Rig Locking – External Reference Oscillator

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Introduction

Elsewhere, there are descriptions of the modifications to rigs to lock them to GPS. Most of the rigs use an oddball internal reference frequency (e.g. 22.625 MHz). This document describes one method of generating this frequency from a GPSDO 10 MHz output.

Implementation

The reference oscillator uses a VCXO module locked by a PLL implemented in a CPLD. The circuit diagram of the oscillator is shown in Figure 1.

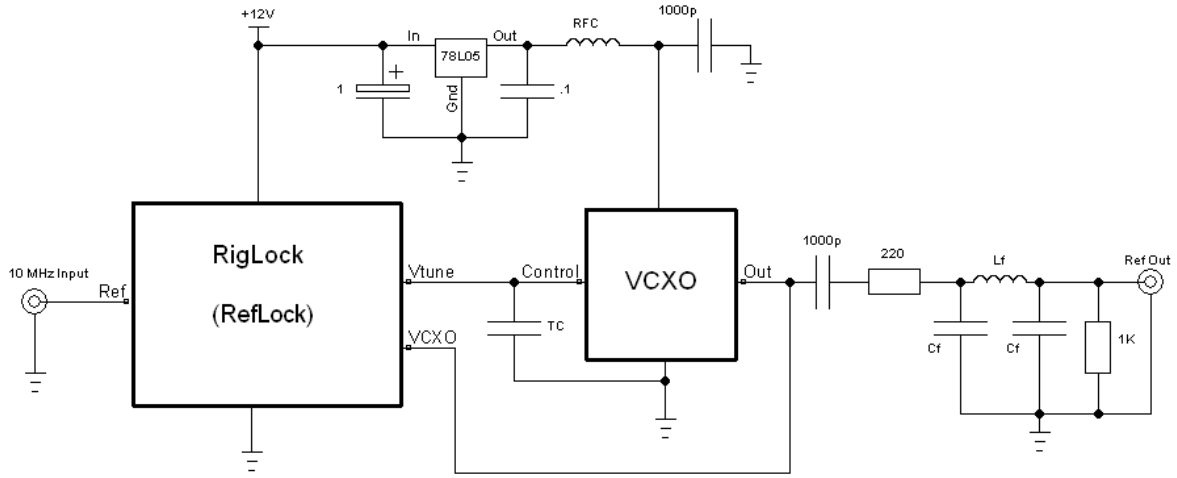

Figure 1 – Reference Oscillator Circuit

For best performance, care must be taken to minimise the amount of noise reaching the VCXO either through the Control line or the power supply. On the Control line, the capacitor from the Loop Filter on the Riglock board has been moved to directly across the pins of the VCXO to minimise the effect of ground loop noise. For power, a separate regulator and filter circuit are used, although a special low-noise regulator may be worth investigating.

The output of the VCXO passes through a low-pass filter. The VCXO has a TTL-level square-wave output, so the filter is used to suppress the harmonics producing a much cleaner sine wave. Details of the filter may be found in the Wenzel Technical Library: http://www.wenzel.com/documents/waveform.html

Typical values for the filter components for different rigs are shown in the table in Figure 2.

Rig	Freq (MHz)	L (uH)	C (pF)
Kenwood TS-2000(X)	15.6	1.0	100
Yaesu FT-817/847/857/897	22.625	0.68	68
Icom IC-910H	30.2	0.47	47

Figure 2 – Filter Values

PLL

The PLL uses a CT1DMK Reflock 1 board with new firmware ("Riglock"). The Riglock firmware implements a simple PLL with two divider chains (Reference and VCXO) and an XOR gate as a phase comparator. The firmware has several link-selectable fixed divider configurations suitable for locking different rigs. The VCXO (N) and Reference (R) division ratios and Phase Comparator operating frequency are shown in Figure 3.

Rig	Freq (MHz)	N	R	PLL (kHz)
Kenwood TS-2000(X)	15.6	78	50	200
Yaesu FT-817/847/857/897	22.625	362	160	62.5
Icom IC-910H	30.2	302	100	100

Figure 3 – PLL Settings

The Reflock board was modified to fix a bug with the programming voltage, and also to substantially reduce current drain. Half of the 74F04 gates were disabled (inputs to +5V). Only one gate is used in the VCXO path to clean up the signal, and two in the Reference path (only the first with feedback). Pullup resistors for any inputs that are wired low were removed. The load resistor on the 3.3V rail was also not needed.

The Loop Filter component values from the original Reflock article were used except that, as mentioned earlier, the output 0.01uF capacitor was mounted directly across pins of the VCXO.

If anyone has a Reflock 1 board and is interested in trying this firmware, please contact the author at <callsign>@wia.org.au

An off-the-shelf alternative to the reprogrammed Reflock could be the VE1ALQ Versatile PLL – version 1 would be more than adequate.

VCXO

The VCXO is a mid-spec QVO-6130 unit from Hy-Q International. Specifications for their range of standard VCXO modules is shown in Figure 4.

MODEL	QVO-6110	QVO-6120	QVO-6130	QVO-6140	QVO-6150
STABILITY	±20ppm	±25ppm	±50ppm	±100ppm	±50ppm
TUNING RANGE	±50ppm	±100ppm	±100ppm	±200ppm	±200ppm
CONTROL VOLTAGE	0.5 – 4.5 VOLTS				

Figure 4 – Hy-Q VCXO Specs

Unfortunately, Hy-Q cannot supply Phase Noise figures for these oscillators. However, it could be assumed that Phase Noise is related to Stability and Tuning Range, so the best performing VCXO is probably the QVO-6110. However, this comes at a price. The QVO-6130 is around $35. The QVO-6110 was quoted several years ago at 5-6 times that price.