DB6SW (KF5OBS)
RF Electronics Engineering Blog

Search

Amateur Radio   Electronics   Other   Reviews   Uncategorized   YouTube

DSSS / BPSK Clock Recovery with the Abracon ABFT

Posted on November 5, 2012 by DB6SW | Leave a comment

Clock recovery in Spread Spectrum applications and BPSK modulated signals can be somewhat tricky. There are no commercial solutions available solely for this task either. Or are there? This article shows a great off-label use of the Abracon ABFT.

Clock recovery in a Direct Sequence Spread Spectrum (DSSS) receiver can be quite a challenge. Because the clock recovery is crucial, this part of the receiver naturally determines the overall performance of the receiver. The Abracon ABFT, which I reviewed in a previous article, might be just the right Commercial Off-The-Shelf (COTS) device to get this job done.

There are two common approaches to recover the clock of a Direct Sequence Spread Spectrum (DSSS) signal, or BPSK modulated signals in general, for that matter. The first one is called a squaring loop and the second one is called a Costas loop.
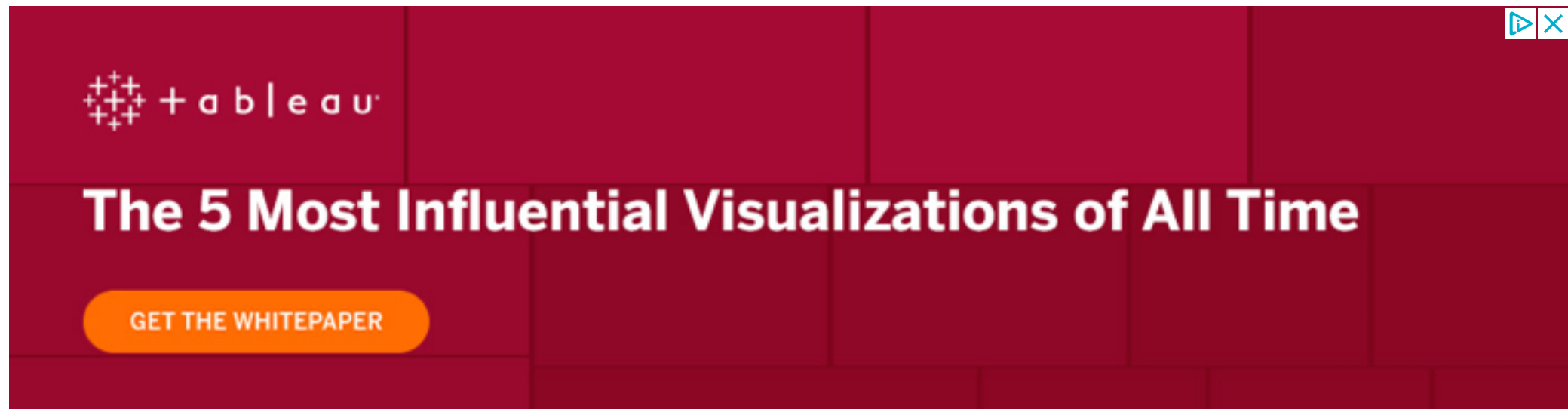
The first technique relies on the fact that because the BPSK modulation causes ±180° phase transitions, the squared signal will have phase transitions of ±360°. The squared signal has now twice the frequency of the original carrier. If this signal is then being divided by two, the output signal will be phase coherent with the original carrier. BPSK and DSBSC signal carriers can be recovered in this fashion.

While this approach is mathematically the simplest, the practical implementation faces some hardships in the actual circuit designs.

The Costas loop is a PLL-based approach using an I/Q demodulator and two individual loops to control a single VCO [1]. The design is rather complex and I am not going into any detail here.

While I was reviewing the Abracon ABFT frequency translator / jitter attenuator, I was immediately curious if this device could lock onto the carrier of a BPSK modulated direct sequence spread spectrum signal. Why did I think it would work?

My first thought was that BPSK modulation can in a way be thought of as jitter. Remember, jitter is the undesired deviation from true periodicity of an assumed periodic signal. If you take a close look at the following BPSK modulated signal in the time domain, you can see where I am getting this idea.
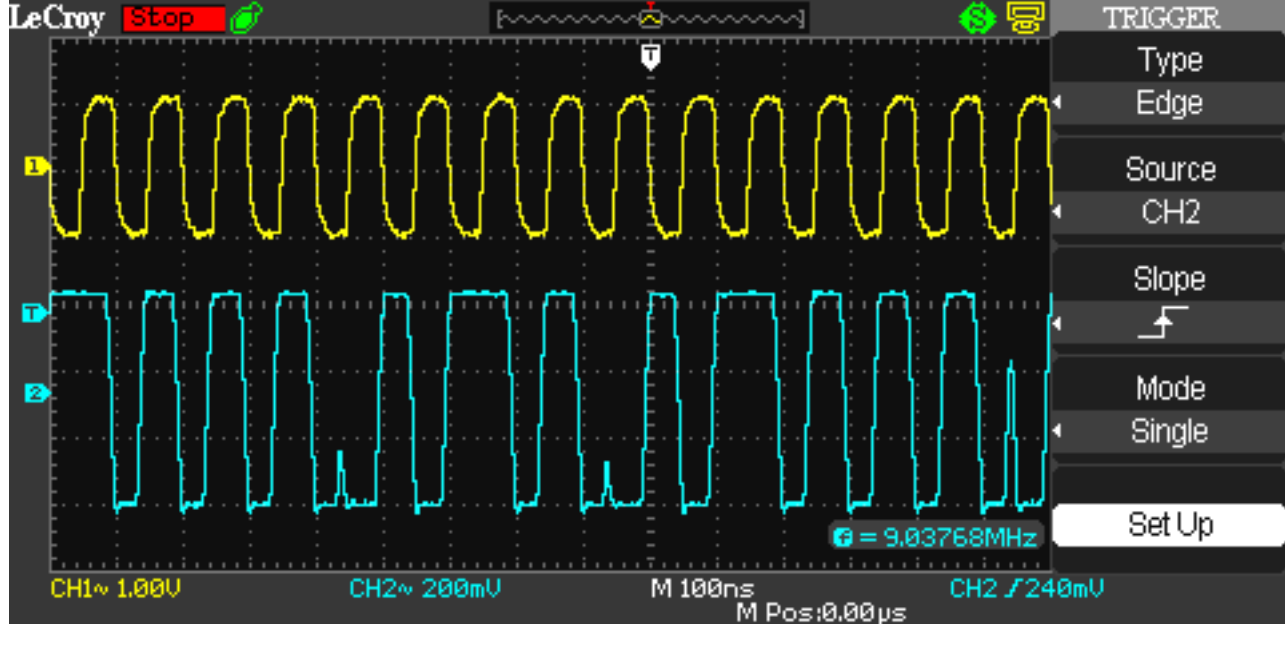
10 MHz carrier (top trace) and BPSK modulated signal (bottom trace)

My second thought revolved around the symmetry of a BPSK modulated signal. The power density of the BPSK modulated DSSS signal is the strongest around the original carrier frequency and declines from there off to the sides. The following picture shows that very well.
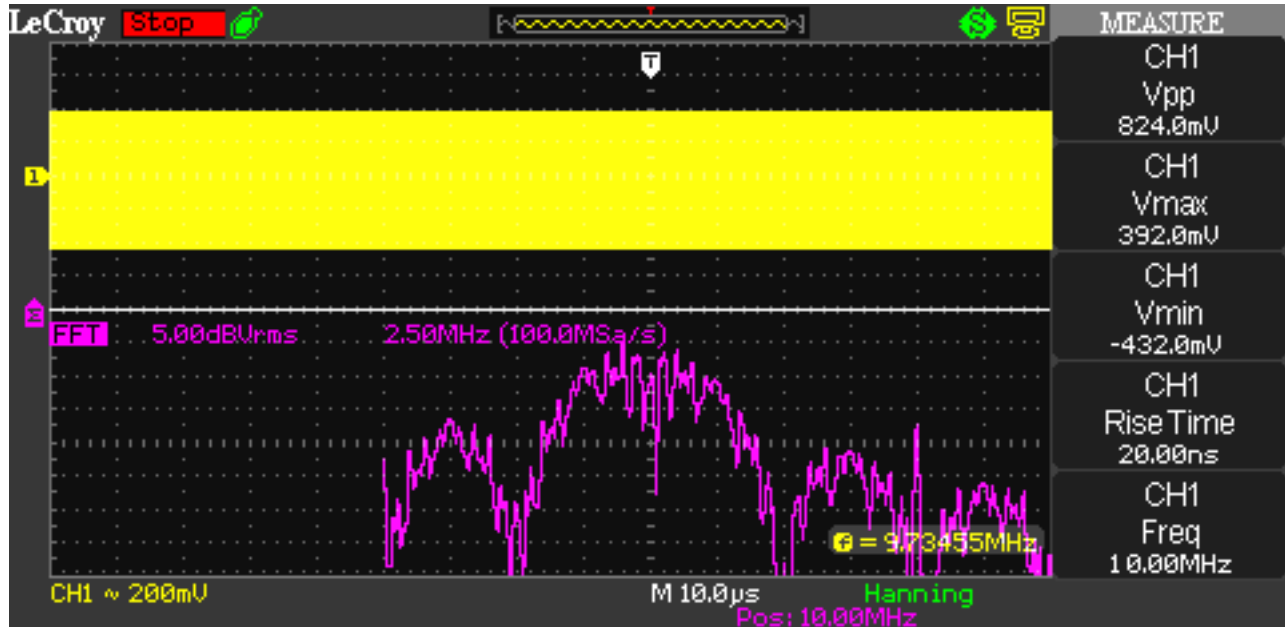
DSSS spectrum (Carrier: 10 MHz, PRBS Clock: 5 MHz)

So the key question is: does the Abracon ABFT lock onto the carrier of a BPSK modulated DSSS signal? Well, the only way to find out is to try it!

In this experiment, I am using the same 127-bit Pseudo Random Number Generator (PRNG) that I have used in my previous article in which I took a closer look at a DSSS signal and its properties.
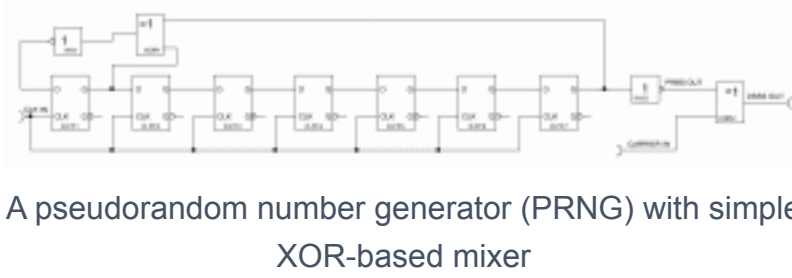
A pseudorandom number generator (PRNG) with simple XOR-based mixer

In my complete test setup I am using a LeCroy WaveStation 2052 waveform generator for the carrier, a Rigol DG1022 for the Pseudo Random Binary Stream (PRBS) clock rate, a TTi TF930 frequency counter and the LeCroy WaveStation 1022 for visualization. The two signal generators and the frequency counter are synchronized to a 10 MHz GPS-disciplined oscillator for highest accuracy and precision possible.

Here's a blog diagram of my setup:
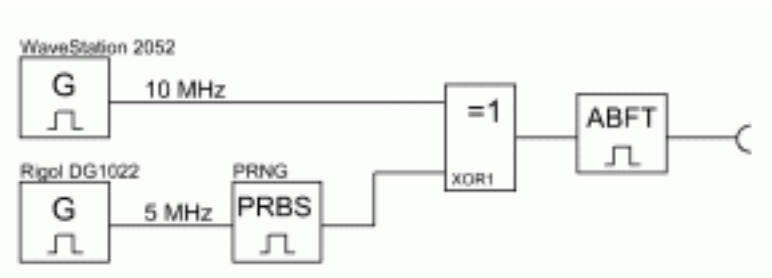
Block diagram of my test setup

The whole setup became a bit messy but ah well, it got the job done!
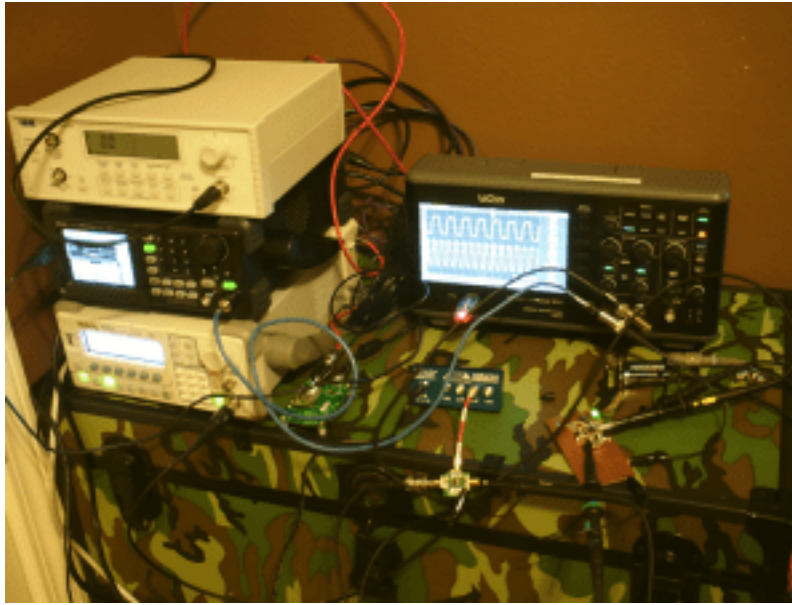
This is what the quick and dirty test setup looked like

Without anything connected to its input, the Abracon ABFT did put out a signal that is slightly below 20 MHz. Once I connected the DSSS signal, the ABF1 immediately locked up and started to put out a rock solid 20 MHz signal. That's right, not even 1 or .1 Hz off frequency! Now, how cool is that?
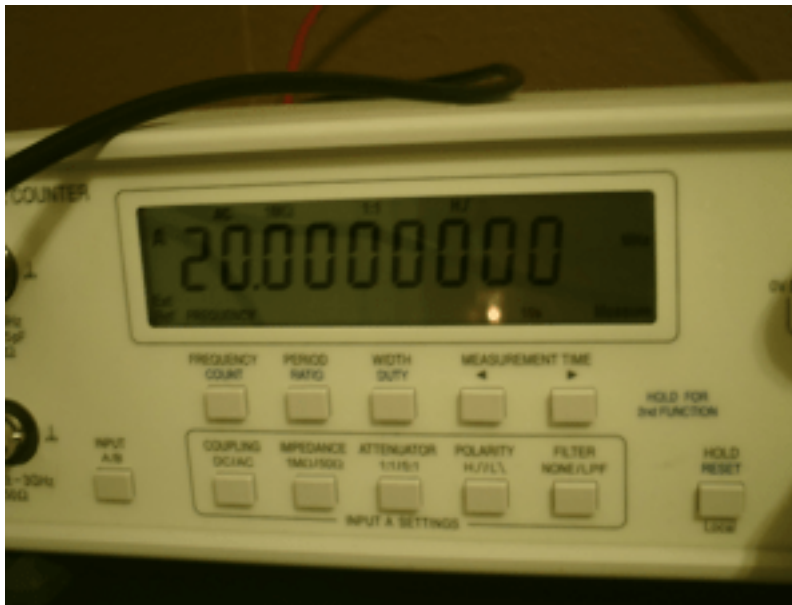
The TF930 says 20.0000000 MHz exactly

A closer look at the signal in the time domain proves that the output of the ABFT is twice the original carrier frequency, but otherwise phase coherent.
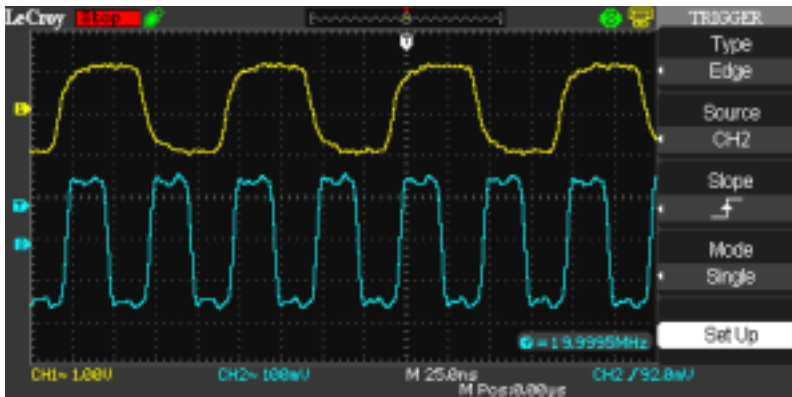
Original 10 MHz carrier (top trace) and recovered carrier from the ABFT's output (bottom trace)

There is a bit of a delay on the bottom trace, but this is expected simply due to the higher delay in the physically longer signal path.

This article proves that it is often worth to think outside the box. Abracon did not design this device for this purpose in any way. There are many parts and pieces out there which can be used for all kinds of things they were not originally designed for.

So where do we go next? Well, I would love to bring this 10 MHz BPSK / DSSS demodulator in the shape of a single PCB and experiment further with it in an actual over the air application. Additionally, I would love to take a look at how well the ABFT does with QPSK and other M-ary PSK modulation. I did ask Abracon to supply some of those modules for the purpose of using them experimental PCB designs. I am hopeful they will respond positively to the request. Stay tuned!

Links & Sources:

[1] Costas Loop Implementation with Hypersignal Block Diagram/RIDE, National Instruments http://www.ni.com/

Share this:

Share 0   Tweet   Share   Gem   Email   Print

Categories: Electronics, Radio Frequency (RF)
Tags: Abracon

Leave a Reply

Enter your comment here...

Sidebar

DE (Deutsch):

YouTube

KF5OBS
92 videoer
Abonner   999+

Recent Searches

1572837577
1572837525
1572823058
1572794880
1572867885

Recent Comments

KF5OBS on Fixing a microstrip line in a professional Microwave ODU
Ron Short on IC-706 MKII Extended Tx Modification
Olivier Schrevens on KF5OBS #37: Tektronix RSA306 Teardown
Paul on Fixing a microstrip line in a professional Microwave ODU
Pravin Pawale on L-Network impedance matching