

Project: IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs)

Submission Title: [Performance comparison between proposed SFDs]

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Abstract: [Report performance comparison results between proposed SFDs]

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Summary

- SFD: 4 SFD plans with length of 16-bits have been proposed for FEC and Non-FEC identification by the due date described in Doc. 10-0051-01

Plan	SFD 1 Value for FEC mode (a)	SFD 2 value for Non-FEC mode (b)
A (Doc. 10-0112-01-004g)	0xF68D	0x7BC9
B (Doc. 10-0112-01-004g)	0x6F4E	0x904E
C (Doc. 10-0112-01-004g)	0x21F6	0xC9C2
D (Doc. 10-0126-00-004g)	0x632D	0x7A0E

- Performance comparisons regarding peak, rms of side lobe of correlation values, have been done by
 - Correlating between 15.4g preamble (24 bit) + a and x, where x= a and b
 - Correlating between 15.4g preamble (24 bit) + b and x, where x= a and b
 - Correlating between -(15.4g preamble (24 bit) + a) and x, where x= a and b
 - Correlating between -(15.4g preamble (24 bit) + b) and x, where x= a and b
 - Correlating between 15.4d preamble (24 bit) + SFD (8bit) and x, where x= a and b
 - Correlating between 15.4g preamble (24 bit) +x 15.4d SFD (8bit) and x, where x= a and b
- **Plan B achieves the best performance** in terms of its correlation properties as well as the co-existence with 802.15.4g

Process to select the SFD values

Doc. 10-0051-01

1. Will be selected based on the following prioritized criteria:
 - a. Autocorrelation and cross correlation to the other pattern
 - b. Good image rejection (low correlation against the image)
 - c. Correlation relative to the preamble (low side lobes against the preamble)

2. The following prioritized differentiators will be used to select SFD values if multiple solutions are found with identical performance. Supporting data for item 2a shall be provided by all proposals.
 - a. The selected code should have good orthogonality against the existing 802.15.4d SFD. (Co-existence with 802.15.4d is imperative).

Summary of RMS side peak values

- From the viewpoint of correlation value, **plan B achieves the best performance** because it offers the lowest side lobe correlation values
- From the viewpoint of co-existence with 802.15.4g, plan B also achieves the best performance because it offers the lowest correlation values with 802.15.4d

	Plan A		Plan B		Plan C		Plan D	
	x=a	x=b	x=a	x=b	x=a	x=b	x=a	x=b
Prem+a \Leftrightarrow x	1.68	1.08	2.20	2.20	2.08	2.31	2.16	3.44
Prem+b \Leftrightarrow x	2.12	2.86	1.87	2.35	2.00	2.65	1.96	3.46
Prem+sfd4d \Leftrightarrow x	2.11	1.28	1.88	1.88	1.88	2.28	2.11	3.85
-(Prem+a) \Leftrightarrow x	1.68	1.08	2.20	2.20	2.08	2.31	2.16	3.44
-(Prem+b) \Leftrightarrow x	2.12	2.86	1.87	2.35	2.00	2.65	1.96	3.46
Average RMS	1.94	1.83	2.00	2.20	2.01	2.44	2.07	3.53
Prem+x \Leftrightarrow sfd4d	2.23	2.43	2.56	2.08	2.33	2.47	2.50	2.26

Summary of Maximal side-peak values

- From the viewpoint of correlation value, **plan B achieves the best performance** because it offers the lowest maximal side lobe correlation values
- From the viewpoint of co-existence with 802.15.4g, plan B also achieves the best performance because plan B offers the lowest correlation values with 802.15.4d

	Plan A		Plan B		Plan C		Plan D	
	x=a	x=b	x=a	x=b	x=a	x=b	x=a	x=b
Prem+a \Leftrightarrow x	4	2	4	4	4	4	4	4
Prem+b \Leftrightarrow x	4	6	4	4	4	6	4	4
Prem+sfd4d \Leftrightarrow x	6	2	6	6	6	4	6	6
-(Prem+a) \Leftrightarrow x	4	2	4	4	4	4	4	4
-(Prem+b) \Leftrightarrow x	4	6	4	4	4	6	4	4
Prem+x \Leftrightarrow sfd4d (Max peak: 8)	6	6	4	4	4	6	6	4

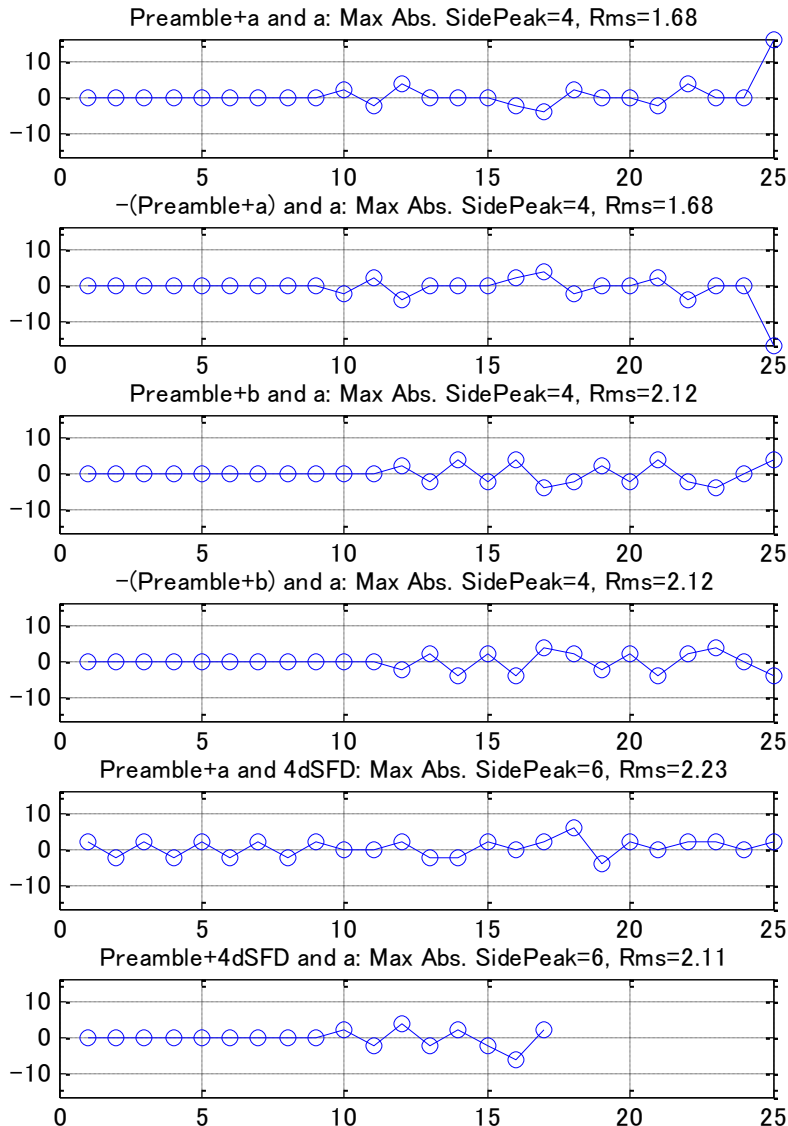
Appendix

(Partially referred by doc. 10-0112-01)

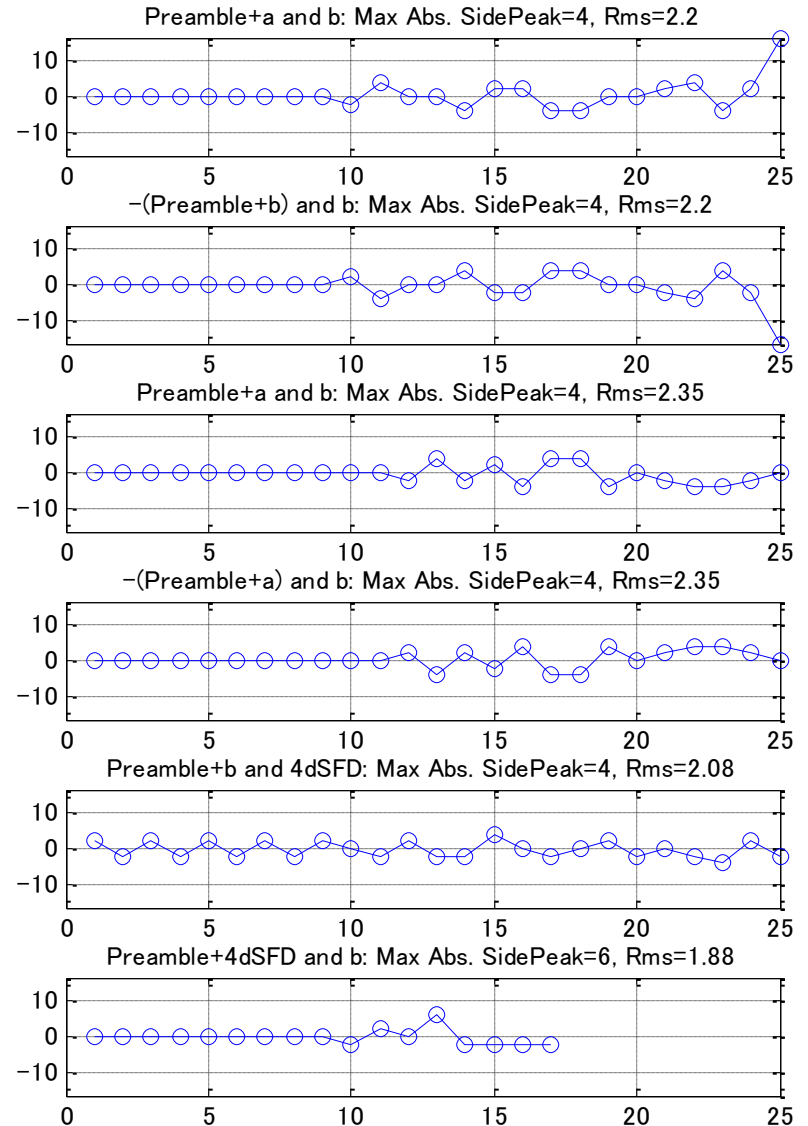
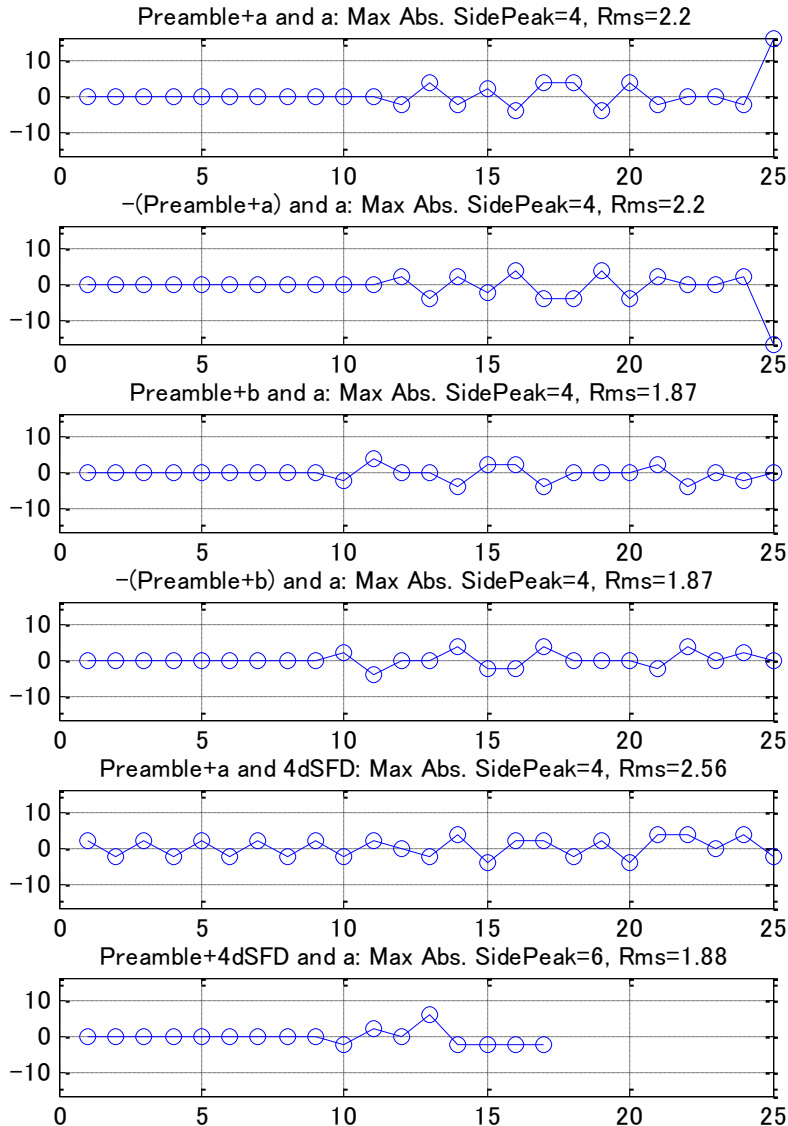
Proposal on SFD

Plan	SFD Value for FEC mode	SFD value for Non-FEC mode
A (Doc. 10-0112-01-004g)	0xF68D	0x7BC9
B (Doc. 10-0112-01-004g)	0x6F4E	0x904E
C (Doc. 10-0112-01-004g)	0x21F6	0xC9C2
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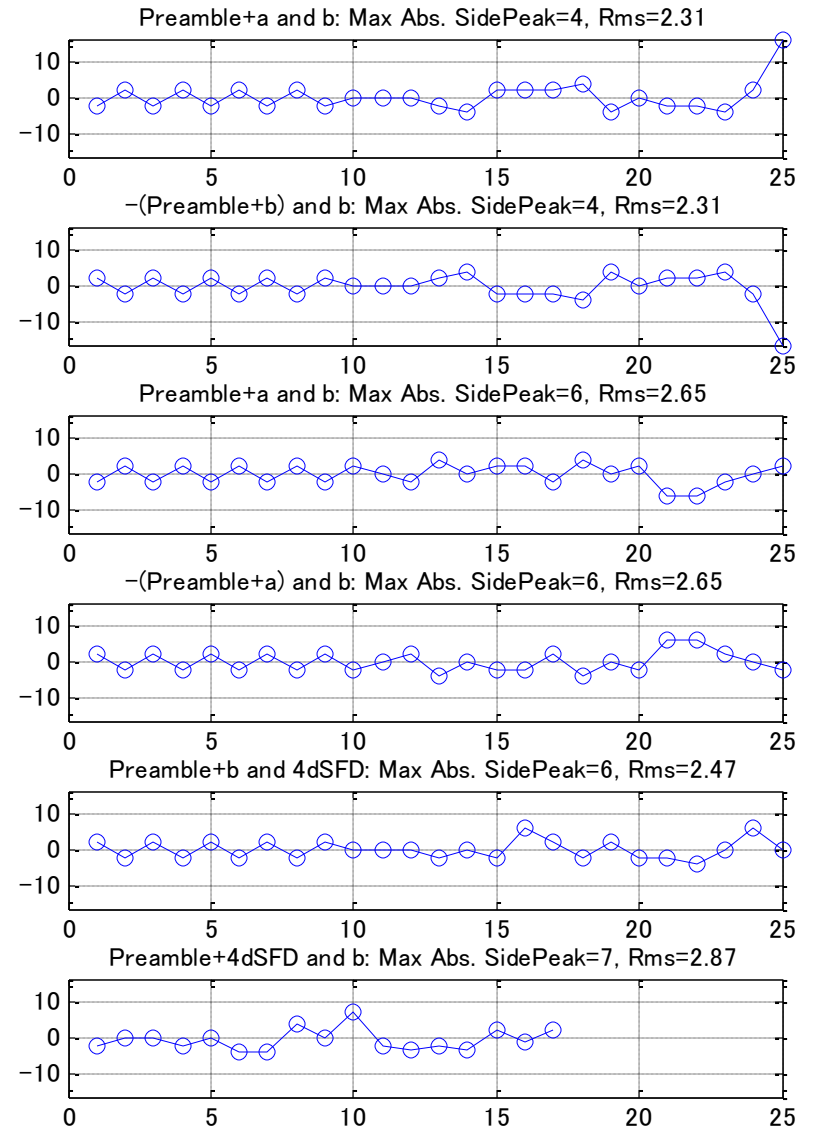
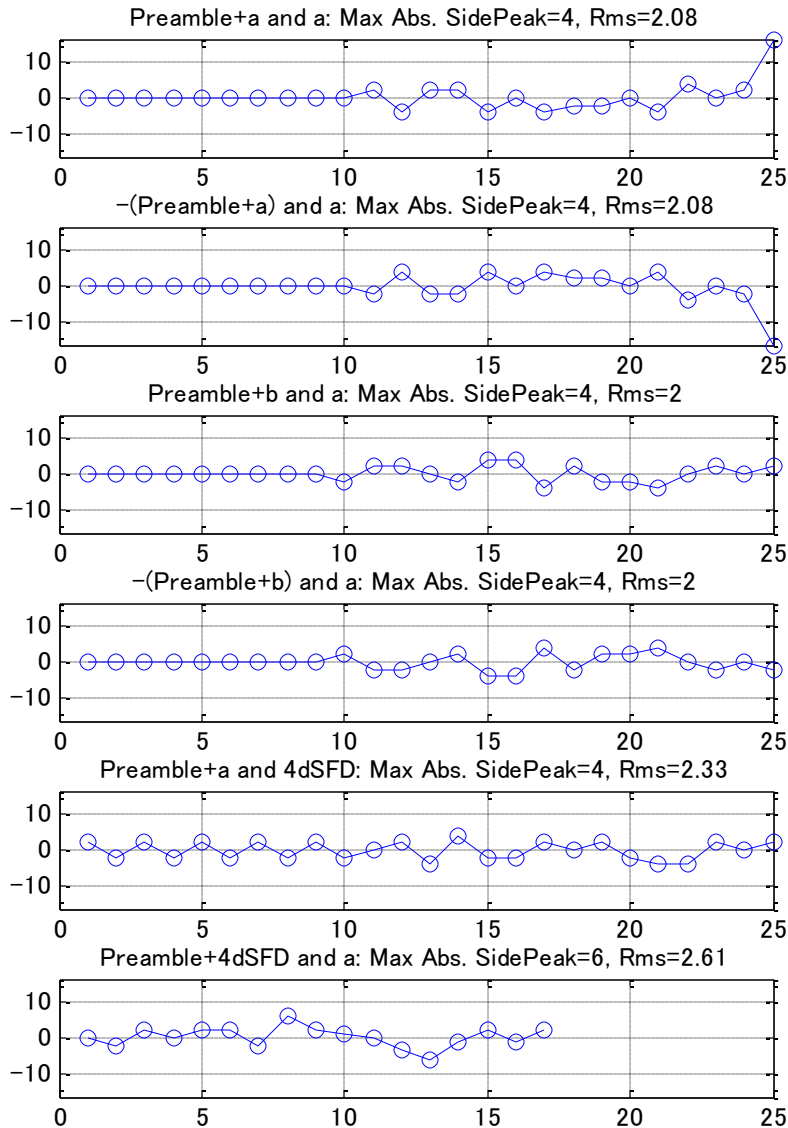
Correlator output of plan A



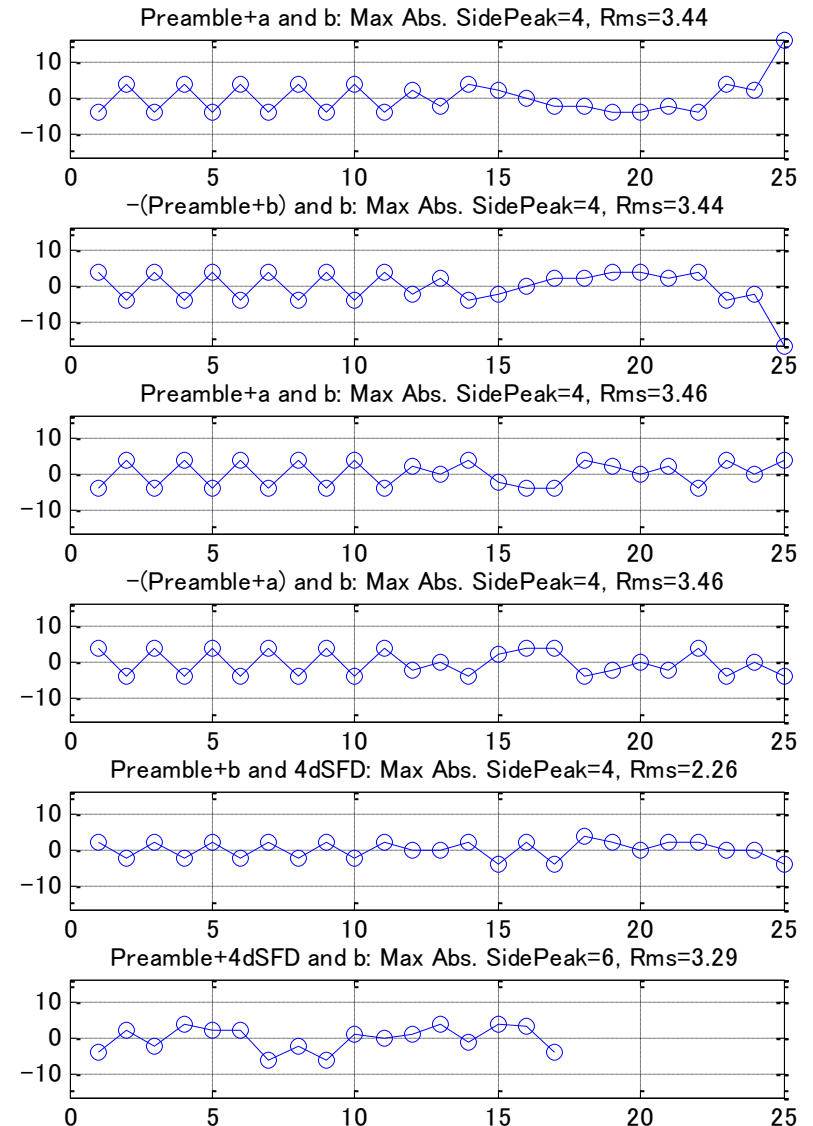
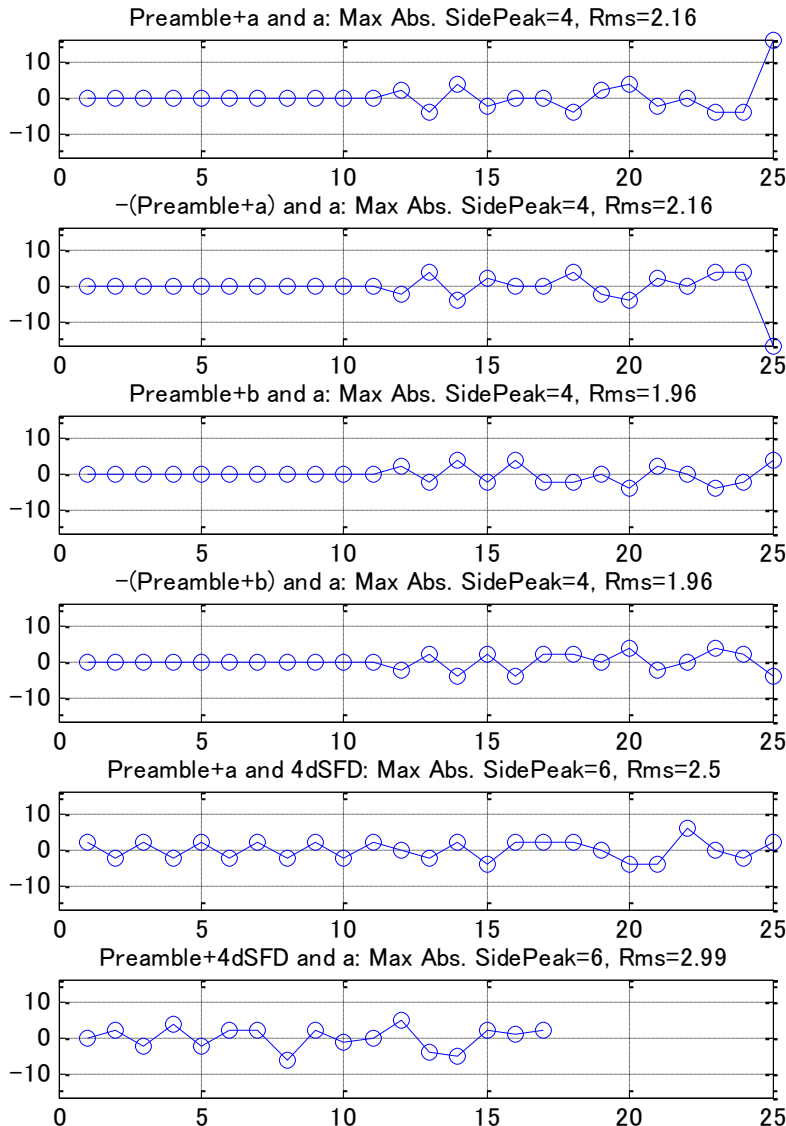
Correlator output of plan B



Correlator output of plan C



Correlator output of plan D



Appendix 2

(From doc. 10-0130-01)

Comments from Doc. 10-0126-00-004g

- While DC imbalance of the SFD's is not a selection criterion, the preamble is designed to have 0 DC and smaller DC imbalances are generally preferable
- The value "The DC imbalance" is computed by finding the absolute value of the (sum of the zeros – sum of the ones). Since there are 2 SFD's, the larger DC imbalance is listed
- From these viewpoints, plan D has the best performance because DC balance will be 0

Resolution

- To have lower DC imbalance is "nice to have" but minor problem from the viewpoint of feasibility
- Because although the DC imbalance value of the 802.15.4d SFD (8-bits) is 2, where five '1' values and three '0' values, the product (chip) has been developed
- In the case of 802.15.4g 16-bit SFD, it would be OK to develop actual chip even if the DC values is 4 or 5 because of the assumption that 16-bit SFD can be supported with smaller imbalance.
- Most important parameters of SFD would be autocorrelation, cross-correlation image-correlation values when the SFD is combined with preamble and correlated with the SFD itself.