

10 MHz Frequency Reference Project

The Aim:

Provide a low cost 10MHz reference

for VHF through microwave equipment

Provide income

to support Group's Beacons and activities

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Brisbane VHF Group

GPS Disciplined Frequency Reference *Traps for the Young and not so Young*

“The ‘flavor of the month’ seems to be GPS locking of radio frequency”

VK4AMG GippsTech 2019

This paper addressed:

- Requirements of frequency locking
- Alternative solutions for locking
- Limitations

Conclusions:

- GPS disciplining lock solutions have short comings
- Locking to high stability 10MHz reference = BEST
- GPS provides advantages if GPS is available

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GPS Disciplined Frequency Reference *Traps for the Young and not so Young*

“The ‘flavor of the month’ seems to be GPS locking of radio frequency”

VK4AMG GippsTech 2019

- **Many implementations have major weaknesses:**
 - Long settling times
 - Wandering during initial disciplining
 - Loss of stability if GPS signal was lost
 - Lack of status – Valid GPS, state of discipline

Why Lock ?

10 MHz Frequency Reference

Frequency Accuracy

So the other station can find me when I call on sked
and

when operating in digital modes

To be on specific frequency

To be reported correctly in reverse beaconing

Within 100 Hz up to 1296MHz

Frequency Stability

So my SSB / CW signal is clear and interference free

So others optimum decode digital modes

decode software is time and frequency critical

So decoding other's digital transmission is not degraded

Preferably better than 10Hz

For all operating conditions;

Voltage, ambient temperature, power output, SWR, radio temperature, fan on/off

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Requirements

Provide a low cost 10MHz reference for a complete shack and rover

- Excellent stability < 10ppb (0.1Hz)
- High accuracy < 100ppb (1Hz)
- Sine wave output > 1 Vp-p (+4dBm)
- Low phase noise better than -140dBc/Hz at > 100Hz
- Fast warmup < 5mins
- Multiple outputs (four or more)
- Wide power supply range 12 – 28Vdc
- Low power consumption < 0.5A @ 12V
- Small footprint
- Boxed or Unboxed for mounting in equipment

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Requirements

GPS Discipline Features:

- GPS disciplining Accuracy < 5ppb (0.05Hz)
- PC time synchronisation and location and heading calculation

GPS Discipline Version MUST:

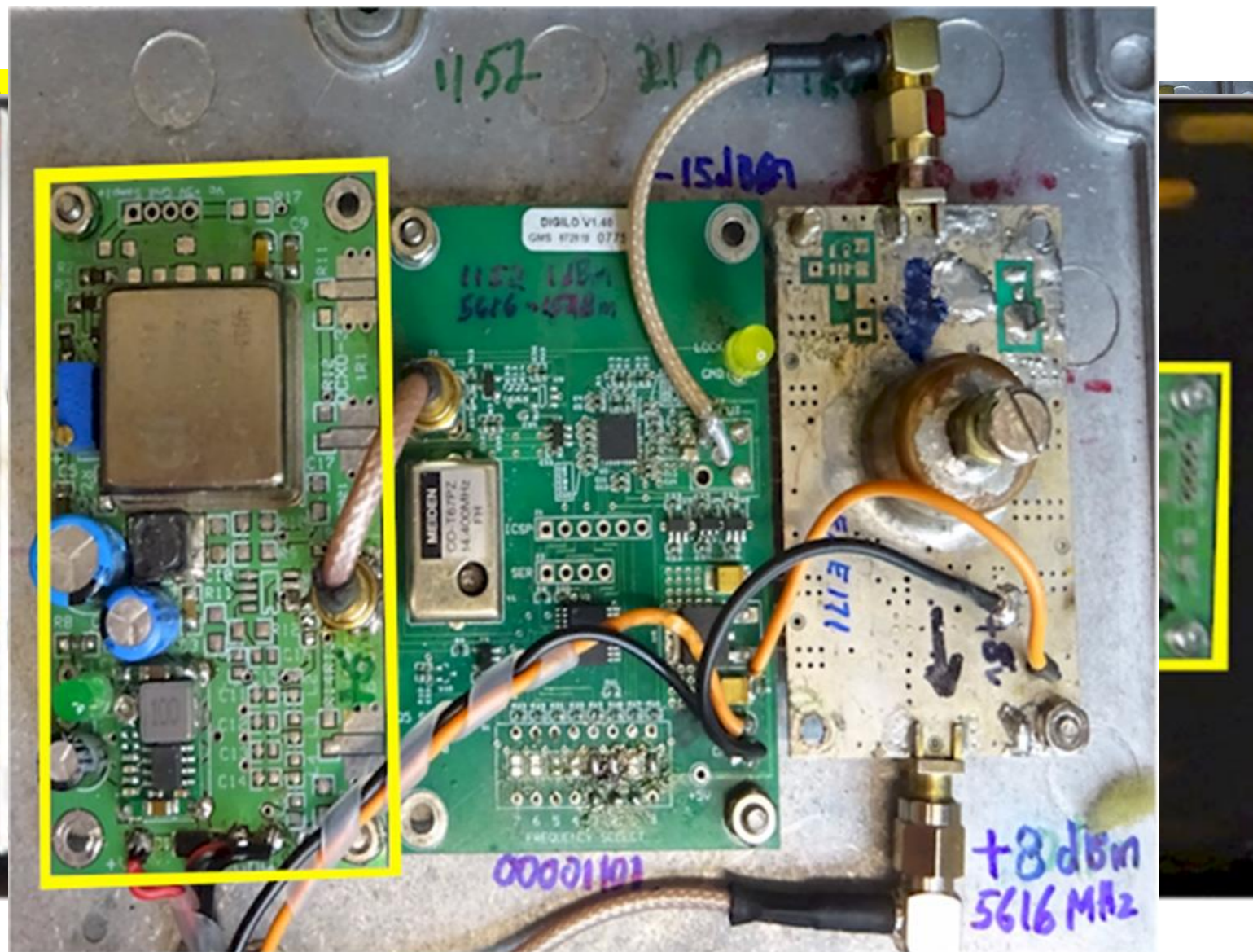
- Not degrade warmup time and stability
- Provide status of warmup, GPS availability, discipline progress, locked
- Not degrade accuracy and stability when GPS not available

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Rover

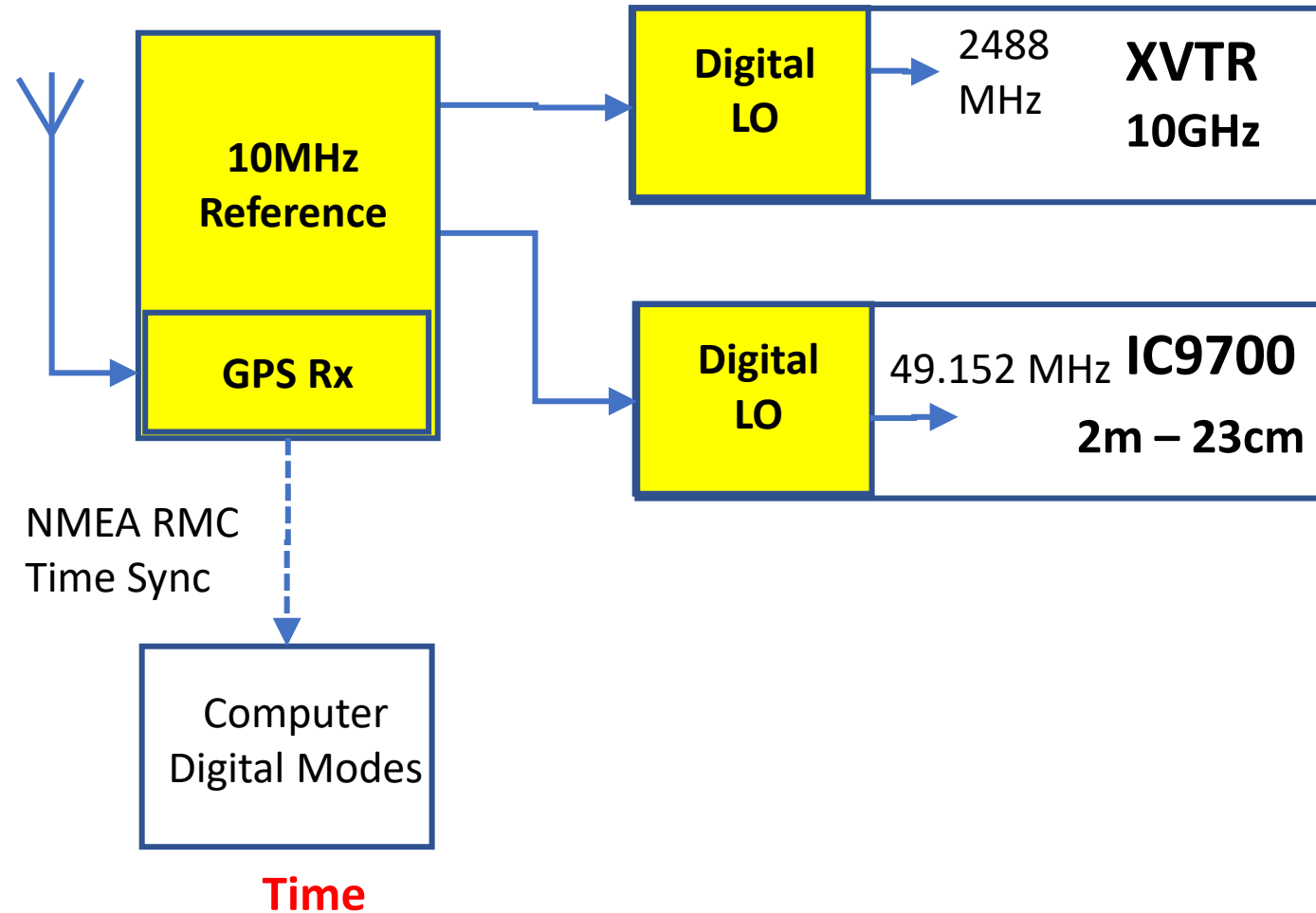
10MHz
OCXO



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Extended Rover Station Solution



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A Whole Shack Solution

NMEA RMC
Time Sync

Computer
Digital Modes

Time



XVTR
10GHz

IC9700
– 23cm

IC7400
2m

IC910H
23cm

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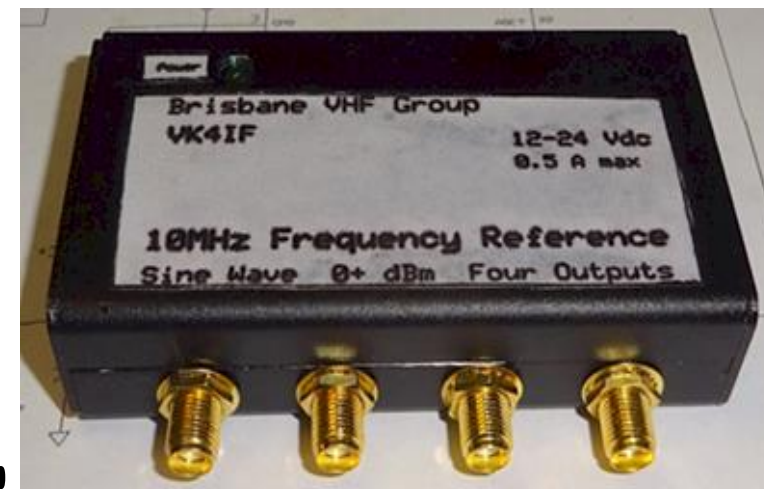
10 MHz OCXO Reference Generator

OCXO-3 Rev 1.1

The Products

GPS Disciplined 10 MHz Reference Generator

GPSD-1 Rev 1.0



10 MHz OCXO Reference Generator

OCXO-3 Rev 1.1



Oven Controlled Crystal Oscillator

Operates from a supply of 12 to 28V dc

Four SMA outputs.

One additional output may be added

Calibrated for 10000000.0 Hz

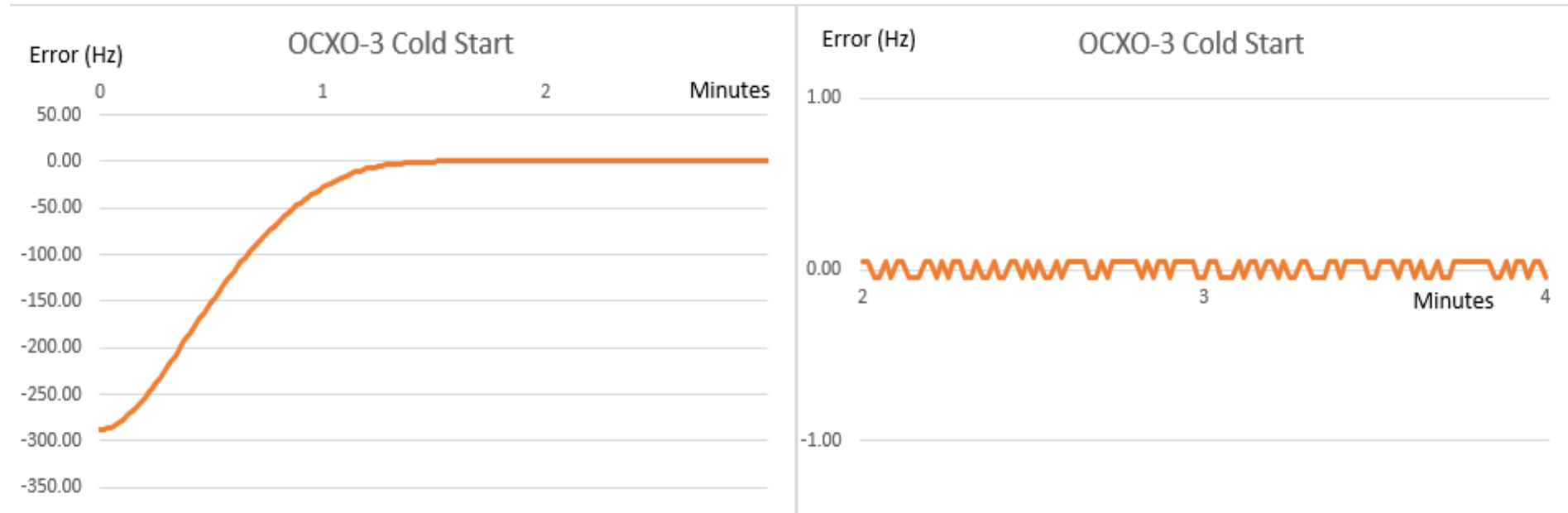
Startup 500mA @ 12V dc

Settled @12V <250mA; @ 26V <150mA.

Sine or square wave > 8 dBm.

10 MHz OCXO Reference Generator

OCXO-3 Rev 1.1



CTI OSC5AB02 oven-controlled crystal oscillator

Warmup < 2 mins

Stability < 10 ppb (0.1Hz) at 0°C to 45°C.

Accuracy Ageing < 100 ppb per year (1Hz) < 400ppb over 10 years.

Phase noise

-80dBc/Hz@1Hz

-120dBc/Hz@10Hz

-140dBc/Hz@100Hz

-145dBc/Hz@ 1kHz.

GPS Disciplined 10 MHz Reference Generator

GPSD-1 Rev 1.0



100 x 50 x 25 mm

u-Blox Neo6 GPS receiver
Arduino Nano microprocessor
Supervise and discipline a high stability OCXO.

- GPS & uP disciplined 10MHz OCXO
- Provide accurate and stable frequency locking
- Four outputs One additional output may be added
- Sine or square wave
- Operates from a supply of 12 to 28V dc
- Startup 0.5A @ 12V dc
- Settled @12V <300mA; @ 26V <170mA.

GPS Disciplined 10 MHz Reference Generator

GPSD-1 Rev 1.0



Status displayed on four LEDs:

- Power (Green) indicates unit is operating;
- 1PPS (Blue) GPS locked and producing 1PPS
- Warn (Red) steady during warm-up
 - long during coarse discipline or error
 - fast during fine discipline
 - off when accurate and stable $\pm 0.1\text{Hz}$
- OK (Green) reference is GPS locked

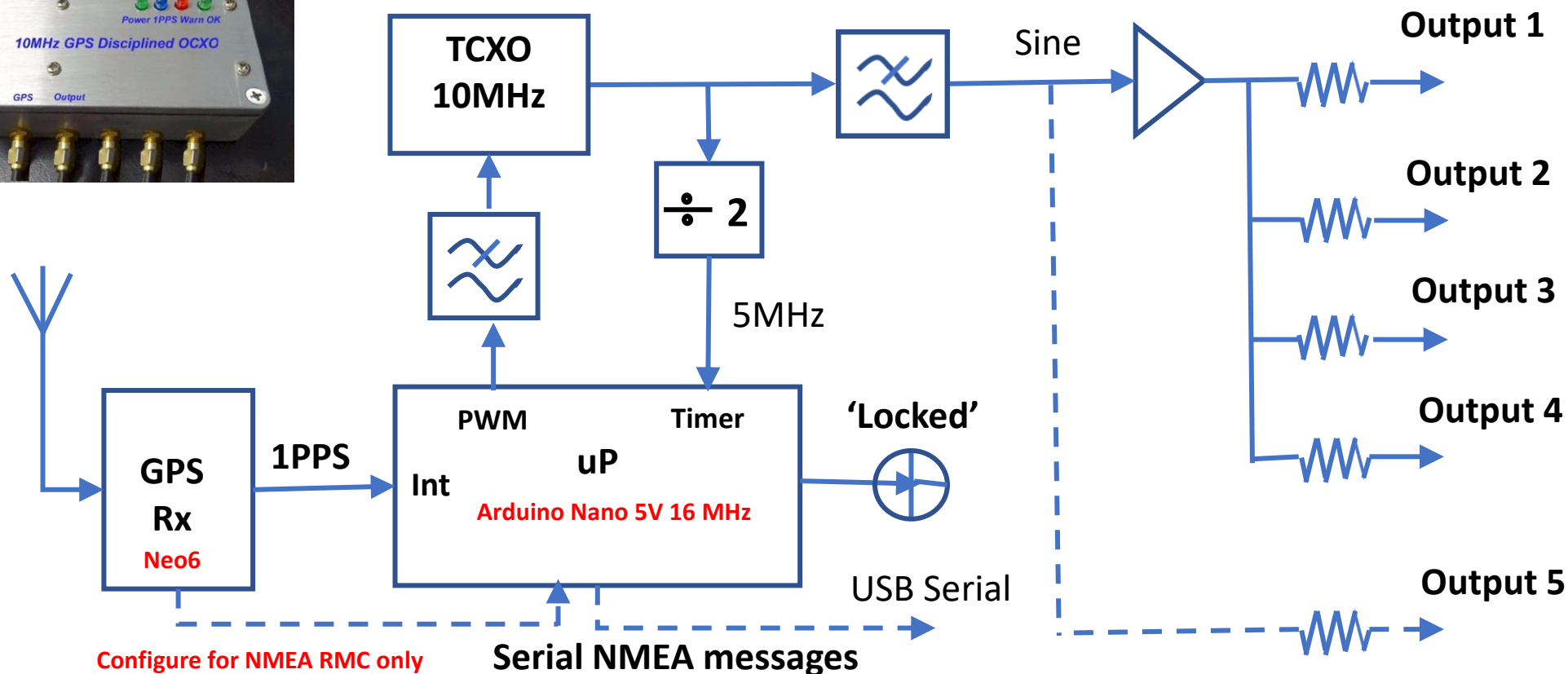
NMEA RMC sentence at 9600 baud via serial USB

PC time synchronisation, grid square calculations, or beam headings

GPS Disciplined 10 MHz Reference Generator

GPSD-1 Rev 1.0

10MHz



What makes the Brisbane VHF Group OCXO Different ?

- Low cost High Stability Fast Warmup OCXO
- Calibrated against GPS disciplined GPSD-01 < 1Hz for years
- Wide range power supply 12 to 28 Vdc
- Sine or Square alternative at manufacture
- Four +8 dBm Outputs
- Low power startup <500mA @12V <300mA @26V startup
- Low power Consumption <150mA @12V <250mA @26V startup

What makes the Brisbane VHF Group OCXO Different ?

- Low cost High Stability Fast Warmup OCXO
- Calibrated against GPS disciplined GPSD-01 < 1Hz for years
- Wide range power supply 12 to 28 Vdc



What makes the Brisbane VHF Group GPSD Different ?

**Builds on Low Cost Stable Low Consumption OCX0-3 Features
Adds Neo6 GPS Receiver and Arduino Nano Microprocessor**

- **Previous calibration values used at start-up No wandering or instability**
- **No GPS discipline until after start-up delay and valid GPS lock**
- **Frequency is measured against GPS 1PPS timing pulses over 30 sec periods**
- **No “coarse” discipline adjustments applied until large error confirmed**
- **Frequency for “fine” calculated over ten count periods (rolling error)**
- **“Fine” discipline adjustments applied in steps transparent to digital operation**
- **LED status indicators for Power; GPS valid; Frequency accuracy; and Reference locked**
- **USB serial broadcast of NMEA RMS sentences for time, location, and bearing calculation**
- **Provides supply for active GPS antenna**
- **Packaged in diecast aluminium shielded enclosure**

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Models and Pricing:

Acknowledgements