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Performance Study of Reed Solomon Code with Effective Error correction and Minimum Area Constraint on FPGA

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Abstract: In wireless, satellite communication systems reducing error rate is crucial. High bit error rates of the wireless communication system need using numerous committals to writing ways on the info transferred. Channel committal to writing for error detection and correction helps the communication system designers to cut back the consequences of a loud channel. The aim of this paper is to review and investigate the performance of Reed-Solomon code that's wont to decode the info stream in electronic communication. This paper presents a style on Reed Solomon Code for Wi-Max Network. The implementation is predicated on Berlekamp Massey, Forney and Chain formula. The 802.16 network customary recommends the use of Reed-Solomon code RS that is enforced and mentioned during this paper. It's targeted to be applied during a forward error correction system supported 802.16 network customary to boost the general performance of the system.

Keywords: Reed Solomon, Generator polynomial, Syndrome calculator, FPGA.

I. INTRODUCTION

Nowadays, we tend to board a world wherever communications play a vital role each in our daily lives and within their involvement in the economic and technological fields. We tend to perpetually got to increase the flow of transmission whereas maintaining and rising their quality. however while not a priority of responsibility, all improvement efforts would be futile as a result of it might essentially mean that some information are to be air a blunder correcting code permits the correcting of 1 or many errors in a very code word by adding redundant symbols to the data, otherwise known as, management symbols. Reed-Solomon committal to writing is a terribly economical and common Forward Error Correction technique discovered by Reed and king [1].

Reed-Solomon (RS) codes are among the foremost wide used block error-correcting codes in electronic communication and storage systems [2] and are terribly effective in correcting random image errors and random burst errors. so they're applied in several systems like storage devices, mobile communications, and digital Television/DVB, high-speed modems etc.RS codes are adopted by numerous Standards like DVBT, DVBS, DVB DSNG, DVB C, and IEEE 802.16 WI-MAX. The purpose of error correction committal to writing are often expressed as increasing the responsibility of information communications or information storage over a clangorous channel, dominant errors thus the reliable copy of knowledge are often obtained, increasing the general system's signal-to-noise energy ratio (SNR), reducing noise effects among a system. The reed-Solomon error correction codes were first of all introduced within the paper "Polynomial codes over bound finite fields" in 1960 for burst error correction. [3].

II. REED SOLOMON CODE

RS code is brief for Reed-Solomon encoder that may be a reasonably non-binary BCH codes, and is especially applicable in correcting burst errors. Reed male monarch codes have higher error correcting capability that the other codes have. The parameters of RS code square measure

m= the number of bits per symbol n= the block length
k = the un coded message length in symbols
(n- k) = the parity check symbols (check bytes)
t= the number of correctable symbol errors.

Reed Solomon (RS) codes a set of BCH codes and conjointly during a category of linear block codes. A RS code is specified as RS (n, k) with s-bit symbols. This implies that the encoder takes k information images of s bits every and adds parity symbols to create an n symbol codeword. There are n – k parity symbols of s bit every. A RS decoder will correct up to t symbols that contain errors during a codeword, wherever $2t = n - k$. Figure.1 shows a typical RS codeword that is additionally referred to as a scientific code.

III. LITERATURE REVIEW

Channel secret writing may be a wide used technique for the reliable transmission and reception of information. Usually systematic linear cyclic codes square measure used for channel secret writing. In 1948, technologist introduced the linear block codes for complete correction of errors. Cyclic codes were 1st mentioned in an exceedingly series of technical notes and reports written between 1957 and 1959 by range. This LED on to the work printed in March and Gregorian calendar month of 1960 by nuclear physicist and Ray- Chaudhuri the BCH codes [3].Codes that reaches "optimal" error correction

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capability square measure known as most Distance severable (MDS). Reed-Solomon codes square measure far and away the dominant members, each in range and utility, of the category of MDS codes. MDS codes have variety of attention-grabbing properties that cause several sensible consequences.

Reed-Solomon codes are that the approach most typically used these days within the error management literature. This approach at the start evolved severally from Reed-Solomon codes as a way for describing cyclic codes. Gorenstein and Zierler then generalized nuclear physicist and Ray-Chaudhuri's work to discretionary Galois fields of size p m, therefore developing a replacement suggests that for describing Reed and Solomon's "polynomial codes".

In 1960 Peterson provided the 1st specific description of a secret writing formula for binary BCH codes [9], His "direct solution" formula is kind of helpful for correcting tiny numbers of errors however becomes computationally unmanageable as the amount of errors will increase. Peterson's formula was improved and extended to non - binary codes by Gorenstein and Zierler (1961) [6], Chien (1964) , and Forney (1965) [7]. These efforts were productive, however Reed-Solomon codes capable of correcting over six or seven errors still couldn't be employed in AN economical manner.

In 1967, Berlekamp incontestable his economical secret writing formula for each non - binary BCH and Reed-Solomon codes. Berlekamp's formula permits for the economical secret writing of dozens of errors at a time victimization terribly powerful Reed- king codes. The operation required for original Berlekamp-Massey formula and changed Berlekamp- Massey formula square measure similar aside from the additional multiplications within the changed technique and therefore the division operation required within the original technique. The division operation required within the original technique needed a table- search to seek out AN inverse component, which might be a tedious and time intense method. In changed Berlekamp- Massey formula, one further reloaded register is employed that stores syndromes codeword following the changed structure. So, VLSI structure of changed Berlekamp- Massey formula is easy and regular and appropriate for secret writing of Reed-Solomon codes. In 1968 Massey showed that the BCH secret writing drawback is corresponding to the matter of synthesizing the shortest Linear Feedback register capable of generating a given sequence.

In communication, data and secret writing theory, error management technique is employed for dominant errors in information transmission over unreliable or droning communication channels to produce strong information transmission through imperfect channel by adding redundancy to the info in step with preset formula. The redundancy permits the receiver to sight a restricted range of errors which will occur anyplace within the message, and infrequently to correct these errors while not retransmission.

Forward Error correction (FEC) is that the key ingredient for rising dependableness of contemporary electronic communication and storage systems and to ensure information integrity.

FEC offers the receiver the flexibility to correct errors while not needing a reverse channel to request retransmission of information, however at the value of a set, higher forward channel information measure. FEC is so applied in things wherever retransmissions square measure expensive or not possible, like once broadcasting to multiple receivers in multicast. In [8] authors, Reed-Solomon (RS) codes square measure wide used as forward correction codes (FEC) in electronic communication and storage systems. Correcting errors of RS codes are extensively studied in each domain and business.

However, for burst-error correction, the analysis continues to be quite restricted as a result of its ultra-high computation quality. During this transient, ranging from a recent theoretical work, a low- quality reformulated inversion less burst-error correcting (RiBC) formula is developed for sensible applications.

IV.PERFORMANCE STUDY OF REED SOLOMON CODE MODEL

The RS decoder model contains the syndrome calculation (SC) block, Error surveyor block, Chien search and Forney algorithms (CSFA) blocks and Error corrector.

A. Syndrome Calculator: The first step in coding the received image is to work out the info syndrome. Here the input received symbols undivided by the generator polynomial. The result ought to be zero. The parity is placed within the codeword to make sure that code is precisely dissociable by the generator polynomial. If there's a remainder, then there are errors. The rest is named the syndrome. The syndromes will then be calculated by subbing the 2t roots of the generator polynomial g(x) into R(x). The method is then iterated for alternative images and web 2t syndromes are obtained as shortly because the last parity symbol has been scan in. The syndromes rely solely on the errors, not on the underlying encoded knowledge. [6].

B. BM Algorithmic Program: To find error polynomial, this needs determination 2t co-occurring equation, one for every syndrome. The 2t syndromes type a co-occurring equation with unknowns. The unknown's are the situation of errors. The method of determination the co-occurring equation is sometimes split into 2 stages. First, a blunder location polynomial is found. This polynomial has roots that provide the error locations. Then the roots of error polynomial are found. The algorithmic program iteratively solves the error surveyor polynomial. If it seems that it cannot solve the equation at some step, then it computes error and weights it, increase the dimensions of error

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polynomial. A most of 2t iterations needed. For n symbols error, the algorithmic program offers a polynomial with n coefficients. At now the decoder fails if there are quite t errors and no corrections are often created [9].

C. Chain search algorithmic program: Once the error polynomial lambda is illustrious, its roots outline wherever the errors are within the received image block. The most typically used algorithmic program for this the chain search. All 2m attainable symbols a substituted into the error polynomial, one by one, and therefore the polynomial evaluated. If the result involves zero, you have got a root.

D. Forney algorithmic program: The next step is to use the syndromes and therefore the error polynomial roots to derive the error values. This can be done victimization the Forney algorithmic program. This algorithmic program is associate degree economical method of performing arts a matrix inversion.

The algorithmic program works in 2 stages. 1st the error judge polynomial is calculated. This can be done by convoluting the syndromes with error polynomial. If a trifles ready in error image, then the corresponding bit within the received image is in error and should be inverted. The received image is XOR with error bit and corrected image is obtained.

V.CHIEN SEARCH

The roots obtained can currently purpose to the error locations within the received message. RS decipherment typically employs the Chien search theme to implement identical. Variety 'n'is alleged to be a root of a polynomial, if the results of substitution of its price within the polynomial evaluates to zero.

Chien Search may be a brute force approach for shot the roots, and adopts direct substitution of components within the Galois field, till a selected i from i=0, 1,.., (n - 1) is found specified σ (αi) = zero . In such a case αi is alleged to be the foundation and therefore the location of the error is evaluated as σ(x). Then the variety of zeros of the error locater polynomial σ(x) is computed and is compared with the degree of the polynomial. If a match is found the error vector is updated and σ (x) is evaluated altogether image positions of the codeword. A couple indicates the presence of additional errors than is corrected.

VI. FPGA IMPLEMENATION OF REED SOLOMON DECODER

Reconfigurable technology is associate degree advance field of study derives from the benefits and applications of FPGA. The versatile hardware will be reconfigured by parameters that verify the architectures of the logic style for various systems consistent with the likeness among the algorithms. Hence, a reconfigurable RS Decoder might be designed to scale back the consumption of hardware and complexness.

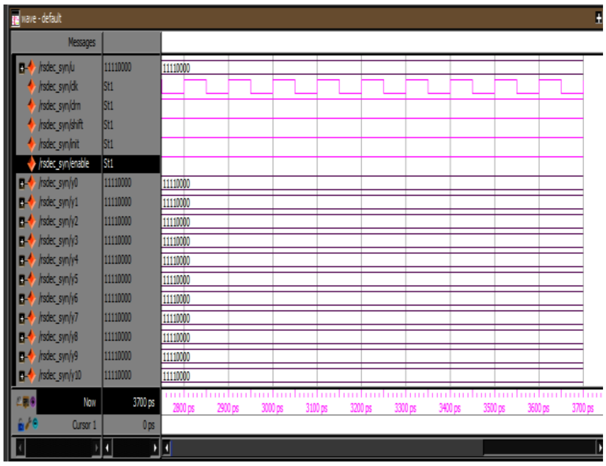

Fig 1. RS Multiply Results

Rs multiplier with different set of inputs changes reduces the switching activity shown in fig 1 .

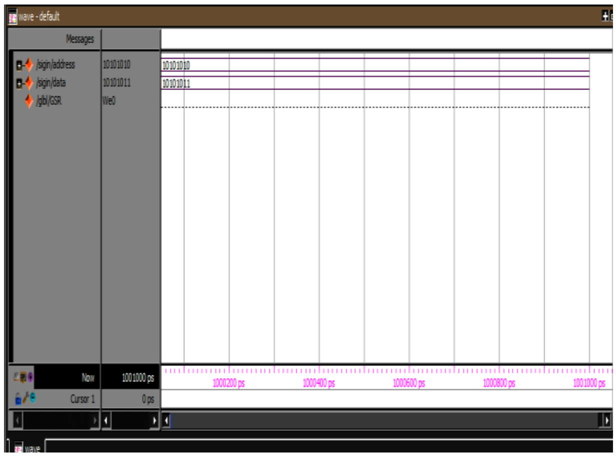

Fig 2. RS Mem_enc Results

Rs multiplier_enc with different set of inputs changes reduces the switching activity shown in fig 2.Rs multiplier_enc determines the delay .

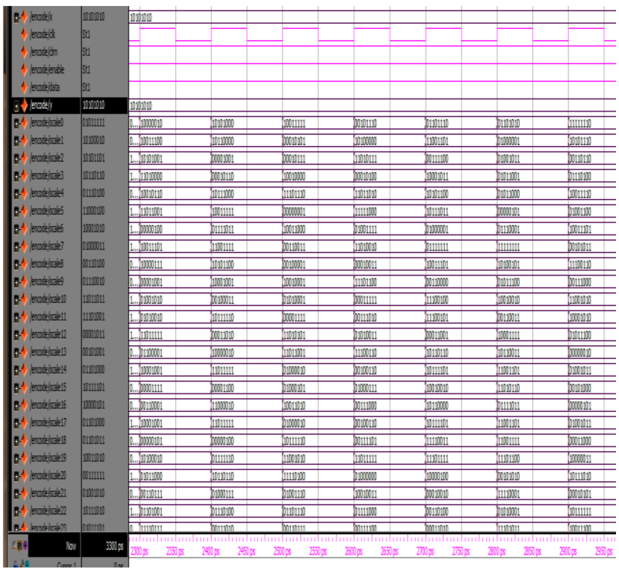

Fig 3. RS Encode Results

Rs encode with different set of inputs changes reduces the switching activity shown in fig 2.Rs multiplier_enc determines the power and delay variations.

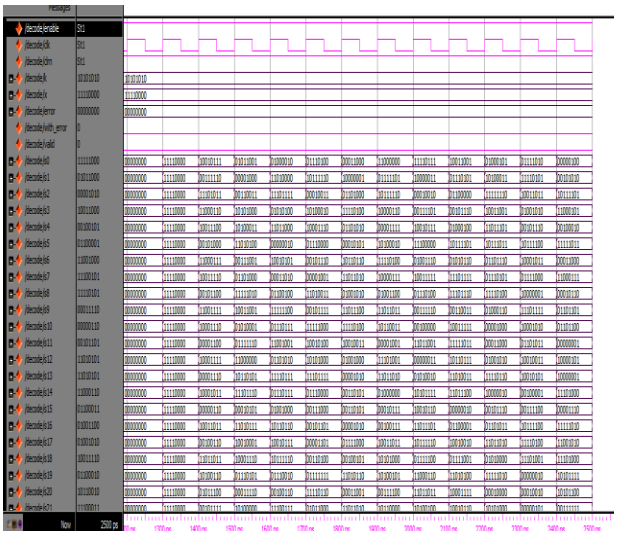

Fig 4 RS decode Results

FPGA Implementation Results: The decoder is synthesized targeting Xilinx Spartan 3E FPGA to live the performance of the enforced RS code, that is compared to the performance of the Reed king code provided by Xilinx Spartan 3e FPGA. The Performance comparison in terms of resource utilization of FPGA and temporal order performance of the decoder area unit shown in Table.

Table I Comparison table

RS Code Description	Area (Device utilization summary)	Power in mW	Delay in ns
RS199, 203	28675	5465	4536
RS 255 , 239	26784	5245	4234

VII. CONCLSION

A simple coding and cryptography rule for RS code is conferred during this paper relies on the very fact that the code word used in Euclid's rule is a non-systematic RS code. It uses the algorithmic extension to cypher the remaining unknown syndromes. Finally, the message symbols square measure so obtained by solely subtracting all identified syndromes from the coefficients of the corrupted info polynomial. Reed-Solomon codes square measure used for error detection and correction for reliable communication. The encoder splits the incoming knowledge stream into blocks and processes every block severally by adding redundancy and also the decoder processes every block severally and it corrects errors by exploiting the redundancy gift within the received knowledge. This code will be enforced mistreatment verilog alpha-lipoprotein language on Xilinx 9.1 and simulated on MODELSIM machine. The code is synthesized on Spartan 3E to match the parameters associated with parallel syndrome. Projected Reed-Solomon encoder and decoder enforced on Spartan3E with parallel syndrome will save lots of space and improves the speed. The performance of Reed-Solomon codes will be improved by mistreatment geometrician rule to resolve Key equation.

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