

ADS127L21 – Digital Filter Design

October 2023

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ADS127L21 – Agenda

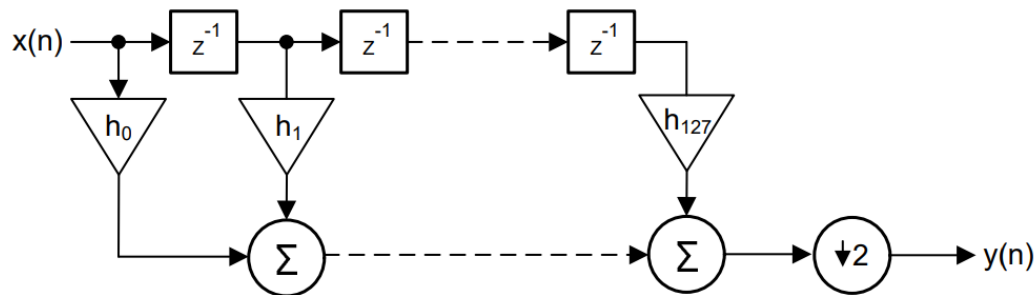
- ADS127L21 programmable coefficient filter options
 - Finite Input Response (FIR)
 - Infinite Input Response (IIR)
 - Convert decimal filter coefficients to fixed-point format
- ADS127L21EVM-PDK GUI Filter file format
 - MATLAB® *'fcf'* file format
- IIR filter design using Bilinear transform
 - Design 10kHz 2nd order filter starting with MFB topology
 - Create *'fcf'* file and evaluate using ADS127L21EVM-PDK hardware
- Filter design using MATLAB® Filter Designer
 - Design IIR 50Hz/60Hz power-line frequency notch filter for 1ksps data rate
 - Design FIR 20kHz Low pass filter for 256ksps data rate

ADS127L21

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ADS127L21 Finite Input Response (FIR)

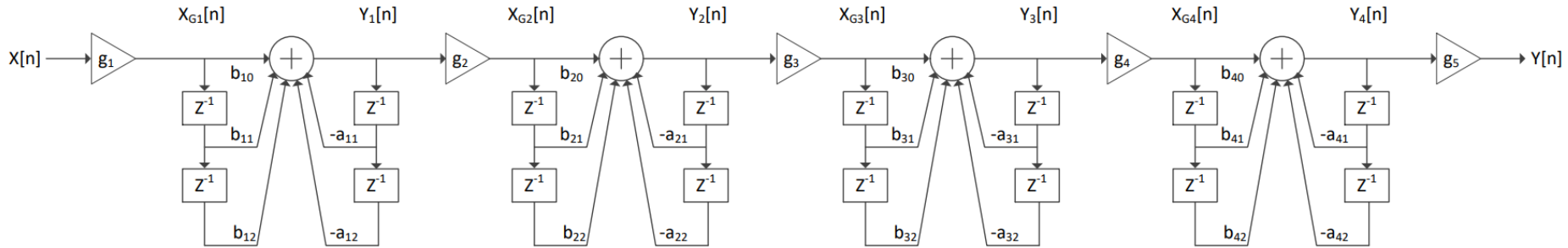
- FIR3 Filter Structure



- 128 coefficients h_0 through h_{127}
- Fixed-point 1.31 format represented as a 32b twos-complement integer
 - Represents decimal numbers in the range from -1 to +0.9999999995343
- Note the decimation by 2 after the FIR3 stage; the input data rate will be 2x the final output data rate.

ADS127L21 Infinite Input Response (IIR)

- IIR Filter Structure



- Consists of 4 direct form I bi-quads, or Second order Sections (SOS)
 - Also includes five scaling factors, g_1 through g_5
- Each biquad uses 5 coefficients b_{k0} , b_{k1} , b_{k2} , a_{k1} , a_{k2} , $k=1$ to 4
- Fixed-point 2.30 format represented as a 32b twos-complement integer
 - Represents decimal numbers in the range from -2 to +1.999999999069

ADS127L21 – convert decimal to fixed-point

- Converting decimal to fixed-point 1.31 format.
 - 32b twos-complement 1.31 fixed-point equivalent of 0.25 decimal
 - $(+0.25) \cdot 2^{31} = 536,870,912d$ (0x20000000h)
 - 32b twos-complement 1.31 fixed-point equivalent of -0.25 decimal
 - $(-0.25) \cdot 2^{31} = -536,870,912d$ (0xE0000000h)
- Converting decimal to fixed-point 2.30 format.
 - 32b twos-complement 2.30 fixed-point equivalent of 1.25 decimal
 - $(+1.25) \cdot 2^{30} = 1,342,177,280d$ (0x50000000h)
 - 32b twos-complement 2.30 fixed-point equivalent of -1.25 decimal
 - $(-1.25) \cdot 2^{30} = -1,342,177,280d$ (0xB0000000h)

ADS127L21

- ADS127L21 programmable coefficient filter options
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 - MATLAB® *'fcf'* file format
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ADS127L21 – MATLAB® *fcf* file format for FIR

- The ADS127L21EVM-PDK-GUI supports the MATLAB® *fcf* file format
 - 32b coefficients in ASCII Hexadecimal format
 - First coefficient in file is h0, then h1, up to a maximum h127 (128 total)
 - The file does not need to include all coefficients
 - The GUI will autofill unused coefficients with default values (00000000h)
 - Lines beginning with ‘%’ are comments and ignored by the GUI
 - Exception is *Coefficient Format* line

```
% Generated by MATLAB(R) 9.13 and Signal Processing Toolbox 9.1.
% Generated on: 01-Jun-2023 16:49:25

% Coefficient Format: Hexadecimal

% Discrete-Time FIR Filter (real)
% -----
% Filter Structure : Direct-Form FIR
% Filter Length   : 11
% Stable          : Yes
% Linear Phase    : Yes (Type 1)
% Arithmetic      : fixed
% Numerator       : s32,31 -> [-1 1]
% Input           : s16,15 -> [-1 1]
% Filter Internals : Full Precision
% Output          : s48,46 -> [-2 2] (auto determined)
% Product         : s46,46 -> [-5.000000e-01 5.000000e-01] (auto determined)
% Accumulator     : s48,46 -> [-2 2] (auto determined)
% Round Mode      : No rounding
% Overflow Mode   : No overflow

Numerator:
0153f90d
f2a9741f
02083d1e
11c1834e
2243375b
296b7734
2243375b
11c1834e
02083d1e
f2a9741f
0153f90d
```

h0

h10

ADS127L21 – MATLAB® *fcf* file format for IIR

- The ADS127L21EVM-PDK-GUI supports the MATLAB® *fcf* file format
 - 32b coefficients in ASCII Hexadecimal format
 - Lines beginning with ‘%’ are comments and ignored
 - Exceptions are *Coefficient Format* and *Number of Sections*
 - MATLAB® includes the a_{k0} coefficients (a_{10} , a_{20} , a_{30} , a_{40})
 - The GUI will ignore the a_{10} , a_{20} , a_{30} and a_{40} coefficients as these are always decimal value +1 (40000000h) and not implemented in the ADS127L21
 - GUI supports less than 4 bi-quads and less than 5 Scale Values
 - GUI will use default values (40000000h) for unused Scale Values
 - GUI will also use default values for unused bi-quads (SOS)

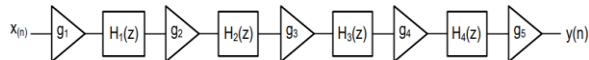
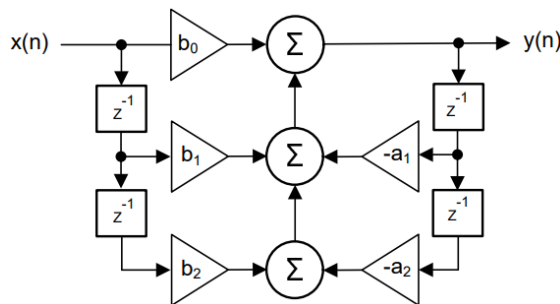
```
% Generated by MATLAB(R) 9.13 and Signal Processing Toolbox 9.1.
% Generated on: 13-Jun-2023 16:42:05
% Coefficient Format: Hexadecimal
% Discrete-Time IIR Filter (real)
% -----
% Filter Structure : Direct-Form II, Second-Order Sections
% Number of Sections : 4
% Stable : Yes
% Linear Phase : No
% Arithmetic : fixed
% Numerator : s32,30 -> [-2 2)
% Denominator : s32,30 -> [-2 2)
% Scale Values : s32,30 -> [-2 2)
% Input : s16,15 -> [-1 1)
% Section Input : s16,9 -> [-64 64)
% Section Output : s16,11 -> [-16 16)
% Output : s16,11 -> [-16 16)
% State : s16,15 -> [-1 1)
% Numerator Prod : s48,45 -> [-4 4)
% Denominator Prod : s48,45 -> [-4 4)
% Numerator Accum : s40,35 -> [-16 16)
% Denominator Accum : s40,35 -> [-16 16)
% Round Mode : convergent
% OverFlow Mode : wrap
% Cast Before Sum : true

SOS Matrix:
40000000 85399fc0 40000000 40000000 b8d3e8e9 298b0977
40000000 8a3eef9e 40000000 40000000 85d2a71c 3b45fbdd
40000000 865e7ef2 40000000 40000000 914338f1 305d450b
40000000 886dd1e7 40000000 40000000 bd1a8876 14fc6f65

Scale Values:
35b10ebb
35b10ebb
2f63d50e
2f63d50e
```

ADS127L21 – MATLAB® *fcf* file format for IIR

- The ADS127L21EVM-PDK-GUI supports the MATLAB® *fcf* file format
 - Lines beginning with ‘%’ are comments
 - Coefficients are defined as follows (a_{x0} ignored)



SOS Matrix:

b_{10}	b_{11}	b_{12}	a_{10}	a_{11}	a_{12}
b_{20}	b_{21}	b_{22}	a_{20}	a_{21}	a_{22}
b_{30}	b_{31}	b_{32}	a_{30}	a_{31}	a_{32}
b_{40}	b_{41}	b_{42}	a_{40}	a_{41}	a_{42}

Scale Values:

g_1
 g_2
 g_3
 g_4
 g_5

```
% Number of Sections : 4
% Stable : Yes
% Linear Phase : No
% Arithmetic : fixed
% Numerator : s32,30 -> [-2 2)
% Denominator : s32,30 -> [-2 2)
% Scale Values : s32,30 -> [-2 2)
% Input : s16,15 -> [-1 1)
% Section Input : s16,9 -> [-64 64)
% Section Output : s16,11 -> [-16 16)
% Output : s16,11 -> [-16 16)
% State : s16,15 -> [-1 1)
% Numerator Prod : s48,45 -> [-4 4)
% Denominator Prod : s48,45 -> [-4 4)
% Numerator Accum : s40,35 -> [-16 16)
% Denominator Accum : s40,35 -> [-16 16)
% Round Mode : convergent
% Overflow Mode : wrap
% Cast Before Sum : true
```

SOS Matrix:

40000000	85399fc0	40000000	40000000	b8d3e8e9	298b0977
40000000	8a3eef9e	40000000	40000000	85d2a71c	3b45fbdd
40000000	865e7ef2	40000000	40000000	914338f1	305d560b
40000000	886dd1e7	40000000	40000000	bd1a8876	14fc6f65

Scale Values:

35b10ebb
 35b10ebb
 2f63d50e
 2f63d50e

ADS127L21 – MATLAB[®] *fcf* file format

- FIR fcf file format
 - 32b 1.31 coefficients in ASCII Hexadecimal format
 - Unused coefficients should be set to 00000000h
- IIR fcf file format
 - 32b 2.30 coefficients in ASCII Hexadecimal format
 - Unused g_x , b_{10} , b_{20} , b_{30} , and b_{40} coefficients should be set to 40000000h
 - All other unused coefficients should be set to 00000000h.

ADS127L21

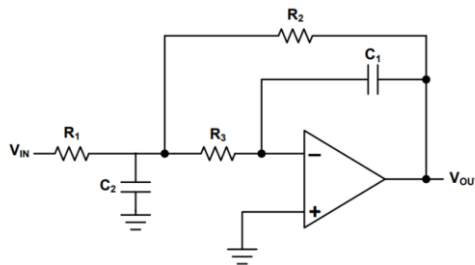
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ADS127L21 – IIR filter Bilinear Transform design

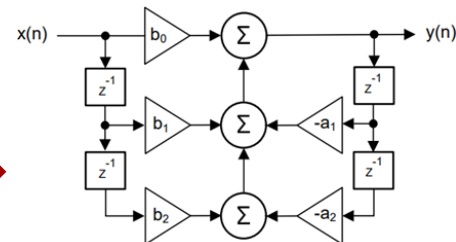
- Start with continuous time design in s-domain
 - Can use filter design software, such as [WEBENCH® analog filter designer](#)
- Transform to z-domain using Bilinear Transform

$$s = K \cdot \frac{(z-1)}{(z+1)}$$

- Limited to 8th order filter designs
 - IIR filter limited to 4 Bi-quads
- Can transform multi-Feedback design directly to Bi-quad coefficients



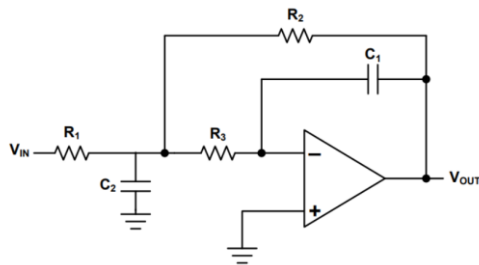
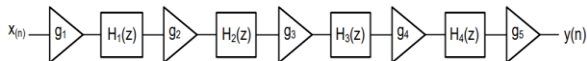
$$H(s) = \frac{B_0 + B_1 \cdot s^{-1} + B_2 \cdot s^{-2}}{A_0 + A_1 \cdot s^{-1} + A_2 \cdot s^{-2}}$$



$$H(z) = \frac{b_0 + b_1 \cdot z^{-1} + b_2 \cdot z^{-2}}{1 + a_1 \cdot z^{-1} + a_2 \cdot z^{-2}}$$

ADS127L21 – IIR filter Bilinear Transform design

- Use Multi-feedback (MFB) topology.
- Set Gain of MFB filter to 1; $R_1=R_2$
- Independent gain setting registers (g_x) in ADS127L21 can be used to adjust gain.



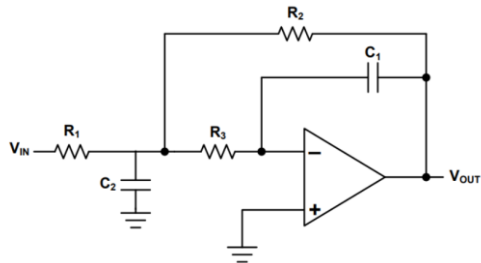
s-domain transfer function

Gain=1
R1=R2

$$H(s) = \frac{\frac{R_2}{R_1}}{(R_2 \cdot R_3 \cdot C_1 \cdot C_2) \cdot s^2 + \left(R_3 \cdot C_1 + R_2 \cdot C_1 + \frac{R_2 \cdot R_3 \cdot C_1}{R_1} \right) \cdot s + 1}$$

$$|H(s)| = \frac{1}{C_1 \cdot C_2 \cdot R_2 \cdot R_3 \cdot s^2 + (2 \cdot C_1 \cdot R_3 + C_1 \cdot R_2) \cdot s + 1}$$

ADS127L21 – IIR filter Bilinear Transform design



- Set Gain=1, R1=R2
 - Independent gain settings in ADS127L21 can be used if different gain is needed.

s-domain transfer function

Gain=1
R1=R2

Equation re-arranged to biquadratic form

$$H(s) = \frac{\frac{R_2}{R_1}}{(R_2 \cdot R_3 \cdot C_1 \cdot C_2) \cdot s^2 + \left(R_3 \cdot C_1 + R_2 \cdot C_1 + \frac{R_2 \cdot R_3 \cdot C_1}{R_1} \right) \cdot s + 1}$$

$$|H(s)| = \frac{1}{C_1 \cdot C_2 \cdot R_2 \cdot R_3 \cdot s^2 + (2 \cdot C_1 \cdot R_3 + C_1 \cdot R_2) \cdot s + 1}$$

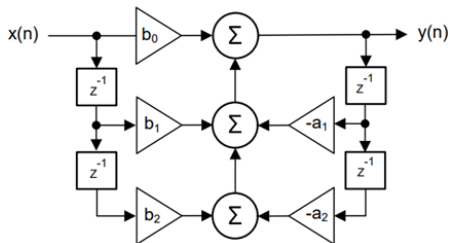
$$|H(s)| = \frac{0 + 0 \cdot s^{-1} + 1 \cdot s^{-2}}{(C_1 \cdot C_2 \cdot R_2 \cdot R_3) + (2 \cdot C_1 \cdot R_3 + C_1 \cdot R_2) \cdot s^{-1} + 1 \cdot s^{-2}} = \frac{B_0 + B_1 \cdot s^{-1} + B_2 \cdot s^{-2}}{A_0 + A_1 \cdot s^{-1} + A_2 \cdot s^{-2}}$$

Bilinear transform, s-domain to z-domain

$$H(s) = \frac{B_0 + B_1 \cdot s^{-1} + B_2 \cdot s^{-2}}{A_0 + A_1 \cdot s^{-1} + A_2 \cdot s^{-2}} \xrightarrow{\text{substitute } s = K \cdot \frac{(z-1)}{(z+1)}} H\left(\frac{K \cdot (z-1)}{z+1}\right) = \frac{(B_0 \cdot K^2 + B_1 \cdot K + B_2) \cdot z^2 + (2 \cdot B_2 - 2 \cdot B_0 \cdot K^2) \cdot z + B_0 \cdot K^2 - B_1 \cdot K + B_2}{(A_0 \cdot K^2 + A_1 \cdot K + A_2) \cdot z^2 + (2 \cdot A_2 - 2 \cdot A_0 \cdot K^2) \cdot z + A_0 \cdot K^2 - A_1 \cdot K + A_2}$$

ADS127L21 – IIR filter Bilinear Transform design

Substitute R and C values, solve for z-domain coefficients



$$H(z) = \frac{b_0 + b_1 \cdot z^{-1} + b_2 \cdot z^{-2}}{1 + a_1 \cdot z^{-1} + a_2 \cdot z^{-2}}$$

Pre-warping filter response
 ω_0 is the filter frequency (radians)
 T is the sampling period (seconds)

$$b_0 = \frac{1}{C_1 \cdot C_2 \cdot R_2 \cdot R_3 \cdot K^2 + (2 \cdot C_1 \cdot R_3 + C_1 \cdot R_2) \cdot K + 1}$$

$$b_1 = \frac{2}{C_1 \cdot C_2 \cdot R_2 \cdot R_3 \cdot K^2 + (2 \cdot C_1 \cdot R_3 + C_1 \cdot R_2) \cdot K + 1}$$

$$b_2 = \frac{1}{C_1 \cdot C_2 \cdot R_2 \cdot R_3 \cdot K^2 + (2 \cdot C_1 \cdot R_3 + C_1 \cdot R_2) \cdot K + 1}$$

$$a_1 = \frac{-(2 \cdot C_1 \cdot C_2 \cdot R_2 \cdot R_3 \cdot K^2) + 2}{C_1 \cdot C_2 \cdot R_2 \cdot R_3 \cdot K^2 + (2 \cdot C_1 \cdot R_3 + C_1 \cdot R_2) \cdot K + 1}$$

$$a_2 = \frac{2 \cdot C_1 \cdot K \cdot (2 \cdot R_3 + R_2)}{C_1 \cdot C_2 \cdot R_2 \cdot R_3 \cdot K^2 + (2 \cdot C_1 \cdot R_3 + C_1 \cdot R_2) \cdot K + 1} + 1$$

$$K = \frac{\omega_0}{\tan\left(\frac{\omega_0 \cdot T}{2}\right)}$$

ADS127L21 – 10kHz IIR low-pass filter design

- Filter Design Criteria
 - 10kHz low-pass filter using IIR
 - Target sample rate of 100ksp/s
 - Example design is 2nd order Butterworth, using a single bi-quad
 - Can be extended to 8th order

The screenshot shows the ADS127L21 EVM software interface. The main window is titled "Digital Filter Configuration". It includes the following sections:

- Filter Sequence:** FIR3 then IIR
- Filter Selection:** FIR: Default coeffs
- FIR2:** Disabled?
- FIR3:** Disabled?
- IIR:** Disabled?

FIR3 Coefficient File: C:\Users\Public\Documents\Texas Instruments\ADS127L21\Configuration Files\Coefficients\FIR3 Presets\DEFAULT_set1_hex.fcf

IIR Coefficient File: C:\Texas_Instruments\ADS127L21_Filter\ADS127L21_IIR_10kHz.fcf

Note: Selecting a valid Coefficient file will write the coefficient values to the device depending the coefficient order selected. Coefficient order for FIR3 : h128 - h1 ; IIR : g5 - g1.

Filter Coefficients | **Filter Response**

The **Filter Response** graph shows Amplitude (dB) vs Frequency (Hz). The amplitude is 0 dB at 0 Hz, drops to approximately -180 dB at 50 kHz, and then rises back to 0 dB at 100 kHz. There are several small ripples in the passband between 80 kHz and 100 kHz.

Interface Configuration:

- Data Width: 24 bits
- Speed Mode: Max Speed
- Input Range: 1 * Vref
- Filter Type: Wide Bandwidth
- OSR: 512
- Clock Divider: No Division
- Vref (V): 2.5
- Samples: 262144
- SCLK: 25.60M
- MCLK: 25.60M
- Data Rate (sp/s): 100.00k

FFT Scaling:

- NFFT: 1000000
- f_MOD [Hz]: 12800000
- f_DATA [Hz]: 100000

ADS127L21 – 10kHz IIR low-pass filter design

- Design low-pass filter using [WEBENCH® analog filter designer](#)
 - Enter 10kHz corner frequency
 - Choose Gain=1, or 0dB
 - Set filter order to 2.
 - Choose Butterworth
 - Select Multiple Feedback Topology

The screenshot displays the Filter Design Tool interface for a Lowpass Filter. The tool is set to the FILTER RESPONSE view. The configuration is as follows:

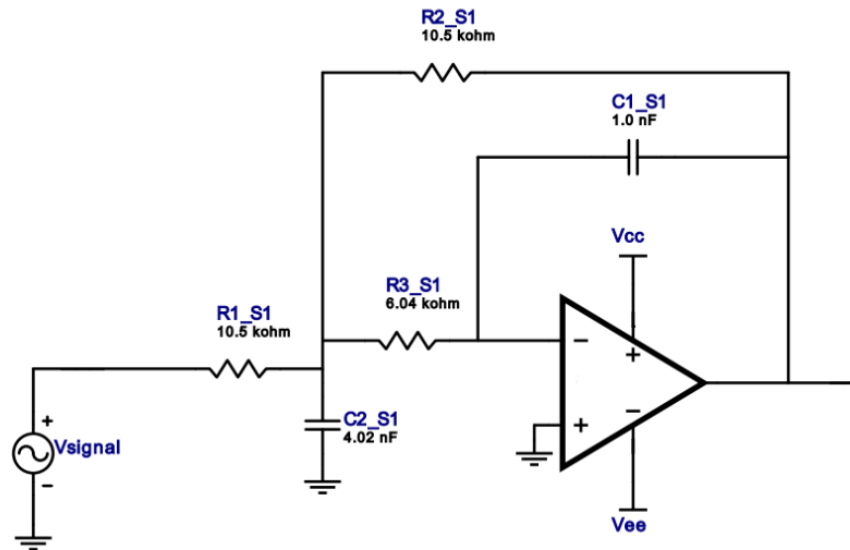
- Specification:**
 - Gain (Ao): 0 dB
 - Frequency (Fp): 10000 Hz
 - Ripple (Rp): 0.01 dB
 - Filter order: 2
- Stopband:** Filter order: 2
- Topology:** Use same topology for all stages (checked), Multiple Feedback

The Magnitude Response graph shows the filter's performance, with the magnitude response (dB) plotted against frequency. The response is flat at 0 dB in the passband and rolls off at -40 dB/decade in the stopband.

View	Filter Response	Order	No. of Stages	Max Q	Stopband Attenuation (dB)	Select
<input type="checkbox"/>	Bessel	2	1	0.577	-35.870	SELECT >
<input checked="" type="checkbox"/>	Butterworth	2	1	0.707	-40.000	SELECT >

ADS127L21 – 10kHz IIR low-pass filter design

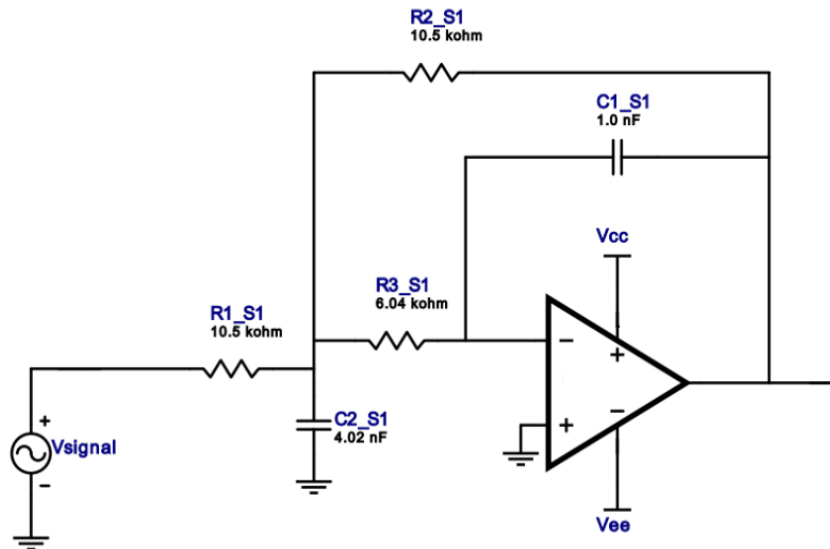
- Design low-pass filter using [WEBENCH® analog filter designer](#)
 - Enter 10kHz corner frequency
 - Choose Gain=1, or 0dB
 - Set filter order to 2.
 - Choose Butterworth for this example
 - Select Multiple Feedback Topology
- Software creates design with following values:
 - $R1=R2=10.5\text{k}\Omega$
 - $R3=6.04\text{k}\Omega$
 - $C1=1.0\text{nF}$
 - $C2=4.02\text{nF}$



ADS127L21 – 10kHz IIR low-pass filter design

- Sample rate 100kspss
 - $T=10\mu\text{s}$
- $F_0=10\text{kHz}$
 - $\omega_0=2\pi F_0$
- Use pre-warping to match gain and phase at F_0
 - T is the sampling period (seconds)
 - $\omega_0=2\pi F_0$ is the filter frequency (radians)

$$K = \frac{\omega_0}{\tan\left(\frac{\omega_0 \cdot T}{2}\right)}$$



ADS127L21 – 10kHz IIR low-pass filter design

$$H(z) = \frac{b_0 + b_1 \cdot z^{-1} + b_2 \cdot z^{-2}}{1 + a_1 \cdot z^{-1} + a_2 \cdot z^{-2}} \quad T := 10 \mu\text{s} \quad f := 10 \text{ kHz} \quad \omega_0 := 2 \cdot \pi \cdot f = 62831.8530717959 \frac{1}{\text{s}} \quad K := \frac{\omega_0}{\tan\left(\frac{\omega_0 \cdot T}{2}\right)} = 193376.559809281 \frac{1}{\text{s}}$$

$$b_0 := \frac{1}{C_1 \cdot C_2 \cdot R_2 \cdot R_3 \cdot K^2 + (2 \cdot C_1 \cdot R_3 + C_1 \cdot R_2) \cdot K + 1} = 0.067113602521748$$

$$b_{0d} := \text{round}(b_0 \cdot 2^{30}) = 72062682$$

$$b_1 := \frac{2}{C_1 \cdot C_2 \cdot R_2 \cdot R_3 \cdot K^2 + (2 \cdot C_1 \cdot R_3 + C_1 \cdot R_2) \cdot K + 1} = 0.134227205043497$$

$$b_{1d} := \text{round}(b_1 \cdot 2^{30}) = 144125364$$

$$b_2 := \frac{1}{C_1 \cdot C_2 \cdot R_2 \cdot R_3 \cdot K^2 + (2 \cdot C_1 \cdot R_3 + C_1 \cdot R_2) \cdot K + 1} = 0.067113602521748$$

$$b_{2d} := \text{round}(b_2 \cdot 2^{30}) = 72062682$$

$$a_0 := 1$$

$$a_{0d} := \text{round}(a_0 \cdot 2^{30}) = 1073741824$$

$$a_1 := \frac{-(2 \cdot C_1 \cdot C_2 \cdot R_2 \cdot R_3 \cdot K^2) + 2}{C_1 \cdot C_2 \cdot R_2 \cdot R_3 \cdot K^2 + (2 \cdot C_1 \cdot R_3 + C_1 \cdot R_2) \cdot K + 1} = -1.14545018755864$$

$$a_{1d} := \text{round}(a_1 \cdot 2^{30}) = -1229917774$$

$$a_2 := 1 - \frac{2 \cdot C_1 \cdot K \cdot (2 \cdot R_3 + R_2)}{C_1 \cdot C_2 \cdot R_2 \cdot R_3 \cdot K^2 + (2 \cdot C_1 \cdot R_3 + C_1 \cdot R_2) \cdot K + 1} = 0.413904597645629$$

$$a_{2d} := \text{round}(a_2 \cdot 2^{30}) = 444426678$$

Coeff	ASCII HEX
b0	044b96d9
b1	08972db3
b2	044b96d9
a0	40000000
a1	b6b0f1b3
a2	1a7d69b5

Calculate z-domain filter coefficients

Results are
in floating
point decimal

Convert to
2.30 fixed
point decimal

Convert to 2.30
fixed point
hexadecimal

ADS127L21 – 10kHz IIR low-pass filter design

- The ADS127L21EVM-PDK-GUI supports the MATLAB® *fcf* file format
 - 32b coefficients in fixed point 2.30 ASCII Hexadecimal format
 - The following lines need to be added in addition to the coefficients
 - % Coefficient Format: Hexadecimal
 - % Number of Sections : 4
 - Can use any text editor to create the file, such as Notepad.
 - Save text file with *.fcf extension, ADS127L21_IIR_10kHz.fcf

Coeff	ASCII HEX
b0	044b96d9
b1	08972db3
b2	044b96d9
a0	40000000
a1	b6b0f1b3
a2	1a7d69b5



```
SOS Matrix:  
b10 b11 b12 a10 a11 a12  
b20 b21 b22 a20 a21 a22  
b30 b31 b32 a30 a31 a32  
b40 b41 b42 a40 a41 a42  
  
Scale Values:  
g1  
g2  
g3  
g4  
g5
```



```
% Coefficient Format: Hexadecimal  
% Number of Sections : 4  
  
SOS Matrix:  
044b96d9 08972db3 044b96d9 40000000 b6b0f1b2 1a7d69b5  
40000000 00000000 00000000 40000000 00000000 00000000  
40000000 00000000 00000000 40000000 00000000 00000000  
40000000 00000000 00000000 40000000 00000000 00000000  
  
Scale Values:  
40000000  
40000000  
40000000  
40000000  
40000000
```

ADS127L21 – 10kHz IIR low-pass filter design

1. Start the ADS127L21EVM-PDK-GUI software and click on the Digital Filter Configuration page
2. Click the file button for the IIR coefficient File
3. Navigate to the *.fcf file just created in the text editor and select file
4. Click on the Filter Response tab

ADS127L21 EVM

File Edit Debug Capture Tools Help

EVM Connected : ADS127L21EVM Connect to Hardware

Digital Filter Configuration

Filter Sequence: FIR3 then IIR Filter Selection: FIR: Default coeffs

FIR2: Disabled? FIR3: Disabled? IIR: Disabled?

FIR3 Coefficient File: C:\Users\Public\Documents\Texas Instruments\ADS127L21\Configuration Files\Coefficients\FIR3 Presets\DEFAULT_set1_hex.fcf

IIR Coefficient File: C:\Texas_Instruments\ADS127L21_Filter\ADS127L21_IIR_10kHz.fcf

Note: Selecting a valid Coefficient file will write the coefficient values to the device depending the coefficient order selected. Coefficient order for FIR3 : h128 - h1 ; IIR : g5 - g1.

Filter Response

FIR3 Coefficients

	0	x	0	h128
		x	0	h127
		x	0	h126
		x	0	h125
		x	0	h124
		x	0	h123
		x	0	h122
		x	0	h121
		x	0	h120
		x	0	h119
		x	0	h118
		x	0	
		x	F743	

IIR Coefficients

Gain Coefficients

x	40000000 ₀	x	40000000 ₁	x	40000000 ₂	x	40000000 ₃	x	40000000 ₄
---	-----------------------	---	-----------------------	---	-----------------------	---	-----------------------	---	-----------------------

IIR Coefficients

x	44B96D9 ₀₁₀	x	40000000 ₀₂₀	x	40000000 ₀₃₀	x	40000000 ₀₄₀
x	8972DB3 ₀₁₁	x	0 ₀₂₁	x	0 ₀₃₁	x	0 ₀₄₁
x	44B96D9 ₀₁₂	x	0 ₀₂₂	x	0 ₀₃₂	x	0 ₀₄₂
x	B680F1B2 ₀₁₃	x	0 ₀₂₃	x	0 ₀₃₃	x	0 ₀₄₃
x	1A7D69B5 ₀₁₄	x	0 ₀₂₄	x	0 ₀₃₄	x	0 ₀₄₄

IIR CRC

x	93
---	----

Interface Configuration

Data Width: 24 bits Speed Mode: Max Speed Input Range: 1 * Vref Filter Type: Wide Bandwidth OSR: 512 Clock Divider: No Division Vref (V): 2.5 Samples: 262144 Capture SCLK: 25.60M MCLK: 25.60M Data Rate (sps): 100.00k

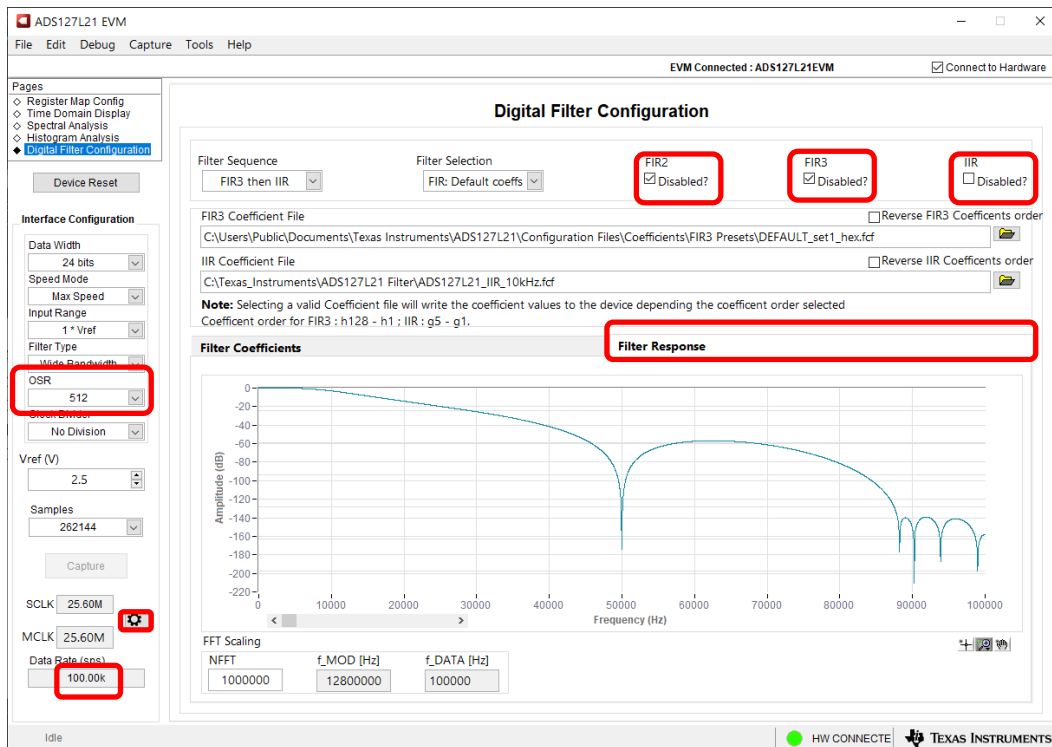
Pages: Register Map Config Time Domain Display Spectral Analysis **Digital Filter Configuration** Histogram Analysis

Device Reset

Idle HW CONNECTE TEXAS INSTRUMENTS

ADS127L21 – 10kHz IIR low-pass filter design

5. Set the sample rate to 100ksp/s
 - Set OSR to 512
6. Click, un-check, the IIR Disabled box
7. Click, check, the FIR2 and FIR3 boxes
8. Set the external MCLK to 25.6M (EVM requires external clock source set to 25.6MHz)
9. The combined IIR filter response, FIR1 and SINC5 response is now plotted and ready for use.

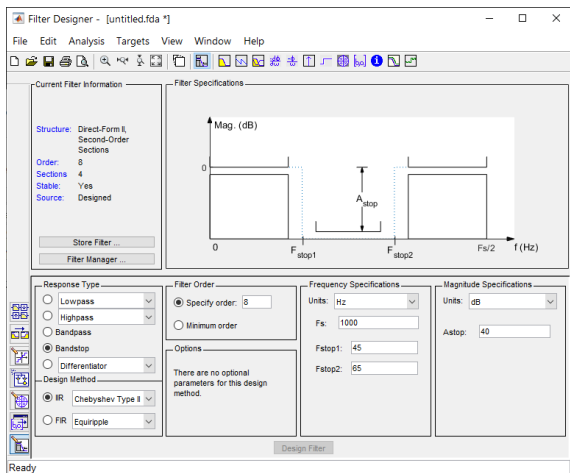


ADS127L21

- ADS127L21 programmable coefficient filter options
 - Finite Input Response (FIR)
 - Infinite Input Response (IIR)
 - Convert decimal filter coefficients to fixed-point format
- ADS127L21EVM-PDK GUI Filter file format
 - MATLAB® *'fcf'* file format
- IIR filter design using Bilinear transform
 - Design 10kHz 2nd order filter starting with MFB topology
 - Create *'fcf'* file and evaluate using ADS127L21EVM-PDK hardware
- **Filter design using MATLAB® Filter Designer**
 - MATLAB® Filter Design overview
 - Design IIR 50Hz/60Hz power-line frequency notch filter for 1ksps data rate
 - Design FIR 20kHz Low pass filter for 256ksps data rate

ADS127L21 – MATLAB® filter design overview

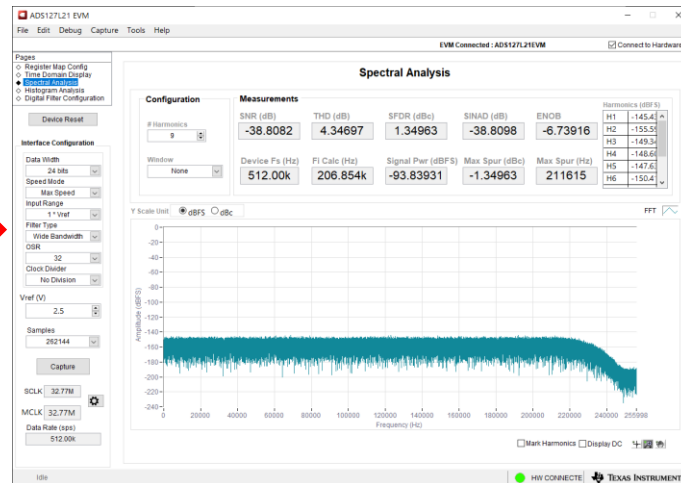
- MATLAB® is the preferred tool to directly design IIR and FIR filters
 - The following examples use MATLAB® version R2022b, but any version can be used
 - In addition to the MATLAB® software, you will need the following add-on packages
 - Signal Processing Toolbox, which includes the Filter Designer tool
 - Fixed-Point Designer, which converts to fixed point coefficients and ASCII HEX exports



```
% Number of Sections : 4
% Stable : Yes
% Arithmetic : Fixed
% Linear Phase : No
% Numerator : s32,30 -> [-2 2]
% Denominator : s32,30 -> [-2 2]
% Scale Values : s32,30 -> [-2 2]
% Input : s16,15 -> [-1 1]
% Section Input : s16,9 -> [-64 64]
% Section Output : s16,11 -> [-16 16]
% Output : s16,11 -> [-16 16]
% State : s16,15 -> [-1 1]
% Numerator Prod : s48,45 -> [-4 4]
% Denominator Prod : s48,45 -> [-4 4]
% Numerator Accum : s48,35 -> [-16 16]
% Denominator Accum : s48,35 -> [-16 16]
% Round Mode : convergent
% Overflow Mode : wrap
% Cast Before Sum : true

SOS Matrix:
48000000 85399fc0 48000000 48000000 b8d3e8e9 298b0977
48000000 8a3eef9e 48000000 48000000 85d2271c 3b45fbd4
48000000 865e7ef2 48000000 48000000 914338f1 305d560b
48000000 886dd1e7 48000000 48000000 bd1a8876 14fc6f65

Scale Values:
35b10ebb
35b10ebb
2f63d50e
2f63d50e
```



ADS127L21 – MATLAB® filter design overview

- Filter Designer is a graphical design tool that enables the creation of multiple filter types.
 - Supports creation of Lowpass, Highpass, Bandpass, and Bandstop profiles
 - Quantization of filter coefficients and export to ADS127L21EVM-PDK-GUI
 - The tool supports creation of both IIR and FIR filter types

The screenshot displays the MATLAB Filter Designer interface. The window title is "Filter Designer - [untitled.fda *]". The menu bar includes File, Edit, Analysis, Targets, View, Window, and Help. The toolbar contains various icons for file operations and analysis. The main workspace is divided into several panels:

- Current Filter Information:** Shows the filter structure as "Direct-Form II, Second-Order Sections", with an order of 8, 4 sections, and a source of "Designed".
- Filter Specifications:** A plot of Magnitude (dB) versus frequency f (Hz). The plot shows a bandstop filter response with a passband from 0 to F_{stop1} and another passband from F_{stop2} to $F_s/2$. The stopband between F_{stop1} and F_{stop2} is labeled with A_{stop} .
- Response Type:** A dropdown menu with radio buttons for Lowpass, Highpass, Bandpass, and Bandstop. The Bandstop option is selected.
- Filter Order:** A dropdown menu with radio buttons for "Specify order" (set to 8) and "Minimum order".
- Frequency Specifications:** Fields for Units (Hz), Fs (1000), Fstop1 (45), and Fstop2 (65).
- Magnitude Specifications:** Fields for Units (dB) and Astop (40).
- Design Method:** Radio buttons for IIR (Chebyshev Type II) and FIR (Equiripple). The IIR option is selected.

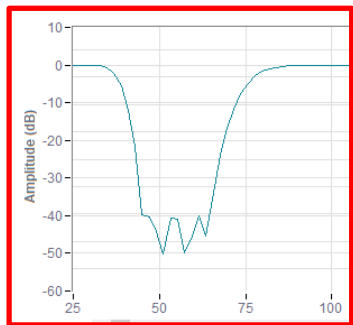
Red arrows from the text on the left point to the "Response Type" and "Design Method" sections of the GUI.

ADS127L21

- ADS127L21 programmable coefficient filter options
 - Finite Input Response (FIR)
 - Infinite Input Response (IIR)
 - Convert decimal filter coefficients to fixed-point format
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 - MATLAB® *'fcf'* file format
- IIR filter design using Bilinear transform
 - Design 10kHz 2nd order filter starting with MFB topology
 - Create *'fcf'* file and evaluate using ADS127L21EVM-PDK hardware
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 - Design IIR 50Hz/60Hz power-line frequency notch filter for 1ksps data rate
 - Design FIR 20kHz Low pass filter for 256ksps data rate

ADS127L21 – 50/60Hz IIR notch filter design

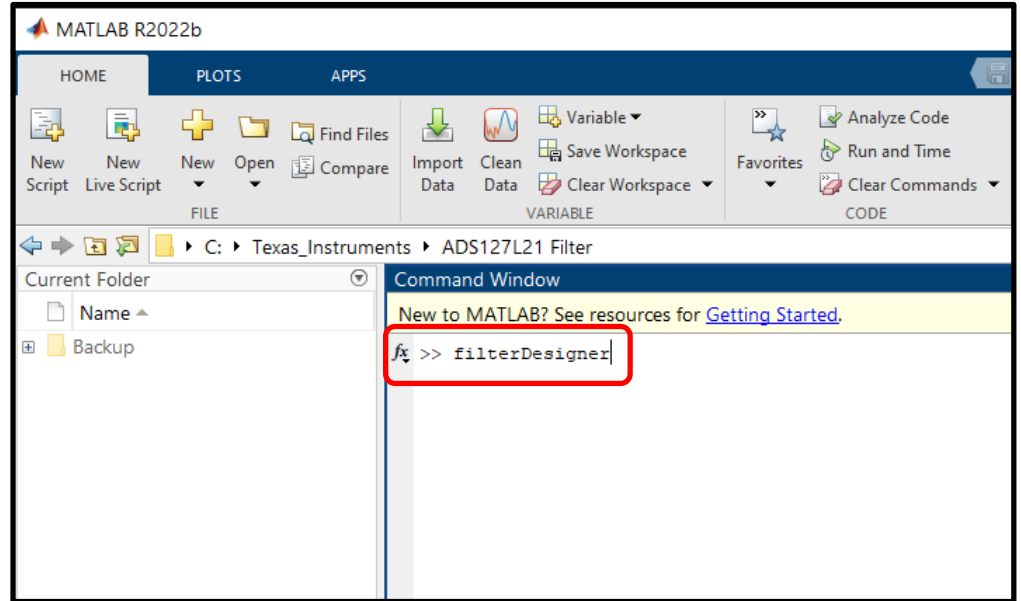
- Filter Design Criteria
 - 50/60Hz notch filter using IIR
 - Target sample rate of 1kps
 - Limited to 8th order, or 4 Second-order-Sections
 - Filter Designer tool creates filter notch from 45Hz to 65Hz with 40dB of attenuation



A screenshot of the ADS127L21 EVM Digital Filter Configuration tool. The interface shows various configuration options for the filter. The 'Filter Sequence' is set to 'FIR3 then IIR'. The 'Filter Selection' is set to 'FIR: Default coeffs'. The 'FIR2', 'FIR3', and 'IIR' options are all disabled. The 'IIR Coefficient File' is set to 'C:\Texas_Instruments\ADS127L21_custom_filter\ADS127L21_IIR_45Hz_65Hz_notch_1kps.fcf'. The 'Filter Coefficients' and 'Filter Response' tabs are visible. The 'Filter Response' plot shows the filter's magnitude response, with a red circle highlighting the notch region between 45 Hz and 65 Hz. The plot shows a sharp notch centered at 50 Hz, reaching approximately -50 dB. There are smaller notches at approximately 55 Hz and 60 Hz. The plot also shows the filter's passband and stopband characteristics.

ADS127L21 – 50/60Hz IIR notch filter design

1. Open MATLAB®
2. In the Command Window, type `filterDesigner` and press Enter
 - This will launch the Filter Designer tool that is part of the Signal Processing Toolbox
3. Wait for Filter Designer to load



ADS127L21 – 50/60Hz IIR notch filter design

4. Select Bandstop under Response Type
5. Select IIR and Chebyshev Type II under Design Method
6. Select Specify order under Filter Order and enter 8
 - ADS127L21 IIR filter uses 4 bi-quad sections (or Second order Sections), for a total filter order of 8

The screenshot shows the Filter Designer software interface with the following configuration:

- Current Filter Information:** Structure: Direct-Form II, Second-Order Sections; Order: 8; Sections: 4; Stable: Yes; Source: Designed.
- Filter Specifications:** A magnitude plot showing a notch filter response with a stopband between F_{stop1} and F_{stop2} , and a passband between 0 and F_{stop1} and between F_{stop2} and $F_s/2$. The stopband attenuation is labeled A_{stop} .
- Response Type:** Bandstop (selected).
- Filter Order:** Specify order: 8 (selected).
- Design Method:** IIR Chebyshev Type II (selected).
- Frequency Specifications:** Units: Hz; F_s : 1000; F_{stop1} : 45; F_{stop2} : 65.
- Magnitude Specifications:** Units: dB; A_{stop} : 40.

ADS127L21 – 50/60Hz IIR notch filter design

7. Enter F_s : 1000 (Hz) under Frequency Specifications
8. Enter F_{stop1} : 45 (Hz) and F_{stop2} : 65 (Hz) under Frequency Specifications
 - 45Hz to 65Hz covers variation in line frequency
9. Enter A_{stop} : 40 (dB) under Magnitude Specifications
 - Higher attenuation results in wider transition bands
10. Click the 'Design Filter' button.


The screenshot shows the Filter Designer software interface. The window title is "Filter Designer - [untitled.fda *]". The menu bar includes File, Edit, Analysis, Targets, View, Window, and Help. The toolbar contains various icons for file operations and analysis. The main workspace is divided into several panels:

- Current Filter Information:** Structure: Direct-Form II, Second-Order Sections; Order: 8; Sections: 4; Stable: Yes; Source: Designed.
- Filter Specifications:** A graph showing Magnitude (Mag. in dB) versus frequency (f in Hz). The graph displays a notch filter response with a stopband between F_{stop1} and F_{stop2} , and a passband centered at $F_s/2$. The stopband attenuation is labeled A_{stop} .
- Response Type:** Bandstop (selected).
- Filter Order:** Specify order: 8 (selected).
- Frequency Specifications:** Units: Hz; F_s : 1000; F_{stop1} : 45; F_{stop2} : 65.
- Magnitude Specifications:** Units: dB; A_{stop} : 40.
- Design Method:** IIR Chebyshev Type II (selected).
- Options:** There are no optional parameters for this design method.
- Design Filter:** A button at the bottom center of the interface.

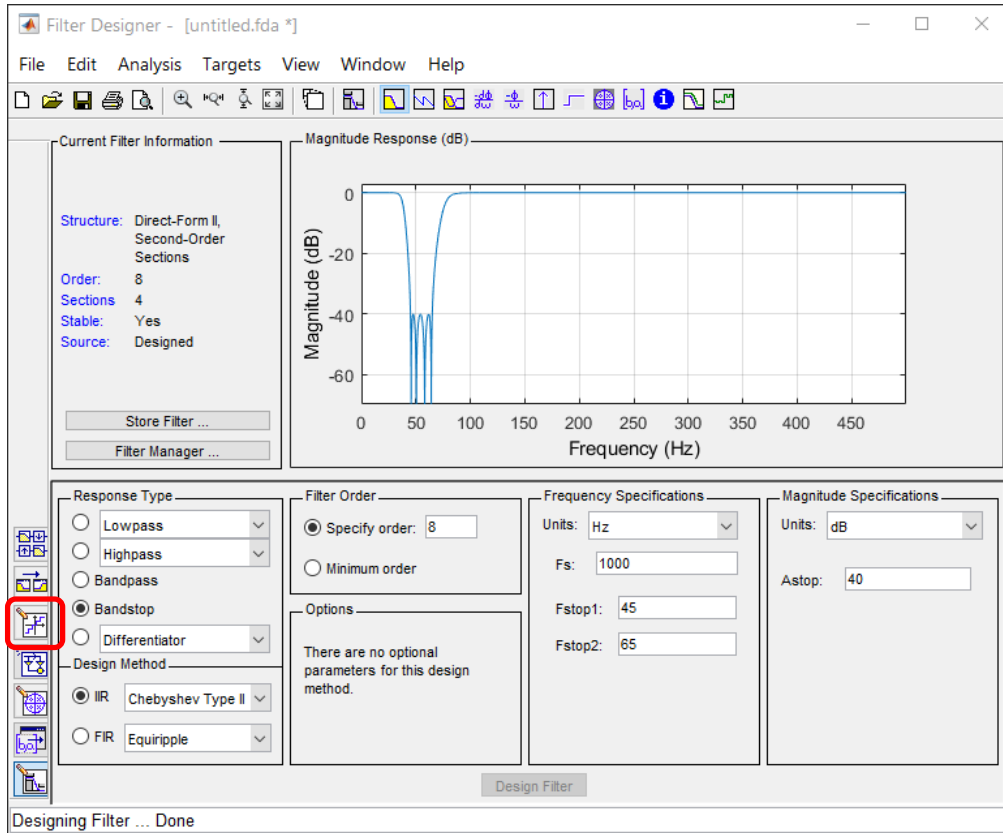
ADS127L21 – 50/60Hz IIR notch filter design

11. Filter Designer will now display the Magnitude response

- You can now make adjustments and recalculate the response if needed

12. Click the ‘Set quantization parameters’ button 

- The initial design uses floating point math. The quantization tool enables fixed point design



ADS127L21 – 50/60Hz IIR notch filter design

13. Select Fixed-point on the Filter arithmetic selection

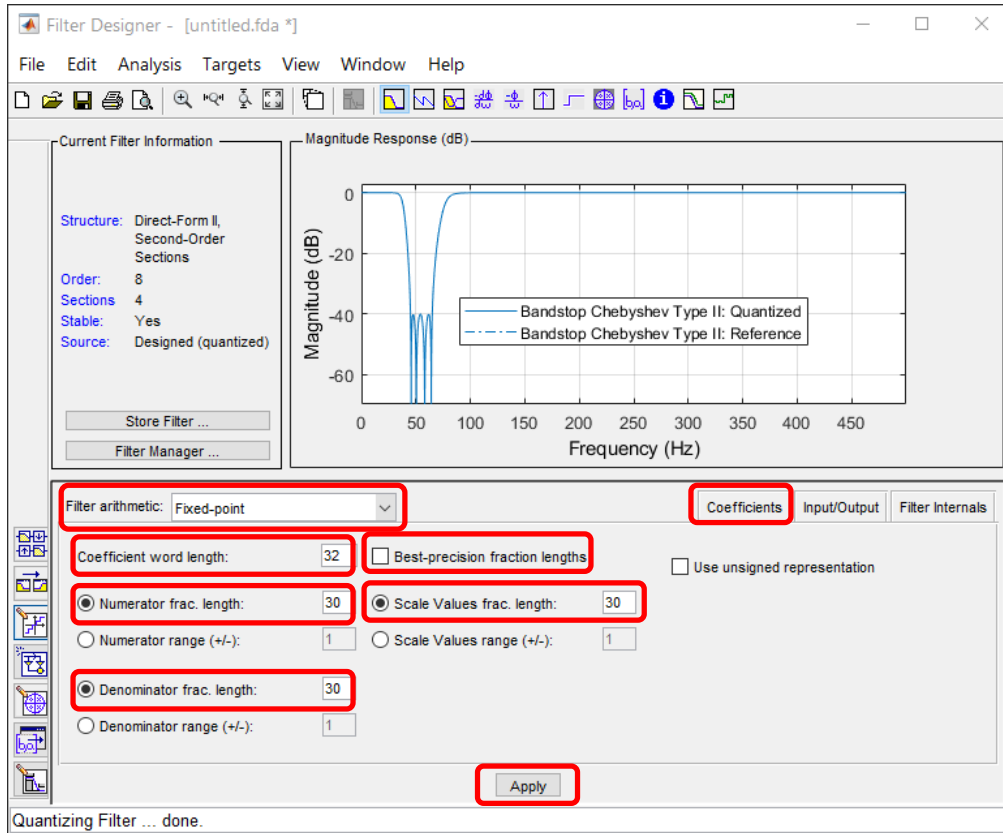
14. Enter 32 for Coefficient word length in the Coefficients tab

15. Uncheck the Best-precision fraction lengths box

16. Enter 30 for:

- Numerator fraction length
- Denominator fraction length
- Scale Values fraction length

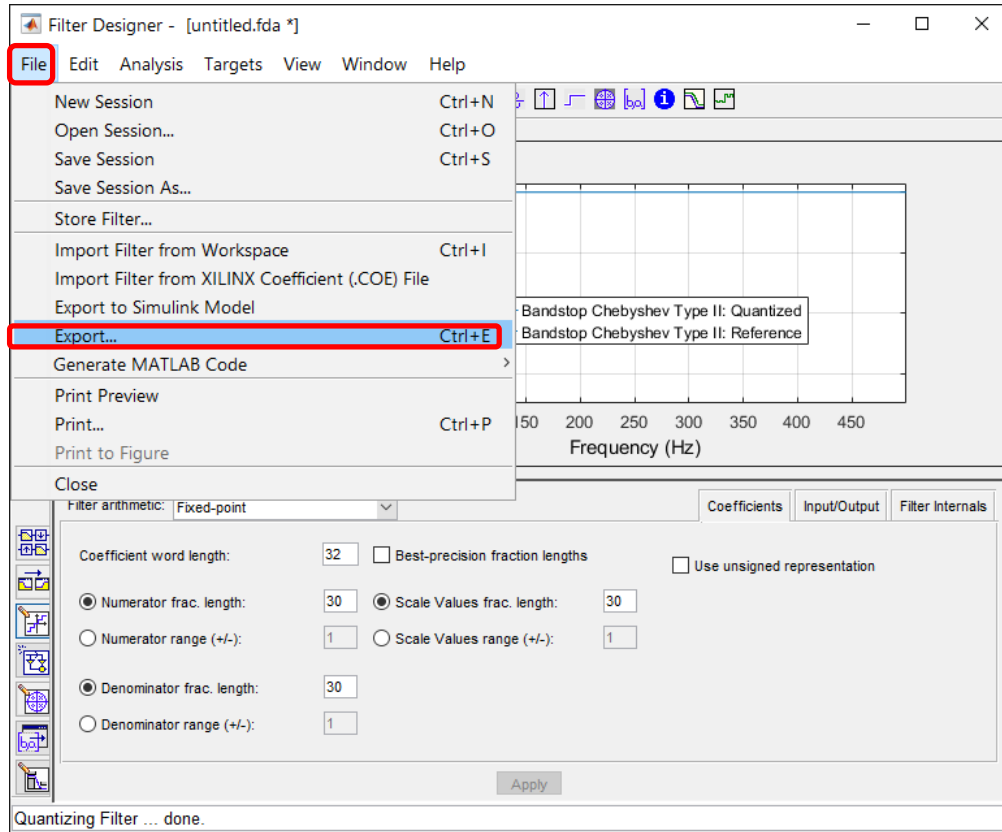
17. Click the 'Apply' button



ADS127L21 – 50/60Hz IIR notch filter design

18. The Magnitude Response display now plots both the original floating point (Reference) and fixed-point (Quantized) results.

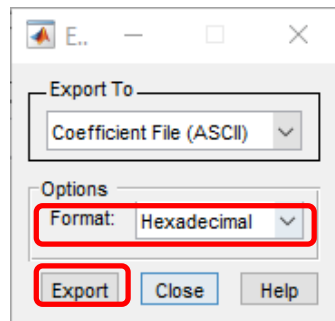
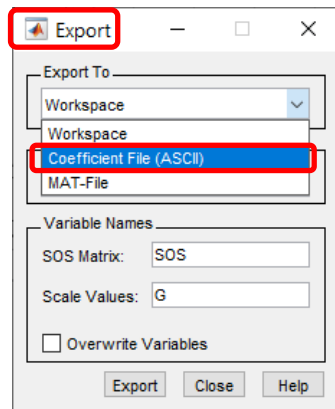
19. Select File->Export



The screenshot shows the Filter Designer application window titled "Filter Designer - [untitled.fda *]". The "File" menu is open, and the "Export..." option is highlighted with a red box. The menu items include: New Session (Ctrl+N), Open Session... (Ctrl+O), Save Session (Ctrl+S), Save Session As..., Store Filter..., Import Filter from Workspace (Ctrl+I), Import Filter from XILINX Coefficient (.COE) File, Export to Simulink Model, Export... (Ctrl+E), Generate MATLAB Code, Print Preview, Print... (Ctrl+P), and Print to Figure. The main workspace displays a plot of the magnitude response for a "Bandstop Chebyshev Type II: Quantized" filter. The x-axis is labeled "Frequency (Hz)" and ranges from 150 to 450. The plot shows a notch at approximately 50 Hz. Below the plot, the "Filter arithmetic" is set to "Fixed-point". The "Coefficients" tab is active, showing settings for coefficient word length (32), numerator and denominator fraction lengths (30), and range (+/-) (1). The "Scale Values" section is also visible, with "Scale Values frac. length" set to 30 and "Scale Values range (+/-)" set to 1. An "Apply" button is located at the bottom right of the settings panel. The status bar at the bottom of the window reads "Quantizing Filter ... done."

ADS127L21 – 50/60Hz IIR notch filter design

20. Under Export pop-up window, Export To, select Coefficient File (ASCII)
21. Under Options, Format, select Hexadecimal
22. Click the Export button
23. Choose directory and file name, save as default *.fcf file name
 - ADS127L21_IIR_45Hz_65Hz_notch_1ksps.fcf



ADS127L21 – 50/60Hz IIR notch filter design

24. Start the ADS127L21EVM-PDK-GUI software and click on the Digital Filter Configuration page

25. Click the file button for the IIR coefficient File

26. Navigate to the *.fcf file just created in MATLAB® and select file

27. Click on the Filter Response tab

ADS127L21 EVM

File Edit Debug Capture Tools Help

EVM Connected : ADS127L21EVM Connect to Hardware

Digital Filter Configuration

Filter Sequence: FIR3 then IIR Filter Selection: FIR: Default coeffs FIR2: Disabled? FIR3: Disabled? IIR: Disabled?

FIR3 Coefficient File: Reverse FIR3 Coefficients order

IIR Coefficient File: Reverse IIR Coefficients order

Note: Selecting a valid Coefficient file will write the coefficient values to the device depending the coefficient order selected. Coefficient order for FIR3 : h128 - h1 ; IIR : g5 - g1.

Filter Response

Filter Coefficients

FIR3 Coefficients

0	x	FFFFAB25
	x	FFF868D
	x	A9B4
	x	1654E
	x	800
	x	FFDDDE9
	x	FFF039E
	x	326B9
	x	33A9A
	x	FFCA90A
	x	FF98363
	x	AESB

IIR Coefficients

Gain Coefficients

x	3D22B985	x	3D22B985	x	3A0F5133	x	3A0F5133	x	40000000
---	----------	---	----------	---	----------	---	----------	---	----------

IIR Coefficients

x	40000000	x	40000000	x	40000000	x	40000000
x	85399FC0	x	8A3EEF9E	x	865E7F23	x	886DD1E7
x	40000000	x	40000000	x	40000000	x	40000000
x	9420A462	x	872881A6	x	8F401391	x	96154AC3
x	3961AC2C	x	3C753A4A	x	35C3BAB3	x	32BA207A

IIR CRC

x	8E
---	----

Interface Configuration

Data Width: 24 bits

Speed Mode: Max Speed

Input Range: 1 * Vref

Filter Type: Wide Bandwidth

OSR: 32

Clock Divider: No Division

Vref (V): 2.5

Samples: 16384

Capture

SCLK: 32.77M

MCLK: 32.77M

Data Rate (sps): 512.00k

Idle

HW CONNECTE TEXAS INSTRUMENTS

ADS127L21 – 50/60Hz IIR notch filter design

28. Set the sample rate to 1kps

- Set OSR to 2048
- Set Clock Divider to Div by 8

29. Click, un-check, the IIR Disabled box

30. The combined FIR Wideband filter and IIR filter response are now plotted and ready for use.

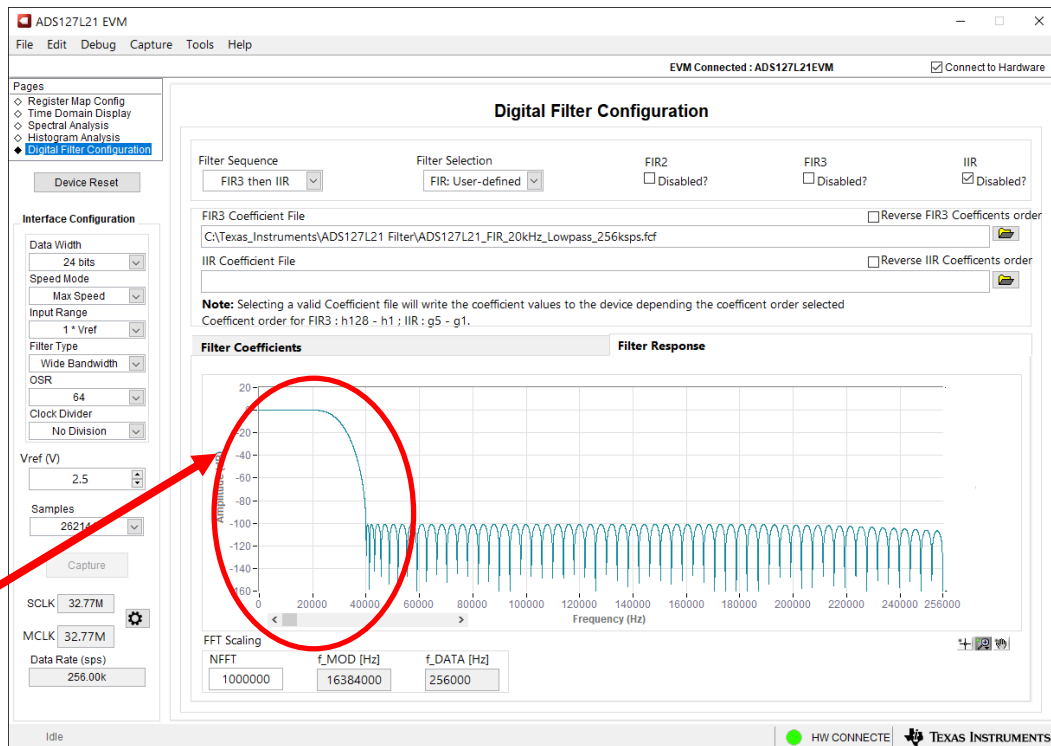
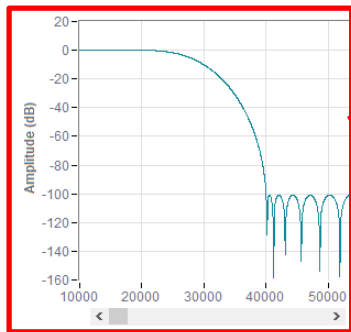
The screenshot displays the ADS127L21 EVM software interface. The main window is titled "Digital Filter Configuration". In the "Filter Selection" section, the "IIR" checkbox is un-checked, and the "IIR Disabled?" checkbox is checked. The "Filter Sequence" is set to "FIR3 then IIR". The "IIR Coefficient File" is set to "C:\Texas_Instruments\ADS127L21_custom_filter\ADS127L21_IIR_45Hz_65Hz_notch_1kps.fcf". The "Filter Response" plot shows the magnitude response of the filter, with a notch at 50/60Hz. The plot shows a sharp dip in the magnitude response at approximately 50 Hz and 60 Hz, indicating the notch filter's effect. The x-axis is labeled "Frequency (Hz)" and ranges from 0 to 1000. The y-axis is labeled "Amplitude (dB)" and ranges from -200 to 20. The "Filter Coefficients" section is also visible, showing the "Filter Response" plot. The "Data Rate (kps)" is set to "1.00k".

ADS127L21

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 - MATLAB® Filter Design overview
 - Design IIR 50Hz/60Hz power-line frequency notch filter for 1ksps data rate
 - Design FIR 20kHz Low pass filter for 256ksps data rate

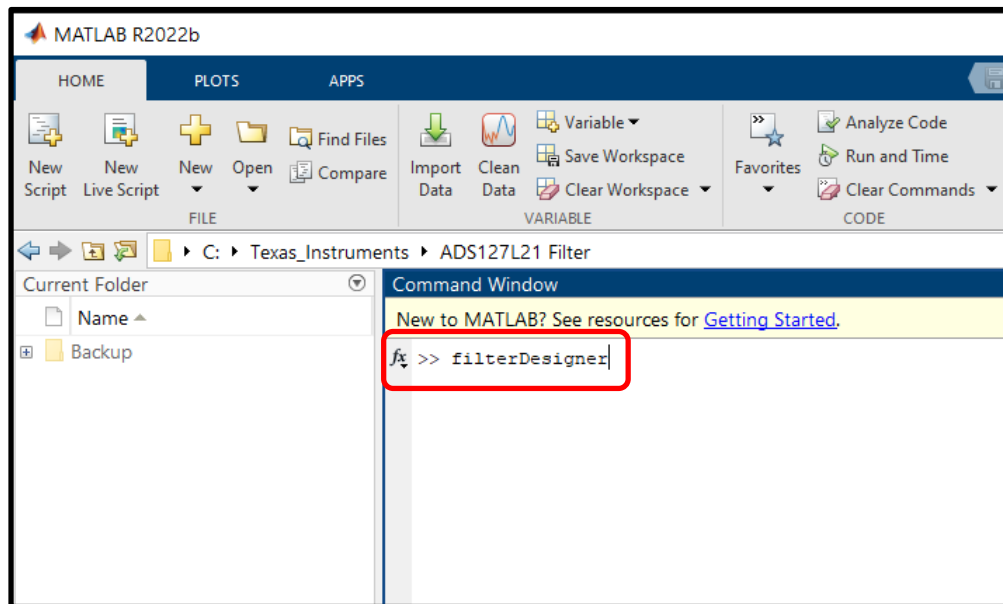
ADS127L21 – 20kHz FIR lowpass filter design

- Filter Design Criteria
 - 20kHz lowpass filter using FIR
 - Target sample rate of 256kps
 - Limited to maximum of 128 coefficients
 - Filter Designer tool creates 20kHz lowpass with $\geq 100\text{dB}$ of attenuation



ADS127L21 – 20kHz FIR lowpass filter design

1. Open MATLAB®
2. In the Command Window, type `filterDesigner` and press Enter
 - This will launch the Filter Designer tool that is part of the Signal Processing Toolbox
3. Wait for Filter Designer to load



ADS127L21 – 20kHz FIR lowpass filter design

4. Select Lowpass under Response Type
5. Select FIR and Equiripple under Design Method
6. Select Minimum order under Filter Order
 - This option allows setting of desired passband ripple and stopband attenuation
 - Requires iterating transition bandwidth ($F_{\text{pass}} - F_{\text{stop}}$) until order is ≤ 127 , or number of coefficients ≤ 128

The screenshot shows the Filter Designer software interface with the following settings and specifications:

- Current Filter Information:**
 - Structure: Direct-Form FIR
 - Order: 50
 - Stable: Yes
 - Source: Designed
- Filter Specifications:** A graph showing Magnitude (dB) vs. Frequency (Hz). The passband is flat at 0 dB up to F_{pass} . The stopband starts at F_{stop} and reaches $F_s/2$. The passband ripple is A_{pass} and the stopband attenuation is A_{stop} .
- Response Type:** Lowpass (selected)
- Design Method:** FIR Equiripple (selected)
- Filter Order:** Minimum order (selected), Specify order: 10
- Frequency Specifications:**
 - Units: Hz
 - F_s : 512000
 - F_{pass} : 20000
 - F_{stop} : 40000
- Magnitude Specifications:**
 - Units: dB
 - A_{pass} : 0.01
 - A_{stop} : 105

ADS127L21 – 20kHz FIR lowpass filter design

7. Enter F_s : 512000 (Hz) under Frequency Specifications

- Final sample rate is 256kHz, $F_s=2*256\text{kHz}$ to account for 2x decimation

8. Enter F_{pass} : 20000 (Hz) and F_{stop} : 40000 (Hz) under Frequency Specifications

9. Enter A_{pass} : 0.01 and A_{stop} : 105 (dB) under Magnitude Specifications

10. Click the 'Design Filter' button.

The screenshot shows the Filter Designer software interface. The window title is "Filter Designer - [untitled.fda *]". The menu bar includes File, Edit, Analysis, Targets, View, Window, and Help. The toolbar contains various icons for file operations and analysis. The main interface is divided into several sections:


- Current Filter Information:** Structure: Direct-Form FIR, Order: 50, Stable: Yes, Source: Designed. Buttons: Store Filter..., Filter Manager...
- Filter Specifications:** A graph showing Magnitude (dB) vs. Frequency (Hz). The passband is flat at 0 dB up to F_{pass} . The stopband starts at F_{stop} and reaches A_{stop} dB. The Nyquist frequency is $F_s/2$.
- Response Type:** Lowpass (selected), Highpass, Bandpass, Bandstop, Differentiator.
- Design Method:** IIR (Butterworth), FIR (Equiripple, selected).
- Filter Order:** Specify order: 10, Minimum order (selected), Options: Density Factor: 20.
- Frequency Specifications:** Units: Hz, F_s : 512000, F_{pass} : 20000, F_{stop} : 40000.
- Magnitude Specifications:** Units: dB, A_{pass} : 0.01, A_{stop} : 105.
- Design Filter:** A button at the bottom center of the interface.

The status bar at the bottom left shows "Ready".

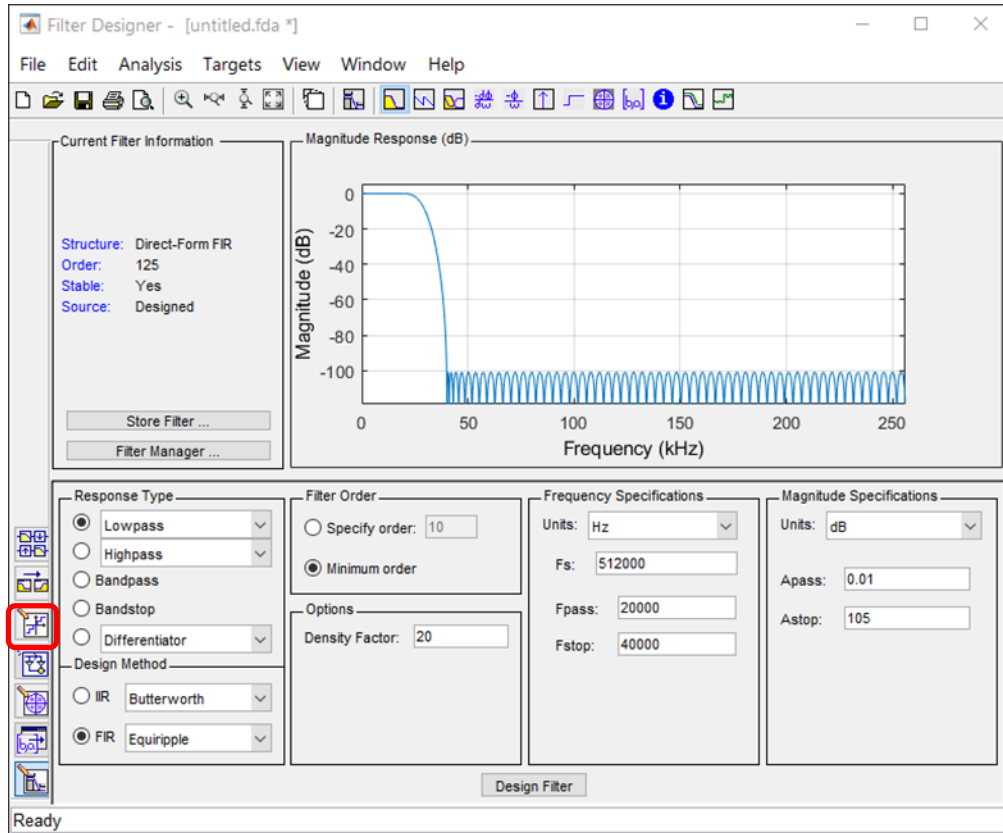
ADS127L21 – 20kHz FIR lowpass filter design

11. Filter Designer will now display the Magnitude response

- You can now make adjustments and recalculate the response if needed
- Filter Order = 125 (<128)

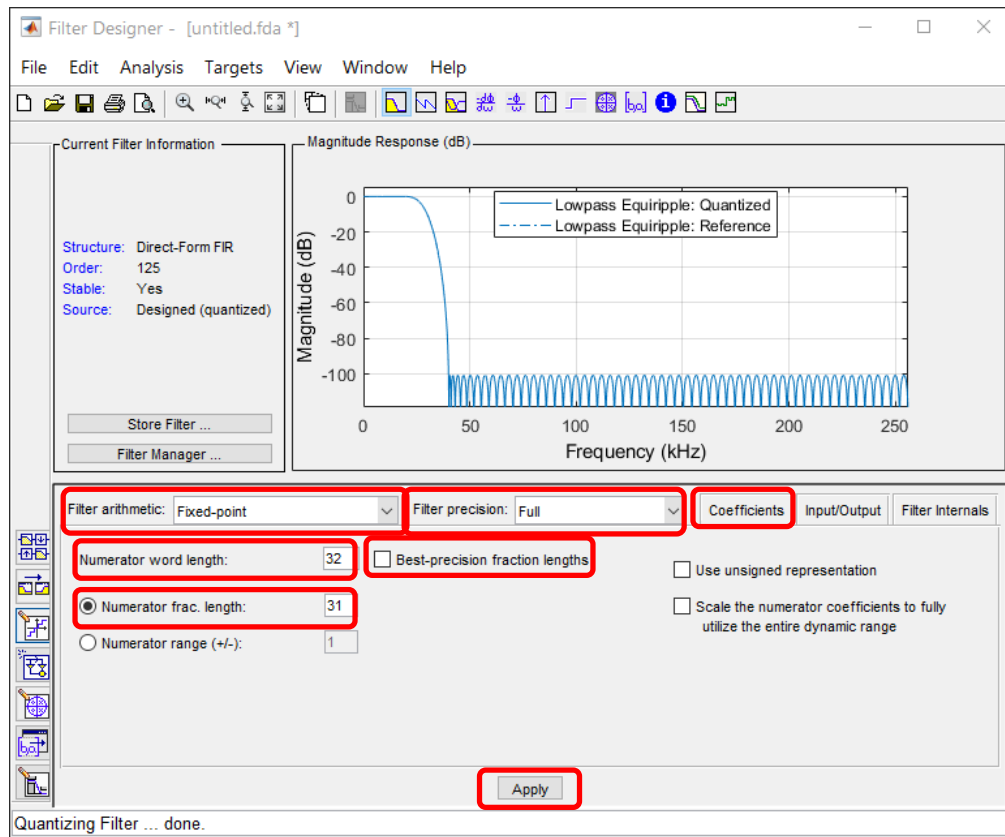
12. Click the ‘Set quantization parameters’ button 

- The initial design uses floating point math. The quantization tool enables fixed point design



ADS127L21 – 20kHz FIR lowpass filter design

13. Select Fixed-point on the Filter arithmetic selection
14. Select Filter precision: Full
15. Enter 32 for Numerator word length in the Coefficients tab
16. Uncheck the Best-precision fraction lengths box
 - Leave other boxes unchecked
17. Enter 31 for Numerator fraction length
18. Click the 'Apply' button



ADS127L21 – 20kHz FIR lowpass filter design

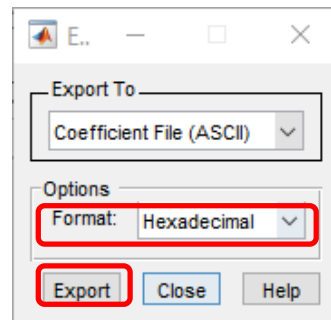
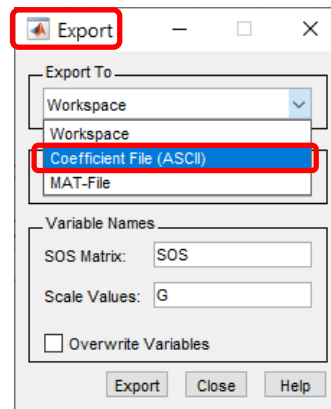
19. The Magnitude Response display now plots both the original floating point (Reference) and fixed-point (Quantized) results.

20. Select File->Export

The screenshot displays the 'Filter Designer' application window. The 'File' menu is open, with the 'Export...' option highlighted by a red rectangle. The 'Export...' option has the keyboard shortcut 'Ctrl+E' next to it. The main window area shows a plot of the magnitude response, with two curves: 'Lowpass Equiripple: Quantized' (solid blue line) and 'Lowpass Equiripple: Reference' (dashed blue line). The x-axis is labeled 'Frequency (kHz)' and ranges from 0 to 250. The y-axis represents magnitude. Below the plot, the 'Filter arithmetic' section is visible, showing 'Fixed-point' selected for the arithmetic type and 'Full' for the filter precision. Other settings include 'Numerator word length: 32', 'Numerator frac. length: 31', and 'Numerator range (+/-): 1'. There are also checkboxes for 'Best-precision fraction lengths', 'Use unsigned representation', and 'Scale the numerator coefficients to fully utilize the entire dynamic range'. An 'Apply' button is located at the bottom right of the settings panel. The status bar at the bottom of the window reads 'Quantizing Filter ... done.'

ADS127L21 – 20kHz FIR lowpass filter design

21. Under Export pop-up window, Export To, select Coefficient File (ASCII)
22. Under Options, Format, select Hexadecimal
23. Click the Export button
24. Choose directory and file name, save as default *.fcf file name
 - ADS127L21_FIR_20kHz_Lowpass_256ksps.fcf



ADS127L21 – 20kHz FIR lowpass filter design

25. Start the ADS127L21EVM-PDK-GUI software and click on the Digital Filter Configuration page

26. Click the file button for the FIR coefficient File

27. Navigate to the *.fcf file just created in MATLAB® and select file

28. Click on the Filter Response tab

ADS127L21 EVM

File Edit Debug Capture Tools Help

EVM Connected : ADS127L21EVM Connect to Hardware

Pages

- Register Map Config
- Time Domain Display
- Spectral Analysis
- Digital Filter Configuration**

Device Reset

Interface Configuration

Data Width: 24 bits

Speed Mode: High Speed

Input Range: 1 * Vref

Filter Type: Wide Bandwidth

OSR: 32

Clock Divider: Div by 2

Vref (V): 2.5

Samples: 262144

Capture

SCLK: 32.77M

MCLK: 32.77M

Data Rate (sps): 256.00k

Idle

Digital Filter Configuration

Filter Sequence: FIR3 then IIR

Filter Selection: FIR: Default coeffs

FIR2: Disabled?

FIR3: Disabled?

IIR: Disabled?

FIR3 Coefficient File: C:\Texas_Instruments\ADS127L21_Filter\ADS127L21_FIR_20kHz_Lowpass_256ksps.fcf

IIR Coefficient File:

Note: Selecting a valid Coefficient file will write the coefficient values to the device depending the coefficient order selected. Coefficient order for FIR3 : h128 - h1 ; IIR : g5 - g1.

Filter Coefficients

FIR3 Coefficients

0	x	0	h128
	x	0	h127
	x	4EAB	h126
	x	6A8D	h125
	x	9608	h124
	x	A867	h123
	x	8F22	h122
	x	2145	h120
	x	FFF42C6	h119
	x	FFDD8A	h118
	x	FFBEDA0	
	x	28A0	

Filter Response

IIR Coefficients

Gain Coefficients

x	40000000	x	40000000	x	40000000	x	40000000	x	40000000
---	----------	---	----------	---	----------	---	----------	---	----------

IIR Coefficients

x	0	g11	x	0	g21	x	0	g31	x	0	g41
x	0	g12	x	0	g22	x	0	g32	x	0	g42
x	0	g13	x	0	g23	x	0	g33	x	0	g43
x	0	g14	x	0	g24	x	0	g34	x	0	g44

IIR CRC

x	0
---	---

HW CONNECTE

ADS127L21 – 20kHz FIR lowpass filter design

29. Set the sample rate to 256ksps

- Set OSR to 64

30. Set Filter Selection to:

- FIR: User-defined

31. The FIR Wideband filter response is now plotted and ready for use.

The screenshot displays the ADS127L21 EVM software interface. The 'Digital Filter Configuration' window is open, showing the following settings:

- Filter Sequence:** FIR3 then IIR
- Filter Selection:** FIR: User-defined
- FIR2:** Disabled?
- FIR3:** Disabled?
- IIR:** Disabled?
- FIR3 Coefficient File:** C:\Texas_Instruments\ADS127L21_Filter\ADS127L21_FIR_20kHz_Lowpass_256ksps.fc
- IIR Coefficient File:** (Empty)
- Note:** Selecting a valid Coefficient file will write the coefficient values to the device depending the coefficient order selected. Coefficient order for FIR3 : h128 - h1 ; IIR : g5 - g1.
- Filter Coefficients:** (Empty)
- Filter Response:** (Plotted)

The 'Filter Response' plot shows the amplitude response of the filter. The x-axis is Frequency (Hz) from 0 to 256,000. The y-axis is Amplitude (dB) from -160 to 20. The plot shows a sharp roll-off at 20,000 Hz, with the amplitude dropping from approximately 0 dB to -120 dB. The plot is titled 'Filter Response' and has a 'Filter Coefficients' label above it.

Other settings visible in the interface include:

- OSR:** 64
- Data Rate (sps):** 256.00k
- SCLK:** 32.77M
- MCLK:** 32.77M

Thanks for your time!



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