8Tx Pilot Patterns for IEEE 802.16m

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Samsung Electronics

Venue:

Re : TGm Call for Contributions and Comments 802.16m-08/003r6 for Session 59

Base Contribution:

IEEE C802.16m-08/0007

Purpose:

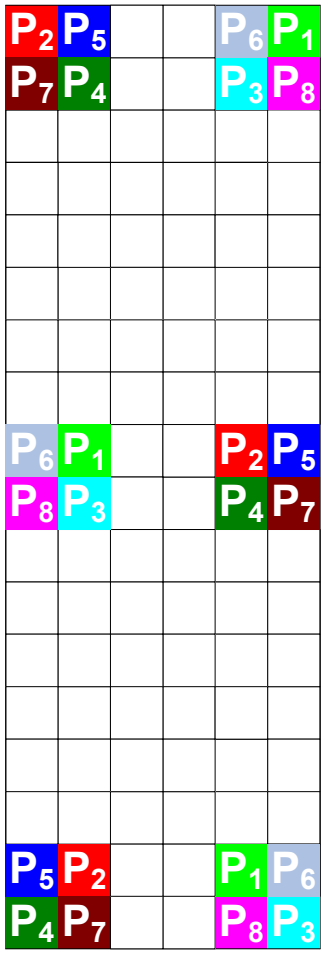
To discuss and adopt the proposed text in the revision of the 802.16m SDD

Background

- Downlink 8Tx MIMO is adopted in SDD
  - IEEE 802.16m-08/003r6, section 11.8.1.1, page 98, line 12
- 8Tx pilot pattern is yet to be defined
- This contribution proposes the 8Tx pilot pattern for IEEE 802.16m downlink

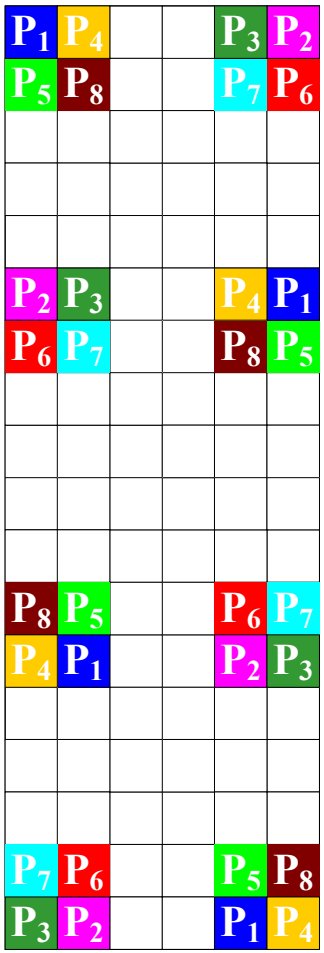
8Tx Pilot Pattern (1)

- 8 pilot streams
  - Overhead: 3/108 = 2.78% each
  - Total overhead 24/108 = 22.22%
- Mirrored pilot patterns
  - Pilot patterns for P_1, P_2, P_3, P_4 mirror in time and frequency
  - Pilot patterns for P_5, P_6, P_7, P_8 mirror in time and frequency
  - Low complexity implementation of channel estimation
- Easy to adapt for 5-symbol subframes (by removing the 3rd or 4th symbol in the pilot pattern for 6-symbol subframes)



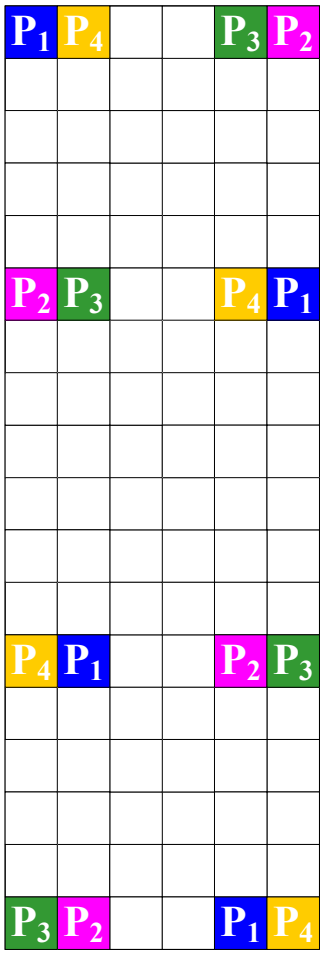
8Tx Pilot Pattern (2)

- 8 pilot streams
  - Overhead: 4/108 = 3.7% each
  - Total overhead 32/108 = 29.63%
- Mirrored pilot patterns
  - Reuse the 4Tx pilot patterns for P_1, P_2, P_3, P_4 (See next page for updated 4Tx pilot pattern)
  - Pilot patterns for P_1, P_2, P_3, P_4 mirror in time and frequency
  - Pilot patterns for P_5, P_6, P_7, P_8 mirror in time and frequency
  - Low complexity implementation of channel estimation
  - Easy to adapt for 5-symbol subframes (by removing the 3rd or 4th symbol in the pilot pattern for 6-symbol subframes)



Updated 4Tx Pilot Pattern

- All 4 pilot streams have mirrored pilot patterns
- Occupy the same set of subcarriers as the original 4Tx pilot pattern
- One sets of MMSE or interpolation weights for all 4 pilots
- Significant complexity reduction



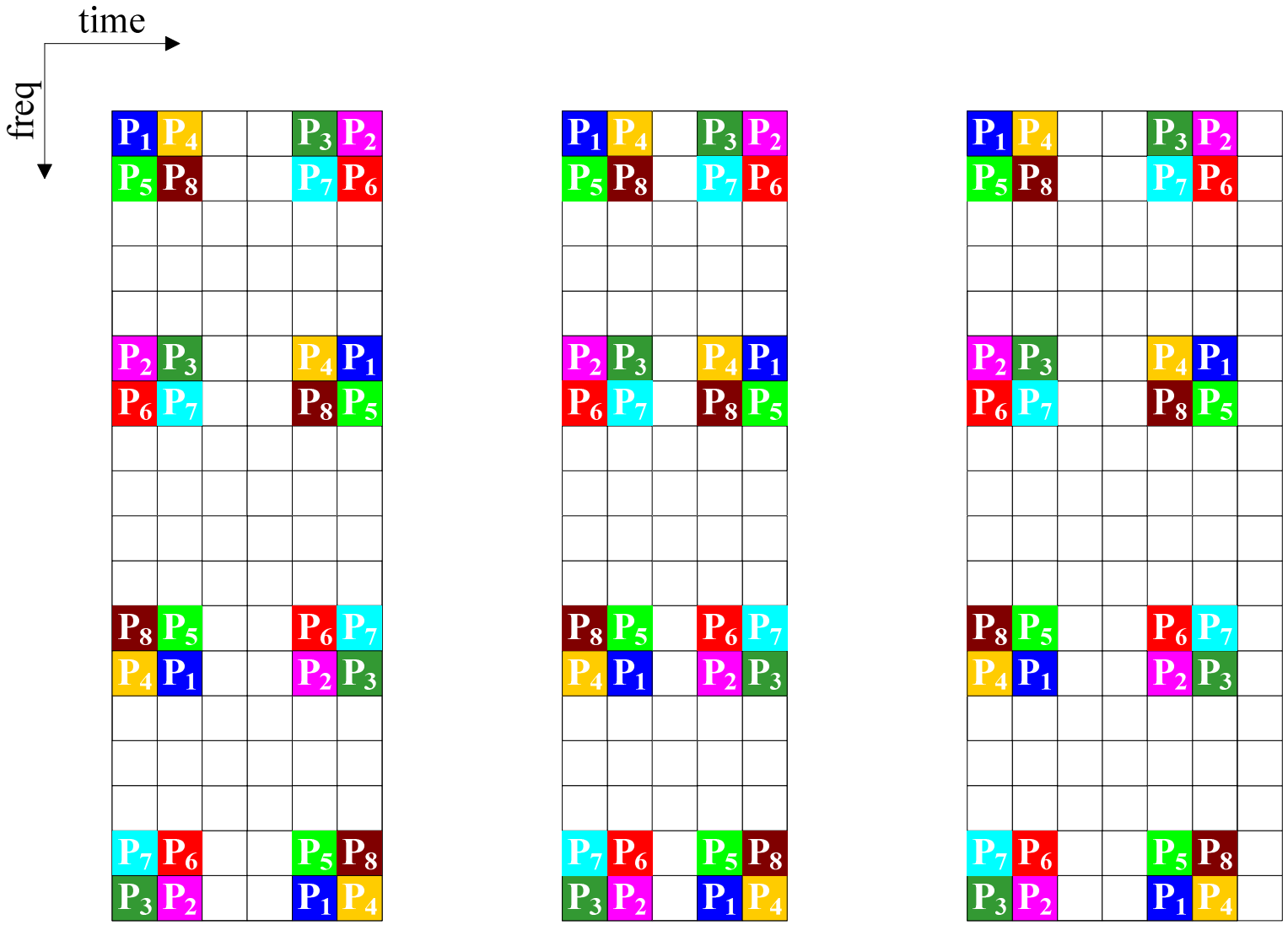
Simulation Assumptions

- 8Tx Pilot Pattern
  - Pilot Pattern 1 vs. Pilot Pattern 2
  - Rank-1 precoder cycling
  - Channel models:
    - Ped A 3kmph, Ped B 3kmph, Veh A 30kmph, Veh A 120kmph
  - MCS
    - QPSK 1/2, QPSK 1/3, 16QAM 1/2, 16QAM 1/3, 64QAM 1/2, 64QAM 1/3
  - 3 contiguous PRUs
  - 2D MMSE channel estimator per PRU

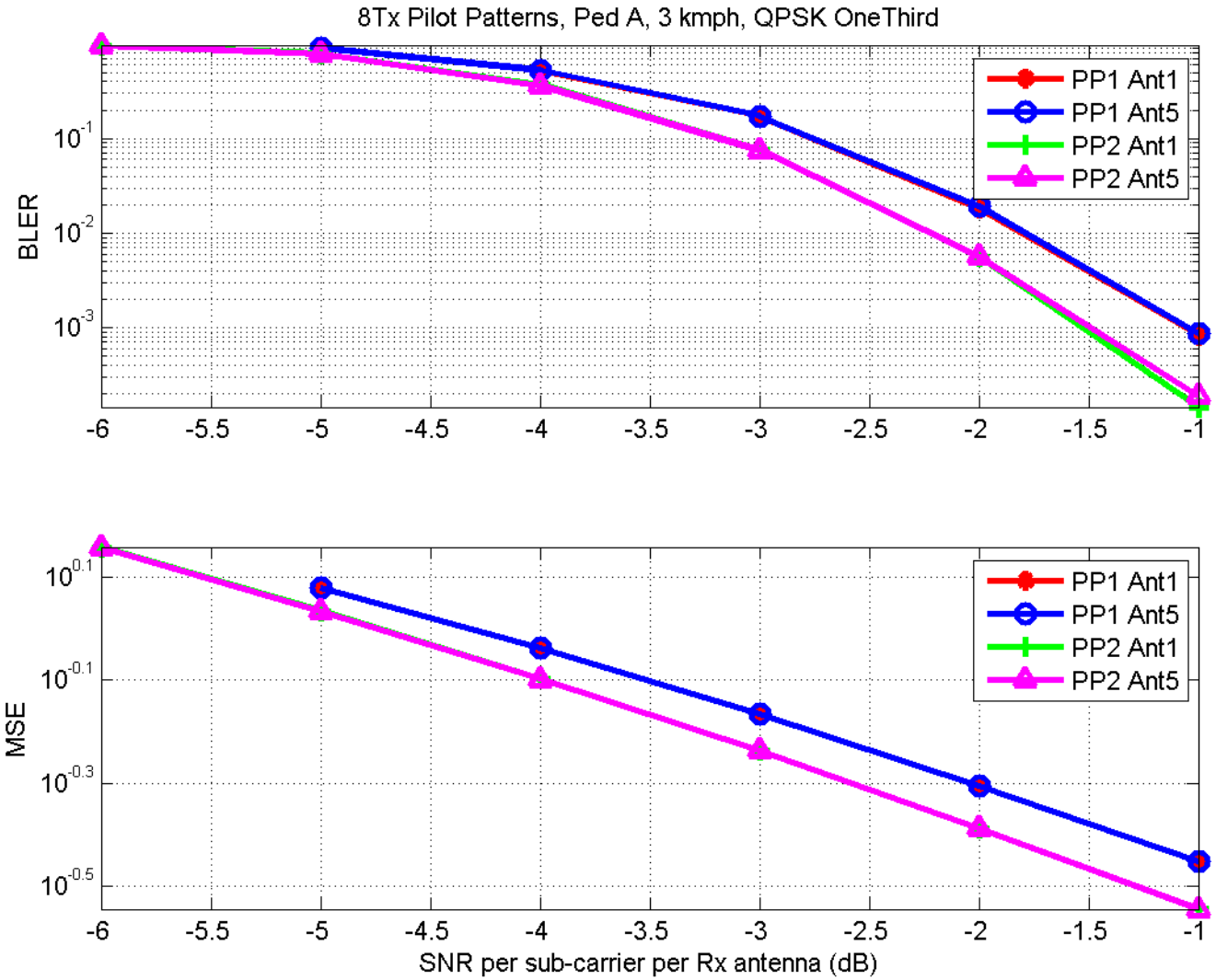
- Metric:
  - BLER
  - MSE

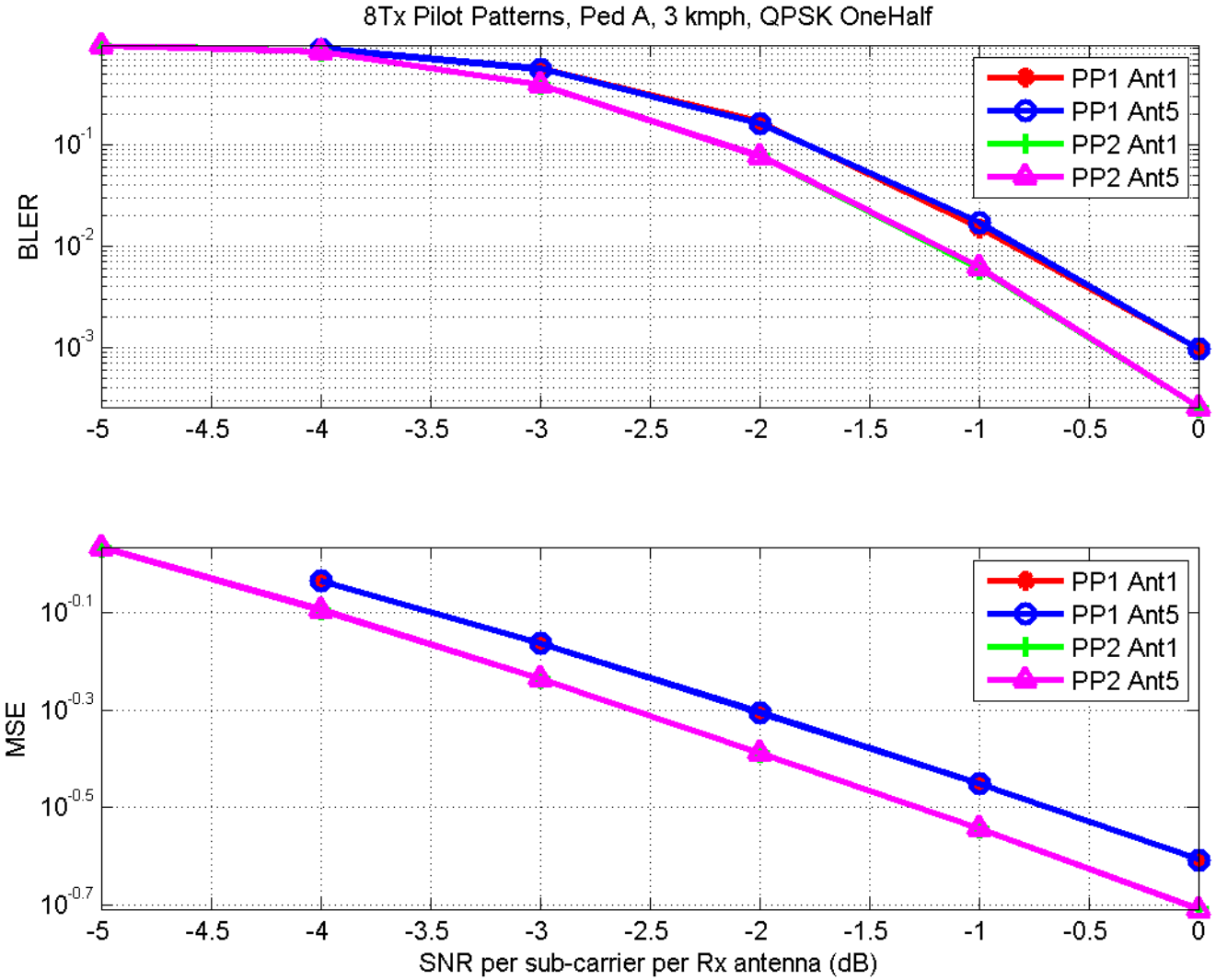
Summary

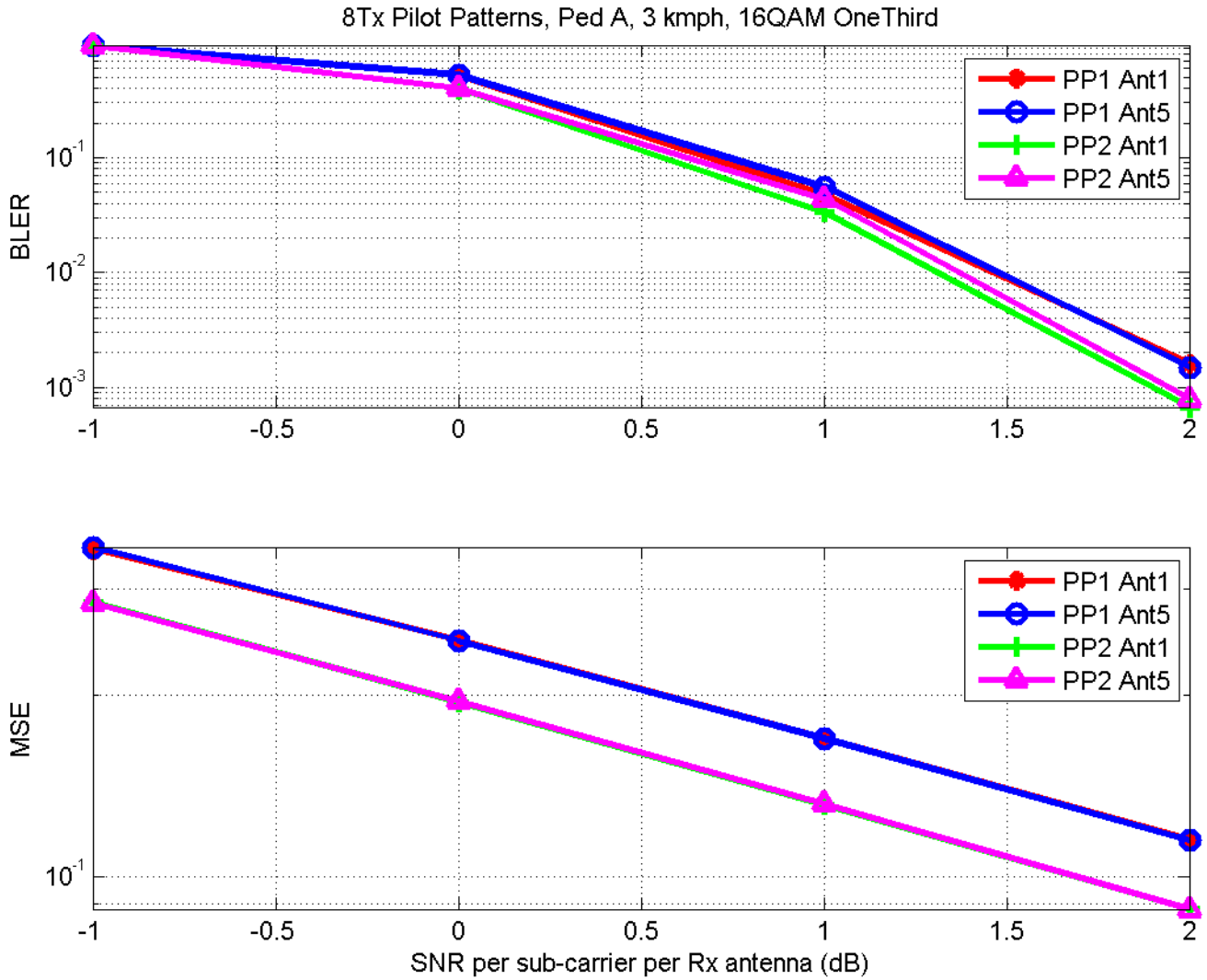
- 8Tx Pilot Patterns
  - 8Tx Pilot Pattern 2 is better than 8Tx Pilot Pattern 1 by up to 1dB
- Recommended SDD text change
  - Section 11.5.3, page 80, line 7
    - Insert the figure as in page 8 of C80216m-08_0007
  - Section 11.5.3, page 80, line 8
    - Add “The pilot patterns for 8 pilot streams are shown in the figure above. The pilot pattern for 6-symbol subframe is shown in subfigure (a); the pilot pattern for 5-symbol subframe is shown in subfigure (b); the pilot pattern for 7-symbol subframe is shown in subfigure (c).”

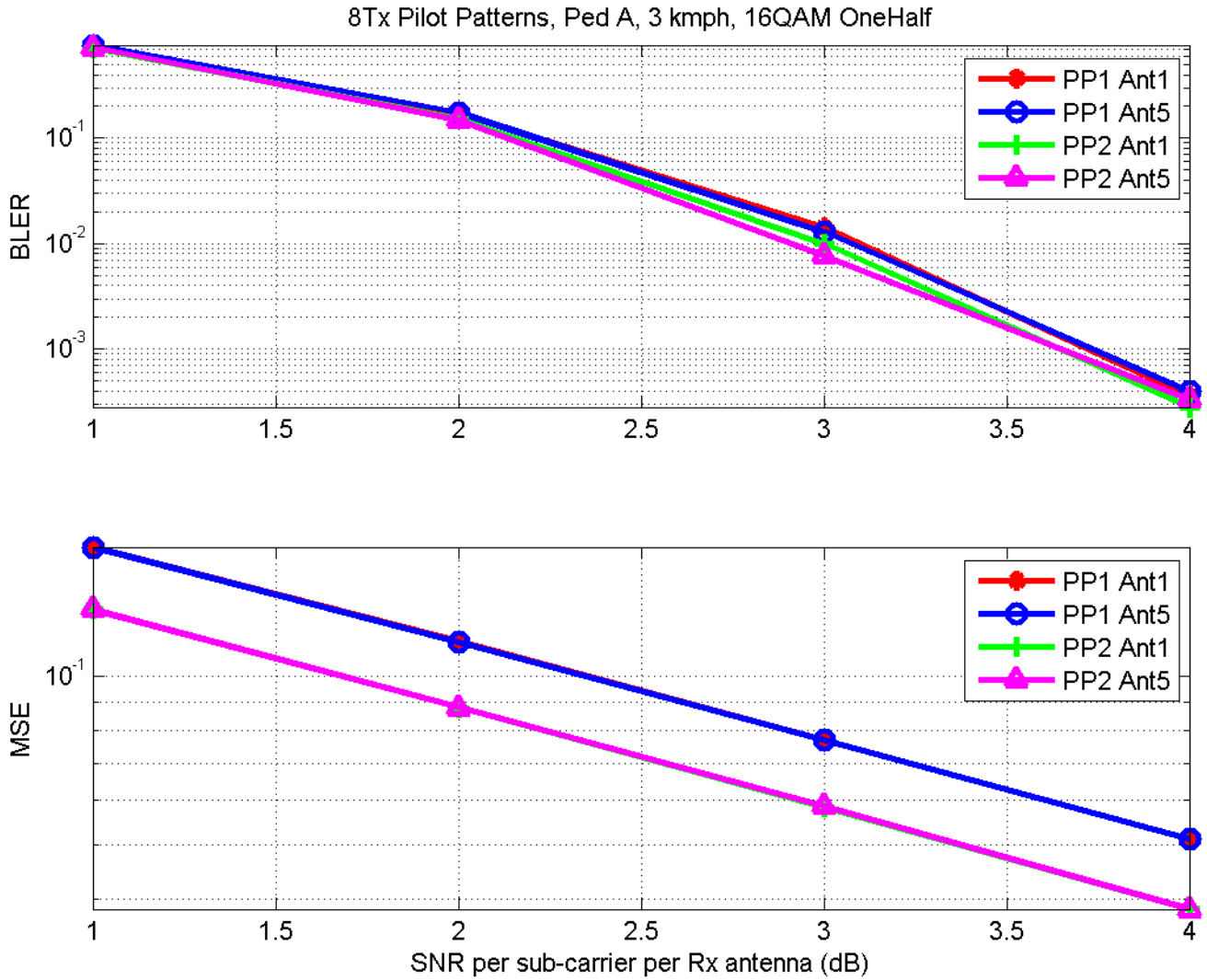

time
freq
P1 P4 P3 P2
P5 P8 P7 P6
P2 P3 P4 P1
P6 P7 P8 P5
P8 P5 P6 P7
P4 P1 P2 P3
P7 P6 P5 P8
P3 P2 P1 P4
(a)
(b)
(c)

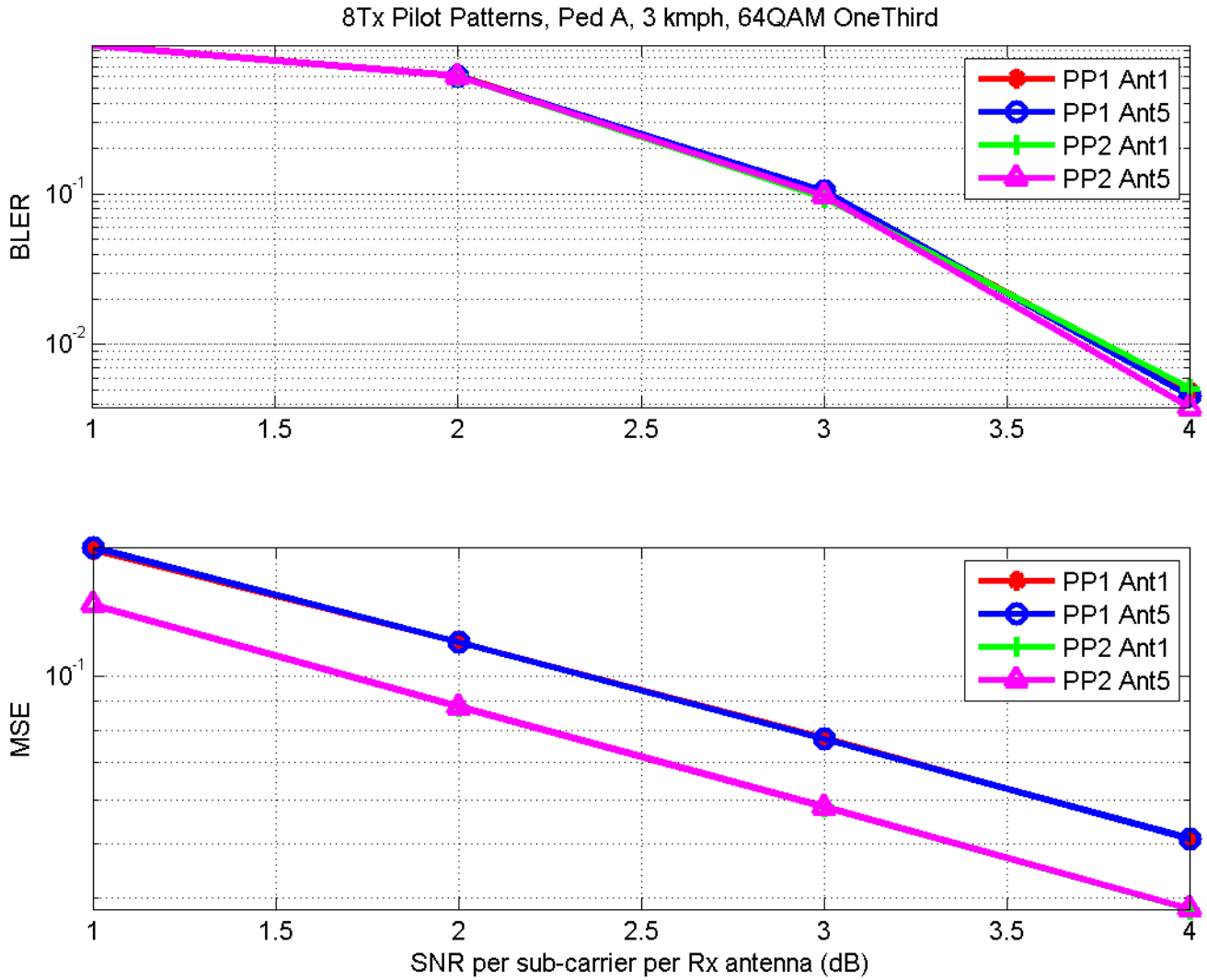
SIMULATION RESULTS – 8TX PILOT PATTERNS

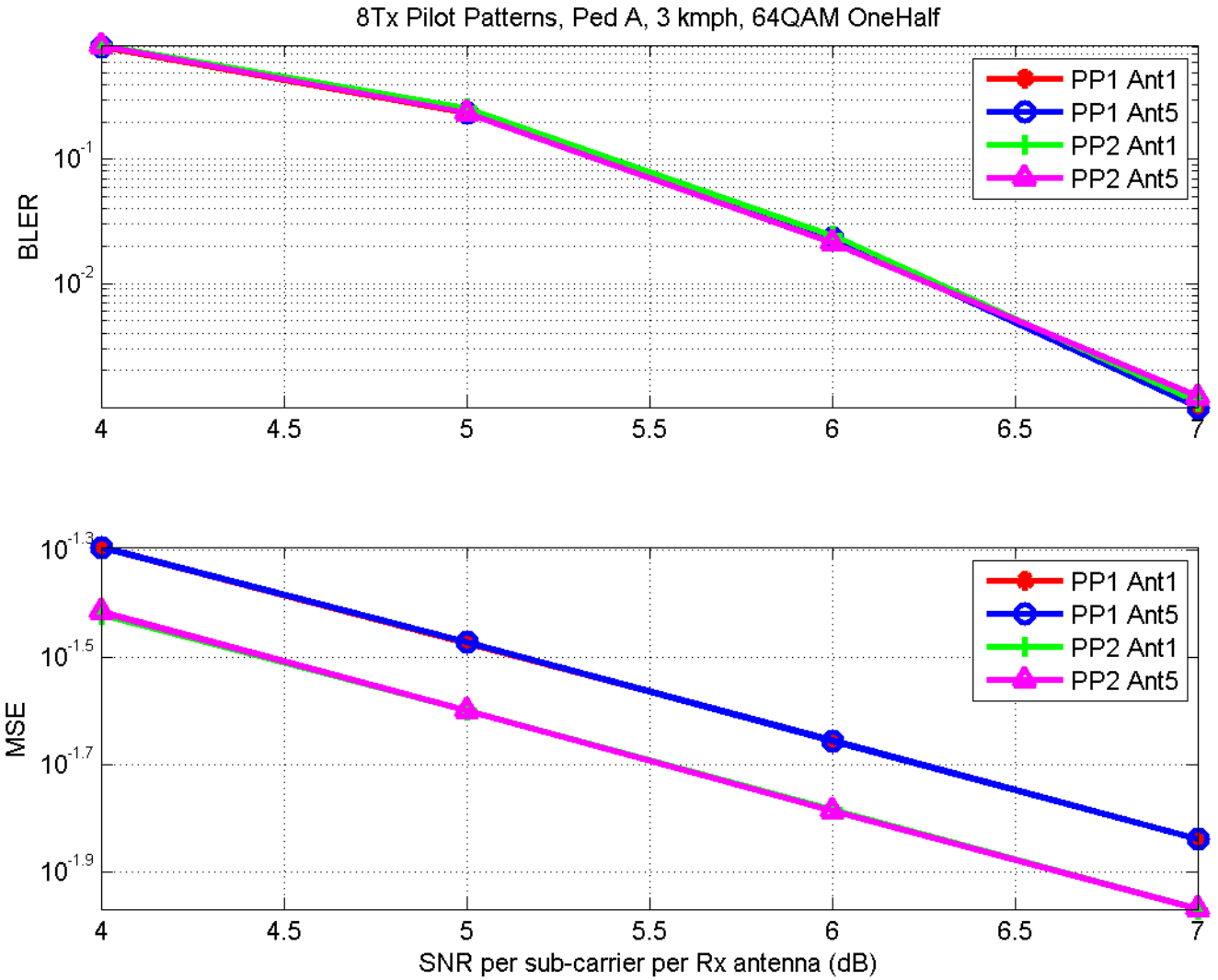

8Tx Pilot Patterns, Ped A, 3 kmph, QPSK OneThird
BLER
MSE
SNR per sub-carrier per Rx antenna (dB)
PP1 Ant1
PP1 Ant5
PP2 Ant1
PP2 Ant5
-6
-5.5
-5
-4.5
-4
-3.5
-3
-2.5
-2
-1.5
-1

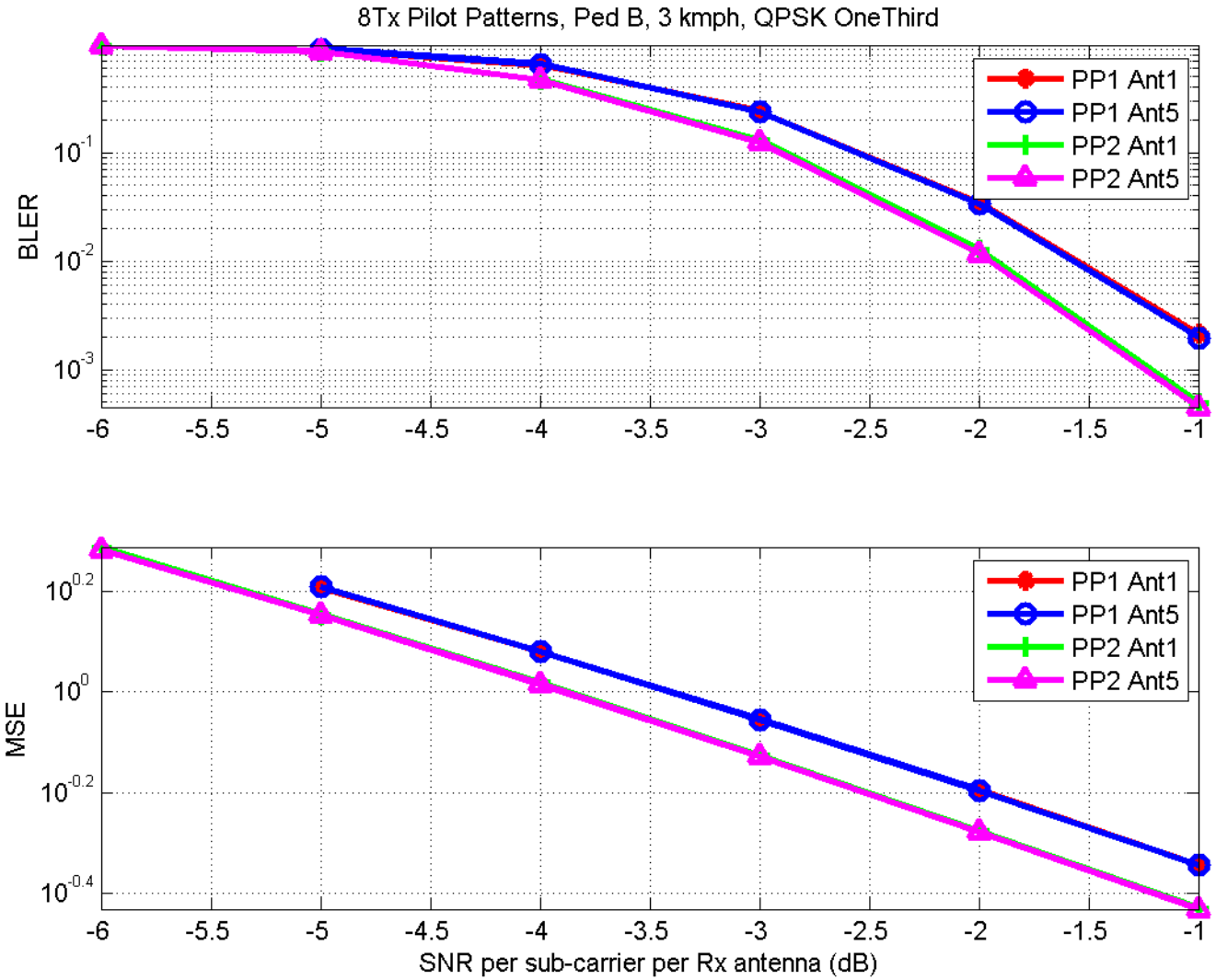

8Tx Pilot Patterns, Ped A, 3 kmph, QPSK OneHalf
BLER
MSE
SNR per sub-carrier per Rx antenna (dB)
PP1 Ant1
PP1 Ant5
PP2 Ant1
PP2 Ant5

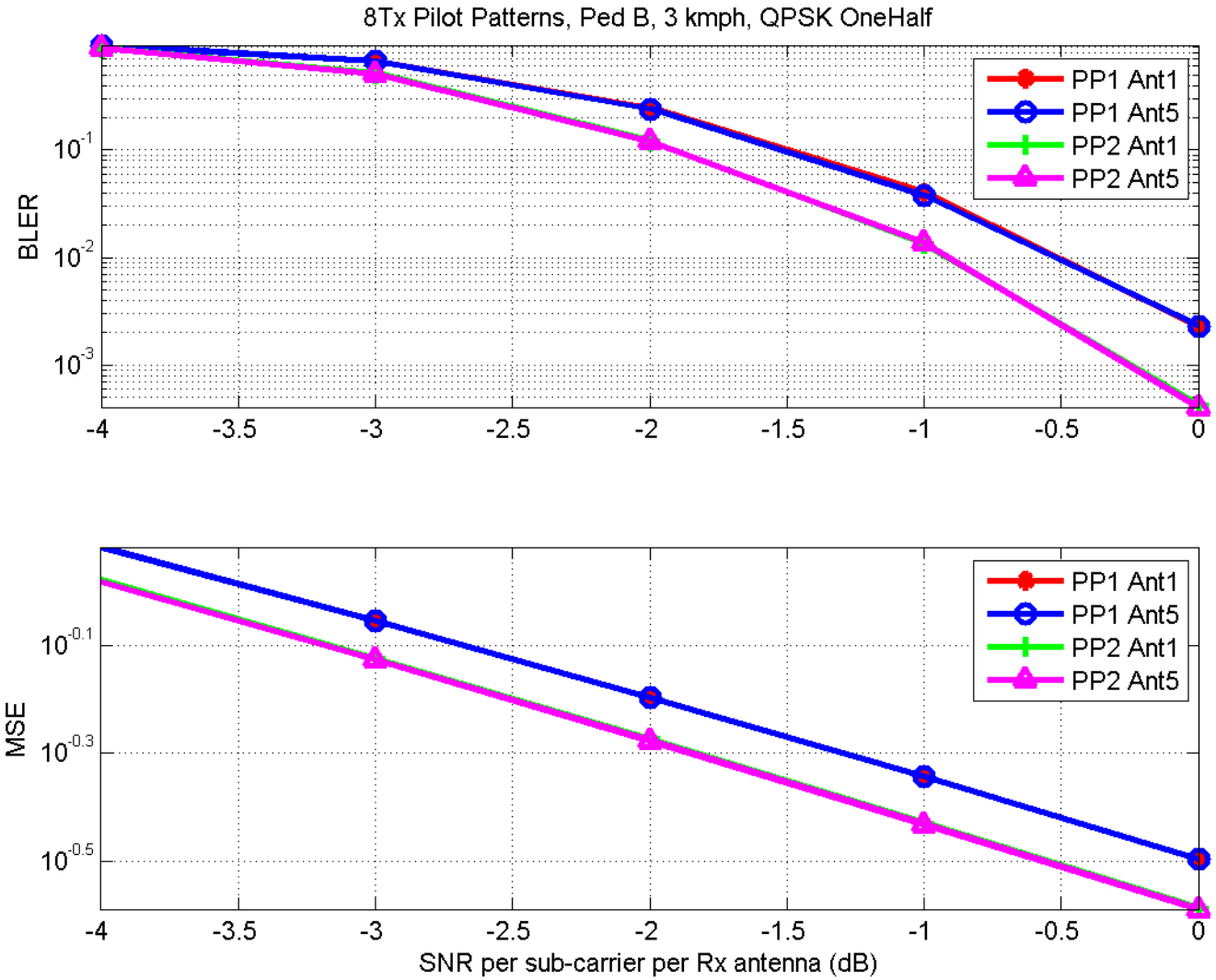

8Tx Pilot Patterns, Ped A, 3 kmph, 16QAM OneThird
BLER
MSE
SNR per sub-carrier per Rx antenna (dB)
PP1 Ant1
PP1 Ant5
PP2 Ant1
PP2 Ant5
10^-1
10^-2
10^-3
-1
-0.5
0
0.5
1
1.5
2

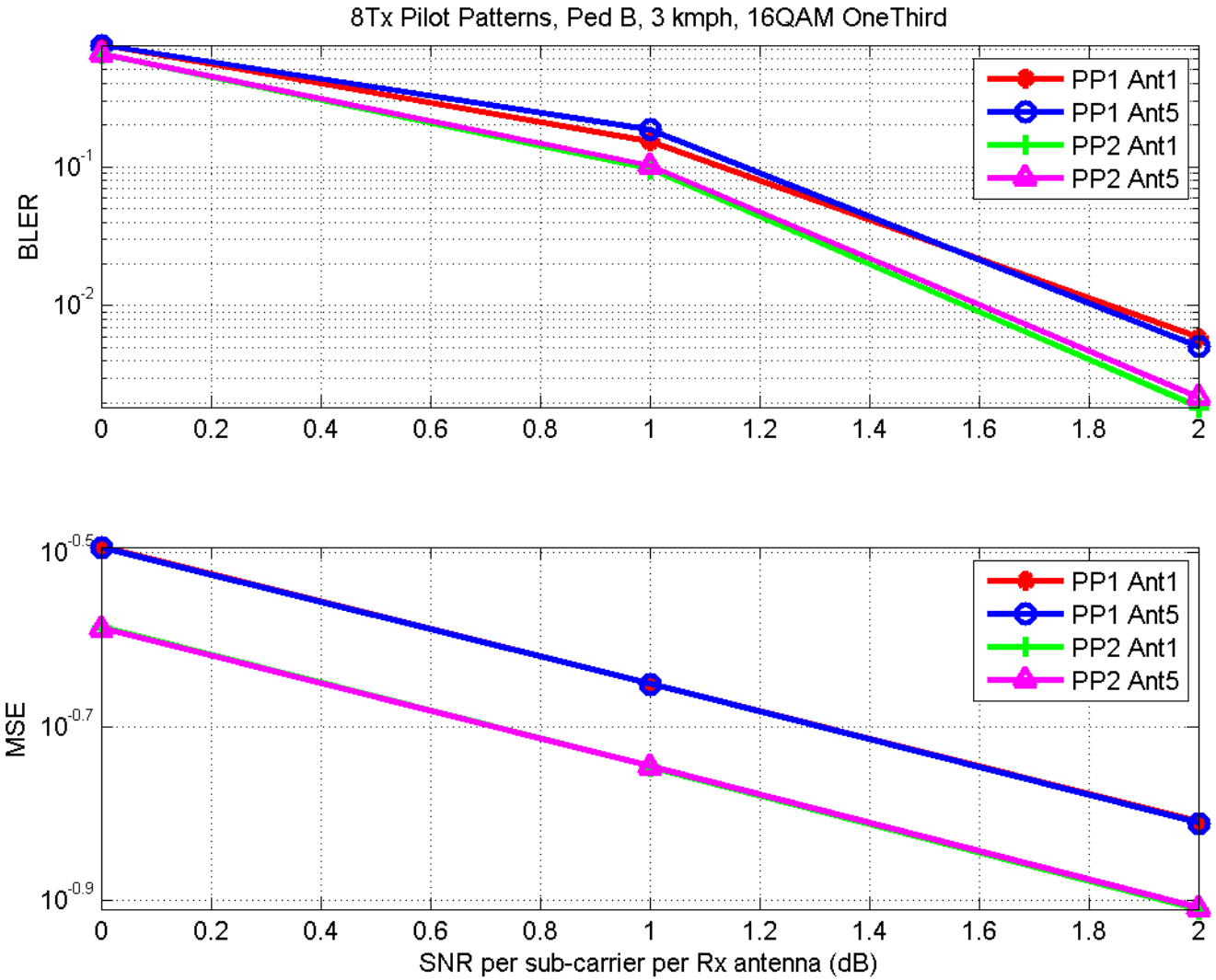

8Tx Pilot Patterns, Ped A, 3 kmph, 16QAM OneHalf
BLER
10^{-1}
10^{-2}
10^{-3}
1
1.5
2
2.5
3
3.5
4
PP1 Ant1
PP1 Ant5
PP2 Ant1
PP2 Ant5
MSE
10^{-1}
SNR per sub-carrier per Rx antenna (dB)

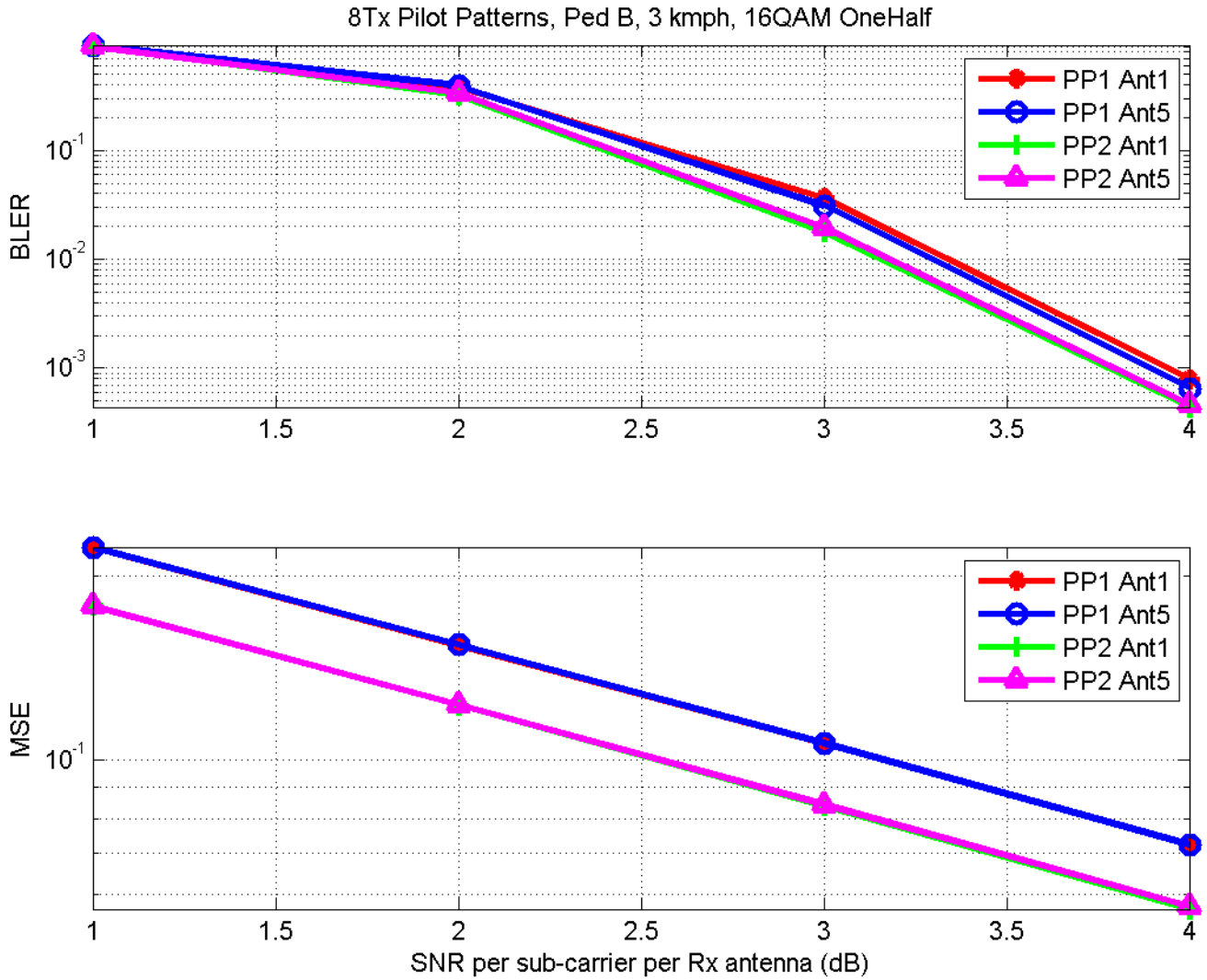

8Tx Pilot Patterns, Ped A, 3 kmph, 64QAM OneThird
BLER
10^{-1}
10^{-2}
1
1.5
2
2.5
3
3.5
4
PP1 Ant1
PP1 Ant5
PP2 Ant1
PP2 Ant5
MSE
10^{-1}
SNR per sub-carrier per Rx antenna (dB)

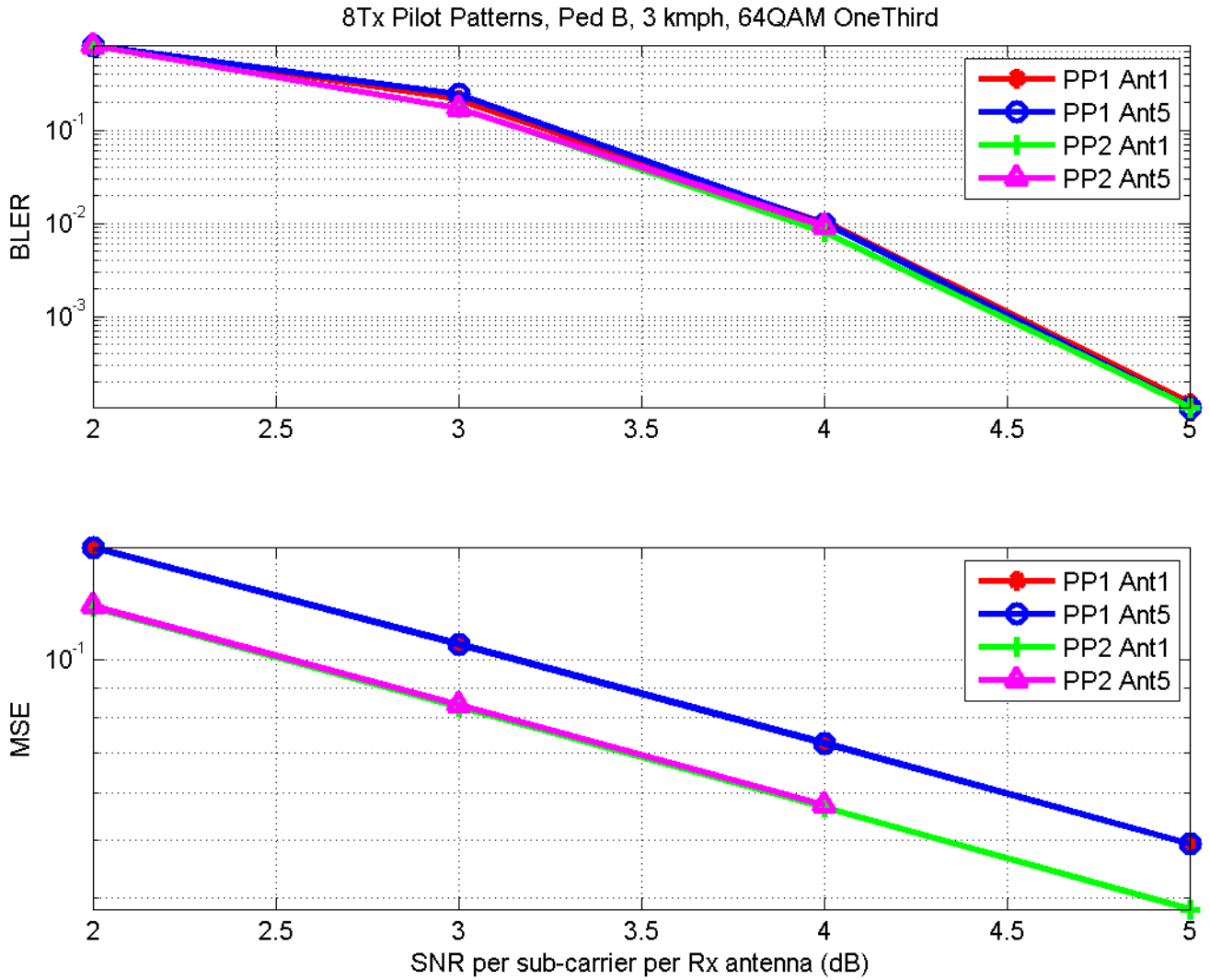

8Tx Pilot Patterns, Ped A, 3 kmph, 64QAM OneHalf
BLER
10^{-1}
10^{-2}
4
4.5
5
5.5
6
6.5
7
PP1 Ant1
PP1 Ant5
PP2 Ant1
PP2 Ant5
MSE
$10^{-1.3}$
$10^{-1.5}$
$10^{-1.7}$
$10^{-1.9}$
SNR per sub-carrier per Rx antenna (dB)

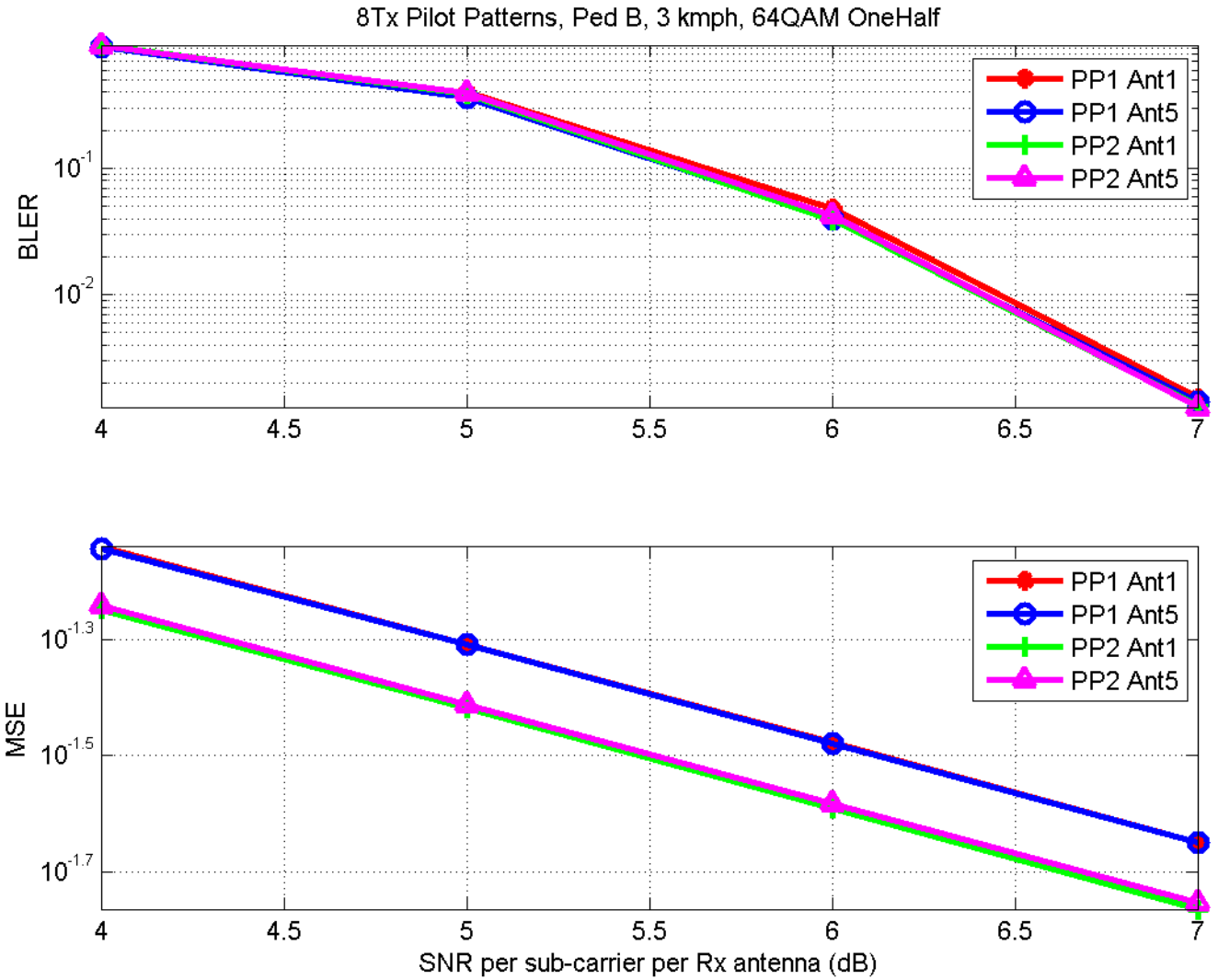

8Tx Pilot Patterns, Ped B, 3 kmph, QPSK OneThird
BLER
MSE
SNR per sub-carrier per Rx antenna (dB)
PP1 Ant1
PP1 Ant5
PP2 Ant1
PP2 Ant5

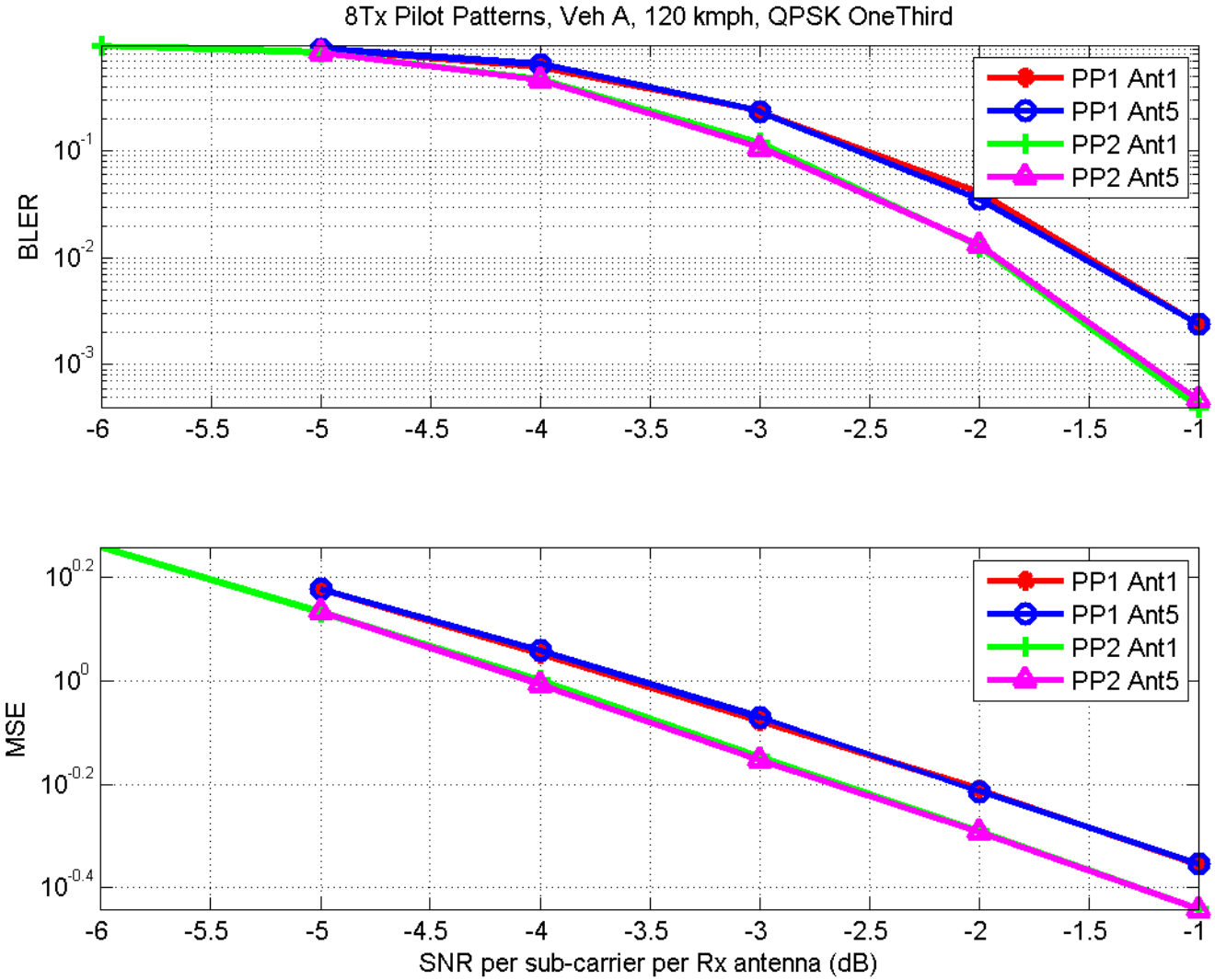

8Tx Pilot Patterns, Ped B, 3 kmph, QPSK OneHalf
BLER
MSE
SNR per sub-carrier per Rx antenna (dB)
PP1 Ant1
PP1 Ant5
PP2 Ant1
PP2 Ant5
10^-1
10^-2
10^-3
10^-0.1
10^-0.3
10^-0.5
-4
-3.5
-3
-2.5
-2
-1.5
-1
-0.5
0

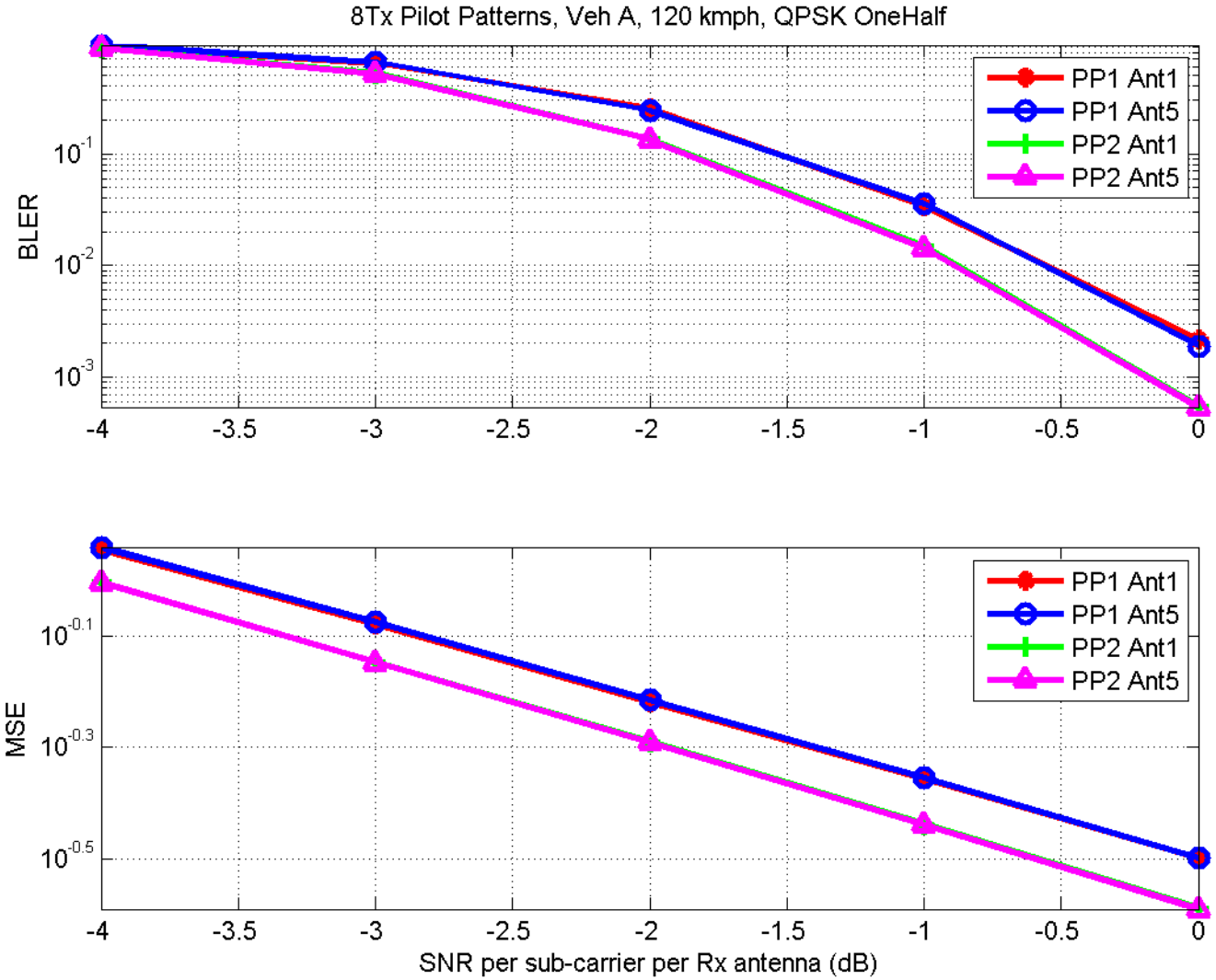

8Tx Pilot Patterns, Ped B, 3 kmph, 16QAM OneThird
BLER
10^{-1}
10^{-2}
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
PP1 Ant1
PP1 Ant5
PP2 Ant1
PP2 Ant5
MSE
$10^{-0.5}$
$10^{-0.7}$
$10^{-0.9}$
SNR per sub-carrier per Rx antenna (dB)

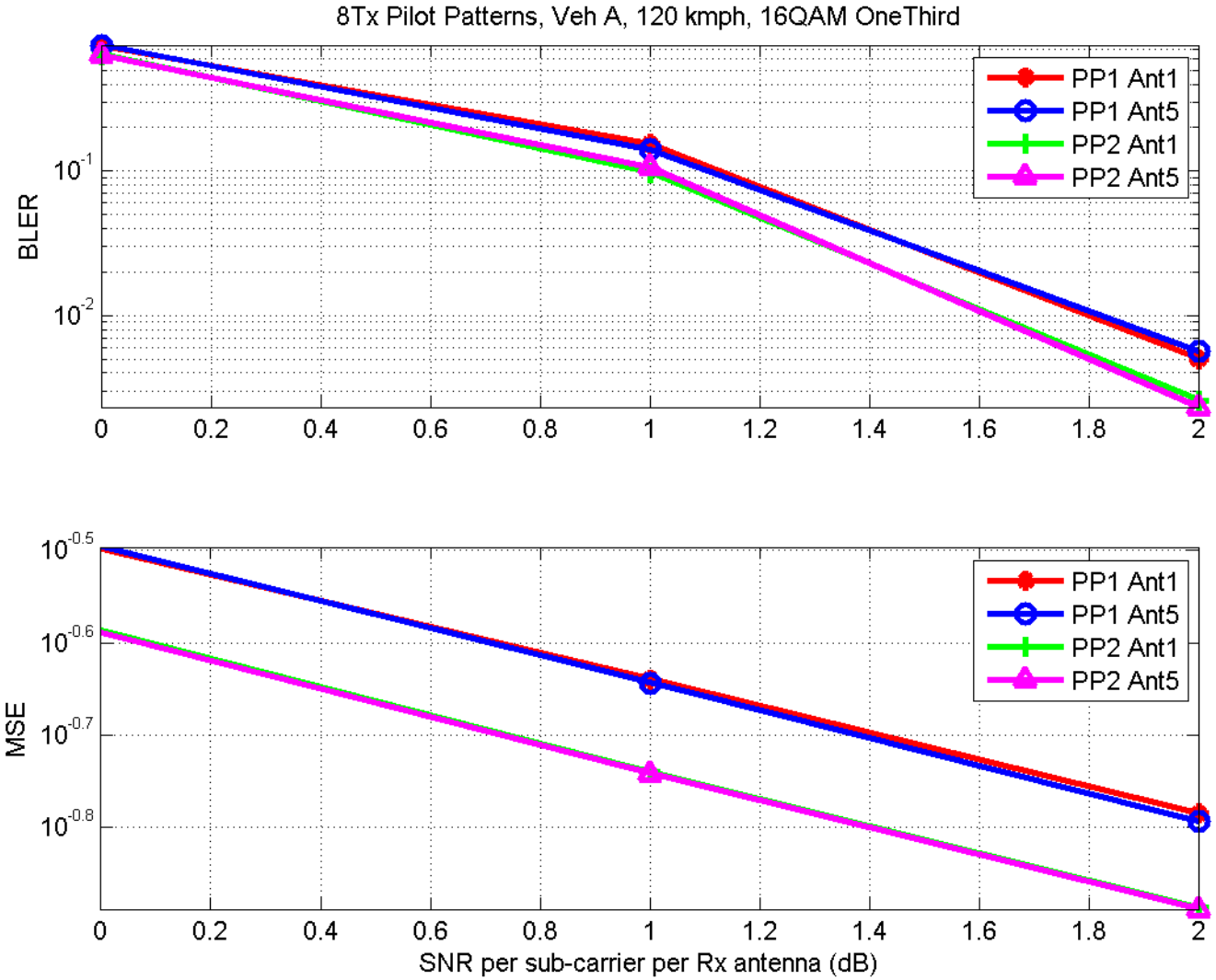

8Tx Pilot Patterns, Ped B, 3 kmph, 16QAM OneHalf
BLER
10^{-1}
10^{-2}
10^{-3}
1
1.5
2
2.5
3
3.5
4
PP1 Ant1
PP1 Ant5
PP2 Ant1
PP2 Ant5
MSE
10^{-1}
SNR per sub-carrier per Rx antenna (dB)

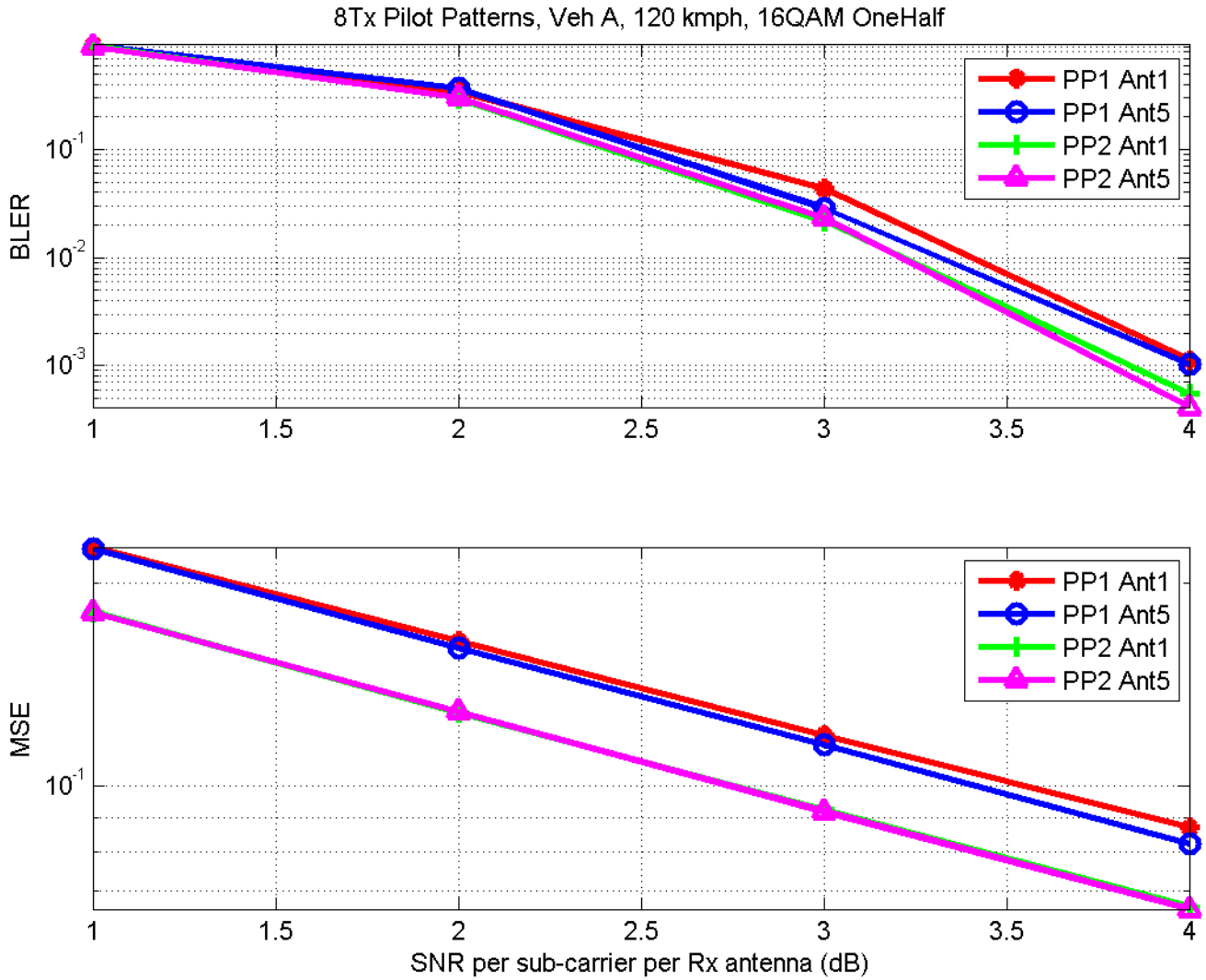

8Tx Pilot Patterns, Ped B, 3 kmph, 64QAM OneThird
BLER
10^{-1}
10^{-2}
10^{-3}
2
2.5
3
3.5
4
4.5
5
PP1 Ant1
PP1 Ant5
PP2 Ant1
PP2 Ant5
MSE
10^{-1}
SNR per sub-carrier per Rx antenna (dB)

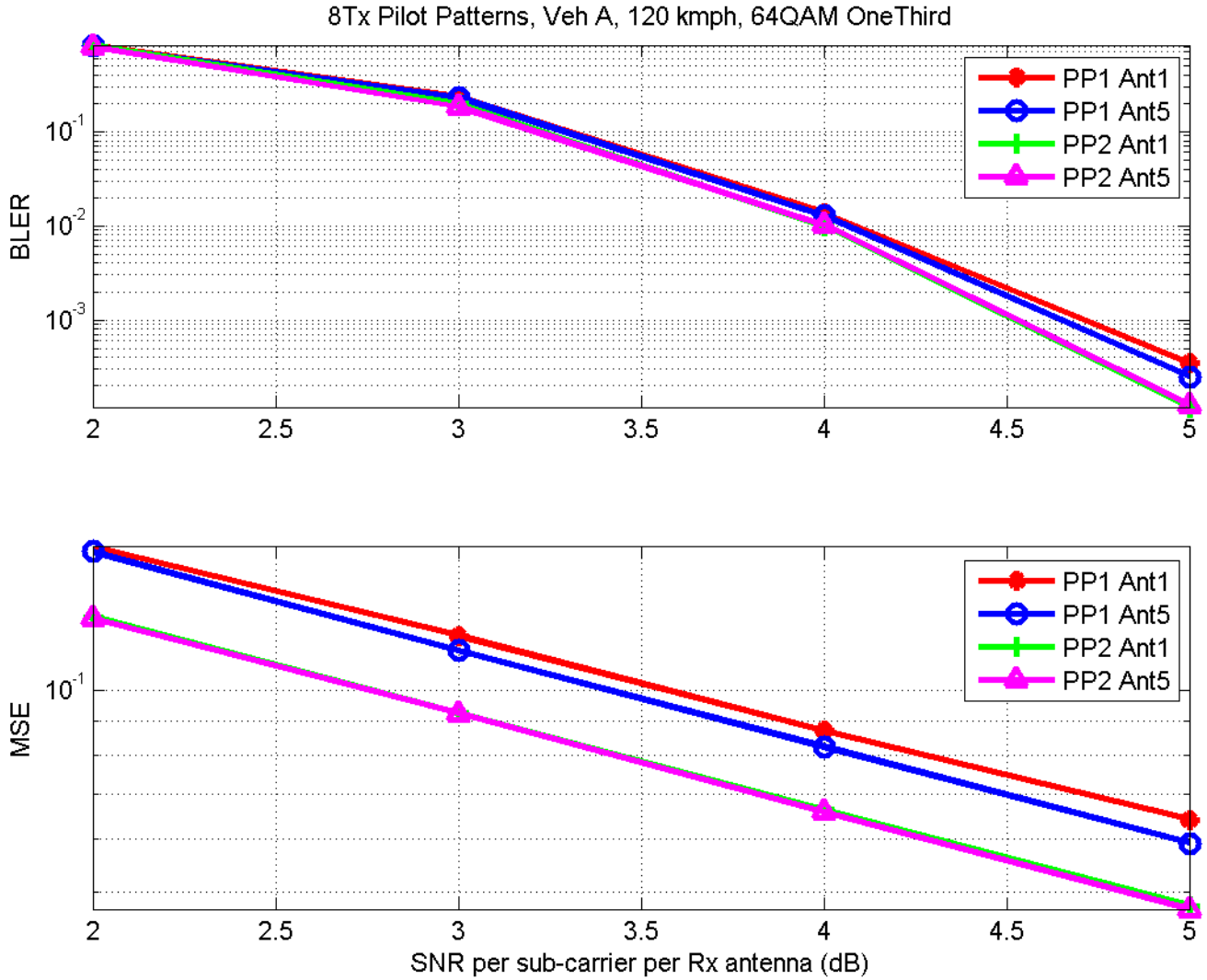

8Tx Pilot Patterns, Ped B, 3 kmph, 64QAM OneHalf
BLER
10^{-1}
10^{-2}
PP1 Ant1
PP1 Ant5
PP2 Ant1
PP2 Ant5
4
4.5
5
5.5
6
6.5
7
MSE
$10^{-1.3}$
$10^{-1.5}$
$10^{-1.7}$
SNR per sub-carrier per Rx antenna (dB)

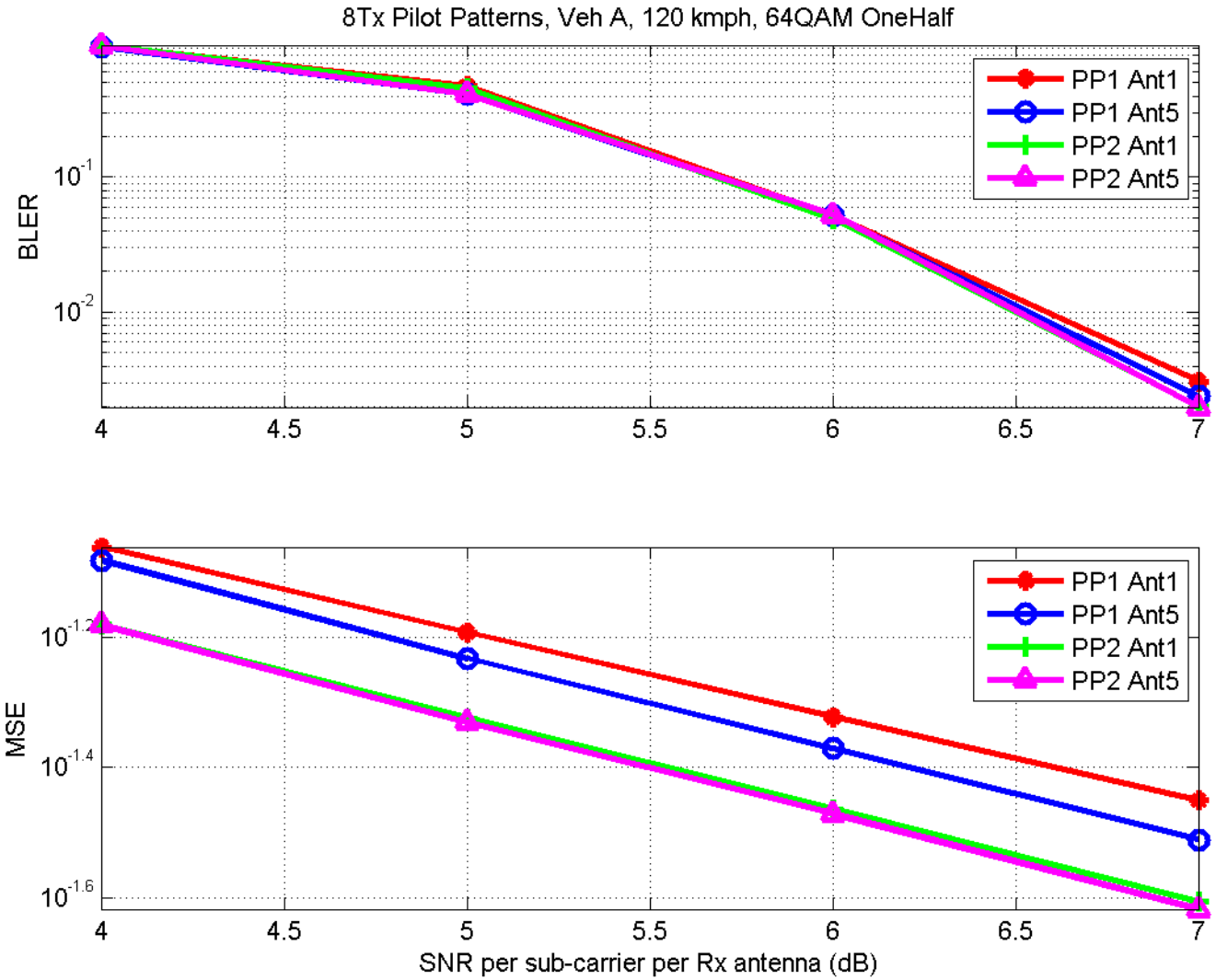

8Tx Pilot Patterns, Veh A, 120 kmph, QPSK OneThird
BLER
MSE
SNR per sub-carrier per Rx antenna (dB)
PP1 Ant1
PP1 Ant5
PP2 Ant1
PP2 Ant5

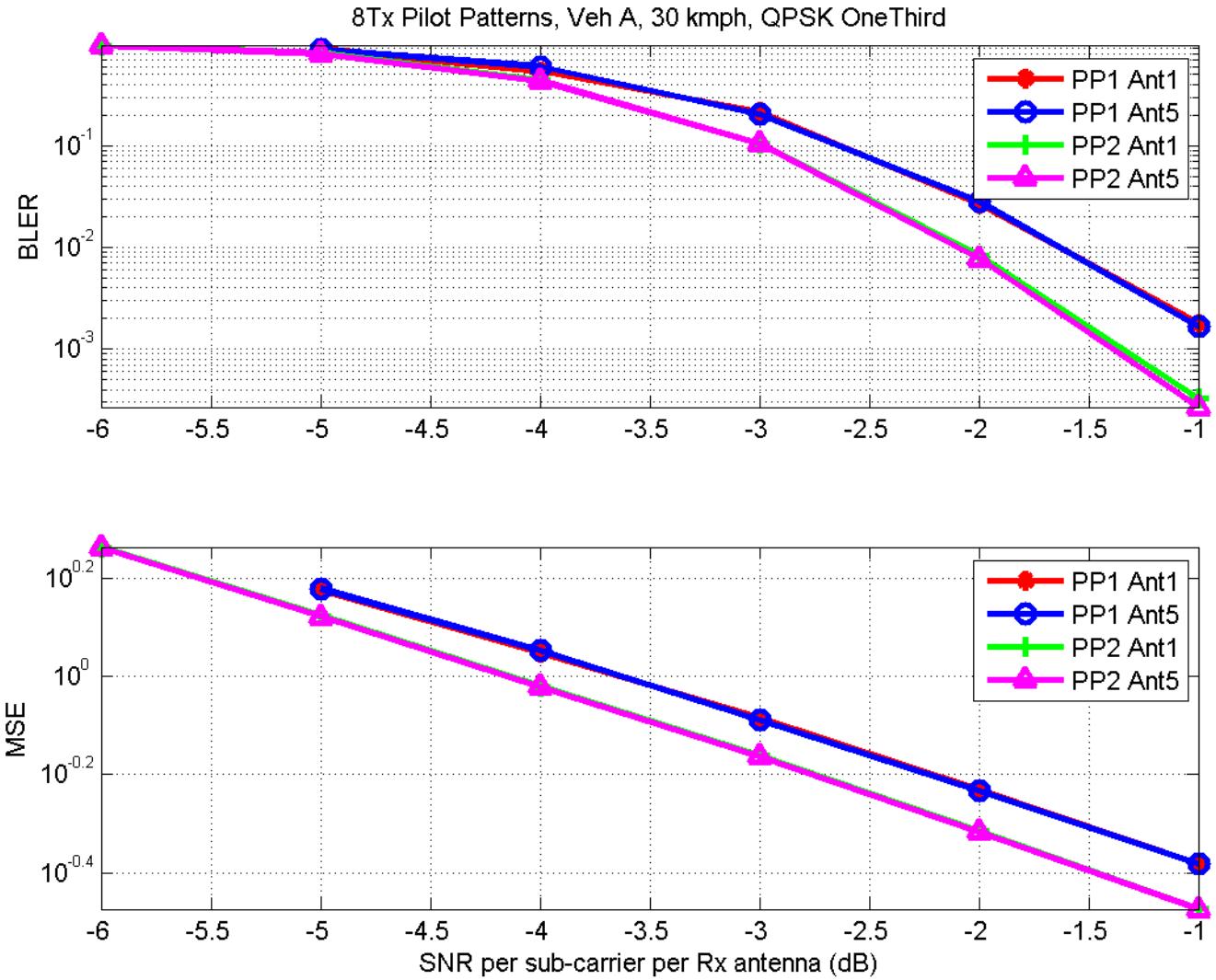

8Tx Pilot Patterns, Veh A, 120 kmph, QPSK OneHalf
BLER
MSE
SNR per sub-carrier per Rx antenna (dB)
PP1 Ant1
PP1 Ant5
PP2 Ant1
PP2 Ant5
-4
-3.5
-3
-2.5
-2
-1.5
-1
-0.5
0

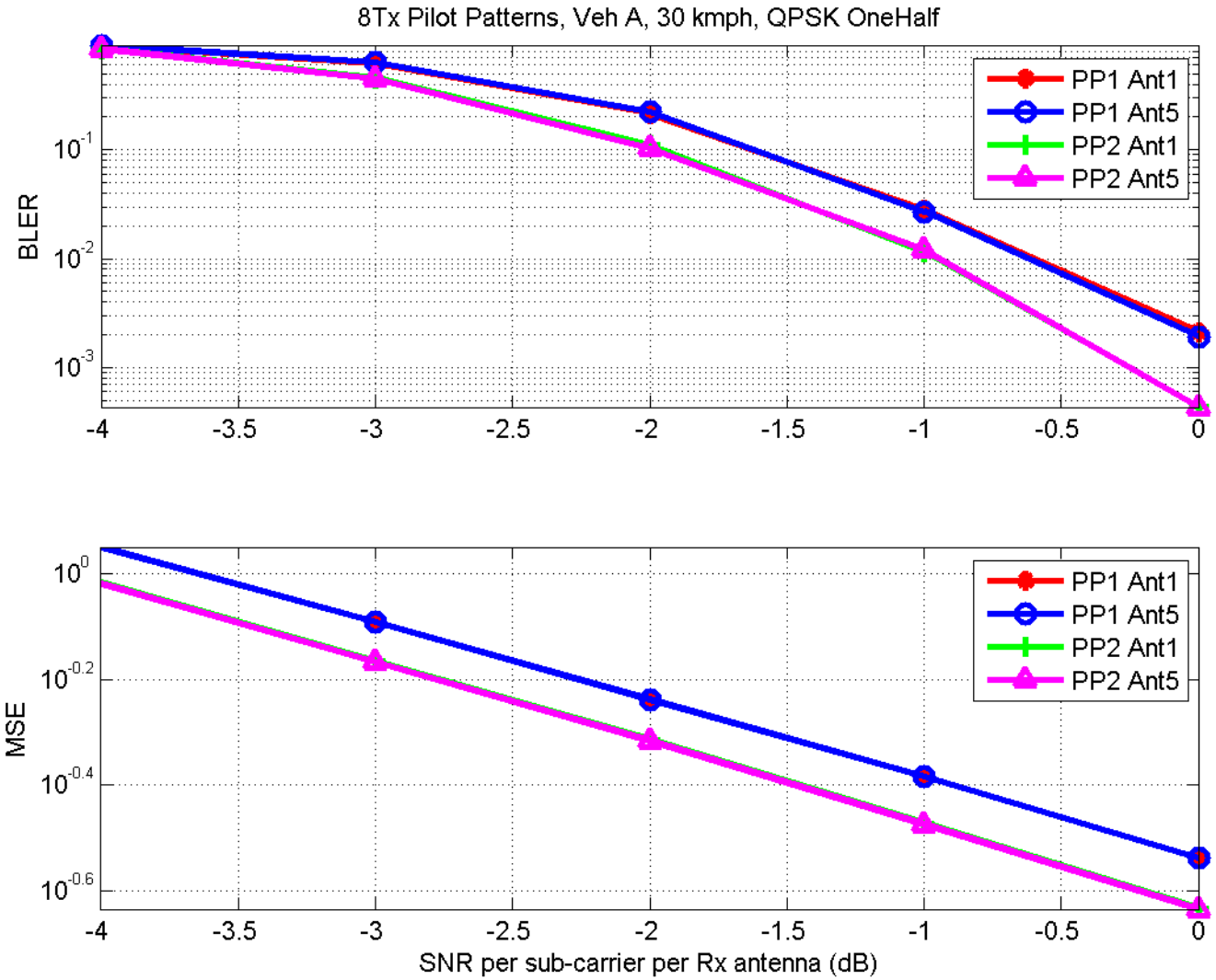

8Tx Pilot Patterns, Veh A, 120 kmph, 16QAM OneThird
BLER
MSE
SNR per sub-carrier per Rx antenna (dB)
PP1 Ant1
PP1 Ant5
PP2 Ant1
PP2 Ant5

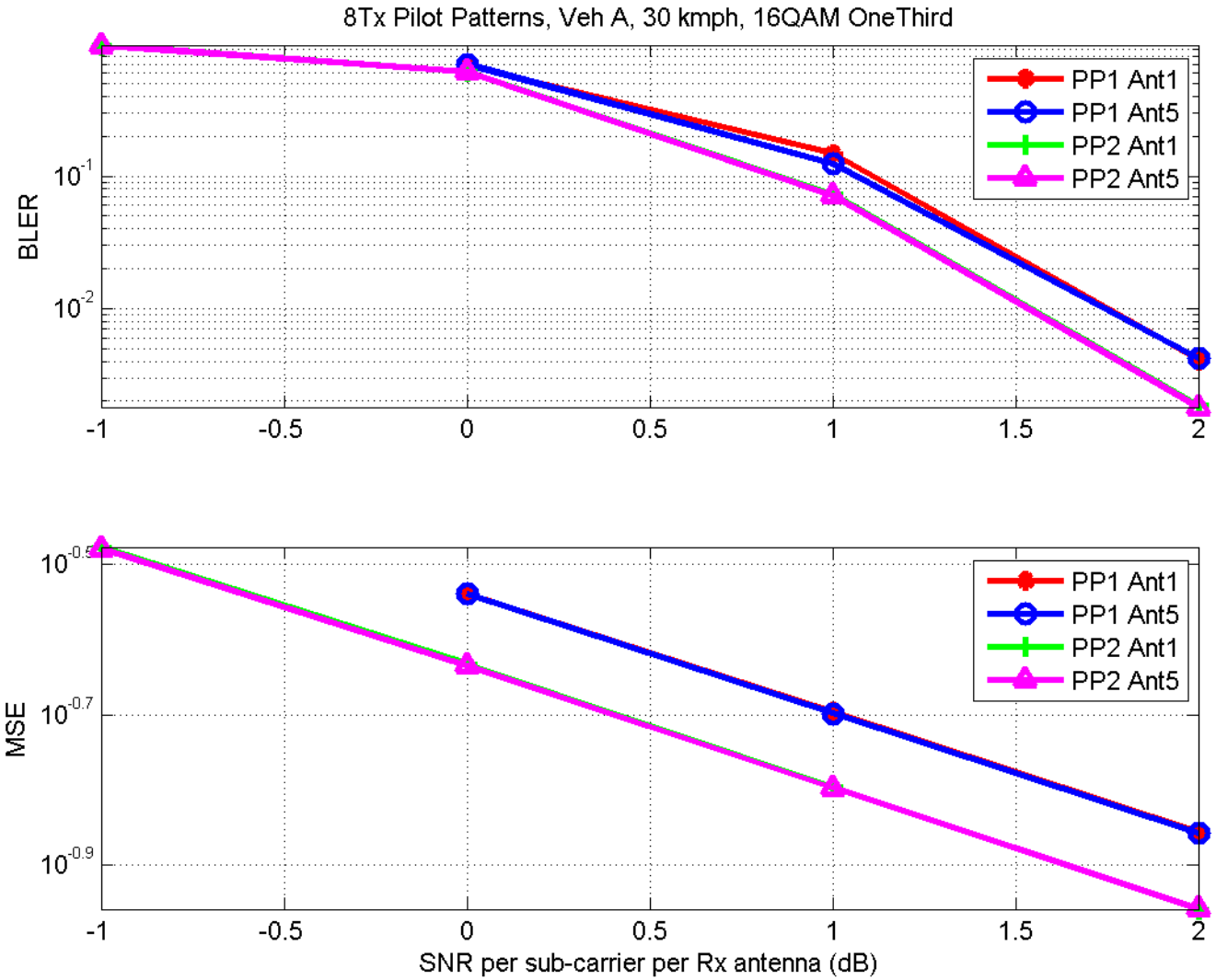

8Tx Pilot Patterns, Veh A, 120 kmph, 16QAM OneHalf
BLER
10^{-1}
10^{-2}
10^{-3}
1
1.5
2
2.5
3
3.5
4
PP1 Ant1
PP1 Ant5
PP2 Ant1
PP2 Ant5
MSE
10^{-1}
SNR per sub-carrier per Rx antenna (dB)

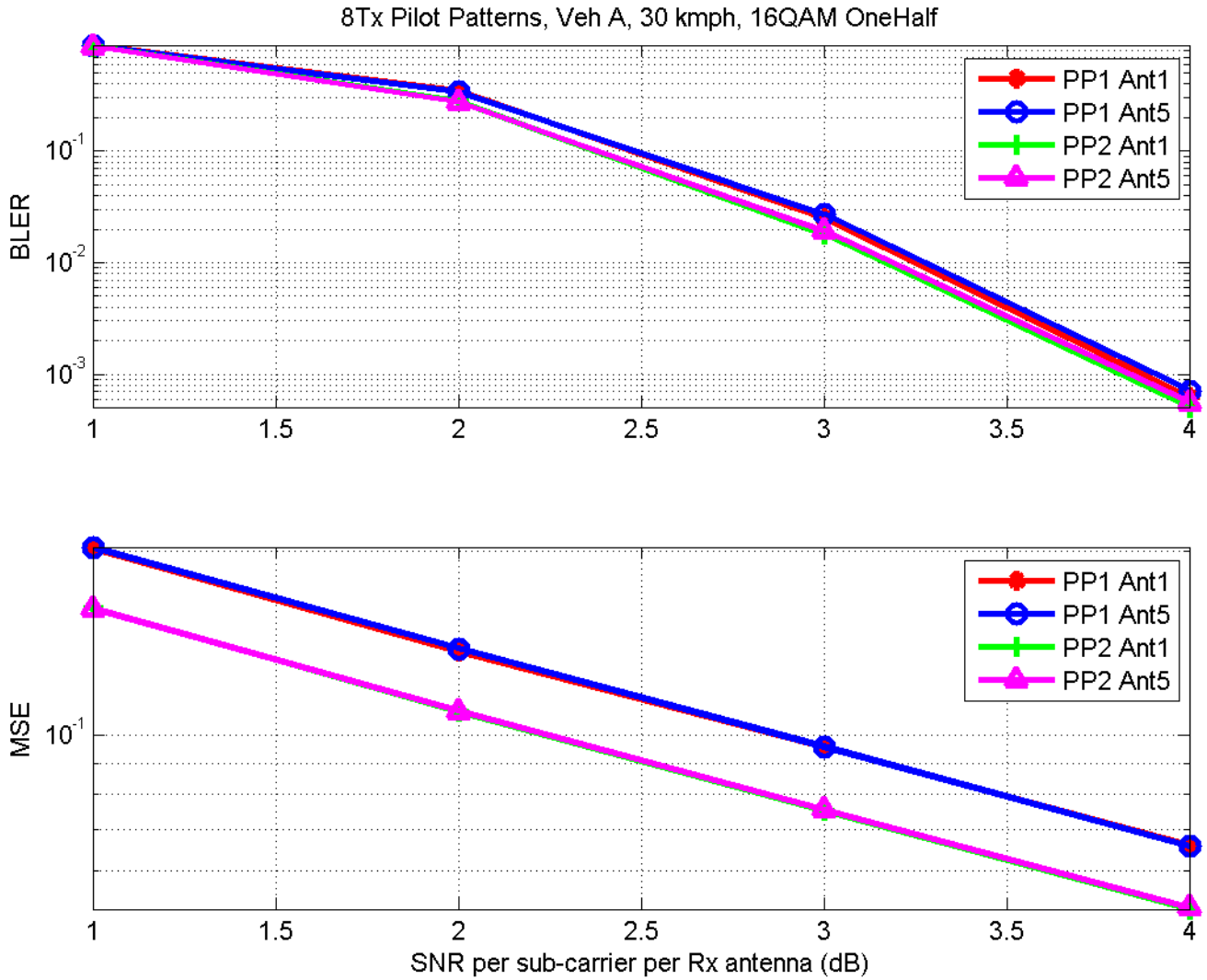

8Tx Pilot Patterns, Veh A, 120 kmph, 64QAM OneThird
BLER
10^{-1}
10^{-2}
10^{-3}
2
2.5
3
3.5
4
4.5
5
PP1 Ant1
PP1 Ant5
PP2 Ant1
PP2 Ant5
MSE
10^{-1}
SNR per sub-carrier per Rx antenna (dB)

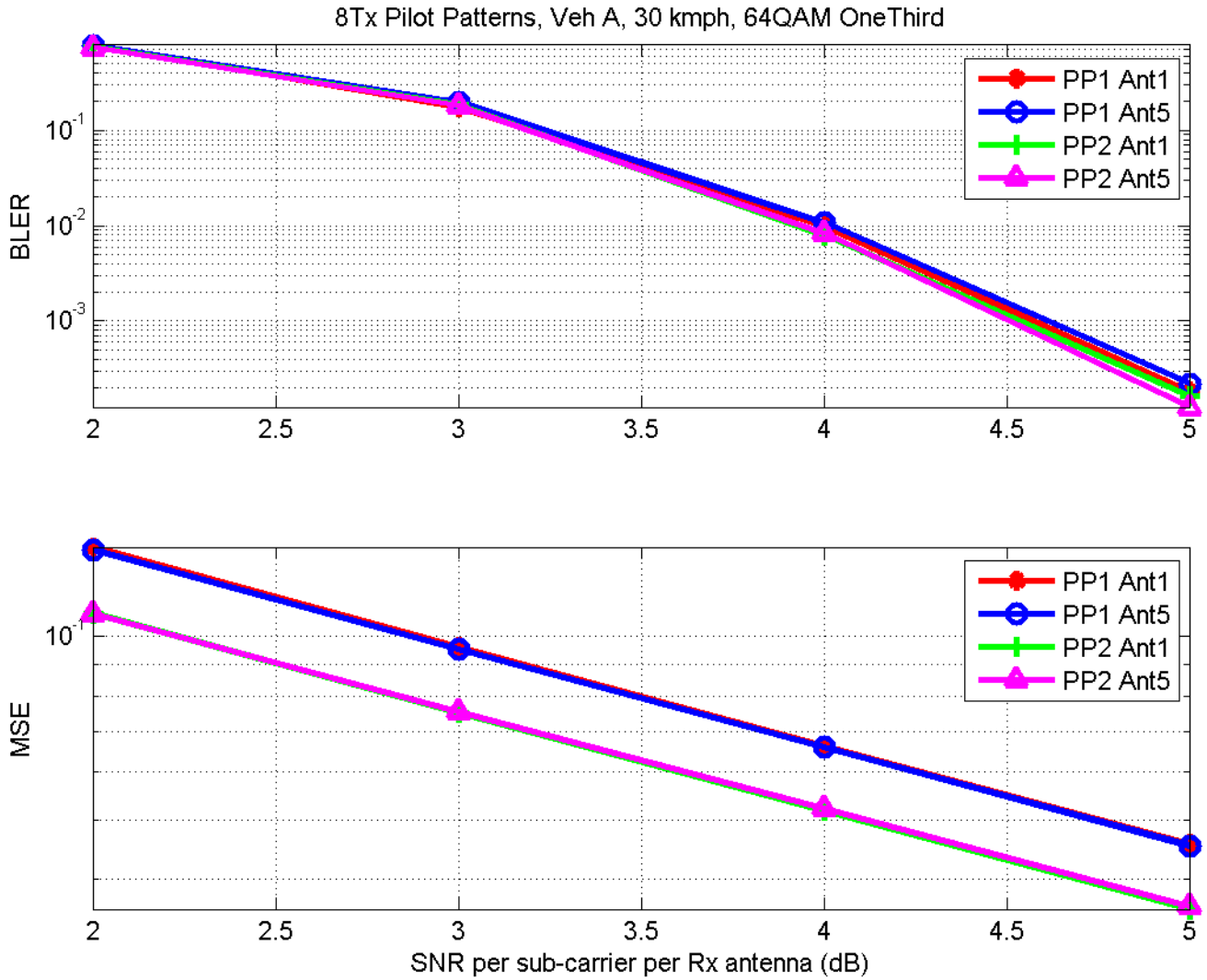

8Tx Pilot Patterns, Veh A, 120 kmph, 64QAM OneHalf
BLER
10^{-1}
10^{-2}
4
4.5
5
5.5
6
6.5
7
PP1 Ant1
PP1 Ant5
PP2 Ant1
PP2 Ant5
MSE
$10^{-1.2}$
$10^{-1.4}$
$10^{-1.6}$
SNR per sub-carrier per Rx antenna (dB)

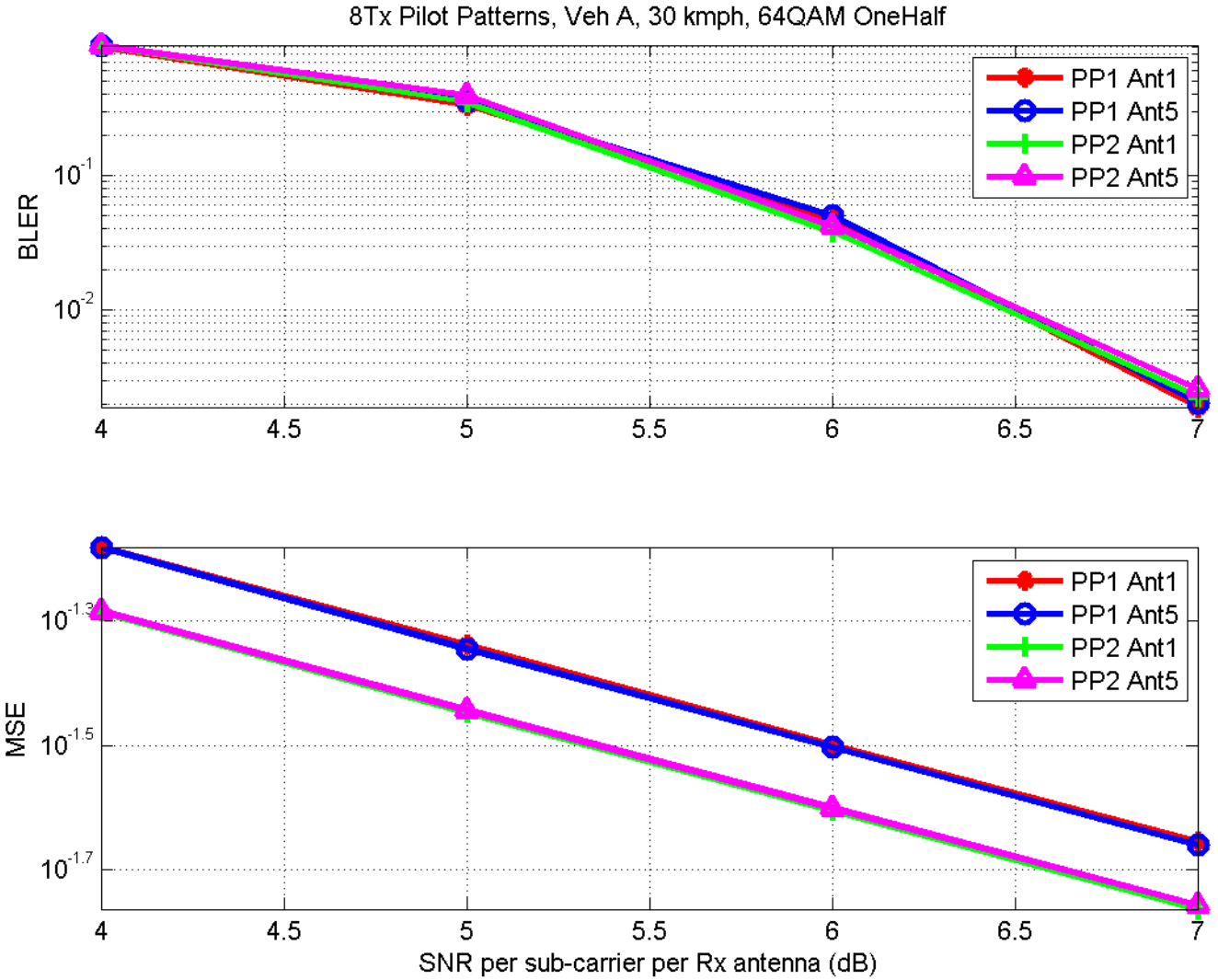

8Tx Pilot Patterns, Veh A, 30 kmph, QPSK OneThird
BLER
MSE
SNR per sub-carrier per Rx antenna (dB)
PP1 Ant1
PP1 Ant5
PP2 Ant1
PP2 Ant5


8Tx Pilot Patterns, Veh A, 30 kmph, QPSK OneHalf
BLER
MSE
SNR per sub-carrier per Rx antenna (dB)
PP1 Ant1
PP1 Ant5
PP2 Ant1
PP2 Ant5
10^-1
10^-2
10^-3
10^0
10^-0.2
10^-0.4
10^-0.6
-4
-3.5
-3
-2.5
-2
-1.5
-1
-0.5
0


8Tx Pilot Patterns, Veh A, 30 kmph, 16QAM OneThird
BLER
10^{-1}
10^{-2}
-1
-0.5
0
0.5
1
1.5
2
PP1 Ant1
PP1 Ant5
PP2 Ant1
PP2 Ant5
MSE
$10^{-0.5}$
$10^{-0.7}$
$10^{-0.9}$
SNR per sub-carrier per Rx antenna (dB)


8Tx Pilot Patterns, Veh A, 30 kmph, 16QAM OneHalf
BLER
10^{-1}
10^{-2}
10^{-3}
1
1.5
2
2.5
3
3.5
4
PP1 Ant1
PP1 Ant5
PP2 Ant1
PP2 Ant5
MSE
10^{-1}
SNR per sub-carrier per Rx antenna (dB)


8Tx Pilot Patterns, Veh A, 30 kmph, 64QAM OneThird
BLER
10^{-1}
10^{-2}
10^{-3}
2
2.5
3
3.5
4
4.5
5
PP1 Ant1
PP1 Ant5
PP2 Ant1
PP2 Ant5
MSE
10^{-1}
SNR per sub-carrier per Rx antenna (dB)


8Tx Pilot Patterns, Veh A, 30 kmph, 64QAM OneHalf
BLER
10^{-1}
10^{-2}
4
4.5
5
5.5
6
6.5
7
PP1 Ant1
PP1 Ant5
PP2 Ant1
PP2 Ant5
MSE
$10^{-1.3}$
$10^{-1.5}$
$10^{-1.7}$
SNR per sub-carrier per Rx antenna (dB)