Application notes for RF components in FM RADAR Design

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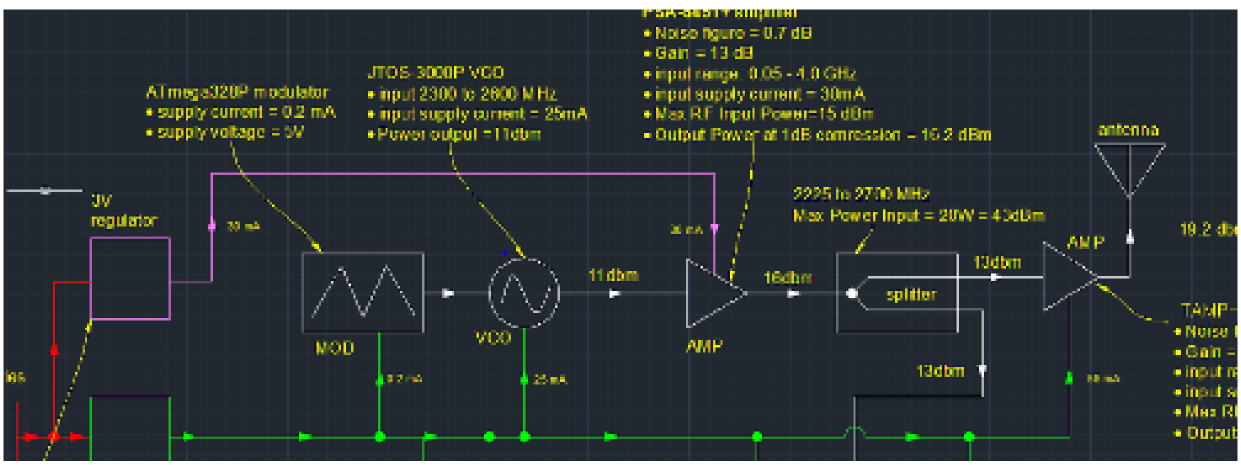
In a FM radar system, it includes modulator, VCO, splitter, mixer, amplifier, filter and microcontroller. Carefully choosing the components can maximize the performance of the radar within the constraints of cost and power consumption.

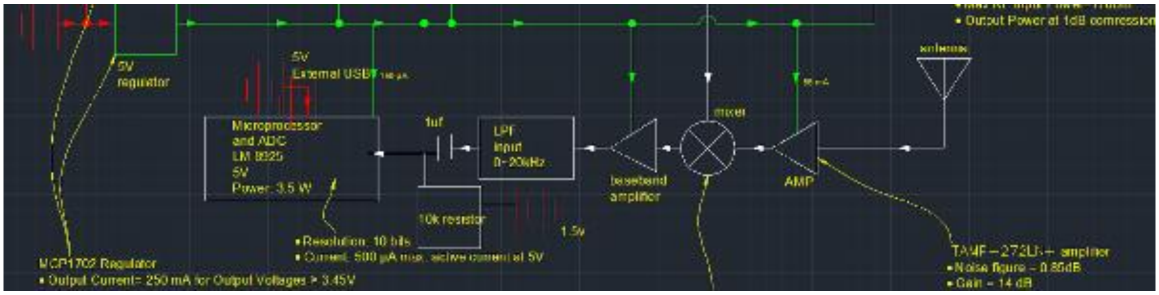
For the system, the operating frequency of all the RF components should be consistent. In our radar, the operating frequency is designed to be from 2.3GHz to 2.6GHz. All the RF components need to function in this frequency range in order for the whole system to work. The resolution of the radar is limited by its bandwidth:

$$Sr \geq \frac{c}{2 * BW}$$

The higher resolution will require larger bandwidth of the system.




The mixer has a specific requirement for the input power of LO (local oscillator) in order to perform functionally. In our system, we use a level 13 mixer, which needs around 13dbm input power in LO. The VCO JSOS 3000P has output power of 11dbm. Using a low noise amplifier with maximum output around 16dbm after the VCO and then connected to a splitter, which will reduce the power by half (-3dB), can change the power to 13dbm before the mixer. In order to increase the detection range of the radar, an amplifier can be added before the antenna on the transmitting side to increase the signal to noise ratio.




On the receiving side, a low noise amplifier is connected to the antenna to amplify the reflected signal. The relation of noise and the gain of different stages of amplifiers:

$$F_{CAS} = F_1 + \frac{F_2 - 1}{G_1} + \frac{F_3 - 1}{G_1 G_2} + ....$$

The noise figure is very important in the first amplifier after the antenna since the signal would be relatively weak after the transmission and the noise will mix with the signal in the amplifier. If the noise level is higher than the receiving signal, the signal will be lost. The noise of the second stage will be compressed by the gain of the first amplifier, so it will have relatively small effect on the signal.

After the amplifier, the receiving signal will mix with the transmitting signal, and the sum (high frequency part) will be attenuated by the low pass filter. The output after the filter should be a sinusoidal wave with frequency of  Δf (frequency difference between the transmitting wave and the reflected wave), and it will be passed to the processor. An offset may be needed to add to the signal for sampling. The offset should be set to the mid-range of the processor to maximize the usage of the sampling. I.e. the processor will take voltage from 0 to 3V, then the offset of the signal should be 1.5V and swing from 0 t0 3V for maximum performance.

When using the battery to supply the system. The voltage may gradually drop due to the power consumption of the system. Regulators can be used to maintain the voltage. It’s important to calculate the current drain of the system and check the supply current of the battery and regulator to make sure they can provide enough power to the system.