>
COOLING FAN= OFF
ALARM RELAYS: MAJOR= OFF MINOR= OFF
ACTIVE ALARMS: NONE
TIME= 18:55:47 DATE= 2024-10-11 STATUS CHANGE <TEMP= +45.5>
COOLING FAN= OFF
ALARM RELAYS: MAJOR= OFF MINOR= ON
ACTIVE ALARMS: MINOR
OUTPUT FAULT
TIME= 18:55:48 DATE= 2024-10-11 STATUS CHANGE <TEMP= +45.5>
COOLING FAN= OFF
ALARM RELAYS: MAJOR= OFF MINOR= OFF
ACTIVE ALARMS: NONE
END OF LOG
```

RS232 Comms



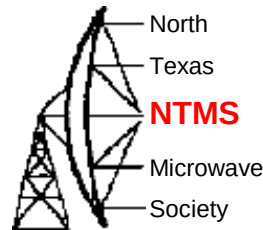
- DOL Command (Display Oscillator Log)
- Phase adjustment:
 - Occur every 6 minutes for OCXO units. (Model 8194B and 8195B)

```

TIME= 22:27:27 DATE= 2024-10-11 PHASE ADJUSTMENT
AVG LEN= 0168 TOTAL= 00007FE7
DAC= D852(84%) TEMPERATURE= +46.0
PHASE ERROR= +046.38 nSEC
TIME= 22:33:27 DATE= 2024-10-11 PHASE CENTER ADJUSTMENT
OLD CENTER= D84D NEW CENTER= D851
BASED ON 010 ENTRIES
TIME= 22:33:27 DATE= 2024-10-11 PHASE ADJUSTMENT
AVG LEN= 0168 TOTAL= 00005AD6
DAC= D854(84%) TEMPERATURE= +46.0
PHASE ERROR= +032.94 nSEC
TIME= 22:39:27 DATE= 2024-10-11 PHASE ADJUSTMENT
AVG LEN= 0168 TOTAL= 000005D8
DAC= D851(84%) TEMPERATURE= +46.0
PHASE ERROR= +002.11 nSEC
TIME= 22:39:53 DATE= 2024-10-11 D/A= D851(84%) FREQ ERROR= +1.00E-10
LONG GATE 10MHZ OFFSET= NONE INTERNAL TEMP= +46.0
FREQ CNT= 10,000,000,001
TIME= 22:45:27 DATE= 2024-10-11 PHASE ADJUSTMENT
AVG LEN= 0168 TOTAL= FFFFBBBF
DAC= D84E(84%) TEMPERATURE= +46.0
PHASE ERROR= -024.75 nSEC
TIME= 22:51:27 DATE= 2024-10-11 PHASE ADJUSTMENT
AVG LEN= 0168 TOTAL= FFFF420
DAC= D84E(84%) TEMPERATURE= +46.0
PHASE ERROR= -027.51 nSEC
TIME= 22:56:35 DATE= 2024-10-11 D/A= D84E(84%) FREQ ERROR= +0.00E-10
LONG GATE 10MHZ OFFSET= NONE INTERNAL TEMP= +46.0
FREQ CNT= 10,000,000,000
TIME= 22:57:27 DATE= 2024-10-11 PHASE ADJUSTMENT
AVG LEN= 0168 TOTAL= FFFF666A
DAC= D84E(84%) TEMPERATURE= +46.0
PHASE ERROR= -026.68 nSEC
TIME= 23:03:27 DATE= 2024-10-11 PHASE ADJUSTMENT
AVG LEN= 0168 TOTAL= FFFF0F8
DAC= D84E(84%) TEMPERATURE= +46.0
PHASE ERROR= -028.66 nSEC
TIME= 23:09:27 DATE= 2024-10-11 PHASE ADJUSTMENT
AVG LEN= 0168 TOTAL= FFFFC201
DAC= D84F(84%) TEMPERATURE= +46.0
PHASE ERROR= -022.48 nSEC
TIME= 23:13:17 DATE= 2024-10-11 D/A= D84F(84%) FREQ ERROR= +0.00E-10
LONG GATE 10MHZ OFFSET= NONE INTERNAL TEMP= +46.0
FREQ CNT= 10,000,000,000
END OF LOG

```

RS232 Comms



SPECTRACOM CORPORATION GPS DISCIPLINED OSCILLATOR SOFTWARE
VERSION 2.14 DATE: JULY 20, 2004 08:21:19

UNIT STARTED 12:47:07 2004-07-26

BAUD GENERATOR 1 = VERSION 2.02

BAUD GENERATOR 2 = VERSION 2.02

BAUD GENERATOR 3 = VERSION 2.02

GPS RECEIVER = 12 CHANNEL M12 VERSION 2

TIME= 11:34:43 DATE= 2004-03-24 PHASE ADJUSTMENT

AVG LEN= 0168 TOTAL= 0001653A

DAC= B201(69%) TEMPERATURE= +37.5

PHASE ERROR= +129.55 nSEC

TIME= 11:36:07 DATE= 2004-03-24

D/A= B201(69%) FREQ ERROR= +1.00E-10

LONG GATE 10MHZ OFFSET= NONE

INTERNAL TEMP= +37.5

FREQ CNT= 10,000,000,001

TIME= 11:40:43 DATE= 2004-03-24 PHASE ADJUSTMENT

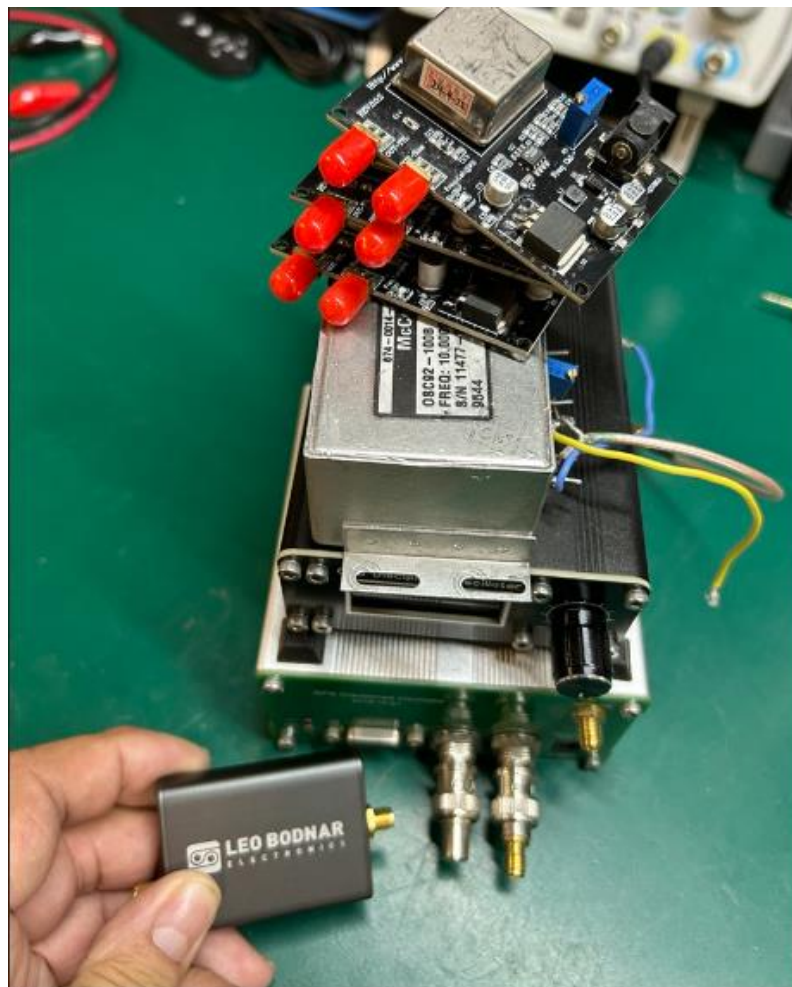
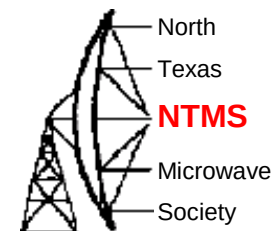
AVG LEN= 0168 TOTAL= 00012001

DAC= B1FE(69%) TEMPERATURE= +37.5

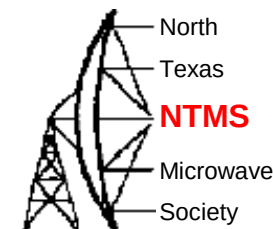
PHASE ERROR= +104.44 nSEC

MORE QUIT

Testing



Black box GPSDO



How to Calibrate



The screen displayed when starting up.

If there is no GPS antenna installed, this content will continue to be displayed.



Once the GPS antenna is installed and satellite locked, the screen will display the correction value of PPb after comparing with the 1PPS signal and the current PWM adjustment value.

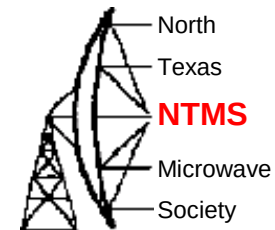


When the PPb value is observed within 0.0 ± 1 , press the encoding switch to enter the menu. Rotate the encoder to find the "PWMSET" option and press the encoder switch to save the current PWM value.



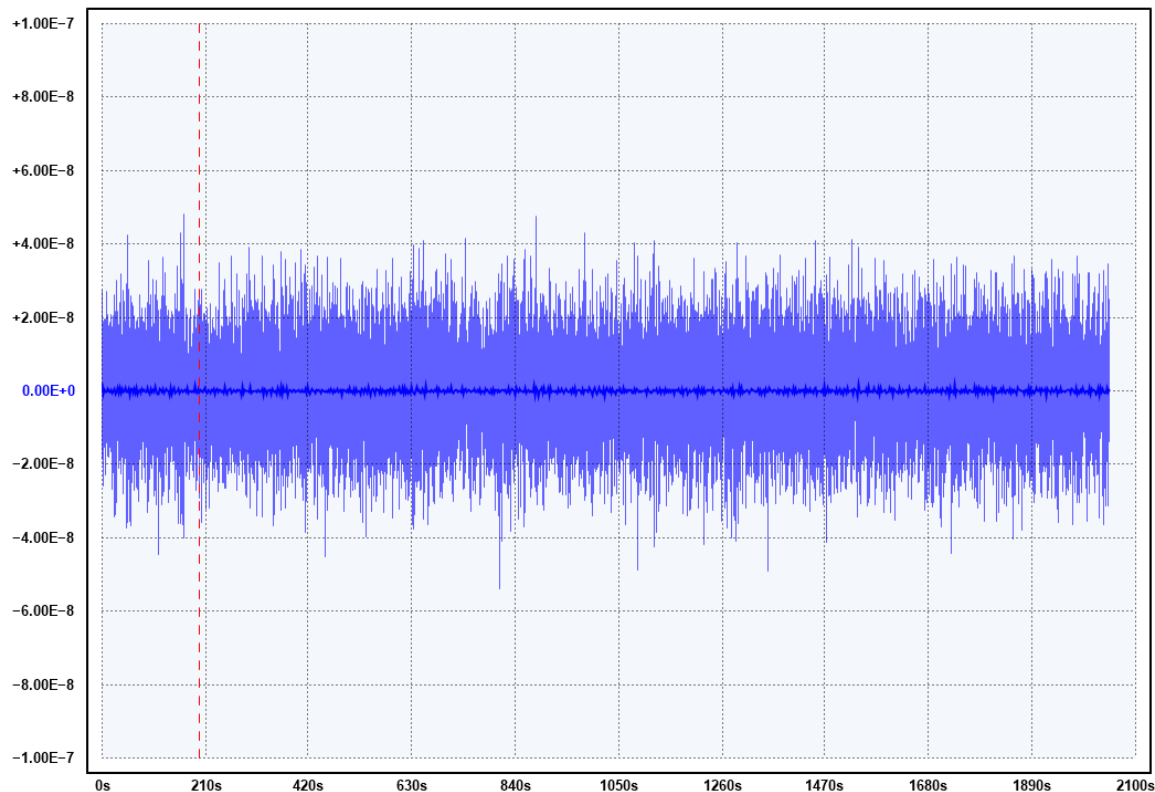
Rotate encoder again and find "EXIT!! OK" and press the encoder switch to exit the menu.

Black box GPSDO



Frequency Difference

Averaging window: Per-pixel

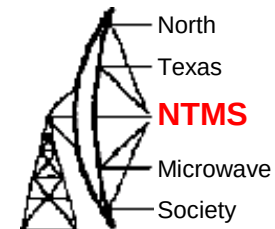


Origin	Drift (Hz/sec)	Drift (Hz/hr)
+2.05E-12	-1.62E-8	-5.85E-5

Avg Time (s)	Freq (Hz) at 2046s	Error
0.1	10 000 000.038 029 550	+3.80E-9
0.3	10 000 000.052 073 997	+5.21E-9
1	10 000 000.014 514 089	+1.45E-9
3	9 999 999.999 230 623	-7.69E-11
10	9 999 999.998 601 934	-1.40E-10
30	9 999 999.999 368 766	-6.31E-11
100	9 999 999.999 985 058	-1.49E-12
300	10 000 000.000 010 753	+1.08E-12
1 000	9 999 999.999 991 752	-8.25E-13

Trace	Notes	Input Freq	Sample Interval	Freq at 197s	Duration	Elapsed	Acquired	Instrument
Black box GPSDO (Unsaved)		10 MHz	0.100 s	9 999 999.983 Hz	1 h	34m 6s	20459 pts	tiny PFA

Green box GPSDO



Frequency Difference

Averaging window: Per-pixel

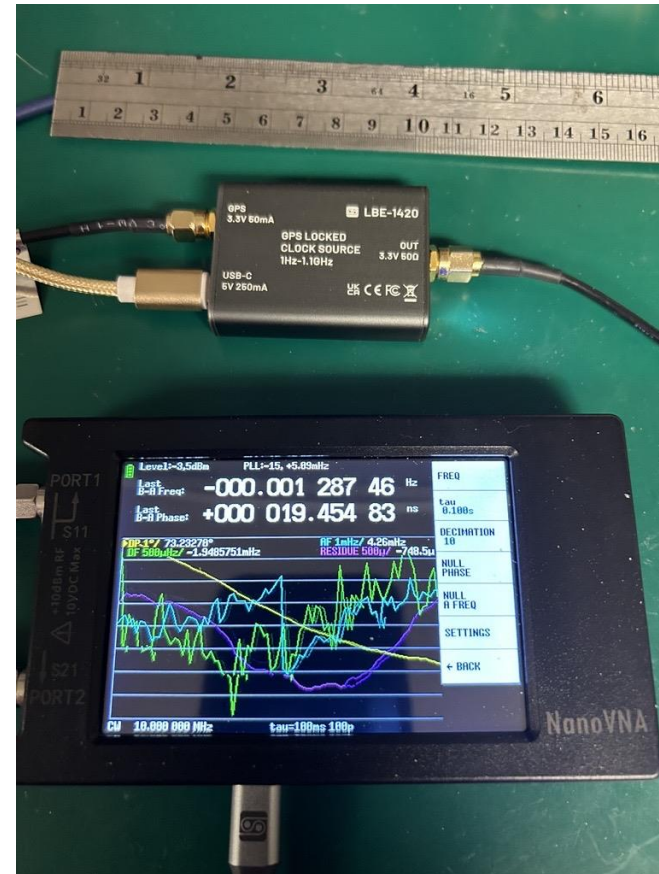
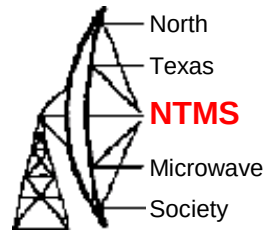


Origin	Drift (Hz/sec)	Drift (Hz/min)
+3.22E-10	-9.13E-7	-5.48E-5

Avg Time (s)	Freq (Hz) at 1795s	Error
0.1	10 000 000.001 918 999	+1.92E-10
0.3	10 000 000.001 899 667	+1.90E-10
1	10 000 000.001 845 500	+1.85E-10
3	10 000 000.001 805 799	+1.81E-10
10	10 000 000.001 863 969	+1.86E-10
30	10 000 000.001 940 444	+1.94E-10
100	10 000 000.002 238 926	+2.24E-10
300	10 000 000.002 039 935	+2.04E-10
1 000	10 000 000.001 823 993	+1.82E-10

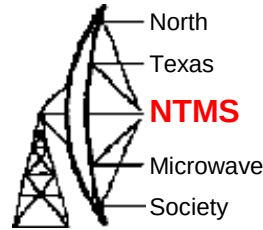
Trace	Notes	Input Freq	Sample Interval	Freq at 220s	Duration	Elapsed	Acquired	Instrument
Black box GPSDO (Unsaved)		10 MHz	0.100 s	10 000 000.002 Hz	1 h	29m 55s	17950 pts	tiny PFA

LBE-1420 GPSDO



[LBE-1420 GPSDO locked clock source : Leo Bodnar Electronics](#)

LBE-1420 GPSDO



LBE-1420 GPS locked clock source diagnostics

Serial number: 0673ED10312D

Hardware firmware version: 1.05, new version 1.06 available at <https://www.leobodnar.com/files/firmware-doctor.exe>

Configuration software version: 1.05, new version 1.06 available at <https://www.leobodnar.com/files/LBE-1420-Configuration-v1.06.exe>

Operating system: Windows 11 (v10.0.22621)

Output frequency: 100000000Hz

Number of satellites: 14

Average satellite signal strength C/No: 34dB

Approximate coordinates (to nearest 10km):

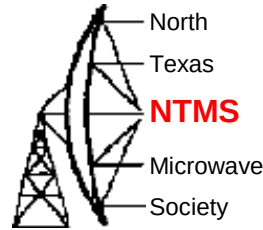
Latitude: 32.5°

Longitude: -97.3°

Altitude: 227m

[Product and support page on leobodnar.com](https://www.leobodnar.com)

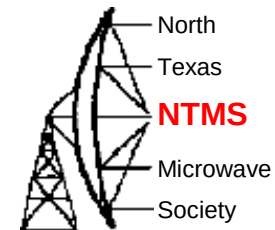
LBE-1420 GPSDO



- N1BUG 10 GHz beacon project
 - 1152 MHz base for x9 but this lands on 10368.000 MHz
 - Several synthesizers have integer Hertz value adjustment which result in close-in spurs and poor ish choices of final beacon frequency
 - LBE-1420 has fractional integer Hertz value but still exhibits close-in spurs at 576 MHz or 1152 MHz
 - But used as a 10 MHz ref to a DigiLO with a programmed output of 10000376.16 the ref signal is clean and this puts the beacon at 10368.390

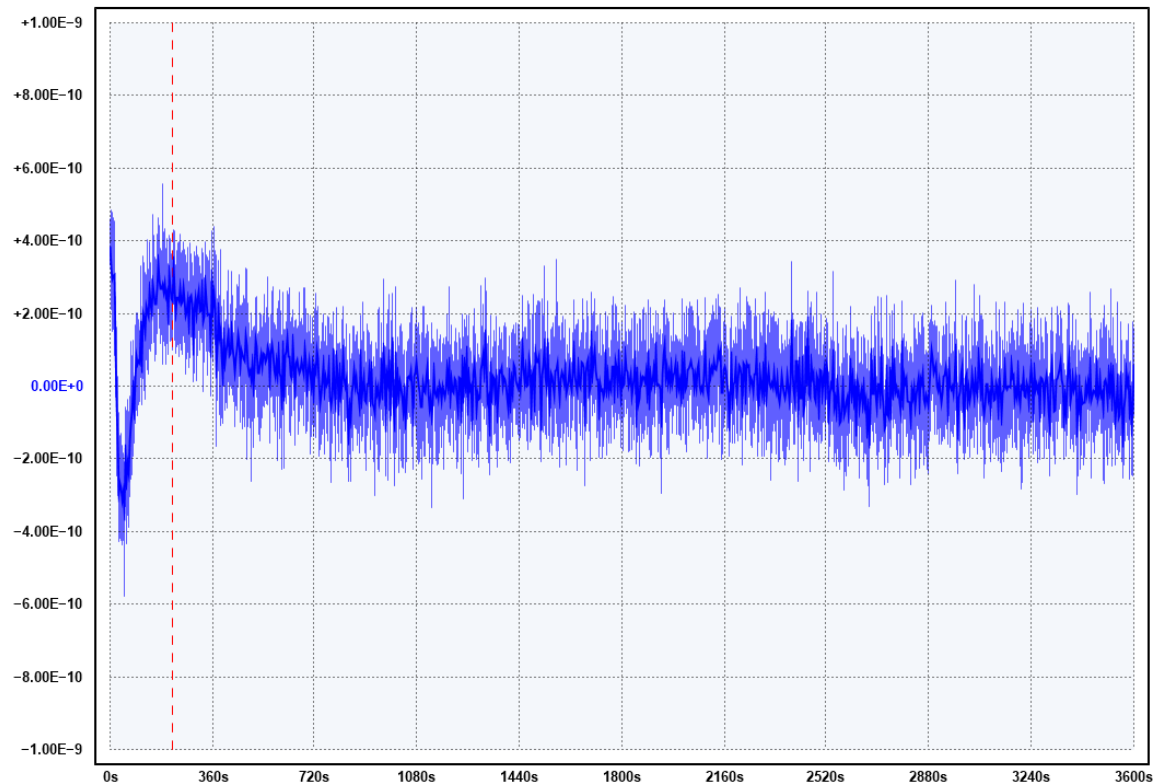
<https://youtu.be/U9Qfisz2QNg?si=hs46SolVWyJZOYs8>

LBE-1420 GPSDO



Frequency Difference

Averaging window: Per-pixel

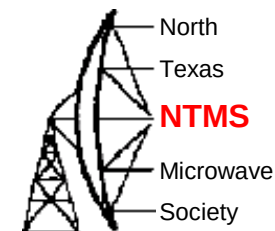


Origin	Drift (Hz/sec)	Drift (Hz/hr)
+8.53E-11	-3.40E-7	-1.22E-3

Avg Time (s)	Freq (Hz) at 3600s	Error
0.1	9 999 999.999 190 999	-8.09E-11
0.3	9 999 999.999 996 001	-4.00E-13
1	10 000 000.000 375 399	+3.75E-11
3	10 000 000.000 466 866	+4.67E-11
10	9 999 999.999 438 670	-5.61E-11
30	9 999 999.999 753 177	-2.47E-11
100	9 999 999.999 720 361	-2.80E-11
300	9 999 999.999 825 317	-1.75E-11
1 000	9 999 999.999 879 243	-1.21E-11
3 000	10 000 000.000 042 407	+4.24E-12

Trace	Notes	Input Freq	Sample Interval	Freq at 220s	Duration	Elapsed	Acquired	Instrument
Leo Bodnar GPSDO LBE-1420 (Unsaved)		10 MHz	0.100 s	10 000 000.003 Hz	1h	1h	36000 pts	tiny PFA

Amazon \$20



Frequency Difference

Averaging window: Per-pixel



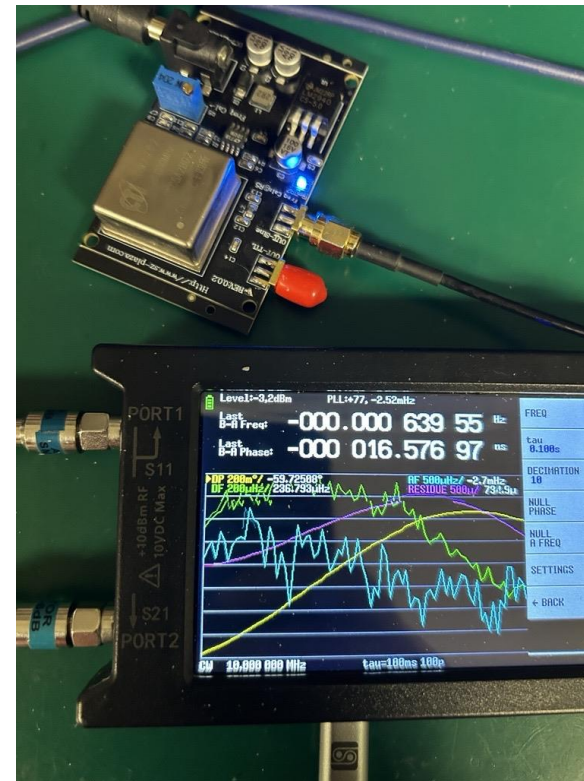
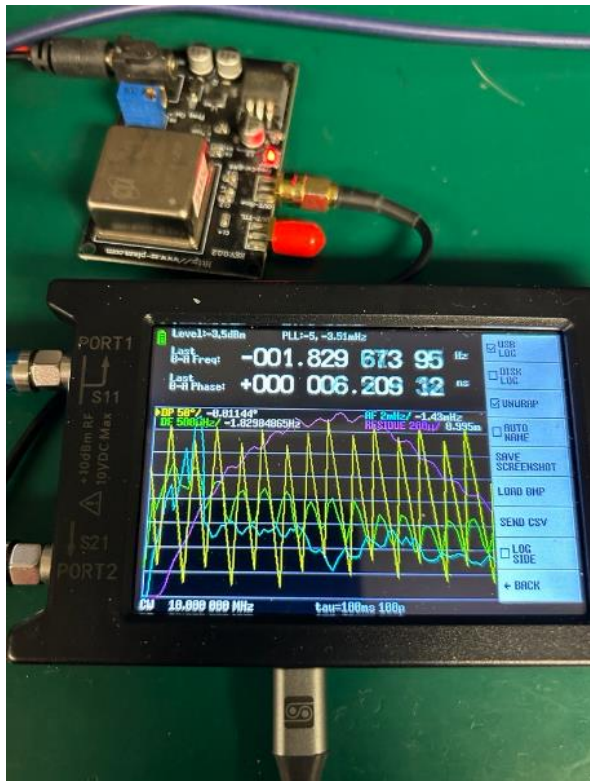
Origin	Drift (Hz/sec)	Drift (Hz/min)
-1.83E-7	+3.04E-6	+1.82E-4

Avg Time (s)	Freq (Hz) at 1113s	Error
0.1	9 999 998.168 800 000	-1.83E-7
0.3	9 999 998.168 400 001	-1.83E-7
1	9 999 998.168 570 001	-1.83E-7
3	9 999 998.168 966 666	-1.83E-7
10	9 999 998.169 301 000	-1.83E-7
30	9 999 998.169 157 667	-1.83E-7
100	9 999 998.169 362 200	-1.83E-7
300	9 999 998.169 881 810	-1.83E-7
1 000	9 999 998.171 448 123	-1.83E-7

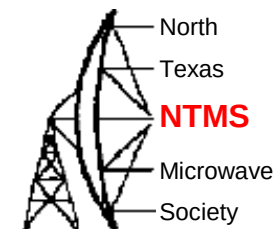
Trace	Notes	Input Freq	Sample Interval	Freq at 220s	Duration	Elapsed	Acquired	Instrument
Amazon \$20 OCXO (Unsaved)		10 MHz	0.100 s	9 999 998.173 Hz	1 h	18m 34s	11133 pts	tiny PFA

Amazon \$20

- 3 units, netting yields -1.8, +.32, -.0006 Hz diffs

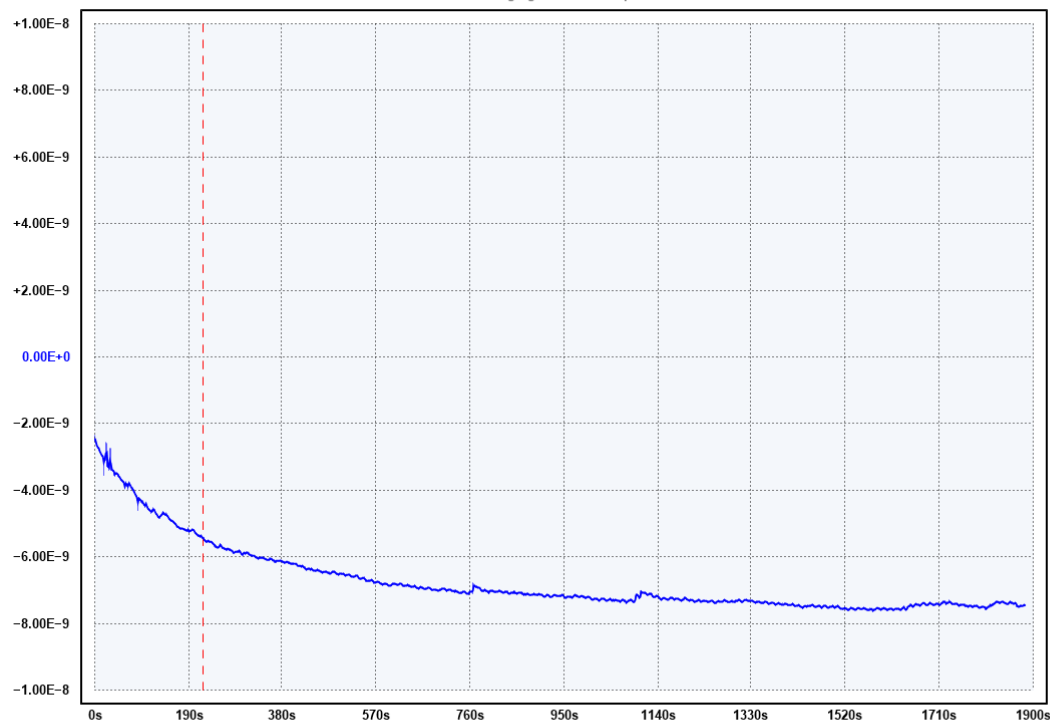


McCoy OCXO



Frequency Difference

Averaging window: Per-pixel

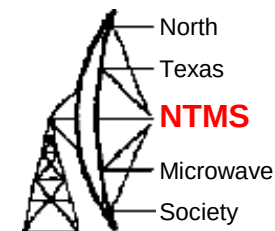


Origin	Drift (Hz/sec)	Drift (Hz/hr)
-5.27E-9	-1.55E-5	-5.60E-2

Avg Time (s)	Freq (Hz) at 1884s	Error
0.1	9 999 999.925 400 000	-7.46E-9
0.3	9 999 999.925 333 334	-7.47E-9
1	9 999 999.925 290 000	-7.47E-9
3	9 999 999.925 413 333	-7.46E-9
10	9 999 999.925 329 000	-7.47E-9
30	9 999 999.925 591 666	-7.44E-9
100	9 999 999.925 633 200	-7.44E-9
300	9 999 999.925 403 366	-7.46E-9
1 000	9 999 999.926 283 440	-7.37E-9

Trace	Notes	Input Freq	Sample Interval	Freq at 220s	Duration	Elapsed	Acquired	Instrument
Amazon S20 OCXO (Unsaved)		10 MHz	0.100 s	9 999 999.946 Hz	1 h	31m 24s	18840 pts	tiny PFA

Results



Test	Drift Hz/Sec	Drift Hz/Hr	Equiv	Best freq diff	Cost
S vs Black box GPSDO	-1.62E-8	-5.85E-5	0.0000585	.000010 Hz	\$129
S vs Green box GPSDO	-9.13E-7	-5.48E-5	0.0000548	.001 Hz	\$209
S vs Leo Bodnar LBE-1420 GPSDO	-3.40E-7	-1.22E-3	0.00122	.000042 Hz	\$155
S vs \$20 Amazon	+3.04E-6	+1.83E-4/min	0.000183	1.8 Hz	\$20
S vs McCoy	-1.55E-5	-5.60E-2	0.056	7.4 Hz	\$10-\$20

Questions?

