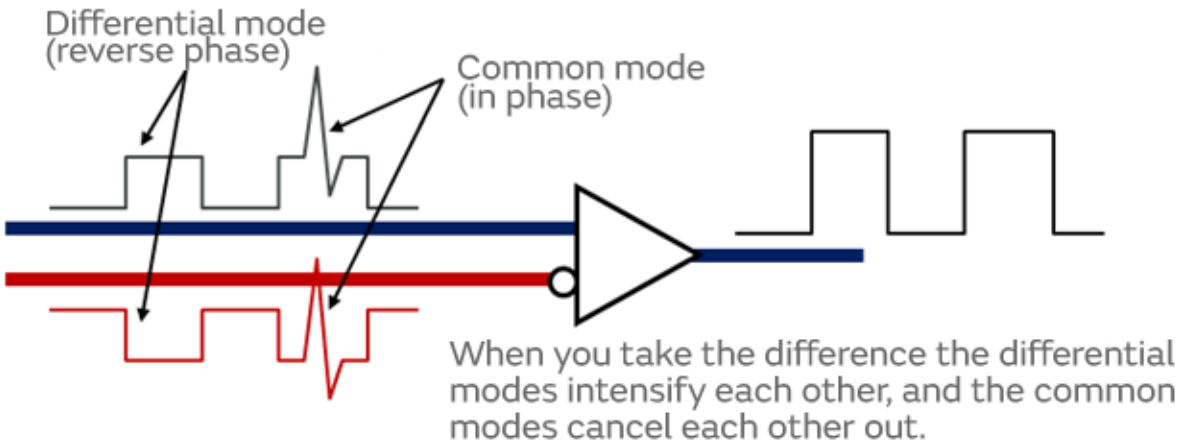
CAN Bus Characterization PCB

Project Description

The goal of this PCB is to perform spectral analysis on the noise of a CAN bus line. The final outcome should be a:

- PCB that samples CAN bus lines using a microcontroller's analog-digital converter (ADC).
- CAN bus lines should pass through a differential filter that isolates common-mode noise before entering the ADC.
- PCB will be an Arduino/Nucleo shield for this phase.

You'll notice that CAN bus is a differential pair, consisting of two lines: CAN_P and CAN_N. CAN protects itself against noise by having the voltages on these lines separated by a fixed amount. This is so that when there is noise on the line it is reflected on both CAN_P and CAN_N. When CAN_P and CAN_N signals reach the transceiver, the transceiver only takes the difference between the signals, thus preserving the digital content and not the noise. This is done using differential amplifiers within the transceiver, which employ common-mode rejection to keep only the differential signal. This signal integrity methodology is best summarized in the following figure:



For our use case in this project, we want to do the opposite and isolate the **noise only**. To do this, you will need to design a differential filter such that the signal that reaches the ADC is only the common-mode noise. The output of your filter should yield a single signal which can be fed into the ADC consisting of only the common-mode noise. Then, in firmware (code), these common mode noise samples can be examined using Fourier transform techniques to determine their spectral profile.

Ideally, this data can then be used to improve our CAN bus performance by filtering out the frequencies with the largest noise amplitudes using a common-mode choke, for example.

For this design, you will use the ADC built into the STM32 F4 microcontroller. You will need to select a pin on the Nucleo F446 that is capable of acting as an ADC input.

Please follow the PCB design process and templates set out in the GitHub repository. If there are any general/admin issues reach out to Logan Lim, and most technical questions will be best answered by Ethan Peterson.

Next Steps

Once the shield design is complete, we can manufacture and test it using the Nucleo F446RE dev boards. More in-depth PCB work can be done embedding an F4 microcontroller onto the board to make it a standalone device, as well as potentially implementing an external ADC for higher bit depth if required.