

European Telecommunications Standards Institute
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Sophia-Antipolis

Source: Edgard Vangeel (Data on radars provided by EUMETNET)

Title: DFS Update: European Weather Radars – Details & Overview

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Document for: Information

RCWG Agenda item: t.b.d

1. Introduction

During BRAN 51 we discussed document BRAN51d026 which contained an ITU-R WP8A & WP8B paper from France on 'Initial Results of DFS 5 GHz Testing'. The document reports on tests of RLAN equipment undertaken by ANFR and the French Meteorological Agency (Meteo France) which had found RLAN devices which did not correctly detect the weather radar located in Trappes (FR).

These test results were also forwarded to the European Commission (TCAM) and the Wi Fi Alliance, both of which were very concerned to hear these results. The document challenges the mechanism for DFS outlined in EN 301 893 V1.3.1. The French Regulator has since submitted the RLAN equipment to a test laboratory in order to verify whether the equipment really was compliant to EN 301 893 V 1.3.1. The outcome of that testing has not been communicated yet.

It was decided during BRAN 51 to send a Liaison Statement to the European Commission (TCAM Chair), Meteo France / EUMETNET as well as to ANFR. In this document (BRAN 51d064) we expressed our concern about the findings and conclusions as reported in the ITU-R paper. We indicated that a possible reason for not detecting the French radar could be that it operates in a mode (Staggered PRF) which might not be sufficiently covered by the present ETSI standard.

In order to make a detailed analysis, ETSI BRAN asked EUMETNET to provide an overview of the different operating modes (radar pulse patterns) used by European weather radars. The informal discussions between Eumetnet, European Commission, ANFR and myself, which started already before BRAN 51, have continued since then. The information provided in this document is an overview of new information recently received and which was not included yet in Document BRAN51d028.

2. Next Steps

2.1 Additional DFS testing

In BRAN 51d028, TC BRAN was already informed on additional testing performed on equipment from a 3rd vendor by ANFR/Meteo France during the week of June 18. Those tests were positive as the equipment could successfully detect the radar in Trappes.

Additional testing on equipment from another vendor is scheduled for September 6 and 7.

2.2 EC TCAM ad-hoc meeting

The TCAM ad-hoc meeting, referred to already in BRAN51d028, will take place on October 1. This is 1 day meeting only dedicated on Weather Radar/RLAN issues. Obviously there will be representatives from Eumetnet but also a manufacturer of weather radars is invited.

In preparation of this TCAM ad-hoc meeting, RLAN industry should study the details of the weather radars contained in this paper. A proposal will be made to have conference calls set-up within ETSI as well as the WFA. The objective is to consolidate our feedback on the weather radar signals and to agree on a way forward.

3. European Weather Radars

3.1 Radar Patterns & other details

Annex 1: Annex 1 to this paper contains an overview of the European countries that provided feedback to the request from Eumetnet regarding operating modes and details of the weather radars in use in their country. In total 14 countries have provided feedback. This overview also contains the most important parameters of the radars.

Annex 2: Annex 2 to this paper contains more details on a per country basis. For each country, the different configurations and related radar pulse patterns are presented in a graphical way.

NOTE: EUMETNET has been requested to verify the data contained in the 2 annexes. An update of the annexes will be made if required.

3.2 Preliminary Conclusions / Observations

Based on the information provided Annex 1 and Annex 2, the following observations are made with regard to Pulse Width and PRF (Pulse Repetition Frequency):

3.2.1 Pulse Width

From the information contained in annex 1 and annex 2, one can see that several European Weather radars can operate in a configuration where the Pulse Width is below 1 μ Sec (even down to 0.5 μ Sec).

Radar signals included in EN 301 893 assume a minimum Pulse Width of 1 μ Sec. This was based on ITU-R Recommendation 1652 which, for the Pulse Width, specifies a range from 1 to 20 μ Sec.

3.2.2 PRF rates/modes

With regard to PRF, 3 different operating modes are used.

3.2.2.1 Constant PRF

The radar signals included in EN 301 893 (all versions) assume a constant PRF. From comparison with Table D.4 in EN 301 893 v 1.3.1 or v 1.4.1 one can conclude whether a radar with a specific PRF is covered or not.

3.2.2.2 Interleaved (Staggered) PRF

Interleaved or Staggered PRF operation is used by radars to cope with multiple-time-around echoes. Far away targets appear as echoes of the following pulse at shorter range. It is possible to remove this range ambiguity by changing the PRI during the time-on-target. With different PRIs, the target will appear at different ranges. Using a proper logic, it is possible for the radar to identify the echo as a second-time-around one, and assign to it the proper range. As a general rule, use of 'n' different PRI allows to solve up to 'n'-th-time around echoes (normally, 3 or 4 are used).

It is possible to change the PRI/PRF at each transmitted pulse, but in modern radars using "packet" processing, they are changed on a packet basis (some tens of pulses).

3.2.2.2.1 Interleaved/Staggered PRF – Single Pulse based.

In this mode, the PRI or PRF changes every pulse. From the information provided in Annex 1 and 2, one can see that most weather radars operating in this mode use 2 different PRIs (or PRFs). The French radars use 3 different PRI/PRF values.

3.2.2.2.2 Interleaved/Staggered PRF – Packet based.

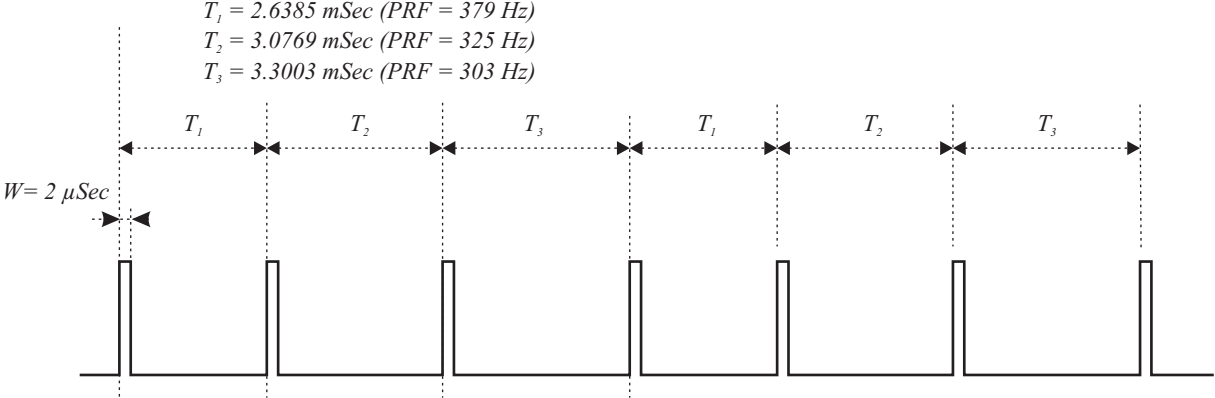
In this mode the PRI/PRF is not changed every pulse but is changed on a packet basis. From the information provided in Annex 1 and 2, one can see that European weather radars operating in this mode use 2 different PRIs/PRFs.

Detection of this type of Staggered PRF is probably easier than detecting a Single Pulse based Staggered PRF.

#	Country	Configur- ation #	PW (µSec)	Constant PRF (Hz)	Staggered PRF - Single Pulse			Staggered PRF - Packet Based				RPM		Ant. Beam Width (3 dB) (Degr.)	
					PRF 1 (Hz)	PRF 2 (Hz)	PRF 3 (Hz)	PRF 1 (Hz)	nr of pulses for PRF 1	PRF 2 (Hz)	nr of pulses for PRF 2	Min	Max		
1	France	1	2		379	325	303					1	2,83		
2	UK	1	2	300								-	1,1		
		2	2	300									?		
		3	0,5		900	1200	-							?	
3	Austria	1	0,8	600								-	4		
		2	0,8				450	19	600	25		-	4		
4	Belgium (Wideum.)	1	0,8	600								-	3		
		2	2,1	483								-	4		
		3	0,8					864	36	1153	48		-	4	
5	Belgium (Belgoctri)	1	2,5	600								-	2,5		
		2	1		800	1200	-					2	4		
6	Czech Rep.	1	0,8	1180								-	4		
		2	0,8	576								2,5	3		
		3	0,8					786	52	1180	79		-	2,5	
7	Finland	1	2	570								2,67	3,67		
		2	1					900	32	675	32	3,67	4		
		3	1					900	32	1200	32		-	5	
		4	2					570	64	472	64		-	1,33	
8	Hungary	1	0,8	600									?		
		2	0,8	300									?		
		3	0,8	960									?		
		4	0,8					600	15	480	14		-	2,5	
9	Ireland	1	2	250									6		
		2	0,58					900	64	1200	64		-	2	
10	Italy	1	0,5	1200									?		
		2	2	300									?		
11	The Netherlands	1	2	250								-	3		
		2	0,8					900	25	1200	33		-	6	
		3	0,8					750	25	1000	33		-	5	
12	Norway	1	2	550									2		
		2	0,83	1200									-	5,167	
		3	0,83		800	1200	-						-	2,5	
13	Portugal	1	0,86	450									4,7		
		2	0,86	600									5,7		
		3	0,86	1200									5,8		
		4	2	450									4,7		
		5	0,8					900	75	1200	100		-	2	
14	Spain	1	2	250									6		
		2	0,5		900	1200							2		
15	Sweden	1	2	250									6		
		2	0,5					900	64	1200	64		-	2	
		3	0,8					600	64	450	64		-	2	
16	Switzerland	1	0,5	600									3		
		2	0,5	800									4		
		3	0,5	1200									6		
17	Finland (Kumpula - Univ.) PRF values listed are max values	1	0,6	2500								?	?		
		2	2,3	1350								?	?		
		3	10	350								?	?		
		4	20	175								?	?		

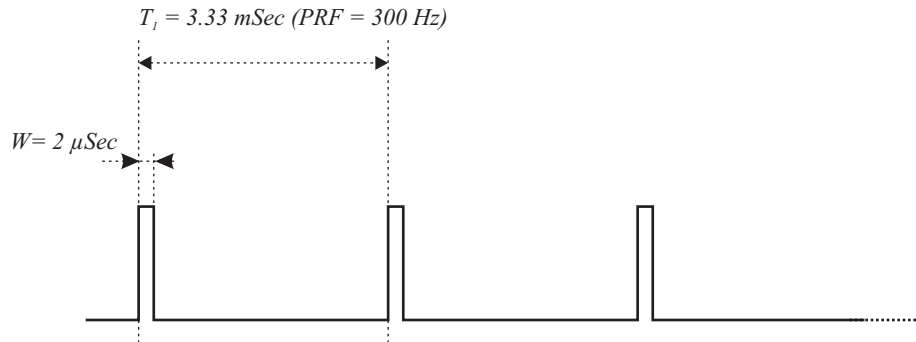
France

Configuration 1 (Single Pulse based Staggered PRF / 1 to 2.83 rpm)



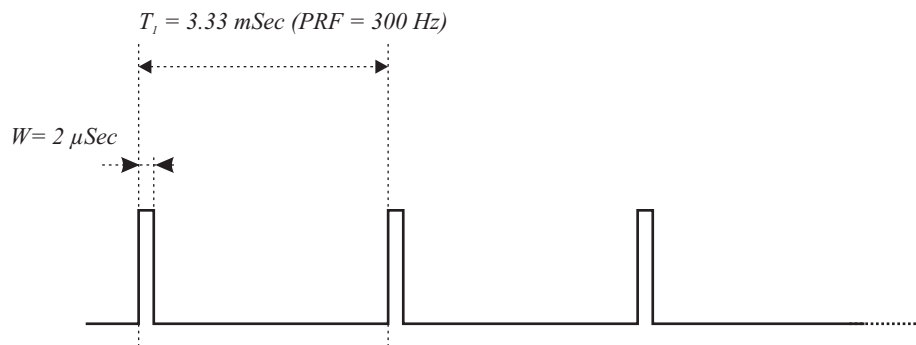
non-Doppler

Configuration 1 (constant PRF / 1.1 rpm)

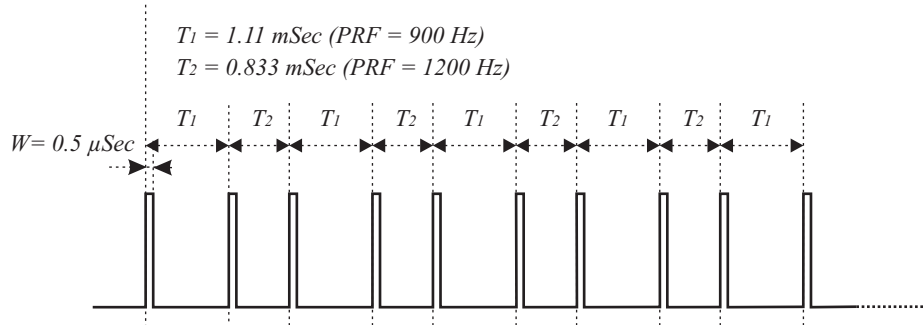


Doppler

Configuration 2 (constant PRF)

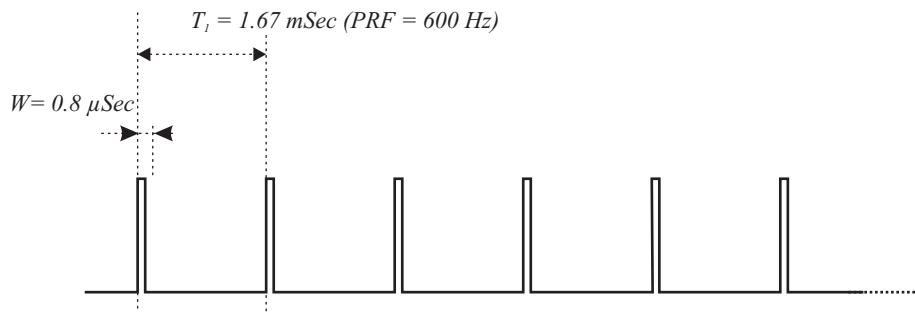


Configuration 3 (Single Pulse based Staggered PRF)

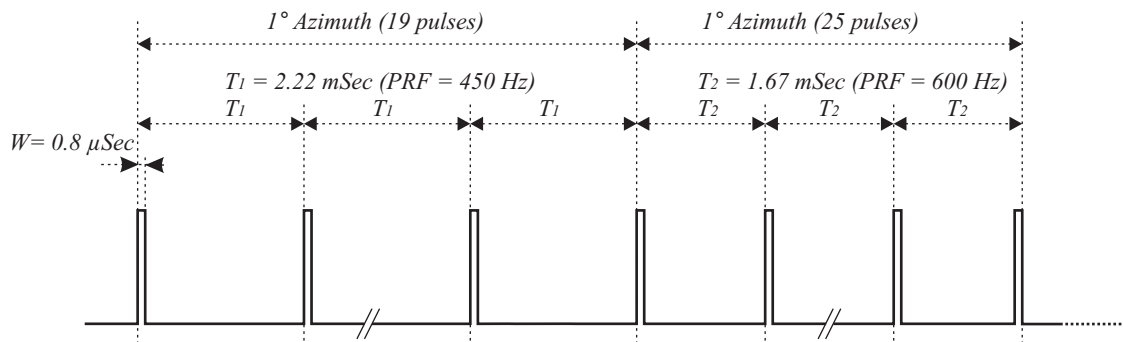


Austria

Configuration 1 (constant PRF / 4 rpm)

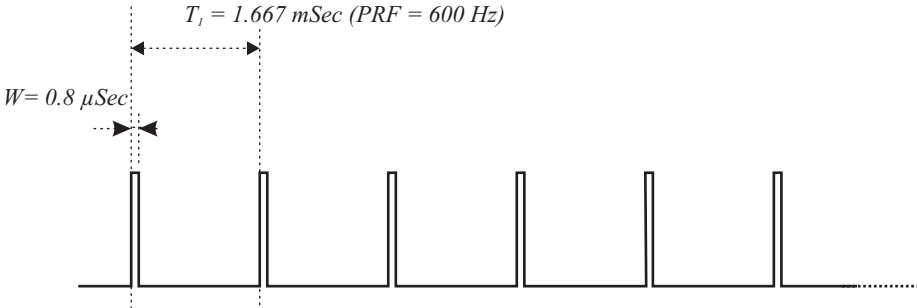


Configuration 2 (Packet based Staggered PRF / 4 rpm)

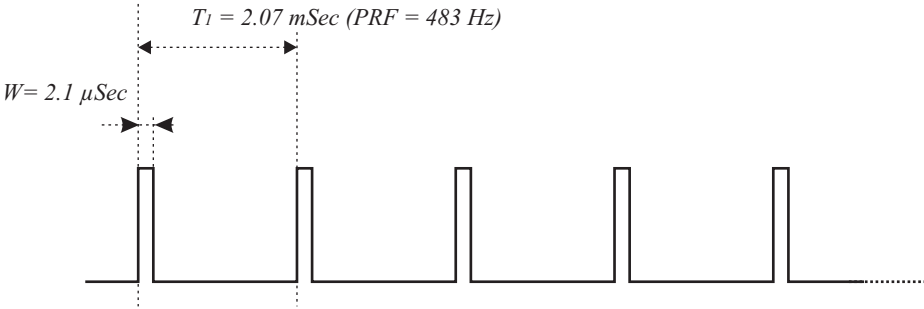


Belgium (Wideumont)

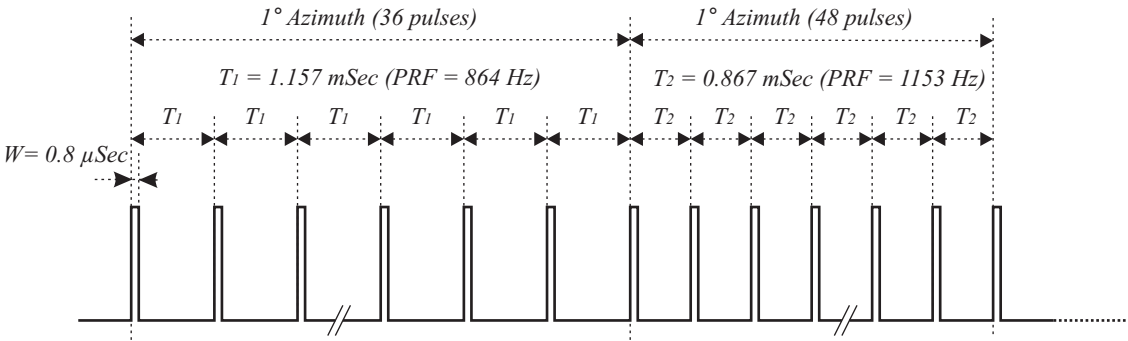
Configuration 1 (constant PRF / 3 rpm)



Configuration 2 (constant PRF / 4 rpm)

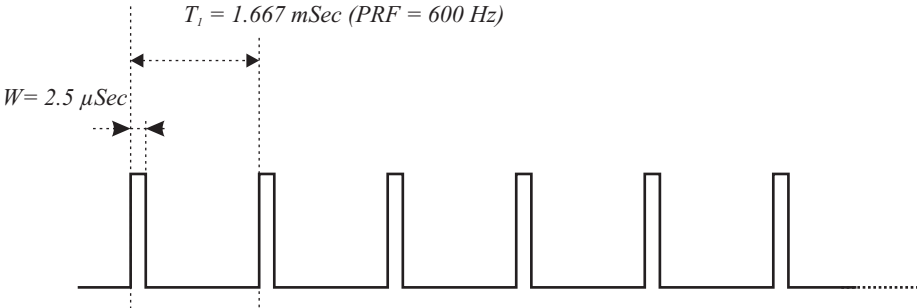


Configuration 3 (Packet based Staggered PRF / 4 rpm)

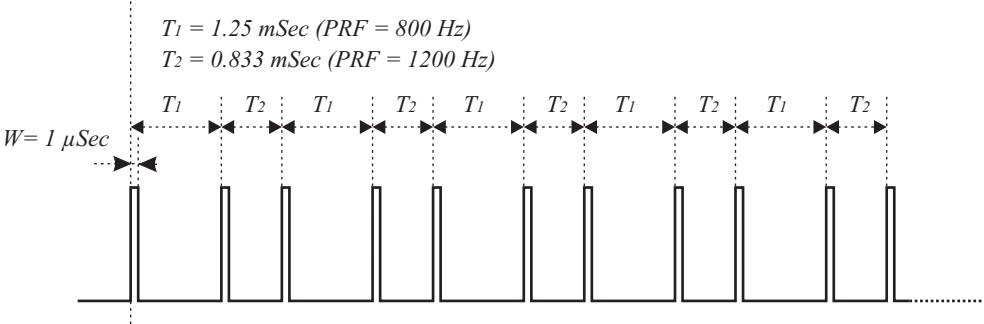


Belgium (Belgocontrol)

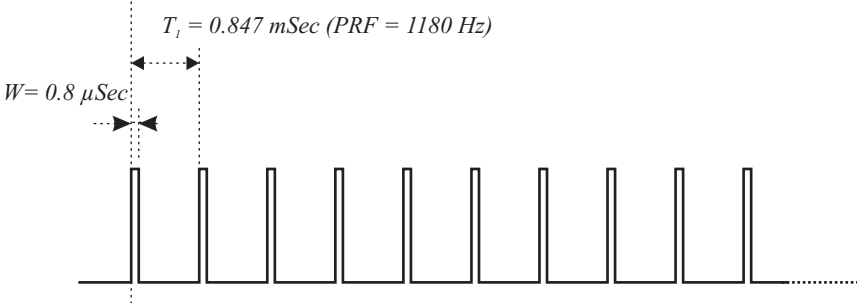
Configuration 1 (constant PRF / 2.5 rpm)



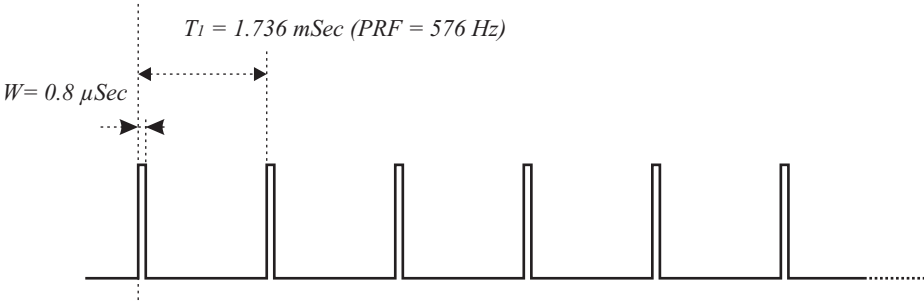
Configuration 2 (Single Pulse based Staggered PRF / 2, 3.67 and 4 rpm)



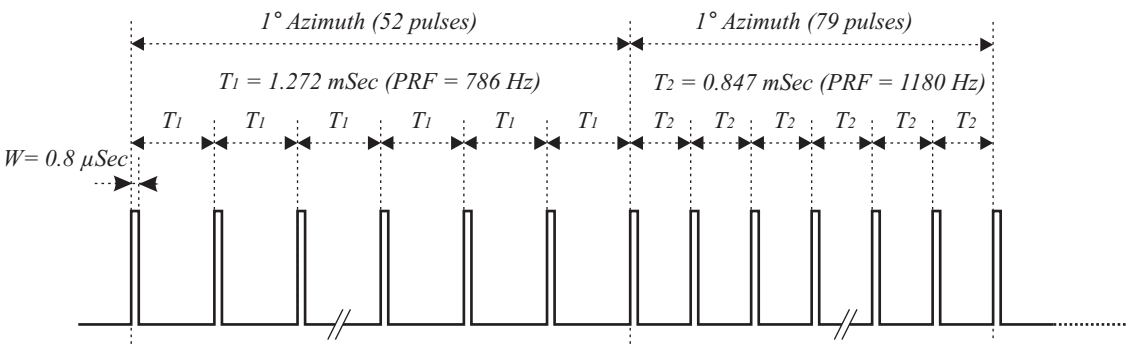
Configuration 1 (constant PRF / 4 rpm)



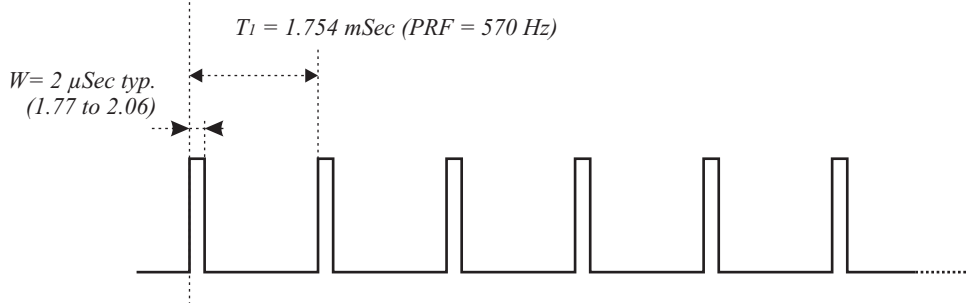
Configuration 2 (constant PRF / 2.5 and 3 rpm)



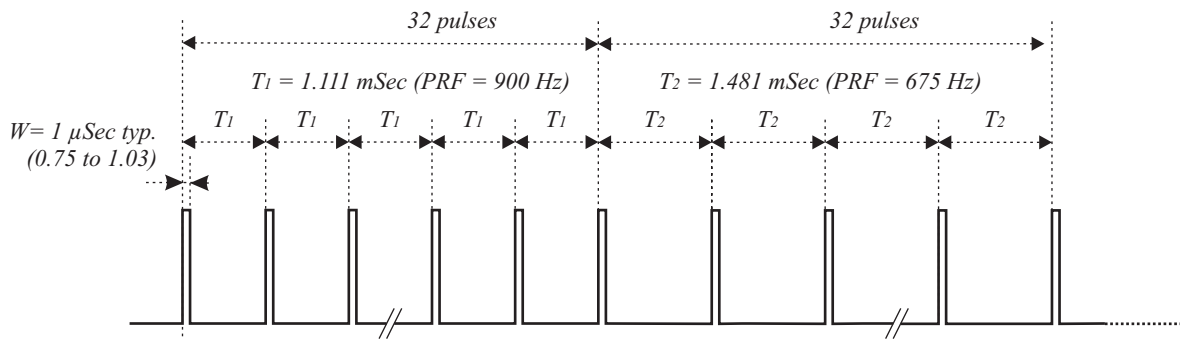
Configuration 3 (Packet based Staggered PRF / 2.5 rpm)



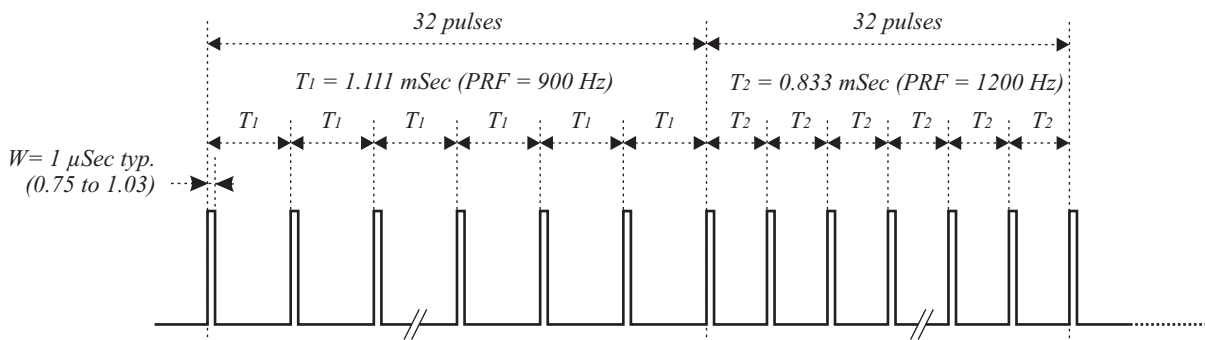
Configuration 1 (constant PRF / 2.67 and 3.67 rpm)



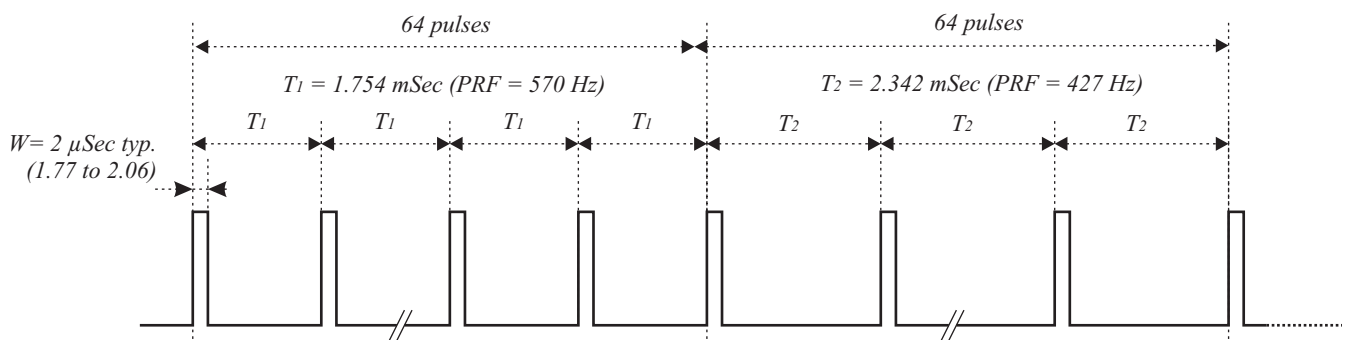
Configuration 2 (Packet based Staggered PRF / 3.67 and 4 rpm)



Configuration 3 (Packet based Staggered PRF / 5 rpm)

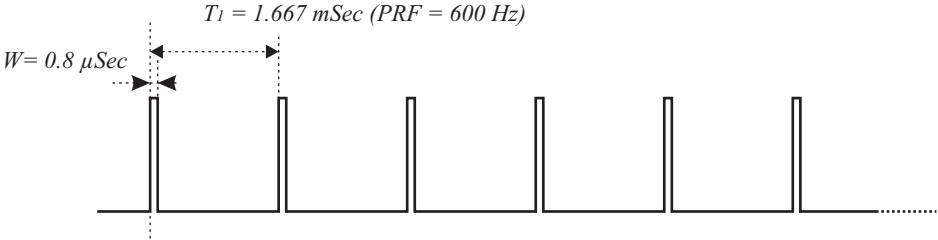


Configuration 4 (Packet based Staggered PRF / 1.33 rpm)

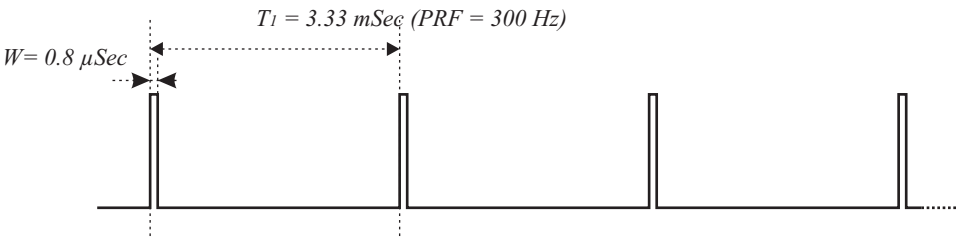


Hungary

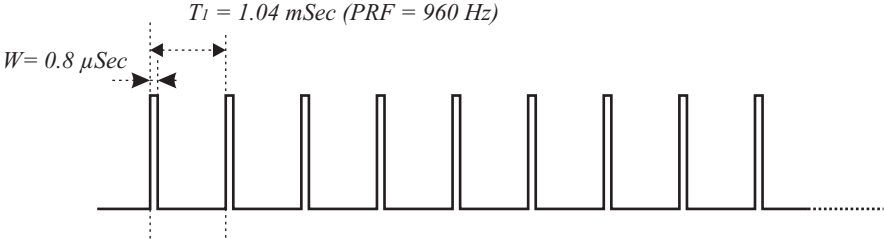
Configuration 1 (constant PRF / ?? rpm)



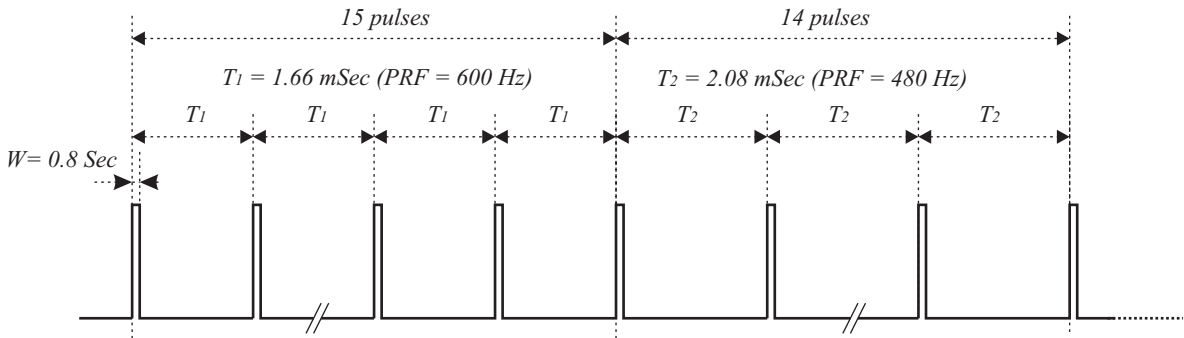
Configuration 2 (constant PRF / ?? Rpm)



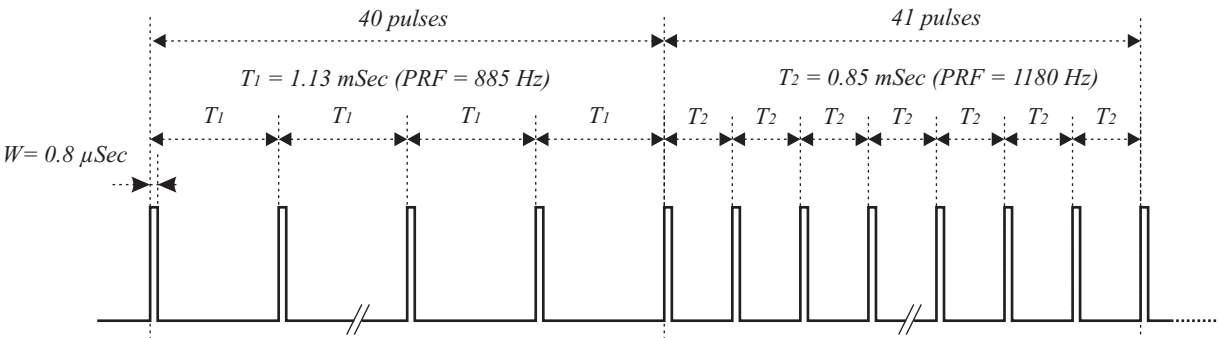
Configuration 3 (constant PRF / ?? rpm)



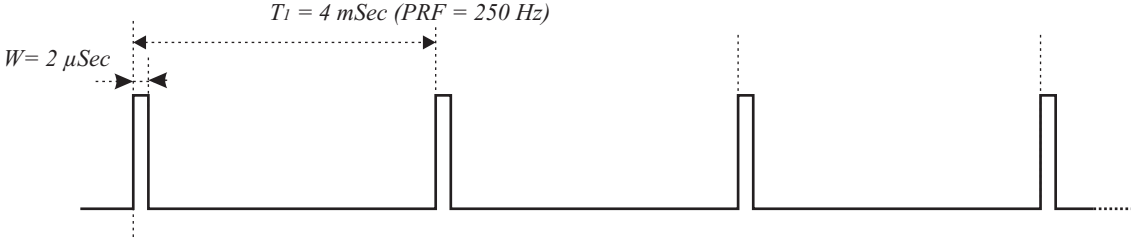
Configuration 4 (Packet based Staggered PRF / 2.5 rpm)



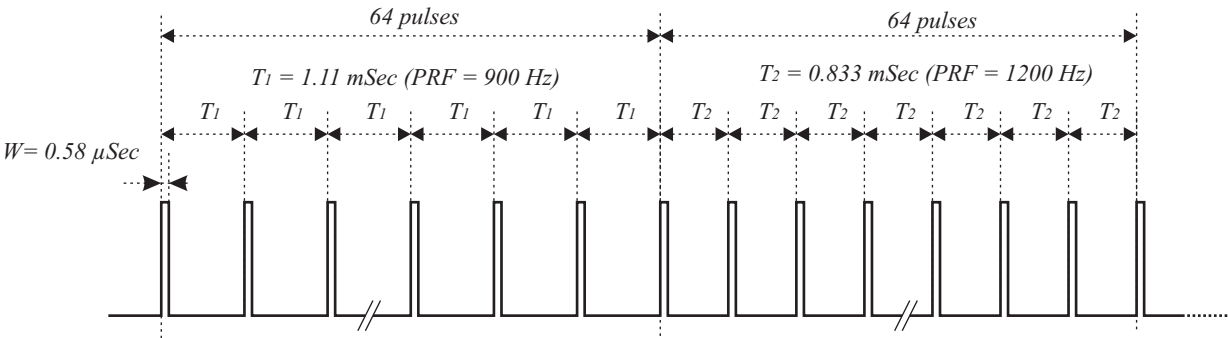
Configuration 5 (Packet based Staggered PRF / 1.67 rpm)



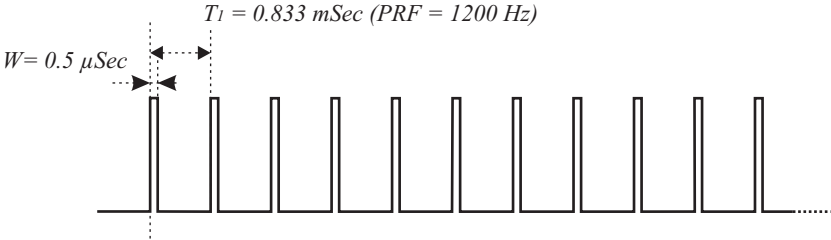
Configuration 1 (constant PRF / 6 rpm)



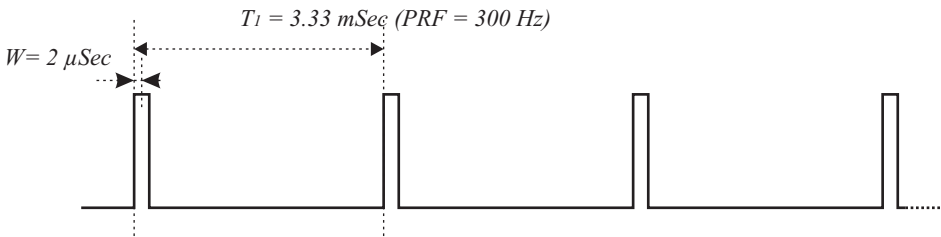
Configuration 2 (Packet based Staggered PRF / 2 rpm)



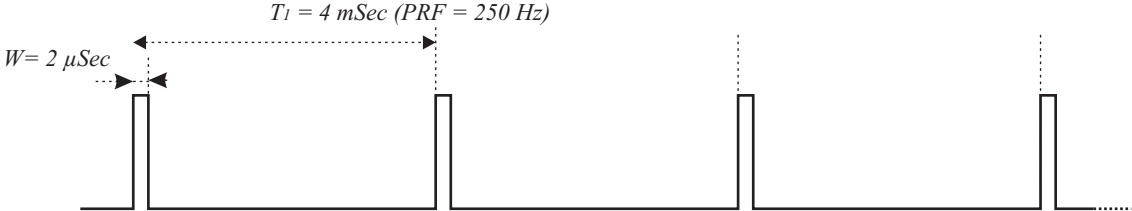
Configuration 1 (constant PRF / ?? rpm)



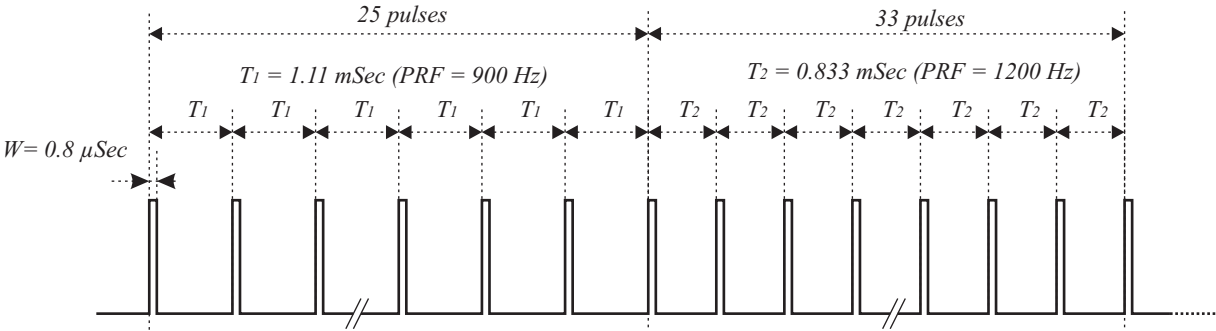
Configuration 2 (constant PRF / ?? Rpm)



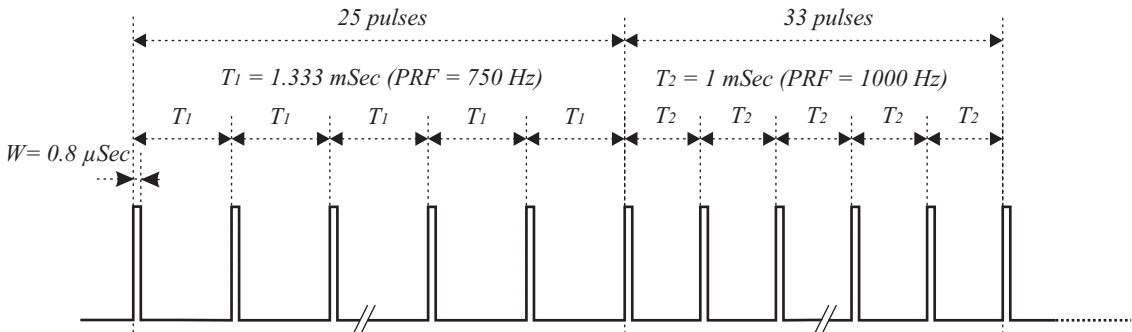
Configuration 1 (constant PRF / 3 rpm)



Configuration 2 (Packet based Staggered PRF / 6 rpm)

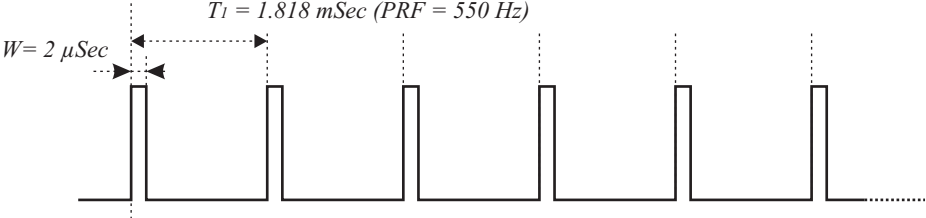


Configuration 3 (Packet based Staggered PRF / 5 rpm)

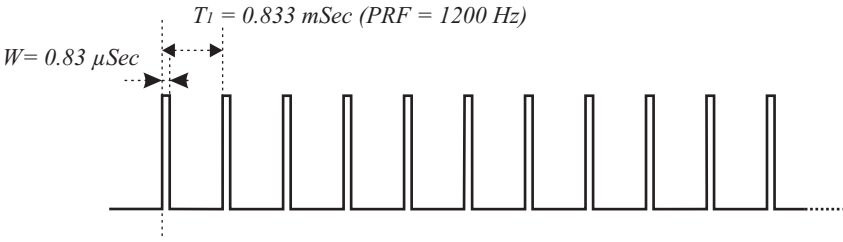


Norway

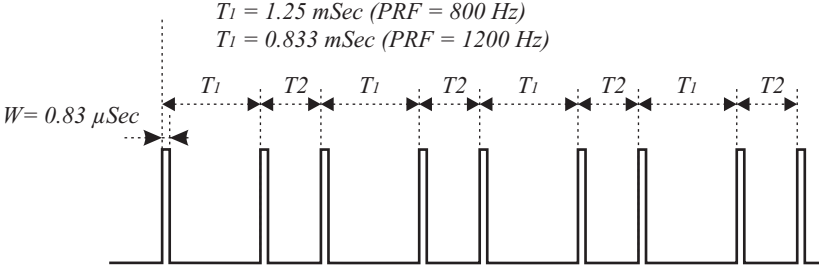
Configuration 1 (constant PRF / 2 rpm)



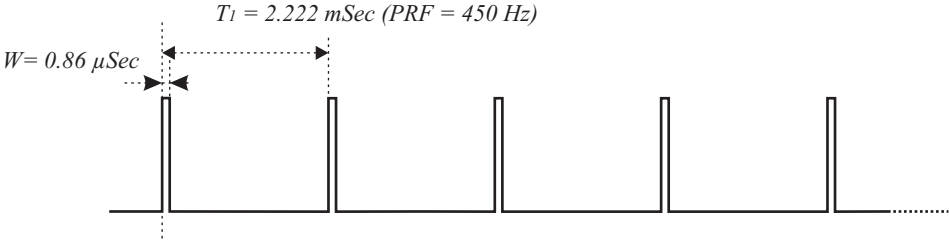
Configuration 2 (constant PRF / 5.167 rpm)



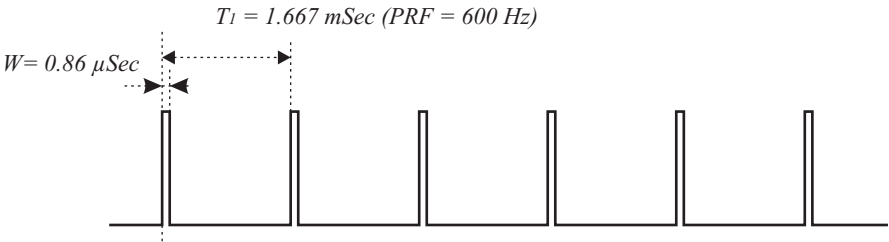
Configuration 3 (Single Pulse based Staggered PRF / 2.5 rpm)



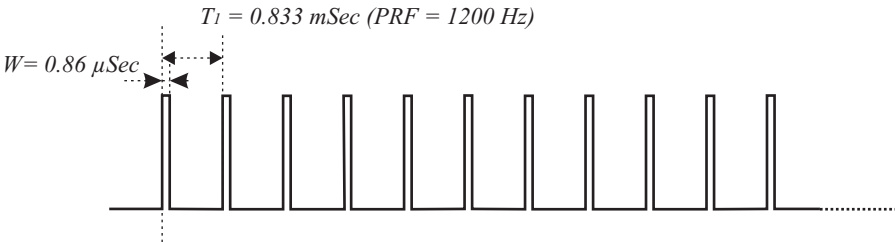
Configuration 1 (constant PRF / 4.7 rpm)



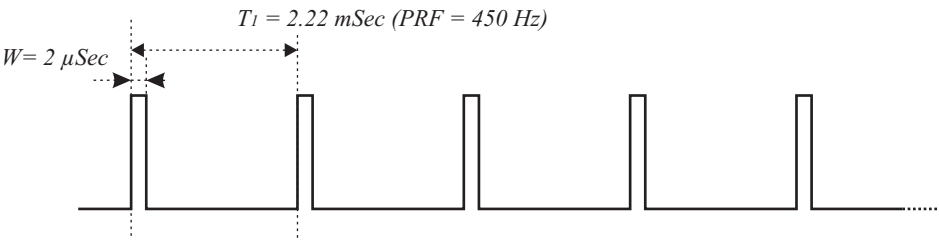
Configuration 2 (constant PRF / 5.7 rpm)



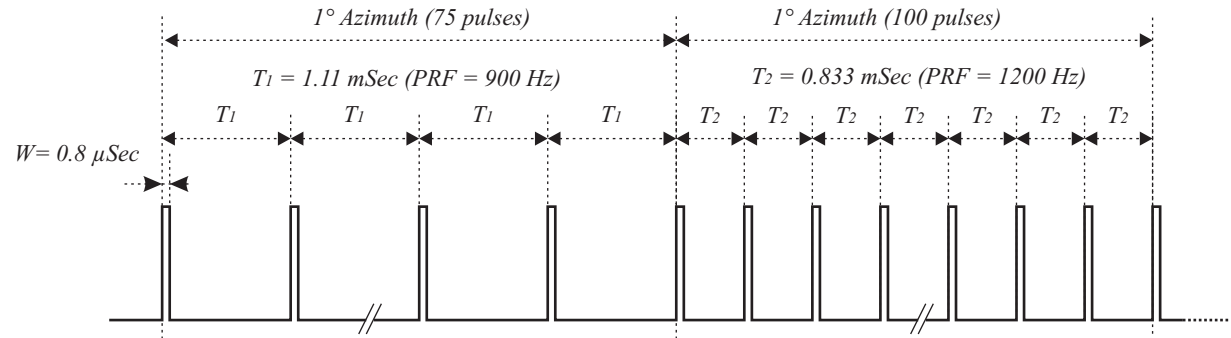
Configuration 3 (constant PRF / 5.8 Rpm)



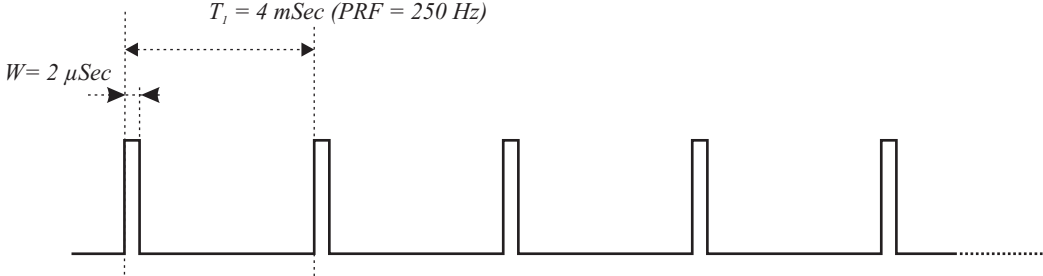
Configuration 4 (constant PRF / 4.7 rpm)



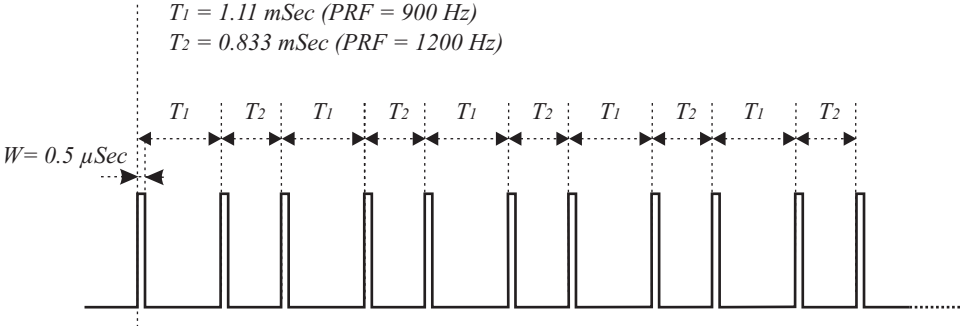
Configuration 5 (Packet based Staggered PRF / 2 rpm)



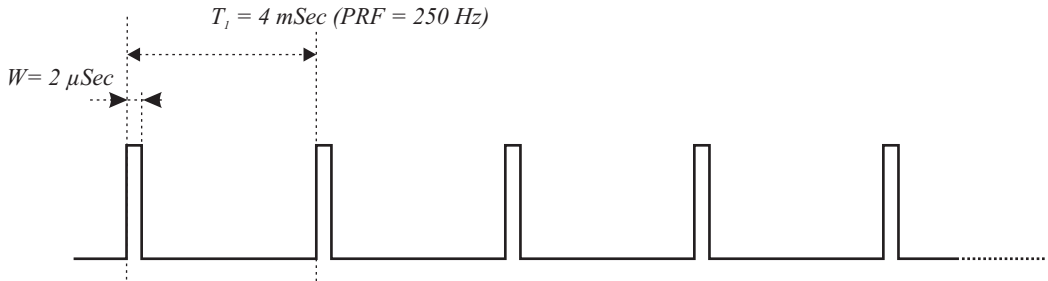
Configuration 1 (constant PRF / 6 rpm)



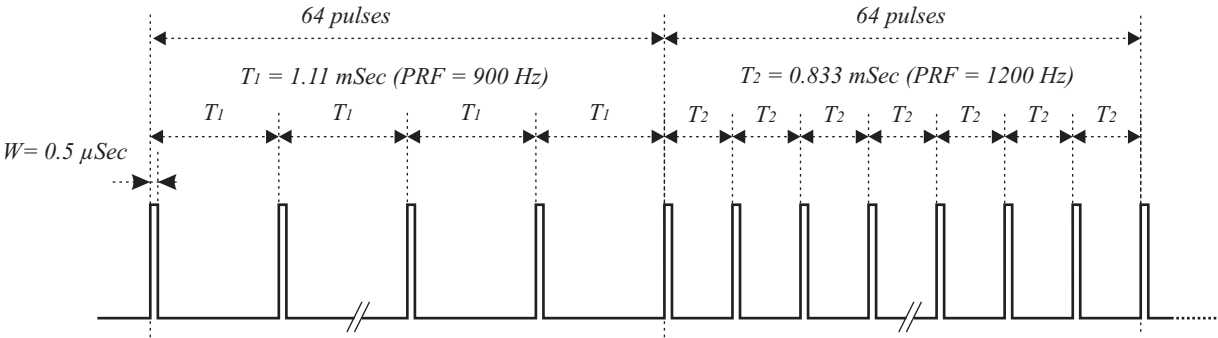
Configuration 2 (Single Pulse based Staggered PRF / 2 prm)



Configuration 1 (constant PRF / 6 rpm)



Configuration 2 (Packet based Staggered PRF / 2 rpm)



Configuration 3 (Packet based Staggered PRF / 2 rpm)

