Multi-Channel Phase Measurements with a PicoPak Module

W.J. Riley
Hamilton Technical Services
Beaufort, SC 29907 USA

• Introduction

It is possible to make scanned multi-channel phase measurements with a single PicoPak clock measurement module, and this can be an effective way of doing so in some applications. For example, the combination of a PicoPak module [1] and a PicoScan quad RF switch [2] can measure four 10 MHz sources. The resulting phase data will obviously have a longer sampling time but it does not suffer from dead time, and is particularly useful for measuring slow thermal effects and long-term drift and aging. With proper measurement system control software, it can be easier to set up and run than separate PicoPak modules, especially if the data are directed to a PicoPak database.

• System Block Diagram

A block diagram of a 4-channel scanned PicoPak clock measurement system is shown in Figure 1. The key elements are (a) a PicoPak Clock Measurement Module, (b) a PicoScan Quad RF Switch and (c) PicoScan clock measurement control software, preferably storing its data in a PicoPak PostgreSQL database from which the measurements can be monitored and the results accessed.

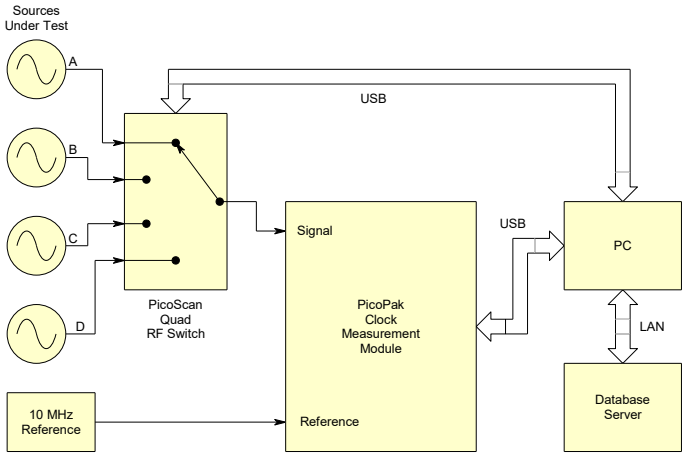

Figure 1. PicoScan System Block Diagram

• System Configuration

A PicoPak operating in the "absolute" phase mode (S=05) outputs a stream of four hex characters at a 1 Hz rate that represent the 14-bit value of its DDS phase offset word. That value will retrace (modulo 14 bits) after the RF signal input is interrupted, thereby allowing switching between different signal sources. The reference input must not be interrupted, and the signals must all be at the same frequency within several pp10^{9} so that the DDS frequency setting does not have to change (the frequency adjustment flag is cleared to off with O=00). In that case, phase continuity is preserved between scanned measurements as long as they are made often enough that there is no RF cycle ambiguity. For example, a frequency offset of 1×10^{-9} results in a phase change of 1 ns per second, so measurements made at 50 second intervals or shorter are satisfactory for a 10 MHz nominal source, and a four-channel system can devote up to about 12 seconds to each measurement. Phase data are available at a 1 Hz rate, and several seconds need to be allowed for channel switching and stabilization of the PicoPak phase tracking loop.

A 5-second per channel scanning rate therefore seems like a reasonable choice that provides "round" analysis tau values of 20s, 1m, 100s, 15m, 1000s, 1 h, etc. This approach is therefore applicable for measuring (say) four 10 MHz ±2 ppb sources at sampling times of 20s and longer with a fractional frequency resolution of about 8×10^{-13} at 20s that improves as tau.

Each scanner relay is cycled 3 times/minute or 4320 times/day. The relays are rated for 50 million cycles, which corresponds to over 30 years of continuous operation.

- **PicoScan Software**

The PicoScan Windows® program supports the operation of a PicoScan 4-channel clock measurement system. Its main function is to capture and store PicoPak phase data while scanning up to four source channels with a PicoScan RF switch.

- **References**

1. W.J. Riley, The PicoPak Clock Measuring Module, Hamilton Technical Services, February 2016.
2. W.J. Riley, The PicoScan Quad RF Switch Module, Hamilton Technical Services, February 2016.

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W.J. Riley
Hamilton Technical Services
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