



Cairo University

# **DESIGN OF HIGH-PERFORMANCE VARIATION- TOLERANT DIFFERENTIAL VOLTAGE-TO-TIME CONVERTER (VTC) CIRCUITS**

By

Abdullah Mohamed Ahmed El-Bayoumi

A Thesis Submitted to the  
Faculty of Engineering at Cairo University  
in Partial Fulfillment of the  
Requirements for the Degree of  
**MASTER OF SCIENCE**  
in  
Electronics and Communications Engineering

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**Title of Thesis:**

Design of Time-based Analog-to-Digital Converter (T-ADC): High-Performance  
Variation-Tolerant Differential Voltage-to-Time Converter (VTC) Circuits

**Key Words:**

Nanometer CMOS technology; voltage-to-time converter; time-based analog-to-digital converter; software-defined radio; biomedical applications; metal-insulator-metal capacitor; dynamic range.

**Summary:**

In this thesis, various metal-insulator-metal (MIM) capacitor-based differential Voltage-to-Time Converters (VTCs) including 2 novel proposed designs, which achieve a high performance at higher sampling frequency for a Software-Defined Radio (SDR) receiver at 65-nm CMOS technology, are presented and compared to their single-ended design. A study on tolerating the process-voltage-temperature (PVT) variations for the 1<sup>st</sup> proposed design with proposing a dynamic calibration technique based on a set of large-sized capacitor-based voltage dividers circuits is presented. Post-layout simulation results are provided for both designs at 130-nm CMOS technology for low-frequency low-power implantable biomedical systems.

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Research is something when you change your way of thinking. This process of change may be slow. Thus, it could leave you completely unaware of the change you have made, and the progress that you are currently making. An instance of recollection, such as writing a summary of the progress you have been doing for the last years brings these things to your attention. This process of change is something that your environment is aware of, as one is thrown between despair and hope. Being a software engineer in a multinational company is stressful and at times it is emotionally challenging to struggle to manage your time between your industrial work background and your academic research. Although, they could fulfill a perfection background of how we innovate ideas till we can provide products to the market. Finally, I am also grateful to all my friends who have encouraged me to keep going on and brought social balance into my life.

## **Dedication**

I have devoted this dissertation with a special thank you to my family for helping me to come this far and for being a continuous source of love, care, warmth and stability throughout my life. Collectively, they are an enormous pool of support for which I would not have succeeded without. I owe them every single achievement in my life.

# Table of Contents

<b>ACKNOWLEDGMENTS .....</b>	<b>I</b>
<b>DEDICATION.....</b>	<b>II</b>
<b>TABLE OF CONTENTS.....</b>	<b>III</b>
<b>LIST OF TABLES .....</b>	<b>VII</b>
<b>LIST OF FIGURES .....</b>	<b>IX</b>
<b>NOMENCLATURE .....</b>	<b>XII</b>
<b>LIST OF PUBLICATIONS.....</b>	<b>XIV</b>
<b>ABSTRACT .....</b>	<b>XV</b>
<b>CHAPTER 1 : INTRODUCTION .....</b>	<b>1</b>
1.1.    MOTIVATION .....	2
1.2.    THESIS SCOPE .....	4
1.3.    THESIS OVERVIEW .....	4
<b>CHAPTER 2 : LITERATURE REVIEW .....</b>	<b>6</b>
2.1.    ANALOG-TO-DIGITAL CONVERTER.....	6
2.1.1.    SAMPLING.....	6
2.1.2.    QUANTIZATION .....	7
2.2.    ADC TYPES .....	8
2.2.1.    DIRECT CONVERSION ADCS.....	9
2.2.1.1.    NYQUIST-RATE ADC .....	9
2.2.1.1.1.    SUCCESSIVE-APPROXIMATION ADC.....	9
2.2.1.1.2.    FLASH ADC.....	10
2.2.1.1.3.    PIPELINED ADC .....	12
2.2.1.1.4.    TIME-INTERLEAVED ADC.....	14
2.2.1.2.    OVERSAMPLING ADC.....	15
2.2.1.2.1.    SIGMA-DELTA MODULATOR .....	15
2.2.2.    INDIRECT CONVERSION ADCS .....	17
2.2.2.1.    NYQUIST-RATE ADC .....	17
2.2.2.1.1.    INTEGRATING-BASED ADC.....	17
2.2.2.2.    OVERSAMPLING ADC.....	18
2.2.2.2.1.    PWM-BASED ADC .....	18

2.2.2.2.2.	VTC-BASED ADC .....	19
2.2.2.2.3.	VCO-BASED ADC.....	19
2.3.	PERFORMANCE METRICS.....	20
2.3.1.	ADC CHARACTERISTICS.....	20
2.3.1.1.	GAIN ERROR.....	20
2.3.1.2.	OFFSET ERROR.....	20
2.3.1.3.	INTEGRAL NON-LINEARITY .....	21
2.3.1.4.	DIFFERENTIAL NON-LINEARITY .....	22
2.3.1.5.	MISSING CODES .....	23
2.3.2.	VTC CHARACTERISTICS.....	23
2.3.2.1.	LINEARITY AND DYNAMIC RANGE.....	23
2.3.2.2.	VOLTAGE SENSITIVITY.....	24
2.3.2.3.	MAXIMUM SAMPLING FREQUENCY .....	24
2.3.2.4.	TOTAL HARMONIC DISTORTION.....	24
2.3.2.5.	SIGNAL-TO-NOISE-AND-DISTORTION RATIO .....	25
2.3.2.6.	EFFECTIVE NUMBER OF BITS .....	25
2.3.2.7.	RESOLUTION.....	25
2.3.2.8.	NOISE .....	25
2.3.2.9.	AREA .....	26
2.3.2.10.	POWER .....	26
2.3.2.11.	FIGURE-OF-MERIT .....	26
<b>CHAPTER 3 : NOVEL DIFFERENTIAL VTC CIRCUITS FOR HIGH-SPEED SDR APPLICATIONS.....</b>		<b>27</b>
3.1.	INTRODUCTION .....	27
3.2.	DIFFERENTIAL FALLING VTC CIRCUIT.....	30
3.2.1.	THE DIFFERENTIAL FALLING VTC DESIGN.....	30
3.2.2.	SIMULATION RESULTS.....	32
3.3.	DIFFERENTIAL RISING VTC CIRCUIT.....	34
3.3.1.	THE DIFFERENTIAL RISING VTC DESIGN.....	34
3.3.2.	SIMULATION RESULTS.....	35
3.4.	DIFFERENTIAL VTC METHODOLOGY CIRCUIT.....	36
3.4.1.	THE DIFFERENTIAL VTC METHODOLOGY DESIGN.....	36



3.4.2.	<b>SIMULATION RESULTS.....</b>	<b>38</b>
3.5.	MODIFIED DIFFERENTIAL VTC METHODOLOGY CIRCUIT .....	40
3.5.1.	<b>THE 1<sup>ST</sup> DIFFERENTIAL VTC PROPOSED DESIGN.....</b>	<b>40</b>
3.5.2.	<b>SIMULATION RESULTS.....</b>	<b>42</b>
3.5.3.	<b>PVT VARIATIONS CALIBRATION.....</b>	<b>45</b>
3.5.3.1.	<b>PROCESS VARIATIONS.....</b>	<b>46</b>
3.5.3.1.1.	<b>BEFORE CALIBRATION.....</b>	<b>46</b>
3.5.3.1.2.	<b>AFTER CALIBRATION.....</b>	<b>48</b>
3.5.3.2.	<b>VOLTAGE VARIATIONS.....</b>	<b>51</b>
3.5.3.2.1.	<b>BEFORE CALIBRATION.....</b>	<b>51</b>
3.5.3.2.2.	<b>AFTER CALIBRATION.....</b>	<b>54</b>
3.5.3.3.	<b>TEMPERATURE VARIATIONS.....</b>	<b>57</b>
3.5.3.3.1.	<b>BEFORE CALIBRATION.....</b>	<b>57</b>
3.5.3.3.2.	<b>AFTER CALIBRATION.....</b>	<b>60</b>
3.5.4.	<b>MIMCAP-BASED DESIGN VERSUS MOSCAP-BASED DESIGN.....</b>	<b>63</b>
3.6.	DIFFERENTIAL HIGH-SPEED VTC CIRCUIT .....	63
3.6.1.	<b>THE 2<sup>ND</sup> DIFFERENTIAL VTC PROPOSED DESIGN .....</b>	<b>63</b>
3.6.2.	<b>SIMULATION RESULTS.....</b>	<b>64</b>
<b>CHAPTER 4 : DIFFERENTIAL VTC CIRCUITS FOR HIGH-ACCURACY BIOMEDICAL APPLICATIONS. ....</b>		<b>67</b>
4.1.	INTRODUCTION .....	67
4.2.	MODIFIED DIFFERENTIAL VTC METHODOLOGY CIRCUIT AT 130-NM CMOS ....	68
4.2.1.	<b>POST-LAYOUT RESULTS WITHOUT THE CALIBRATION CIRCUIT.....</b>	<b>68</b>
4.2.2.	<b>POST-LAYOUT RESULTS WITH THE CALIBRATION CIRCUIT ...</b>	<b>74</b>
4.3.	DIFFERENTIAL HIGH-SPEED VTC CIRCUIT AT 130-NM CMOS .....	77
<b>DISCUSSION AND CONCLUSIONS .....</b>		<b>81</b>
1.	PROPOSED DESIGNS PERFORMANCE .....	81
2.	FUTURE WORK.....	81
3.	CONCLUSION .....	83
<b>REFERENCES .....</b>		<b>84</b>
<b>APPENDIX A: DESIGN PARAMETERS.....</b>		<b>88</b>
A.1	DIFFERENTIAL FALLING VTC DESIGN PARAMETERS AT 65-NM CMOS.....	88

A.2	DIFFERENTIAL RISING VTC DESIGN PARAMETERS AT 65-NM CMOS.....	88
A.3	DIFFERENTIAL VTC METHODOLOGY DESIGN PARAMETERS AT 65-NM CMOS..	89
A.4	MODIFIED DIFFERENTIAL VTC METHODOLOGY DESIGN PARAMETERS AT 65- NM CMOS .....	89
A.5	DIFFERENTIAL HIGH-SPEED VTC DESIGN PARAMETERS AT 65-NM CMOS .....	90
A.6	DIFFERENTIAL VTC METHODOLOGY DESIGN PARAMETERS AT 130-NM CMOS	92
A.7	DIFFERENTIAL HIGH-SPEED VTC DESIGN PARAMETERS AT 130-NM CMOS .....	92
<b>APPENDIX B: SIMULATIONS METHODS .....</b>		<b>94</b>
B.1	LINEARITY CHECK .....	94
B.2	CIRCUIT SENSITIVITY .....	102
B.3	TOTAL HARMONIC DISTORTION .....	102
B.4	POWER CONSUMPTION .....	104
B.5	NOISE FIGURE.....	105
B.6	EFFECTIVE NUMBER OF BITS .....	107
B.7	PVT VARIATIONS .....	115

## List of Tables

Table 2.1: ADC resolution and sampling rate for various applications .....	24
Table 3.1: Performance comparison between the differential falling VTC circuit and its single-ended design @ 3% linearity error .....	33
Table 3.2: Performance comparison of the differential falling while sweeping the sampling frequency with a 3% linearity error. ....	34
Table 3.3: Performance comparison between the differential rising VTC circuit and its single-ended design @ 3% linearity error .....	35
Table 3.4: Performance comparison between the differential VTC methodology circuit and its single-ended design @ 3% linearity error.....	39
Table 3.5: Performance comparison of the differential methodology while sweeping the sampling frequency with a 3% linearity error. ....	40
Table 3.6: Performance comparison between the modified differential VTC methodology circuit and its single-ended design @ 3% linearity error. ....	44
Table 3.7: Performance comparison before calibration between the proposed design and the single-ended design at different corners. ....	47
Table 3.8: Performance comparison after calibration between the proposed design and the single-ended design at different corners. ....	50
Table 3.9: Performance comparison before calibration between the proposed design and the single-ended design at supply voltage variations. ....	53
Table 3.10: Performance comparison after calibration between the proposed design and the single-ended design at supply voltage variations. ....	56
Table 3.11: Performance comparison before calibration between the proposed design and the single-ended design at temperature variations. ....	57
Table 3.12: Performance comparison after calibration between the proposed design and the single-ended design at temperature variations.....	60
Table 3.13: Performance comparison between the proposed design with a MIMCAP and a MOSCAP at a fixed dynamic range and DC bias voltage. ....	63
Table 3.14: Performance comparison between the differential high-speed VTC circuit and its single-ended design @ 3% linearity error.....	66
Table 3.15: Performance comparison of the single-ended high-speed VTC while sweeping the sampling frequency. ....	66
Table 3.16: Performance comparison of the differential high-speed VTC while sweeping the sampling frequency. ....	66
Table 4.1: Post-layout performance comparison between the 1 <sup>st</sup> proposed design and its single-ended VTC circuit at 3 % linearity error. ....	68
Table 4.2: Post-layout performance comparison of the 1 <sup>st</sup> proposed design corner variations at 3 % linearity error before calibration.....	74
Table 4.3: Post-layout performance comparison of the 1 <sup>st</sup> proposed design corner variations at 3 % linearity error after calibration.....	76
Table 4.4: Post-layout performance comparison between the 2 <sup>nd</sup> proposed design and its single-ended VTC circuit. ....	77
Table A.1: Design parameters of the core of the differential falling VTC circuit. ....	88
Table A.2: Design parameters of the core of the differential rising VTC circuit.....	88

Table A.3: Design parameters of the XNOR gate of the single core of the differential VTC methodology circuit.....	89
Table A.4: Design parameters of the output inverter of the single core of the differential VTC methodology circuit.....	89
Table A.5: Design parameters of the modified differential VTC methodology circuit.	90
Table A.6: Design parameters of the set of the calibration circuits on PVT variations.	90
Table A.7: Design parameters of the single core of the differential high-speed VTC circuit.....	91
Table A.8: Design parameters of the single core of the 1 <sup>st</sup> proposed differential VTC circuit.....	91
Table A.9: Design parameters of the set of the calibration circuits on PVT variations.	92
Table A.10: Design parameters of the single core of the 2 <sup>nd</sup> proposed VTC circuit.....	93

# List of Figures

Figure 1.1: TADC architecture .....	2
Figure 2.1: A functionality of a 3-bit ADC .....	6
Figure 2.2: An input signal spectrum achieving the Nyquist-rate criterion .....	7
Figure 2.3: An input signal spectrum not achieving the Nyquist-rate criterion .....	7
Figure 2.4: Original signal versus quantized signal .....	8
Figure 2.5: Quantization error representation .....	8
Figure 2.6: SAR architecture .....	9
Figure 2.7: SAR algorithm .....	10
Figure 2.8: Flash ADC architecture.....	11
Figure 2.9: Folded flash ADC architecture .....	12
Figure 2.10: Pipeline ADC architecture .....	13
Figure 2.11: Block diagram of a single stage of a pipeline ADC.....	13
Figure 2.12: Cyclic ADC architecture.....	14
Figure 2.13: Time-interleaved ADC architecture.....	15
Figure 2.14: First-order $\Sigma\Delta$ ADC architecture. (a) error feedback model. (b) output feedback model.....	16
Figure 2.15: Second-order $\Sigma\Delta$ ADC architecture.....	17
Figure 2.16: Single-slope ADC architecture .....	17
Figure 2.17: Dual-slope ADC architecture.....	18
Figure 2.18: PWM based ADC architecture.....	19
Figure 2.19: ADC gain error .....	20
Figure 2.20: ADC offset error .....	21
Figure 2.21: ADC integral non-linearity .....	22
Figure 2.22: ADC differential non-linearity.....	22
Figure 2.23: ADC missing code output.....	23
Figure 3.1: Smartphone receiver chains. ....	27
Figure 3.2: Software defined radio receiver block diagram. ....	28
Figure 3.3: The differential VTC architecture.....	29
Figure 3.4: Circuit schematic of the core of a differential falling VTC circuit.....	30
Figure 3.5: VTC operation mode timing diagram. ....	31
Figure 3.6: Differential falling VTC. (a) Linear range at $F_S = 250$ MS/s. (b) Linearity error check at $F_S = 250$ MS/s. (c) Linear range at $F_{S,MAX} = 4$ GS/s. (d) Linearity error check at $F_{S,MAX} = 4$ GS/s. ....	33
Figure 3.7: Circuit schematic of the core of a differential rising VTC circuit. ....	35
Figure 3.8: Differential rising VTC. (a) Linear range at $F_S = 250$ MS/s. (b) Linearity error check at $F_S = 250$ MS/s. (c) Linear range at $F_{S,MAX} = 0.7$ GS/s. (d) Linearity error check at $F_{S,MAX} = 0.7$ GS/s.....	36
Figure 3.9: The differential methodology architecture.....	37
Figure 3.10: The VTC core of the differential methodology architecture. ....	37
Figure 3.11: The XNOR circuit schematic.....	38
Figure 3.12: Differential VTC methodology. (a) Linear range at $F_S = 250$ MS/s. (b) Linearity error check at $F_S = 250$ MS/s. (c) Linear range at $F_{S,MAX} = 2.5$ GS/s. (d) Linearity error check at $F_{S,MAX} = 2.5$ GS/s. ....	39
Figure 3.13: The proposed modified differential methodology architecture. ....	41

Figure 3.14: The modified differential VTC methodology design. (a) Dynamic linear range (b) Linearity error check. ....	42
Figure 3.15: The single-ended VTC core. (a) Dynamic linear range (b) Linearity error check. ....	44
Figure 3.16: The calibration circuit integrated with the proposed design. ....	45
Figure 3.17: The proposed differential VTC before calibration at worst-case corners variations. (a) Dynamic linear range (b) Linearity error check. ....	47
Figure 3.18: The single-ended VTC core before calibration at worst-case corners variations. (a) Dynamic linear range (b) Linearity error check. ....	48
Figure 3.19: The proposed differential VTC after calibration at worst-case corners variations. (a) Dynamic linear range (b) Linearity error check. ....	49
Figure 3.20: The single-ended VTC core after calibration at worst-case corners variations. (a) Dynamic linear range (b) Linearity error check. ....	51
Figure 3.21: The proposed differential VTC before calibration at voltage variations. (a) Dynamic linear range (b) Linearity error check. ....	52
Figure 3.22: The single-ended VTC core before calibration at voltage variations. (a) Dynamic linear range (b) Linearity error check. ....	54
Figure 3.23: The proposed differential VTC after calibration at voltage variations. (a) Dynamic linear range (b) Linearity error check. ....	55
Figure 3.24: The single-ended VTC core after calibration at voltage variations. (a) Dynamic linear range (b) Linearity error check. ....	56
Figure 3.25: The proposed differential VTC before calibration at temperature variations. (a) Dynamic linear range (b) Linearity error check. ....	58
Figure 3.26: The single-ended VTC core before calibration at temperature variations. (a) Dynamic linear range (b) Linearity error check. ....	59
Figure 3.27: The proposed differential VTC after calibration at temperature variations. (a) Dynamic linear range (b) Linearity error check. ....	61
Figure 3.28: The single-ended VTC core after calibration at temperature variations. (a) Dynamic linear range (b) Linearity error check. ....	62
Figure 3.29: Circuit schematic of the core of the differential high-speed VTC design. ....	64
Figure 3.30: Curve fitting of the linear range using MATLAB. (a) The 2 <sup>nd</sup> proposed differential VTC design. (b) The single-ended design. ....	65
Figure 3.31: Linearity error check of the linear range using MATLAB. (a) The 2 <sup>nd</sup> proposed differential VTC design. (b) The single-ended VTC design. ....	65
Figure 4.1: Layout of the 1 <sup>st</sup> proposed VTC design. ....	68
Figure 4.2: The post-layout linear range of the 1 <sup>st</sup> proposed VTC design at 3 % linearity error. ....	69
Figure 4.3: The post-layout linear range with the DC bias of the single-core of the 1 <sup>st</sup> proposed VTC design at 3 % linearity error. ....	69
Figure 4.4: The post-layout linearity error check of the 1 <sup>st</sup> proposed VTC design. ....	70
Figure 4.5: The post-layout linearity error check of the single-core of the 1 <sup>st</sup> proposed VTC design. ....	70
Figure 4.6: Dynamic range of the 1 <sup>st</sup> proposed differential VTC at SS corner before calibration at 3% linearity error. ....	71
Figure 4.7: Linearity error check of the 1 <sup>st</sup> proposed differential VTC at SS corner before calibration. ....	72
Figure 4.8: Linearity error check of the 1 <sup>st</sup> proposed differential VTC at FF corner. ....	72
Figure 4.9: Linearity error check of the 1 <sup>st</sup> proposed differential VTC at FF corner. ....	73

Figure 4.10: Dynamic range of the 1 <sup>st</sup> proposed differential VTC at SS corner after calibration at 3% linearity error.....	75
Figure 4.11: Linearity error check of the 1 <sup>st</sup> proposed differential VTC at SS corner after calibration.....	75
Figure 4.12: Layout of the 2 <sup>nd</sup> proposed VTC design. ....	77
Figure 4.13: The post-layout linear range of the 2 <sup>nd</sup> proposed VTC design at allowed linearity error. ....	78
Figure 4.14: The post-layout linear range of the single-core of the 2 <sup>nd</sup> proposed VTC design at allowed linearity error. ....	78
Figure 4.15: The post-layout linearity error check of the 2 <sup>nd</sup> proposed VTC design.....	79
Figure 4.16: The post-layout linearity error check of the single-core of the 2 <sup>nd</sup> proposed VTC design.....	79
Figure B.1: Choosing the DC analysis on Virtuoso Analog Design Environment. ....	94
Figure B.2: Choosing the transient analysis on Virtuoso ADE.....	95
Figure B.3: Adding the design variables on Virtuoso ADE.....	95
Figure B.4: Opening the Virtuoso Calculator.....	96
Figure B.5: Delay equation on Virtuoso Calculator.....	96
Figure B.6: Outputs on Virtuoso ADE.....	97
Figure B.7: Outputting the Delay equation on Virtuoso ADE.....	97
Figure B.8: Parametric Analysis on Virtuoso ADE.....	98
Figure B.9: Sweeping the input voltage.....	98
Figure B.10: Starting drawing the delay equation.....	99
Figure B.11: The VTC dynamic linear range.....	99
Figure B.12: Delay buffer calculation.....	100
Figure B.13: CSV saved file.....	100
Figure B.14: Circuit sensitivity.....	102
Figure B.15: DFT on Virtuoso Calculator.....	103
Figure B.16: Power configuration on Virtuoso ADE.....	104
Figure B.17: Current configuration on Virtuoso ADE.....	104
Figure B.18: Power equation on Virtuoso Calculator.....	105
Figure B.19: Noise analysis configuration on Virtuoso ADE.....	106
Figure B.20: Noise expression on Virtuoso ADE.....	106
Figure B.21: Model libraries setup on Virtuoso ADE.....	115
Figure B.22: Modifying the device model process.....	115
Figure B.23: Temperature libraries setup on Virtuoso ADE.....	116
Figure B.24: The operating temperature setup on Virtuoso ADE.....	116