W5HN

North Texas NTMS Microwave Society

The N1JEZ *Simple* GPS Stabilized 10 MHz Oscillator

Dave Robinson

WW2R

The problem

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- WA5TKU has told us how to ensure antenna alignment when roving, so what other variables can prevent a QSO?

The problem

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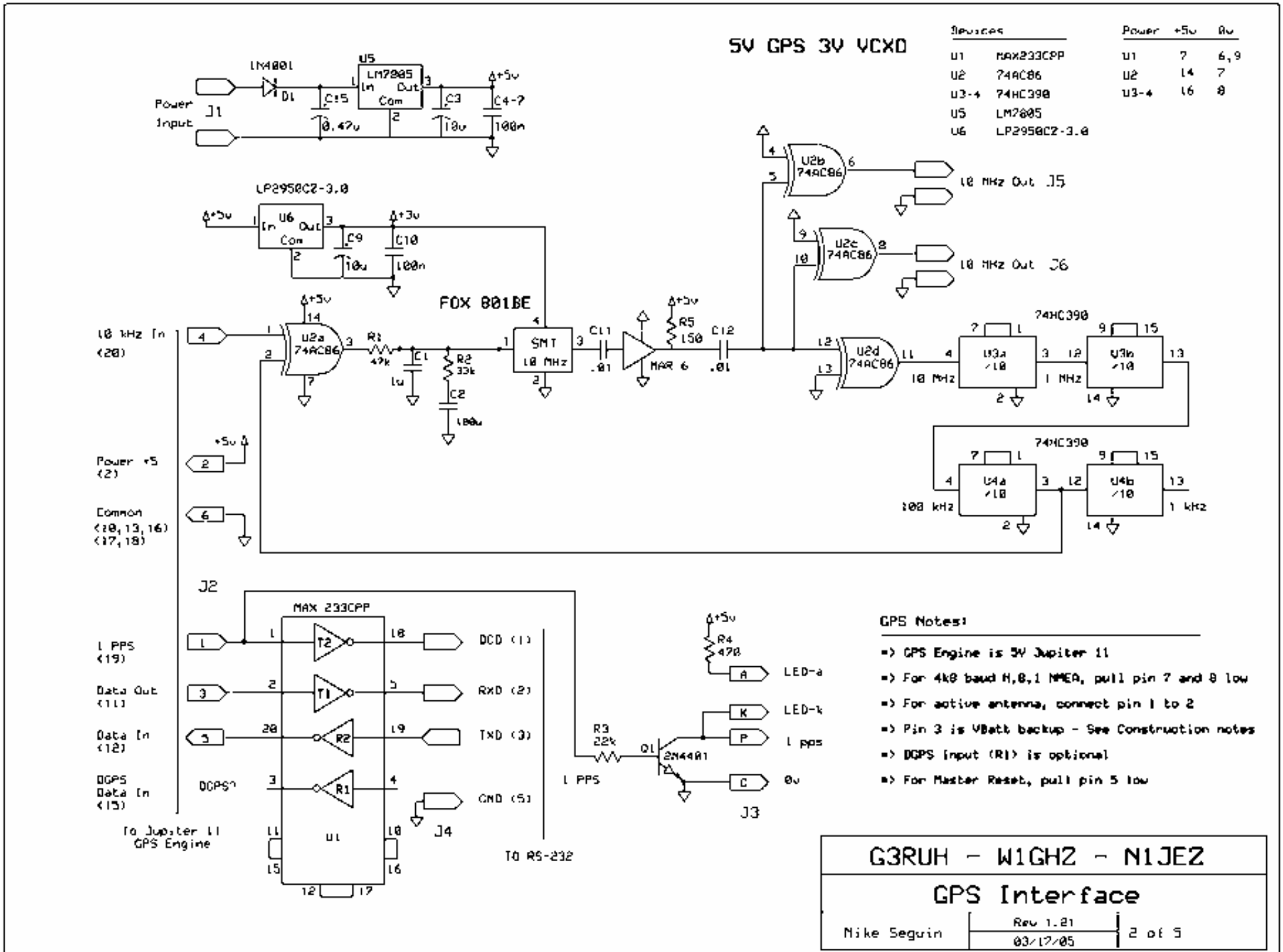
- WA5TKU has told us how to ensure antenna alignment when roving, so what other variables can prevent a QSO?
- QSOS can be lost due to not being able to know what frequency you are on!

Solutions

- Use a rubidium standard
- HP Z3801 10MHz GPS locked reference is a solution but is costly and bulky
- G3RUH and G4JNT have produced solutions using 10kHz outputs from GPS boards (not 1PPS)
- I used cheaper, smaller N1JEZ solution


5V GPS 3V VCXO
Devices
U1 MAX233CPP
U2 74AC86
U3-4 74HC390
U5 LM7805
U6 LP2950CZ-3.0
Power +5v 0v
U1 7 6,9
U2 14 7
U3-4 16 8
1N4001
D1
U5
LM7805
In Out
Com
Power Input
J1
C5
0.47u
C3
10u
C4-7
100n
+5v
LP2950CZ-3.0
U6
C9
10u
C10
100n
+3v
FOX 801BE
10 kHz In (20)
U2a 74AC86
R1 47k
C1 1u
R2 33k
C2 100u
SMT 10 MHz
C11 .01
MAR 6
R5 150
C12 .01
U2b 74AC86
10 MHz Out J5
U2c 74AC86
10 MHz Out J6
U2d 74AC86
74HC390
U3a /10
U3b /10
10 MHz
1 MHz
U4a /10
U4b /10
100 kHz
1 kHz
Power +5 (2)
Common (28,13,16) (17,18)
J2
MAX 233CPP
1 PPS (19)
Data Out (11)
Data In (12)
DGPS Data In (15)
To Jupiter II GPS Engine
DGPS?
T2
T1
R2
R1
U1
DCD (1)
RXD (2)
TXD (3)
GND (5)
J4
TO RS-232
R3 22k
Q1 2N4401
R4 470
LED-a
LED-k
1 pps
0v
J3
GPS Notes:
=> GPS Engine is 5V Jupiter II
=> For 4k8 baud N,8,1 NMEA, pull pin 7 and 8 low
=> For active antenna, connect pin 1 to 2
=> Pin 3 is VBatt backup - See Construction notes
=> DGPS input (R1) is optional
=> For Master Reset, pull pin 5 low
G3RUH - W1GHZ - N1JEZ
GPS Interface
Mike Seguin
Rev 1.21
03/17/05
2 of 5

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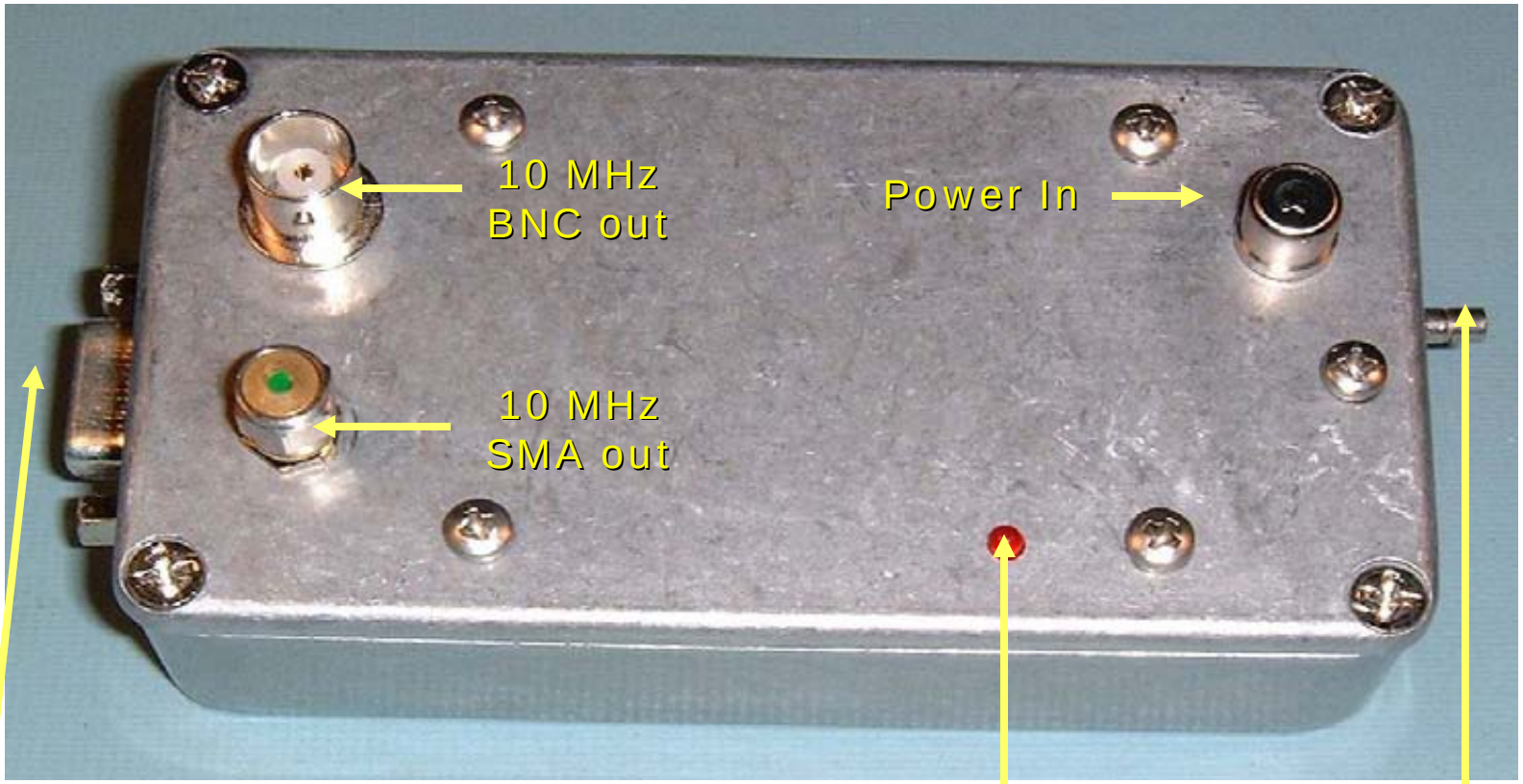

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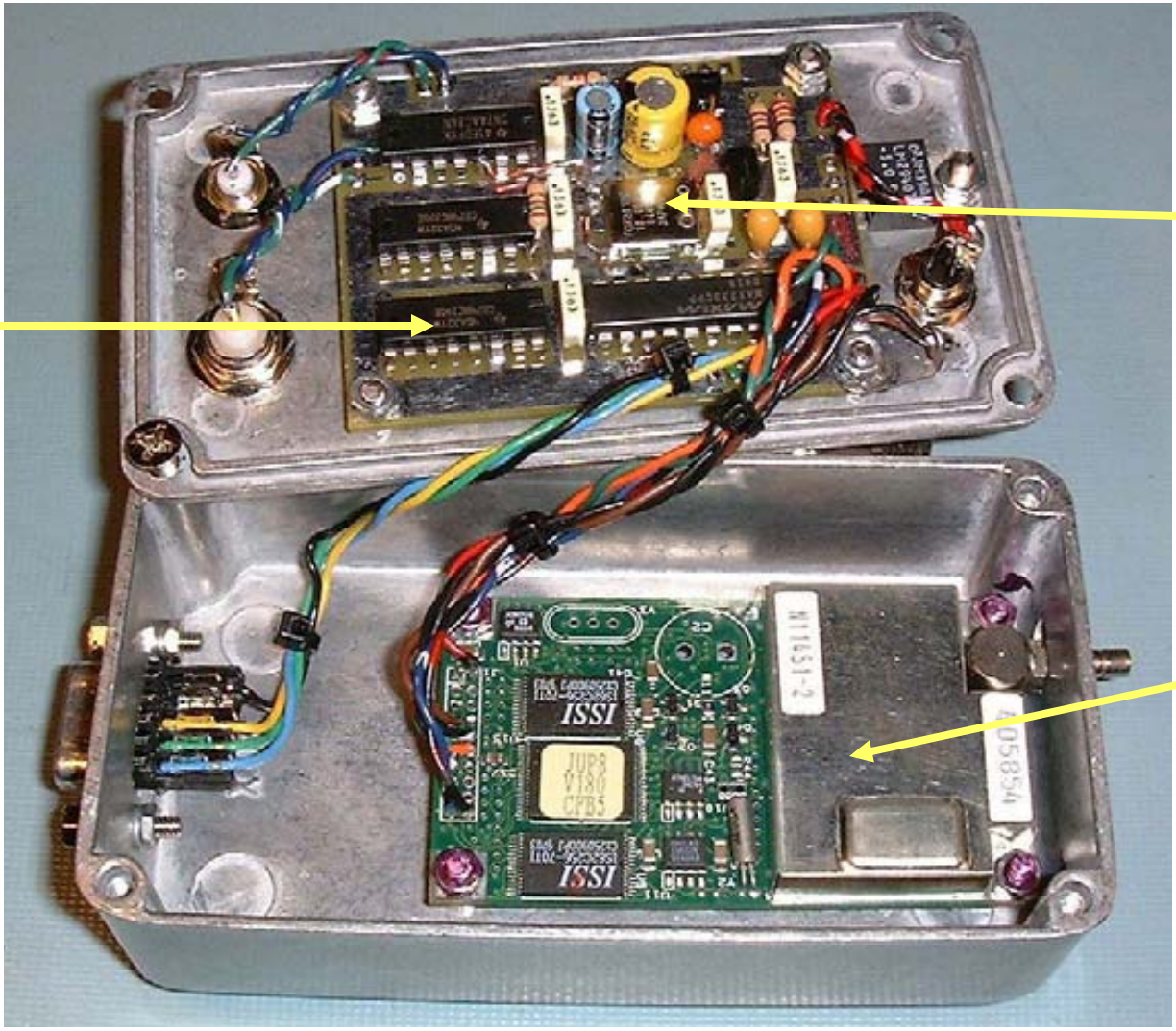
Interface Board



SMD VC-TCXO

Jupiter GPS Engine

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The Interface Board

Supports 4 Different Versions

- 5 volt GPS – 5 volt DIL-14 VCXO
- 5 volt GPS – 3 volt SMD VCXO
- 3.3 volt GPS – 5 volt DIL-14 VCXO
- 3.3 volt GPS – 3 volt SMD VCXO

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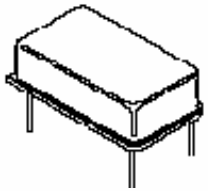
Pletronics, Inc.
19013 36th Ave. W, Suite I I · Lynnwood, WA 98036 USA
Manufacturer of High Quality Frequency Control Products



5 v DIL-14

Model	VC13 & VC15	VC14 & VC16	
Frequency Range	2.00 to 20.00 MHz	2.00 to 20.00 MHz	20.001 to 160.00 MHz
Overall Frequency Stability	± 25, 50, 100 PPM	± 15 PPM only	± 15, 25, 50, 100 PPM over OTR
Operating Temperature Range (OTR)	0 to +70°C is standard, but can be extended to 40 to +85°C for certain frequencies		
Supply Voltage (Vcc)	5.0 volts and 3.3 volts available		
Output Load	Standard load is 15pF maximum, see Test Circuit 7 (consult factory for **heavier** loads)		
Control Voltage Range (CVR)	0.5 to 4.5 volts for 5.0 volt Supply; 0.0 to 3.3 volts for 3.3 volt Supply		
Pullablity over CVR	± 25, 50, 100, 150, 200 PPM. Consult factory for ± 300 PPM.		
Linearity	± 10% (Consult factory for ± 5%)		

VC13H50BY
± 50 PPM
± 200 PPM pull

Pletronics Voltage/Frequency Characteristic

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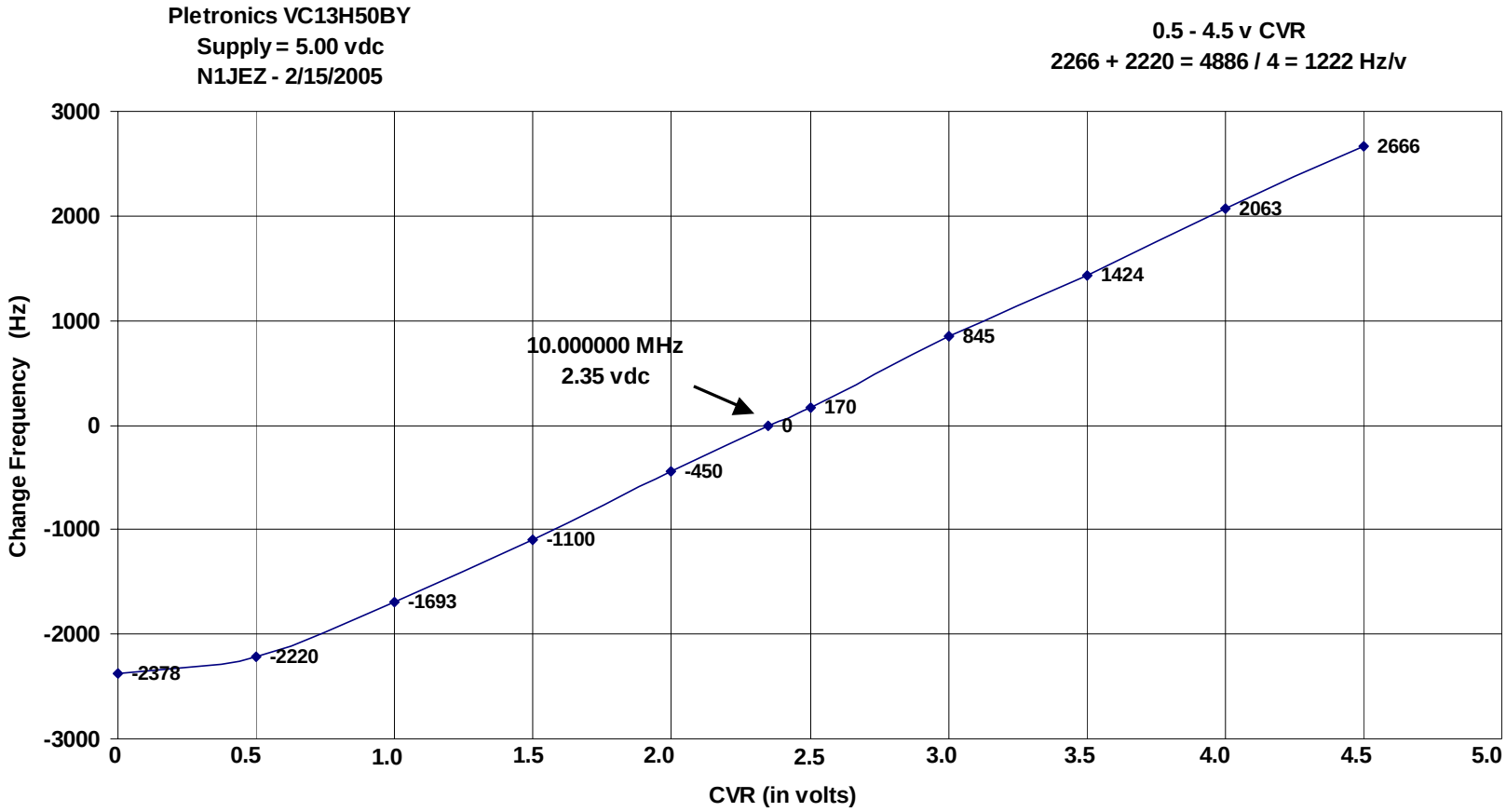

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• ELECTRICAL CHARACTERISTICS

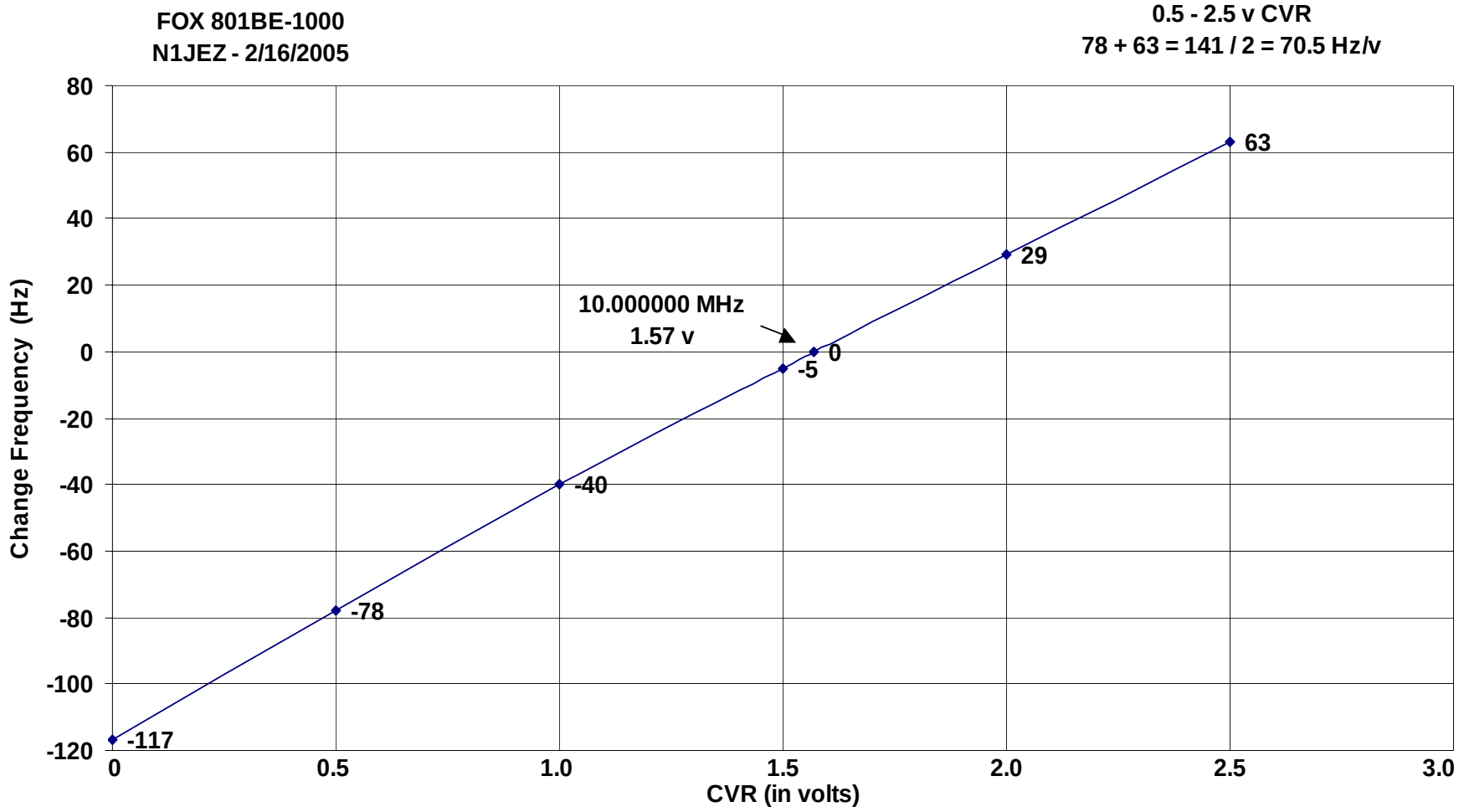
PARAMETERS	MAX (unless otherwise noted)
Frequency Range (Fo)	10.000 ~ 50.000 MHz
Temperature Range	
Operating (TOPR)	-30°C ~ +75°C
Storage (TSTG)	-35°C ~ +85°C
Frequency Tolerance (@25°C)	
Vc = 1.5V[1]	±0.5PPM
Supply Voltage (VDD)	3.0V ± 5%
Input Current (IDD)	2.0mA
Frequency Stability	
Over Temperature Range	±2.5PPM
Over Supply Voltage Change (3.0V ± 5%)	±0.3PPM
Over Load Change (10Ω ± 10% // 10pF ± 10%)	±0.3PPM
Voltage Control[1] (1.5V ± 1.0V)	±3.0PPM Min
Output Waveform (Clipped Sine)	
Peak-to-Peak Level (Vp-p)	
10.000 ~ 14.400	0.8V Min
14.400+ ~ 22.000	0.7V Min
Output Load	10KΩ // 10pF
Frequency Adjustment (Internal Trimmer)	±3.0PPM
Aging per year	±0.8PPM

3 v SMD

± 0.5 PPM

± 3 PPM pull

Fox Voltage/Frequency Characteristic



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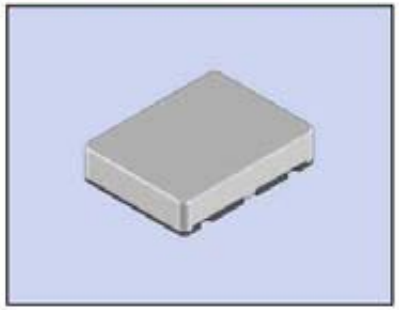
VC-TXO-39SM SERIES VC-TCXO

ECS INC. INTERNATIONAL



The VC-TXO-39SM is a VC (Voltage Controlled) TCXO (Temperature Compensated Crystal Oscillator) featuring very tight stability over a wide temperature range. The small SMD ceramic package measures 11.4 x 9.6 x 2.3 mm. The voltage control has a tuning range of ± 12 ppm typical. The low profile package is ideal for wireless communications applications.

FEATURES

- Highly stable output
- Wide temperature range
- Voltage control function
- Tape and Reel (500 pcs)

PART NUMBERING GUIDE

SERIES		FREQUENCY		STABILITY / TEMPERATURE OPTION
VC-TXO-39SM	–	128	–	A

Sample Part Number: VC-TXO-39SM-128-A, 128=12.8 MHz, A=±1.5 ppm -20 to +75°C

STANDARD FREQUENCIES

10.000, 13.000, 16.800 AND 19.440 MHz

OPERATING CONDITIONS/ELECTRICAL CHARACTERISTICS

PARAMETERS	CONDITIONS	ECS-3955C (5V)			UNITS
		MIN	TYP	MAX	
FREQUENCY RANGE		10.000		19.440	MHz
FREQUENCY STABILITY/TEMP	Operating Temperature				
STANDARD	-30 – +75°C			±2.5	PPM
OPTION A	-20 – +75°C			+1.5	PPM
SUPPLY VOLTAGE CHANGE	+3V ±5%			+0.3	PPM
LOAD CHANGE	10k Ω ±10%//10pF ±10%			+0.3	PPM
AGING	First Year @ +25°C			±1	PPM
STORAGE TEMPERATURE		-40		+85	°C
SUPPLY VOLTAGE	+3.0 V DC Nominal	+2.85	+3.0	+3.15	V DC
CURRENT CONSUMPTION	10k Ω ±10%//10pF ±10%			1.5	mA
OUTPUT VOLTAGE	Clipped sine wave (DC-Cut)	0.8			Vp-p
OUTPUT LOAD	10k Ω ±10%//10pF ±10%				
FREQUENCY CONTROL RANGE	+1.5 V DC ± 1V Positive Slope	±9	±12		PPM
CONTROL VOLTAGE		+0.5	+1.5	+2.5	V

ECS Osc Freq v Tuning Volts

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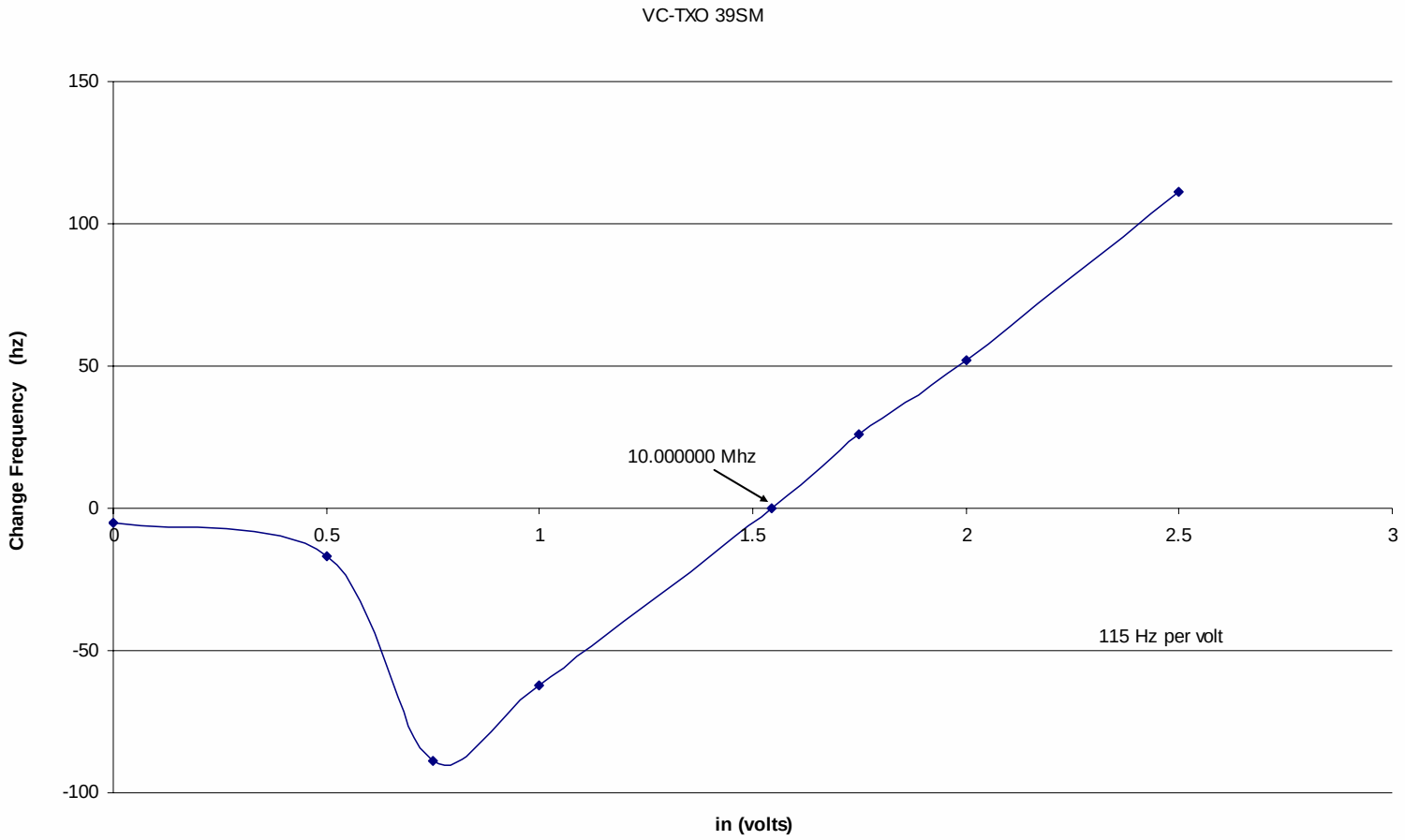
BEWARE!



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WHAT CAN YOU DO WITH IT ?

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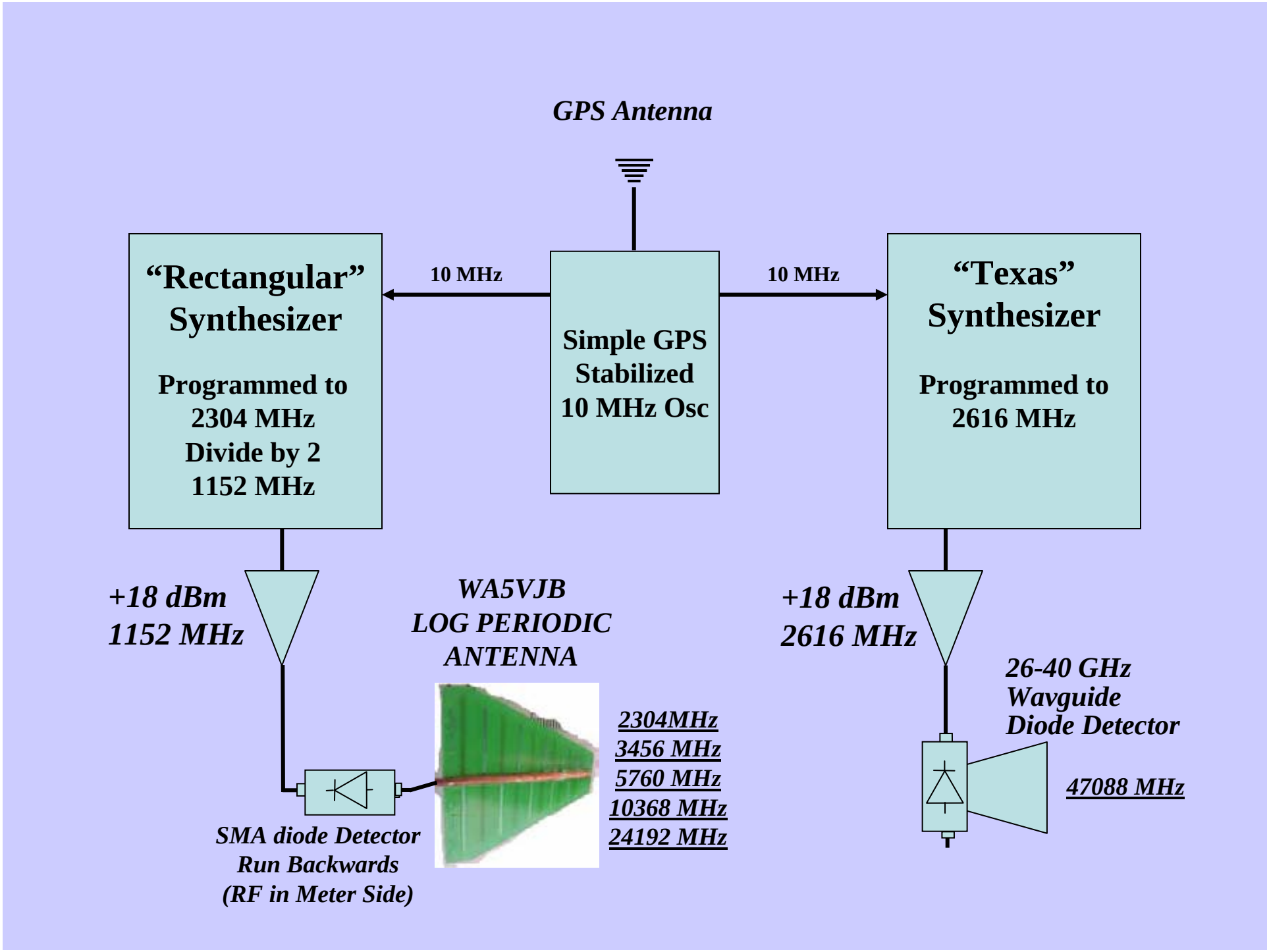
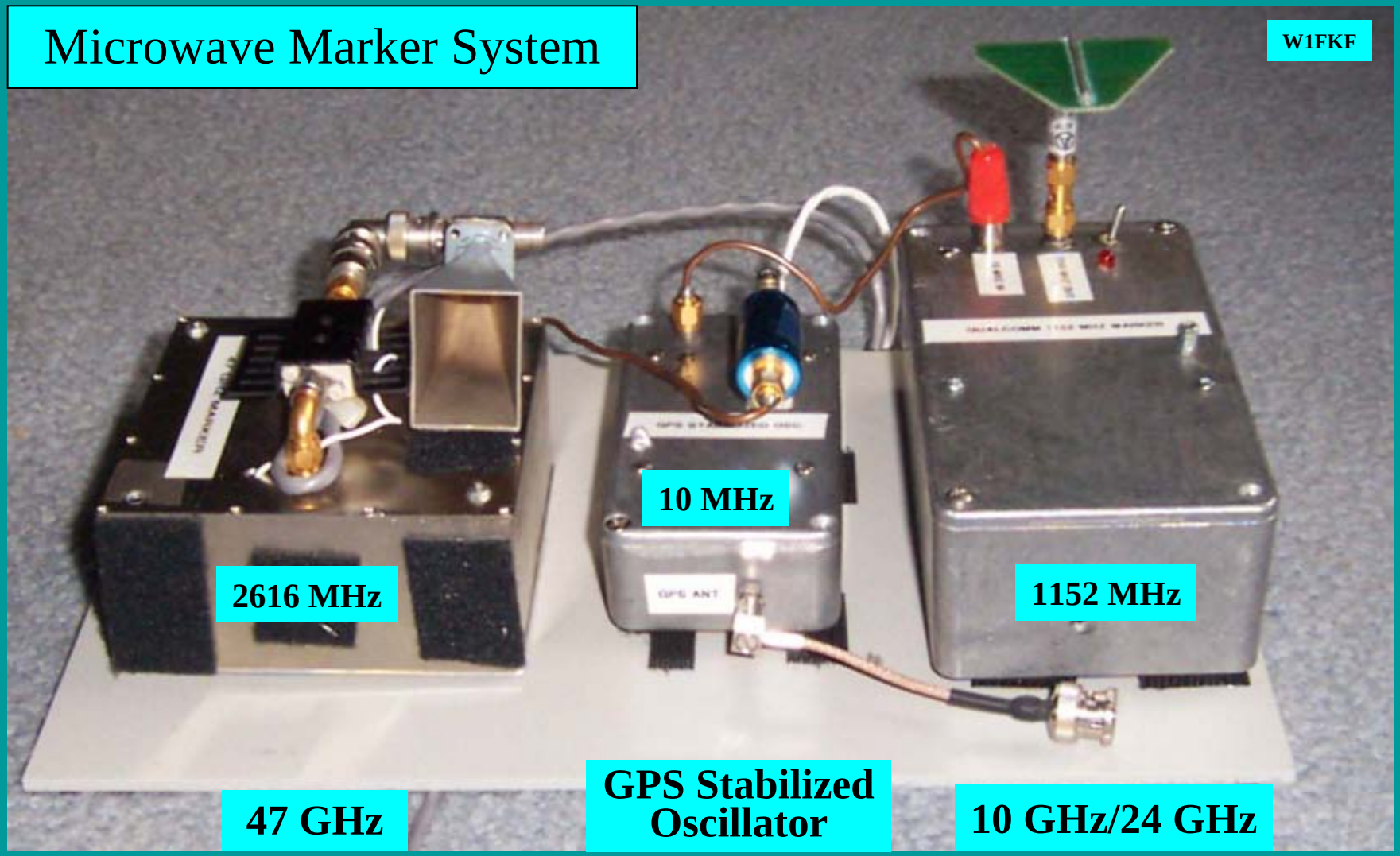
- **Reference as a Marker**
  10 MHz to 2500 MHz
- **Reference for a Qualcomm Source**
  1152 MHz (2304 – 24192 MHz)
  2616 MHz (47088 MHz)
- **Reference for a Brick Oscillator**
  Such as CTI
- **Reference for CT1DMK lock box**
- **DSP-10 Reference**


GPS Antenna
"Rectangular" Synthesizer
Programmed to 2304 MHz Divide by 2 1152 MHz
10 MHz
Simple GPS Stabilized 10 MHz Osc
10 MHz
"Texas" Synthesizer
Programmed to 2616 MHz
+18 dBm 1152 MHz
WA5VJB LOG PERIODIC ANTENNA
+18 dBm 2616 MHz
26-40 GHz Wavguide Diode Detector
2304MHz
3456 MHz
5760 MHz
10368 MHz
24192 MHz
47088 MHz
SMA diode Detector Run Backwards (RF in Meter Side)

The Use of a *Simple* GPS Stabilized 10 MHz Oscillator



N1JEZ Startup from Cold (Rb Reference)

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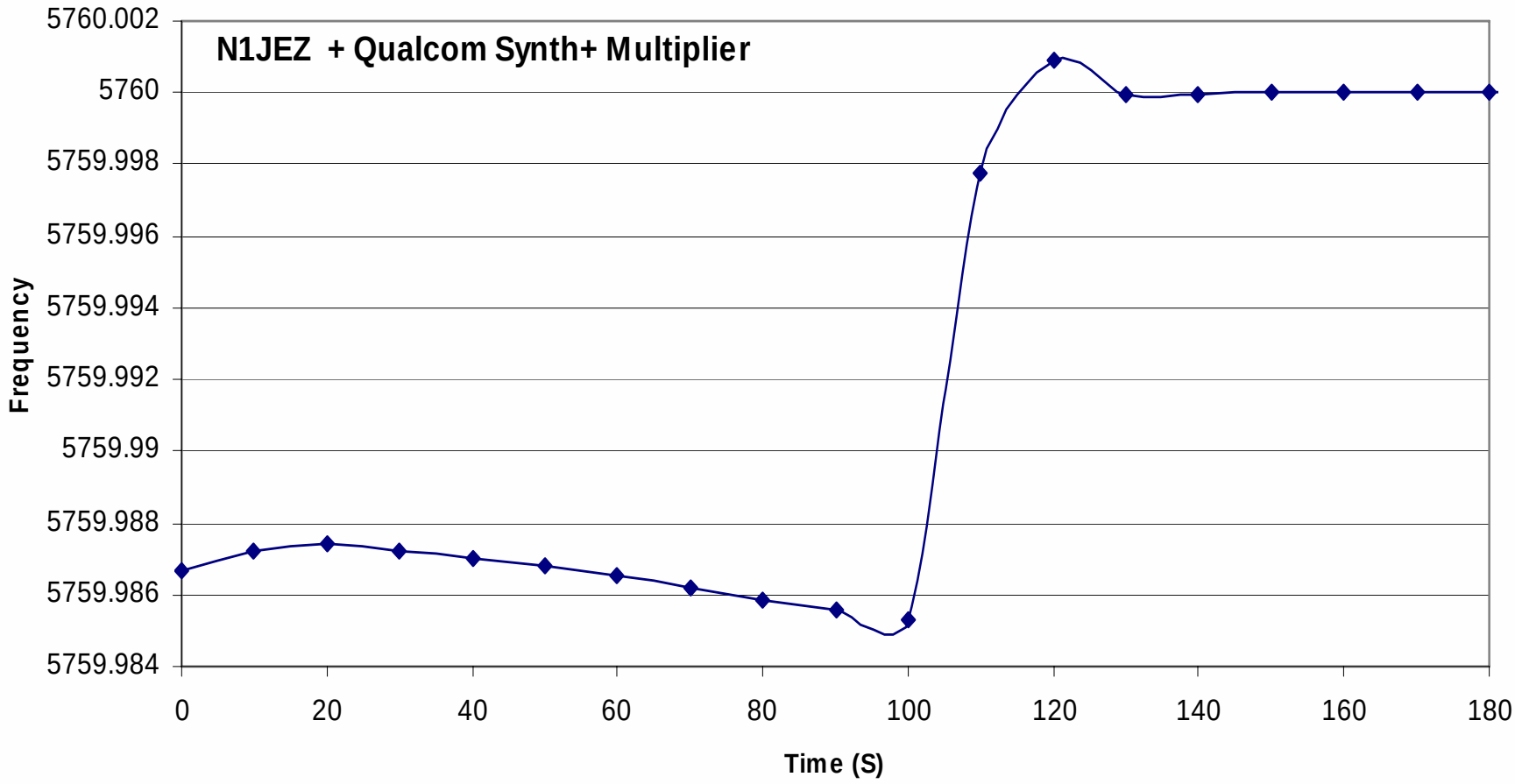

Frequency distribution (sampled every 30S)

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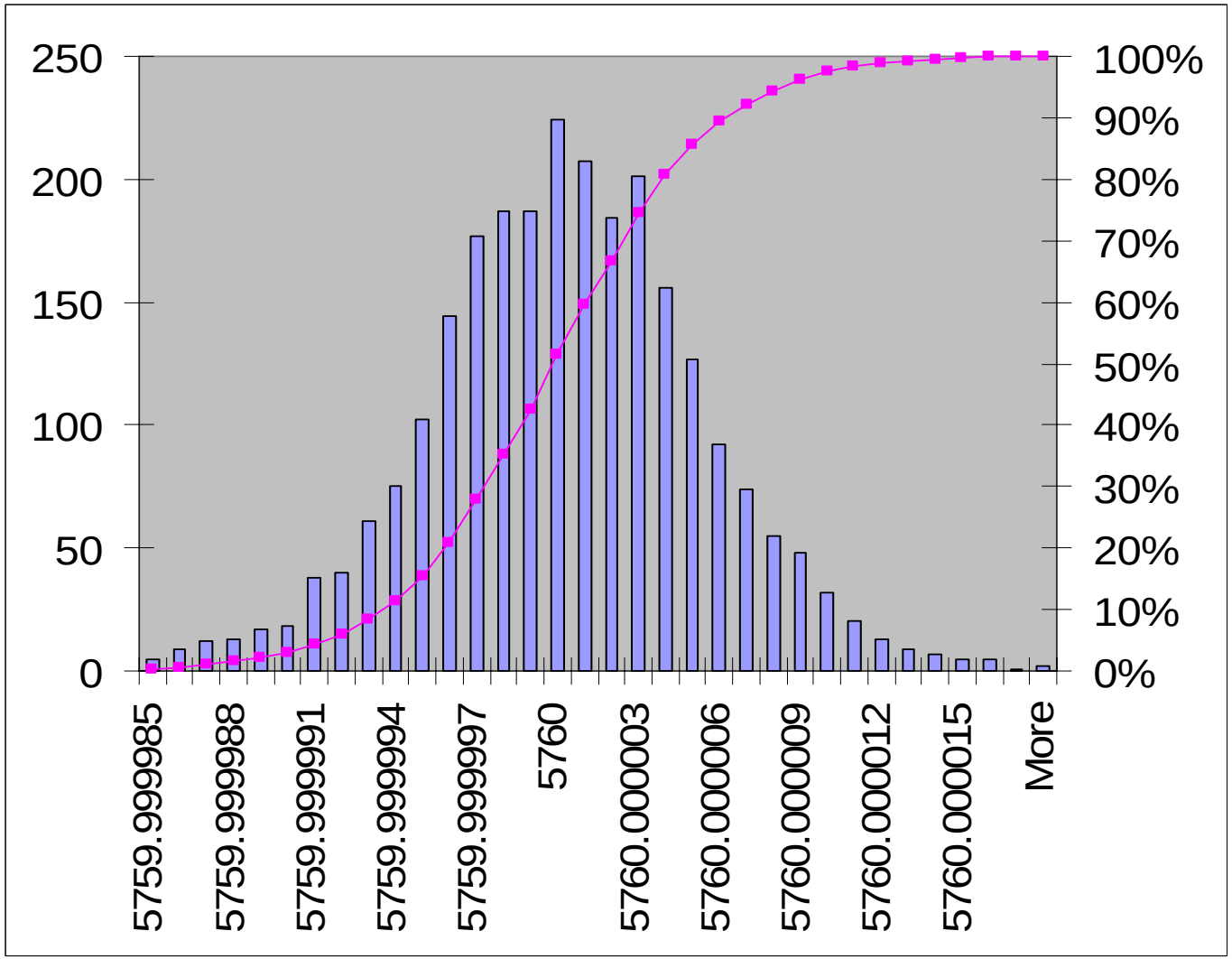
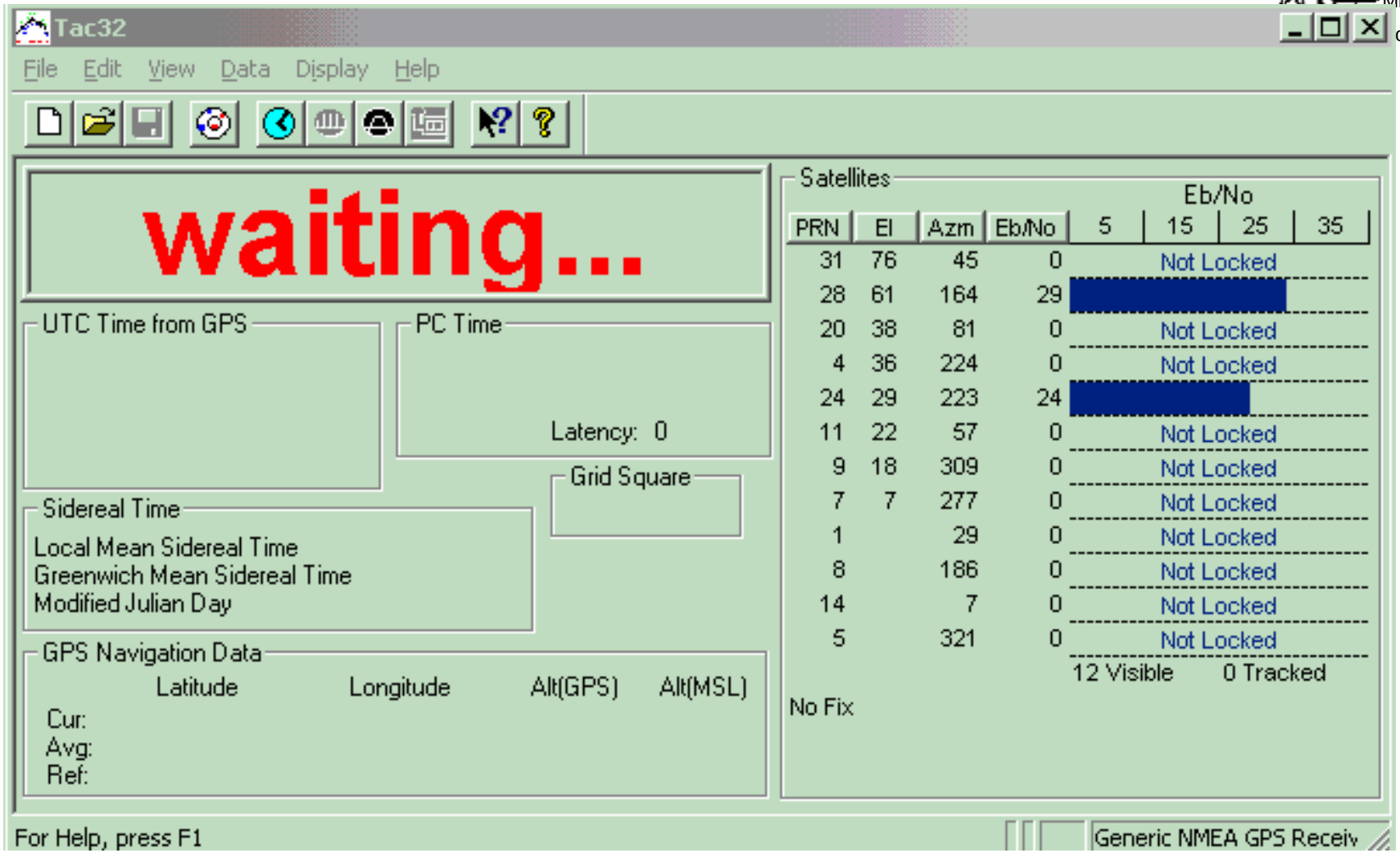


Is the lock good?

- Can see status using Terminal program or TAC32 to inspect NMEA strings

Initial GPS Power Up



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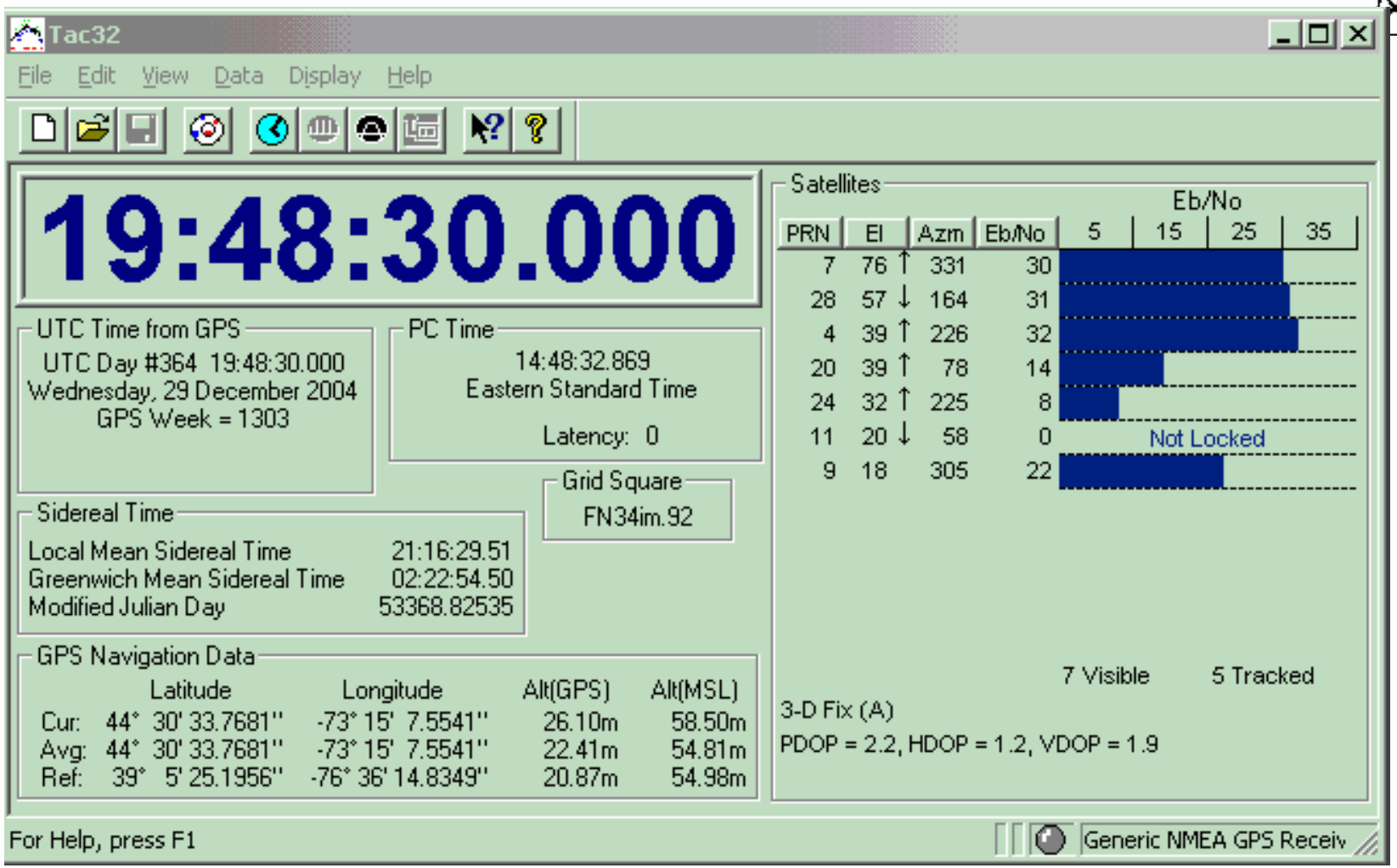

Less bulky alternative?

- Using PC is a bulky option
- Can use a PIC to monitor NMEA string and inhibit the output if not a good GPS lock

Determining Lock Status


```
-> $GPGSA,A,1,,,,,,,,,,,,,2.33,1.23,1.98
-> $GPRMC,194055,V,4430.5592,N,07315.1285,W,0.000,0.0,291204,15.9,W
? $PRWIZCH,24,6,20,0,20,0,20,0,28,4,20,0,20,0,20,0,04,0,20,0,20,0,20,0
? $GPGGA,,,,,,0,00,,,,,,
-> $GPGSA,A,1,,,,,,,,,,,,,2.33,1.23,1.98
-> $GPGSV,3,1,12,31,76,045,,28,61,164,46,20,38,081,00,04,36,224,00
-> $GPGSV,3,2,12,24,29,223,41,11,22,057,,09,18,309,,07,07,277,
-> $GPGSV,3,3,12,01,,029,,08,,186,,14,,007,,05,,321,
-> $GPRMC,194056,V,4430.5592,N,07315.1285,W,0.000,0.0,291204,15.9,W
? $PRWIZCH,24,6,20,0,20,0,20,0,28,4,20,0,20,0,20,0,04,0,20,0,20,0,04,0
? $GPGGA,,,,,,0,00,,,,,,
-> $GPGSA,A,1,,,,,,,,,,,,,2.33,1.23,1.98
-> $GPRMC,194057,V,4430.5592,N,07315.1285,W,0.000,0.0,291204,15.9,W
? $PRWIZCH,24,6,20,0,20,0,20,0,28,4,20,0,20,0,20,0,04,0,20,0,20,0,04,0
```

GPGGA sentence (0,1,2)

GPGSA sentence – second character = 3

Use HDOP and PDOP values. Beware Jupiter gives values with no satellites

Measure VC line. Beware loading effects!

NMEA Time problems

- Time output by NMEA strings can be 1-3 seconds out. Acknowledged by manufacturer
- Reason: Putting time information in the NMEA strings is THE lowest priority activity of the Jupiter GPS board!
- Binary outputs from the GPS don't have this problem, but cannot be used by time programs requiring NMEA strings (eg NMEATIME)
- One solution is to use the PIC doing valid lock detect function from the binary data and have it synthesise an NMEA string (like my Z3801 clock does). Work in progress

References

G3RUH design

- http://www.jrmiller.demon.co.uk/projects/freqstd/frqstd.htm

G4JNT design

- http://www.scrbg.org/g4jnt/SimpleGPSDO.htm

N1JEZ design

- http://mysite.verizon.net/n1jez/osc/page5.html

TAC32

- http://www.cnssys.com/Tac32/