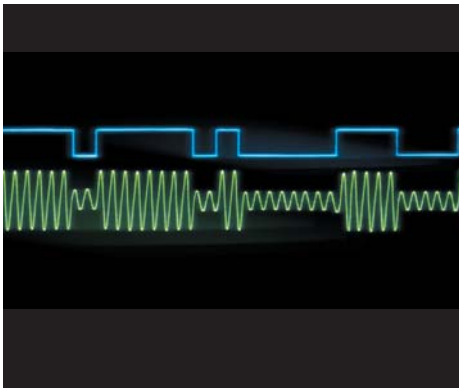
Symmetricom

Rubidium Keeps the Signal Stable



ARTICLE REPRINT

THIS MATURE TECHNOLOGY PROVIDES A LOW-COST ALTERNATIVE

As deadlines draw near for broadcasters to become digital, solutions are being sought by an industry in transition. Many solutions offered are works in progress. One very simple, proven, low cost solution exists today.

Production facilities have enough new digital requirements to last a lifetime, however there are several choices for UHF/VHF digital transmitters. What the manufacturers leave to the chief engineer to decide is how to provide a stable reference (clock) for their digital exciter.

Typically, the manufacturer has their suggested solution consisting of a quartz-based GPS receiver, possibly with a low noise source (oscillator). What is not brought to light are some of the underlying costs associated with a GPS solution (See Table 2).

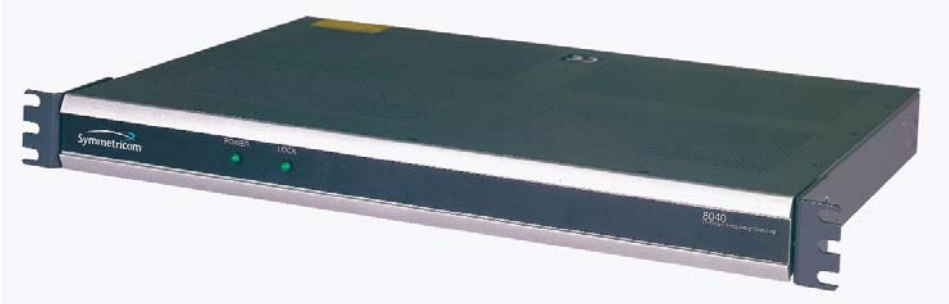


FIGURE 1 8040

A more economical, lower maintenance, solution is the Rubidium Atomic Reference. A rubidium oscillator will provide better short-term stability and frequency accuracy, which becomes important for signal integrity and co-channel interference. Phase noise, that relates to jitter in the digital world, is much better than a standard GPS receiver.

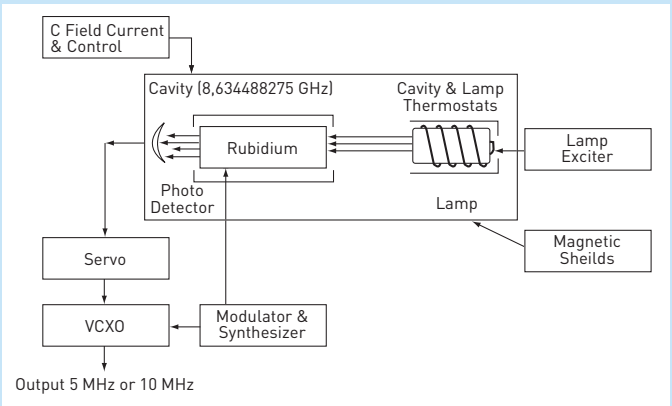
Rubidium also offers a low aging rate of IE-9 over a 10-year period. This translates to less than 1Hz of drift over 10 years for a typical 840 MHz UHF transmitter. A periodic calibration is available if needed.

Overall, a Rubidium Atomic Frequency Reference is much simpler than to implement than a GPS receiver. There is no fear

About Rubidium Technology

A rubidium clock is basically a crystal oscillator locked to an atomic reference, as shown in the block diagram below. The rubidium physics package serves as a passive discriminator, producing an error signal that varies in magnitude and sense as a function of the difference in frequency between the applied RF excitation and the atomic resonance.

The rubidium frequency is about 6835 MHz, and a line of Q ten million is typical. The error signal is a result of audio frequency (150 Hz) FM applied to the microwave excitation, which causes variations in the transmission of light through the resonance cell. A photo-detector senses this response, which has a typical signal -to-noise ratio of 70 dB in a 1 Hz bandwidth.



Physics package operation is supported by an exciter for the rubidium lamp and temperature controllers for the lamp and cell ovens. The error signal is processed by a servo-amplifier, which generates a voltage that controls the frequency of a crystal oscillator. This oscillator produces the output and also, via a synthesizer and multiplier chain, drives the physics package. The overall scheme is that of a frequency lock loop. The actual resonant frequency can be adjusted over a range of several parts per billion by means of an internal DC magnetic field. Rubidium is a small, low weight and low cost atomic standard that is quickly activated. It delivers good phase noise performance, exhibits low G force sensitivity and operates in a wide temperature range. These advantages make it an ideal alternative to quartz technology.

-Karl Reuning

Phase Noise	
1 Hz	-75 dBc
10 Hz	-89 dBc
100 Hz	-128 dBc
1000 Hz	-140 dBc
10 kHz	-147 dBc
Accuracy — +/- 5E-11 Aging — 5E-11 per month <1E-9 10 years	

Table 1

of the reliability of this reference due to fading or the odd GPS satellite going offline. No antenna or cabling needs to be installed and maintained, and with the typical cost under $4,000, it is less expensive than the cost of a GPS receiver.

Recently, WCVB-TV, an ABC affiliate located in Boston, purchsed two Symmetricom 8040 Rubidium standards. WCVB is located in one of the top 10 markets and thus was required to be on the air with a digital signal by May 1. Thanks in part to the direction of Ross Kaufman, director of engineering at WCVB, they met their goal of providing a DTV signal — well ahead of the FCC-mandated May 1, 1999 deadline.

Kauffman faced several challenges while gearing up for the new digital venue. Digital equipment for the broadcast industry was hard to obtain due to factors such as products being to new or under development. When available, the prices for this new technology put a strain on the budget. Additionally, interface formats between the multitude of new digital products created headaches of their own.

One issue Kauffman wanted to resolve was the stability of the broadcast signal. Boston is a relatively congested market, so in an effort to eliminate out-of-band emissions (co-channel interference), he selected the Symmetricom 8040 Rubidium standard for his Harris Sigma DTV exciter. The Symmetricom unit provided a highly accurate and stable 10 MHz reference from

	GPS	Rubidium
Initial cost drivers		
Hardware	$4,300	$3,500
Planning	$500	$125
Engineering	$1,700	$425
Installation	$3,500	$75
Training	$800	$75
Annual recurring costs		
Maintenence	$267	$67
Administration	$150	$38
Other	$150	$38
Total Initial Cost	$6,500	$700
Total Annual Cost	$567	$143
Total Savings		
Total initial cost savings	$5,800	
Total annual recurring cost saving	$424	
*Estimated cost based on data collected by Symmetricom.		

Table 2

his digital transmitter, while a second unit was purchased for a precise in-house sync generator reference.

The reason Kauffman decided not to use a GPS, he said, is that the system is subject to fading due to weather conditions and vegetation at or near the GPS antenna location. Every other technology he researched provided less accuracy than the Symmetricom 8040 Rubidium Standard or was not cost effective.

The Symmetricom 8040 was delivered to WCVB, and in essence, Kauffman plugged them in and walked away. He said that the 8040 is a highly practical solution for TV broadcasters faced with adjacent channel assignments as they transition to DTV.

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TECHNOLOGY TRANSMISSION

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