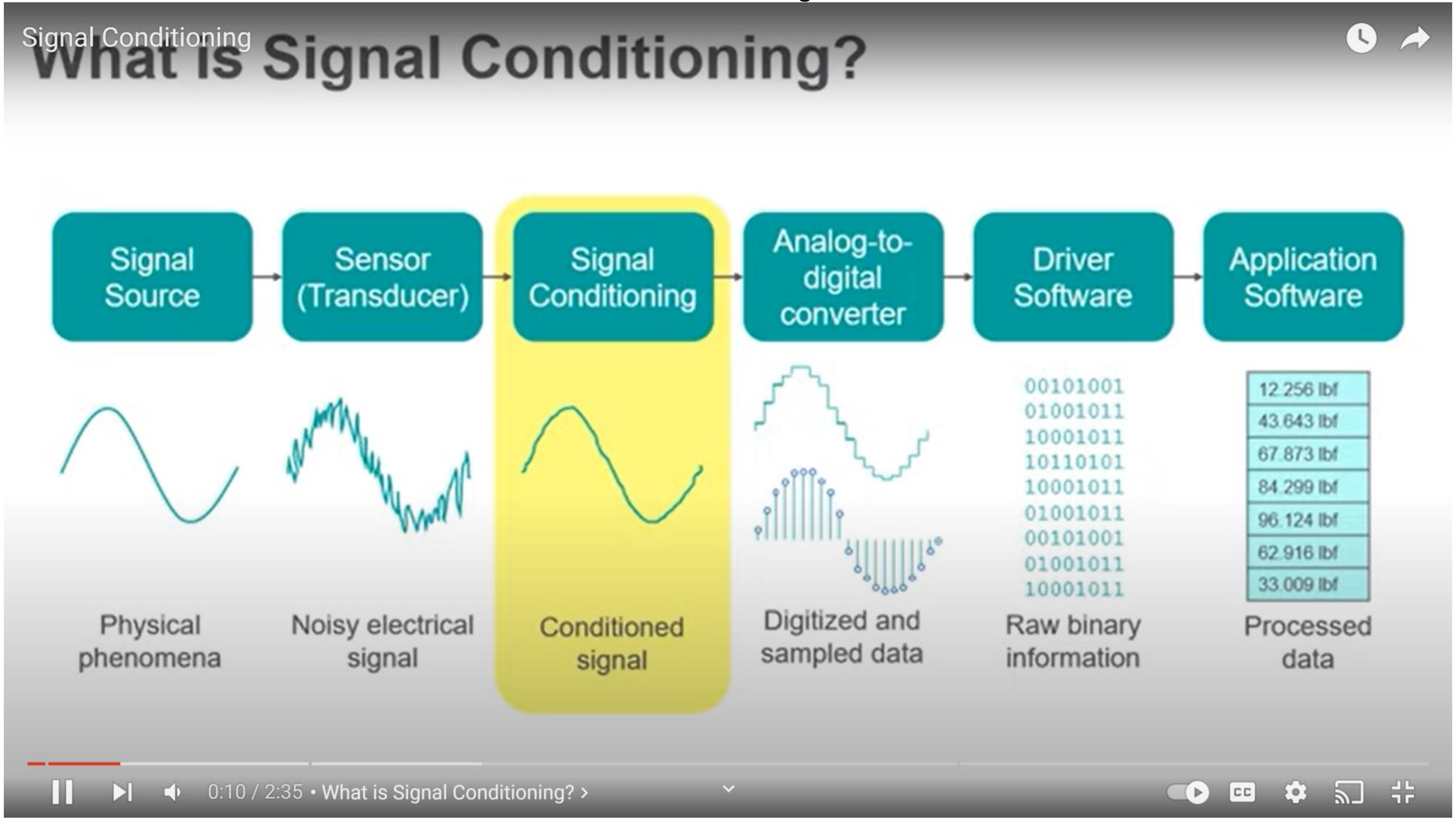
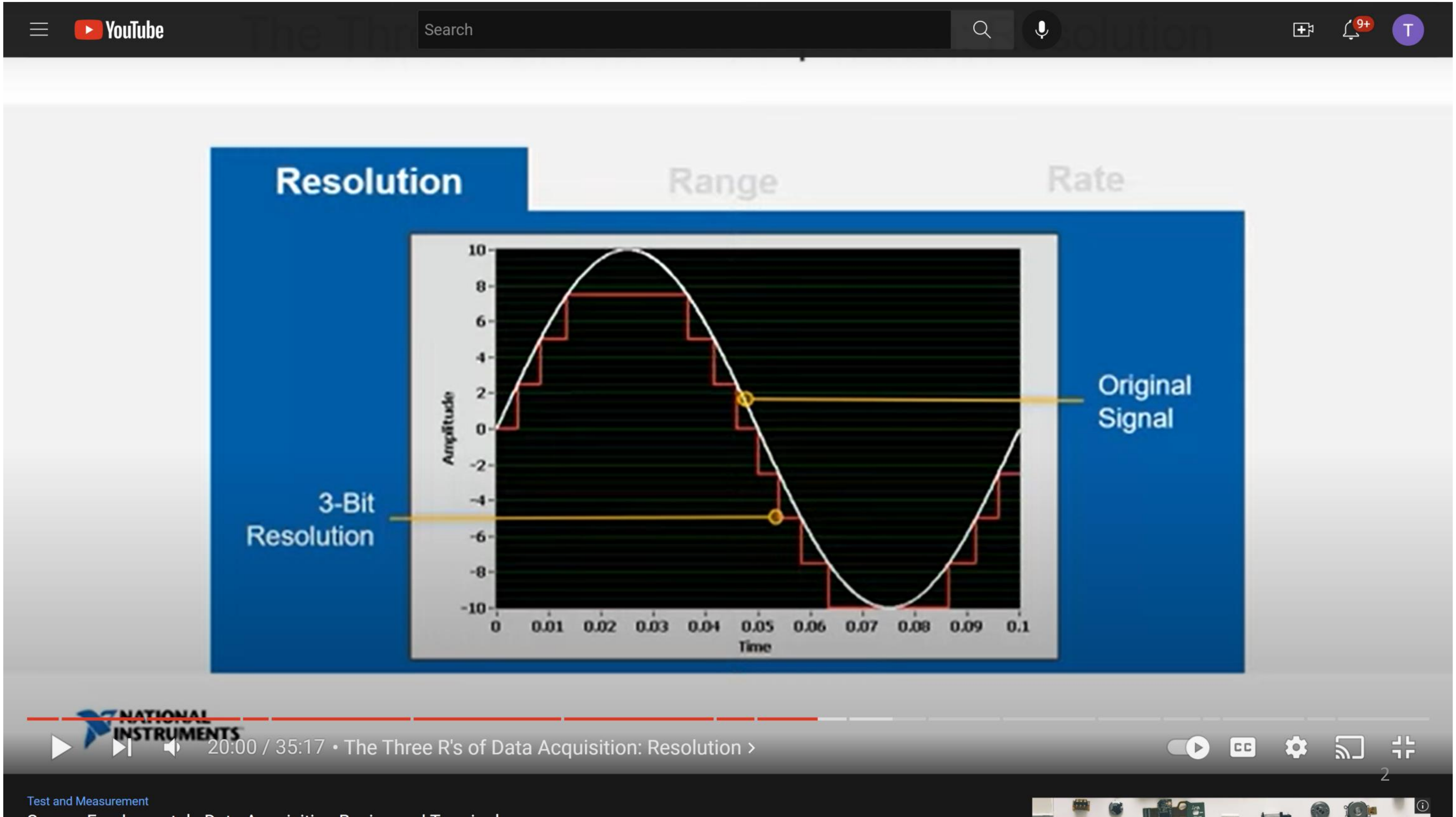
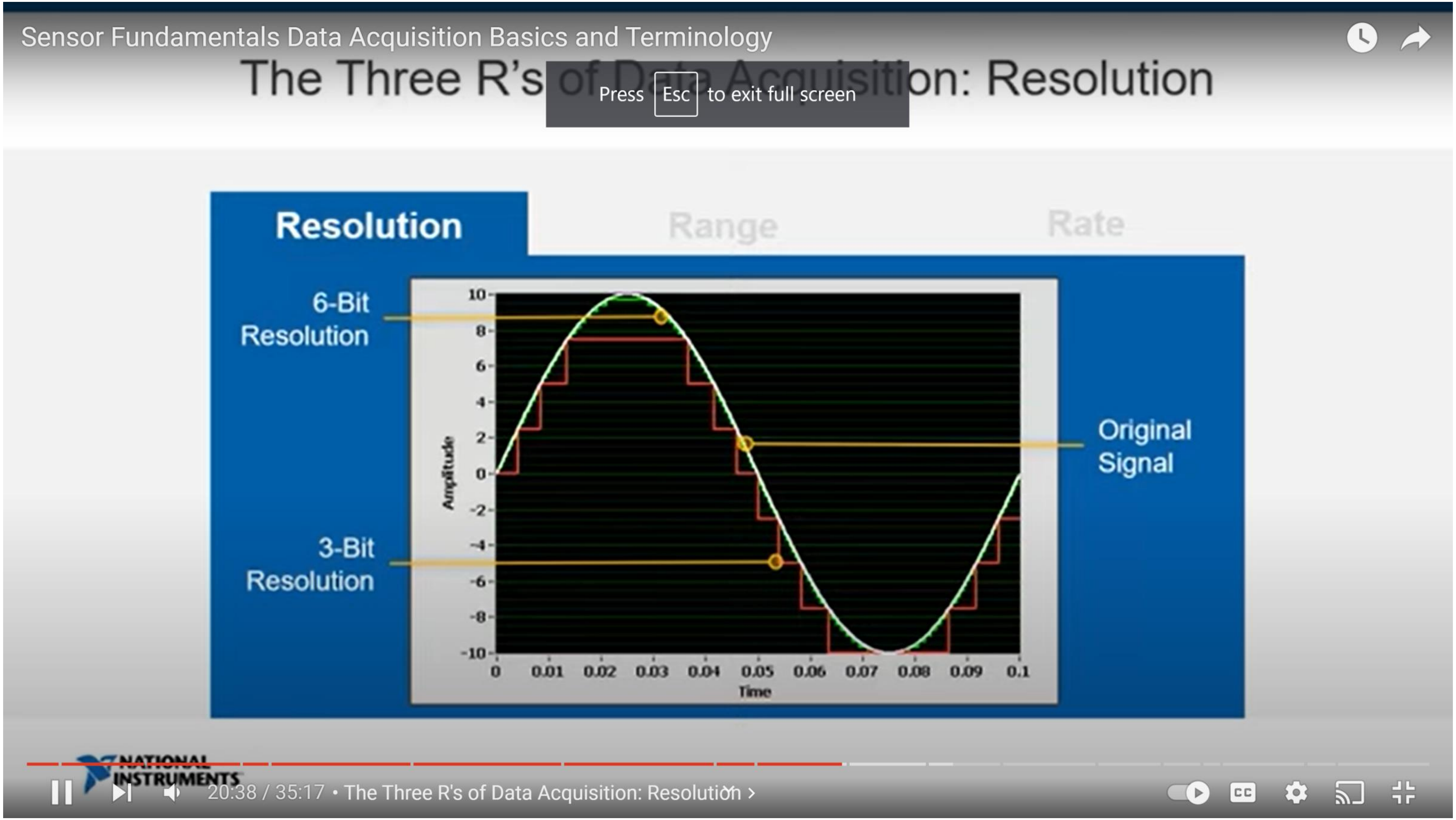
Data Acqusition



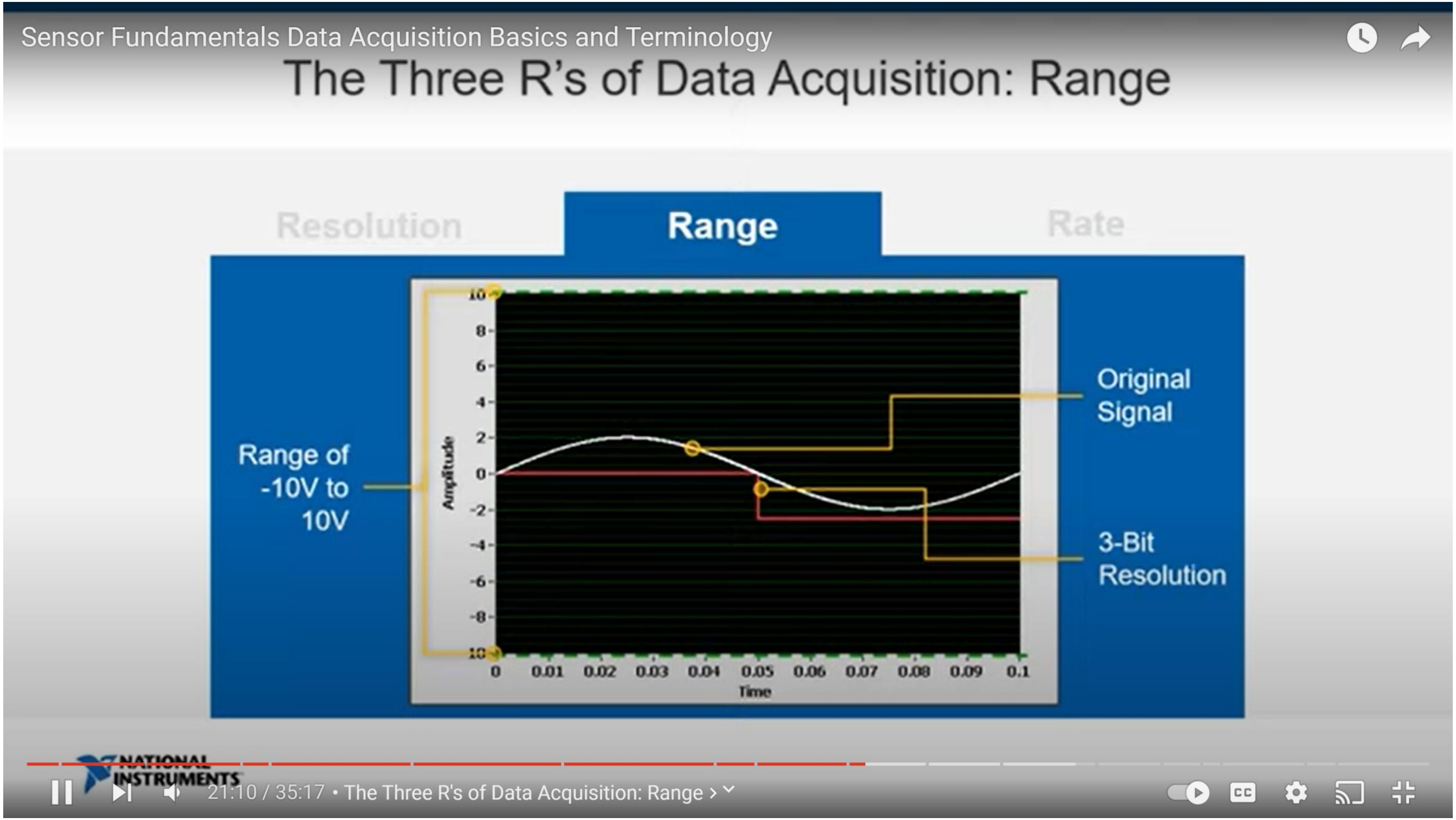
https://www.youtube.com/watch?v=HSHJXXFigz8 https://www.youtube.com/watch?v=Xc8dP0PdC_4

Sensor Fundamentals Data Acquisition Basics and Terminology
17,370 views Nov 5, 2020

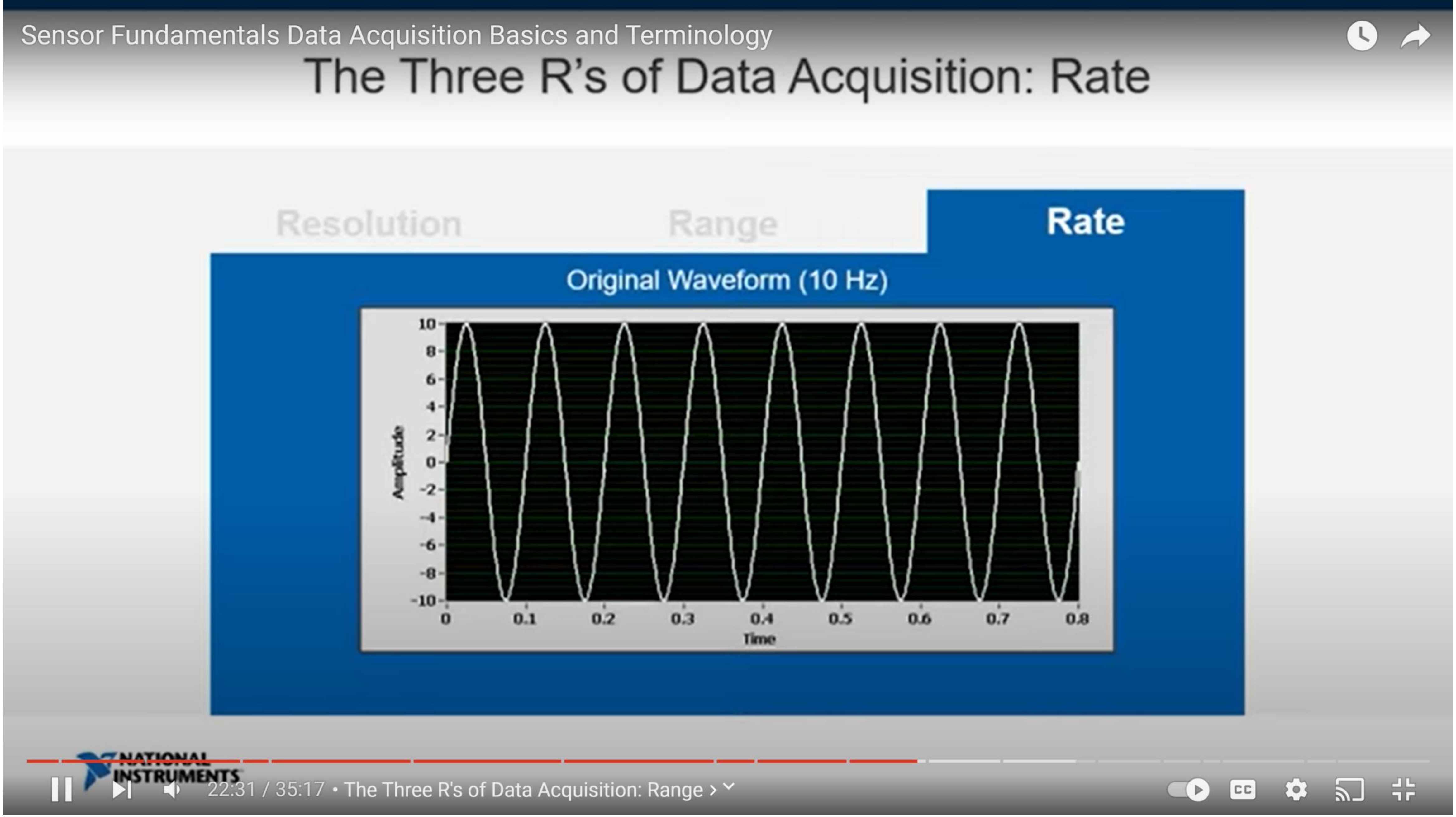




Sensor Fundamentals Data Acquisition Basics and Terminology
The Three R's of Data Acquisition: Resolution
Press Esc to exit full screen
Resolution
Range
Rate
6-Bit Resolution
3-Bit Resolution
Original Signal
Amplitude
Time
10
8
6
4
2
0
-2
-4
-6
-8
-10
0 0.01 0.02 0.03 0.04 0.05 0.06 0.07 0.08 0.09 0.1
NATIONAL INSTRUMENTS
20:38 / 35:17 • The Three R's of Data Acquisition: Resolution



8 states (3 Bits) to represent the voltage range   Here 20v/8 = 2.5 volts per step

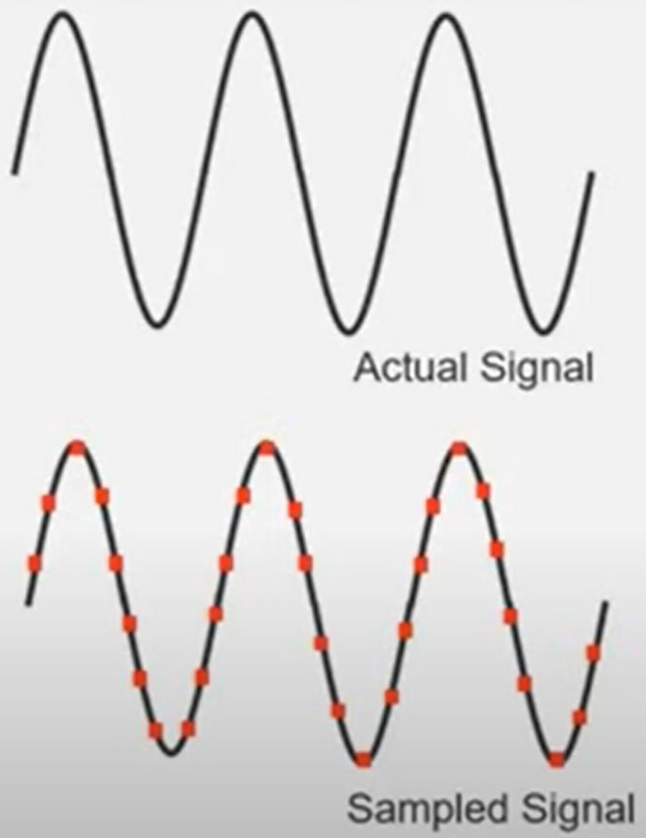


Number of Samples per second

Sensor Fundamentals Data Acquisition Basics and Terminology

Sampling Rate Considerations

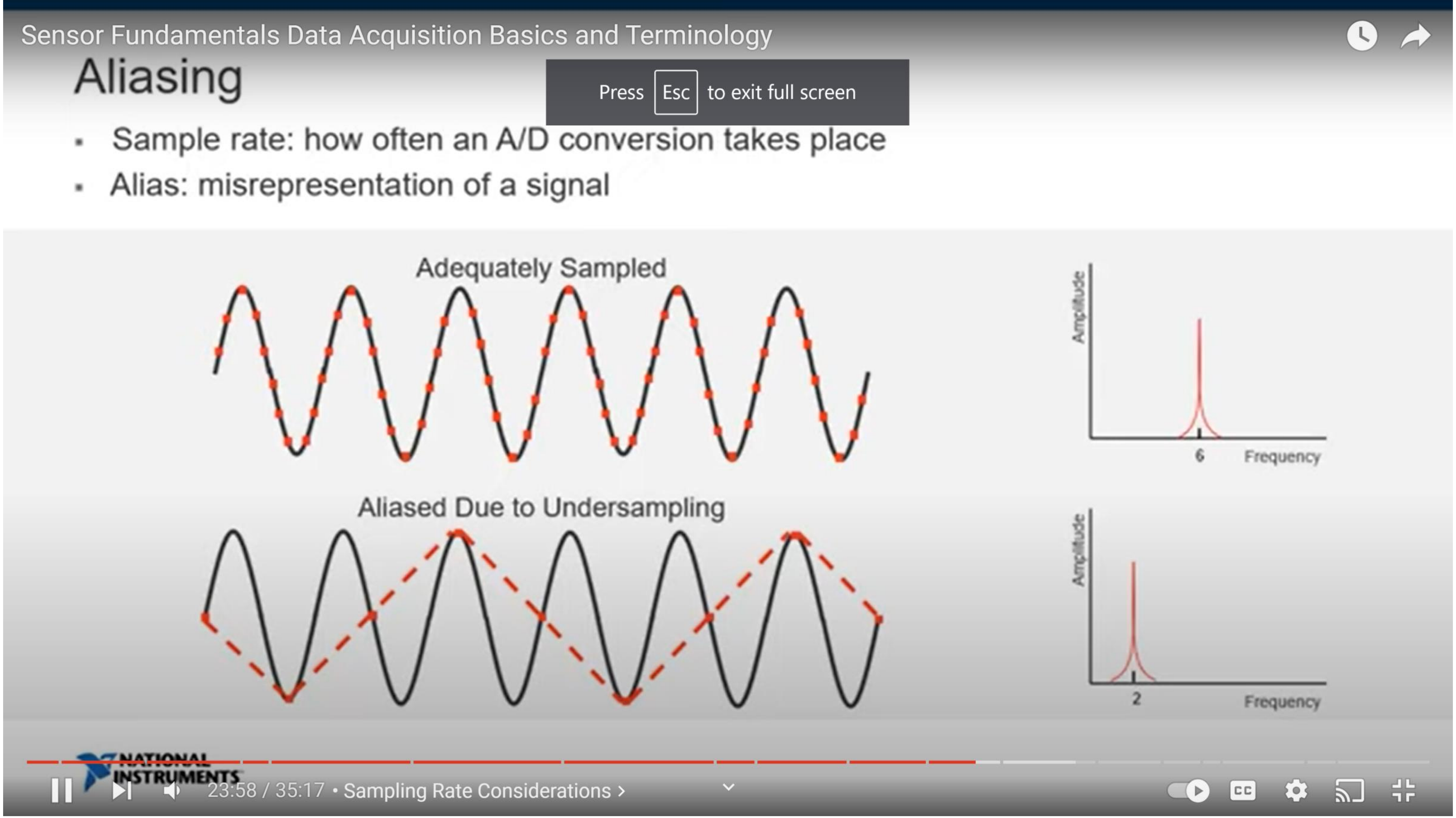
- An analog input signal is continuous with respect to time.
- Sampled signal is series of discrete samples acquired at a specified sampling rate.
- The faster we sample, the more our sampled signal will look like our actual signal.
- If not sampled fast enough, a problem known as aliasing will occur.



View chapter

NATIONAL INSTRUMENTS

23:08 / 35:17 • Sampling Rate Considerations ›



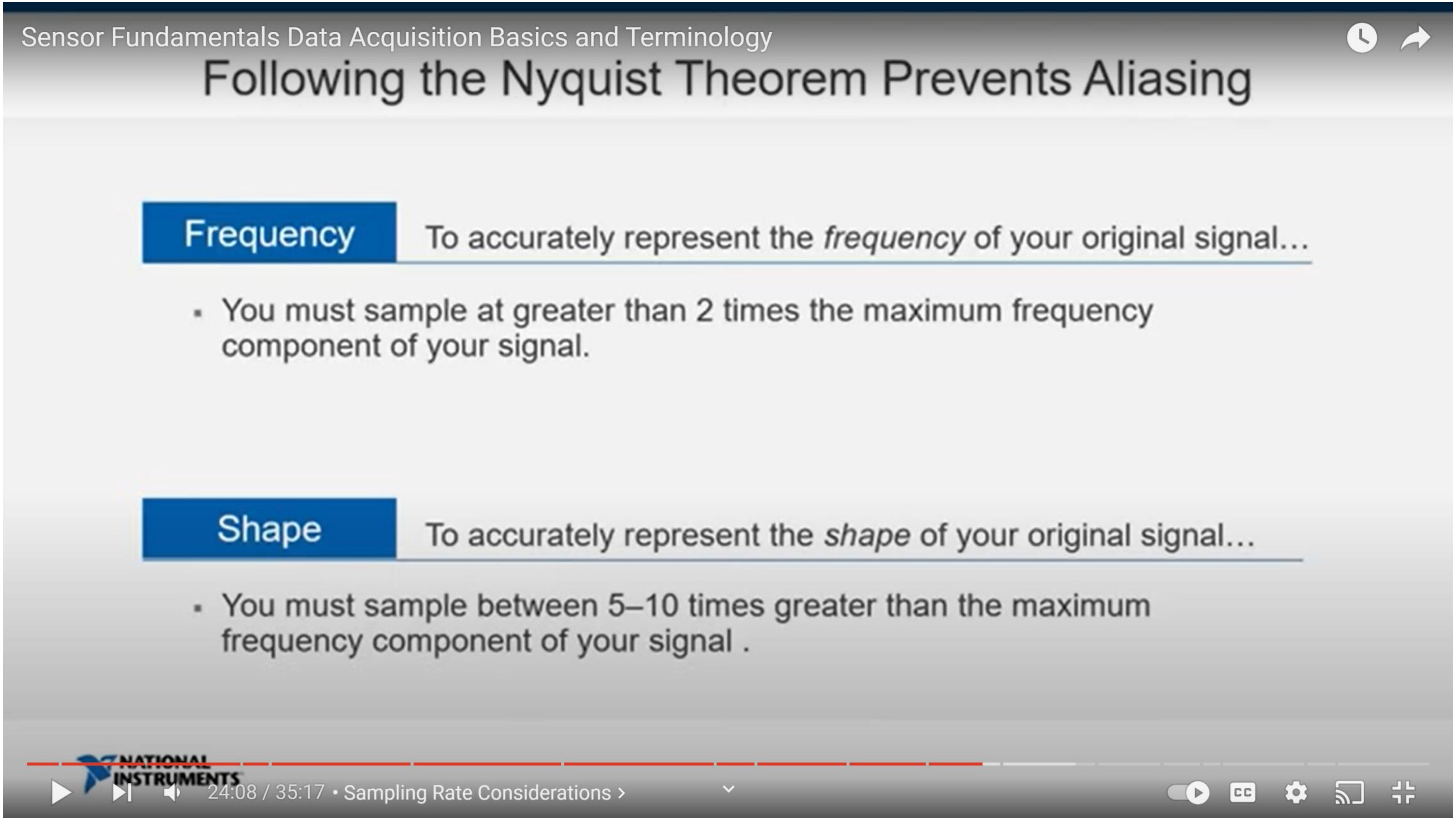
Aliasing means that the true frequency of the signal is determined as LOWER than it really is.

What Question are You Asking?

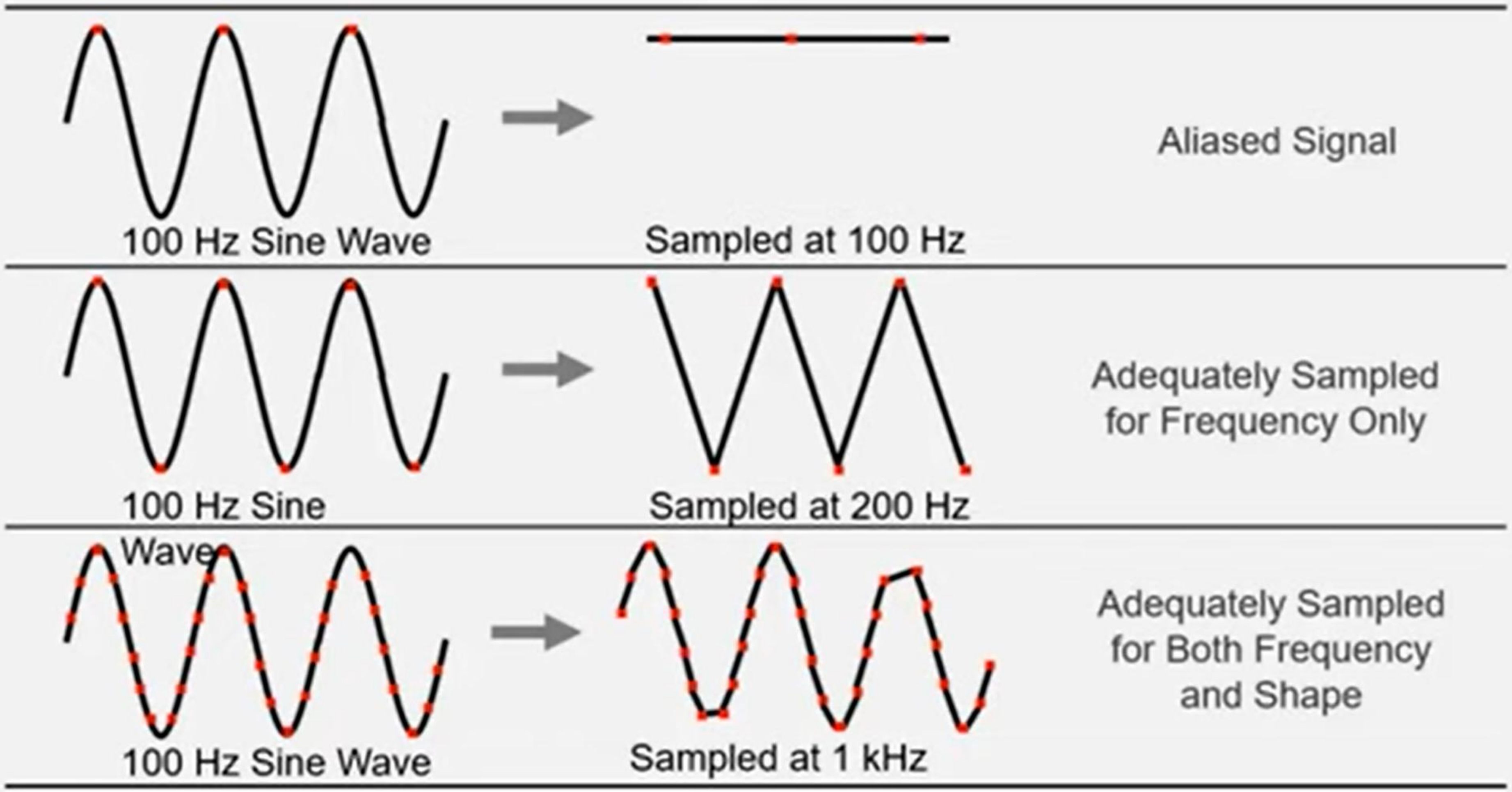
Do you want the frequencies in a signal ?

OR

Do you want the shape of the signal?


Sensor Fundamentals Data Acquisition Basics and Terminology
Following the Nyquist Theorem Prevents Aliasing
Frequency
To accurately represent the *frequency* of your original signal…
You must sample at greater than 2 times the maximum frequency component of your signal.
Shape
To accurately represent the *shape* of your original signal…
You must sample between 5–10 times greater than the maximum frequency component of your signal .
NATIONAL INSTRUMENTS
24:08 / 35:17 • Sampling Rate Considerations ›

The Nyquist Theorem in Action

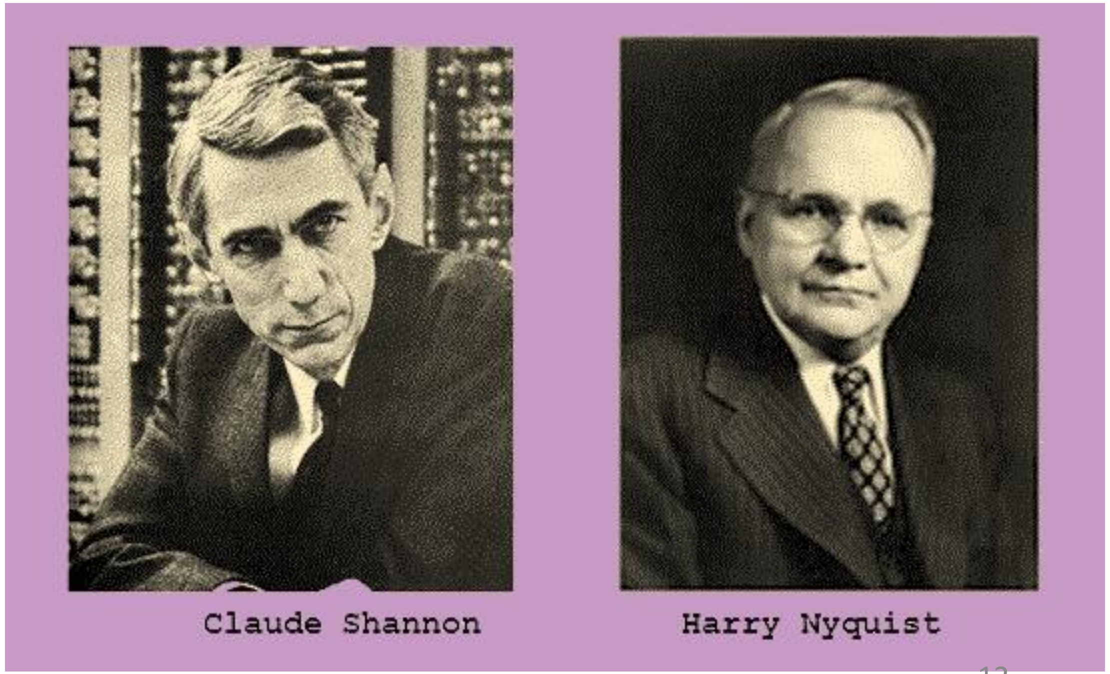


The sampling statement for a signal is not complete so it can misleading when sampling a signal.

https://www.wescottdesign.com/articles/Sampling/sampling.pdf

The Nyquist-Shannon sampling theorem is useful, but often misused when engineers establish sampling rates or design anti-aliasing filters. This article explains how sampling affects a signal, and how to use this information to design a sampling system with known performance.

VS



The assertion made by the Nyquist-Shannon sampling theorem is simple: if you have a signal **that is perfectly band limited to a bandwidth of f_0** then you can collect all the information there is in that signal by sampling it at discrete times, as long as your sample rate is greater **than $2f_0$**. As theorems go this statement is delightfully short. Unfortunately, while the theorem is simple to state it can be very misleading when one tries to apply it in practice.

The difficulty with the Nyquist-Shannon sampling theorem is that it is based on the notion
that the signal to be sampled must be perfectly band limited. This property of the theorem is unfortunate because no real world signal is truly and perfectly band limited. In fact, if a signal were to be perfectly band limited—if it were to have absolutely no energy outside of some finite frequency band—**then it must extend infinitely in time.**

Think of a sine wave - ONE FREQUENCY BUT EXTENDS FOR ALL TIME!

TIME-FREQUENCY RESOLUTION

http://sepwww.stanford.edu/sep/prof/fgdp/c4/paper_html/node2.html

$$\Delta\omega \, \Delta t \geq 2\pi$$

$$\omega = 2\pi f \text{ rad/sec}$$

So and Engineer asks – How close are we?

One rule of thumb is to use the **Engineer's Nyquist frequency** of 2.5 f_c which is 25% more than the exact Nyquist frequency. An engineer's Nyquist frequency is sorta like a baker's dozen, a conventional safety margin added to a well-known quantity.

https://www.johndcook.com/blog/2018/01/02/the-engineers-nyquist-frequency-and-the-sampling-theorem/

For Control Problems, sampling a rising signal using 5 to 10 samples along the rise should be sufficient. One of the previous slides showed that.

Aliasing Example

Audio Sampling Rate Demo 0:35
https://www.youtube.com/watch?v=hRhVb6iRArg&feature=youtu.be

This video demonstrates how the sampling rate affects audio. The same short musical excerpt is played first with a sampling rate of 44.1 kHz, then 22.05 kHz, and finally 11.025 kHz. The maximum frequency in each example—known as the Nyquist Frequency—is half of the sampling rate.

Do you believe me or your own Ears?

Be careful... See the References on the Website

https://www.youtube.com/watch?v=qgvuQGY946g

May 2016 18

OR YOUR OWN EYES!