Application Report

Clamp On Water Meter for PVC Pipes

Eddie LaCost and Leo Estevez *MSP430 System Applications*

ABSTRACT

This document describes nonintrusive clamp on ultrasonic metering solutions for PVC pipes. The solutions described here use the MSP430FR6047 Ultrasonic Sensing Evaluation Module.

Table of Contents

List of Figures

Trademarks

1 Introduction

In this example, the MSP430FR6047 Ultrasonic Sensing Evaluation Module (EVM430-FR6047) is used with a pair of Jiakang 1-MHz transducers. These transducers use a 50° 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 0.75-inch PVC pipe.

Different transducer configurations can be used to obtain ultrasonic time-of-flight measurements. The testing described in this document uses a direct face-to-face configuration as shown in the first option in Figure 1-1.

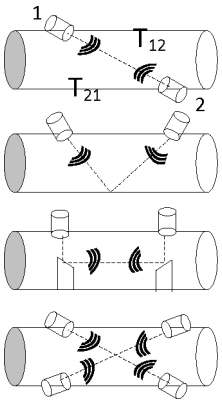

Figure 1-1. Different Possible Configurations for Ultrasonic TOF-Based Measurement

Figure 1-2. Jiakang 1-MHz Transducer

1.1 Transducer Placement and Couplant

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 as little space for air as possible.

The transducers are aligned using the 3D printed fixture in Figure 1-3. The fixture is two separate pieces clamped together with metal hose clamps.

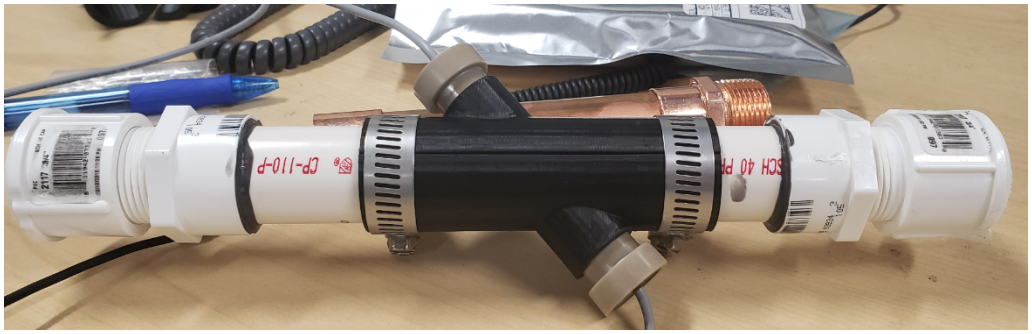

Figure 1-3. 3D Printed Fixture Attached the PVC Pipe

Testing showed that typical ultrasound gel dries out quickly, and industrial grease provides similar performance without drying out. Magnalube-G (https://www.magnalube.com/) is readily available and was used for these tests.

1.2 EVM430-FR6047 Configuration

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

The following figures show the Design Center configuration that was used for testing. Only the internal PGA (programmable gain amplifier) was used with no external amplification required. A good signal level was acquired with 22.8-dB gain. The internal PGA of the MSP430FR6047 allows for up to 30.8 dB.

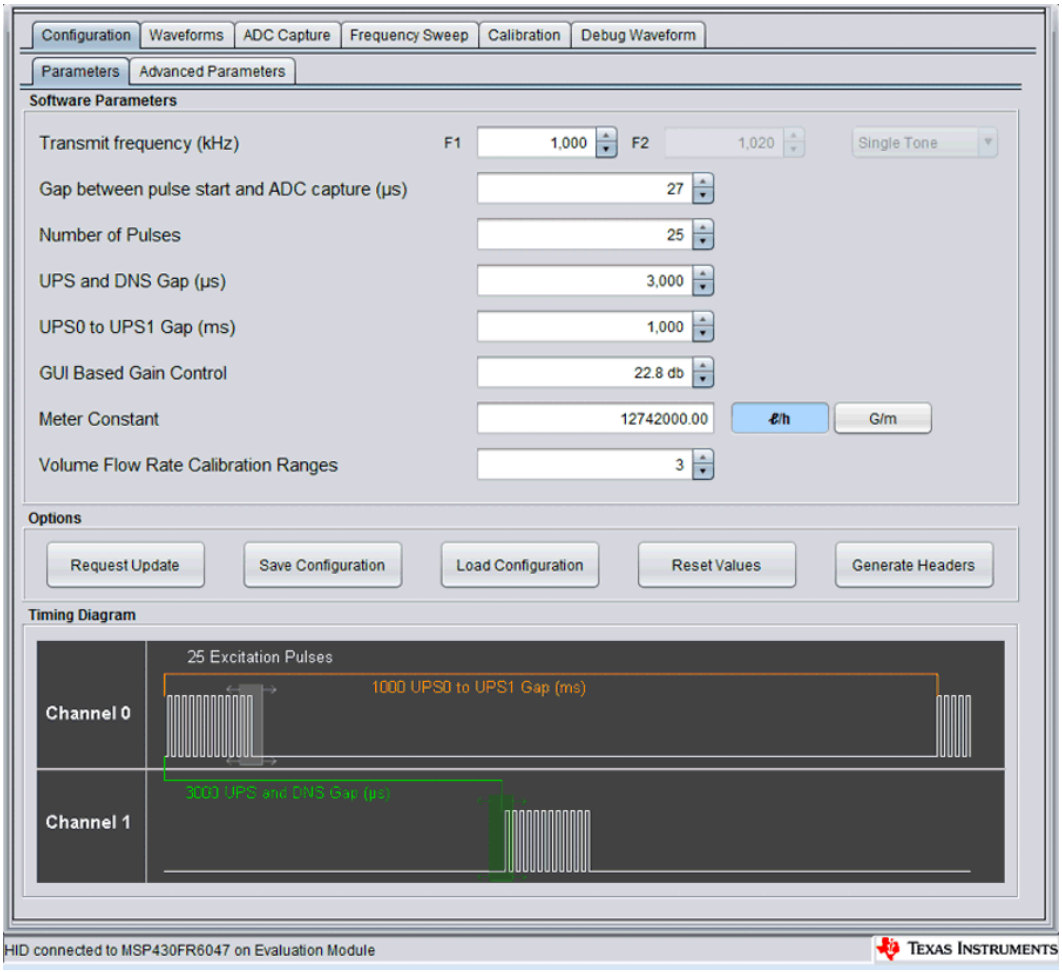

Figure 1-4. Design Center Configuration

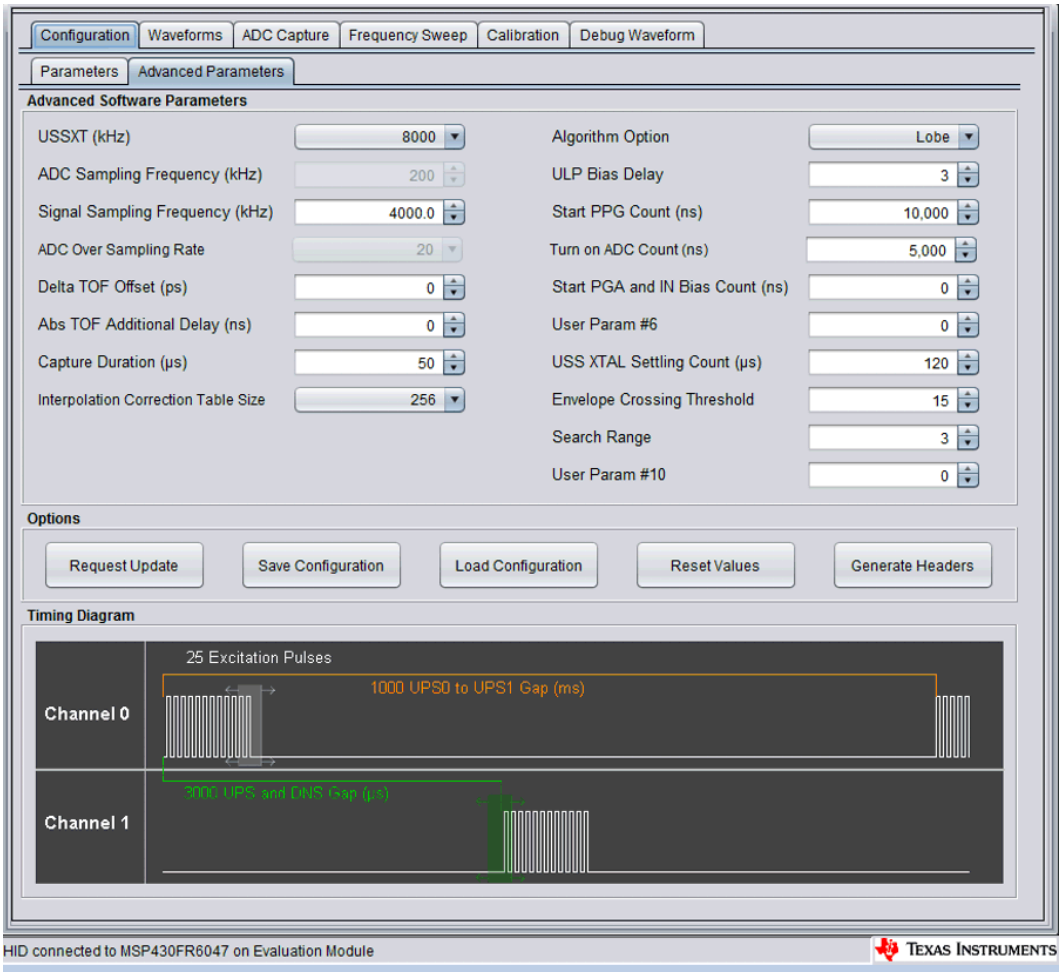

Figure 1-5. Design Center Configuration (continued)

2 Test Results

Figure 2-1 shows the captured ADC waveform at zero-flow and measured-flow rates. These tests were performed at room temperature.

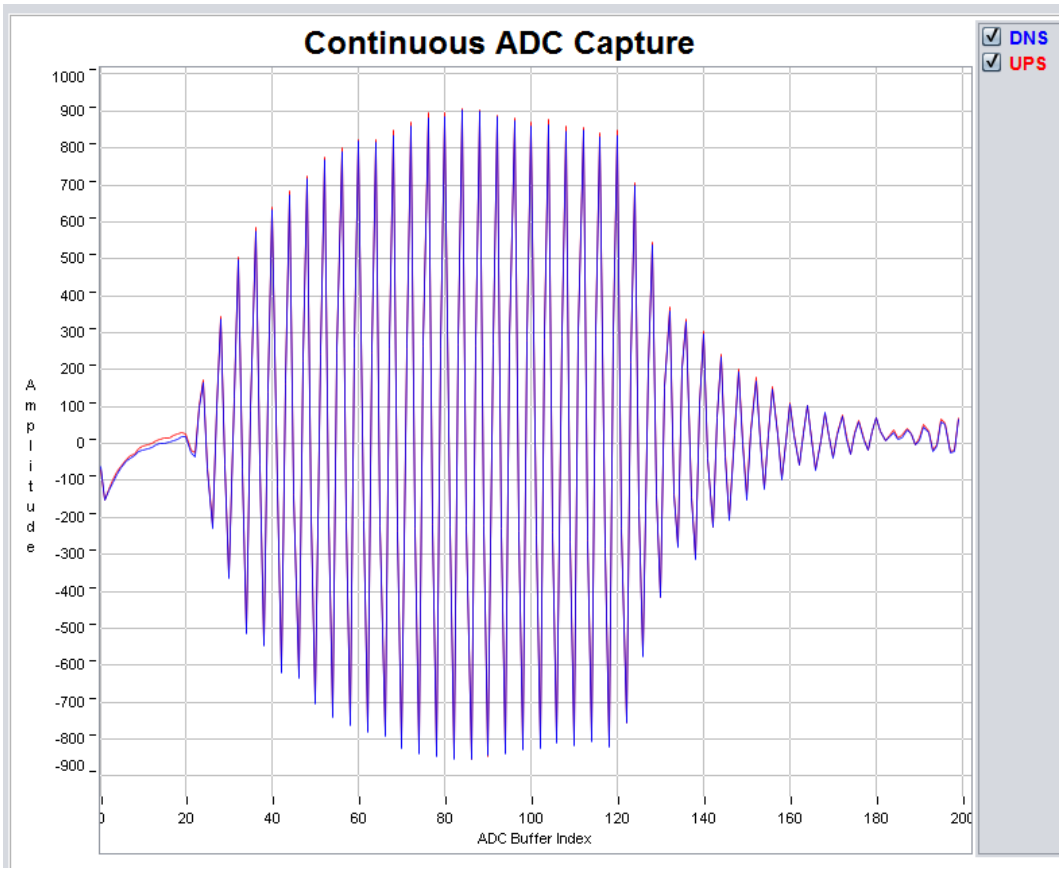

Figure 2-1. ADC Capture

Flow measurements were acquired by clamping the transducers to the PVC of an existing flow meter test setup (see Figure 2-2), which includes a reference meter in series and a pump to vary the flow rate.

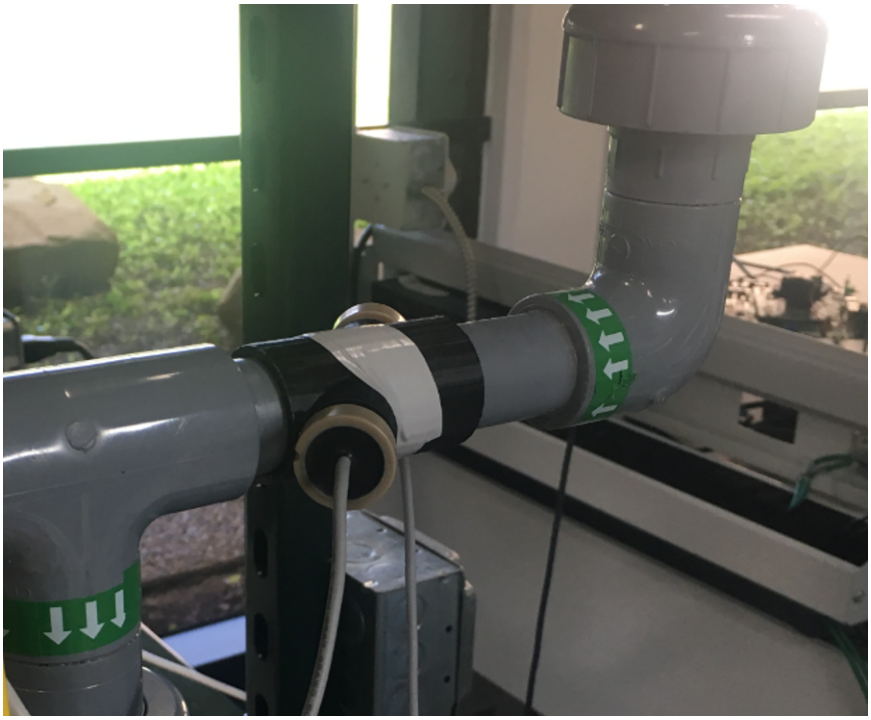

Figure 2-2. Flow Meter Test Setup

Figure 2-3 shows a linear relationship between the reference flow rate and MSP430FR6047 measured flow rate.

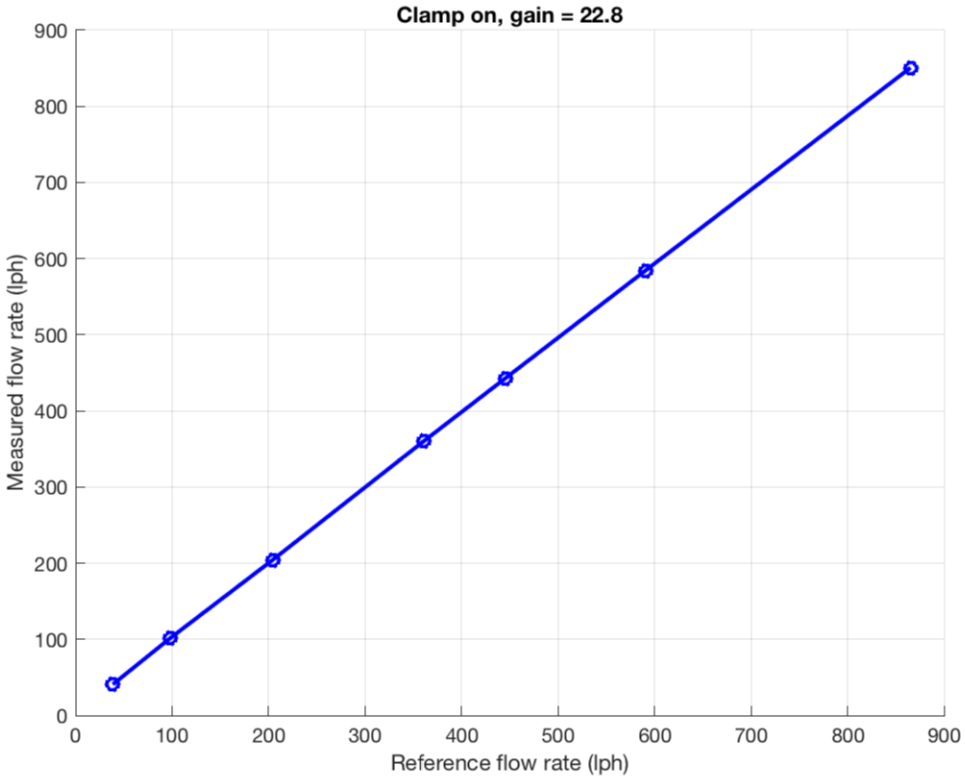

Figure 2-3. Flow Measurement Results

IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATA SHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES “AS IS” AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, regulatory or other requirements.

These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you will fully indemnify TI and its representatives against, any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI’s products are provided subject to TI’s Terms of Sale or other applicable terms available either on ti.com or provided in conjunction with such TI products. TI’s provision of these resources does not expand or otherwise alter TI’s applicable warranties or warranty disclaimers for TI products.

TI objects to and rejects any additional or different terms you may have proposed.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265