http://www.jctjournals.com

ISSN(ONLINE):2278 - 3814

Volume-11, Issue 04, April 2022

JOURNAL OF COMPUTING TECHNOLOGIES (JCT)

International Journal

Page Number: 01-05

Design & Implementation of VLSI Architecture of 2^5 bit Approximate Square Root for DSP-FPGA Applications:A Review

Smita Nagle[1], Prof. Nishi Pandey[2], Prof. Abhishek Agwekar[3]

[1]PG Scholar (M.Tech) , [2]Assistant Professor, [3]Head of department

[1,2,3]Department of Electronics and Communication Engineering *(ECE)*,

TRUBA College of Science and Technology, Bhopal

[1]smitanagle123456@gmail.com, [2]pandeynishi738@gmail.com, [3]abhiagwekar@gmail.com

***Abstract*— This dissertation presents implementation of VLSI Architecture of 32 bit approximate square root for DSP-FPGA applications. We propose a new non-restoring square root algorithm that requires neither square roots nor multiplexors. Compared with previous square root algorithms and our algorithm will be efficient for VLSI implementation. It will be generated the correct resulting value at each iteration and does not require extra circuitry for adjusting the result bit. The operation at each iteration will be simple: addition or subtraction based on the result bit generated in previous iteration. Simulation and synthesis is done using Xilinx ISE 14.7 software with verilog coding. Simulation results show that the proposed code is extension of the existing work. The proposed square root is implemented for the 32 bit square root while previous it is designed for the 16 bit. The total area is optimized 245 number of component or 2.66% while previous its is 536. The delay is 3.01ns while previous it is 3.69ns. The frequency optimized is 293 MHz by proposed and 107.50 MHz by the previous. Therefore proposed square root VLSI code gives the better performance in terms of the calculated parameters.**

***Keywords*— Adaptive active damper, grid connected inverters, harmonic current reference compensation technique, PI controller, DSMPI Controller.**

I. INTRODUCTION

Variable precision floating point operations are widely used in many fields of computer and IOT engineering. Floating point arithmetic operations are included in most processing units. There are many floating point operations including addition, subtraction, multiplication, division, reciprocal and square root. The Northeastern Reconfigurable Computing Lab has developed its own variable precision floating point library called VFLOAT, which is vender agnostic, easy to use and has a good tradeoff between hardware resources, maximum clock frequency and latency. Field Programmable Gate Arrays (FPGAs), due to their flexibility, low power consumption and short development time compared to Application Specific ICs (ASICs), are chosen as the platform for the VFloat library to run on. Very-high-speed integrated circuits Hardware Description Language (VHDL) is used to describe these components. Xilinx and Altera are the two main suppliers of programmable logic devices. Each company has its own Integrated Development Environment (IDE). Both IDE from Altera and Xilinx have been used to implement this cross platform project. VFloat is an open-source library unlike the intellectual property cores the IP Cores from Xilinx or Mega cores from Altera, contributing more flexibility to the development process. In the operations of the variable precision floating point library, reciprocal, division and square root are much more difficult to implement than addition, subtraction and multiplication and their running time is much longer. There is limited ability to improve the performance or the resource usage for operations like addition, sub-traction and multiplication. However, there are several methods to choose from to implement reciprocal, division and square root, including digit recurrence, iterative method and table-based method. Improving division and square root can significantly speed up the performance of floating point applications. Our goal is to find a good tradeoff among resource usage on an FPGA, the maximum clock frequency of the operation, and the number of clock cycles latency. This thesis examines a table-based approach to division, reciprocal and square root that achieves this goal.

II. LITERATURE REVIEW

N. Arya et al.,[1] approximate computing is acquiring force for plan of exactness energy configurable circuits for blunder open minded applications. In this work, a low power diminished region square root (SQR) circuit is introduced that accomplishes amazing region and energy proficiency, while presenting unimportant mistakes in the

outcomes. Two estimated plans are proposed for reestablishing cluster based square-pull circuit for mistake tough applications. In the principal configuration, estimated reestablishing subtractor cells are utilized to substitute definite SQR subtractor cells by working on the boolean articulations. The subsequent plan lessens the plan intricacy and expands energy productivity by utilizing the exemplary rough figuring strategy of spot truncation. Both the plans are executed for 8-and 16-bit square-root circuit plan with various upsides of guess boundary 'd' for accomplishing different plan compromise focuses. Our results demonstrate that the proposed approximated SQR plans show an improvement as far as postponement, power utilization, energy and region and works on these boundaries on normal by 37%, 24%, 18%, and 44%, separately for 16-bit SQR plans when executed on CMOS 45- nm innovation hub without compromising much on precision. Likewise, the proposed surmised plans are tried on blunder open minded applications including contrast improvement for clinical pictures and envelope recognition in AM (Abundancy Tweak) correspondence frameworks. Moreover, our results approve the inexact square-root plans with progress Rather than Commotion proportion (CNR) for picture handling applications and an adequate Sign to Clamor proportion (SNR) for simple correspondence framework.

R. Nayar et al.,[2] This work presents another equipment improved surmised adder that has basically zero normal blunder and an ordinary i.e., a Gaussian mistake dissemination. We call the proposed surmised adder HOAANED, which is extended as equipment upgraded rough adder with an ordinary mistake dissemination. We considered the utilization of HOAANED for computerized picture handling close by the exact adder and numerous other rough adders for a reasonable examination. Specifically, the augmentations engaged with performing quick Fourier Change and backwards quick Fourier change activities to reproduce the pictures were executed utilizing precise and inexact adders independently. We observed that HOAANED further develops the pinnacle signal-to-commotion proportion of the recreated pictures better contrasted with the other rough adders. Further, HOAANED has enhanced plan measurements. This perception depends on actual execution utilizing a 32/28nm CMOS standard advanced cell library. Moreover, in view of the mistake examination of numerous 32-digit rough adders utilizing 1,000,000 irregular info vectors we observed that HOAANED has for all intents and purposes zero normal blunder, an improved root mean square blunder and a typical mistake circulation.

Y. Fu,et al.,[3] This article presents a 32- GHz recurrence tweaked persistent wave (FMCW) modulator in light of the stage locked circle (PLL) with settled sub-PLL structure in a 65-nm CMOS process. With the sub-PLL, the low-pass impact in stage space is acknowledged, decreasing the clamor collapsing impact, quantization commotion, and spikes because of the delta sigma modulator (DSM). To accomplish great solidness and stage commotion execution, both the stage space model and the stage clamor model are dissected and mimicked. In light of these models, the trill linearity is talked about and recreated, which assists with deciding the plan boundaries and checks the linearity improvement. The estimation results outline that in fragmentary N mode, the settled PLL accomplishes the stage commotion of - 91 dBc/Hz at 1-MHz offset recurrence and the partial prods of not exactly - 54 dBc at 30.78-GHz yield recurrence. In FMCW mode, the proposed modulator accomplishes a three-sided tweet with 1.08-2.16-GHz data transfer capacity at around 32-GHz focus recurrence. Furthermore, the deliberate root mean square (rms) recurrence blunders of 400 and 770 kHz are accomplished with the incline slants of 1.08 GHz/93 µs and 2.16 GHz/93 µs, separately. Estimation results demonstrate the enhancementsof the stage clamor and tweet linearity with the sub-PLL. Counting all cushions, the chip involves a silicon area of 1.5 mm 2 , and consumes 62-mW dc power.

T. Fujibayashi et al.,[4] An exactly stage controlled transmitter working in 76-to 81-GHz for the auto radar application is introduced. To accomplish exact stage control, a clever stage identifier utilizing third request mutilation is utilized to repay the transmitter stage mistake. The multi- channel transmitter utilizing this finder accomplishes under 0.6° root-mean-square (RMS) gradually work blunder in 76-to 81-GHz recurrence range. Since the proposed stage identifier doesn't depend on the other TX channels, it's not difficult to expand the quantity of channels. This proposed transmitter is executed in 65-nm CMOS innovation. The stage locator consumes 1.8mW per channel.

S. U. Rehman et al.,[5] This short presents a 4-cycle carefully controlled differential postpone component (DCDE) with fast and high-goal capacity, two testing prerequisites in the plan of defer components. Two info bits, inside the differential current-mode rationale (CML) DCDE, direct its inclination current and the resistive burden, while the other two pieces arrange the result capacitive burden empowering the introduced DCDE to accomplish a stage shift of 20 ps and a normal goal of 1.25 ps. Planned in 45-nm silicon-on-protector (SOI) CMOS, the DCDE disseminates 4 mW of force under most extreme biasing condition and can work up to 10 Gb/s while adding just 0.6 ps of root-mean-square jitter to the deferred input. To the best of creators information, the planned DCDE is the initial 4-digit low-jitter 10-Gb/s variable-load CML DCDE offering a period goal of 1.25 ps, making it an appropriate possibility for fast and high-goal applications.

S. Yang et al.,[6] This work portrays a super smaller all-advanced increasing postponement locked circle (MDLL) including a low-power block-sharing without offset recurrence following circle (FTL) to align the cycle voltage-temperature varieties of the voltage-controlled oscillator (VCO) recurrence. Such FTL uses an advanced controlled postpone line (DCDL)- based low-power time-span comparator and a contiguous edge selector, to unequivocally distinguish the static stage offset (SPO) brought about by the VCO recurrence floating within the sight of reference infusion. The square sharing-based SPO

identification helps invalidating the circuit-confuse and counterbalance actuated deterministic blunder. Additionally, for the adjoining edge selector, block dividing among its control age circuits and the coarse FTL further lessens the power utilization. The varactor-tuned double multiplexed-ring VCOs (MRVCOs) serve to decrease jitter variety while broadening the recurrence tuning range. Manufactured in a 28-nm CMOS with a center area of 0.0056 mm 2 , the proposed MDLL covers a tuning range from 1.55 to 3.35 GHz, and shows a root-mean-square (rms) jitter of 292 fs at 3-GHz yield, under a 200-MHz reference clock. The power utilization is 1.45 mW at a 0.8-V inventory, bringing about a FoM of - 249 dB well similar with the best in class. J.-

H. Hsieh et al.,[7] In this work, a speed and power-effective set apportioning in various leveled trees (SPIHT) plan is presented for one-layered (1-D) wavelet-based electrocardiography (ECG) pressure frameworks with quality assurance. To accomplish constant and low-power plan destinations toward wearable quality-on-request (QoD) ECG applications, we initially propose a coding-timeand calculation effective SPIHT calculation utilizing different kinds of coding status register records to conquer the hindrances of low coding speeds and convoluted equipment designs describing earlier SPIHT calculations coming about because of the need of dynamic calculation and course of action in the arranging and refinement handling stage. Second, a profoundly pipelined and power-effective exceptionally enormous scope combination (VLSI) engineering is created to carry out an elite presentation and low-power SPIHT configuration in light of the proposed calculation. The last recreation results show that our proposed calculation can accelerate the normal coding time 1.52 to 2.74 occasions contrasted with earlier work with an indistinguishable pressure proportion for a 11-level 1024 × 11-D discrete wavelet change at assorted objective rate root- mean-square contrasts (PRDT) on different MIT-BIH arrhythmia datasets. Applied to wearable wavelet-based QoD ECG applications, our proposed VLSI engineering achieves a functioning recurrence of 740 MHz and consumes a normal of 23 μW of force with Taiwan Semiconductor Assembling Organization 90-nm CMOS innovation, which shows the adequacy of speed and control over the best in class plans. **H. Fuketa et al.,[8]** In this work, a shut structure articulation for assessing the base working voltage (VDDmin) of D flip-flops (FFs) is proposed. VDDmin is characterized as the base inventory voltage at which the FFs are utilitarian without blunders. The proposed articulation demonstrates that VDDmin of FFs is a direct capacity of the square foundation of logarithm of the quantity of FFs, and its incline relies upon the inside pass on variety of the edge voltage (VTH) and its catch relies upon the harmony among nMOS and pMOS, which is basically because of the kick the bucket to-bite the dust VTH variety. The proposed articulation of VDDmin is approved by the recreation results just as the silicon estimations. At long last, we talk about the reliance of VDDmin on the gadget boundaries.

J. J. Pimentel et al.,[9] Hybrid drifting point (FP) executions further develop programming FP execution without bringing about the area overhead of full equipment FP units. The proposed executions are incorporated in 65-nm CMOS and coordinated into little fixed-point processors with a RISC-like design. Unsigned, shift convey, and driving zero location (USL) support is added to a processor to expand a current guidance set engineering and increment FP throughput with little region overhead. The hybrid executions with USL support increment programming FP throughput per center by 2.18× for option/deduction, 1.29× for increase, 3.07-4.05× for division, and 3.11-3.81× for square root, and utilize 90.7-94.6% less region than committed melded duplicate add (FMA) equipment. Hybrid executions with custom FP-explicit equipment increment throughput per center over a fixed-point programming portion by 3.69-7.28× for expansion/deduction, 1.22-2.03× for duplication, 14.4× for division, and 31.9× for square root, and utilize 77.3-97.0% less region than devoted FMA equipment. The circuit region and throughput are found for 38 increase add, 8 option/deduction, 6 duplication, 45 division, and 45 square root plans. 33 duplicate add executions are introduced, which further develop throughput per center versus a fixed-point programming execution by 1.11-15.9× and utilize 38.2-95.3% less region than devoted FMA equipment. T.

Lee et al.,[10] Ring oscillators (ROs) are well known because of their little region, humble power, wide tuning reach, and simplicity of scaling with process innovation. In any case, their utilization in numerous applications is restricted because of helpless stage clamor and jitter execution. Warm clamor and glint commotion contribute jitter that diminishes contrarily with wavering recurrence. This work depicts a recurrence help procedure to diminish jitter in ROs. We support the interior swaying recurrence and present a recurrence divider following the oscillator to keep up with the ideal result recurrence. This methodology offers decreased jitter just as the chance to compromise yield jitter with power for dynamic execution the board. The oscillator has 32 working modes, comparing to various qualities for the ring size and recurrence division. In a 0.5-μm CMOS process, the most elevated swaying recurrence accomplished is 25 MHz with a root-mean-square period jitter of 54 ps and a power utilization of 817 μW at 5 V inventory. A jitter model for current-starved oscillators was inferred and confirmed by estimation; an immediate connection between swaying recurrence and jitter was determined and estimated. Contrasted and different oscillators, this plan accomplishes the best exhibition as far as jitter per unit stretch and figure-of- merit. The presentation is relied upon to work on in further developed innovations. The outcomes are summed up to offer plan direction in view of the recurrence support method.

II.PROBLEM FORMULATION

The variety of computer arithmetic techniques can be used to implement a square root. Most techniques involve computing a set of partial products, and then summing the partial products together. In existing system computing the

square root, there are three steps similar to the reciprocal computation. First step is reduction, second is evaluation, and the last step is post-processing. In the design of most commercial RISC processors, a square root is used for all iterations of div or sqrt instructions.There is still some of the limitation or challenges in square root detection code so the observed problem formulation is as followings

- The existing technique based circuit complexity is high for detection of the square root, it generate more number of carry adder.
- The square root requires a rather large number of gate counts.
- It is impractical to place as many square roots as required to realize fully pipelined operation for division and square root instructions.
- The existing circuits give more latency and consume more power during operation.

III. PROPOSED WORK METHODOLOGY

The proposed system proposes a new non-restoring square root algorithm that requires neither square roots nor multiplexors. Compared with previous square root algorithms, proposed algorithm is very efficient for VLSI implementation. This is feasible for the digital signal processing and field programmable gate array applications.

IV.RESULT AND ANALYSIS

The ISE Design Suite is the Xilinx® design environment, which allows you to take your design from design entry to Xilinx device programming. With specific editions for logic, embedded processor, or Digital Signal Processing (DSP) system designers, the ISE Design Suite provides an environment tailored to meet your specific design needs.
Xilinx ISE (Integrated Software Environment) is a software tool produced by Xilinx for synthesis and analysis of HDL designs, enabling the developer to synthesize their designs, perform timing analysis, examine RTL diagrams, simulate a design's reaction to different stimuli, and configure the target device with the programmer.

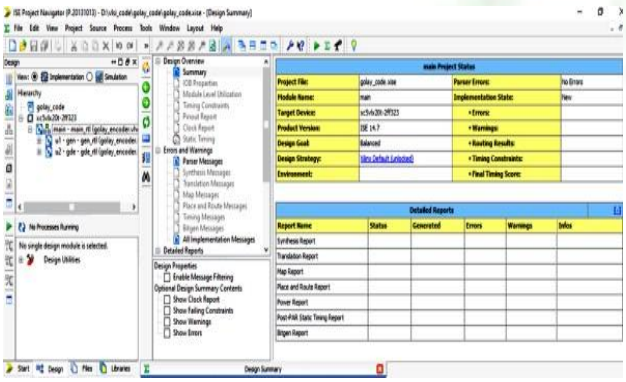

Figure 5.1: Snap shot of Xilinx

ISE Design Suite: Logic Edition

The ISE Design Suite: Logic Edition allows you to go from design entry, through implementation and verification, to device programming from within the unified environment of the ISE Project Navigator or from the command line. This edition includes exclusive tools and technologies to help achieve optimal design results, including the following: PlanAhea software - allows you to do advance FPGA floor planning. The PlanAhead software includes PinAhead, an environment designed to help you to import or create the initial I/O Port list, group the related ports into separate folders called “Interfaces” and assign them to package pins. PinAhead supports fully automatic pin placement or semi-automated interactive modes to allow controlled I/O Port assignment. With early, intelligent decisions in FPGA I/O assignments, you can more easily optimize the connectivity between the PCB and FGPA.

V.CONCLUSION AND FUTURE WORK

Variable precision fixed and floating point operations have various fields of applications including scientific computing and signal processing.
Field Programmable Gate Arrays(FPGAs) are a good platform to accelerate such applications because of their flexibility, low development time and cost compared to Application Specific Integrated Circuits (ASICs) and low power consumption compared to Graphics Processing Units (GPUs). Among those operations, the square root can differ based on the algorithm implemented. They can highly affect the total performance of the application running them.This research proposes a new non-restoring square root algorithm that requires neither square roots nor multiplexors. Compared with previous square root algorithms, our algorithm is very efficient for VLSI implementation. It generates the correct resulting value at each iteration and does not require extra circuitry for adjusting the result bit. The operation at each iteration is simple: addition or subtraction based on the result bit generated in previous iteration. The remainder of the addition or subtraction is fed via registers to the next iteration directly even it is negative. At the last iteration, if the remainder is non-negative, it is a precise remainder. Otherwise, we can obtain a precise remainder by an addition operation.

FUTURE SCOPE

Performance analysis through other new approaches.
More parameters can be calculated when use different approaches.
Experiential test in real time environment.
Implemented multi error correction and detection after square root can be used in real-time IOT based wireless sensor network applications..

REFERENCE

1. N. Arya, T. Soni, M. Pattanaik and G. K. Sharma, "Area and Energy Efficient Approximate Square Rooters for Error Resilient Applications," 2020 33rd International Conference on VLSI Design and 2020 19th International Conference on Embedded Systems (VLSID), 2020, pp. 90-95, doi: 10.1109/VLSID49098.2020.00033.
2. R. Nayar, P. Balasubramanian and D. L. Maskell, "Hardware Optimized Approximate Adder with

Normal Error Distribution," 2020 IEEE Computer Society Annual Symposium on VLSI (ISVLSI), 2020, pp. 84-89, doi: 10.1109/ISVLSI49217.2020.00025.

3. Y. Fu, L. Li, Y. Liao, X. Wang, Y. Shi and D. Wang, "A 32-GHz Nested-PLL-Based FMCW Modulator With 2.16- GHz Bandwidth in a 65-nm CMOS Process," in IEEE Transactions on Very Large Scale Integration (VLSI) Systems, vol. 28, no. 7, pp. 1600-1609, July 2020, doi: 10.1109/TVLSI.2020.2992123.
4. T. Fujibayashi and Y. Takeda, "A 76- to 81-GHz, 0.6° rms Phase Error Multi-channel Transmitter with a Novel Phase Detector and Compensation Technique," 2019 Symposium on VLSI Circuits, 2019, pp. C16-C17, doi: 10.23919/VLSIC.2019.8778158.
5. S. U. Rehman, M. M. Khafaji, C. Carta and F. Ellinger, "A 10-Gb/s 20-ps Delay-Range Digitally Controlled Differential Delay Element in 45-nm SOI CMOS," in IEEE Transactions on Very Large Scale Integration (VLSI) Systems, vol. 27, no. 5, pp. 1233-1237, May 2019, doi:10.1109/TVLSI.2019.2894736.
6. S. Yang, J. Yin, P. Mak and R. P. Martins, "A 0.0056-mm2−249-dB-FoM All-Digital MDLL Using a Block-Sharing Offset-Free Frequency-Tracking Loop and Dual Multiplexed- Ring VCOs," in IEEE Journal of Solid-State Circuits, vol. 54, no. 1, pp. 88-98, Jan. 2019, doi: 10.1109/JSSC.2018.2870551.
7. J. -H. Hsieh, K. -C. Hung, Y. -L. Lin and M. -J. Shih, "A Speed- and Power-Efficient SPIHT Design for Wearable Quality-On-Demand ECG Applications," in IEEE Journal of Biomedical and Health Informatics, vol. 22, no. 5, pp. 1456- 1465, Sept. 2018, doi: 10.1109/JBHI.2017.2773097.
8. H. Fuketa, S. -i. O'uchi and T. Matsukawa, "A Closed- Form Expression for Minimum Operating Voltage of CMOS D Flip-Flop," in IEEE Transactions on Very Large Scale Integration (VLSI) Systems, vol. 25, no. 7, pp. 2007-2016, July 2017, doi: 10.1109/TVLSI.2017.2677978.
9. J. J. Pimentel, B. Bohnenstiehl and B. M. Baas, "Hybrid Hardware/Software Floating-Point Implementations for Optimized Area and Throughput Tradeoffs," in IEEE Transactions on Very Large Scale Integration (VLSI) Systems, vol. 25, no. 1, pp. 100-113, Jan. 2017, doi 10.1109/TVLSI.2016.2580142.
10. .T. Lee and P. A. Abshire, "Frequency-Boost Jitter Reduction for Voltage-Controlled Ring Oscillators," in IEEE Transactions on Very Large Scale Integration (VLSI) Systems, vol. 24, no. 10, pp. 3156-3168, Oct. 2016, doi: 10.1109/TVLSI.2016.2541718.
11. Z. Yan, G. He, Y. Ren, W. He, J. Jiang and Z. Mao, "Design and Implementation of Flexible Dual-Mode Soft- Output MIMO Detector With Channel Preprocessing," in IEEE Transactions on Circuits and Systems I: Regular Papers, vol. 62, no. 11, pp. 2706-2717, Nov. 2015, doi: 10.1109/TCSI.2015.2479055.
12. K. Chen and Y. H. Kim, "Current source model of combinational logic gates for accurate gate-level circuit analysis and timing analysis," VLSI Design, Automation and Test(VLSI-DAT), 2015, pp. 1-4, doi: 10.1109/VLSI- DAT.2015.7114529.
13. J. Lin, C. Yang and H. Wu, "A 2.5-Gb/s DLL-Based Burst-Mode Clock and Data Recovery Circuit With $4\times$ Oversampling," in IEEE Transactions on Very Large Scale Integration (VLSI) Systems, vol. 23, no. 4, pp. 791-795, April 2015, doi: 10.1109/TVLSI.2014.2316553.
14. H. Amir-Aslanzadeh, E. J. Pankratz, C. Mishra and E. Sanchez-Sinencio, "Current-Reused 2.4-GHz Direct-Modulation Transmitter With On-Chip Automatic Tuning," in IEEE Transactions on Very Large Scale Integration (VLSI) Systems, vol. 21, no. 4, pp. 732-746, April 2013, doi: 10.1109/TVLSI.2012.2190538.
15. K. Gupta, M. Bhardwaj, B. P. Singh and R. Choudhary, "Design of Low Power Low Cost True RMS-to-DC Converter," 2012 Second International Conference on Advanced Computing & Communication Technologies, 2012, pp. 364-367, doi: 10.1109/ACCT.2012.44.

