Bandwidth and DI-8B/DI-5B Series Signal Conditioning Modules

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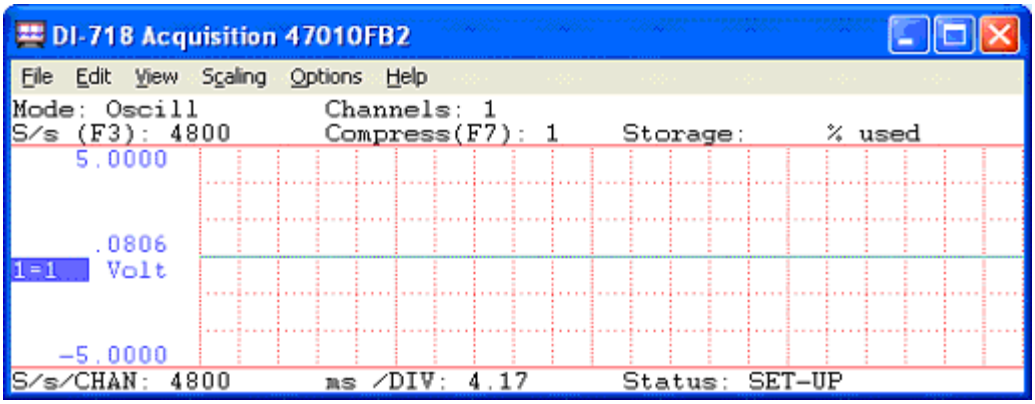
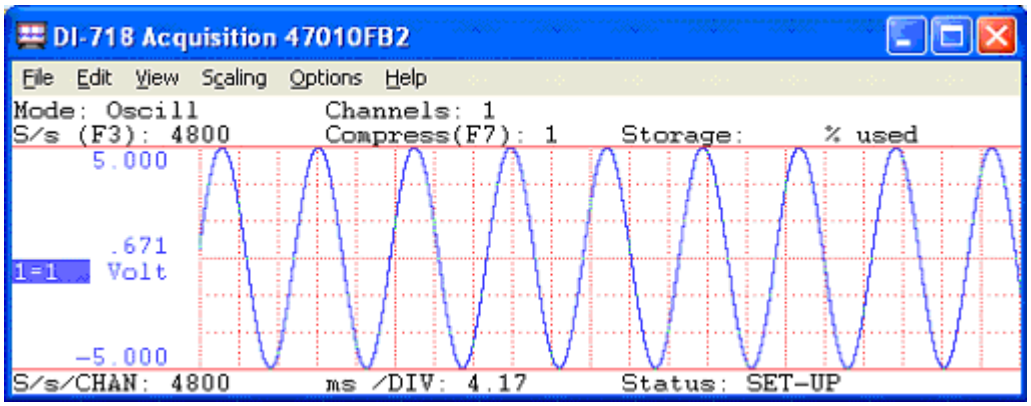
Suppose you're browsing the DATAQ web site looking for a DI-8B series, analog voltage module to acquire a 10V peak-to-peak, 100Hz waveform. You come across the DI-8B31-02. It's an analog voltage module; it has a full scale measurement range of ±5V, perfect. Not so fast! The DI-8B31-02 has a bandwidth of 3Hz. What does that mean? It means that sub-3 Hz frequencies will be displayed correctly, while any component of the waveform with a frequency approaching 3Hz will begin to lose amplitude or get smaller (attenuate). As a result, your 10V peak-to-peak, 100Hz signal will look something like this:



A 10V peak-to-peak, 100Hz signal acquired using a DI-8B31-02 module.

As you can see, the amplitude of the 100Hz waveform has attenuated to nothing and the data is useless.

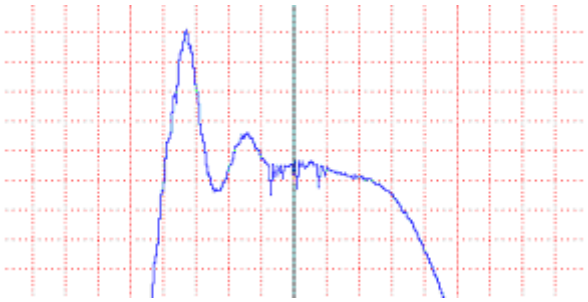
Below, the same signal is acquired using a DI-8B41-02 module with a bandwidth of 1 kHz.



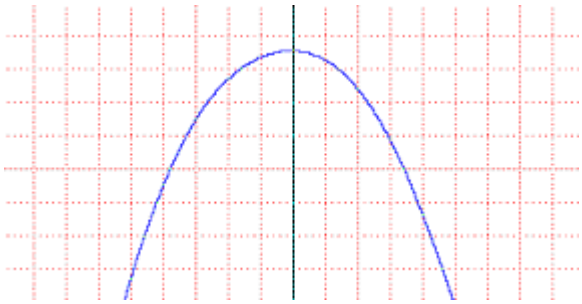
The 10V peak-to-peak, 100Hz signal acquired using a DI-8B41-02.

To further illustrate this point, let's look at a real-life application where bandwidth became an issue.

For years a customer of ours had been using DI-8B38-05 modules (with a bandwidth of 8 kHz) to acquire data from strain-gage based pressure transducers. In a pinch, needing to acquire an additional channel, the customer substituted a DI-8B38-32 (with a bandwidth of 3Hz). The resulting waveforms are displayed below.



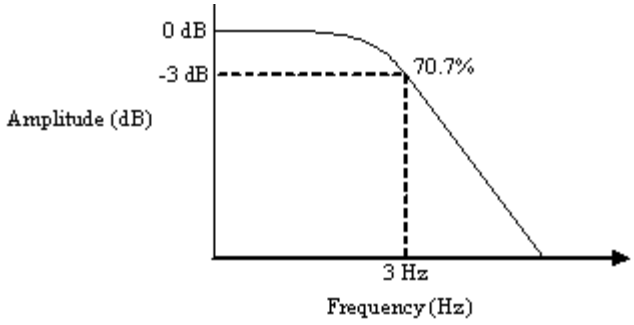
Pressure data recorded using a DI-8B38-05 module.



Pressure data recorded using a DI-8B38-32 module.

As you can clearly see, any component above 3 Hz is non-existent on the channel containing the DI-8B38-32. It just so happened that these high frequency changes were essential to the customer's analysis and so the data were useless.

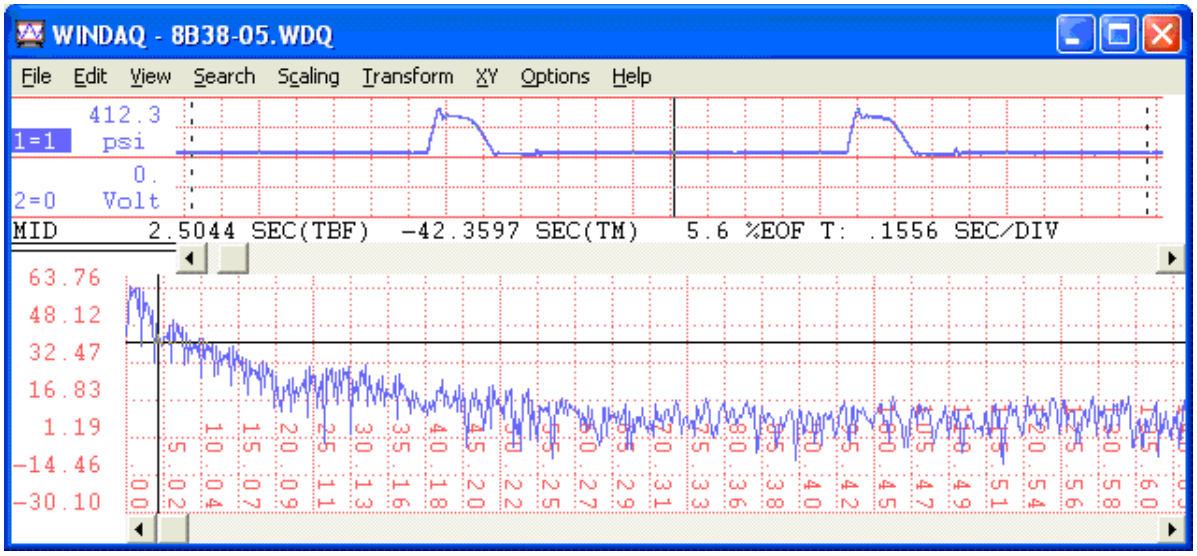
This outcome is the result of the bandwidth limitation of the DI-8B38-32 whereby the amplitude of the signal gradually attenuates to 70.7% (-3 dB) as the frequency approaches 3Hz. As shown in the plot below, amplitude will attenuate more and more as the frequency continues to rise beyond the bandwidth of the module.



Amplitude drops to 70.7% at 3 Hz (the cutoff frequency) and continues to attenuate as the frequency rises.

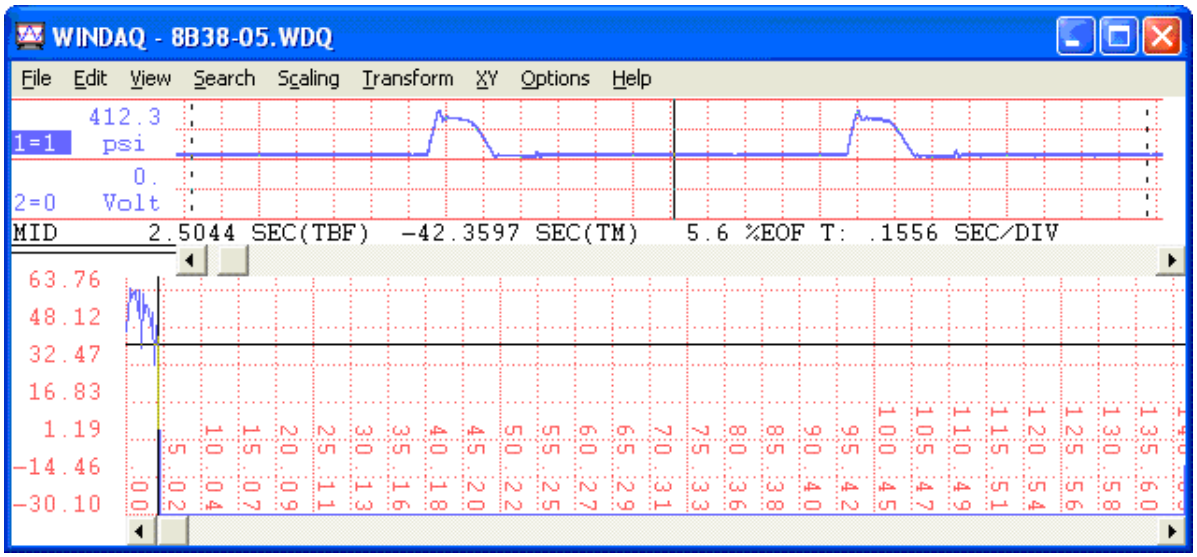
This is easily verified by applying a low-pass filter to the waveform generated using the DI-8B38-05 module.

We'll begin by performing a Fast Fourier Transform (FFT).



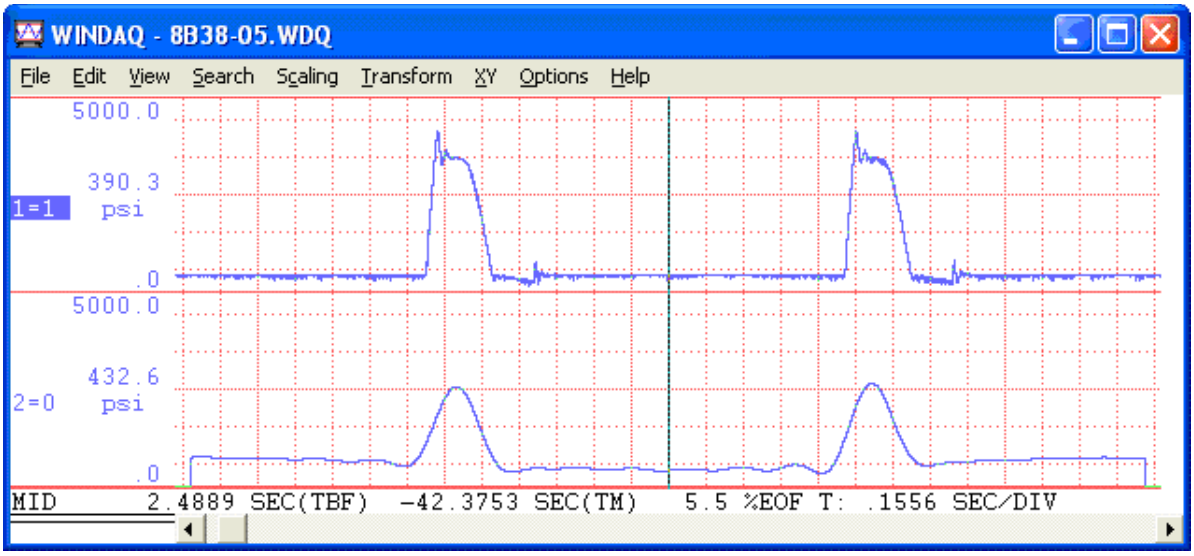
The power spectrum is displayed after performing a FFT.

Next, we'll apply the low pass filter (at 3Hz).



Frequencies above 3Hz are eliminated using a low pass filter.

Finally, we'll perform an Inverse Transform.



The filtered waveform is displayed in strip 2.

The filtered waveform is displayed in strip 2. As you can see, when frequencies above 3 Hz are filtered out, the waveform appears virtually identical to one generated using the DI-8B38-32.

The moral of this story is that when selecting a DI-8B series signal conditioning module; make sure that the bandwidth exceeds the maximum frequency of the input signal or any component thereof that you wish to capture. If you pour a 10 gallon container of water into a 1 gallon jug, you'll be left with 1 gallon of water.