Clamp on water meter for PVC pipes

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ABSTRACT

In this document we describe non-intrusive clamp on ultrasonic metering solutions for PVC pipes.

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1 Setup

EVM430-FR6047 is used with a pair of Jiakang 1MHz transducers. These transducers use a 50 degree angle intended for use with clamp on meters. A 3d printed fixture is used to attach and clamp the transducers to the PVC pipe. All tests are performed with ¾" PVC pipe.

Different transducer configurations are possible to obtain ultrasonic time of flight measurements. The testing discussed in this document uses a direct face to face configuration as shown in the figure below. This is the first configuration shown below.

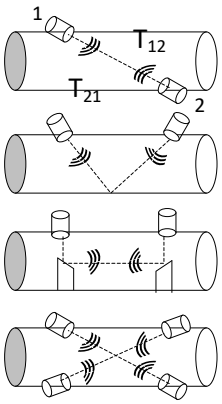

Figure 1: Different possible configurations for ultrasonic TOF based measurement.

Figure 2: Jiakang 1MHz Transducer

1.1 Transducer placement and couplant

In order to obtain proper signal levels, the transducers must be aligned and couplant such as ultrasound gel or industrial grease must be placed between the transducers and pipe. For zero flow tests, the pipe must be filled with water with a little space for air as possible.

The transducers are aligned using the 3d printed fixture shown below. The fixture is 2 separate pieces clamped together with metal hose clamps.

Figure 3: 3D Printed fixture attached the PVC pipe

In testing, it was found that typical ultrasound gel will dry out quickly and industrial grease provides similar performance without drying out. Magnalube-G(https://www.magnalube.com/) is readily available and was used for the purpose of these tests.

1.2 EVM430-FR6047 Configuration

EVM430-FR6047 is used in the standard water meter configuration with transducers connected to J8. The Design Center GUI is utilized to configure the MSP430FR6047 and capture data.

Design Center configuration used for testing can be seen in the figures below. It should be noted that only the internal PGA(programmable gain amplifier) was used with no external amplification required. A good signal level was acquired with 22.8dB gain. The internal PGA of the MSP430FR6047 allows for up to 30.8dB.

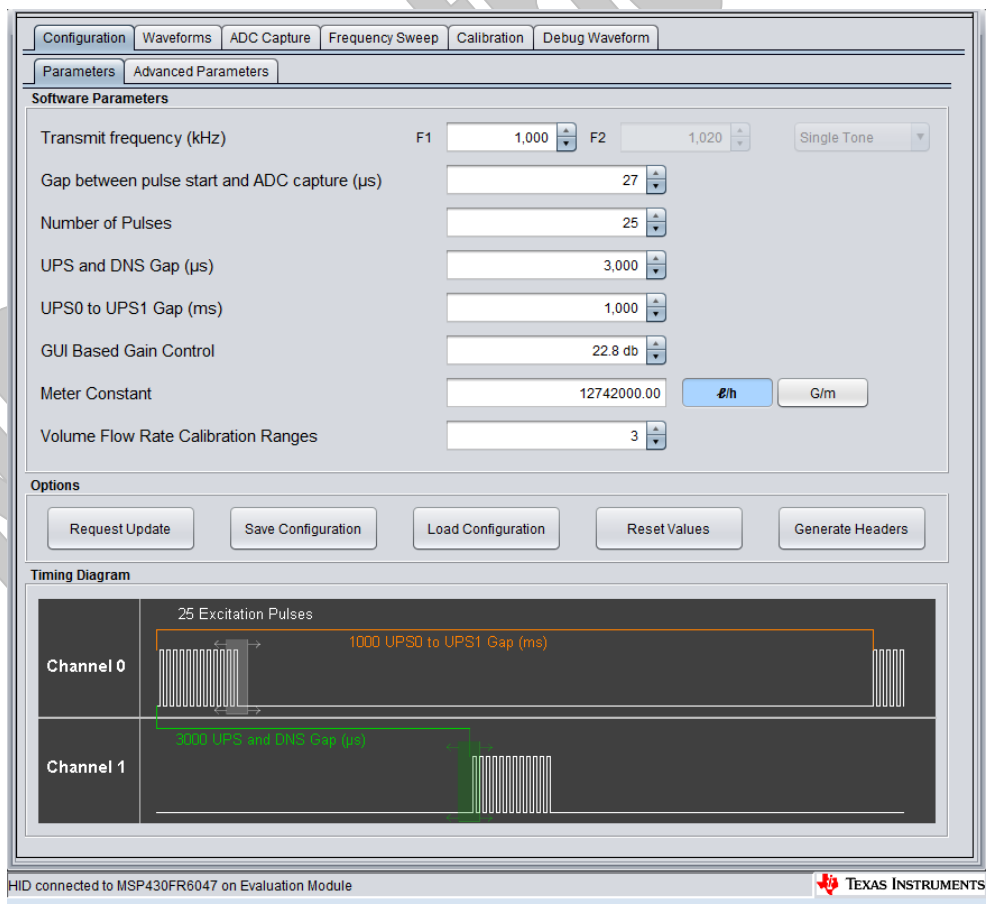

Figure 4: Design Center Configuration

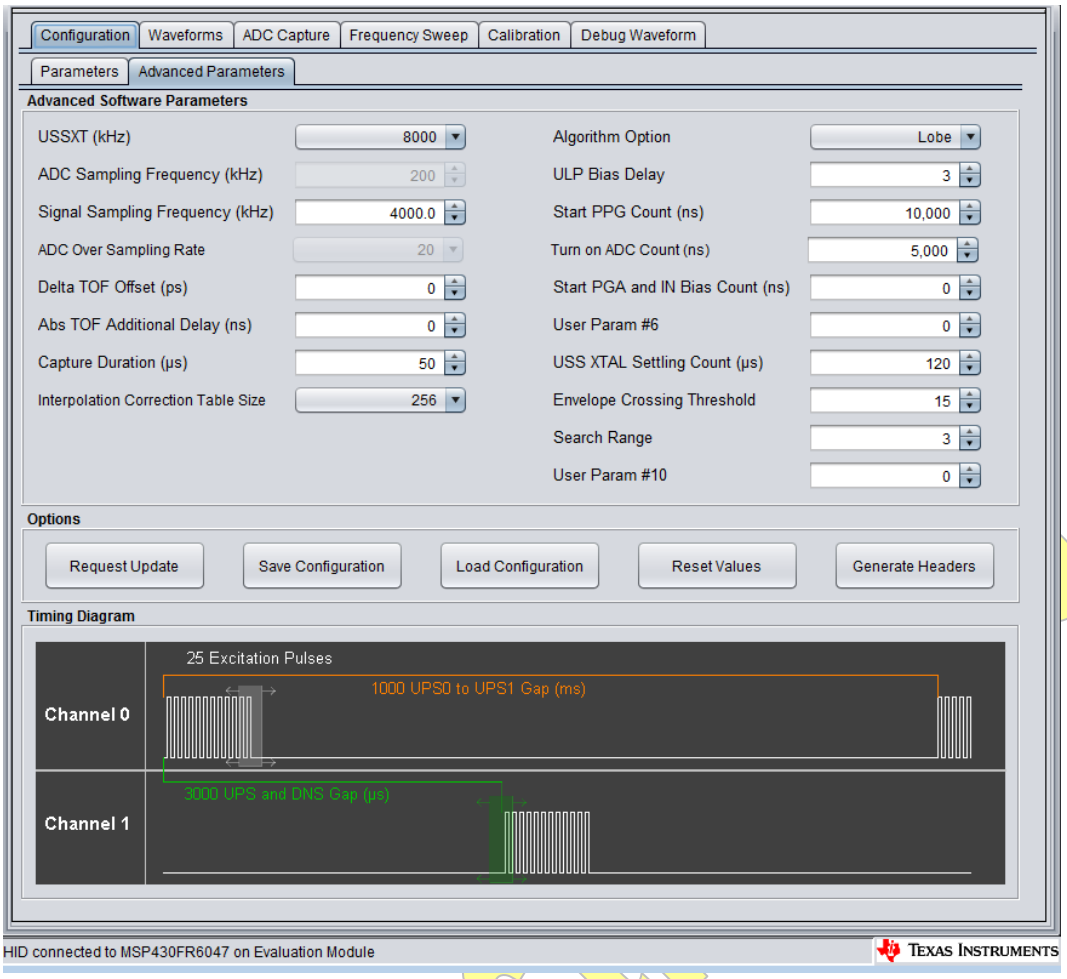

Figure 5: Design Center Configuration(continued)

2 Test Results

Test results below show the Captured ADC waveform at zero flow and measured flow rate. These tests were performed at room temperature.

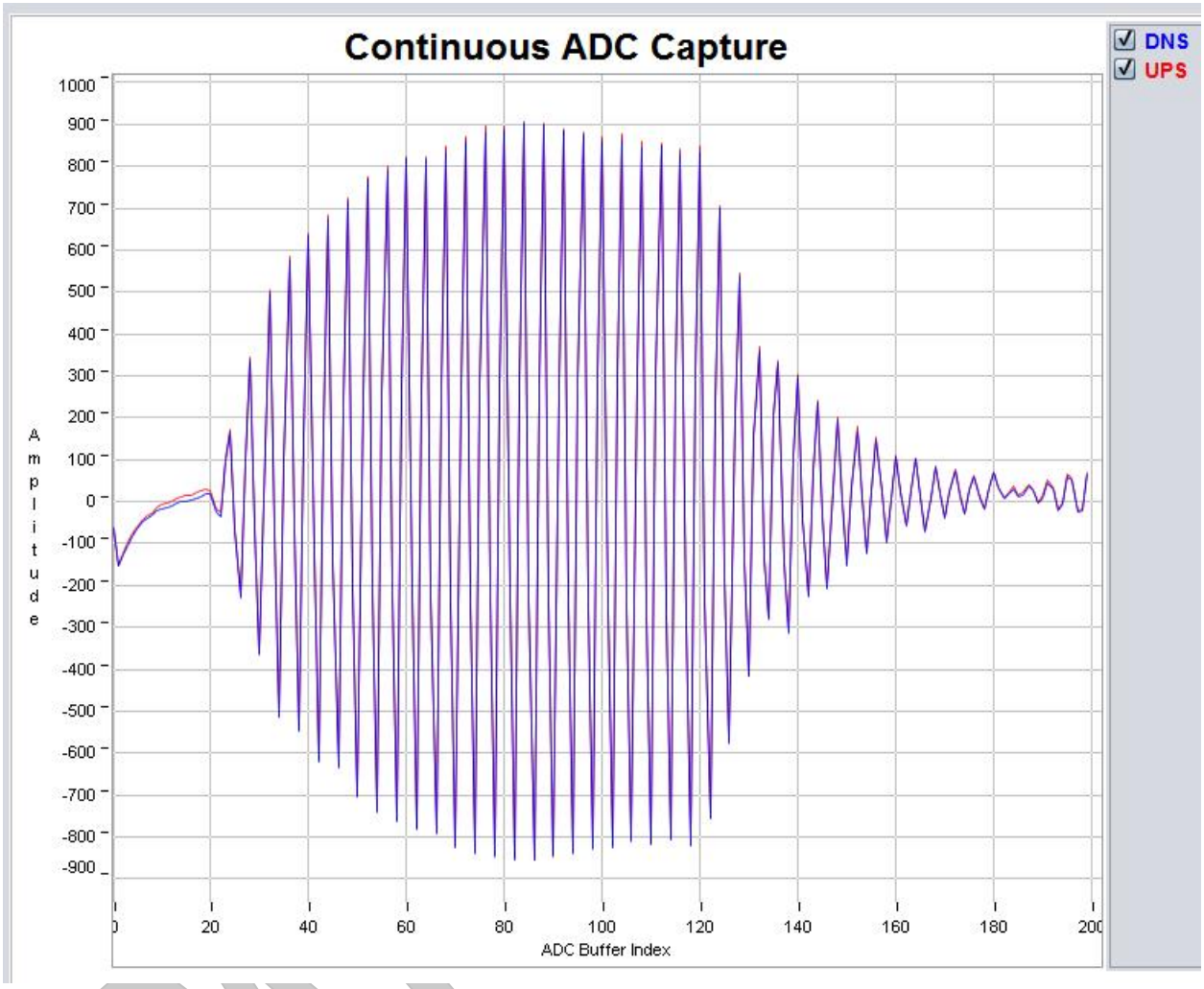

Figure 6: ADC Capture

Flow measurements were acquired by clamping the transducers to the PVC of our existing flow meter test setup which includes a reference meter in series and pump to vary the flow rate. The figure below shows a linear relationship between the reference flow rate and MSP430FR6047 measured flow rate.

Figure 7: Flow meter test setup

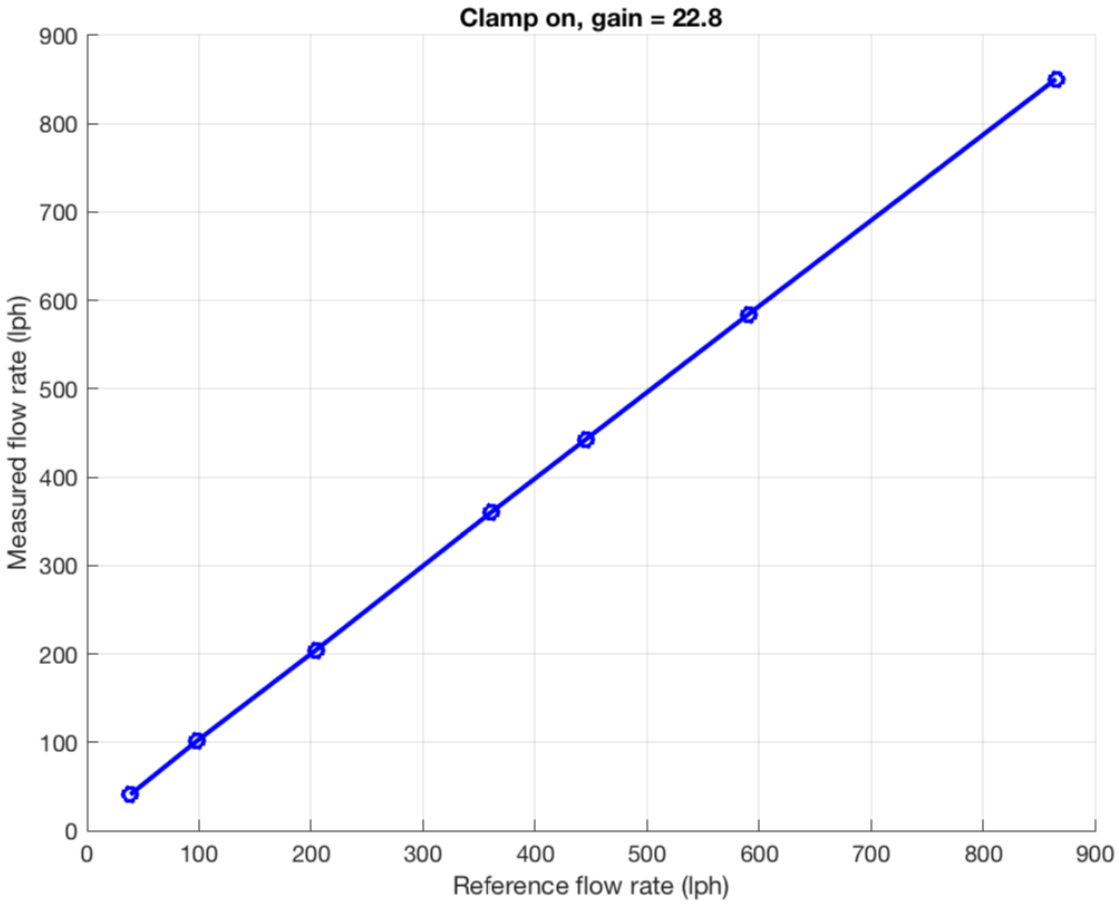

Figure 8: Flow Measurement Results

3 Revision Information

This is version 0.0 of the document, last updated on June 21, 2019.

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