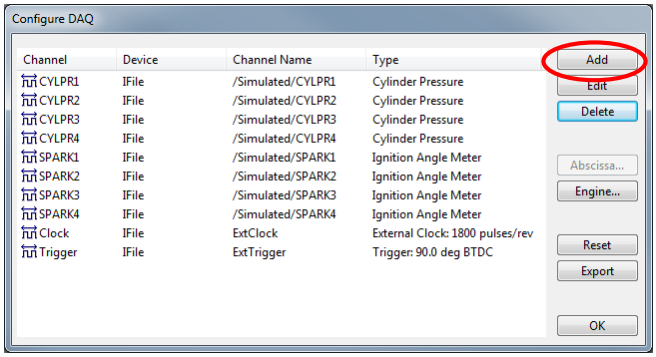
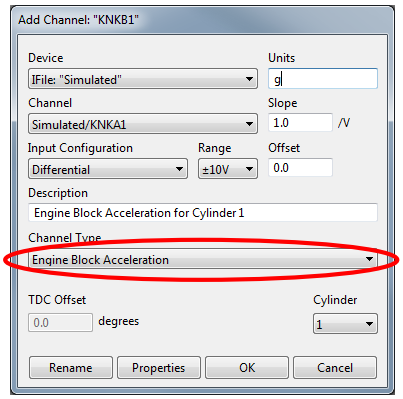
catoolRT Knock Sensor Analysis

catoolRT can be used to indicate engine knock using either a cylinder pressure transducer or an engine mounted knock sensor. When fitted with both it can be used to tune the knock sensor location and to correlate to known in-cylinder knock pressure levels.

Ref: Brunt, M., Pond, C., and Biundo, J., "Gasoline Engine Knock Analysis using Cylinder Pressure Data," SAE Technical Paper 980896, 1998.

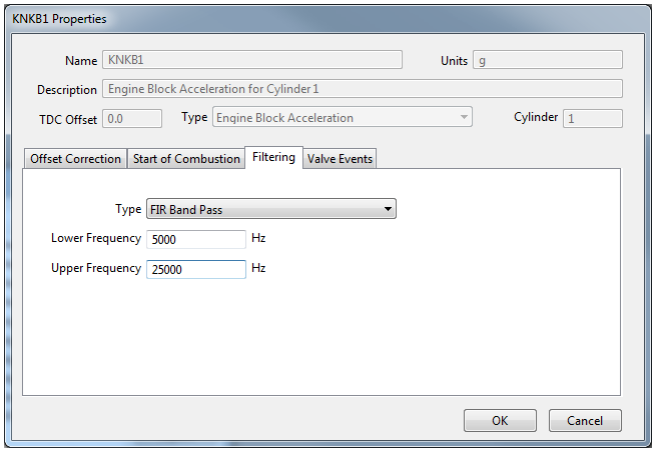


Firstly we need to add a new channel for the knock sensor. Select “Acquistion” -> “Configure DAQ”. Then click on the “Add” button and select “DAQ Channel” and click “OK”. Then give the new channel a name such as “KNKB1” and click “OK”.

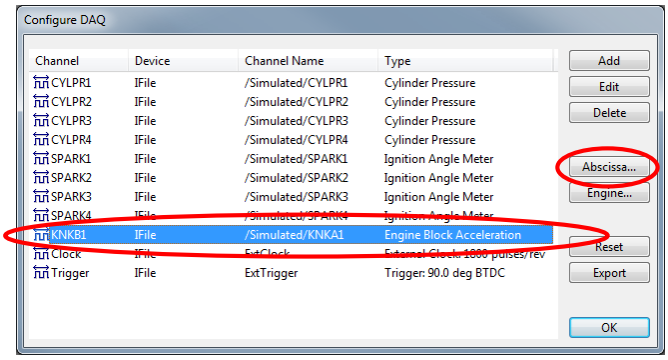


Change the “Channel Type” to “Engine Block Acceleration” and change the “Units” to g, “Offset” to zero and “Slope” to that appropriate for your sensor. Bosch generally publish information for their sensors with a typical value of 35 mV/g.

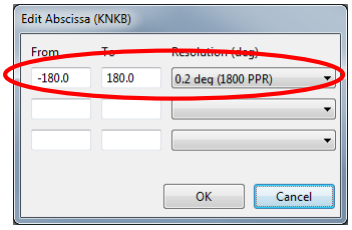
$$slope = \frac{1000}{35\ (\mathrm{mV/g})} = 28.57\ (g/V)$$



Click on “Properties” and select the “Filtering” tab. Change the “Filter Type” to “FIR Band Pass” with a range of 5000 to 25000 Hz. The high pass aspect of the filter with remove any DC offset from the signal so it is centred around zero.

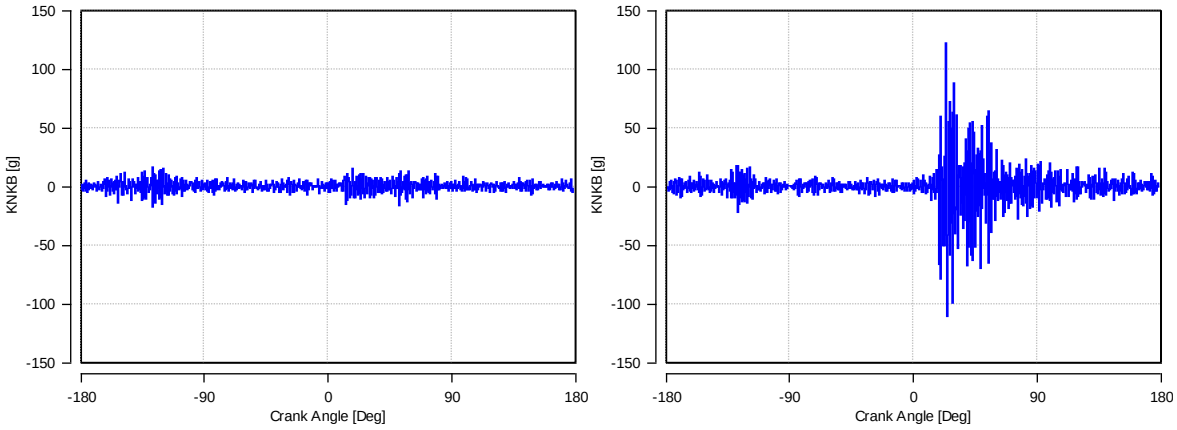


Click “OK” to return to the channel properties and “OK” to return to the “Configure DAQ” window. Select the new channel in the list and click “Abscissa…”.

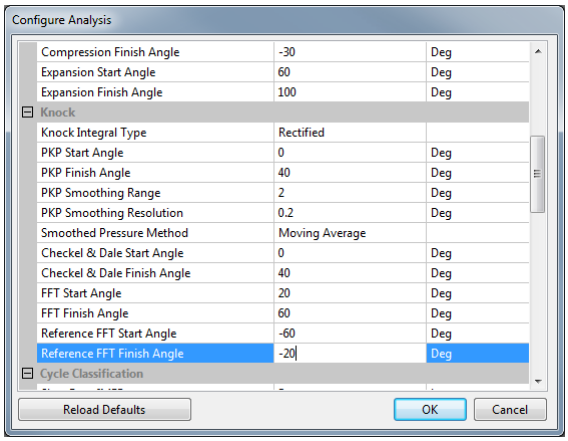


Change the resolution to the smallest available, i.e. 0.2 degrees and the angular range from -180 to +180 degrees.

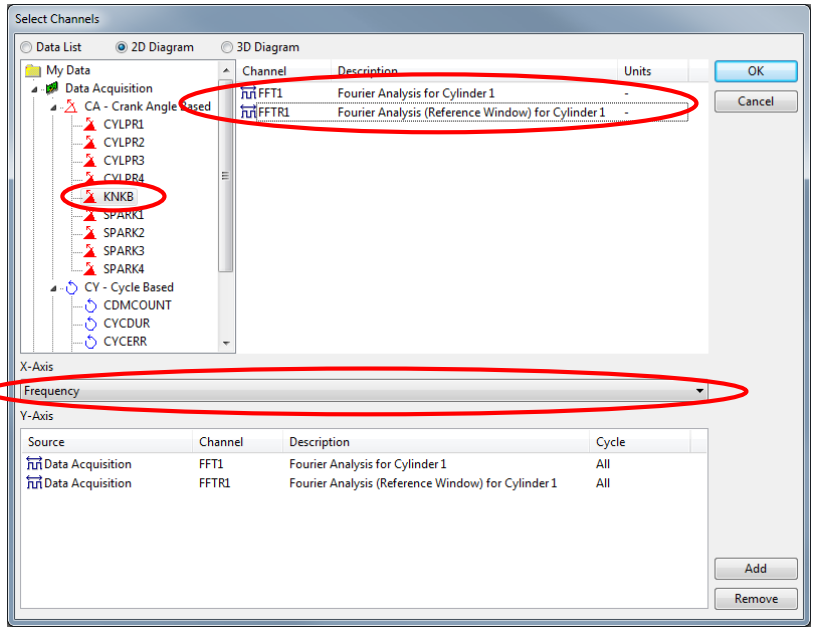
Now would be a good time to go online and check the raw accelerometer signal.



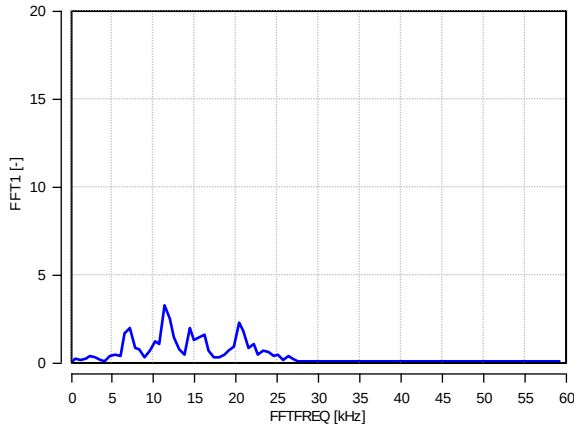
This shows two cycles. No knock (left) and with knock (right). Examine data from a range of engine speed and load conditions to determine crank angle windows where knock does and does not occur. In this example knock occurs between 20 and 60 degrees ATDC and there is a quiet window at 20 and 60 degrees BTDC. This quiet window should be free from noise from other cylinders combustion and valvetrain closing events.



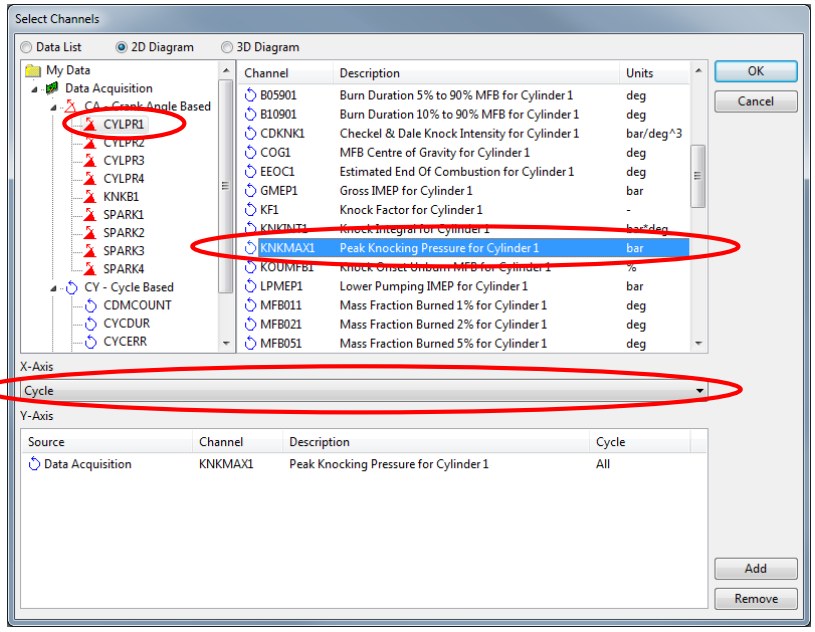
Select “Analysis” -> “Configure Analysis” and scroll to the “Knock” section. Configure the “FFT” and “Reference FFT” windows using the values determined above. These windows can also be used to calibrate your ECU knock control.



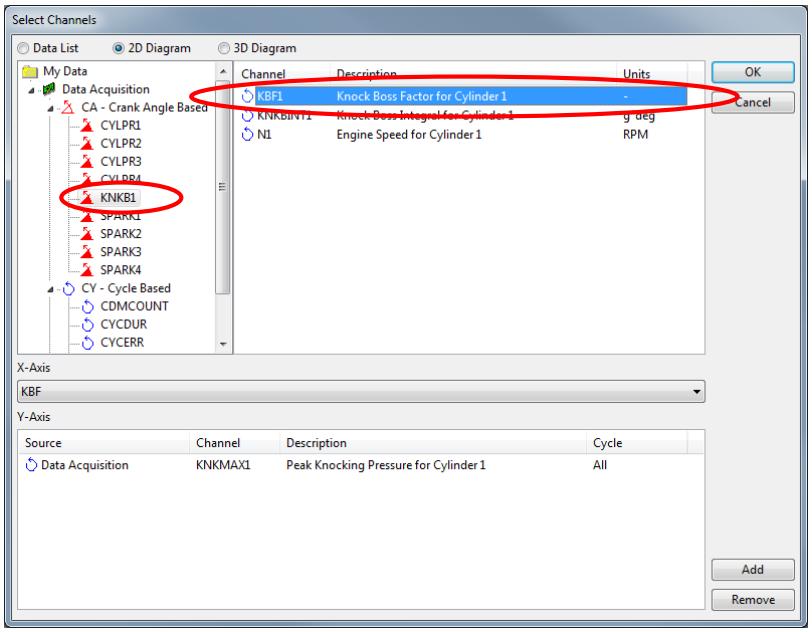
Now we can examine where in the frequency domain the primary knock mode occurs. The Fast Fourier Transformation (FFT) will show us which frequencies dominate the knock sensor signal. Add a new diagram (press F5), change the “X-Axis” to “Frequency” and select the knock sensor channel. Now select the FFT channel (double-click to add) and click “OK”.



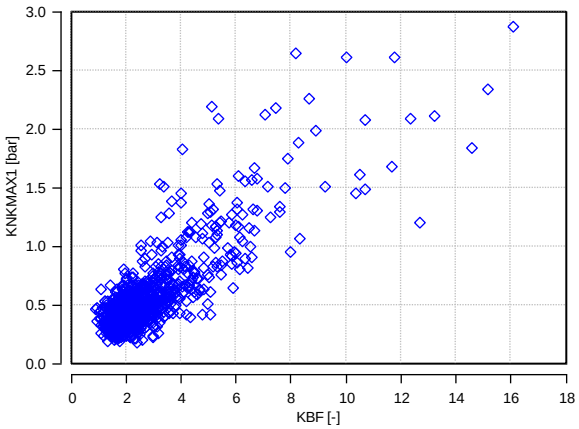
You can see how the band pass filter is already removing frequencies below 5000 Hz and above 25000 Hz. Again, this will help you to characterise the centre frequency that your ECU knock control uses.



If you are acquiring both cylinder pressure and knock sensor channels you can use them together to verify how well the sensor and its location can detect knock. Add a new diagram and change the "X-Axis" to "Cycle". Select the cylinder pressure channel and add the KNKMAX analysis channel.



Now select the knock sensor channel and right-click your mouse on the KBF analysis channel. Select "Add Analysis Type as X-Axis" and click "OK".



You can now see the correlation between knock detected by the cylinder pressure transducer (KNKMAX) and knock detected by the knock sensor (KBF). This can help determine the detection threshold and gain used by the ECU knock control. It can also be used to determine if a particular location on an engine block is suitable for knock detection on a particular cylinder.