

SSR Operation Mode OEM

Software Detailed Design

NACOS Platinum - Transceiver

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1 Revisions

REV.	DATE	CHANGES	NAME	ORGANISATION
01A	2023-08-31	First Draft	Bolls	ANDR
01B	2023-09-07	Change internal sample rate for short pulse range in 24NM operating mode to 2.89; Change number of output sweep per scan to 2048; Change PTRF	Bolls	ANDR
02A	2023-09-14	Harmonize RACON and BEACON Improve description for S1, S2, M1, M2, L1, L2 and L3 pulse. Merge content with document DMTA00071386	Bolls	ANDR
03A	2023-09-27	Update information about sample log scale and reference power in Table 3	Bolls	ANDR
03B	2023-10-12	Change name Beacon to Racon Change document template	Bolls	ANDR

Table 1

2 Referenced Documents

REF.	DOCUMENT NO.	REV.	SOURCE	DOCUMENT TITLE

Table 2

3 Introduction

3.1 Purpose

The purpose of this document is to describe the operation modes used by the NACOS Platinum Solid State X-Band Transceivers configured in OEM version. The intention is to use the same operating mode for Solid State S-Band transceiver too.

3.2 Intended audience

This document is intended for research and development as well as test and release stake holders.

4 Basic System Parameters

This chapter describes the basic system parameter of the antenna (see section 4.1), transmitter (see section 4.2) and the receiver (see section 4.3).

4.1 Antenna

- Rotation speed ~24 rpm
- Azimuth opening angle
 - 0.95° X-Band 8 ft.
 - 1.5° X-Band 5ft.
 - 1.9° S-Band 14 ft.
- 27 dBi to 30 dBi
- Wideband end-fed narrow wall slotted waveguide design

4.2 Transmitter

- Peak Output Power > 100W (X-Band), ~200W (S-Band), Duty Cycle max. 10%
- Transmit Frequency Band 2900 MHz – 3100 MHz (S-Band)
- Transmit Frequency Band 9300 MHz – 9500 MHz (X-Band)

4.2.1 Modulation Scheme

- Multi-Pulse Transmission Frames (Up to 3 pulses per frame)
- Unmodulated (CW) as well as frequency modulated pulses
- Individual carrier frequencies for different pulses inside pulse train
- Frequency modulated pulses, bandwidth from 2.5 MHz up to 10 MHz
- Pulse lengths from ~100ns (unmodulated) to 55 us
- Variable pulse compression ratio (always < 150)
- Variable pulse train repetition frequency up to ~4 kHz

4.3 Receiver

- 77.76 MSPS ADC
- Pulse Compression, sidelobe suppression > 50 dB
- Coherent Integration
- Doppler Capable
- Integrated CFAR
- Max. Range 48NM (~600 us receive window time, 1.2 kHz PTRF)

5 Operating Modes

For all operating modes a pulse train consisting of up to three pulses is used. The 12NM operating mode is using S1, M1 and L3 pulse. The 24NM operating mode is using the S1, M1 and L1 pulse. The 48NM operating mode is using the S1, M2 and L2 pulse. The BEACON mode is using the S2 pulse only. The energy on target depends on the transmitted pulse amplitude, multiplied by the pulse length and the number of pulses. The RF input power corresponding to the sample values can be found in the table below.

Pulse	Pulse Length	Band-width	Compressed Pulse Length	RF Range Resolution	BB Sample Rate	PPI Sample Log Scale [dB/LSB]	PPI Sample for -76dBm RF Power
S1	0.1 μ s	-	100 ns	15 m	2.89m	0.373	78
S2	0.3 μ s	-	300 ns	45 m	2.89m	0.373	65
M1	4 μ s	10 MHz	100 ns	15 m	2.89m	0.373	138
M2	6 μ s	10 MHz	100 ns	15 m	5.78m	0.373	133
L1	25 μ s	5 MHz	200 ns	30 m	11.57m	0.373	165
L2	55 μ s	2.5 MHz	400 ns	60 m	23.13m	0.373	155
L3	25 μ s	5 MHz	200 ns	30 m	5.78m	0.373	165

Table 3: Pulse description

The SSR-X radar provides up to 7 frequency channels. The first channel starts at 9327MHz. The frequency spacing between the channels is 24.6MHz. The SSR-S radar provides up to 8 frequency channels. This first channel starts at 2930MHz. The frequency spacing between the channels is 30MHz.

The short pulse (S1 and S2) is located always 13.3MHz below the carrier frequency. The medium pulse (M1 and M2) is located always 18.8325 MHz above the carrier frequency. The long pulse (L1, L2 and L3) is located always 9.1125 MHz above the carrier frequency.

Antenna squint compensation will be applied automatically by the radar based on radar configuration.

The Table 4 shows the different operating modes. The PTRF is a theoretically calculated value with a PTRF deviation of 0%. In practice, they may deviate slightly. Due to PTRF deviation configuration the real PTRF might be up to 5% higher or lower. This will then have a corresponding effect on the number of sweeps per antenna rotation and the hits per scan. The number of sweeps per revolution in Table 4 is based on an antenna revolution duration of 2.5 seconds.

Operating Mode	PTRF (Max)	PTRF (@0% PTRF deviation)	Sweep per revolution transferred via network	Cell resolution	Number of cells per sweep	Number of sweeps used for coherent integration		
						5 ft antenna X-Band	8 ft antenna X-Band	14 ft antenna S-Band
12 NM	3163 Hz	3954 Hz	2048	5.78m	3843	16	16	16
24 NM	2345 Hz	2796 Hz	2048	11.57m	3843	16	15	16
48 NM	1145 Hz	1279 Hz	2048	23.13m	3843	11	7	15
BEACON	1200 Hz	1200 Hz	2048	5.78m	3843	NA	NA	NA

Table 4: Operating Mode Overview

5.1 Operation Mode 12NM

Operating Mode	12,00NM		
	Pulse Selection		
	Short Pulse	Medium Pulse	Long Pulse
Puls Length	100 ns	4 μ s	25 μ s
Pulse Window Function	Kaiser ($\beta = 4$)	Kaiser ($\beta = 5$)	Kaiser ($\beta = 5$)
Bandwidth	10,0MHz	10,0MHz	5,0MHz
Pulse Compression Ratio	0	40	125
Compressed Pulse Length	100 ns	100 ns	200 ns
RF Range Resolution	15,0m	15,0m	30,0m
Short pulse range	Sample 0 to sample 255		
Medium pulse range	Sample 256 to sample 831		
Long pulse range	Sample 832 to sample 3842		
PPI sample for display	3843 Samples		
PPI sample resolution	5,78m		

Table 5: Operation Mode 12NM

5.2 Operation Mode 24NM

Operating Mode	24,00NM		
	Pulse Selection		
	Short Pulse	Medium Pulse	Long Pulse
Puls Length	100 ns	4 μ s	25 μ s
Pulse Window Function	Kaiser ($\beta = 4$)	Kaiser ($\beta = 5$)	Kaiser ($\beta = 5$)
Bandwidth	10,0MHz	10,0MHz	5,0MHz
Pulse Compression Ratio	0	40	125
Compressed Pulse Length	100 ns	100 ns	200 ns
RF Range Resolution	15,0m	15,0m	30,0m
Short pulse range	Sample 0 to sample 127		
Medium pulse range	Sample 128 to sample 415		
Long pulse range	Sample 416 to sample 3842		
PPI sample for display	3843 Samples		
PPI sample resolution	11,57m		

Table 6: Operation mode 24NM

5.3 Operation Mode 48NM

Operating Mode	48,00NM		
	Pulse Selection		
	Short Pulse	Medium Pulse	Long Pulse
Puls Length	100 ns	6 μ s	55 μ s
Pulse Window Function	Kaiser ($\beta = 4$)	Kaiser ($\beta = 5$)	Kaiser ($\beta = 5$)
Bandwidth	10,0MHz	10,0MHz	2,5MHz
Pulse Compression Ratio	0	60	137,5
Compressed Pulse Length	100 ns	100 ns	400 ns
RF Range Resolution	15,0m	15,0m	60,0m
Short pulse range	Sample 0 to sample 39		
Medium pulse range	Sample 40 to sample 367		
Long pulse range	Sample 368 to sample 3842		
PPI sample for display	3843 Samples		
PPI sample resolution	23,13m		

Table 7: Operation mode 48NM

5.4 Operation Mode RACON

Operating Mode	RACON (12NM)		
	Pulse Selection		
	Short Pulse	Medium Pulse	Long Pulse
Puls Length	300 ns		
Pulse Window Function	Kaiser ($\beta = 4$)		
Bandwidth	0,0MHz		
Pulse Compression Ratio	0		
Compressed Pulse Length	300 ns		
RF Range Resolution	45,0m		
Range	Sample 0 to sample 3855		
PPI sample for display	3843 Samples		
PPI sample resolution	5,78m		

Table 8: RACON Operation Mode