Design and Implementation of 77G Radar System

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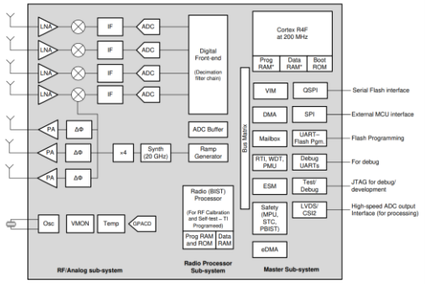
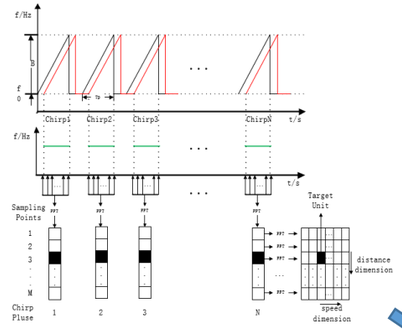
Introduction of the AWR1243 Device

AWR1243 Device could be broadly split as two sub-systems:

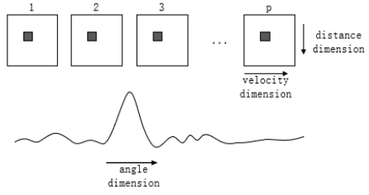
- Master Subsystem:
  - Bootloader – Responsible for the device initialization, boot time tests.
  - Functional firmware – Is responsible for the external host API communication,
- Radar/Millimetre Wave Subsystem: Is responsible for configuring RF/analog and digital front-end in real-time, as well as to Periodically schedule calibration and functional safety monitoring.



Radar Signal Processing Flow



Calculate the beat frequency and Doppler frequency of the signal by taking the FFT of the range dimension and velocity dimension of the chip signal, and then finding the row and column where the target peak is located.



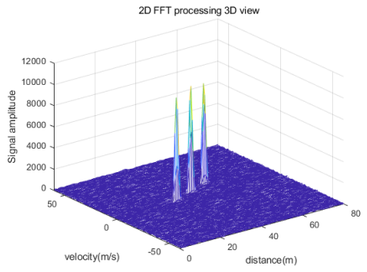
That is, on the basis of the two-dimensional FFT spectrum, find the peak value of each channel representing the radar target information, do the Q-point FFT,and find the corresponding position of the peak from the spectrum diagram to calculate the spatial frequency, so as to calculate the angle information.

The cubic FFT is expressed by the formula as follows:

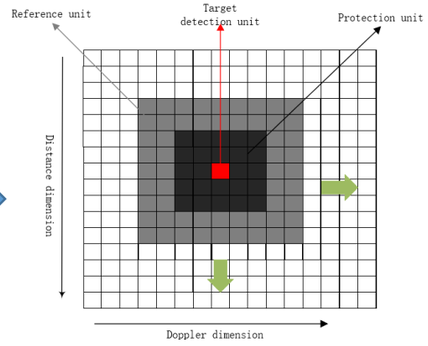
$$F(k,l,q)=\sum_{p=0}^{P-1}\sum_{n=0}^{N-1}\sum_{m=0}^{M-1} exp\left[j2\pi\left(f_b m T_s + n f_D T_p + p\frac{dsin\theta}{\lambda}+\frac{2R_0}{\lambda}\right)-j\phi_0\right]$$
$$\cdot exp\left[-j2\pi\left(\frac{k\cdot m}{M}+\frac{l\cdot n}{N}+\frac{q\cdot p}{Q}\right)\right]$$

Radar target detection

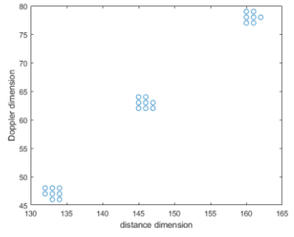
Simulate three targets and do 2D FFT



2D−CFAR



simulation

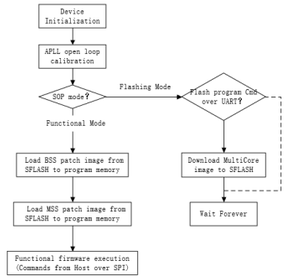


On the basis of two-dimensional FFT processing, two-dimensional CFAR processing is performed on it, and the position of the target on the two-dimensional matrix is obtained as shown in the right figure. Then, the beat frequency and Doppler frequency can be calculated by using its coordinate position and formula, and then the target distance and speed information can be derived.

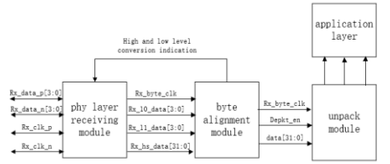
Hardware Platform Construction and Algorithm Implementation

This article uses a three-transmit four-receiver AWR1243 radar chip under TI. The AWR1243 device is a self-contained FMCW transceiver single-chip solution that simplifies the implementation of Automotive Radar sensors in the band of 76 to 81 GHz.

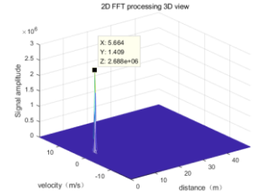
Radar chip startup process



Hardware design platform



Interface implementation



A frame of radar data simulation diagram

Applications

a) Automated highway driving .b) Automatic emergency braking
c) Adaptive cruise control .d) Imaging radar using cascading configuration