液体流量计

本入门指南介绍了包含MSP430FR6047超声水表评估版，并告诉您如何快速开始使用MSP430FR6047设备用于液体流量计量方案。本指南中的信息同样也适用于使用MSP430FR6043芯片做液体流量计量。 有关EVM430-FR6043在液体计量使用中的更多信息，请参见Optimized ultrasonic sensing metrology reference design for water flow measurement.

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商标

Code Composer Studio is a trademark of Texas Instruments.
IAR Embedded Workbench is a registered trademark of IAR Systems.

1 简介

感谢您申请了MSP430FR6047开发板套装。 本入门指南将包含对套装中内容的概述，并介绍了如何快速使用MSP430FR6047实现液体流量检测方案。

1.1 套装内容

套装中的内容包括：

a. 包含MSP430FR6047及一对换能器接口的2.0硬件版本的超声波模块评估版: http://www.ti.com/tool/EVM430-FR6047
b. 用于调节可配置参数并查看包括飞行时间差（dToF），绝对飞行时间（aToF），测得的流量和ADC波形的上位机GUI： http://software-dl.ti.com/msp430/msp430_public_sw/mcu/msp430/USSSWLib/USSSWLibWater/latest/index_FDS.html
c. 一个可用Code Composer Studio™ IDE (CCS) 或 IAR Embedded Workbench®® IDE进行编译的示例工程。这个工程使用TI的超声波计量方案算法库并可与上位机进行通讯。 http://software-dl.ti.com/msp430/msp430_public_sw/mcu/msp430/USSSWLib/USSSWLibWater/latest/index_FDS.html
d. 超声波算法库及其开放的API的说明文档: http://software-dl.ti.com/msp430/msp430_public_sw/mcu/msp430/USSSWLib/USSSWLibWater/latest/index_FDS.html

1.2 套装不包含的

本文测试中使用的奥迪威换能器及配套的黄铜管。 这套换能器套装可以在奥迪威官网获得。

1.3 系统要求

电脑系统需要安装最新的Java和Uniflash standalone flash tool. 如果没有安装好这两个软件，可以分别在 https://java.com/en/download/ 和 http://www.ti.com/tool/UNIFLASH进行下载。

2 连接EVM评估版和水表换能器

这部分内容是介绍硬件连接。需要获取更多详细信息，请看EVM430-FR6047 Hardware Guide.

1. 将EVM430-FR6047评估版与水表管段相连（见图1）。

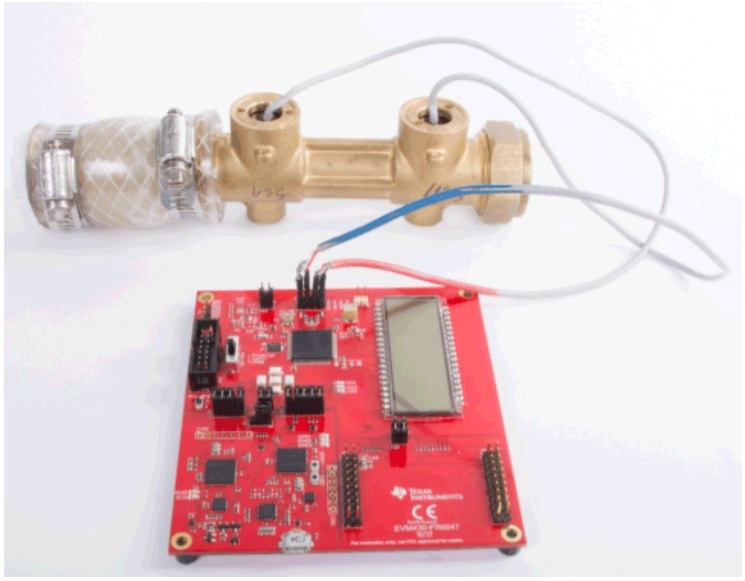


图 **1.** 水表管段与**EVM430-FR6047**连接

2. 将跳线帽配置为图2所示。与上位机通讯需要连接插排J5上的COMM_IRQ, COMM_SDA和COMM_SCL。对评估版进行烧写程序需要连接插排J2上的TEST和RST。电源选择开关应该选在中间位置（即ezFET供电）。插排J1的跳线帽应在右侧， 并且插排J3是用来连接使用USB电源。这些跳线帽的连接位置在图2中已标记为高亮。

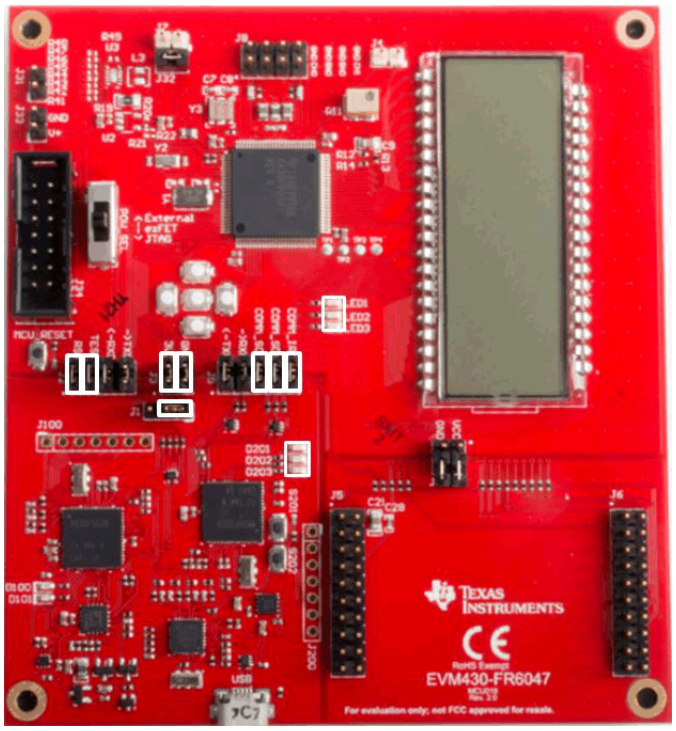


图 **2. EVM430-FR6047**跳线帽配置

3. 确保管段中有充足的水

4. 从PC端连一根USB线到EVM上然后检查EVM板上的LED D201（供电正常）是否常亮，LED D202（HID）是否闪烁。

   注意：如果LED3被点亮，则表明当前系统存在错误。 请到GUI中的错误提示栏查看错误代码。 如果错误代码是“未在上下行通道中检测到信号”，请参阅第4.3节确保获得正确的信号

5. 6. 更多的硬件配置信息请参考*Ultrasonic Sensing Metrology Subsystem Reference Design for Water Flow Measurement* design guide，及相关视频介绍Getting Started with the MSP430FR6047 Ultrasonic sensing EVM.

3 给EVM板烧录程序和安装上位机

在连接好EVM板与电脑之后，给EVM板烧录最新版的水表应用程序。你可以使用Uniflash tool工具去给EVM烧录程序。

1. 在电脑上安装 Uniflash tool工具
2. 安装最新的水表应用软件，你可以在这里进行下载 http://software-dl.ti.com/msp430/msp430_public_sw/mcu/msp430/USSSWLib/USSSWLibWater/latest/index_FDS.html
3. 打开Uniflash工具并选择MSP430FR6047芯片

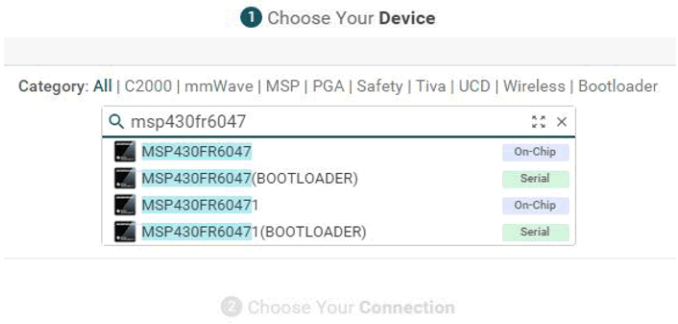


图 **3.** 选择**MSP430FR6047**芯片

4. 选择连接方式
5. 选择加载被下载的文件，默认路径在 C:\ti\msp\UltrasonicWaterFR604x_revision_number\image
6. 点击加载按钮

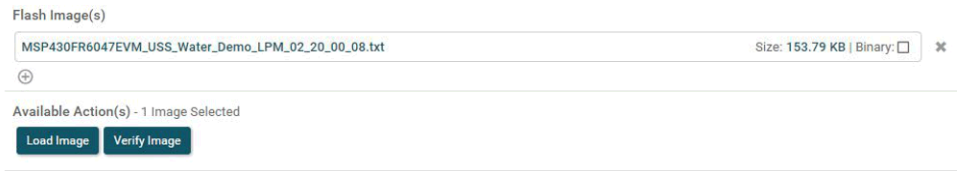


图 **4.** 加载文件

7. 安装USS上位机，可以在这里进行下载 http://software-dl.ti.com/msp430/msp430_public_sw/mcu/msp430/USSSWLib/USSSWLibWater/latest/index_FDS.html

   Windows开始菜单中的Texas Instruments文件夹中安装了名为USS的执行文件，点击启动USS上位机。

4 USS上位机

4.1 连接USS上位机

在安装好上位机并给EVM板烧录了最新程序后，运行USS上位机。点击”Communications”菜单中的”Connect”完成连接。上位机会汇报连接结果，如图5中所示。

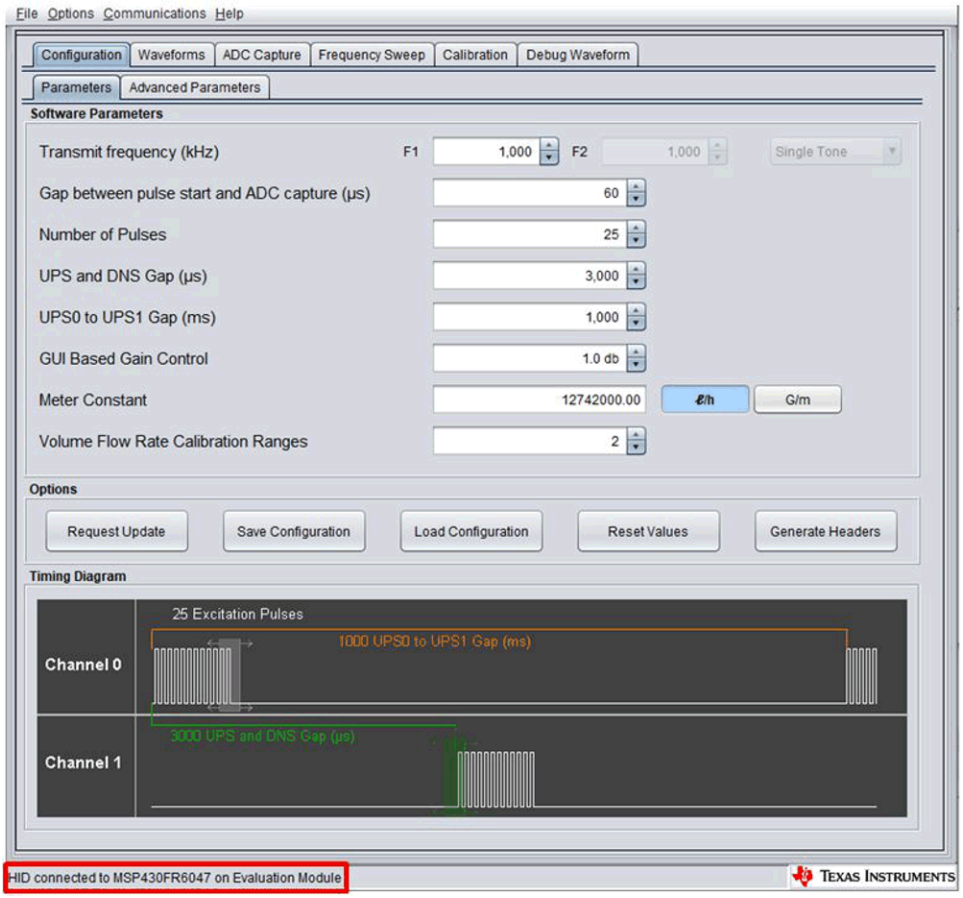


图 **5.** 评估版连接到上位机

4.2 参数配置

4.2.1 基本参数配置

图6所示为主要的配置参数。

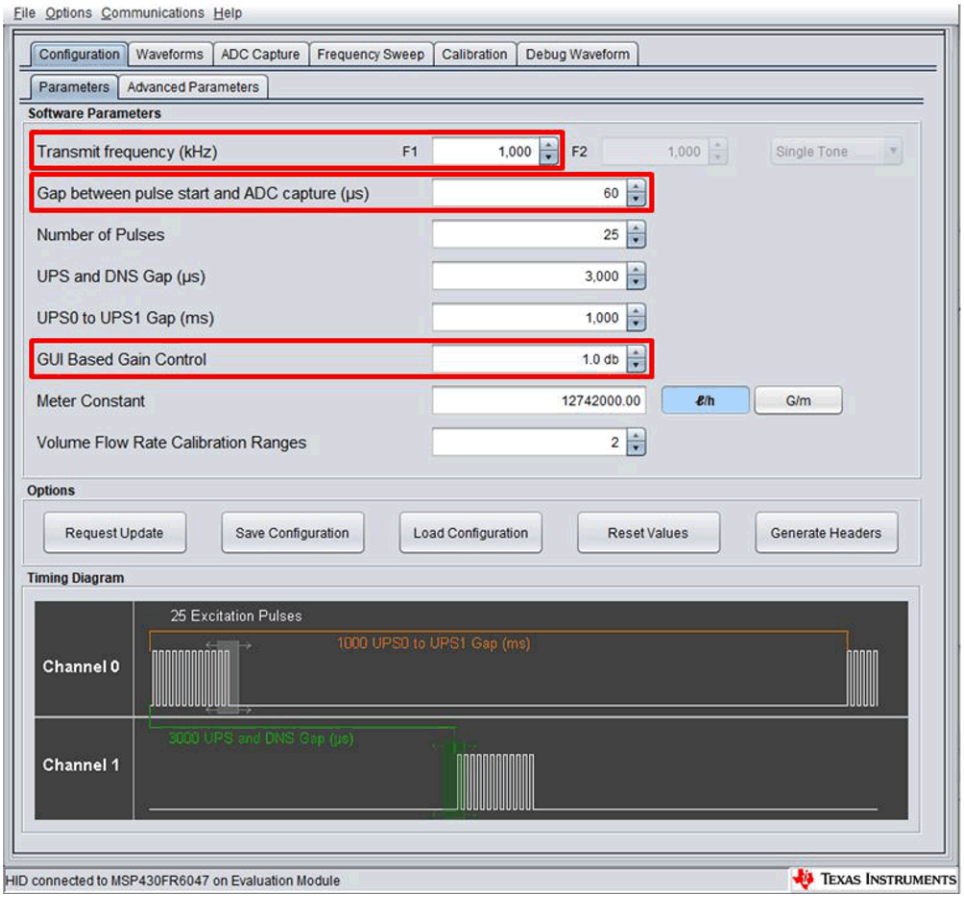


图 **6.** 参数设置栏

F1，Gap和Gain参数是需要在最开始就进行调整的参数。对于1-MHz换能器，其他参数应先使用默认值。这三个参数控制换能器的激励频率，ADC开启时间及PGA的增益大小。

先将激励频率"Transmit Frequency"设置为换能器的标称频率，单位为kHz（例如，使用1MH在换能器及将激励频率设置为1000）。在对换能器进行扫频后（详见章节4.5），可以根据扫频结果调整激励频率。在其他的参数配置好后，可以通过调整激励频率得到一个更好的信号（详见章节4.3）。

根据预期的超声波飞行时间，设置脉冲开始和ADC工作的时间间隙"Gap between pulse start and ADC capture"。注意需要留一些余量，以应对由于温度变化引起的飞行时间偏移。

增益控制参数"GUI Based Gain Control"用来设置内部集成的PGA增益。通过ADC capture栏观察采样到的波形信号，调节该增益使信号幅值散布在在±900的ADC数值内。虽然TI的方案可以处理低至±150 ADC数值的信号，但是适当的设置增益可以得到更好的数据标准差结果。

以一个DN25的管道为例，其对应的超声波飞行时间大约为65us。这是基于超声波传输路径即两个换能器之间的距离大约为9.5cm和在水中的声速（1450m/s）得到的。考虑到由温度变化导致的声速变化影响，可以设置采样间隔设置为60us。同时考虑到温度及流速的影响，超声波传输路径的长度决定需要预留的采样间隔的长短。例如，一个拥有19cm的超声波传输路径的基表，可能需要额外增加10us的预留时间。

脉冲数量"Number of Pulses"影响激励信号强度和零流量下dTOF的标准差。通常，越多数量的脉冲会产生一个越低的dTOF标准差。但是越多的脉冲会带来功耗及信号干扰的问题，需要自行权衡利弊。随着脉冲数量的增加，在一些特殊的流道设计中，过多的激励信号会干扰到随后发射的反方向激励信号。您可以先从默认值着手调试。

上下行时间间隔"UPS and DNS gap"是指上下行两路超声波发送激励的时间间隔。两路激励之间所需的时间间隔由超声波飞行时间决定。 较大的管道需要更长的间隔。 在UPS和DNS两路激励之间还需要预留足够的时间，以确保DNS信号不会受到UPS信号的残留反射干扰。您可以先从默认值着手调试。

两次上行时间间隔"UPS0 to UPS1 Gap"是指一组测量的结束到下一组测量的开始之间的时间间隔。测量频率直接决定功耗。 1秒一组测量的功耗大约是是2秒一组功耗的两倍。您可以先从默认值着手调试。

仪表常数"Meter Constant"是用来计算得到瞬时流量的一个系数。有关确定仪表常数的校准过程的更多的详细信息，请参考"Calibration User's Guide"。您可以先从默认值着手调试。

在设置了所有所需设置的参数后，您可以点击"Request Update"按钮向芯片更新这些参数。保存参数"Save Configuration"按钮会将当前参数保存到一个文件中。加载参数"Load Configuration"会将之前保存的一组参数文件加载到上位机中。配置的时序图显示在上位机GUI界面的底部，如图7所示。该时序图仅体现时序逻辑，并不精确。

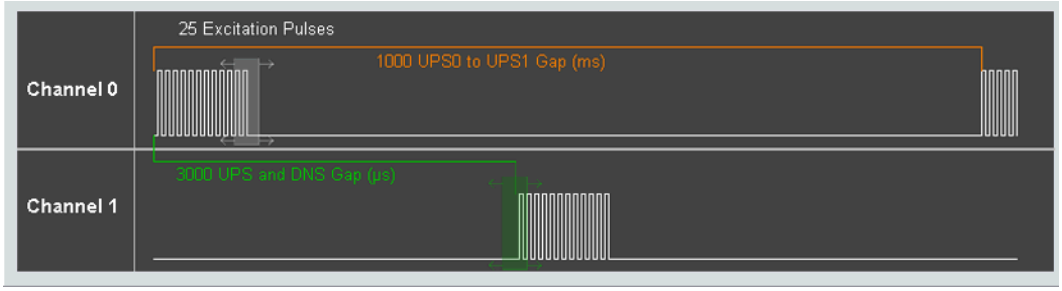


图 **7.** 配置时序图

4.2.2 高级参数配置

高级参数栏”Advanced Parameters”提供了更多的高级参数供配置，如图8所示。

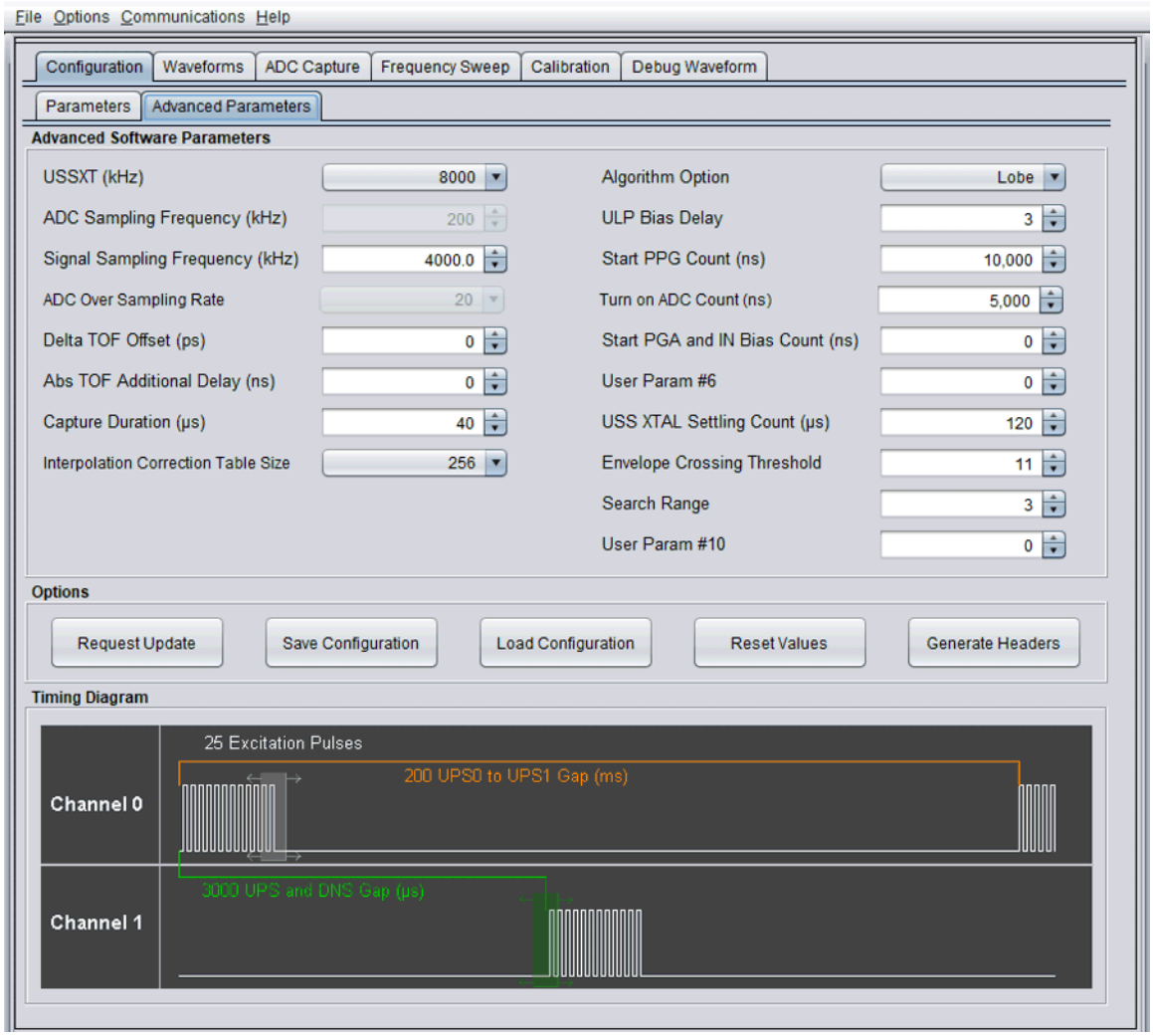


图 **8.** 高级参数配置栏

对于1MHz换能器，将信号采样频率”Signal Sampling Frequency”设置为3.6 MHz，对于2MHz换能器，则设置为8 MHz。 其他选项（包括3.4、3.8和4 MHz）也可以用于1-MHz传感器。

dTOF偏置”Delta ToF Offset”是在使用USS library算法库计量瞬时流量时用来调整时间差的。开发人员可以根据算法库提供的ToF结果对瞬时流速和体积自行计算。更多详细信息，请参考”Calibration User’s Guide”。AbsTOF偏置” Abs ToF Additional Delay”是用来调整绝对飞行时间的。该值取决于信号的形状和包络阈值。开发人员可以选择将此值设置为零，并在应用程序层中自行调整绝对ToF结果。

ADC采样时长”Capture Duration”，通常由脉冲数量决定。较多数量的脉冲需要较长的采样时长，较少数量的脉冲使用较短的采样时长。只需保证信号被完整的采集下来即可。注意，需要预留足够的采样时长以应对温度变化带来的影响。

插值表大小”Interpolation Correction Table Size”决定了在计算abs TOF算法中使用的插值算法点数。更大的插值表可以得到更高的计算精度。更多详细信息，请参考”Calibration User’s Guide”。

算法选项"Algorithm Option"决定了在USS library中使用了哪种算法。目前，水表应用中智能使用Lobe算法。关于此算法的更多信息请参考*Ultrasonic Sensing Metrology Subsystem Reference Design for Water Flow Measurement* design guide.

包络阈值设置"Envelope Crossing Threshold" 决定abs TOF算法将会锁定到哪个波峰。通过设置此阈值将算法锁定到高于噪音的第一个波峰。例如图9所示，可将该包络阈值设置为22%。关于此阈值设定的更多信息请参考 Optimized ultrasonic sensing metrology reference design for water flow measurement.

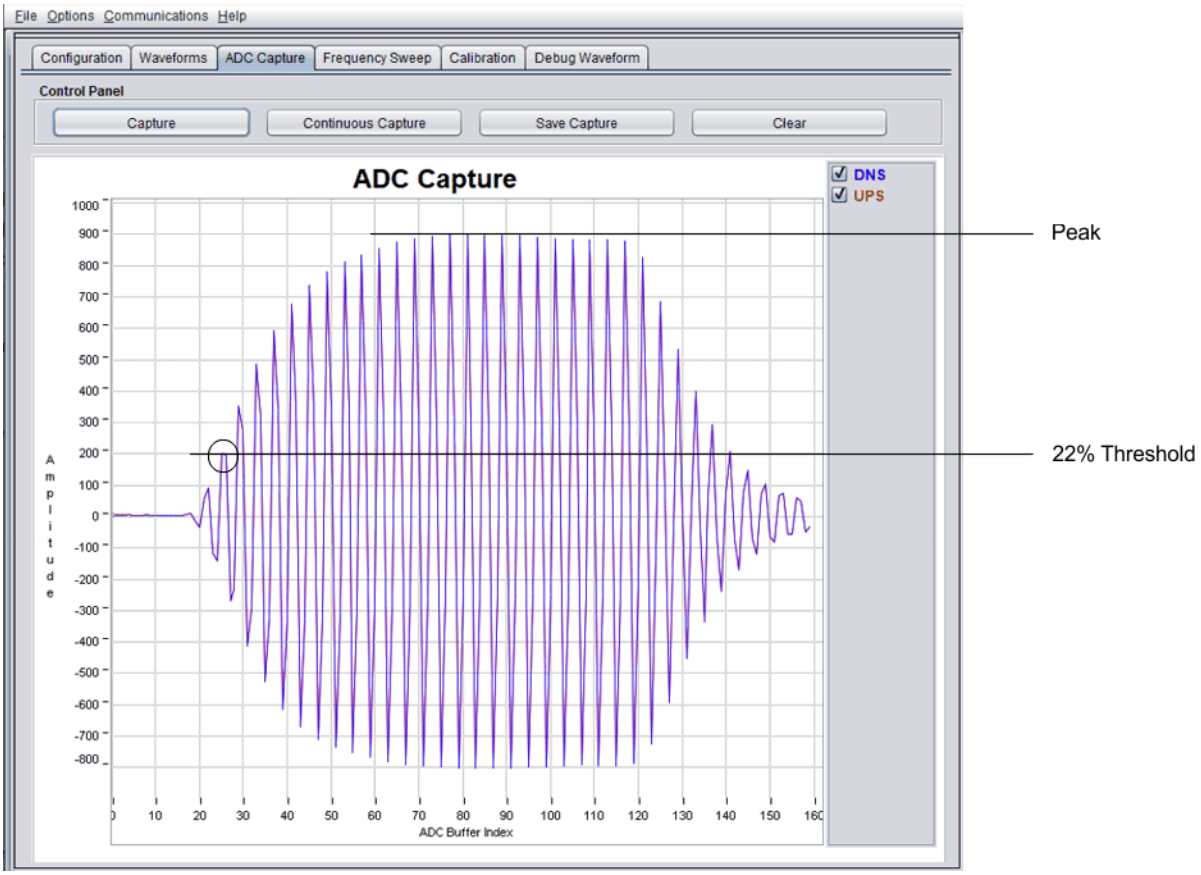


图 **9.** 带阈值参数的**ADC**波形示例

搜索范围参数"Search Range"仅限于气体计量算法。目前Lobe算法不适用。

保留"User Param #6"以供未来使用。

保留"User Param #10"以供未来使用。

4.2.3 特殊参数

以下为仅需在特定条件下进行修改的参数。

"ULP Bias Delay"决定偏置电路的开启时间。相关的时序信息可以参考*MSP430FR58xx, MSP430FR59xx, and MSP430FR6xx Family User's Guide*。对于低功耗模式，推荐将此参数设置为3。

"Start PPG Count"决定PPG模块的开启时间。相关的时序信息可以参考*MSP430FR58xx, MSP430FR59xx, and MSP430FR6xx Family User's Guide*。对于低功耗模式，推荐将此参数设置为10000ns。当且仅当绝对飞行时间少于30us时才有必要修改此参数。随着飞行时间的变短需要同步增加此参数。例如，在绝对飞行时间为25us时，将此参数增加到15000ns。

“Trun on ADC Count”决定ADC模块的开启时间。相关的时序信息可以参考*MSP430FR58xx, MSP430FR59xx, and MSP430FR6xx Family User's Guide*。不要修改此参数。

“Start PGA and In Bias Count”决定PGA模块和偏置电路的开启时间。相关的时序信息可以参考*MSP430FR58xx, MSP430FR59xx, and MSP430FR6xx Family User's Guide*。不要修改此参数。

“USS XTAL Settling Count”决定晶振的启动稳定时长。基于过往的经验，陶瓷晶振推荐值为120us，石英晶振推荐值为5000us。

“Search Range”仅适用于气体计量算法，目前Lobe算法不适用。

4.2.4 参数调试

设置好一套可以正常工作的参数后，您可以尝试修改部分参数以获得最佳的性能及功耗。表1列出了相关参数与系统性能的关系。

表 1. 参数调试

Parameter	参数改变影响的因素			
	功耗	流量表现	标准差	零流量温度偏移
脉冲数	✓	✓	✓	✓
上下行时间间隔	✓			
增益控制			✓	✓
激励频率		✓	✓	✓
包络阈值		✓		
采样时长	✓	✓		✓

4.3 采集信号

为了采集ADC数据，请进入”ADC Capture”栏并点击”Capture”按钮。如果您在使用奥迪威DN25管段，在零流量时您应该看到如图10所示的信号。

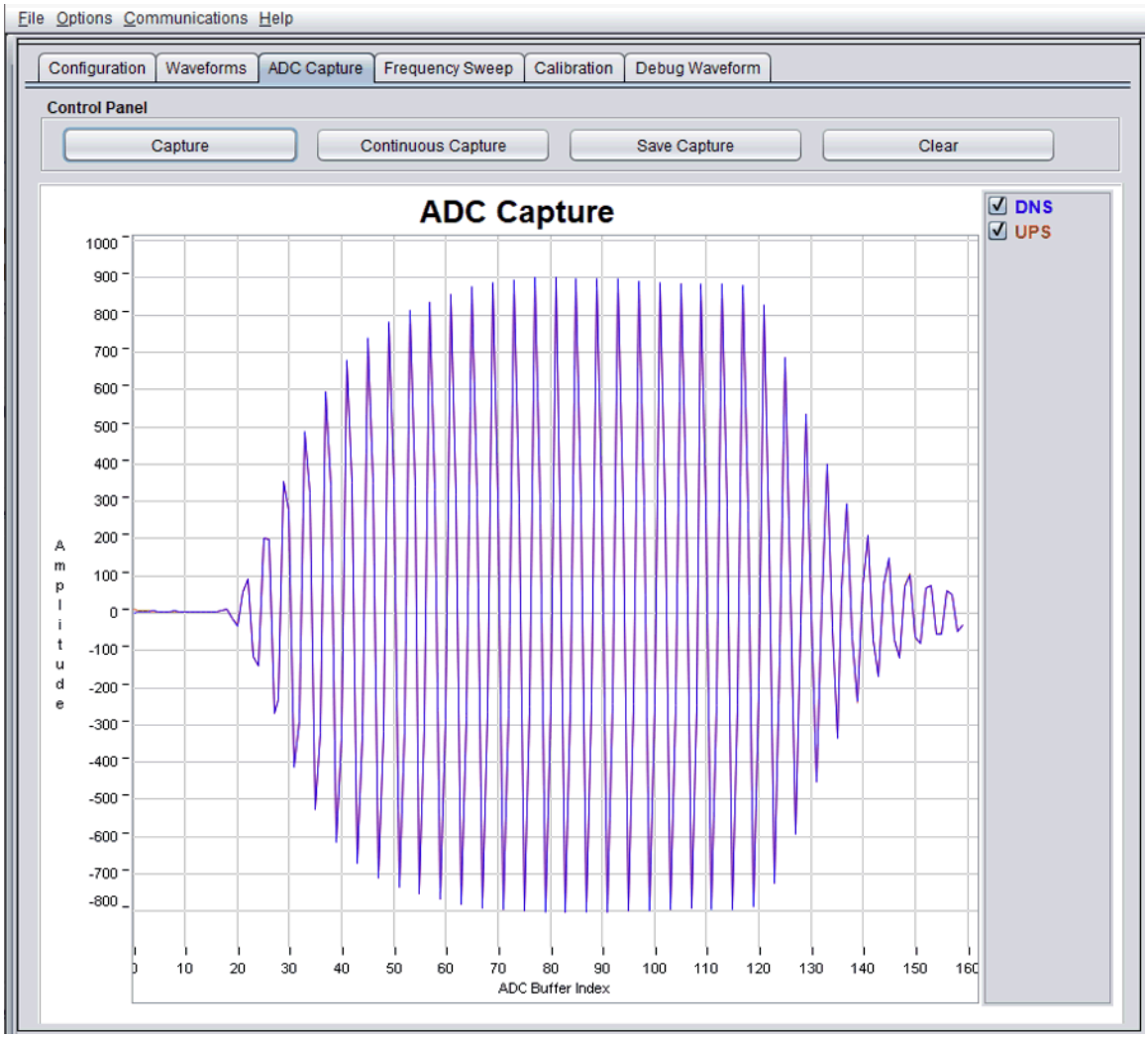


图 10. ADC采集信号

如果您的波形与上图中的结果有差异，请首先检查以下几项。

- 将参数中的信号增益调整为-6.5db。在较大的增益下，信号的顶端可能会失真。
- 调整脉冲开始与ADC工作的时间间隔。图11为该时间间隔设置过长的结果。图12为该时间间隔设置过短的结果。

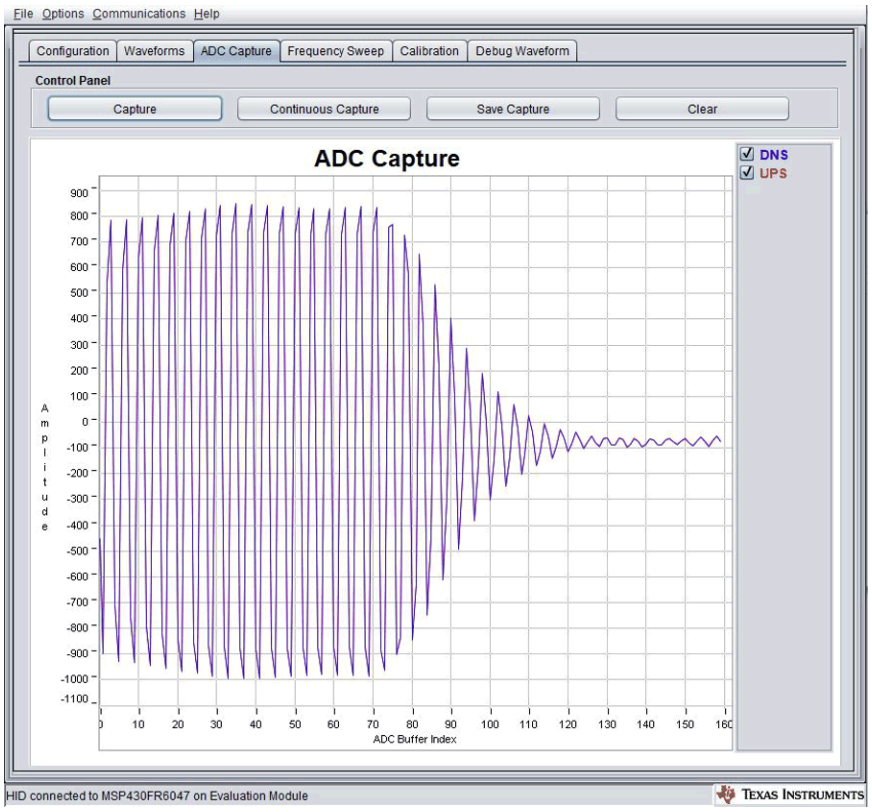


图 **11.** 时间间隔设置过长

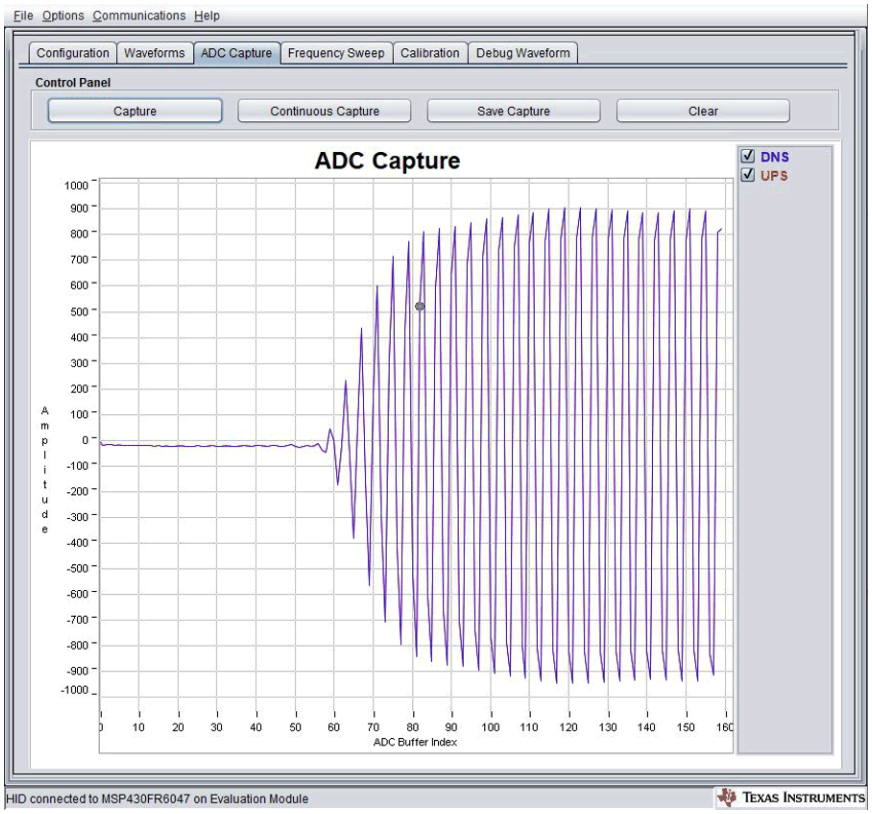


图 **12.** 时间间隔设置过短

- 如果观测不到信号，请检查换能器与板子之间的连接。连接方式参考本文第二部分。
- 保证管道内是注满水的。如果管道内没有水或者换能器没有正确连接到EVM板，采集到的信号会看起来如图13所示。

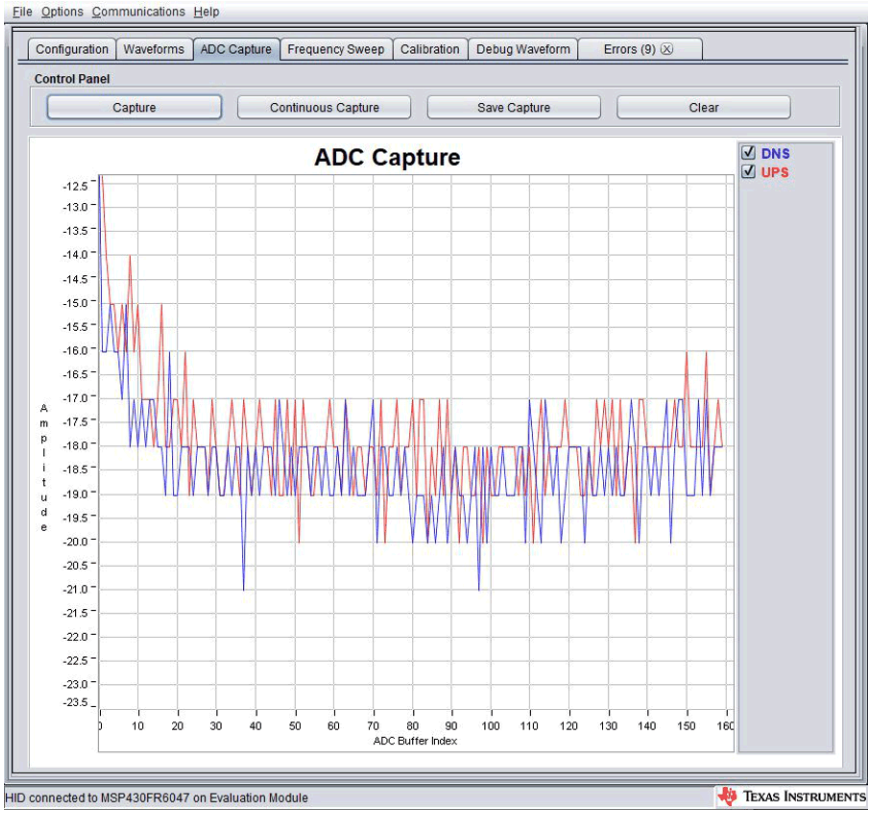


图 **13.** 管道内没有水或者换能器连接不好

点击"Save Capture"并输入一个文件名来保存当前的ADC信号数据。点击"Continuous Capture"按钮并输入一个文件名来保存连续的ADC采样数据。

4.4 采集数据

在得到了一个良好的ADC数据后，前往”Waveform“栏获得时间结果数据。在”Waveform“栏点击”Start”按钮开始采集。上位机显示时间差dTOF，绝对飞行时间absTOF和瞬时流量Volume Flow rate，如图14所示。且每个结果都有实时的统计数据。一个典型的时间差结果的标准差结果标注在图14的红色框中。

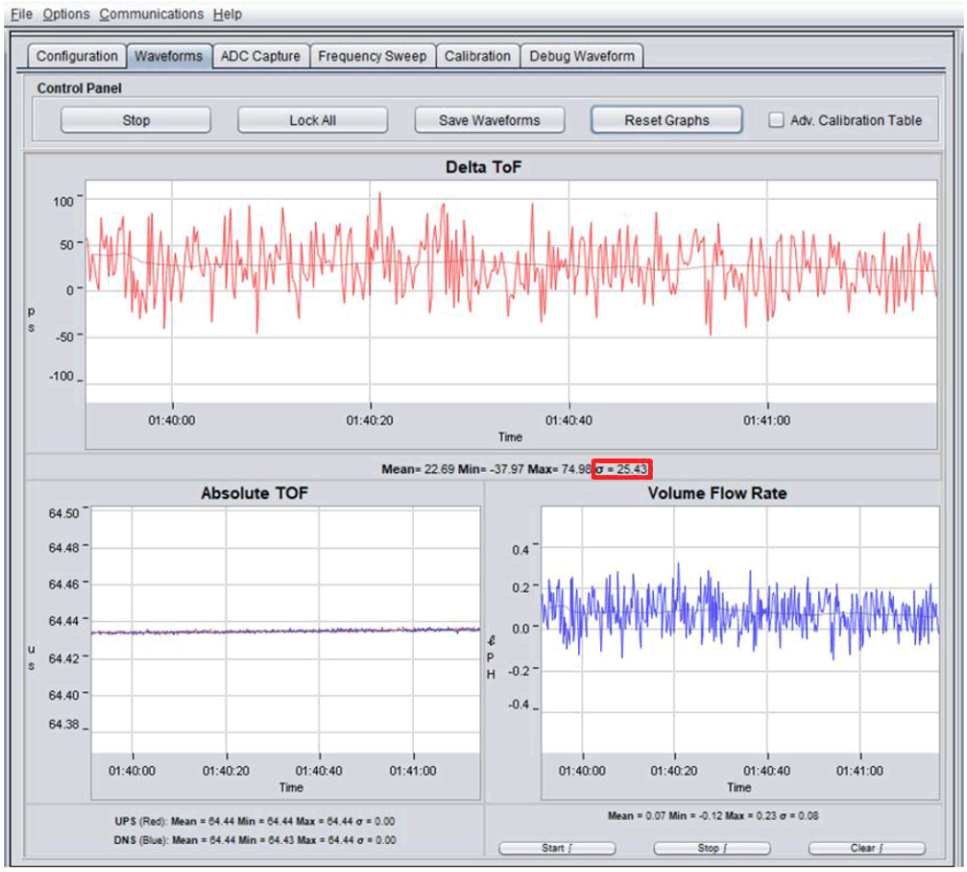


图 **14.** 数据结果

数据更新频率可以通过调整”Configuration”界面中的”UPS0 to UPS1 Gap”来改变。

在采集一段时间的数据后，你可以通过点击”Save waveforms”按钮保存这些数据。”Lock All”按钮会停止更新数据，”Reset Graphs”会擦掉当前的全部数据。

4.5 频率响应

可以在上位机中确定换能器的频率响应，以确保使用最佳激励频率。首先在”Configuration”设置起始激励频率F1，然后在”Frequency Sweep”栏中设置”Capture”和”Step Size”以覆盖您想测试的全部频带。图15中所示，扫频范围从800kHz到1208kHz。”Frequency Sweep”按钮需要首先提供一个保存的文件名然后启动扫频功能。

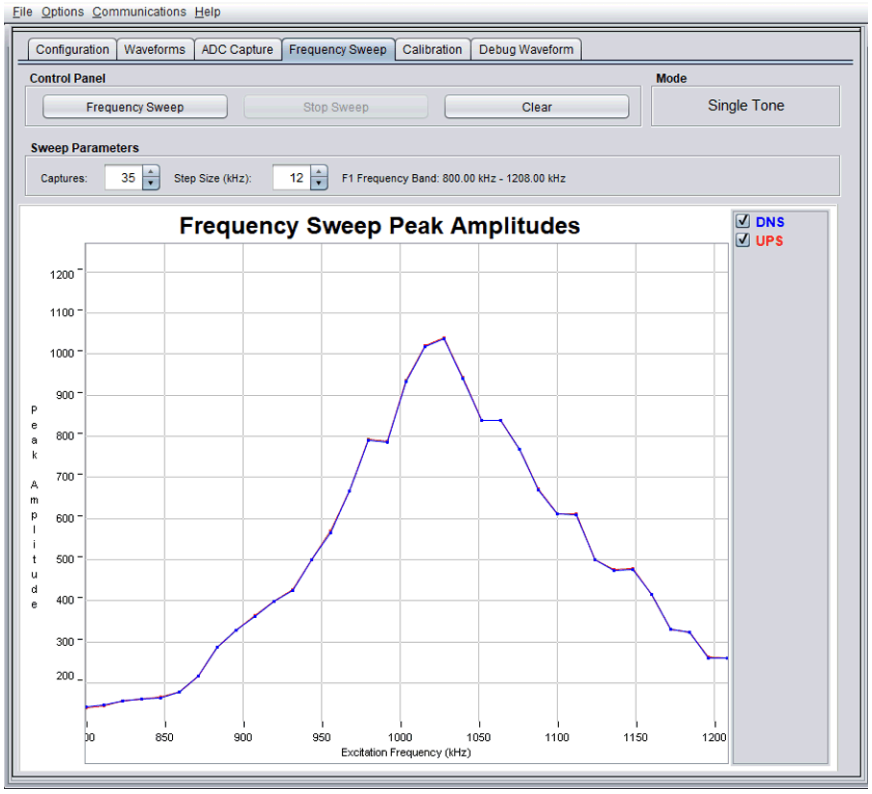


图 **15.** 扫频结果

从图中结果可得，对于这只被测表可将激励频率设置为1020kHz。将配置调整到最佳值的过程可以总结如下：

注意：步骤1到3应该在章节4.3中被设置好

1. 设置激励频率”Transmit Frequency”为换能器的标称值。
2. 调整脉冲开始与ADC工作的时间间隔”Gap between pulses start and ADC capture”和采样时长”Capture Duration”，保证”ADC Capture”中可以看到完整的波形。
3. 调整信号增益，使其峰峰值处在±900数值左右
4. 将激励频率”Transmit Frequency”设置为比标称频率少200kHz后，执行扫频功能，扫频终点设置到大于标称频率200kHz即可。
5. 找到扫频结果峰值点的频率坐标，并将该频率设置为激励频率”Transmit Frequency”。

5 性能指标

性能指标包括标准差，零流量温漂偏移和流量测试。

5.1 标准差

时间差或流量的标准差通常被用来描述能够达到的测量精度。尽管可以对多次测量结果求均值来达到更高的精度，但是会在实际应用中带来计量时间增加导致的系统延迟和功耗的问题。

标准偏差测试通常在室温下每秒测量1次，总共测量30分钟，以确保统计上有效的平均值。时间差结果显示在上位机中的"Waveform"栏中。图16显示了200次测量的全部标准差值结果。 每个数据代表200次测量的一次标准差数据。 该图清楚地表明每次STD的变化仅为±2 ps，平均值小于25 ps。

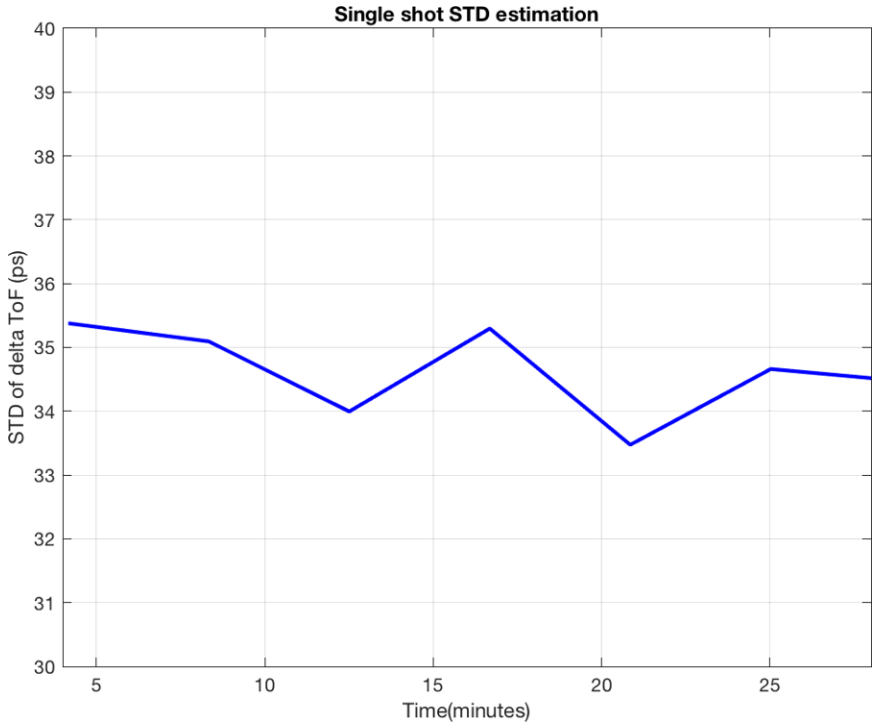


图 **16.** 标准差结果

5.2 零流量温漂偏移测试

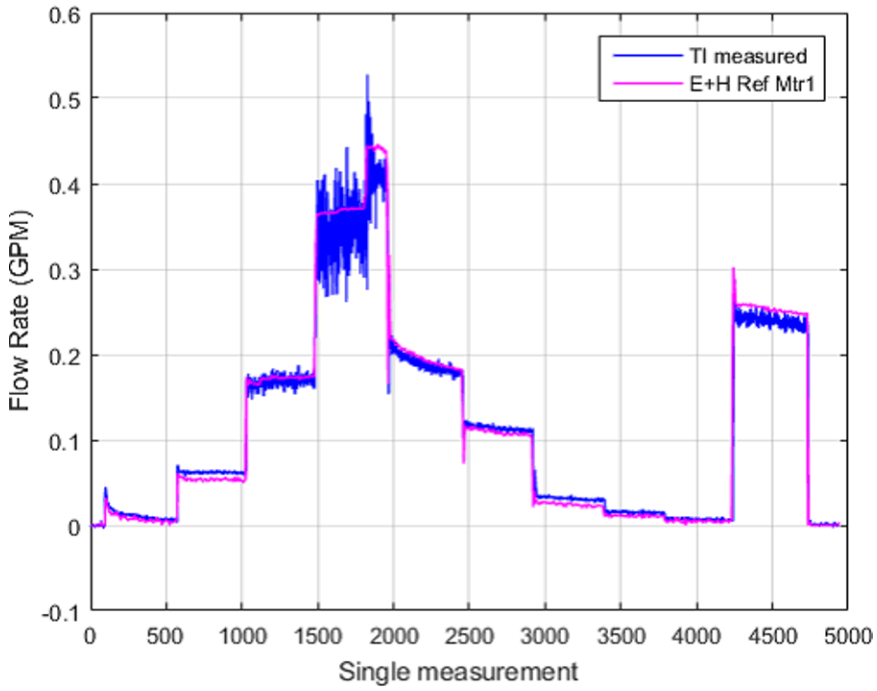
零流量温漂偏移结果通常用来描述最低检测流量。最低检测流速即起始流速由温漂特性和灵敏度决定。较高的灵敏度和较低的温漂偏移可以得到一个较低的起始流速。起始流速会受到dTOF在全温度范围下产生的偏移影响。该测试通常在5摄氏度到85摄氏度的温箱中进行测试4至24小时，测试时长取决于测试的可靠性。为了排除电子部分受到温度变化产生的干扰，测试包含了将管段和电子部分同时放入温箱中进行测试及仅将管段部分放入温箱中进行测试作对比。更多的关于零流量温漂偏移测试结果信息，请参考*Ultrasonic Sensing Metrology Subsystem Reference Design for Water Flow Measurement* design guide.

5.3 流量测试

流量测试通常在包含参考水表在内的温控水循环系统中进行。图17展示了典型的流量测试装置。该装置包含一个大水箱，两个参考表和一个被测表。在不同的流速下记录参考表和被测表的流速数据。通过向水箱中添加冰或热水，并使用温度计来记录温度数据。可以在超声波水流量计演示中找到有关装置介绍和流量测量的视频。

图 **17.** 流量测量装置

流量数据通常将参考表与被测表几分钟内得到的数据进行平均处理后再进行对比。图18显示了在几种不同流速下参考表与被测表的对比测试结果。



注：该测试在常温下进行

图 **18.** 奥迪威管段流量测试结果

关于水表流速测量的更多信息请参考*MSP430FR6047 and Ultrasonic Software Based Water Flow Meter Measurement Results* application report.

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2 *Limited Warranty and Related Remedies/Disclaimers*:

   2.1 These terms do not apply to Software. The warranty, if any, for Software is covered in the applicable Software License Agreement.

   2.2 TI warrants that the TI EVM will conform to TI's published specifications for ninety (90) days after the date TI delivers such EVM to User. Notwithstanding the foregoing, TI shall not be liable for a nonconforming EVM if (a) the nonconformity was caused by neglect, misuse or mistreatment by an entity other than TI, including improper installation or testing, or for any EVMs that have been altered or modified in any way by an entity other than TI, (b) the nonconformity resulted from User's design, specifications or instructions for such EVMs or improper system design, or (c) User has not paid on time. Testing and other quality control techniques are used to the extent TI deems necessary. TI does not test all parameters of each EVM. User's claims against TI under this Section 2 are void if User fails to notify TI of any apparent defects in the EVMs within ten (10) business days after delivery, or of any hidden defects with ten (10) business days after the defect has been detected.

   2.3 TI's sole liability shall be at its option to repair or replace EVMs that fail to conform to the warranty set forth above, or credit User's account for such EVM. TI's liability under this warranty shall be limited to EVMs that are returned during the warranty period to the address designated by TI and that are determined by TI not to conform to such warranty. If TI elects to repair or replace such EVM, TI shall have a reasonable time to repair such EVM or provide replacements. Repaired EVMs shall be warranted for the remainder of the original warranty period. Replaced EVMs shall be warranted for a new full ninety (90) day warranty period.

WARNING

Evaluation Kits are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems.

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NOTE:

EXPOSURE TO ELECTROSTATIC DISCHARGE (ESD) MAY CAUSE DEGREDATION OR FAILURE OF THE EVALUATION KIT; TI RECOMMENDS STORAGE OF THE EVALUATION KIT IN A PROTECTIVE ESD BAG.

3 *Regulatory Notices:*

3.1 *United States*

3.1.1 *Notice applicable to EVMs not FCC-Approved:*

FCC NOTICE: This kit is designed to allow product developers to evaluate electronic components, circuitry, or software associated with the kit to determine whether to incorporate such items in a finished product and software developers to write software applications for use with the end product. This kit is not a finished product and when assembled may not be resold or otherwise marketed unless all required FCC equipment authorizations are first obtained. Operation is subject to the condition that this product not cause harmful interference to licensed radio stations and that this product accept harmful interference. Unless the assembled kit is designed to operate under part 15, part 18 or part 95 of this chapter, the operator of the kit must operate under the authority of an FCC license holder or must secure an experimental authorization under part 5 of this chapter.

3.1.2 *For EVMs annotated as FCC – FEDERAL COMMUNICATIONS COMMISSION Part 15 Compliant:*

CAUTION

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

FCC Interference Statement for Class A EVM devices

NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

FCC Interference Statement for Class B EVM devices

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- *Reorient or relocate the receiving antenna.*
- *Increase the separation between the equipment and receiver.*
- *Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.*
- *Consult the dealer or an experienced radio/TV technician for help.*

3.2 *Canada*

3.2.1 *For EVMs issued with an Industry Canada Certificate of Conformance to RSS-210 or RSS-247*

Concerning EVMs Including Radio Transmitters:

This device complies with Industry Canada license-exempt RSSs. Operation is subject to the following two conditions:

(1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Concernant les EVMs avec appareils radio:

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Concerning EVMs Including Detachable Antennas:

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication. This radio transmitter has been approved by Industry Canada to operate with the antenna types listed in the user guide with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Concernant les EVMs avec antennes détachables

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante. Le présent émetteur radio a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés dans le manuel d'usage et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur

3.3 *Japan*

3.3.1 *Notice for EVMs delivered in Japan:* Please see http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_01.page 日本国内に輸入される評価用キット、ボードについては、次のところをご覧ください。
http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_01.page

3.3.2 *Notice for Users of EVMs Considered "Radio Frequency Products" in Japan:* EVMs entering Japan may not be certified by TI as conforming to Technical Regulations of Radio Law of Japan.

If User uses EVMs in Japan, not certified to Technical Regulations of Radio Law of Japan, User is required to follow the instructions set forth by Radio Law of Japan, which includes, but is not limited to, the instructions below with respect to EVMs (which for the avoidance of doubt are stated strictly for convenience and should be verified by User):

1. Use EVMs in a shielded room or any other test facility as defined in the notification #173 issued by Ministry of Internal Affairs and Communications on March 28, 2006, based on Sub-section 1.1 of Article 6 of the Ministry's Rule for Enforcement of Radio Law of Japan,
2. Use EVMs only after User obtains the license of Test Radio Station as provided in Radio Law of Japan with respect to EVMs, or
3. Use of EVMs only after User obtains the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to EVMs. Also, do not transfer EVMs, unless User gives the same notice above to the transferee. Please note that if User does not follow the instructions above, User will be subject to penalties of Radio Law of Japan.

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3.4 *European Union*

3.4.1 *For EVMs subject to EU Directive 2014/30/EU (Electromagnetic Compatibility Directive)*:

This is a class A product intended for use in environments other than domestic environments that are connected to a low-voltage power-supply network that supplies buildings used for domestic purposes. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

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4.2 User must read and apply the user guide and other available documentation provided by TI regarding the EVM prior to handling or using the EVM, including without limitation any warning or restriction notices. The notices contain important safety information related to, for example, temperatures and voltages.

4.3 *Safety-Related Warnings and Restrictions:*

4.3.1 User shall operate the EVM within TI's recommended specifications and environmental considerations stated in the user guide, other available documentation provided by TI, and any other applicable requirements and employ reasonable and customary safeguards. Exceeding the specified performance ratings and specifications (including but not limited to input and output voltage, current, power, and environmental ranges) for the EVM may cause personal injury or death, or property damage. If there are questions concerning performance ratings and specifications, User should contact a TI field representative prior to connecting interface electronics including input power and intended loads. Any loads applied outside of the specified output range may also result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the EVM user guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative. During normal operation, even with the inputs and outputs kept within the specified allowable ranges, some circuit components may have elevated case temperatures. These components include but are not limited to linear regulators, switching transistors, pass transistors, current sense resistors, and heat sinks, which can be identified using the information in the associated documentation. When working with the EVM, please be aware that the EVM may become very warm.

4.3.2 EVMs are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems. User assumes all responsibility and liability for proper and safe handling and use of the EVM by User or its employees, affiliates, contractors or designees. User assumes all responsibility and liability to ensure that any interfaces (electronic and/or mechanical) between the EVM and any human body are designed with suitable isolation and means to safely limit accessible leakage currents to minimize the risk of electrical shock hazard. User assumes all responsibility and liability for any improper or unsafe handling or use of the EVM by User or its employees, affiliates, contractors or designees.

4.4 User assumes all responsibility and liability to determine whether the EVM is subject to any applicable international, federal, state, or local laws and regulations related to User's handling and use of the EVM and, if applicable, User assumes all responsibility and liability for compliance in all respects with such laws and regulations. User assumes all responsibility and liability for proper disposal and recycling of the EVM consistent with all applicable international, federal, state, and local requirements.

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10. *Governing Law:* These terms and conditions shall be governed by and interpreted in accordance with the laws of the State of Texas, without reference to conflict-of-laws principles. User agrees that non-exclusive jurisdiction for any dispute arising out of or relating to these terms and conditions lies within courts located in the State of Texas and consents to venue in Dallas County, Texas. Notwithstanding the foregoing, any judgment may be enforced in any United States or foreign court, and TI may seek injunctive relief in any United States or foreign court.

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