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Title	**MCS Level Addition for Lower Rate Coding**
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Re:	
Abstract	Propose to add two MCS levels of QPSK 1/12, QPSK 1/24
Purpose	Adopting of proposed method into P802.16e
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MCS Level Addition for Lower Rate Coding

Introduction

Currently, the most robust coding scheme is QPSK rate 1/2 with six repetitions. However, some users in poor channel condition (such as in cell boundary) can have too low SINR to support that coding scheme, but for some services such as VoIP, control information as well as traffic channels of even very low data rate should be reached to them. If MCS levels of lower rate are added, low data rate services can be provided to such users. So, two more coding schemes - QPSK rate 1/2 with 12 repetitions and QPSK rate 1/2 with 24 repetitions - should be defined to enable normal operation.

Performance

Simulation results of the link performances of the two proposed MCS levels (QPSK 1/24, QPSK 1/48) are shown in Figure 1. The link performances of the two currently lowest rate MCS levels (QPSK 1/6, QPSK 1/12) are also shown in the figure. In the simulations, Ped-B channels with 3 km/h velocity are considered. Figure 1 shows PER (Packet Error Rate) versus SINR (Signal to Interference and Noise Ratio per subcarrier) with various MCS levels. We can see that in the error rate of 10^{-2} region, the QPSK 1/12 requires SINR of –0.7 dB which cannot be satisfied with high probability for the case of cell boundary users, however QPSK 1/48 requires SINR of only –6.7 dB. Since the ideal channel estimation is assumed in the simulation, the performance may be degraded by few dB in real situation.

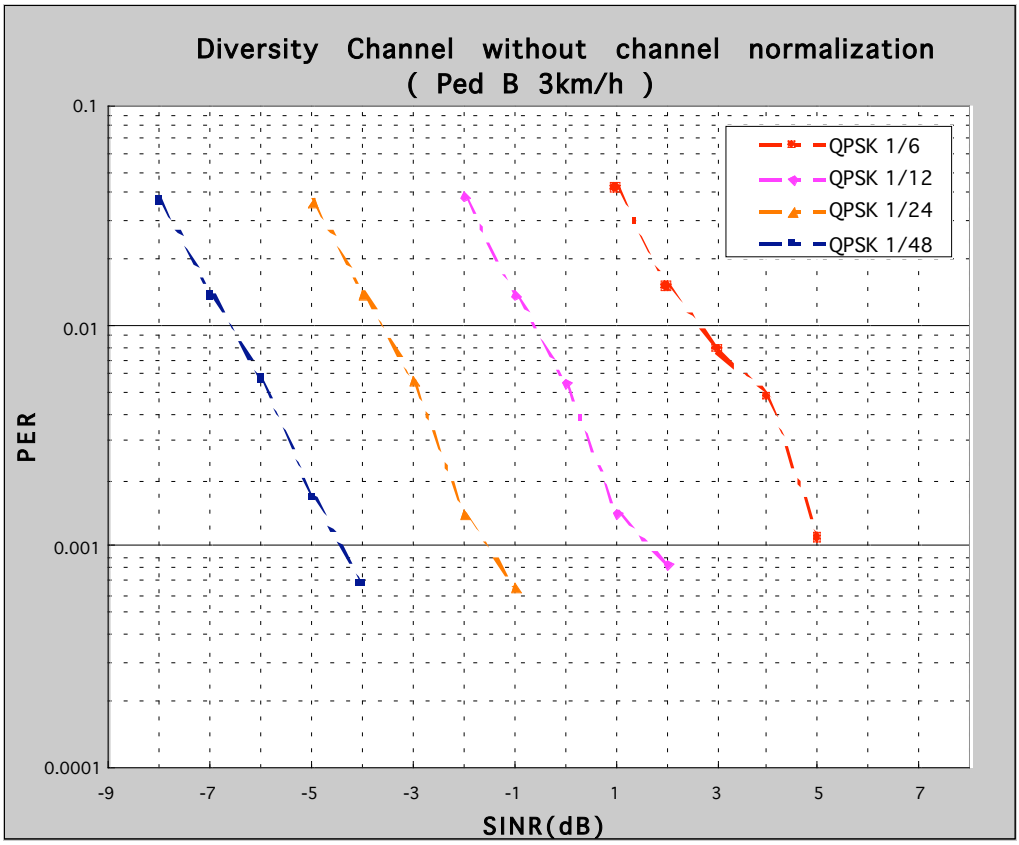

Figure 1—Link performances with four kinds of MCS levels

Suggested change to the standard

[Adopt the following changes in section 8.4.4.2, page 502, line 36]

The first ~~two~~ ~~six~~ four transmitted subchannels in the first data symbol of the downlink is called FCH. The FCH shall be transmitted using QPSK rate 1/2 with ~~four~~ ~~six~~ four repetitions using the mandatory coding scheme (e.g. the FCH information will be sent on ~~four~~ ~~six~~ four four adjacent subchannels) in a PUSC zone. In case that all subchannels are used, the FCH shall be transmitted using QPSK rate 1/2 with ~~24~~ 12 repetitions using the mandatory coding scheme.

[Adopt the following changes in section 8.4.4.4, page 504, line 43]

These slots contain 48 bits modulated by QPSK with coding rate 1/2 and repetition coding of ~~4~~ ~~6~~ 4. In case that all subchannels are used, repetition coding of ~~24~~ 12 shall be applied.

[Adopt the following changes in Table 266, page 503]

Repetition_Coding_Indication	~~2~~3 bits	0b000-No repetition coding on DL-MAP 0b001-Repetition coding of 2 used on DL-MAP 0b010-Repetition coding of 4 used on DL-MAP 0b011-Repetition coding of 6 used on DL-MAP 0b100-Repetition coding of 12 used on DL-MAP 0b101-Repetition coding of 24 used on DL-MAP 0b110 to 0b111-*Reserved*
reserved	~~4~~3 bits	Shall be set to zero

[Adopt the following changes in Table 273, page 523]

OFDMA Symbol offset	~~8~~7 bits	
Subchannel offset	6 bits	
Boosting	3 bits	
No. OFDMA Symbols	7 bits	
No. Subchannels	6 bits	
Repetition_Coding_Indication	~~2~~3 bits	0b000-No repetition coding 0b001-Repetition coding of 2 0b010-Repetition coding of 4 0b011-Repetition coding of 6 0b100-Repetition coding of 12 0b101-Repetition coding of 24 0b110 to 0b111-*Reserved*

[Adopt the following changes in Table 283, page 531]

Repetition_Coding_Indication	3 bits	0b000-No repetition coding

| 0b001-Repetition coding of 2
| 0b010-Repetition coding of 4
| 0b011-Repetition coding of 6
| 0b100-Repetition coding of 12
| 0b101-Repetition coding of 24
| 0b110 to 0b111-*Reserved*

reserved | 41 bits | Shall be set to zero

[Adopt the following changes in Table 329, page 609]

Table 329 – Transmission format and modulation level for DL

Nep	144	192	288	384	480	960	1920	2880	3840	4800
Sch	1.00	1.00								
MPR	3.00	4.00								
MOD	6.00	6.00								
Rate	1/2	2/3								
Rate	0.50	0.67								
Sch	2.00	2.00	2.00	2.00	2.00					
MPR	1.50	2.00	3.00	4.00	5.00					
MOD	4.00	4.00	6.00	6.00	6.00					
Rate	3/8	1/2	1/2	2/3	5/6					
Rate	0.38	0.50	0.50	0.67	0.83					
Sch	3.00	3.00	3.00	3.00	3.00					
MPR	1.00	1.33	2.00	2.67	3.33					
MOD	2.00	2.00	4.00	4.00	6.00					
Rate	1/2	2/3	1/2	2/3	5/9					
Rate	0.50	0.67	0.50	0.67	0.56					
Sch		4.00	4.00	4.00	4.00	4.00				
MPR		1.00	1.50	2.00	2.50	5.00				
MOD		2.00	4.00	4.00	4.00	6.00				
Rate		1/2	3/8	1/2	5/8	5/6				
Rate		0.50	0.38	0.50	0.63	0.83				
Sch	5.00		5.00	5.00	5.00	5.00				
MPR	0.60		1.20	1.60	2.00	4.00				
MOD	2.00		2.00	4.00	4.00	6.00				
Rate	3/10		3/5	2/5	1/2	2/3				
Rate	0.30		0.60	0.40	0.50	0.67				
Sch	6.00	6.00	6.00	6.00	6.00	6.00				
MPR	0.50	0.67	1.00	1.33	1.67	3.33				
MOD	2.00	2.00	2.00	2.00	4.00	6.00				
Rate	1/4	1/3	1/2	2/3	5/12	5/9				
Rate	0.25	0.33	0.50	0.67	0.42	0.56				
Sch		8.00		8.00	8.00	8.00	8.00			
MPR		0.50		1.00	1.25	2.50	5.00			
MOD		2.00		2.00	2.00	4.00	6.00			
Rate		1/4		1/2	5/8	5/8	5/6			
Rate		0.25		0.50	0.63	0.63	0.83			

Sch	9.00		9.00				9.00			
MPR	0.33		0.67				4.44			
MOD	2.00		2.00				6.00			
Rate	1/6		1/3				20/27			
Rate	0.17		0.33				0.74			
Sch					10.00	10.00	10.00			
MPR					1.00	2.00	4.00			
MOD					2.00	4.00	6.00			
Rate					1/2	1/2	2/3			
Rate					0.50	0.50	0.67			
Sch	12.00	12.00	12.00	12.00				12.00		
MPR	0.25	0.33	0.50	0.67				5.00		
MOD	2.00	2.00	2.00	2.00				6.00		
Rate	1/8	1/6	1/4	1/3				5/6		
Rate	0.13	0.17	0.25	0.33				0.83		
Sch						13.00	13.00	13.00		
MPR						1.54	3.08	4.62		
MOD						4.00	6.00	6.00		
Rate						5/13	20/39	10/13		
Rate						0.38	0.51	0.77		
Sch					15.00	15.00	15.00	15.00		
MPR					0.67	1.33	2.67	4.00		
MOD					2.00	2.00	4.00	6.00		
Rate					1/3	2/3	2/3	2/3		
Rate					0.33	0.67	0.67	0.67		
Sch		16.00		16.00					16.00	
MPR		0.25		0.50					5.00	
MOD		2.00		2.00					6.00	
Rate		1/8		1/4					5/6	
Rate		0.13		0.25					0.83	
Sch	18.00		18.00						18.00	
MPR	0.17		0.33						4.44	
MOD	2.00		2.00						6.00	
Rate	1/12		1/6						20/27	
Rate	0.08		0.17						0.74	
Sch					20.00	20.00	20.00	20.00	20.00	20.00
MPR					0.50	1.00	2.00	3.00	4.00	5.00
MOD					2.00	2.00	4.00	6.00	6.00	6.00
Rate					1/4	1/2	1/2	1/2	2/3	5/6
Rate					0.25	0.50	0.50	0.50	0.67	0.83
Sch								22.00		22.00
MPR								2.73		4.55
MOD								4.00		6.00
Rate								15/22		25/33
Rate								0.68		0.76
Sch		24.00	24.00	24.00						
MPR		0.17	0.25	0.33						
MOD		2.00	2.00	2.00						

Rate		1/12	1/8	1/6						
Rate		0.08	0.13	0.17						
Sch							26.00		26.00	26.00
MPR							1.54		3.08	3.85
MOD							4.00		6.00	6.00
Rate							5/13		20/39	25/39
Rate							0.38		0.51	0.64
Sch					30.00	30.00	30.00	30.00	30.00	
MPR					0.33	0.67	1.33	2.00	2.67	
MOD					2.00	2.00	2.00	4.00	4.00	
Rate					1/6	1/3	2/3	1/2	2/3	
Rate					0.17	0.33	0.67	0.50	0.67	
Sch				32.00						32.00
MPR				0.25						3.13
MOD				2.00						6.00
Rate				1/8						25/48
Rate				0.13						0.52
Sch	36.00		36.00							
MPR	0.08		0.17							
MOD	2.00		2.00							
Rate	1/24		1/12							
Rate	0.04		0.08							
Sch										38.00
MPR										2.63
MOD										4.00
Rate										25/38
Rate										0.66
Sch					40.00	40.00	40.00	40.00	40.00	
MPR					0.25	0.50	1.00	1.50	2.00	
MOD					2.00	2.00	2.00	4.00	4.00	
Rate					1/8	1/4	1/2	3/8	1/2	
Rate					0.13	0.25	0.50	0.38	0.50	
Sch								44.00		
MPR								1.36		
MOD								2.00		
Rate								15/22		
Rate								0.68		
Sch		48.00		48.00						
MPR		0.08		0.17						
MOD		2.00		2.00						
Rate		1/24		1/12						
Rate		0.04		0.08						
Sch										50.00
MPR										2.00
MOD										4.00
Rate										1/2
Rate										0.50
Sch									52.00	

MPR									1.54	
MOD									4.00	
Rate									5/13	
Rate									0.38	
Sch					60.00	60.00	60.00	60.00	60.00	
MPR					0.17	0.33	0.67	1.00	1.33	
MOD					2.00	2.00	2.00	2.00	2.00	
Rate					1/12	1/6	1/3	1/2	2/3	
Rate					0.08	0.17	0.33	0.50	0.67	
Sch										64.00
MPR										1.56
MOD										4.00
Rate										25/64
Rate										0.39
Sch	72.00		72.00							
MPR	0.04		0.08							
MOD	2.00		2.00							
Rate	1/48		1/24							
Rate	0.02		0.04							
Sch						80.00	80.00		80.00	
MPR						0.25	0.50		1.00	
MOD						2.00	2.00		2.00	
Rate						1/8	1/4		1/2	
Rate						0.13	0.25		0.50	
Sch								90.00		
MPR								0.67		
MOD								2.00		
Rate								1/3		
Rate								0.33		
Sch		96.00		96.00						
MPR		0.04		0.08						
MOD		2.00		2.00						
Rate		1/48		1/24						
Rate		0.02		0.04						
Sch										100.00
MPR										1.00
MOD										2.00
Rate										1/2
Rate										0.50
Sch					120.00	120.00	120.00	120.00	120.00	
MPR					0.08	0.17	0.33	0.50	0.67	
MOD					2.00	2.00	2.00	2.00	2.00	
Rate					1/24	1/12	1/6	1/4	1/3	
Rate					0.04	0.08	0.17	0.25	0.33	
Sch			144.00							
MPR			0.04							
MOD			2.00							
Rate			1/48							

Rate			0.02							
Sch										150.00
MPR										0.67
MOD										2.00
Rate										1/3
Rate										0.33
Sch							160.00		160.00	
MPR							0.25		0.50	
MOD							2.00		2.00	
Rate							1/8		1/4	
Rate							0.13		0.25	
Sch								180.00		
MPR								0.33		
MOD								2.00		
Rate								1/6		
Rate								0.17		
Sch				192.00						
MPR				0.04						
MOD				2.00						
Rate				1/48						
Rate				0.02						
Sch										200.00
MPR										0.50
MOD										2.00
Rate										1/4
Rate										0.25
Sch					240.00	240.00	240.00	240.00	240.00	
MPR					0.04	0.08	0.17	0.25	0.33	
MOD					2.00	2.00	2.00	2.00	2.00	
Rate					1/48	1/24	1/12	1/8	1/6	
Rate					0.02	0.04	0.08	0.13	0.17	
Sch										300.00
MPR										0.33
MOD										2.00
Rate										1/6
Rate										0.17
Sch									320.00	
MPR									0.25	
MOD									2.00	
Rate									1/8	
Rate									0.13	
Sch								360.00		
MPR								0.17		
MOD								2.00		
Rate								1/12		
Rate								0.08		
Sch										400.00
MPR										0.25

MOD										2.00
Rate										1/8
Rate										0.13
Sch						480.00	480.00		480.00	
MPR						0.04	0.09		0.17	
MOD						2.00	2.00		2.00	
Rate						1/48	1/24		1/12	
Rate						0.02	0.04		0.08	

[Adopt the following changes in Table 331, page 614]

Table 331 – Transmission format and modulation level for UL

Nep	48	96	144	192	288	384	480	960	1920	2880	3840	4800
Sch	1.00	1.00	1.00									
MPR	1.00	2.00	3.00									
MOD	2.00	4.00	4.00									
Rate	1/2	1/2	3/4									
Rate	0.50	0.50	0.75									
Sch	2.00	2.00	2.00	2.00	2.00							
MPR	0.50	1.00	1.50	2.00	3.00							
MOD	2.00	2.00	4.00	4.00	4.00							
Rate	1/4	1/2	3/8	1/2	3/4							
Rate	0.25	0.50	0.38	0.50	0.75							
Sch	3.00	3.00	3.00	3.00	3.00	3.00	3.00					
MPR	0.33	0.67	1.00	1.33	2.00	2.67	3.33					
MOD	2.00	2.00	2.00	2.00	4.00	4.00	4.00					
Rate	1/6	1/3	1/2	2/3	1/2	2/3	5/6					
Rate	0.17	0.33	0.50	0.67	0.50	0.67	0.83					
Sch	4.00	4.00		4.00	4.00	4.00	4.00					
MPR	0.25	0.50		1.00	1.50	2.00	2.50					
MOD	2.00	2.00		2.00	4.00	4.00	4.00					
Rate	1/8	1/4		1/2	3/8	1/2	5/8					
Rate	0.13	0.25		0.50	0.38	0.50	0.63					
Sch			5.00		5.00	5.00	5.00					
MPR			0.60		1.20	1.60	2.00					
MOD			2.00		2.00	4.00	4.00					
Rate			3/10		3/5	2/5	1/2					
Rate			0.30		0.60	0.40	0.50					
Sch	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00				
MPR	0.17	0.33	0.50	0.67	1.00	1.33	1.67	3.33				
MOD	2.00	2.00	2.00	2.00	2.00	2.00	4.00	4.00				
Rate	1/12	1/6	1/4	1/3	1/2	2/3	5/12	5/6				
Rate	0.08	0.17	0.25	0.33	0.50	0.67	0.42	0.83				
Sch								7.00				
MPR								2.86				
MOD								4.00				
Rate								5/7				
Rate								0.714				

Sch		8.00		8.00		8.00	8.00	8.00				
MPR		0.25		0.50		1.00	1.25	2.50				
MOD		2.00		2.00		2.00	2.00	4.00				
Rate		1/8		1/4		1/2	5/8	5/8				
Rate		0.13		0.25		0.50	0.625	0.625				
Sch			9.00		9.00							
MPR			0.33		0.67							
MOD			2.00		2.00							
Rate			1/6		1/3							
Rate			0.17		0.33							
Sch							10.00	10.00				
MPR							1.00	2.00				
MOD							2.00	4.00				
Rate							1/2	1/2				
Rate							0.50	0.50				
Sch	12.00	12.00	12.00	12.00	12.00	12.00			12.00			
MPR	0.08	0.17	0.25	0.33	0.50	0.67			3.33			
MOD	2.00	2.00	2.00	2.00	2.00	2.00			4.00			
Rate	1/24	1/12	1/8	1/6	1/4	1/3			5/6			
Rate	0.04	0.08	0.13	0.17	0.25	0.33			0.83			
Sch									13.00			
MPR									3.08			
MOD									4.00			
Rate									10/13			
Rate									0.77			
Sch							15.00	15.00	15.00			
MPR							0.67	1.33	2.67			
MOD							2.00	2.00	4.00			
Rate							1/3	2/3	2/3			
Rate							0.33	0.67	0.67			
Sch				16.00		16.00						
MPR				0.25		0.50						
MOD				2.00		2.00						
Rate				1/8		1/4						
Rate				0.13		0.25						
Sch			18.00		18.00					18.00		
MPR			0.17		0.33					3.33		
MOD			2.00		2.00					4.00		
Rate			1/12		1/6					5/6		
Rate			0.08		0.17					0.83		
Sch							20.00	20.00	20.00	20.00		
MPR							0.50	1.00	2.00	3.00		
MOD							2.00	2.00	4.00	4.00		
Rate							1/4	1/2	1/2	3/4		
Rate							0.25	0.50	0.50	0.75		
Sch	24.00	24.00		24.00	24.00	24.00				24.00	24.00	
MPR	0.04	0.08		0.17	0.25	0.33				2.50	3.33	
MOD	2.00	2.00		2.00	2.00	2.00				4.00	4.00	
Rate	1/48	1/24		1/12	1/8	1/6				5/8	5/6	
Rate	0.02	0.04		0.08	0.13	0.17				0.63	0.83	

Sch									26.00		26.00	
MPR									1.54		3.08	
MOD									4.00		4.00	
Rate									5/13		10/13	
Rate									0.385		0.77	
Sch							30.00	30.00	30.00	30.00	30.00	30.00
MPR							0.33	0.67	1.33	2.00	2.67	3.33
MOD							2.00	2.00	2.00	4.00	4.00	4.00
Rate							1/6	1/3	2/3	1/2	2/3	5/6
Rate							0.17	0.33	0.67	0.50	0.67	0.83
Sch						32.00						
MPR						0.25						
MOD						2.00						
Rate						1/8						
Rate						0.13						
Sch												34.00
MPR												2.94
MOD												4.00
Rate												25/34
Rate												0.74
Sch			36.00		36.00							
MPR			0.08		0.17							
MOD			2.00		2.00							
Rate			1/24		1/12							
Rate			0.04		0.08							
Sch												38.00
MPR												2.63
MOD												4.00
Rate												25/38
Rate												0.66
Sch							40.00	40.00	40.00	40.00	40.00	
MPR							0.25	0.50	1.00	1.50	2.00	
MOD							2.00	2.00	2.00	4.00	4.00	
Rate							1/8	1/4	1/2	3/8	1/2	
Rate							0.13	0.25	0.50	0.38	0.50	
Sch										45.00		
MPR										1.33		
MOD										2.00		
Rate										2/3		
Rate										0.67		
Sch		48.00		48.00		48.00						
MPR		0.04		0.08		0.17						
MOD		2.00		2.00		2.00						
Rate		1/48		1/24		1/12						
Rate		0.02		0.04		0.08						
Sch												50.00
MPR												2.00
MOD												4.00
Rate												1/2
Rate												0.50

Sch											52.00	
MPR											1.54	
MOD											4.00	
Rate											5/13	
Rate											0.38	
Sch							60.00	60.00	60.00	60.00	60.00	
MPR							0.17	0.33	0.67	1.00	1.33	
MOD							2.00	2.00	2.00	2.00	2.00	
Rate							1/12	1/6	1/3	1/2	2/3	
Rate							0.08	0.17	0.33	0.50	0.67	
Sch												66.00
MPR												1.52
MOD												4.00
Rate												25/66
Rate												0.38
Sch			72.00		72.00							
MPR			0.04		0.08							
MOD			2.00		2.00							
Rate			1/48		1/24							
Rate			0.02		0.04							
Sch												76.00
MPR												1.32
MOD												2.00
Rate												25/38
Rate												0.66
Sch								80.00	80.00		80.00	
MPR								0.25	0.50		1.00	
MOD								2.00	2.00		2.00	
Rate								1/8	1/4		1/2	
Rate								0.13	0.25		0.50	
Sch										90.00		
MPR										0.67		
MOD										2.00		
Rate										1/3		
Rate										0.33		
Sch				96.00		96.00						
MPR				0.04		0.08						
MOD				2.00		2.00						
Rate				1/48		1/24						
Rate				0.02		0.04						
Sch												100.00
MPR												1.00
MOD												2.00
Rate												1/2
Rate												0.50
Sch							120.00	120.00	120.00	120.00	120.00	
MPR							0.08	0.17	0.33	0.50	0.67	
MOD							2.00	2.00	2.00	2.00	2.00	
Rate							1/24	1/12	1/6	1/4	1/3	
Rate							0.04	0.08	0.17	0.25	0.33	

Sch					144.00							
MPR					0.04							
MOD					2.00							
Rate					1/48							
Rate					0.02							
Sch												150.00
MPR												0.67
MOD												2.00
Rate												1/3
Rate												0.33
Sch									160.00		160.00	
MPR									0.25		0.50	
MOD									2.00		2.00	
Rate									1/8		1/4	
Rate									0.13		0.25	
Sch										180.00		
MPR										0.33		
MOD										2.00		
Rate										1/6		
Rate										0.17		
Sch						192.00			_	_	_	
MPR						0.04			_	_	_	
MOD						2.00			_	_	_	
Rate						1/48			_	_	_	
Rate						0.02			_	_	_	
Sch									_	_	_	200.0
MPR									_	_	_	0.50
MOD									_	_	_	2.00
Rate									_	_	_	1/4
Rate									_	_	_	0.25
Sch							240.00	240.00	240.0	240.0	240.0	_
MPR							0.04	0.08	0.17	0.25	0.33	_
MOD							2.00	2.00	2.00	2.00	2.00	_
Rate							1/48	1/24	1/12	1/8	1/6	_
Rate							0.02	0.04	0.08	0.13	0.17	_