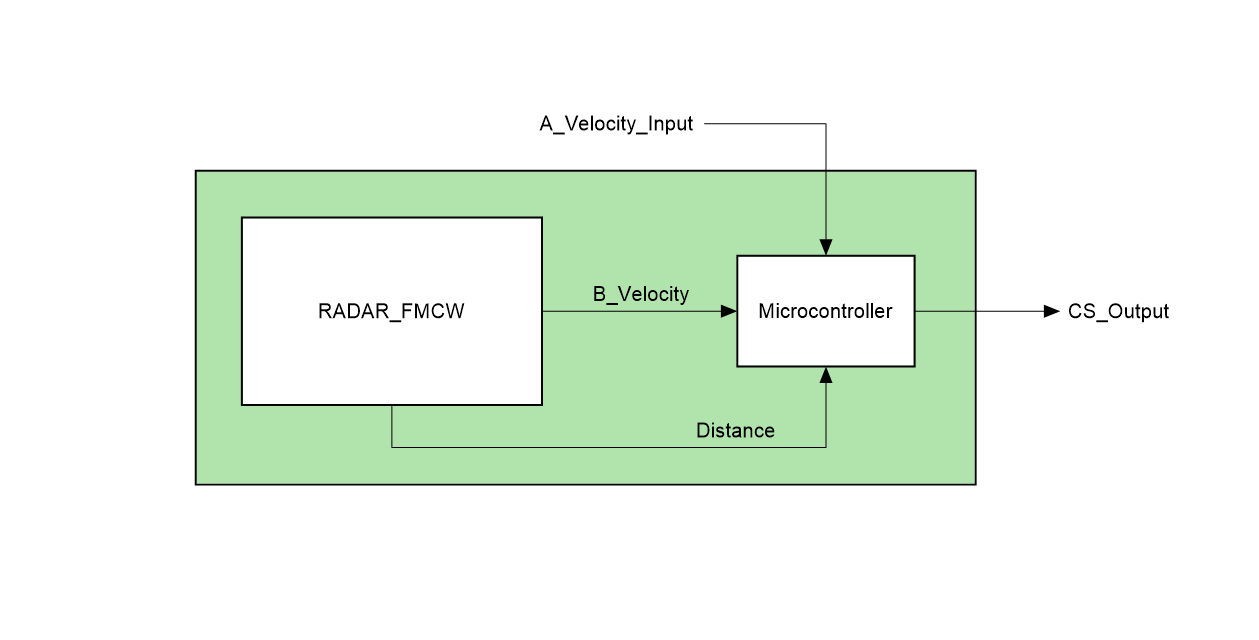
**Automotive safety: FMCW radar for emergency braking**

I am working on a project focused on automotive radar technology. The goal is to develop a PCB capable of detecting both the speed and distance of the vehicle ahead. My idea is to create a programmable radar board that can generate the control signal for emergency braking. The emergency braking distance dynamically adjusts based on the differential speed between our vehicle and the one in front. The general diagram that summarizes:



1. RADAR\_FMCW: Antenna, VCO, low-noise amplifiers, filters, signal processing
2. A\_Velocity\_Input: It is the speed of the vehicle equipped with the radar
3. B\_Velocity: It is the speed of the vehicle ahead, calculated by the radar
4. Distance: It is calculated based on the data detected by the radar
5. CS\_Output: It is the control signal that triggers the emergency braking

**Basic automotive radar theory**

An automotive radar is a device that generates electromagnetic waves, which are typically emitted by an antenna and received by multiple antennas. The electromagnetic wave that bounces off an object and returns to the radar device is called an 'echo.' This echo is detected, amplified, and analyzed. To design automotive radar, one must have a deep understanding of high-frequency electromagnetic waves, specifically microwaves and mmWaves. While classical design at lower frequencies helps in understanding how automotive radar boards work, the PCB design rules are much more different and complex. Once the echo is received, an intermediate frequency mixing occurs to work with frequencies closer to the baseband of the transmitted signal. In the case of FMCW radar, a VCO is used to generate the necessary frequencies: the voltage-controlled oscillator converts a voltage signal into a frequency signal proportional to the voltage. The FMCW radar uses a sawtooth frequency modulation, with frequency variations adjustable based on the available bandwidth. On the following page, the input-output graph of a VCO in FMCW mode is shown:

