A KU-BAND ROTATING FAN-BEAM SCATTEROMETER: DESIGN AND PERFORMANCE SIMULATIONS

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1. INTRODUCTION

Ocean surface wind vector is one of the essential ocean dynamic environmental parameters. This paper presents the design and performance simulation results of Ku-band rotating fan-beam scatterometer (Ku-RFSCAT), which will be flown in accompany with a real-aperture radar for ocean surface wave spectra vector measurement [1]. In order to investigate the interaction mechanism of sea surface wind and wave, SWIM (surface wave investigation and monitoring). In order to investigate the interaction mechanism of sea surface wind and wave, it is required that the swath of SCAT needs to cover that of SWIM, which means that nadir gap should be avoided. Rotating fan-beam scatterometer is a new concept for ocean surface wind vector measurement [2]. It has a continues wide coverage swath without nadir gap as the rotating pencil beam scatterometer (such as Seawinds onboard the Quickscat and ADEOS-2 satellite), but requires a much lower rotating speed due to the longer footprint of the fan-beam antenna, which will lead to higher liability of the rotating servo mechanism and smaller disturbance to the platform.

Because both SCAT and SWIM are Ku-band radars, EMC is one of the key issues for the systems design, some considerations will be presented in the paper.

2. DESCRIPTIONS OF THE INSTRUMENT

Ku-RFSCAT will be Ku-band dual-polarization (HH and VV) scatterometer. Table-I gives the system parameters of the instrument. The wind retrieval accuracy requirement is:

- Wind speed: 2m/s or 10% (which is larger) for wind speed of 4~24m/s;
- Wind direction: 20 degree within 600km swath.

Ku-RFSCAT is composed of the following units:

- Antenna: two waveguide slotted arrays (H-polarization and V-polarization) with the beam being shaped to compensate returned power decrease for the far-part of the footprint by distance increase and sigma 0 decrease.

- Rotating servo mechanism and actuator: provide support, drive and control of the scanning rotation for the antennas.
- RF switch matrix: a set of ferrite switches, circulators and EMC filters.
- RF and IF receivers;
- Frequency synthesizer unit;
- TWTA unit;
- Digital unit, and
- Power unit.

Table-I specifications of Ku-RFSCAT

No.	Specification	Parameter	No.	Specification	Parameter
1	Center frequency	12.256GHz	11	Dynamic range	>60dB
2	Band width	0.5MHz	12	Uncertainty of internal calibration	≤0.15dB
3	Polarizations	HH，VV	13	Rotating speed	3.4rpm
4	Swath width	>1000km	14	Pulse width	1.35ms
5	Surface resolution	≤10km	15	Duty cycle ratio	20%
6	Sigma 0 accuracy	Better than 0.5dB	16	PRF	150Hz
7	Antenna beam	Fan-beam	17	Rotation momentum	<0.170Nms
8	Antenna dimension	<1.2m×0.4m ×0.35m	18	Total mass	70kg
9	Antenna gain	≥30dB	19	Total power consumption	200W
10	Receiver sensitivity	Better than -130dBm (minimum detectable power level)	20	Reliability (at the end of 3 yrs life)	0.942

In order to ensure the reliability requirement, all the electronic units will be equipped with a primary and secondary unit with cold standby. Fig. 1 gives the diagram of the system.

3. PARAMETER DESIGN AND PERFORMANCE SIMULATIONS

For the fan-beam scatterometer, the signal-to-noise ratio varies along the footprint due to the variation of the distance between the antenna and the surface resolution cells and variation of sigma 0 with different incident angles. As a result, performance of this kind of scatterometer can only be optimized statistically.

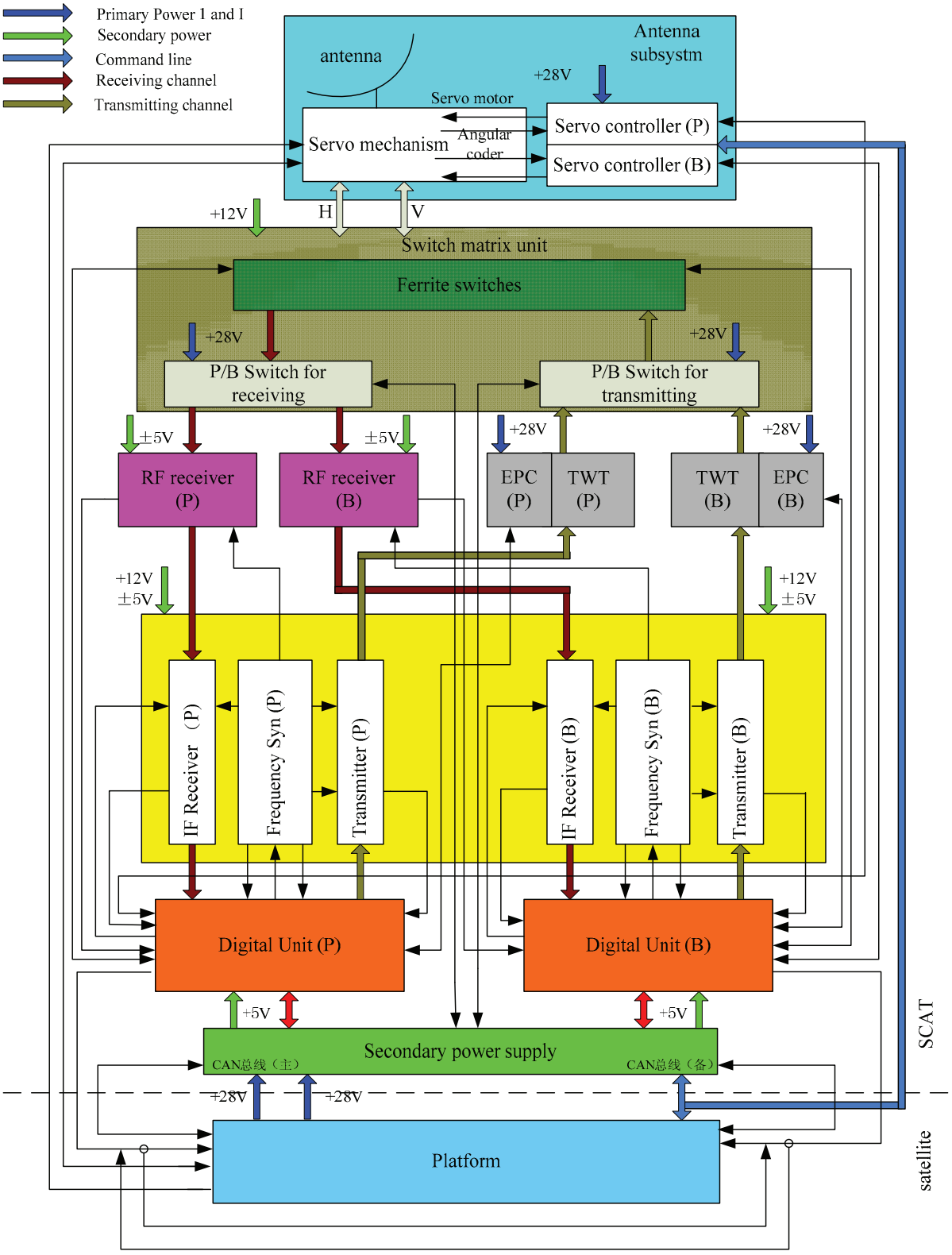

Fig.1 System diagram of Ku-RFSCAT

Design and parameter trade-off is done by optimization of the sigma 0 measurement precision and wind retrieval accuracy. Specification parameters in Table-I is the optimized results. Optimization of some key system parameters, such as the rotation speed, signal bandwidth, antenna beam shape and so on, will be provided in the paper. Simulation results of both the sigma 0 precision and wind retrieval accuracies for different wind speed from 4m/s to 24m/s will be provided in the paper, which shows that Ku-RFSCAT can satisfy the performance requirements within most part of the swath.

11. REFERENCES

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