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Results of simple PER tests for DBPSK and DQPSK with coherent reception

The following is information about a (simple) packet error test conducted to analyze the performance of the DQPSK and DBPSK receivers. The purpose was to compare the performance of a Feed-forward AGC loop to a Feed-back AGC loop under similar conditions and for a small range of variables. The transmitter amplitude mentioned is a constant gain value used before sending the signal to the USRP and does not directly represent a voltage or power value. Full scale range is ±16384, but previous tests have shown that above 15000 starts to produce some harmonics above the noise floor (observed with a direct cable connection to an Anritsu Signature signal analyzer), so 15000 was used for the maximum transmit value.

The conclusions are, well, ambiguous. Both the feed-forward and feed-back AGC loop have similar performance under the proper condition with the Costas loop for DQPSK. The feed-forward loop seems to have a slight edge over more conditions than the feed-back loop though with slightly better performance for BPSK reception.

Test Constants:
Transmitter to receiver separation: ~3 m
Frequency: 420.1 MHz
Bit Rate: 250 kbps (samples/symbol = 4)
Receiver RFX Gain: 50.0
M&M loop: default values
Gray Coded

DBPSK with Feed-Forward AGC Loop
Costas loop alpha = 0.05
Costas loop frequency limits = ±0.002
AGC Settings:
      Number symbols = 16
      Reference = 1.0

DQPSK with Feed-Forward AGC Loop (1)
Costas loop alpha = 0.05
Costas loop frequency limits = ±0.002
AGC Settings:
      Number symbols = 16
      Reference = 1.0

DQPSK with Feed-Forward AGC Loop (2)
Costas loop alpha = 0.1
Costas loop frequency limits = ±0.002
AGC Settings:
      Number symbols = 16
      Reference = 1.0

DBPSK with Feed- Back Logarithmic AGC Loop

Costas loop alpha = 0.05
Costas loop frequency limits = ±0.002
AGC Settings:
      Gain = 0.08
      Reference = 1.0

DQPSK with Feed- Back Logarithmic AGC Loop (1)

Costas loop alpha = 0.05
Costas loop frequency limits = ±0.002
AGC Settings:
      Gain = 0.08
      Reference = 1.0

DQPSK with Feed-Back Logarithmic AGC Loop (2)

Costas loop alpha = 0.1
Costas loop frequency limits = ±0.002
AGC Settings:
      Gain = 0.08
      Reference = 1.0

Table of Packet Error Rates

Tx Amp	DBPSK FF	DBPSK FB	DQPSK (1) FF	DQPSK (1) FB	DQPSK(2) FF	DQPSK (2) FB
10	2.2556E-02	3.0075E-02	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00
25	0.0000E+00	1.5038E-03	1.0075E-01	8.1203E-02	3.9098E-02	5.4135E-02
50	1.5038E-03	0.0000E+00	2.0301E-01	1.3684E-01	3.1579E-02	2.8571E-02
250	0.0000E+00	0.0000E+00	9.1729E-02	4.8120E-02	0.013533835	1.3534E-02
15000	0.0000E+00	4.5113E-03	1.5188E-01	2.7068E-01	5.5639E-02	5.1128E-02
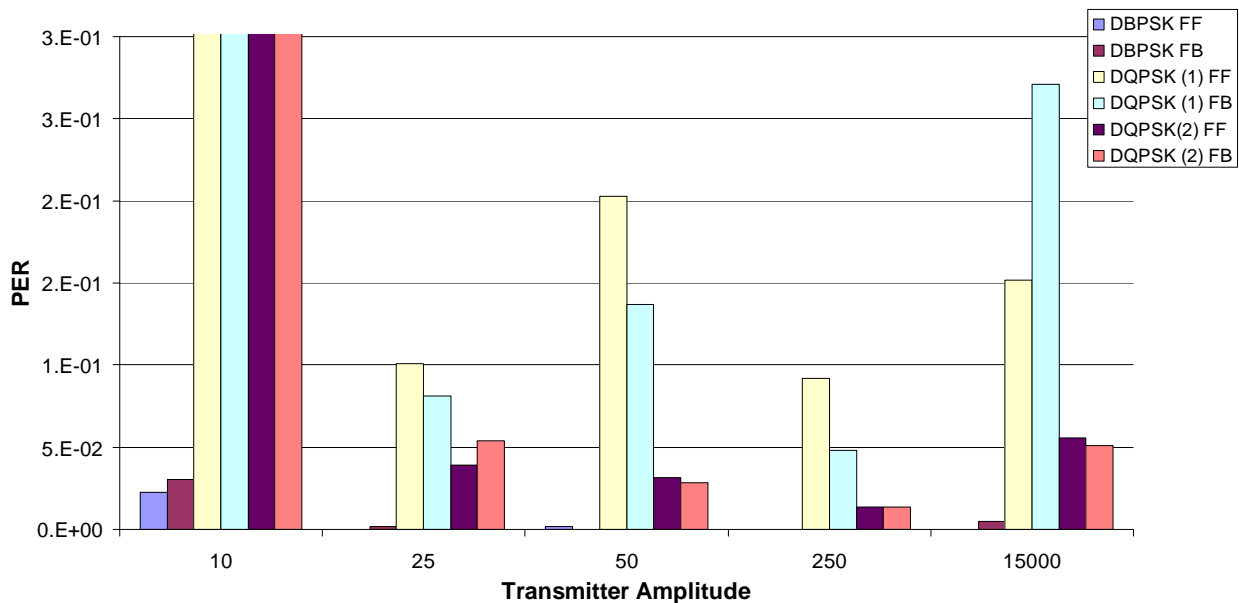
[Figure values cut off for amplitude 10 to show results of successful tests better]

All Collected Data

BPSK FF	Tx Amp:	10	25	50	250	15000
Packets Transmitter		665	665	665	665	665
Packets Received		662	665	665	665	665
Packets Received without Errors		650	665	664	665	665
Packets Received with Errors		12	0	1	0	0
Packets Not Received		3	0	0	0	0
Packet Error Rate		2.26E-02	0.00E+00	1.50E-03	0.00E+00	0.00E+00

QPSK (1) FF	Tx Amp:	10	25	50	250	15000
Packets Transmitter		665	665	665	665	665
Packets Received		365	615	563	610	579
Packets Received without Errors		0	598	530	604	564
Packets Received with Errors		365	17	33	6	15
Packets Not Received		300	50	102	55	86
Packet Error Rate		1.00E+00	1.01E-01	2.03E-01	9.17E-02	1.52E-01

QPSK (2) FF	Tx Amp:	10	25	50	250	15000
Packets Transmitter		665	665	665	665	665
Packets Received		348	646	647	656	631
Packets Received without Errors		0	639	644	656	628
Packets Received with Errors		348	7	3	0	3
Packets Not Received		317	19	18	9	34
Packet Error Rate		1.00E+00	3.91E-02	3.16E-02	1.35E-02	5.56E-02

BPSK FB	Tx Amp:	10	25	50	250	15000
Packets Transmitter		665	665	665	665	665
Packets Received		656	665	665	665	664
Packets Received without Errors		645	664	665	665	662
Packets Received with Errors		11	1	0	0	2
Packets Not Received		9	0	0	0	1
Packet Error Rate		3.01E-02	1.50E-03	0.00E+00	0.00E+00	4.51E-03

QPSK (1) FB	Tx Amp:	10	25	50	250	15000
Packets Transmitter		665	665	665	665	665
Packets Received		326	625	598	635	495
Packets Received without Errors		0	611	574	633	485
Packets Received with Errors		326	14	24	2	10
Packets Not Received		339	40	67	30	170
Packet Error Rate		1.00E+00	8.12E-02	1.37E-01	4.81E-02	2.71E-01

QPSK (2) FB	Tx Amp:	10	25	50	250	15000
Packets Transmitter		665	665	665	665	665
Packets Received		376	635	647	657	625
Packets Received without Errors		0	629	646	656	631
Packets Received with Errors		376	6	1	1	-6
Packets Not Received		289	30	18	8	40
Packet Error Rate		1.00E+00	5.41E-02	2.86E-02	1.35E-02	5.11E-02