

TEST EQUIPMENT PLUS

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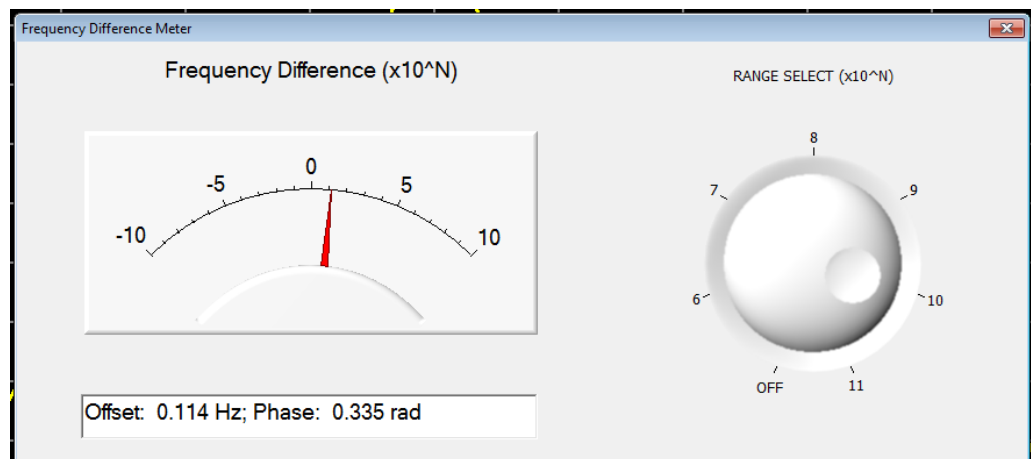
Signal Hound USB-SA44B / USB-TG44A

# Application Note 2: Frequency Difference Meter

## 1 Using the Frequency Difference Meter

### *Measuring Small Frequency Differences*

The Signal Hound USB-SA44B can be used with an external reference 10 MHz input to make relative frequency measurements. Parts in  $10^{-11}$  can be readily measured, and parts per trillion can be calculated. This is achieved by observing the relative phase change over time, and is displayed using the traditional analog meter needle.



### 1.1 Activating the Frequency Difference Utility

1. Connect the Signal Hound USB-SA44B to the PC using the included USB cable.
2. Launch the Signal Hound application software.
3. Connect an external reference 10 MHz to your USB-SA44B spectrum analyzer using a BNC cable.

4. From the Menu, select Settings→External Reference.
5. Enter a span of 10 KHz, and set your center frequency to the frequency of your oscillator to be tested. You may alternately use the oscillator to be tested as the input to an RF generator, and set the generator to 1 GHz.
6. Connect your oscillator to be tested to the Signal Hound's RF IN.
7. Adjust your reference level so that the signal level peak is within 1 division of the top reference level.
8. Launch the Frequency Difference Meter utility from the Utilities menu.
9. Select your desired range, where 6 is parts in  $10^{-6}$ , or parts per million, 9 is parts in  $10^{-9}$ , or parts per billion, and so on. The meter will begin updating automatically.

## 1.2 Taking Measurements

Please note that there is a small rounding error associated with the phase computations, and this error can accumulate over time. This limits the usefulness of the Signal Hound for making measurements below parts per trillion.

Starting at 6, increase the range setting until the needle deflection is between 1 and 10. You will see 8 updates per second as the phase data is processed. This is fast enough for a real-time oscillator adjustment. Once your oscillator is adjusted to "zero", switch to the next range to fine-tune the zero.

On the last 2 ranges, parts in  $10^{-10}$  or  $10^{-11}$ , the Signal Hound may enter a mode where the frequency offset is calculated from the phase change over time. In this mode, you will still see 8 updates per second, but there will be an FIR averaging filter of approximately 1/2 second applied, which causes a small lag between the change in frequency and the change in reading.

### 1.2.1 Measuring Very Small Frequency Differences

To measure a very small frequency difference (a fraction of a part per trillion), a different approach is required. You will need an RF synthesizer capable of producing a 1 GHz output from your oscillator's input.

Using the 1 GHz signal as your input, time how long it takes for the phase reading to make a complete cycle (0 to  $\pi$  then  $-\pi$  to 0). The frequency error is  $1000 / t(\text{sec})$  parts per trillion. The accuracy may be degraded from the phase rounding error described earlier.

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