Project	**IEEE 802.16 Broadband Wireless Access Working Group** <http://ieee802.org/16>	
Title	**Proposal for a 4-antenna Codebook**	
Date Submitted	**2008-09-05**	
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Re:	PHY: MIMO; in response to the TGm Call for Contributions and Comments 802.16m-08/033 for Session 57	
Abstract	This document proposes a specific codebook for inclusion in Chapter 11	
Purpose	To be discussed and adopted in 802.16m SDD	
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Proposal for a 4-antenna Codebook

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1. Introduction

The proposed 4-bit constant modulus codebook is provided in the appendix.

This codebook is constant-modulus and uses the simplest alphabet possible (+/-1, +/-j) which greatly reduces implementation complexity.

Performance comparison with two other constant modulus 4-bit codebook proposals shows very similar results for cross-polarized antennas and closely spaced vertically polarized antennas.

In conjunction with our proposal in C80216m-08_915, we recommend the adoption of this codebook for SU-MIMO and MU-MIMO as the combination provides the best tradeoff of complexity and performance.

2. Proposed Text

11.8.2.1.2.1 Precoding technique

Add to current text on line 3 the text in the appendix

11.8.2.2.3.2 CSI Feedback

Add to current text on line 40 the text in the appendix:

3. Appendix

We use $j = \sqrt{-1}$:

For rank 2 the description [V0 V1] means that the precoder has two columns – rank-1 column 0 and rank-1 column 1. Similarly for ranks 3 and 4.

Rank-2 matrices should be further divided by $\sqrt{2}$ to normalize power.
Rank-3 matrices should be further divided by $\sqrt{3}$ to normalize power.

4-Bit 4-Tx Codebook for Close Loop MIMO

Codebook Index	Rank 1	Rank 2	Rank 3	Rank 4
0	$\frac{1}{2}\begin{bmatrix} -j \\ 1 \\ -j \\ -1 \end{bmatrix}$	[V0 V1]	[V1 V2 V3]	[V0 V1 V2 V3]
1	$\frac{1}{2}\begin{bmatrix} -j \\ -1 \\ -j \\ 1 \end{bmatrix}$	[V1 V3]	[V0 V2 V3]	[V4 V5 V6 V7]
2	$\frac{1}{2}\begin{bmatrix} -j \\ 1 \\ j \\ 1 \end{bmatrix}$	[V2 V3]	[V0 V1 V3]	[V8 V9 V10 V11]
3	$\frac{1}{2}\begin{bmatrix} -j \\ -1 \\ j \\ -1 \end{bmatrix}$	[V0 V2]	[V0 V1 V2]	[V12 V13 V14 V15]
4	$\frac{1}{2}\begin{bmatrix} -1 \\ -j \\ -j \\ 1 \end{bmatrix}$	[V4 V5]	[V5 V6 V7]	_
5	$\frac{1}{2}\begin{bmatrix} -1 \\ -j \\ j \\ -1 \end{bmatrix}$	[V5 V7]	[V4 V6 V7]	_
6	$\frac{1}{2}\begin{bmatrix} -j \\ -1 \\ -1 \\ j \end{bmatrix}$	[V6 V7]	[V4 V5 V7]	_

7	$\frac{1}{2}\begin{bmatrix} j \\ 1 \\ -1 \\ j \end{bmatrix}$	[V4 V6]	[V4 V5 V6]	_
8	$\frac{1}{2}\begin{bmatrix} -1 \\ -1 \\ j \\ -j \end{bmatrix}$	[V8 V9]	[V9 V10 V11]	_
9	$\frac{1}{2}\begin{bmatrix} j \\ j \\ -1 \\ 1 \end{bmatrix}$	[V9 V11]	[V8 V10 V11]	_
10	$\frac{1}{2}\begin{bmatrix} j \\ -j \\ -1 \\ -1 \end{bmatrix}$	[V10 V11]	[V8 V9 V11]	_
11	$\frac{1}{2}\begin{bmatrix} 1 \\ -1 \\ -j \\ -j \end{bmatrix}$	[V8 V10]	[V8 V9 V10]	_
12	$\frac{1}{2}\begin{bmatrix} j \\ j \\ j \\ j \end{bmatrix}$	[V12 V13]	[V13 V14 V15]	_
13	$\frac{1}{2}\begin{bmatrix} 1 \\ -1 \\ 1 \\ -1 \end{bmatrix}$	[V13 V15]	[V12 V14 V15]	_
14	$\frac{1}{2}\begin{bmatrix} j \\ j \\ -j \\ -j \end{bmatrix}$	[V14 V15]	[V12 V13 V15]	_

15	$\frac{1}{2}\begin{bmatrix}-1\\1\\1\\-1\end{bmatrix}$	[V12 V14]	[V12 V13 V14]	_