

PAM3 Mapping for 802.3bp

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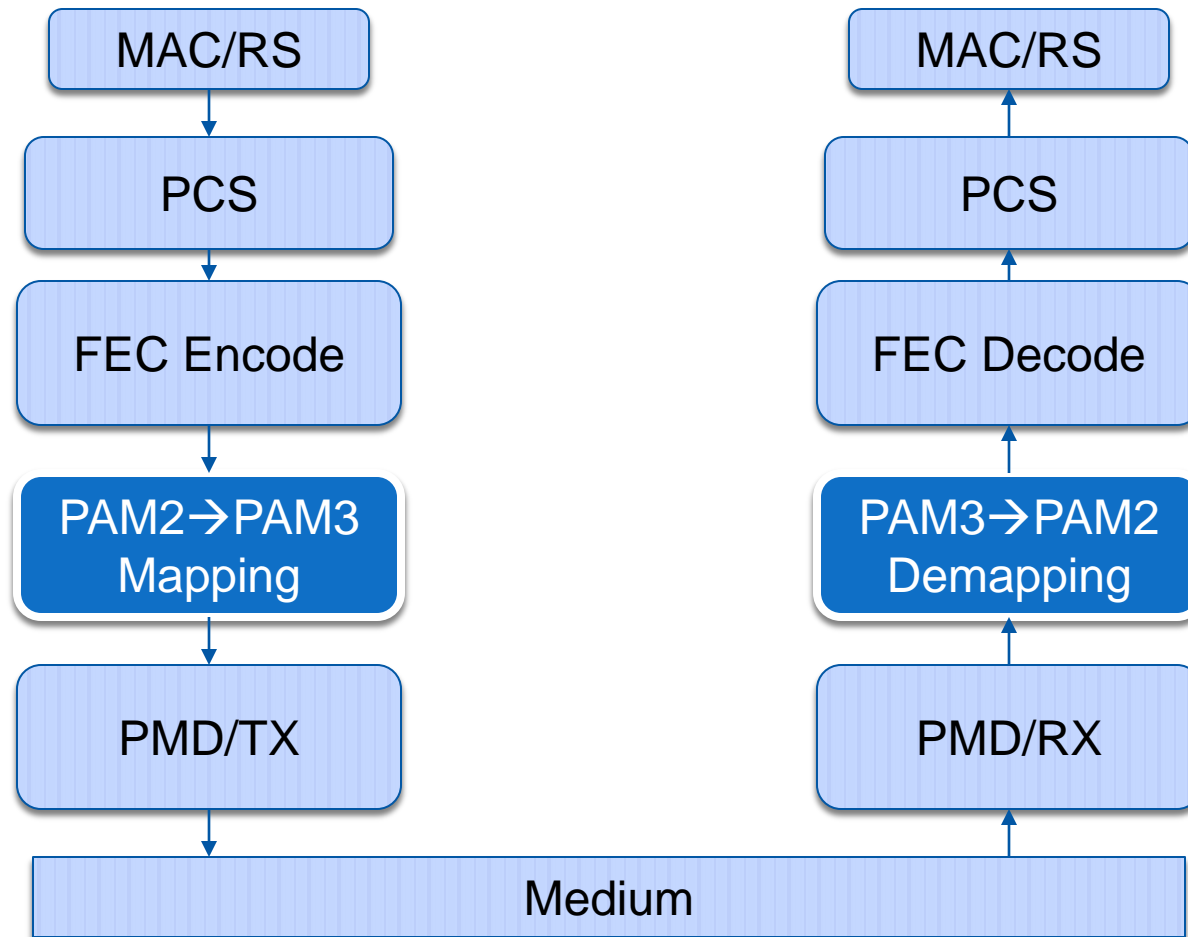
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PAM3 Mapping in the PHY



Criteria for Mapping

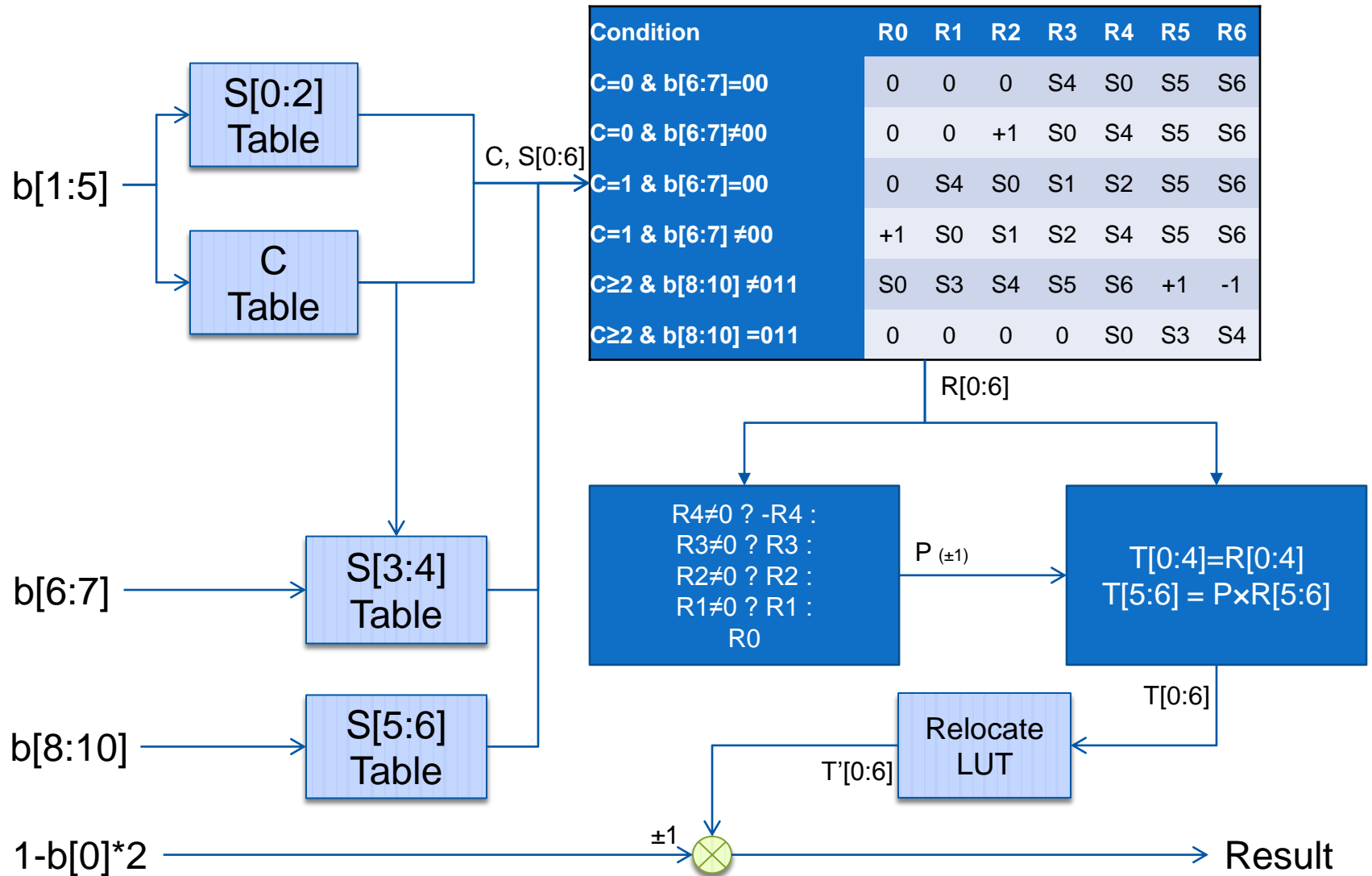
- We propose a PAM2→PAM3 mapping with:
 - Efficient use of bandwidth
 - Easy implementation
 - PSD property for Tx mask
 - Sufficient timing information

Efficiency

- For easy implementation, we want to convert N bits into M PAM3 symbol
 - No memory
- 11bit→7PAM3 is an efficient choice
- Alternatively: 19bit→12PAM3
 - Implementation complexity is higher

# of PAM3 Symbol	Capacity (bits)	# of bits	Efficiency
2	3.1699	3	94.6%
3	4.7549	4	84.1%
5	7.9248	7	88.3%
7	11.0947	11	99.15%
9	14.2647	14	98.1%
11	17.4346	17	97.5%
12	19.0196	19	99.9%

Mapper Diagram



Tables

C and S[0:2] Table					
b[3:5]	S[0:2], C				
	b[1:2]=	00	01	10	11
000		000, 1	0-0, 1	+00, 1	+ -0, 1
001		00+, 1	0-+, 1	+0+, 1	+ -+, 1
010		00-, 1	0--, 1	+0-, 1	+ --, 1
011		-00, 1	-0-, 1	-+0, 1	+XX, 2
100		0+0, 1	0XX, 0	++0, 1	--0, 1
101		0++, 1	+XX, 0	+++, 1	--+, 1
110		0+-, 1	-XX, 0	++-, 1	---, 1
111		-0+, 1	0XX, 2	-+++, 1	+XX, 3

S[3:4] Table		
b[6:7]	S[3:4]	
	C≠3	C=3
00	0+	--
01	+ -	-0
10	++	0-
11	+0	00

S[5:6] Table	
b[8:10]	S[5:6]
000	--
001	-0
010	0-
011	-+
100	++
101	+0
110	0+
111	00

Relocate Table		
T[0:6]		T'[0:6]
+++++++		+ -+ - - -
+++++++0		+ -+ - - -0
+++++++0+		+ -+ - - -0-
+++++++0++		+ -+ - - -00
+++0+++		+ -+ - - -0+
++0++++		+ -+ - - -+0
+0+++++		+ -+ - - -++
0+++++		+ -+ - - -0+
0+-0-+-		0+- - - -++
0+-+0+-		0+- - - -+-
+ -0-0-+		+0- - - -++
+ -00+-+		+ -+ +0+-
+0+-0-+		+ -+ - - -++
+0+0-+-		+0+- - -+-
00+0-+-		00+- - -+-
0+-0-+-		0+0- - -++
++-0-+-		++++ - -+-
+ -00-+-		0000+- -+
+ -0-+-0		0+- - - - - -
+ -0-+0+		0+- - - - -0
+ -+0+-0		0+- - - - -+
+ -+0+0+		0+- - - -0+
+0+- - -0		000+0+-
+0+-+0+		000+- -+

'+' = +1, '-' = -1, '0' = 0, 'X' = do not care

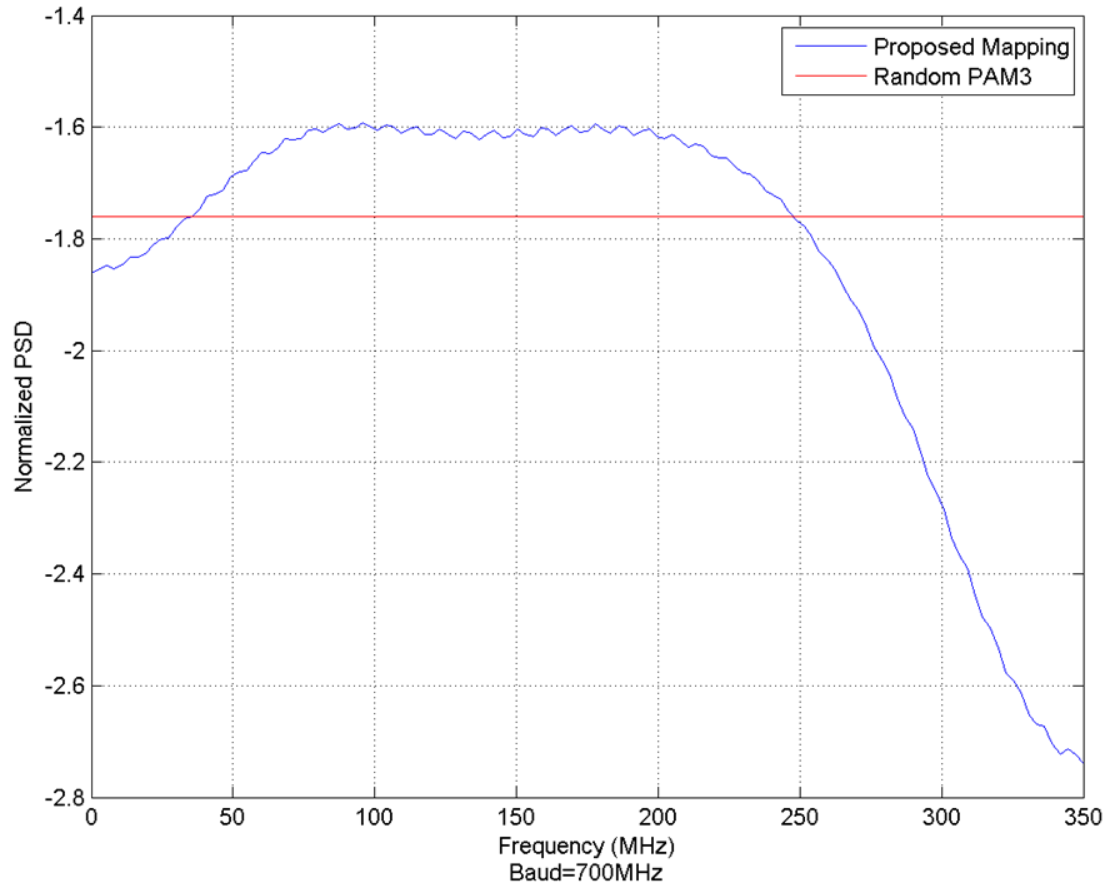
PSD and Extra PAM3 Patterns

- We have $3^7 - 2^{11} = 139$ extra constellation points
- Some “high frequency” patterns are selectively removed to shape the PSD
 - Result is a slightly low-pass PSD (~1.1dB attenuation)
 - Can help to fit Tx PSD mask
- Some high DC patterns are also removed

Timing Information

- “Flat” patterns are removed to guarantee transition
 - ++++++, 000000, -----, etc.
- Maximum run length is 12

PSD



Simulated with PRBS31 input

Error Correction Considerations

- It is difficult to find “Gray-like” code for PAM3 mapping
- Single PAM3 error will propagate to multiple bit errors
- Can be mitigated by employing $GF(2^{11})$ symbols in RS code

Thank you!