# Appendix A: Requirements and Verifications Table

| Requirement | Verification | Pass/Fail? |
|---|---|---|
| 1. Receiver Circuit<br>a) Must apply correct amount of gain to map 5Vpp to 3V<br>b) Must bias signal so that it becomes centered between 0 and 3V<br>c) Must apply a low-pass filter with -3dB cutoff at 60kHz | 1. Receiver circuit will be connected to a signal generator at the input and an oscilloscope at the output. We will use a voltage divider to supply power from the workbench.<br>a) We will apply a 60Hz 5Vpp signal from the signal generator and make sure the output signal has a max of 3V.<br>b) We will also be able to use the 60Hz 5Vpp signal to make sure the output signal is between 0V and 3V.<br>c) We will use the signal generator to send a frequency sweep and view the attenuation with the oscilloscope to make sure the cutoff is -3dB at 60kHz. | Pass |
| 2. Transmitter Circuit<br>a) Must apply correct amount of gain to map 1.5V to 3V | 2. Transmitter circuit will be connected to a signal generator at the input and an oscilloscope at the output. We will use a voltage divider to supply power from the workbench.<br>a) We will apply a 60Hz 1.5Vmax signal and make sure the output signal has a max of 3V. | Pass |
| 3. Power<br>a) Discovery Board must receive sufficient power from the USB source<br>b) Discovery Board must supply sufficient power to power peripheral circuitry | 3. We will be able to use a multimeter to measure the voltage and current supplied at the input of the USB power supply and the Vdd pins we are using to supply our Pre-Amp and transmitter circuits .<br>a) The USB cable will be hooked up to the computer and using a multimeter we will measure to see if it outputs at 3V.<br>b) Then we will measure the Vdd ,which can be manually set in the code, using a multimeter off of the Vdd pins. | Pass |

| | | |
|---|---|---|
| 4. Transducers<br>a) Transducers should have a flat or near flat frequency response from 22kHz to 30kHz<br>b) Transducers should be able to output at around 100dB | 4. We will drive the transducer using a signal generator and measure the voltage across the terminals using an oscilloscope.<br>a) We will send a signal out of the speaker and measure the response at the mic input. The mic input will be connected to an oscilloscope, which we will use to view whether the mic can pick up the ultrasonic frequencies or not.<br>b) We will drive the signal generator at 500Hz and 16Vpp. We will then measure the sounds pressure level using a sound level meter to verify that around 100dB are being produced. | Pass |
| 5. Input Buffer<br>a) Input buffer must be able to obtain reflected signal from the ADC and then be able to send it to rest of code | 5. The processing will be done on an STM32F4 Discovery Board using a Cortex-M4 DSP. Coding, compiling, and debugging of the DSP will be handled by the program Keil uVision which is pre-installed on the lab computers.<br>a) We will connect a signal generator to the necessary ADC pin. The signal generator will send out a 0V-1V 30kHz signal. The input buffer is working when the discretized signal shows up in the correct memory location using the Keil debugger. | Pass |
| 6. Output Buffer<br>a) Output buffer must be able to obtain entire chirp signal and then be able to send it to the DAC | 6. The processing will be done on an STM32F4 Discovery Board using a Cortex-M4 DSP. Coding, compiling, and debugging of the DSP will be handled by the program Keil uVision which is pre-installed on the lab computers.<br>a) We will connect the pin for the necessary DAC to an oscilloscope. If the chirp is sent out correctly, it will show up on the oscilloscope. | Pass |
| 7. High-Pass Filter<br>a) The reflected signal must be high-pass filtered with a | 7. The processing will be done on an STM32F4 Discovery Board using a Cortex-M4 DSP. Coding, compiling, and | Fail |

| | | |
|---|---|---|
| cutoff of 22kHz | debugging of the DSP will be handled by the program Keil uVision which is pre-installed on the lab computers.<br>a) We will connect a signal generator to the ADC pin and an oscilloscope to the DAC pin. We will send in a frequency sweep into the Discovery Board and show the filtered signal with the oscilloscope in order to verify a -3dB cutoff at 22kHz. | |
| 8. Cross Correlation<br>a) In time-domain mode, the reflected signal must be properly cross-correlated with the chirp | 8. The processing will be done on an STM32F4 Discovery Board using a Cortex-M4 DSP. Coding, compiling, and debugging of the DSP will be handled by the program Keil uVision which is pre-installed on the lab computers.<br>a) We will send the cross-correlated signal that is stored in memory to MATLAB for analysis. | Pass |
| 9. Power Spectrum<br>a) In frequency domain mode, the power spectrum must be correctly calculated | 9. The processing will be done on an STM32F4 Discovery Board using a Cortex-M4 DSP. Coding, compiling, and debugging of the DSP will be handled by the program Keil uVision which is pre-installed on the lab computers.<br>a) We will send the power spectrum signal to a second DAC. The second DAC is set up with the express purpose of being hooked to an oscilloscope which can then output data to MATLAB for analysis. | Fail |
| 10. Output Link<br>a) Output pin must send information correctly using USART protocols | 6. We will hook the designated USART pin on the Discovery Board to an oscilloscope.<br>a) We will program USART to output an 8 bit word which we can read using an oscilloscope at the output pin. It will be working properly when the correct 8 bit word can be read on the oscilloscope. | Fail |

# Appendix B: Figures

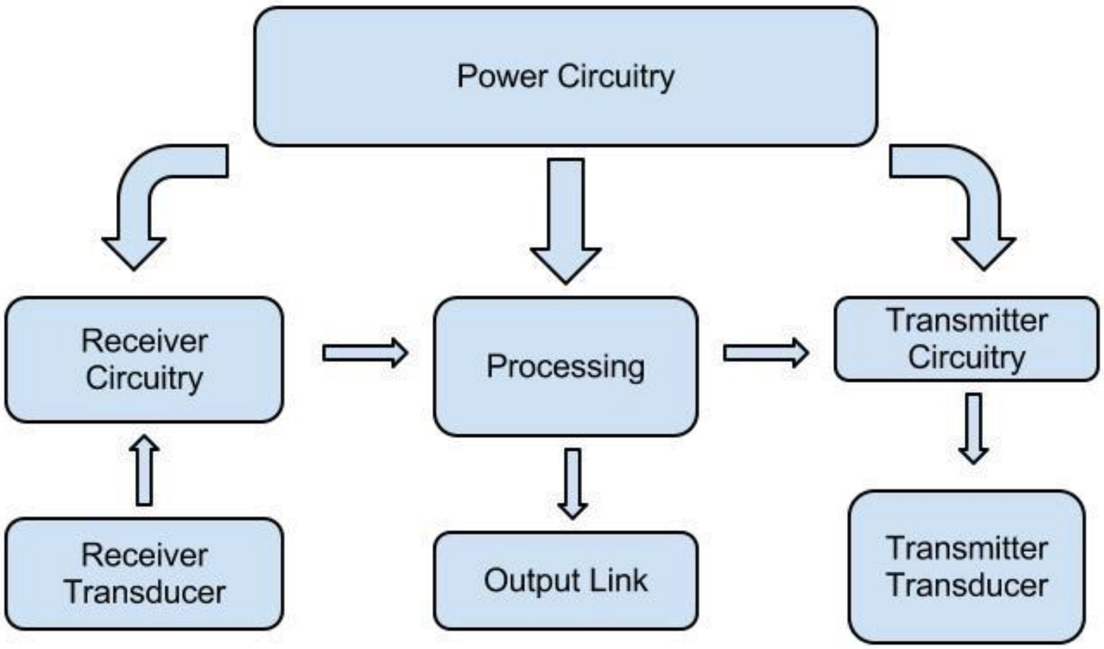


**Figure B.1:** Block Diagram

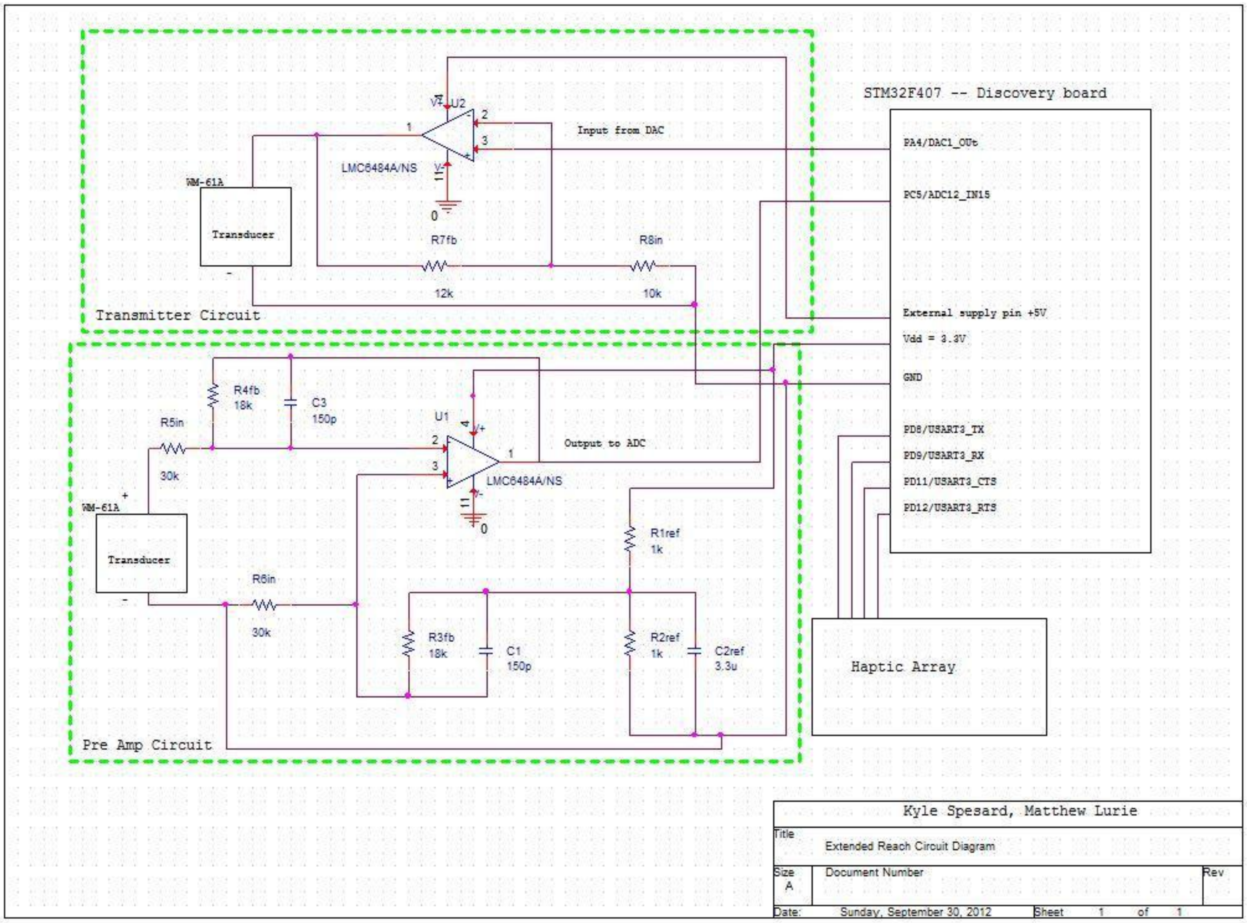


**Figure B.2:** Hardware Schematic

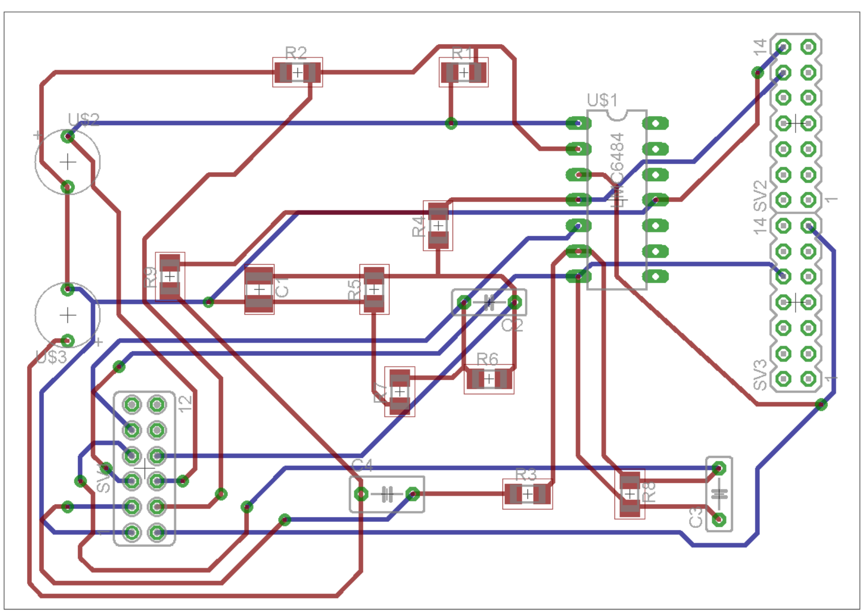


**Figure B.3:** PCB Design in Eagle

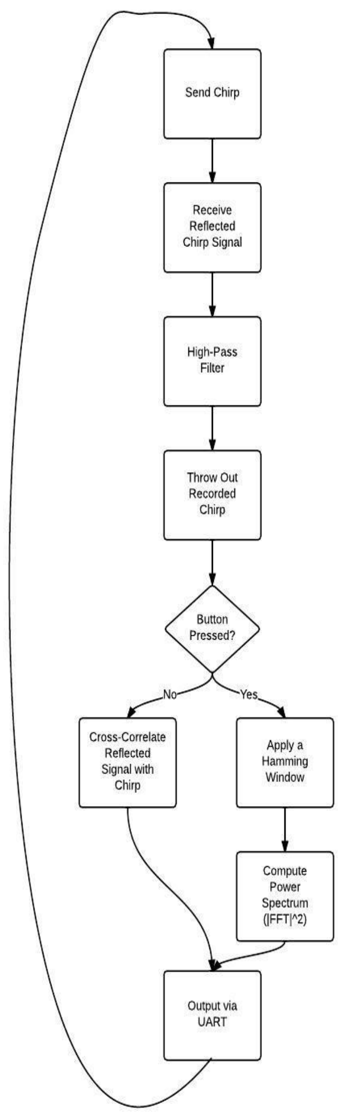


**Figure B.4:** Software Flowchart

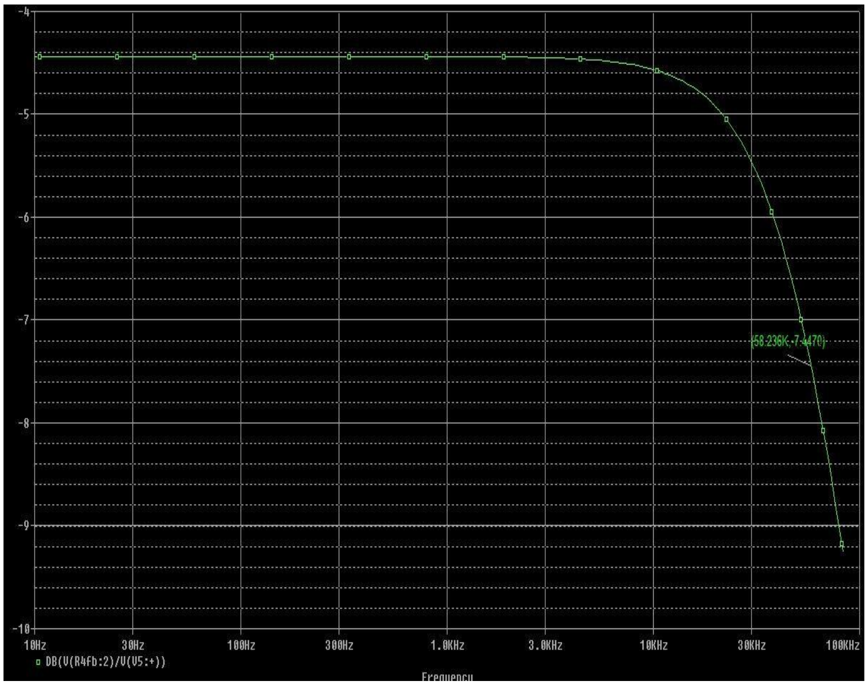


**Figure B.5:** Low-Pass Filter Hardware pSpice Simulation

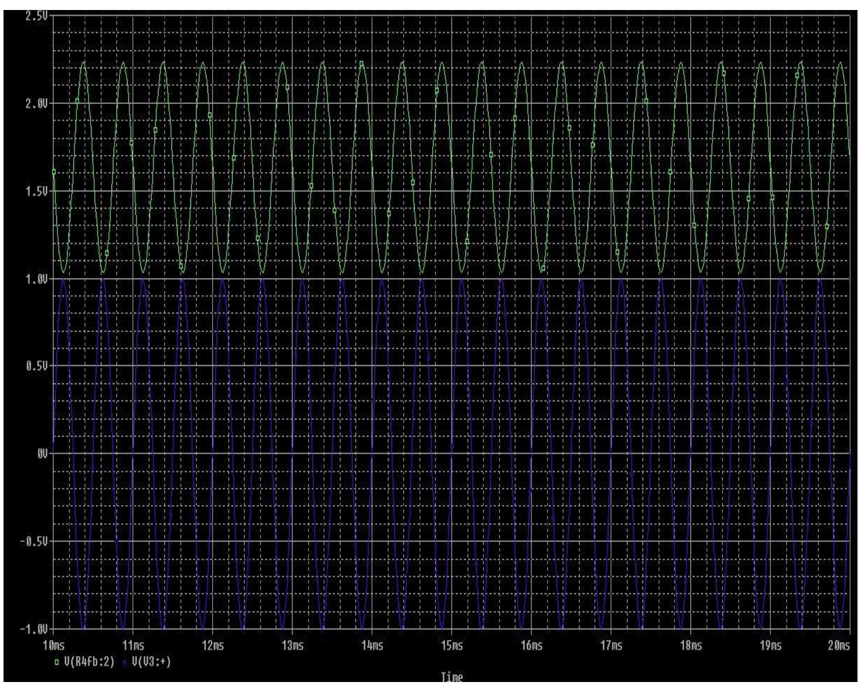


**Figure B.6:** pSpice Simulation Showing Correct Biasing and Scaling of Input Signal

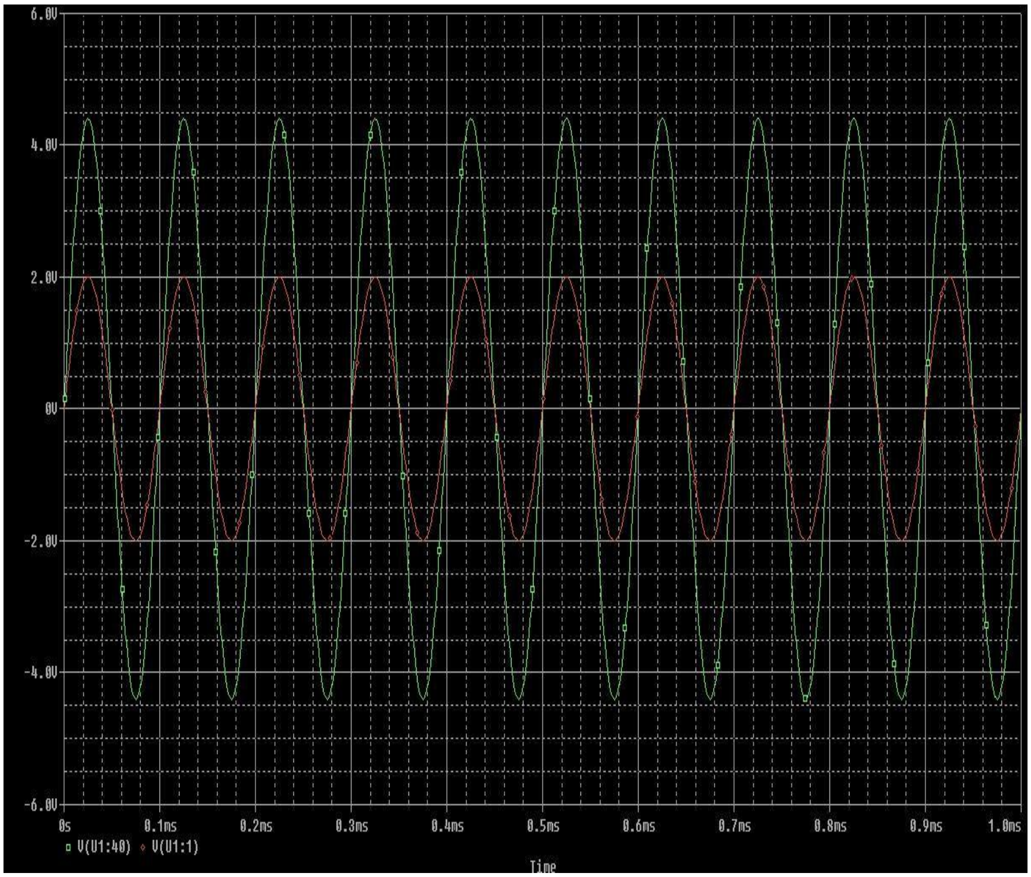


**Figure B.7:** pSpice Simulation Showing Correct Amplification of Output Signal

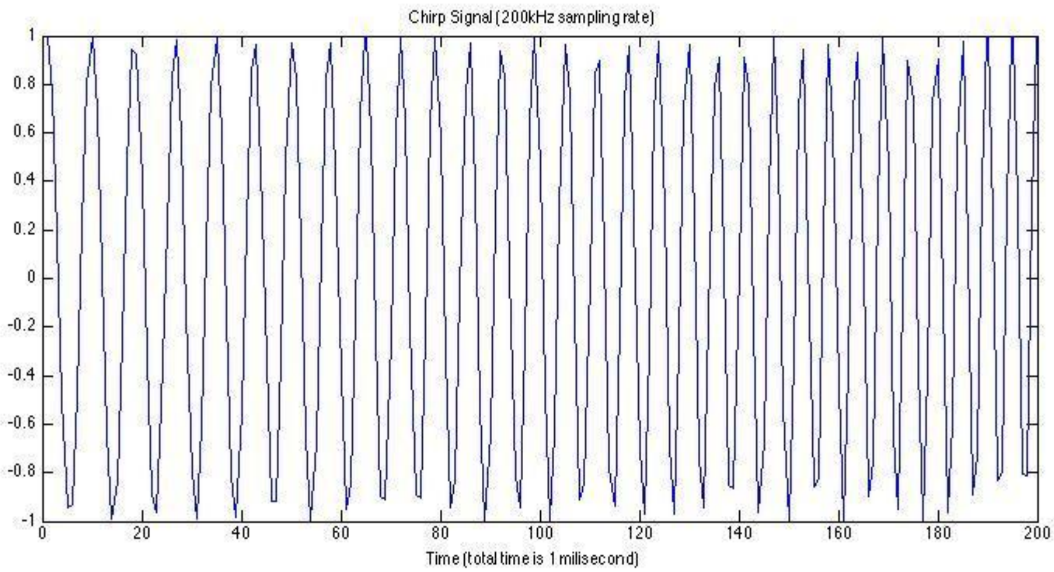


**Figure B.8:** Linear Chirp

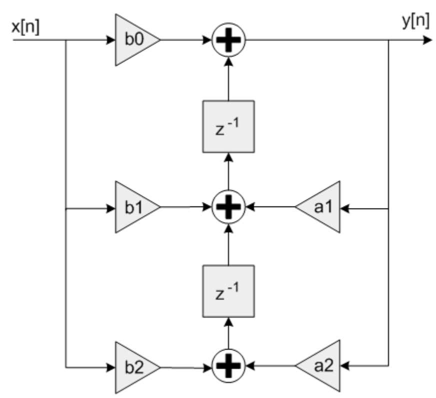


**Figure B.9:** High-Pass Filter IIR Algorithm Structure

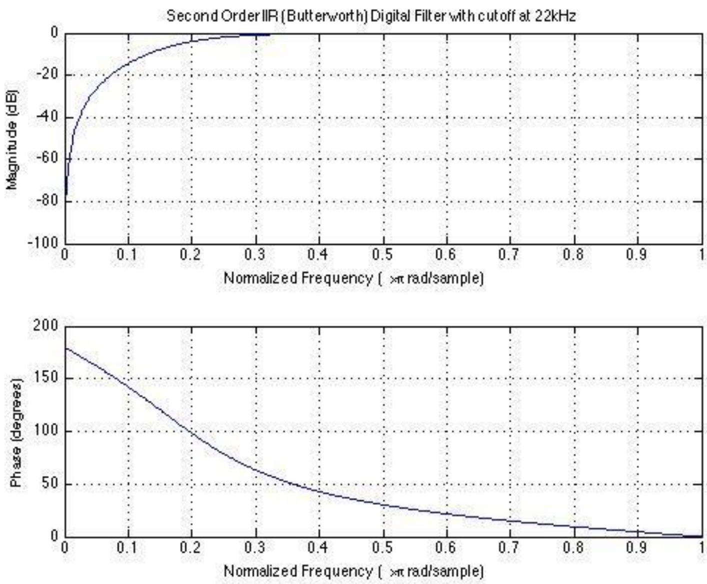


**Figure B.10:** MATLAB Simulation of High-Pass Filter

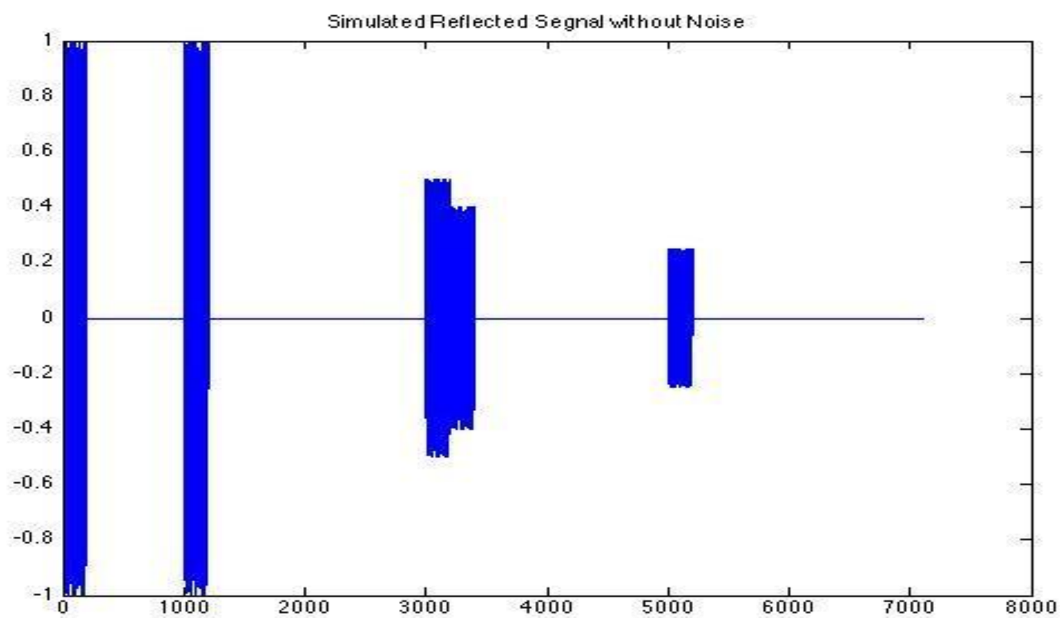


**Figure B.11:** MATLAB Simulated Reflected Signal Without Noise

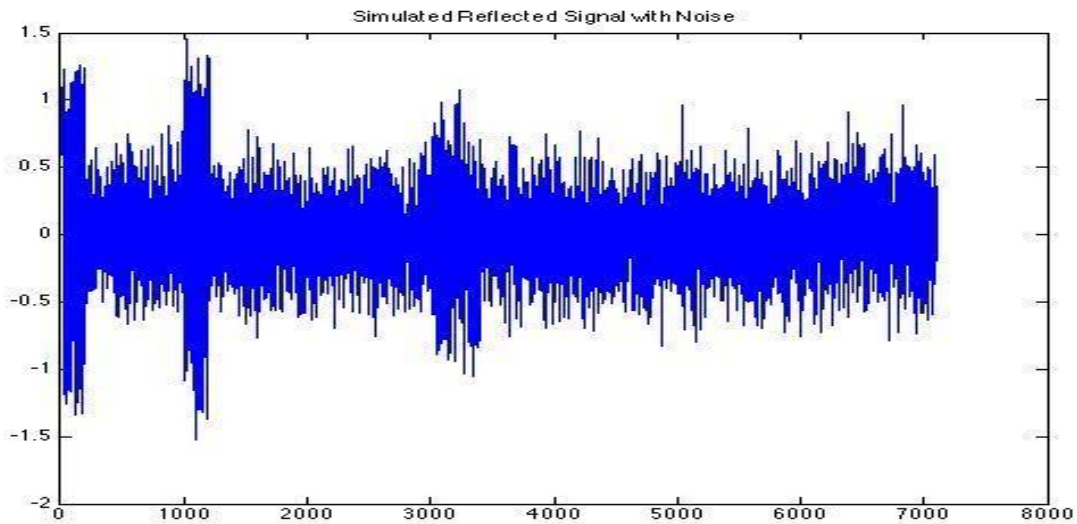


**Figure B.12:** MATLAB Simulated Reflected Signal With Noise

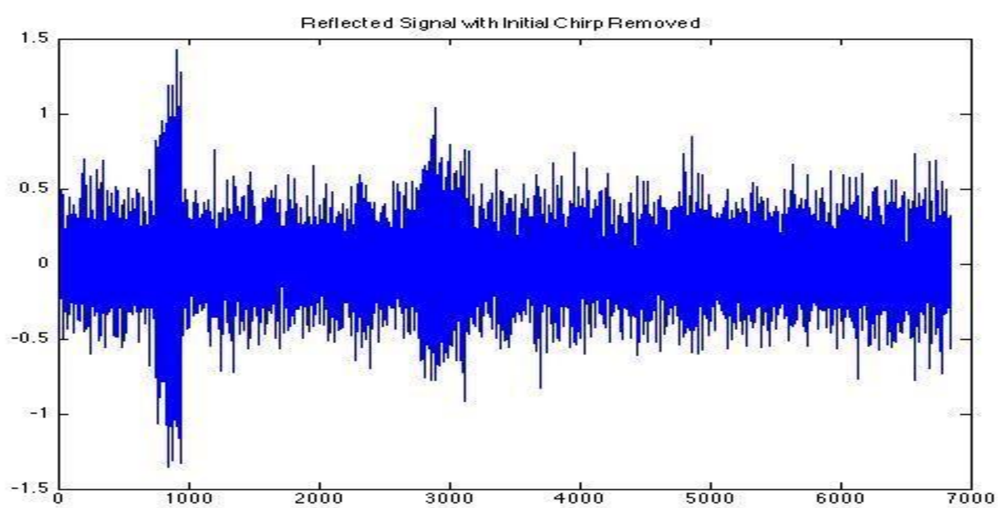


**Figure B.13:** MATLAB Simulated Reflected Signal With Initial Recorded Chirp Removed

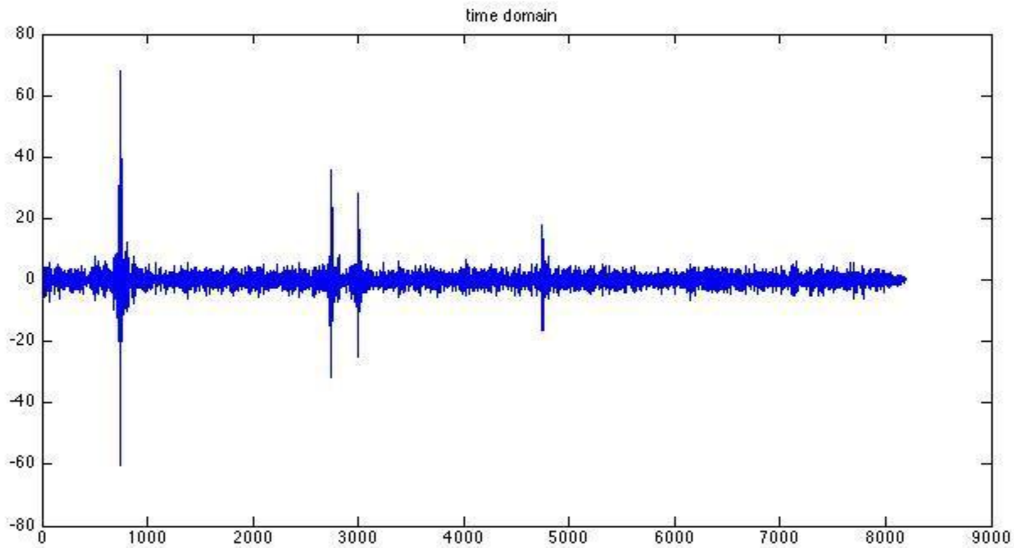


**Figure B.14:** MATLAB Simulated Cross-correlation Computed in Time Domain

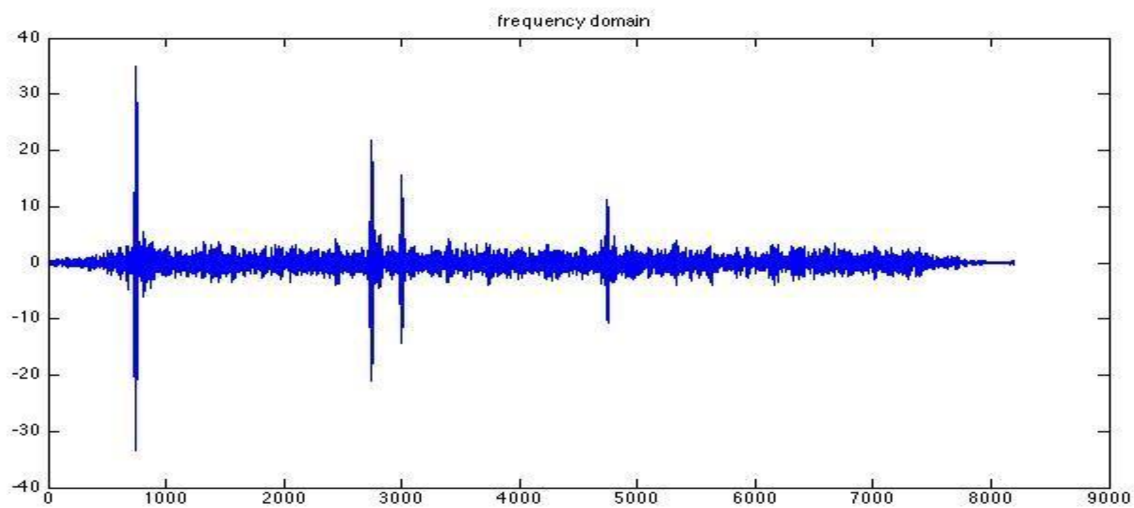


**Figure B.15:** MATLAB Simulated Cross-correlation Computed in Frequency Domain

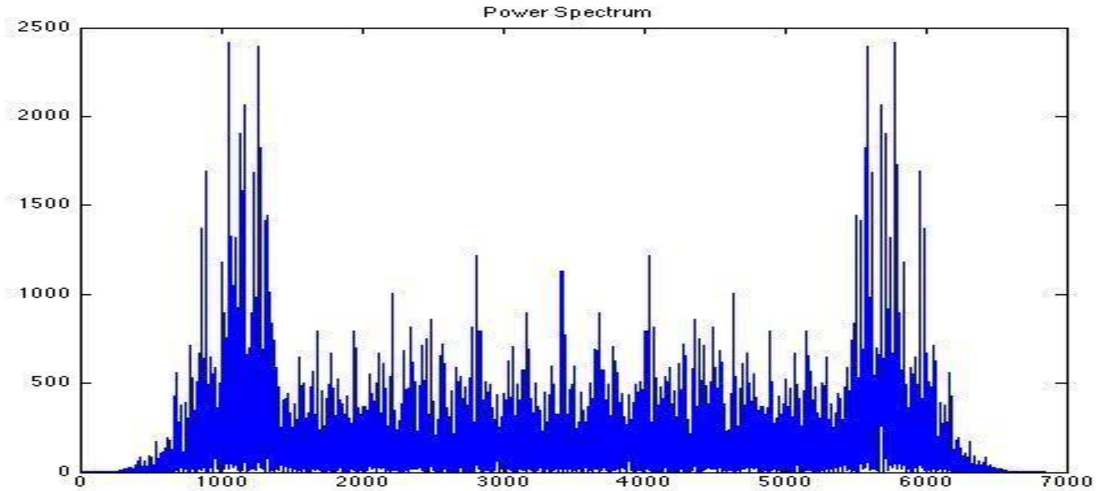


**Figure B.16:** MATLAB Simulated Power Spectrum

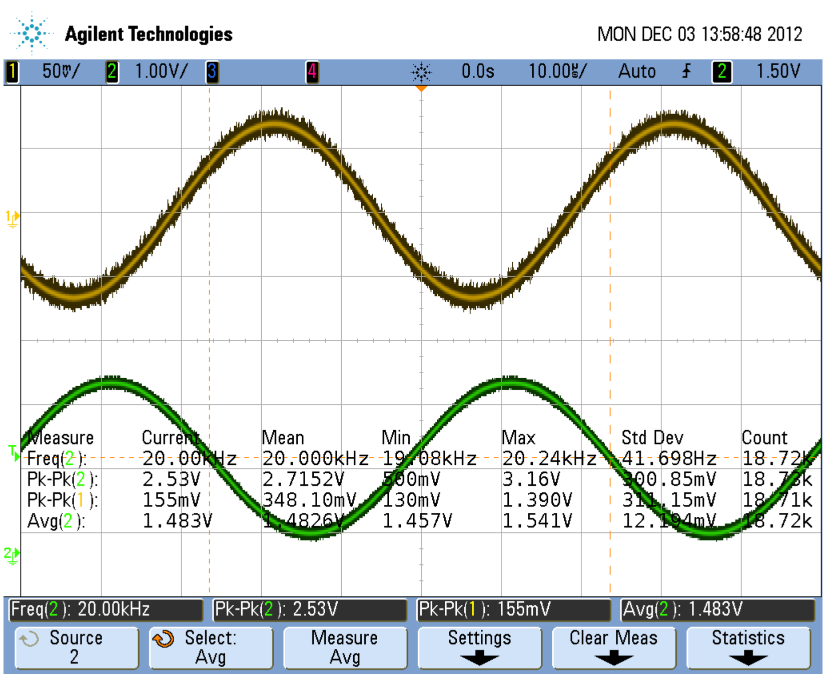


**Figure B.17:** Verification of Input Circuit

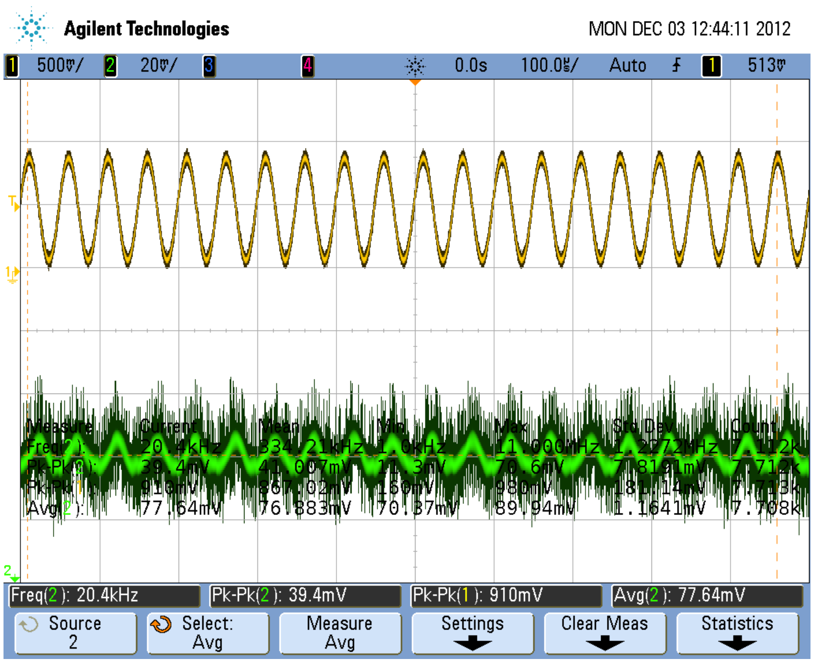


**Figure: B.18:** Verification at Mic Input

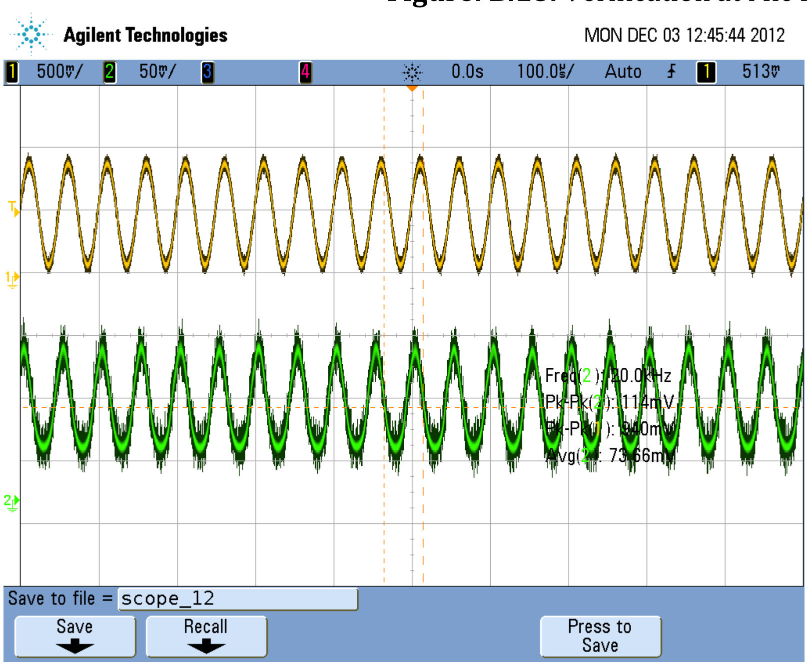


**Figure: B.19:** Verification at ADC Input

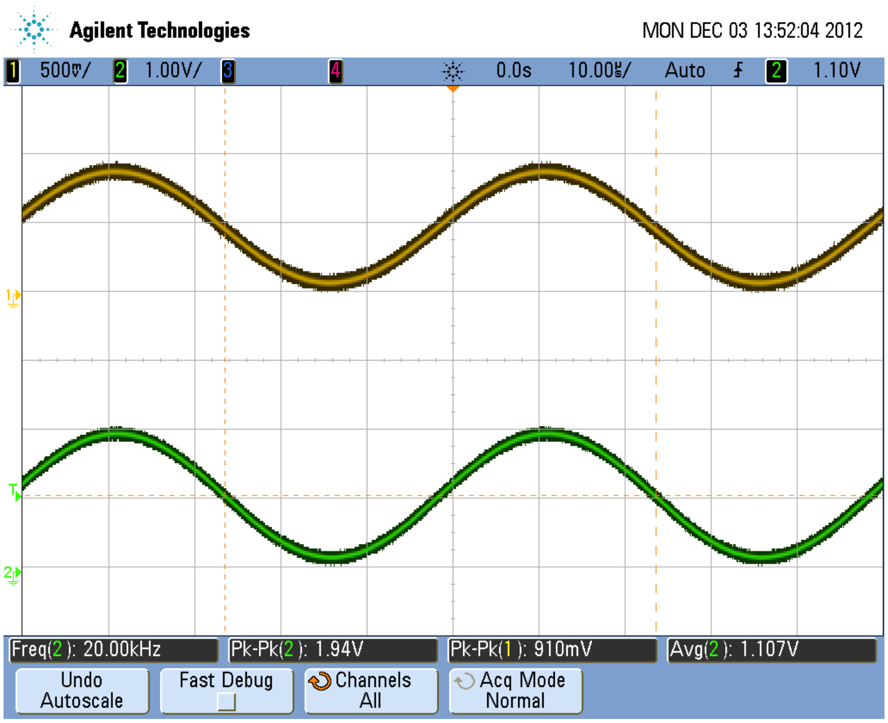


**Figure: B.20:** Verification of Transmitter Circuit

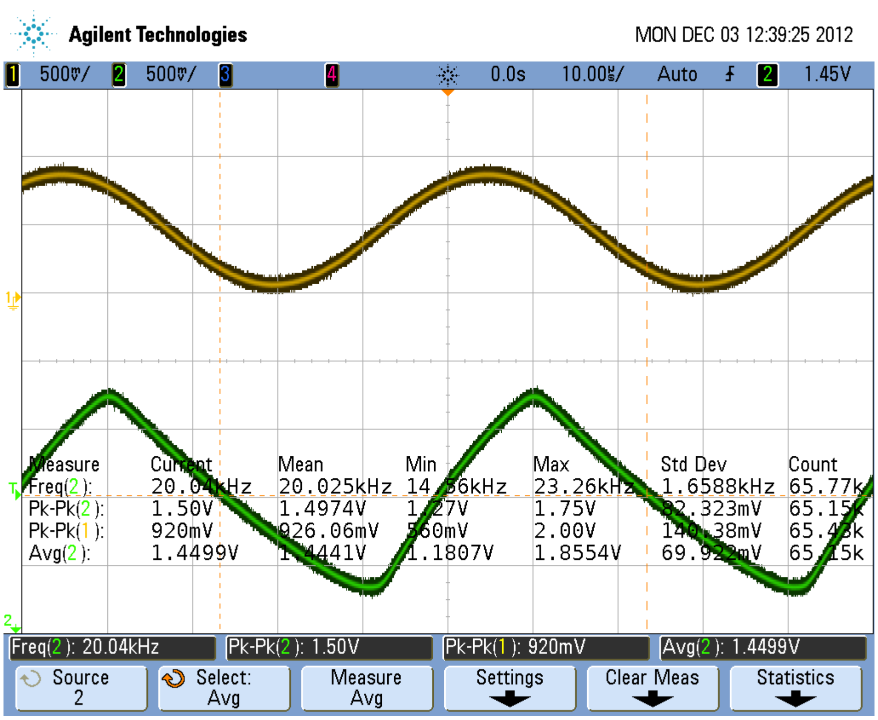


**Figure: B.20:** Speaker Distortion

# Appendix C: Pictures

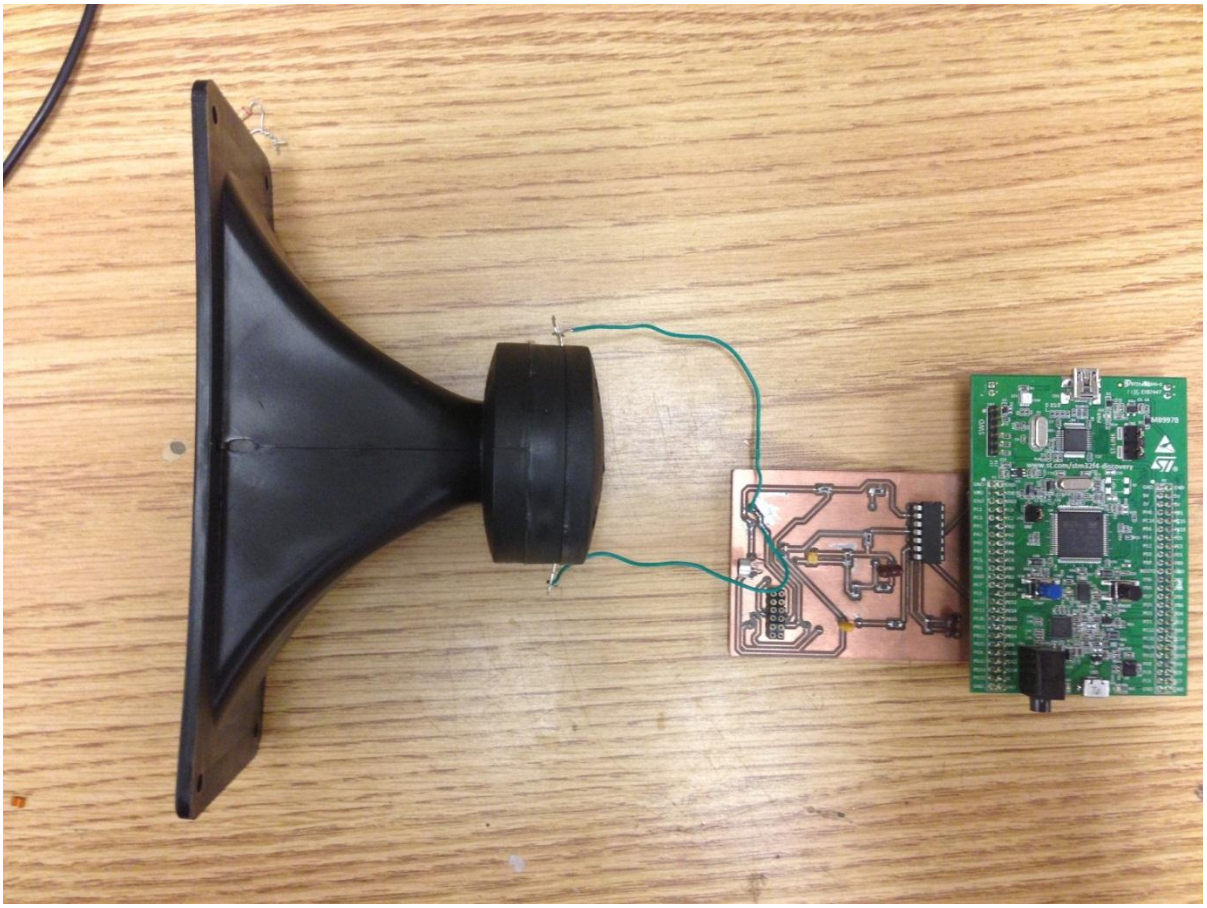

**Figure C.1:** Picture of Complete System

# Appendix D: MATLAB Code

```
% script for main program for echolocation sensor simulator %

% generate chirp %
t = linspace(0,0.001,256);
Chirp = chirp(t,22000,0.001,40000);



% generate reflected signal %
ref_signal = zeros(1,8448);
ref_signal(1:256) = Chirp;
ref_signal(1001:1256) = Chirp;
```

```
ref_signal(3001:3256) = (0.5)*Chirp;
ref_signal(3257:3512) = (0.4)*Chirp;
ref_signal(5001:5256) = (0.25)*Chirp;

%plot(ref_signal)

ref_signal = ref_signal + 0.25*randn(1,8448);

%figure
%plot(ref_signal)

% high-pass the received chirp %
[B,A] = butter(2,0.22,'high');
ref_signal = filter(B,A,ref_signal);

% throw out initial received chirp %
ref_chirp = ref_signal(1:256);
ref_signal = ref_signal(257:8448);

%figure
%plot(ref_signal)

% complete match filtering/fourier stuff %

time1 = cputime;
p = cross_corr(ref_signal,ref_chirp);
time_1 = cputime - time1

figure
plot(p)
title('time domain')

time2 = cputime;
[h,z] = freq_cross_corr(ref_signal,ref_chirp,0);
time_2 = cputime - time2

figure
plot(h)
title('frequency domain')

figure
plot(z)
title('power spectrum')

window = hamming(length(ref_signal));
m = ref_signal.*window';
fft_m = abs(fft(m)).^2;

figure
plot(fft_m)

%figure
%plot(Chirp)
```

```
function [ Corr_Signal ] = cross_corr( signal, part )
%CROSS_CORR does cross correlation in the time domain.




part_len = length(part);
signal_len = length(signal);

Corr_Signal = zeros(1,signal_len);
zero_padded_signal = zeros(1,signal_len + part_len);

for i = 1:signal_len
    zero_padded_signal(i) = signal(i);
end

for i = (signal_len+1):(signal_len + part_len)
    zero_padded_signal(i) = 0;
end

for i = 1:signal_len
    Corr_Signal(i) = 0;
    for j = 1:part_len
        Corr_Signal(i) = Corr_Signal(i) + part(j)*zero_padded_signal(i+j);
    end

end



function [Corr_Signal,Power_Spec] = freq_cross_corr( signal, part, mode)
% cross correlation in the frequency domain
% 50 percent overlap

% set Corr_Signal to all zeros
for i = 1:8192
    Corr_Signal(i) = 0;
end

for i = 1:2048
    Power_Spec(i) = 0;
end

% create windows
window1 = hamming(256);
window2 = hamming(2048);

% window the part
for i = 1:256
    windowed_part(i) = part(i)*window1(i);
end

% zero pad the part
for i = 257:2048
    windowed_part(i) = 0;
end
```

```
% fft and conjugate the part
p_fft = fft(windowed_part);
p_fft_conj = conj(p_fft);


for i = 1:1024:6145

  for j = 1:2048
     windowed_signal(j) = signal(i+j-1)*window2(j);
  end

  s_fft = fft(windowed_signal);

  if mode == 0

      for j=1:2048
          mult_fft(j) = s_fft(j)*p_fft_conj(j);
      end

      ifft_corr = ifft(mult_fft);

      for j=i:(i+2047)
         Corr_Signal(j) = Corr_Signal(j) + ifft_corr(j-i+1);
      end

  else

     for j = 1:2048
         s_conj(j) = conj(s_fft(j));
         s_power(j) = s_fft(j)*s_conj(j);
         Power_Spec(j) = Power_Spec(j) + s_power(j);
     end

  end

end

%for j = 1:2048
   %Power_Spec(j) = Power_Spec(j)/8;
%end
```

# Appendix E: Keil uVision C Code

```
/**
 ******************************************************************************
 * @file    main.h
 * @author  MCD Application Team, Matthew Lurie, Kyle Spesard
 * @version V1.0.0
```

```
 * @date    19-September-2011
 * @brief   Header for main.c module
 ******************************************************************************
 * @attention
 *
 * THE PRESENT FIRMWARE WHICH IS FOR GUIDANCE ONLY AIMS AT PROVIDING
CUSTOMERS
 * WITH CODING INFORMATION REGARDING THEIR PRODUCTS IN ORDER FOR THEM
TO SAVE
 * TIME. AS A RESULT, STMICROELECTRONICS SHALL NOT BE HELD LIABLE FOR ANY
 * DIRECT, INDIRECT OR CONSEQUENTIAL DAMAGES WITH RESPECT TO ANY CLAIMS
ARISING
 * FROM THE CONTENT OF SUCH FIRMWARE AND/OR THE USE MADE BY CUSTOMERS
OF THE
 * CODING INFORMATION CONTAINED HEREIN IN CONNECTION WITH THEIR
PRODUCTS.
 *
 * <h2><center>&copy; COPYRIGHT 2011 STMicroelectronics</center></h2>
 ******************************************************************************
 */

/* Define to prevent recursive inclusion -------------------------------------*/
#ifndef __STM32F4_DISCOVERY_DEMO_H
#define __STM32F4_DISCOVERY_DEMO_H

/* Includes ------------------------------------------------------------------*/
#include "stm32f4_discovery.h"
#include "stm32f4_discovery_audio_codec.h"
#include "stm32f4_discovery_lis302dl.h"
#include "selftest.h"
#include <stdio.h>
#include "seven_sine.h"
#define ARM_MATH_CM4

/* Exported types ------------------------------------------------------------*/
/* Exported constants --------------------------------------------------------*/
/* TIM2 Autoreload and Capture Compare register values */
#define TIM_ARR                          (uint16_t)1999
#define TIM_CCR                          (uint16_t)1000

/* MEMS Microphone SPI Interface */
#define SPI_SCK_PIN                   GPIO_Pin_10
#define SPI_SCK_GPIO_PORT             GPIOB
#define SPI_SCK_GPIO_CLK              RCC_AHB1Periph_GPIOB
```

```
#define SPI_SCK_SOURCE              GPIO_PinSource10
#define SPI_SCK_AF                  GPIO_AF_SPI2

#define SPI_MOSI_PIN                GPIO_Pin_3
#define SPI_MOSI_GPIO_PORT          GPIOC
#define SPI_MOSI_GPIO_CLK           RCC_AHB1Periph_GPIOC
#define SPI_MOSI_SOURCE             GPIO_PinSource3
#define SPI_MOSI_AF                 GPIO_AF_SPI2

/* Exported macro ------------------------------------------------------------*/
#define ABS(x)         (x < 0) ? (-x) : x
#define MAX(a,b)       (a < b) ? (b) : a
/* Exported functions ------------------------------------------------------- */
void TimingDelay_Decrement(void);
void Delay(__IO uint32_t nTime);
void Fail_Handler(void);
void Timer_Config(void);
void Input_Config(void);
void Output_Config(uint32_t* buffer);
void ADC3_CH12_DMA_Config(void);
#endif /* __STM32F4_DISCOVERY_DEMO_H */

/******************* (C) COPYRIGHT 2011 STMicroelectronics *****END OF FILE****/

/**
 ******************************************************************************
 * @file    main.c
 * @author  MCD Application Team, Matthew Lurie, Kyle Spesard
 * @version V1.0.0
 * @date    19-September-2011
 * @brief   Main program body
 ******************************************************************************
 * @attention
 *
 * THE PRESENT FIRMWARE WHICH IS FOR GUIDANCE ONLY AIMS AT PROVIDING
CUSTOMERS
 * WITH CODING INFORMATION REGARDING THEIR PRODUCTS IN ORDER FOR THEM
TO SAVE
 * TIME. AS A RESULT, STMICROELECTRONICS SHALL NOT BE HELD LIABLE FOR ANY
 * DIRECT, INDIRECT OR CONSEQUENTIAL DAMAGES WITH RESPECT TO ANY CLAIMS
ARISING
 * FROM THE CONTENT OF SUCH FIRMWARE AND/OR THE USE MADE BY CUSTOMERS
OF THE
```

```
 * CODING INFORMATION CONTAINED HEREIN IN CONNECTION WITH THEIR
PRODUCTS.
 *
 * <h2><center>&copy; COPYRIGHT 2011 STMicroelectronics</center></h2>
 ******************************************************************************
 */

/* Includes ------------------------------------------------------------------*/
#include "main.h"
#include "usbd_hid_core.h"
#include "usbd_usr.h"
#include "usbd_desc.h"
#define ARM_MATH_CM4
#include "arm_math.h"

/** @addtogroup STM32F4-Discovery_Demo
 * @{
 */

/* Private typedef -----------------------------------------------------------*/
/* Private define ------------------------------------------------------------*/

#define TESTRESULT_ADDRESS         0x080FFFFC
#define ALLTEST_PASS               0x00000000
#define ALLTEST_FAIL               0x55555555
#define ADC1_DR_ADDRESS     ((uint32_t)0x4001204C)
#define ADC3_DR_ADDRESS     ((uint32_t)0x4001224C)

/* Private macro -------------------------------------------------------------*/
/* Private variables ---------------------------------------------------------*/
#ifdef USB_OTG_HS_INTERNAL_DMA_ENABLED
 #if defined ( __ICCARM__ ) /*!< IAR Compiler */
   #pragma data_alignment = 4
 #endif
#endif /* USB_OTG_HS_INTERNAL_DMA_ENABLED */
__ALIGN_BEGIN USB_OTG_CORE_HANDLE  USB_OTG_dev __ALIGN_END;

uint16_t PrescalerValue = 0;

__IO uint32_t TimingDelay;
__IO uint8_t DemoEnterCondition = 0x00;
__IO uint8_t UserButtonPressed = 0x00;
LIS302DL_InitTypeDef  LIS302DL_InitStruct;
LIS302DL_FilterConfigTypeDef LIS302DL_FilterStruct;
```

```
__IO int8_t X_Offset, Y_Offset, Z_Offset  = 0x00;
uint32_t Buffer[4096];
__IO uint16_t ADC1ConvertedValue = 0;
__IO uint32_t ADC1ConvertedVoltage = 0;
__IO uint16_t ADC3ConvertedValue = 0;
__IO uint32_t ADC3ConvertedVoltage = 0;

uint32_t seven_sine[4096] =
        {0.5,0.000892773148988668,0.559625283885443,0.991984159327325,0.38160038148
4878,0.0221603180236262,0.675484199055719,0.956875659371208,0.26993566380175,0.07
0608717972496,0.781361083092391,0.895778796471002,0.171357647821766,0.1434820927
55278,0.871233363259801,0.812168930749758,0.0914737262896523,0.236635201377085,0.
939988853369651,0.71080202477955,0.0348279196705017,0.344769234968051,0.98371654
9202798,0.597444111153515,0.00464239958028329,0.461733227824836,0.99992909734778
9,0.478543304454648,0.00263420266933362,0.58087394151045,0.987704282806211,0.3608
63014498196,0.0289175607841363,0.695414319630937,0.947737487156532,0.25109722469
9401,0.0819974031410747,0.798838985721318,0.882302133309095,0.155489719610324,0.1
58854400126125,0.8852648560488,0.795120366863363,0.0794789210237022,0.2551167111
92668,0.949775785837754,0.691151330076473,0.0273885353586878,0.365308667356559,0.
988702213309492,0.576309072005903,0.00218160917066401,0.48316224253271,0.9998298
94600421,0.45712614089149,0.00529198279002291,0.601973596358585,0.98252585613397,
0.340381994571957,0.0365427294821948,0.714984407348529,0.937774399925122,0.232717
365999729,0.0941562195341514,0.815766305086642,0.868121113733636,0.1402565198099
03,0.174855236794557,0.898586533880847,0.77752807092562,0.0682588870531977,0.2740
49395878353,0.958734047911645,0.67114845668116,0.0208198940729502,0.386096256100
275,0.992787488670236,0.555033440432855,0.000638003223134453,0.504622279255574,0.
998809801380828,0.435787968458802,0.0088612167963083,0.622885374262565,0.9764584
20084087,0.320195056096198,0.0450217754479281,0.734158406127988,0.92700475374591
4,0.214829950896584,0.107062765654383,0.83211185416381,0.853261864964449,0.125686
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//2059,  693,   15,  369, 1580, 3030, 3979, 3938,
//2925, 1460,  296,   37,  819, 2240, 3561, 4095,
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//   0,   0,   0,   0,   0,   0,   0,   0,
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//   0,   0,   0,   0,   0,   0,   0,   0,
//   0,   0,   0,   0,   0,   0,   0,   0,
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//   0,   0,   0,   0,   0,   0,   0,   0,
//   0,   0,   0,   0,   0,   0,   0,   0,
//   0,   0,   0,   0,   0,   0,   0,   0,
//   0,   0,   0,   0,   0,   0,   0,   0,
//   0,   0,   0,   0,   0,   0,   0,   0,
//   0,   0,   0,   0,   0,   0,   0,   0,
//   0,   0,   0,   0,   0,   0,   0,   0,
//   0,   0,   0,   0,   0,   0,   0,   0,
//   0,   0,   0,   0,   0,   0,   0,   0,
//   0,   0,   0,   0,   0,   0,   0,   0,
//   0,   0,   0,   0,   0,   0,   0,   0,
//   0,   0,   0,   0,   0,   0,   0,   0,
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//  0,  0,  0,  0,  0,  0,  0,  0,
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//  0,  0,  0,  0,  0,  0,  0,  0,
//  0,  0,  0,  0,  0,  0,  0,  0,
//  0,  0,  0,  0,  0,  0,  0,  0,
//  0,  0,  0,  0,  0,  0,  0,  0,
//  0,  0,  0,  0,  0,  0,  0,  0,
//  0,  0,  0,  0,  0,  0,  0,  0,
//  0,  0,  0,  0,  0,  0,  0,  0,
//  0,  0,  0,  0,  0,  0,  0,  0,
//  0,  0,  0,  0,  0,  0,  0,  0,
//  0,  0,  0,  0,  0,  0,  0,  0,
//  0,  0,  0,  0,  0,  0,  0,  0,
//  0,  0,  0,  0,  0,  0,  0,  0,
//  0,  0,  0,  0,  0,  0,  0,  0,
//  0,  0,  0,  0,  0,  0,  0,  0,
//  0,  0,  0,  0,  0,  0,  0,  0,
//  0,  0,  0,  0,  0,  0,  0,  0,
//  0,  0,  0,  0,  0,  0,  0,  0,
//  0,  0,  0,  0,  0,  0,  0,  0,
```

```
//   0,    0,    0,    0,    0,    0,    0,    0,
//   0,    0,    0,    0,    0,    0,    0,    0,
//   0,    0,    0,    0,    0,    0,    0,    0,
//   0,    0,    0,    0,    0,    0,    0,    0,
//   0,    0,    0,    0,    0,    0,    0,    0,
//   0,    0,    0,    0,    0,    0,    0,    0,
//   0,    0,    0,    0,    0,    0,    0,    0,
//   0,    0,    0,    0,    0,    0,    0,    0,
//   0,    0,    0,    0,    0,    0,    0,    0,
//   0,    0,    0,    0,    0,    0,    0,    0,
//   0,    0,    0,    0,    0,    0,    0,    0,
//   0,    0,    0,    0,    0,    0,    0,    0,
//   0,    0,    0,    0,    0,    0,    0,    0
//};

/* Private function prototypes -----------------------------------------------*/
static uint32_t Demo_USBConfig(void);
static void TIM4_Config(void);
static void Demo_Exec(void);
void CrossCorrTimeDomain(uint32_t * signal, uint32_t * part, uint32_t * corr_output);

/* Private functions ---------------------------------------------------------*/

/**
 * @brief  Main program.
 * @param  None
 * @retval None
 */
int main(void)
{


 RCC_ClocksTypeDef RCC_Clocks;
 uint8_t togglecounter = 0x00;
 uint16_t dacval = 0;
 GPIO_InitTypeDef  GPIO_InitStruct2;
 uint16_t count = 0;
 const uint8_t out_volume = 75;
 const uint32_t fsample = 80000;
 //float32_t iir_state[2];
 //float32_t iir_coeffs[5] = {0.6102,-1.2204,0.6102,-1.0622,0.3786};
 //float32_t iir_input[4096];
 //float32_t iir_output[4096];
 const uint8_t num_stages = 1;
```

```
 uint32_t iir_block_size = 4096;
 arm_biquad_cascade_df2T_instance_f32 S1;
 uint16_t ADC_input[4096];
 int i;
 float32_t test_float = 1;
 uint32_t signal[4096];
 uint32_t part[256];
 uint32_t corr_output[4096];
 int index = 0;

 //arm_biquad_cascade_df2T_instance_f32 S1 = {num_stages, iir_state, iir_coeffs};

 /* Initialize ADC on STM32F4-Discovery --------------------*/
 //EVAL_AUDIO_SetAudioInterface(AUDIO_INTERFACE_I2S);
 //EVAL_AUDIO_Init(OUTPUT_DEVICE_AUTO, out_volume, fsample);
 //EVAL_AUDIO_Play((uint16_t*)seven_sine, 4096*sizeof(uint16_t));

 /* Initialize LEDs and User_Button on STM32F4-Discovery --------------------*/
 STM_EVAL_PBInit(BUTTON_USER, BUTTON_MODE_EXTI);

 STM_EVAL_LEDInit(LED4);
 STM_EVAL_LEDInit(LED3);
 STM_EVAL_LEDInit(LED5);
 STM_EVAL_LEDInit(LED6);

 /* SysTick end of count event each 10ms */
 RCC_GetClocksFreq(&RCC_Clocks);
 SysTick_Config(RCC_Clocks.HCLK_Frequency / 100);


//    Demo_Exec();
//}
//
///**
// * @brief  Execute the demo application.
// * @param  None
// * @retval None
// */
//static void Demo_Exec(void)
//{

//Buffer[5] = 8;

test_float = test_float + 2;
```

```
 Timer_Config();
 Input_Config();
//ADC3_CH12_DMA_Config();
 Output_Config(seven_sine);

// for(i=0;i<4096;i++) {
//          iir_input[i] = 0;
//          iir_output[i] = 0;
//          }
//
//// arm_biquad_cascade_df2T_instance_f32 S1 = {(uint8_t)1, iir_state, iir_coeffs};
//
// arm_biquad_cascade_df2T_init_f32(&S1, num_stages, &iir_coeffs[0], &iir_state[0] );
// arm_biquad_cascade_df2T_f32(&S1, &iir_input[0] , &iir_output[0] , iir_block_size );

   for (i=0;i<4096;i++) {
          signal[i]=1;
          corr_output[i]=0;
   }

   for (i=0;i<256;i++) {
          part[i]=1;
   }

   CrossCorrTimeDomain(signal,part,corr_output);


 ADC_SoftwareStartConv(ADC1);

//  while (1)
//  {
//  /* convert the ADC value (from 0 to 0xFFF) to a voltage value (from 0V to 3.3V)*/
//    ADC1ConvertedVoltage = ADC1ConvertedValue *3300/0xFFF;
//          Buffer[index]=ADC1ConvertedVoltage;
//          index++;
//          if (index == 4096)
//                      index=0;
//
//  }
//
   while (1)
  {
  /* convert the ADC value (from 0 to 0xFFF) to a voltage value (from 0V to 3.3V)*/
```

```
    ADC1ConvertedVoltage = ADC1ConvertedValue *3300/0xFFF;
            Buffer[index]=ADC1ConvertedVoltage;
            index++;
            if (index == 4096)
                    index=0;

  }

 while(1)
 {
            DAC_SetChannel1Data(DAC_Align_12b_R, dacval);
            dacval = (dacval + 1) & 0x03FF;
            Delay(10);
 }

// while(1)
// {
//          if (TIM_GetFlagStatus(TIM8, TIM_FLAG_Update))
//          {
//                  DAC_SetChannel1Data(DAC_Align_12b_R, dacval);
//                  dacval = (dacval + 1) & 0x0FFF;
//          }
// }

 while(1)
 {

            GPIO_InitStruct2.GPIO_Pin = GPIO_Pin_7;
    GPIO_InitStruct2.GPIO_Mode = GPIO_Mode_OUT;
    GPIO_InitStruct2.GPIO_Speed = GPIO_Speed_25MHz;
    GPIO_InitStruct2.GPIO_OType = GPIO_OType_PP;
            GPIO_InitStruct2.GPIO_PuPd = GPIO_PuPd_UP;
            GPIO_Init(GPIOA, &GPIO_InitStruct2);

            //GPIO_InitStruct2.GPIO_PuPd = GPIO_PuPd_DOWN;
            //GPIO_Init(GPIOA, &GPIO_InitStruct2);

            //ADC_input[dacval] = ADC_GetConversionValue(ADC1);   //DO NOT USE EVERRRRR

            DAC_SetChannel1Data(DAC_Align_12b_R, dacval);
//          DAC_SetChannel1Data(DAC_Align_12b_R, dacval);
            dacval = (dacval + 1) & 0x0FFF;
```

```
//		DAC_SetChannel1Data(DAC_Align_12b_R, 400*seven_sine[dacval]);
//		dacval = (dacval + 1) & 0x0FFF;

		DemoEnterCondition = 0x00;

    /* Reset UserButton_Pressed variable */
    UserButtonPressed = 0x00;

    /* Initialize LEDs to be managed by GPIO */
    STM_EVAL_LEDInit(LED4);
    STM_EVAL_LEDInit(LED3);
    STM_EVAL_LEDInit(LED5);
    STM_EVAL_LEDInit(LED6);

    /* SysTick end of count event each 10ms */
    RCC_GetClocksFreq(&RCC_Clocks);
    SysTick_Config(RCC_Clocks.HCLK_Frequency / 100);

    /* Turn OFF all LEDs */
    STM_EVAL_LEDOff(LED4);
    STM_EVAL_LEDOff(LED3);
    STM_EVAL_LEDOff(LED5);
    STM_EVAL_LEDOff(LED6);

		STM_EVAL_LEDToggle(LED4);
//		STM_EVAL_LEDOff(LED4);
//    Delay(10);
//		STM_EVAL_LEDToggle(LED4);
//		Delay(10);

		STM_EVAL_LEDToggle(LED6);
//		STM_EVAL_LEDOff(LED4);
//    Delay(10);
//		STM_EVAL_LEDToggle(LED6);
//		Delay(10);

//    /* Waiting User Button is pressed */
//    while (UserButtonPressed == 0x00)
//    {
//      /* Toggle LED4 */
//      STM_EVAL_LEDToggle(LED4);
//      Delay(10);
//      /* Toggle LED4 */
//      STM_EVAL_LEDToggle(LED3);
```

```
//     Delay(10);
//     /* Toggle LED4 */
//     STM_EVAL_LEDToggle(LED5);
//     Delay(10);
//     /* Toggle LED4 */
//     STM_EVAL_LEDToggle(LED6);
//     Delay(10);
//     togglecounter ++;
//     if (togglecounter == 0x10)
//     {
//       togglecounter = 0x00;
//       while (togglecounter < 0x10)
//       {
//         STM_EVAL_LEDToggle(LED4);
//         STM_EVAL_LEDToggle(LED3);
//         STM_EVAL_LEDToggle(LED5);
//         STM_EVAL_LEDToggle(LED6);
//         Delay(10);
//         togglecounter ++;
//       }
//      togglecounter = 0x00;
//     }
//    }


//    /* TIM4 channels configuration */
//    TIM4_Config();
//
//    /* Disable all Timer4 channels */
//    TIM_CCxCmd(TIM4, TIM_Channel_1, DISABLE);
//    TIM_CCxCmd(TIM4, TIM_Channel_2, DISABLE);
//    TIM_CCxCmd(TIM4, TIM_Channel_3, DISABLE);
//    TIM_CCxCmd(TIM4, TIM_Channel_4, DISABLE);

 }
}

/**
 * @brief  Initializes the USB for the demonstration application.
 * @param  None
 * @retval None
 */
static uint32_t Demo_USBConfig(void)
{
```

```
 USBD_Init(&USB_OTG_dev,
          USB_OTG_FS_CORE_ID,
          &USR_desc,
          &USBD_HID_cb,
          &USR_cb);

 return 0;
}

/**
 * @brief  Configures the TIM Peripheral.
 * @param  None
 * @retval None
 */
static void TIM4_Config(void)
{
 GPIO_InitTypeDef GPIO_InitStructure;
 TIM_OCInitTypeDef  TIM_OCInitStructure;
 TIM_TimeBaseInitTypeDef  TIM_TimeBaseStructure;

 /* --------------------------- System Clocks Configuration -----------------*/
 /* TIM4 clock enable */
 RCC_APB1PeriphClockCmd(RCC_APB1Periph_TIM4, ENABLE);

 /* GPIOD clock enable */
 RCC_AHB1PeriphClockCmd(RCC_AHB1Periph_GPIOD, ENABLE);

 /*-------------------------- GPIO Configuration ----------------------------*/
 /* GPIOD Configuration: Pins 12, 13, 14 and 15 in output push-pull */
 GPIO_InitStructure.GPIO_Pin = GPIO_Pin_12 | GPIO_Pin_13 | GPIO_Pin_14 | GPIO_Pin_15;
 GPIO_InitStructure.GPIO_Mode = GPIO_Mode_AF;
 GPIO_InitStructure.GPIO_OType = GPIO_OType_PP;
 //GPIO_InitStructure.GPIO_PuPd = GPIO_PuPd_NOPULL;
 GPIO_InitStructure.GPIO_PuPd = GPIO_PuPd_UP;
 GPIO_InitStructure.GPIO_Speed = GPIO_Speed_100MHz;
 GPIO_Init(GPIOD, &GPIO_InitStructure);

 /* Connect TIM4 pins to AF2 */
 //GPIO_PinAFConfig(GPIOD, GPIO_PinSource12, GPIO_AF_TIM4);
 //GPIO_PinAFConfig(GPIOD, GPIO_PinSource13, GPIO_AF_TIM4);
 //GPIO_PinAFConfig(GPIOD, GPIO_PinSource14, GPIO_AF_TIM4);
 //GPIO_PinAFConfig(GPIOD, GPIO_PinSource15, GPIO_AF_TIM4);

   /* -----------------------------------------------------------------------
```

```
  TIM4 Configuration: Output Compare Timing Mode:

  In this example TIM4 input clock (TIM4CLK) is set to 2 * APB1 clock (PCLK1),
  since APB1 prescaler is different from 1 (APB1 Prescaler = 4, see system_stm32f4xx.c file).
   TIM4CLK = 2 * PCLK1
   PCLK1 = HCLK / 4
   => TIM4CLK = 2*(HCLK / 4) = HCLK/2 = SystemCoreClock/2

  To get TIM4 counter clock at 2 KHz, the prescaler is computed as follows:
    Prescaler = (TIM4CLK / TIM1 counter clock) - 1
    Prescaler = (168 MHz/(2 * 2 KHz)) - 1 = 41999

  To get TIM4 output clock at 1 Hz, the period (ARR)) is computed as follows:
    ARR = (TIM4 counter clock / TIM4 output clock) - 1
        = 1999

  TIM4 Channel1 duty cycle = (TIM4_CCR1/ TIM4_ARR)* 100 = 50%
  TIM4 Channel2 duty cycle = (TIM4_CCR2/ TIM4_ARR)* 100 = 50%
  TIM4 Channel3 duty cycle = (TIM4_CCR3/ TIM4_ARR)* 100 = 50%
  TIM4 Channel4 duty cycle = (TIM4_CCR4/ TIM4_ARR)* 100 = 50%

  ==> TIM4_CCRx = TIM4_ARR/2 = 1000  (where x = 1, 2, 3 and 4).

  Note:
  SystemCoreClock variable holds HCLK frequency and is defined in system_stm32f4xx.c file.
  Each time the core clock (HCLK) changes, user had to call SystemCoreClockUpdate()
  function to update SystemCoreClock variable value. Otherwise, any configuration
  based on this variable will be incorrect.
--------------------------------------------------------------------- */


/* Compute the prescaler value */
PrescalerValue = (uint16_t) ((SystemCoreClock /2) / 2000) - 1;

/* Time base configuration */
TIM_TimeBaseStructure.TIM_Period = TIM_ARR;
TIM_TimeBaseStructure.TIM_Prescaler = PrescalerValue;
TIM_TimeBaseStructure.TIM_ClockDivision = 0;
TIM_TimeBaseStructure.TIM_CounterMode = TIM_CounterMode_Up;
TIM_TimeBaseInit(TIM4, &TIM_TimeBaseStructure);

/* Enable TIM4 Preload register on ARR */
TIM_ARRPreloadConfig(TIM4, ENABLE);
```

```
 /* TIM PWM1 Mode configuration: Channel */
 TIM_OCInitStructure.TIM_OCMode = TIM_OCMode_PWM1;
 TIM_OCInitStructure.TIM_OutputState = TIM_OutputState_Enable;
 TIM_OCInitStructure.TIM_Pulse = TIM_CCR;
 TIM_OCInitStructure.TIM_OCPolarity = TIM_OCPolarity_High;

 /* Output Compare PWM1 Mode configuration: Channel1 */
 TIM_OC1Init(TIM4, &TIM_OCInitStructure);
 TIM_CCxCmd(TIM4, TIM_Channel_1, DISABLE);

 TIM_OC1PreloadConfig(TIM4, TIM_OCPreload_Enable);

 /* Output Compare PWM1 Mode configuration: Channel2 */
 TIM_OC2Init(TIM4, &TIM_OCInitStructure);
 TIM_CCxCmd(TIM4, TIM_Channel_2, DISABLE);

 TIM_OC2PreloadConfig(TIM4, TIM_OCPreload_Enable);

 /* Output Compare PWM1 Mode configuration: Channel3 */
 TIM_OC3Init(TIM4, &TIM_OCInitStructure);
 TIM_CCxCmd(TIM4, TIM_Channel_3, DISABLE);

 TIM_OC3PreloadConfig(TIM4, TIM_OCPreload_Enable);

 /* Output Compare PWM1 Mode configuration: Channel4 */
 TIM_OC4Init(TIM4, &TIM_OCInitStructure);
 TIM_CCxCmd(TIM4, TIM_Channel_4, DISABLE);

 TIM_OC4PreloadConfig(TIM4, TIM_OCPreload_Enable);

 /* TIM4 enable counter */
 TIM_Cmd(TIM4, ENABLE);
}

/**
 * @brief  Inserts a delay time.
 * @param  nTime: specifies the delay time length, in 10 ms.
 * @retval None
 */
void Delay(__IO uint32_t nTime)
{
 //TimingDelay = nTime;

 while(nTime != 0)
```

```
 {
   nTime--;
 }

}

/**
 * @brief  Decrements the TimingDelay variable.
 * @param  None
 * @retval None
 */
void TimingDelay_Decrement(void)
{
 if (TimingDelay != 0x00)
 {
    TimingDelay--;
 }
}

/**
 * @brief  This function handles the test program fail.
 * @param  None
 * @retval None
 */
void Fail_Handler(void)
{
 /* Erase last sector */
 FLASH_EraseSector(FLASH_Sector_11, VoltageRange_3);
 /* Write FAIL code at last word in the flash memory */
 FLASH_ProgramWord(TESTRESULT_ADDRESS, ALLTEST_FAIL);

 while(1)
 {
    /* Toggle Red LED */
    STM_EVAL_LEDToggle(LED5);
    Delay(5);
 }
}

/**
 * @brief  MEMS accelerometre management of the timeout situation.
 * @param  None.
 * @retval None.
 */
```

```
uint32_t LIS302DL_TIMEOUT_UserCallback(void)
{
 /* MEMS Accelerometer Timeout error occured during Test program execution */
 if (DemoEnterCondition == 0x00)
 {
   /* Timeout error occured for SPI TXE/RXNE flags waiting loops.*/
   Fail_Handler();
 }
 /* MEMS Accelerometer Timeout error occured during Demo execution */
 else
 {
   while (1)
   {
   }
 }
 return 0;
}

#ifdef  USE_FULL_ASSERT

/**
 * @brief  Reports the name of the source file and the source line number
 *   where the assert_param error has occurred.
 * @param  file: pointer to the source file name
 * @param  line: assert_param error line source number
 * @retval None
 */
void assert_failed(uint8_t* file, uint32_t line)
{
 /* User can add his own implementation to report the file name and line number,
   ex: printf("Wrong parameters value: file %s on line %d\r\n", file, line) */

 /* Infinite loop */
 while (1)
 {
 }
}
#endif




/**
 * @brief    Sets up timer for the ADC and DAC and DMA for the input/output buffer
 * @param
```

```
 *
 */
void Timer_Config(void)
{

/* Declarations */
TIM_TimeBaseInitTypeDef TIM_TimeBaseInitStruct;
GPIO_InitTypeDef GPIO_InitStructure;

/* Initialize prescaler value */
//uint16_t prescalervalue = 0;
//prescalervalue = (uint16_t)(0);

/* Timer initializations */
TIM_TimeBaseInitStruct.TIM_Prescaler = 0x0000;
TIM_TimeBaseInitStruct.TIM_CounterMode = TIM_CounterMode_Up;
//TIM_TimeBaseInitStruct.TIM_Period = 1457; // given by(168e6/desired_freq)-1
TIM_TimeBaseInitStruct.TIM_Period = 4000; // given by(168e6/desired_freq)-1
TIM_TimeBaseInitStruct.TIM_ClockDivision = TIM_CKD_DIV1;
// TIM_TimeBaseInitStruct.TIM_RepetitionCounter =      not needed?

/* Initialize timer clock */
RCC_APB2PeriphClockCmd(RCC_APB2Periph_TIM8, ENABLE);
RCC_AHB1PeriphClockCmd(RCC_AHB1Periph_GPIOD, ENABLE);

/* Timer Function Calls */
TIM_TimeBaseInit(TIM8, &TIM_TimeBaseInitStruct);
TIM_ARRPreloadConfig(TIM8, ENABLE);
TIM_SelectOutputTrigger(TIM8,TIM_TRGOSource_Update);
TIM_Cmd(TIM8,ENABLE);


/* GPIOD Configuration: Pins 12, 13, 14 and 15 in output push-pull */
 GPIO_InitStructure.GPIO_Pin = GPIO_Pin_12 | GPIO_Pin_13 | GPIO_Pin_14 | GPIO_Pin_15;
 GPIO_InitStructure.GPIO_Mode = GPIO_Mode_OUT;
 GPIO_InitStructure.GPIO_OType = GPIO_OType_PP;
 GPIO_InitStructure.GPIO_PuPd = GPIO_PuPd_UP;

 GPIO_InitStructure.GPIO_Speed = GPIO_Speed_2MHz;
 GPIO_Init(GPIOE, &GPIO_InitStructure);
 GPIO_ToggleBits(GPIOE, GPIO_Pin_13);
// GPIOE->ODR ^= GPIO_Pin_13;

 /* Connect TIM4 pins to AF2 */
```

```
 //GPIO_PinAFConfig(GPIOE, GPIO_PinSource12, GPIO_AF_TIM8);
 //GPIO_PinAFConfig(GPIOE, GPIO_PinSource13, GPIO_AF_TIM8);
 //GPIO_PinAFConfig(GPIOE, GPIO_PinSource14, GPIO_AF_TIM8);
 //GPIO_PinAFConfig(GPIOE, GPIO_PinSource15, GPIO_AF_TIM8);


}




/**
 * @brief    Sets up ADC and DAC and DMA for the input/output buffer
 * @param
 *
 */
void Input_Config(void)
{
  /* Declarations */
  ADC_InitTypeDef ADC_InitStructure;
  DMA_InitTypeDef DMA_InitStructure;
  GPIO_InitTypeDef GPIO_InitStructure;
  ADC_CommonInitTypeDef ADC_CommonInitStructure;

        /* Initialize ADC clock */
  RCC_AHB1PeriphClockCmd(RCC_AHB1Periph_DMA2 | RCC_AHB1Periph_GPIOC,
ENABLE);
  RCC_APB2PeriphClockCmd(RCC_APB2Periph_ADC1, ENABLE);
  /* Initialize DMA Clock for ADC*/
  //RCC_AHB1PeriphResetCmd(RCC_AHB1Periph_DMA2, ENABLE);
  /* Initialize GPIO Clock */
  //RCC_AHB1PeriphClockCmd(RCC_AHB1Periph_GPIOC, ENABLE);

  /* DMA Initialization for ADC*/
  DMA_InitStructure.DMA_Channel = DMA_Channel_0;
  //DMA_InitStructure.DMA_Channel = DMA_Channel_2;
  DMA_InitStructure.DMA_PeripheralBaseAddr = (uint32_t)ADC1_DR_ADDRESS;
  DMA_InitStructure.DMA_Memory0BaseAddr = (uint32_t)&ADC1ConvertedValue;
  DMA_InitStructure.DMA_DIR = DMA_DIR_PeripheralToMemory;
  DMA_InitStructure.DMA_BufferSize = 1;
  DMA_InitStructure.DMA_PeripheralInc = DMA_PeripheralInc_Disable;
  DMA_InitStructure.DMA_MemoryInc = DMA_MemoryInc_Disable;
  DMA_InitStructure.DMA_PeripheralDataSize = DMA_PeripheralDataSize_HalfWord;
  DMA_InitStructure.DMA_MemoryDataSize = DMA_MemoryDataSize_HalfWord;
  DMA_InitStructure.DMA_Mode = DMA_Mode_Circular;
```

```
DMA_InitStructure.DMA_Priority = DMA_Priority_High;
DMA_InitStructure.DMA_FIFOMode = DMA_FIFOMode_Disable;
DMA_InitStructure.DMA_FIFOThreshold = DMA_FIFOThreshold_HalfFull;
DMA_InitStructure.DMA_MemoryBurst = DMA_MemoryBurst_Single;
DMA_InitStructure.DMA_PeripheralBurst = DMA_PeripheralBurst_Single;
DMA_Init(DMA2_Stream0,&DMA_InitStructure);
DMA_Cmd(DMA2_Stream0,ENABLE);

 /* GPIO Initialization */
GPIO_InitStructure.GPIO_Pin = GPIO_Pin_5;
//GPIO_InitStructure.GPIO_Pin = GPIO_Pin_2;
GPIO_InitStructure.GPIO_Mode = GPIO_Mode_AN;
//GPIO_InitStruct.GPIO_Speed = GPIO_Speed_25MHz;
//GPIO_InitStruct.GPIO_OType = GPIO_OType_PP;
GPIO_InitStructure.GPIO_PuPd = GPIO_PuPd_NOPULL;
GPIO_Init(GPIOC,&GPIO_InitStructure);

/* ADC Common Initialization  */
ADC_CommonInitStructure.ADC_Mode = ADC_Mode_Independent;
ADC_CommonInitStructure.ADC_Prescaler = ADC_Prescaler_Div2;
ADC_CommonInitStructure.ADC_DMAAccessMode = ADC_DMAAccessMode_Disabled;
ADC_CommonInitStructure.ADC_TwoSamplingDelay = ADC_TwoSamplingDelay_5Cycles;
ADC_CommonInit(&ADC_CommonInitStructure);

  /* ADC initialization */
ADC_InitStructure.ADC_Resolution = ADC_Resolution_12b;
ADC_InitStructure.ADC_ScanConvMode = DISABLE;
ADC_InitStructure.ADC_ContinuousConvMode = ENABLE;
ADC_InitStructure.ADC_ExternalTrigConvEdge = ADC_ExternalTrigConvEdge_None;
//ADC_InitStruct.ADC_ExternalTrigConv = ADC_ExternalTrigConv_T8_TRGO;
ADC_InitStructure.ADC_DataAlign = ADC_DataAlign_Right;
ADC_InitStructure.ADC_NbrOfConversion = 1;

/* ADC Function Calls  */
ADC_Init(ADC1, &ADC_InitStructure);
ADC_RegularChannelConfig(ADC1, ADC_Channel_15, 1, ADC_SampleTime_3Cycles);
//ADC_RegularChannelConfig(ADC3, ADC_Channel_12, 1, ADC_SampleTime_3Cycles);
ADC_DMARequestAfterLastTransferCmd(ADC1,ENABLE);
ADC_DMACmd(ADC1,ENABLE);
ADC_Cmd(ADC1,ENABLE);


/* ADC Channel Config */
//ADC_RegularChannelConfig(ADC1,ADC_Channel_1,1,ADC_SampleTime_480Cycles);
```

```
  /* DMA Function Calls for ADC */

}

void ADC3_CH12_DMA_Config(void)
{
  ADC_InitTypeDef       ADC_InitStructure;
  DMA_InitTypeDef       DMA_InitStructure;
  GPIO_InitTypeDef      GPIO_InitStructure;
  ADC_CommonInitTypeDef ADC_CommonInitStructure;

  /* Enable ADC3, DMA2 and GPIO clocks ****************************************/
  RCC_AHB1PeriphClockCmd(RCC_AHB1Periph_DMA2 | RCC_AHB1Periph_GPIOC,
ENABLE);
  RCC_APB2PeriphClockCmd(RCC_APB2Periph_ADC3, ENABLE);

  /* DMA2 Stream0 channel0 configuration **************************************/
  DMA_InitStructure.DMA_Channel = DMA_Channel_2;
  DMA_InitStructure.DMA_PeripheralBaseAddr = (uint32_t)ADC3_DR_ADDRESS;
  DMA_InitStructure.DMA_Memory0BaseAddr = (uint32_t)&ADC3ConvertedValue;
  DMA_InitStructure.DMA_DIR = DMA_DIR_PeripheralToMemory;
  DMA_InitStructure.DMA_BufferSize = 1;
  DMA_InitStructure.DMA_PeripheralInc = DMA_PeripheralInc_Disable;
  DMA_InitStructure.DMA_MemoryInc = DMA_MemoryInc_Disable;
  DMA_InitStructure.DMA_PeripheralDataSize = DMA_PeripheralDataSize_HalfWord;
  DMA_InitStructure.DMA_MemoryDataSize = DMA_MemoryDataSize_HalfWord;
  DMA_InitStructure.DMA_Mode = DMA_Mode_Circular;
  DMA_InitStructure.DMA_Priority = DMA_Priority_High;
  DMA_InitStructure.DMA_FIFOMode = DMA_FIFOMode_Disable;
  DMA_InitStructure.DMA_FIFOThreshold = DMA_FIFOThreshold_HalfFull;
  DMA_InitStructure.DMA_MemoryBurst = DMA_MemoryBurst_Single;
  DMA_InitStructure.DMA_PeripheralBurst = DMA_PeripheralBurst_Single;
  DMA_Init(DMA2_Stream0, &DMA_InitStructure);
  DMA_Cmd(DMA2_Stream0, ENABLE);

  /* Configure ADC3 Channel12 pin as analog input ******************************/
```

```
  GPIO_InitStructure.GPIO_Pin = GPIO_Pin_2;
  GPIO_InitStructure.GPIO_Mode = GPIO_Mode_AN;
  GPIO_InitStructure.GPIO_PuPd = GPIO_PuPd_NOPULL ;
  GPIO_Init(GPIOC, &GPIO_InitStructure);

  /* ADC Common Init **********************************************************/
  ADC_CommonInitStructure.ADC_Mode = ADC_Mode_Independent;
  ADC_CommonInitStructure.ADC_Prescaler = ADC_Prescaler_Div2;
  ADC_CommonInitStructure.ADC_DMAAccessMode = ADC_DMAAccessMode_Disabled;
  ADC_CommonInitStructure.ADC_TwoSamplingDelay = ADC_TwoSamplingDelay_5Cycles;
  ADC_CommonInit(&ADC_CommonInitStructure);

  /* ADC3 Init ****************************************************************/
  ADC_InitStructure.ADC_Resolution = ADC_Resolution_12b;
  ADC_InitStructure.ADC_ScanConvMode = DISABLE;
  ADC_InitStructure.ADC_ContinuousConvMode = ENABLE;
  ADC_InitStructure.ADC_ExternalTrigConvEdge = ADC_ExternalTrigConvEdge_None;
  ADC_InitStructure.ADC_DataAlign = ADC_DataAlign_Right;
  ADC_InitStructure.ADC_NbrOfConversion = 1;
  ADC_Init(ADC3, &ADC_InitStructure);

  /* ADC3 regular channel12 configuration *************************************/
  ADC_RegularChannelConfig(ADC3, ADC_Channel_12, 1, ADC_SampleTime_3Cycles);

 /* Enable DMA request after last transfer (Single-ADC mode) */
  ADC_DMARequestAfterLastTransferCmd(ADC3, ENABLE);

  /* Enable ADC3 DMA */
  ADC_DMACmd(ADC3, ENABLE);

  /* Enable ADC3 */
  ADC_Cmd(ADC3, ENABLE);
}

void Output_Config(uint32_t* buffer)
{
   /* Declarations */
   DAC_InitTypeDef DAC_InitStruct;
   DMA_InitTypeDef DMA_InitStruct;
   GPIO_InitTypeDef GPIO_InitStruct;
   GPIO_InitTypeDef GPIO_InitStruct2;

   /* Initialize DAC Clock */
   RCC_APB1PeriphClockCmd(RCC_APB1Periph_DAC, ENABLE);
```

```
  /* DAC Initialization */
  DAC_InitStruct.DAC_Trigger = DAC_Trigger_T8_TRGO;
  DAC_InitStruct.DAC_WaveGeneration = DAC_WaveGeneration_None;
  DAC_InitStruct.DAC_LFSRUnmask_TriangleAmplitude = DAC_TriangleAmplitude_1;
  DAC_InitStruct.DAC_OutputBuffer    = DAC_OutputBuffer_Enable;

  /* DAC Function Calls */
  DAC_Init(DAC_Channel_1,&DAC_InitStruct);

   /* Initialize DMA Clock for DAC */
  RCC_AHB1PeriphResetCmd(RCC_AHB1Periph_DMA1, ENABLE);

  /* DMA Initialization for DAC*/
  DMA_InitStruct.DMA_Channel = DMA_Channel_7;
  DMA_InitStruct.DMA_PeripheralBaseAddr = DAC_BASE+0x00; // possibly 0x04?? see
pg263-264 in Ref Man
  DMA_InitStruct.DMA_Memory0BaseAddr = (uint32_t)buffer;
  DMA_InitStruct.DMA_DIR = DMA_DIR_MemoryToPeripheral;
  DMA_InitStruct.DMA_BufferSize = 4096;
  DMA_InitStruct.DMA_PeripheralInc = DMA_PeripheralInc_Disable;
  DMA_InitStruct.DMA_MemoryInc = DMA_MemoryInc_Enable;
  DMA_InitStruct.DMA_PeripheralDataSize = DMA_PeripheralDataSize_Word;
  DMA_InitStruct.DMA_MemoryDataSize = DMA_MemoryDataSize_Word;
  DMA_InitStruct.DMA_Mode = DMA_Mode_Circular;
  DMA_InitStruct.DMA_Priority = DMA_Priority_High;
  DMA_InitStruct.DMA_FIFOMode = DMA_FIFOMode_Disable;
  DMA_InitStruct.DMA_FIFOThreshold = DMA_FIFOThreshold_1QuarterFull;
  DMA_InitStruct.DMA_MemoryBurst = DMA_MemoryBurst_Single;
  DMA_InitStruct.DMA_PeripheralBurst = DMA_PeripheralBurst_Single;

  /* DMA Function Calls for DAC */
  DMA_Init(DMA1_Stream5,&DMA_InitStruct);
  DMA_Cmd(DMA1_Stream5,ENABLE);
  DAC_DMACmd(DAC_Channel_1,ENABLE);
  DAC_Cmd(DAC_Channel_1,ENABLE);

  /* GPIO Initialization */
  GPIO_InitStruct.GPIO_Pin = GPIO_Pin_4;
  GPIO_InitStruct.GPIO_Mode = GPIO_Mode_AN;
  GPIO_InitStruct.GPIO_Speed = GPIO_Speed_25MHz;
  GPIO_InitStruct.GPIO_OType = GPIO_OType_PP;
  GPIO_InitStruct.GPIO_PuPd = GPIO_PuPd_NOPULL;
  GPIO_Init(GPIOA,&GPIO_InitStruct);
```

```
  GPIO_InitStruct2.GPIO_Pin = GPIO_Pin_7;
  GPIO_InitStruct2.GPIO_Mode = GPIO_Mode_OUT;
  GPIO_InitStruct2.GPIO_Speed = GPIO_Speed_25MHz;
  GPIO_InitStruct2.GPIO_OType = GPIO_OType_PP;
  GPIO_InitStruct2.GPIO_PuPd = GPIO_PuPd_UP;



  GPIO_Init(GPIOA, &GPIO_InitStruct2);

  /* Initialize GPIO Clock */
  RCC_AHB1PeriphClockCmd(RCC_AHB1Periph_GPIOA, ENABLE);




}

void CrossCorrTimeDomain(uint32_t * signal, uint32_t * part, uint32_t * corr_output)
{
 /*  initializations */
 int i = 0;
 int j = 0;

 for (i=0;i<(4096-256);i++)
 {
        corr_output[i] = 0;
  for (j=0;j<256;j++)
  {
                corr_output[i] = corr_output[i] + part[j]*signal[i+j];
  }

 }








}
```

```
// if (STM_EVAL_PBGetState(BUTTON_USER) == Bit_SET)
// {
//    /* Turn on LEDs available on STM32F4-Discovery ---------------------------*/
//    STM_EVAL_LEDOn(LED4);
//    STM_EVAL_LEDOn(LED3);
//    STM_EVAL_LEDOn(LED5);
//    STM_EVAL_LEDOn(LED6);
//
//    if ((*(__IO uint32_t*) TESTRESULT_ADDRESS) == ALLTEST_PASS)
//    {
//     TimingDelay = 300;
//     /* Waiting User Button is pressed or Test Program condition verified */
//     while ((STM_EVAL_PBGetState(BUTTON_USER) == Bit_SET)&&(TimingDelay != 0x00))
//     {}
//    }
//    else
//    {
//     /* Waiting User Button is Released  or TimeOut*/
//     TimingDelay = 300;
//     while ((STM_EVAL_PBGetState(BUTTON_USER) == Bit_SET)&&(TimingDelay != 0x00))
//     {}
//     if (STM_EVAL_PBGetState(BUTTON_USER) == Bit_RESET)
//     {
//       TimingDelay = 0x00;
//     }
//    }
//    if (TimingDelay == 0x00)
//    {
//     /* Turn off LEDs available on STM32F4-Discovery ------------------------*/
//     STM_EVAL_LEDOff(LED4);
//     STM_EVAL_LEDOff(LED3);
//     STM_EVAL_LEDOff(LED5);
//     STM_EVAL_LEDOff(LED6);
//
//     /* Waiting User Button is released */
//     while (STM_EVAL_PBGetState(BUTTON_USER) == Bit_SET)
//     {}
//
//     /* Unlocks the FLASH control register access */
//     FLASH_Unlock();
//
//     /* Move discovery kit to detect negative and positive acceleration values
//     on X, Y and Z axis */
```

```
//     Accelerometer_MEMS_Test();
//
//     /* USB Hardware connection */
//     USB_Test();
//
//     /* Audio Hardware connection */
//     Audio_Test();
//
//     /* Microphone MEMS Hardware connection */
//     Microphone_MEMS_Test();
//
//     /* Write PASS code at last word in the flash memory */
//     FLASH_ProgramWord(TESTRESULT_ADDRESS, ALLTEST_PASS);
//
//     while(1)
//     {
//       /* Toggle Green LED: signaling the End of the Test program */
//       STM_EVAL_LEDToggle(LED4);
//       Delay(10);
//     }
//    }
//    else
//    {
//     Demo_Exec();
//    }
// }
// else
// {
//    Demo_Exec();
// }

//     /* USB configuration */
//    Demo_USBConfig();



/**
 * @}
 */


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```