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DIGITAL SYNCHRONIZATION AND COMMUNICATION TECHNIQUES

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RESEARCH IN DIGITAL SYNCHRONIZATION AND COMMUNICATIONS

- DIGITAL CODING/MODULATION UNDER INVESTIGATION
  - MPSK (BPSK, QPSK, OQPSK, MSK)
  - MDPSK (DBPSK, DQPSK, ODQPSK, DMSK)

  } OFFSET VS NON-OFFSET
  - CONVOLUTIONAL CODES AND TRELLIS-CODED MODULATION
  - BANDWIDTH EFFICIENT
- CHANNELS UNDER INVESTIGATION
  - AWGN
  - RAYLEIGH/RICE/SCINTILLATION
  - JAMMED
- RESEARCH EMPHASIZES

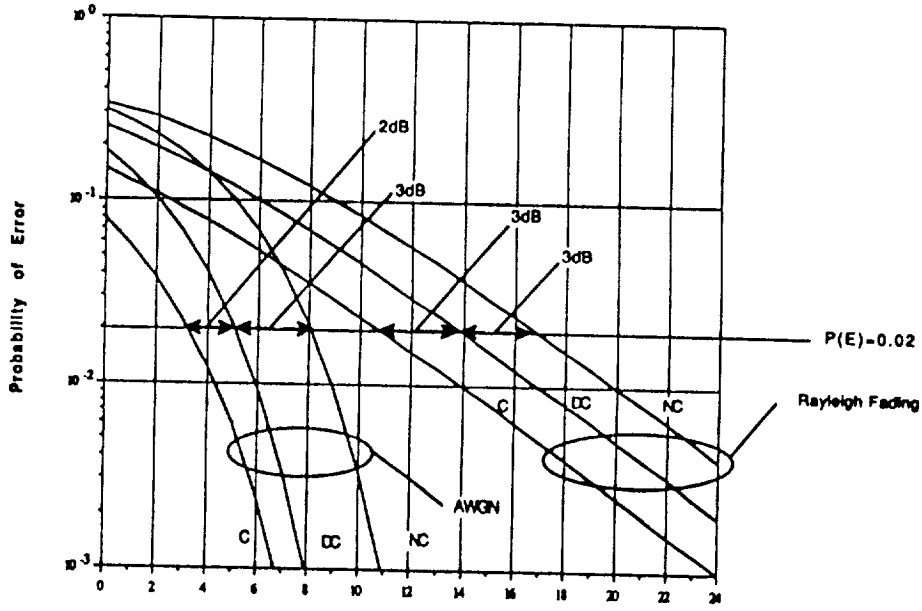
  ACQ
  - RAPID ACQUISITION WITH HIGH PROBABILITY
  - AVOIDING HANG-UP DURING ACQUISITION

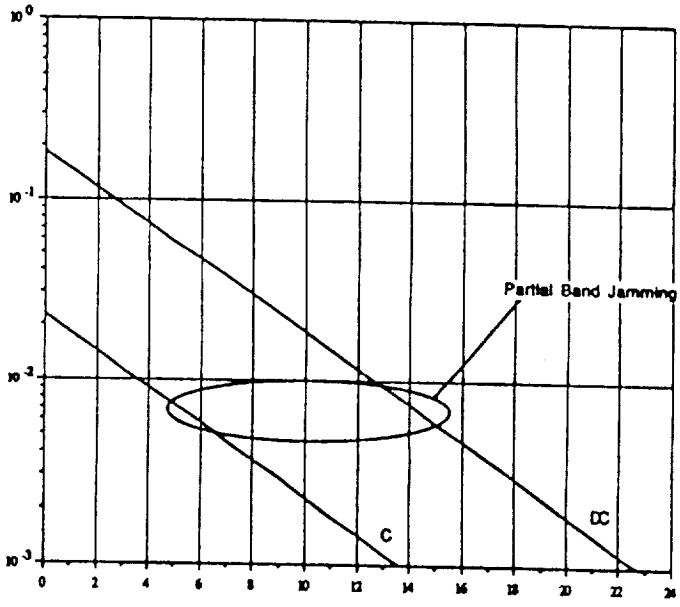
  TRACK
  - AVOIDING CYCLE SLIPPING
  - MINIMIZE TRACKING JITTER
  - ELIMINATE PHASE AMBIGUITIES
  - ACHIEVING PERFORMANCE OF CODED-COHERENT COMMUNICATIONS

DIGITAL SYNCHRONIZATION PROJECT MOTIVATION

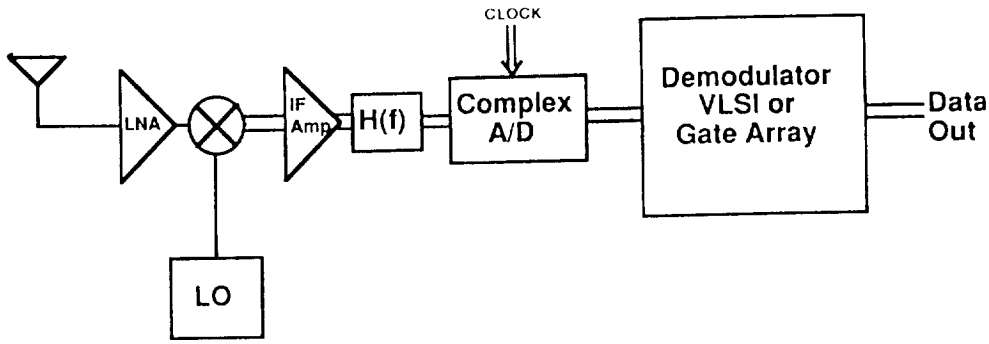
- FUTURE COMMUNICATION MODEMS ARE LIKELY TOO EMPLOY ALL DIGITAL IMPLEMENTATIONS AS THE DIGITAL SIGNAL PROCESSING SPEED BARRIER BETWEEN DIGITAL AND ANALOG HARDWARE RISES DUE TO EMERGING TECHNOLOGIES, E.G., VLSI.

- COHERENT (C) VS. DIFFERENTIALLY COHERENT (DC) VS. NONCOHERENT (NC) DETECTION IN MODEMS

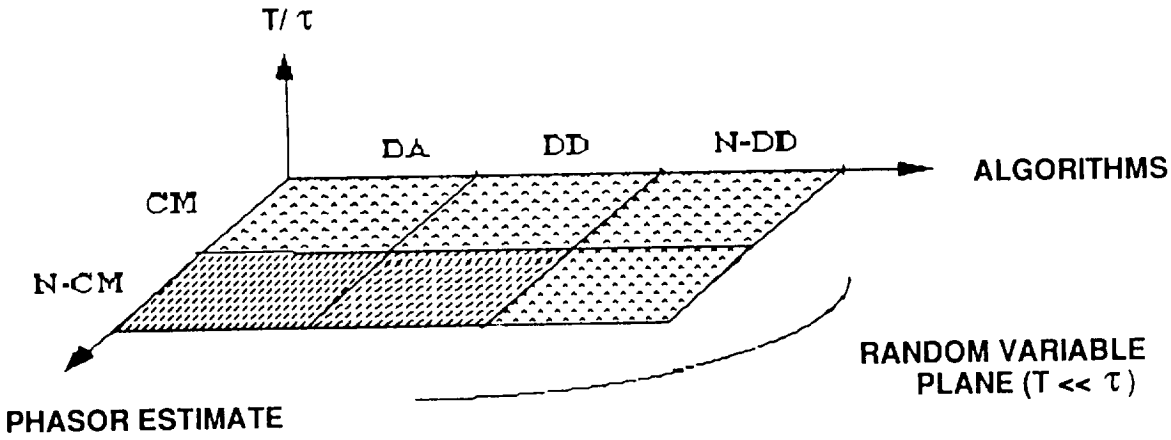




Desired Modem Implementation



DIGITAL SYNCHRONIZATION PROBLEM SPACE



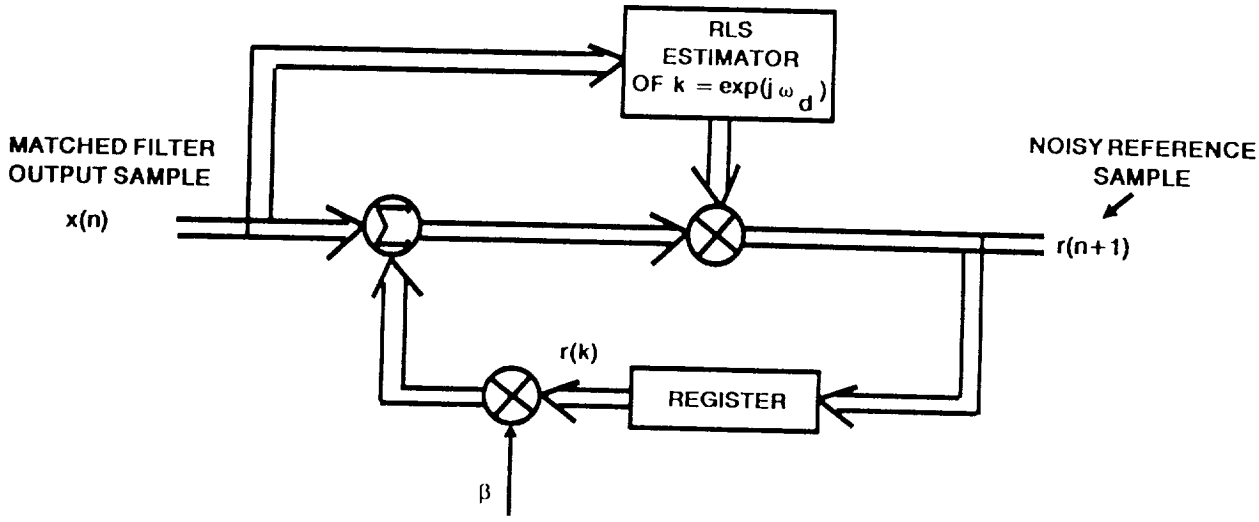
CM: CONSTANT MODULUS
N-CM: NON-CONSTANT MODULUS

DA: DATA-AIDED
DD: DECISION DIRECTED
NDD: NON-DECISION DIRECTED

SALIENT CHARACTERISTICS OF OPEN LOOP DIGITAL SYNCHRONIZERS

- DERIVED FROM ADAPTIVE FILTERING THEORY
- DO NOT REQUIRE LOCALLY GENERATED SYNC REFERENCE BY MEANS OF A VCO OR NCO
- SYNC REFERENCE IS NON-CONSTANT MODULUS
- DOES NOT REQUIRE A PHASE-ERROR MEASUREMENT TO UPDATE PHASE ESTIMATE

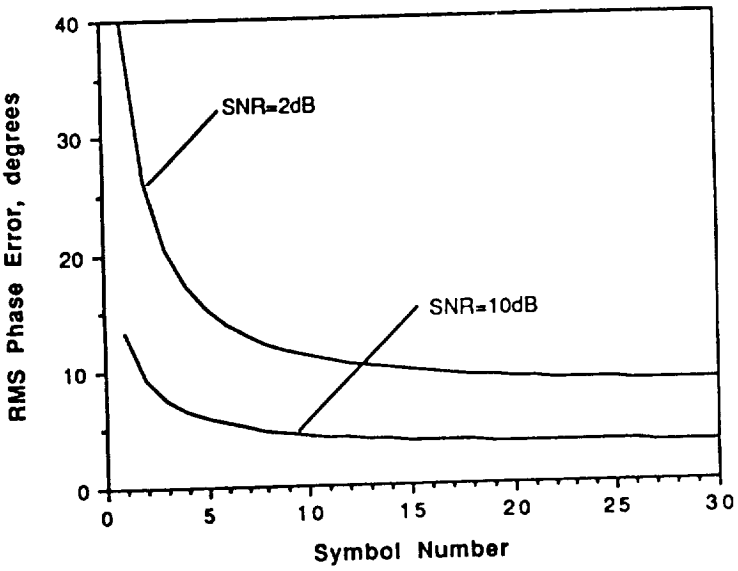
OPEN LOOP PHASE AND FREQUENCY ESTIMATOR



β - SAMPLE WEIGHTING FACTOR

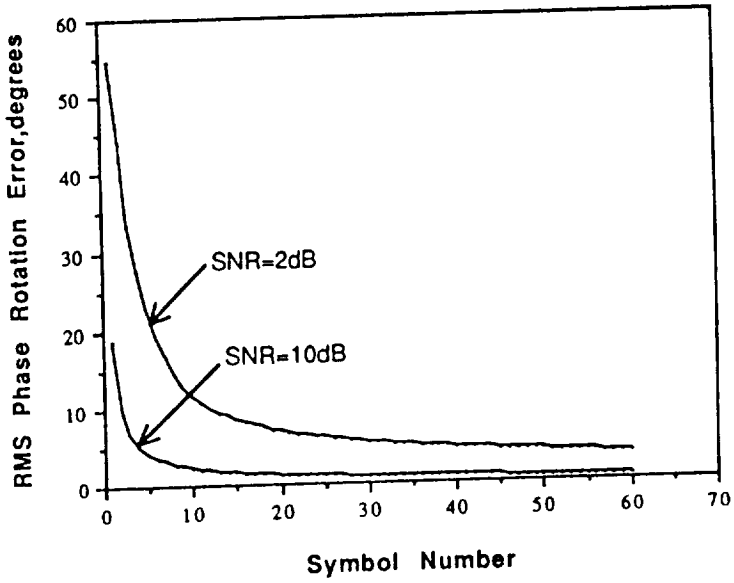
EXPONENTIALLY WEIGHTED PHASE ESTIMATOR LEARNING CURVES.

$\beta = 0.875$

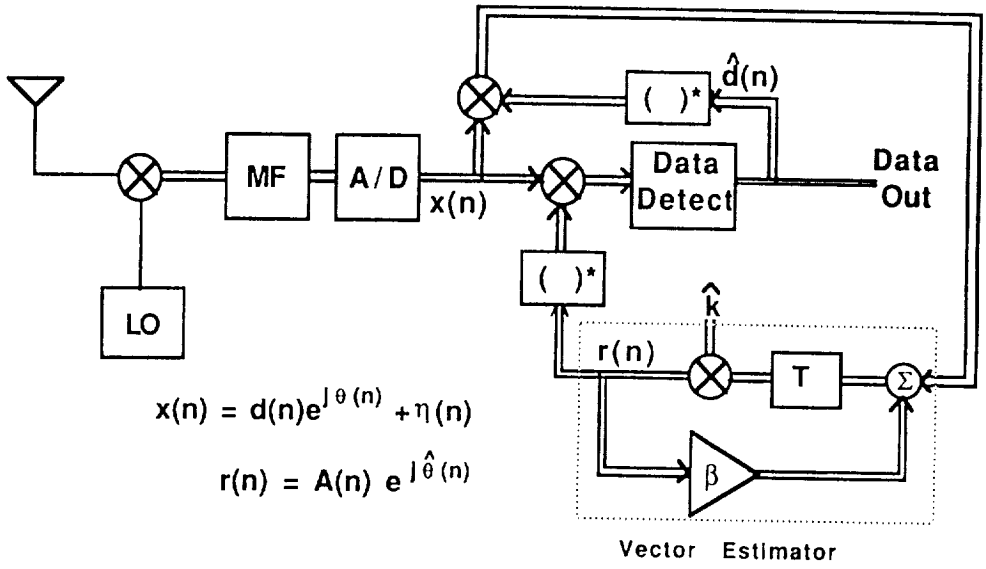


SYMBOL TO SYMBOL PHASE ROTATION LEARNING CURVE.

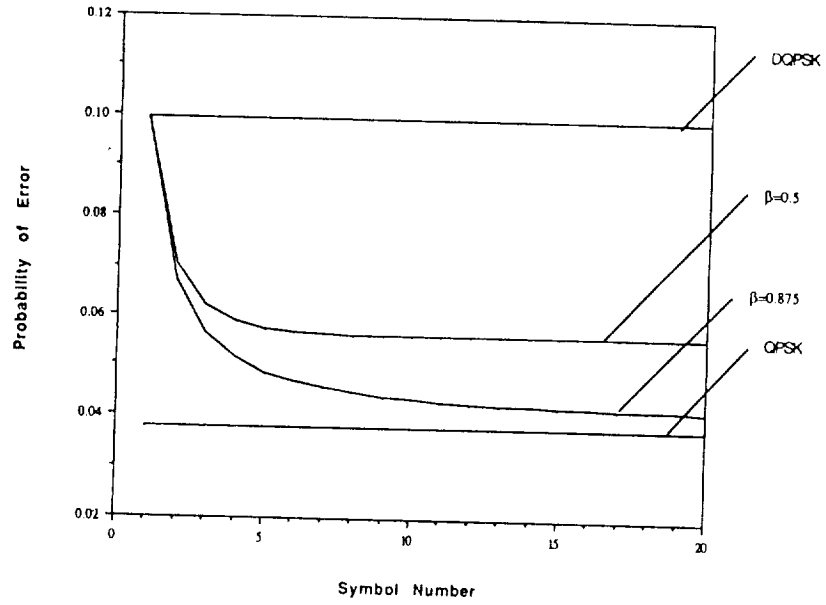
$\omega_0 = 1.0$ radians/symbol



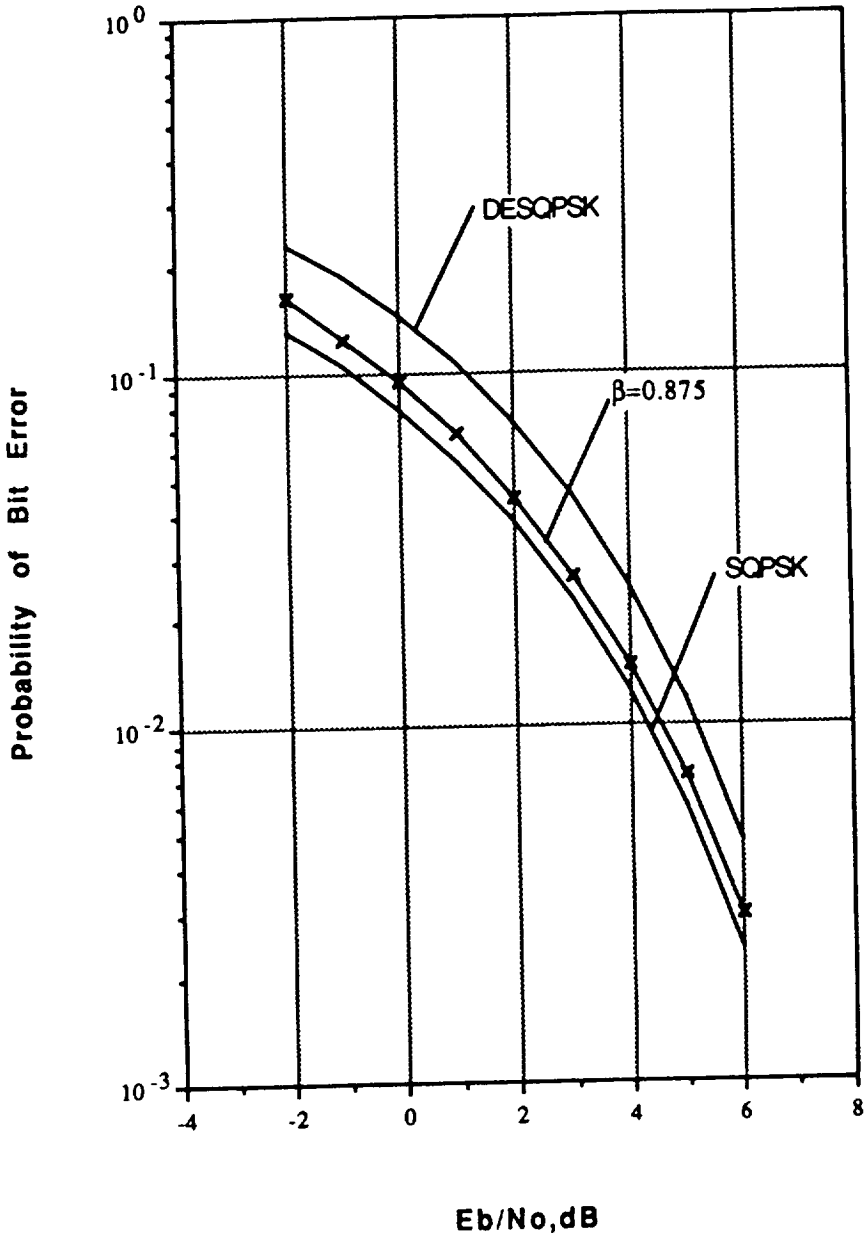
A Digital Receiver Structure Utilizing an Open Loop Estimator in a Decision-Directed Architecture



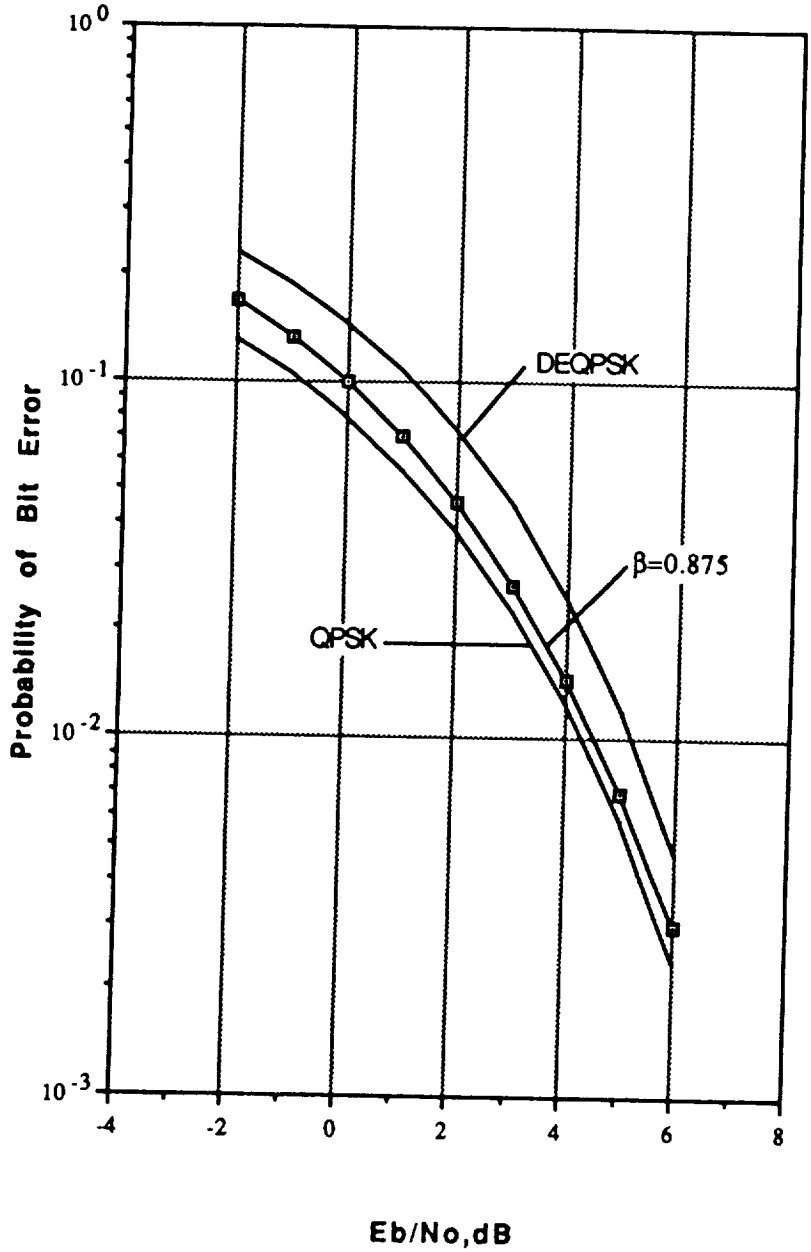
The BER Learning Curve of the Exponentially Weighted Estimator for QPSK Modulation (E_b/N_o=2dB)



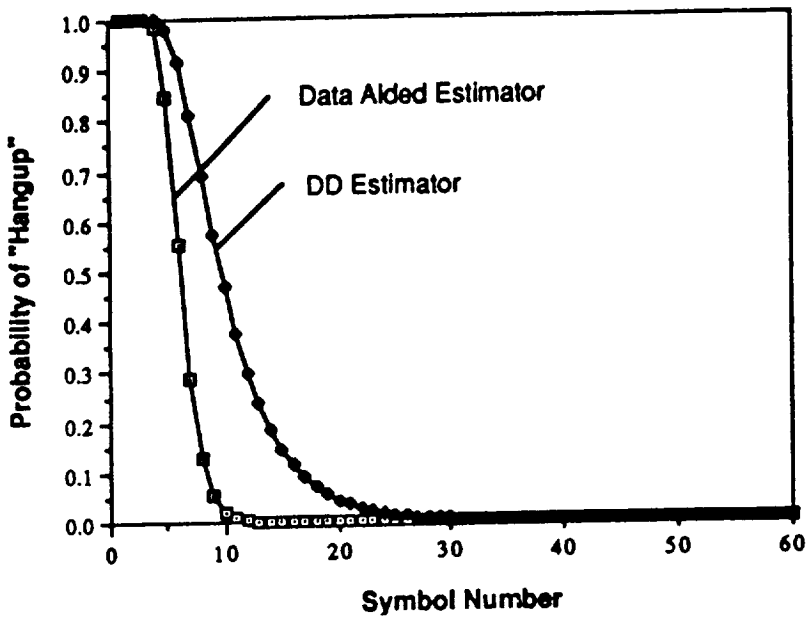
SIMULATED STEADY STATE WATERFALL CURVE OF THE EW DD ESTIMATOR FOR SQPSK MODULATION. $\beta = 0.875$



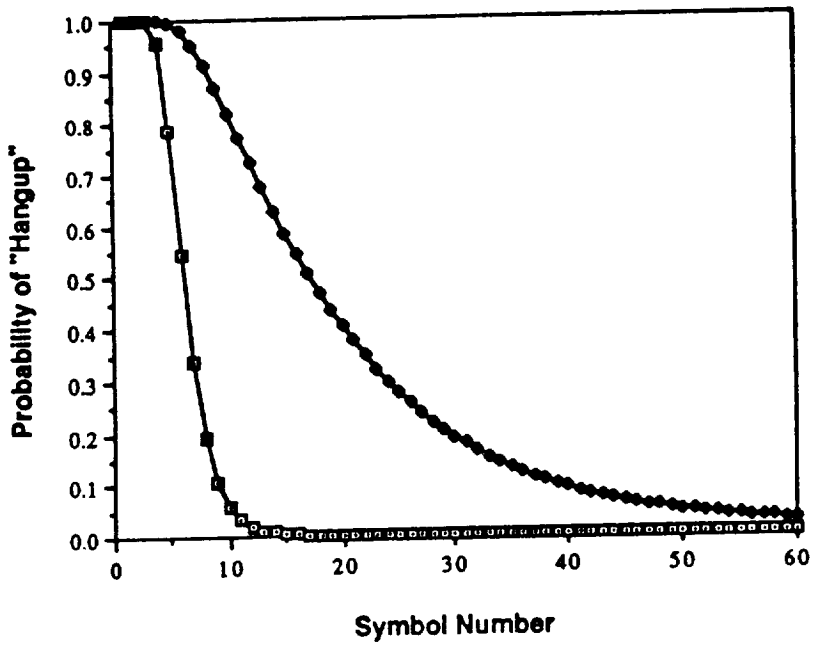
SIMULATED STEADY STATE WATERFALL CURVE OF THE EW DD ESTIMATOR FOR QPSK MODULATION. $\beta = 0.875$



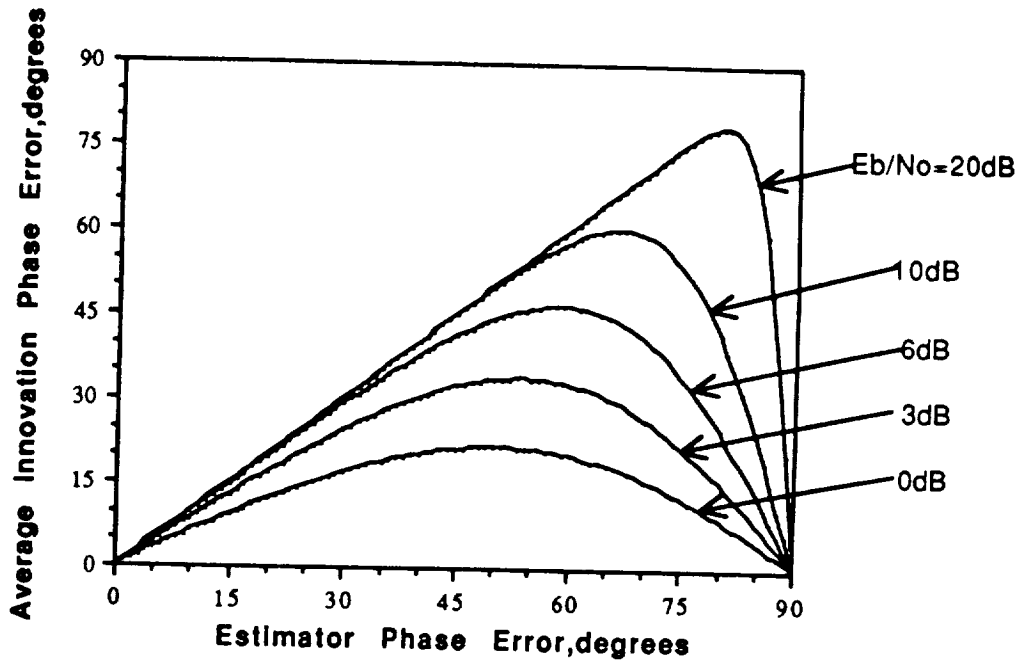
PROBABILITY OF REMAINING IN A HANGUP CONDITION FOR BPSK MODULATION. R_b = 2dB, β = 0.875.

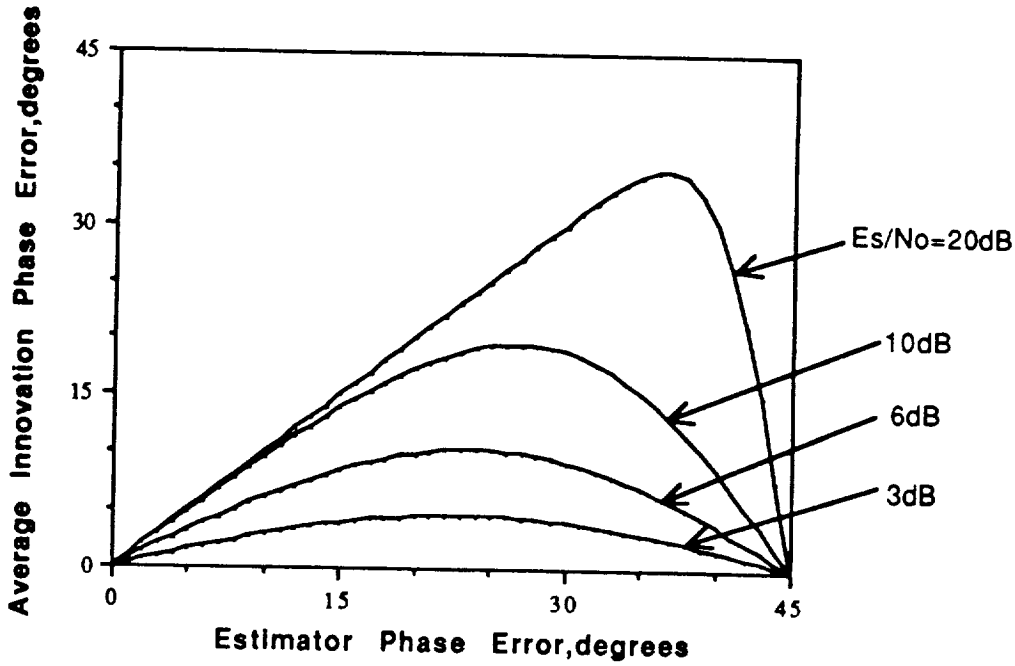


PROBABILITY OF REMAINING IN A HANGUP CONDITION FOR QPSK MODULATION. R_b = 2dB, β = 0.875.



'S' CURVE FOR A DECISION-DIRECTED BPSK AND QPSK LOOP EW ESTIMATORS





Motivation For Research

- Modems used in burst mode communication systems (TDMA or FHSS) or a fading channel typically use noncoherent demodulation techniques
  - PLL structures and fast acquisition with high probability requirements are not compatible
  - Coherent demodulation improves the performance
- Technology advances favor digital receiver structures
  - VLSI or gate array implementations can significantly reduce the cost, size, and possibly power consumption while improving the reliability of modems.