Q1 How to determine the gain of amplifier?

Note: In the situation which the volumn can be frequently changing, how to adjust it in that case.

If the input signal have stable peak-to-peak range, we usually adjust the gain so that it can utilize the full range of ADC.
If the input signal is not stable, automatic gain control algorithms are used to determine and update the gain based on statistics of the input signal.

Q2 How many bits should be used for ADC and DAC?

This depends on the input voltage range and what precision you want to have.
Large input voltage range requires more bits to achieve same precision.

Q3 What should the sampling rate be?

Note: $n\times$ of the signal frequency.

Due to the aliasing effect, sampling with $f_s = 2f_M$ leads to making fold back signal overlaped with original samples. To prevent aliasing messing up the signal, f_s should be at least 4 times of f_M. But in practice, filters are used to remove aliasing artifacts, and their curve need spaces between each section of signal and aliased signal to that it can prevent some high frequency components of signal being affected. I think this is the reason why usually people choose $5f_M \leq f_s \leq 10f_M$.

Q4 What is the difference of SAR ADC and CODEC?

Sucessive Approximation Register (SAR) ADC is generally accurate and fast at a relatively low cost. But it value variation is limited by internal clock rate.
CODEC is consisted with a ADC and DAC, which mostly use sigma-delta ADC block for their high-quality and relatively low cost.

Q5 What should the input voltage range be for a DSP system?

This depends on both chatacteristics of input signal and the ADC. For precise signal processing, decreasing input voltage range can provide more accuracy for ADC output. Increase input voltage range results in larger voltage gap between ADC output values resulting in less accuracy.

Q6 What is the physical difference of AGC(ex. ADI-AD8338) and PGA(ex. TI-PGA280)?

Note: Difference in functional block diagram.
AGC stands for Automatic Gain Control, which performs additional gain manipulation based on the base gain input. (AD8338, analog controlled). With this technique, the gain adjustment is finished automatically within the chip, and doesn't need additional control circuits.
PGA stands for Programmable Gain Amplifier, which adjust signal gain based on a digital signal input. (TI-PGA280, diginal controlled). It is required to have additional control circuit using communication protocols to adjust gain.

Q7 What is the functionality/purpose of "decimation"?

Decimation is used to increase or decrease the sampling rates of the existing digital signals.
Its use case can be matching the sampling frequency with system to increase its resolution.

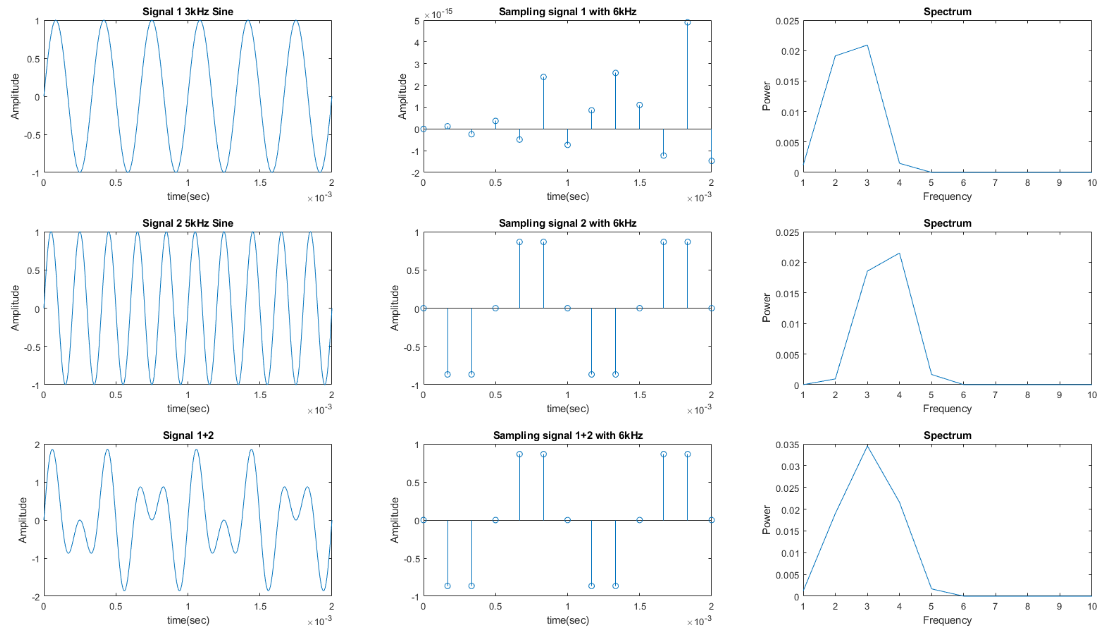
Q8 Why does ADAU-1787 used HP after DAC on output stage?

Based on the detail information from the datasheet, in "OUTPUT SIGNAL PATHS" section "HP" is referring to as Headphone Output with output like "HPOUTP0", "HPOUTN0", ... These output pins can be set as headphone driver.
This does not refer to High Pass filters. Which corresponds to the usual setup as Low Pass filters.

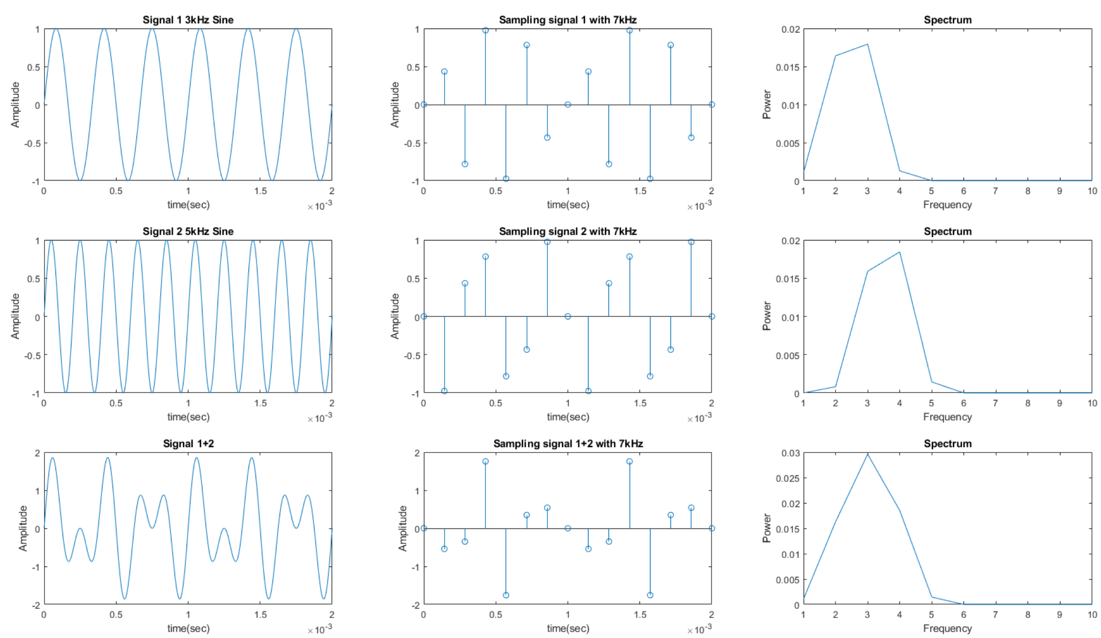
Q9 If a signal consisted with 3Hz and 5Hz frequency is sampled with 6Hz sample rate, what would happen?

Note: In Matlab simulation, we can use 3k, 5k, and 6k. As long as it suit the purpose.
Check example 1.1 at p27 mid

3Hz signal after sampling and reconstructing will still be 3Hz. But 5Hz signal will become 1Hz after reconstruction due to aliasaing effect.
I've tried to simulate the aliasing effect occuring while sampling with MatLab but with failure.
This is the result sampling both signals with 6Hz frequency.



This is the result sampling both signals with 7Hz frequency.



I think why the output spectrum is not precise is because the signal is not being reconstructing before calculating its spectrum. Also, despite sampling with fulfilling Nyquist frequency condition, my code can't accurately sample the 3Hz signal.

Q10 Why sampling results in SQNR value roughly 6 times of bandwidth?

Note: 2.4.3 Signal Quantization, eq2.88
I don't understand the calculation which leads to this result, but this rule is based on both math calculation and experiment.

Q11 What is single precision and double precision? Which precision can you use for Matlab? Which one didi you use? Why?

Single precision: 32bits = 1bit (sign) + 8bit (exponent) + 23bit (mantissa/fraction), represents precision of about 7 decimal digits.
Double precision: 64bits = 1bit (sign) + 11bit (exponent) + 52bit (mantissa/fraction), represents precision of about 16 decimal digits.
Matlab can use both single and double precision, but as double in default.
Double precision provides higher precision, and requires more memory to store. If the task required higher precision, then double precision is prefered.
If we have a ADC with input voltage ranging from $\pm 200mV$ with 32bits output, then the precision is $\frac{4 \times 10^{-1} V}{2^{32}} \approx 9.313225746154786 \times 10^{-11}$. To store this number as float, single precision is sufficient.

Q12 What is IEEE754?

This standard is used to define floating-point arithmetic. This includes the following things:

- arithmetic formats
- interchange formats
  - binary
    - binary16 (half precision)
    - binary32 (single precision)
    - binary64 (double precision)
    - binary128 (quadruple precision)
    - binary256 (qctuple precision)
  - decimal
    - decimal32
    - decimal64
    - decimal128
- rounding rules
  - rounding to nearest
  - direct rounding
- operations
  - conversions to and from integer
  - previous and enxt consecutive values

- arithmetic operations like add, subtract, multiply....
    - conversionns between formats (to and from string)
    - scaling and quantizing
    - copying and manipulating the sign (abs, negate)
    - comparisons and total ordering
    - classification of numbers adn testing for NaNs
    - testing and steting status flags
- exception handling
    - invalid operation
    - division by zero
    - overflow
    - underflow
    - inexact

It also defines other special values like

- signed zero
- subnormal numbmers
- infinites
- Nans

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