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AMPSE: VCO Based ADC in TSMC 65nm CMOS

I. Introduction

In this design a 1GS/s, 6-bit, VCO-based ADC has been implemented. DLL is a commonly used design block for generating multi-phase clocks. The block diagram representation of the design is as follows:

ADC Architecture:

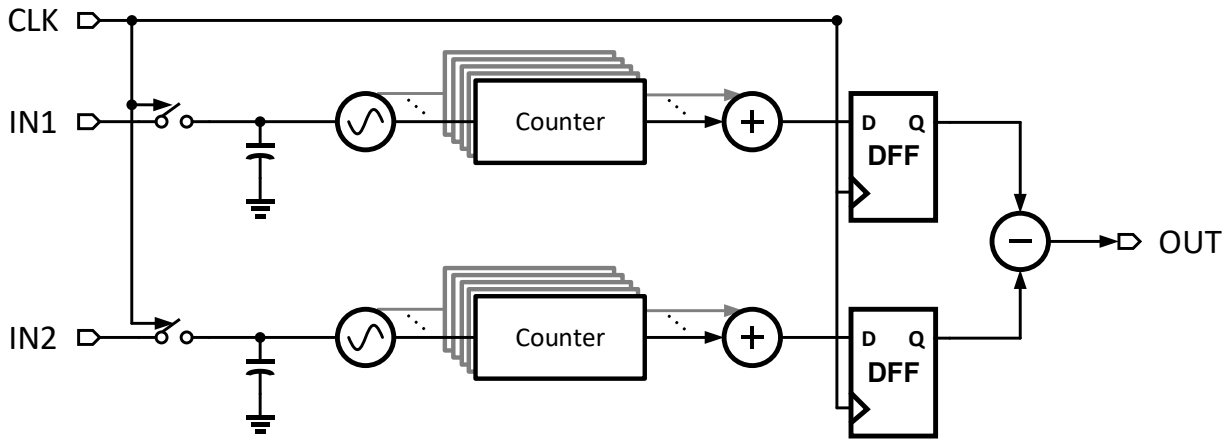


Figure 1: Architecture of VCO-based ADC with AMPSE

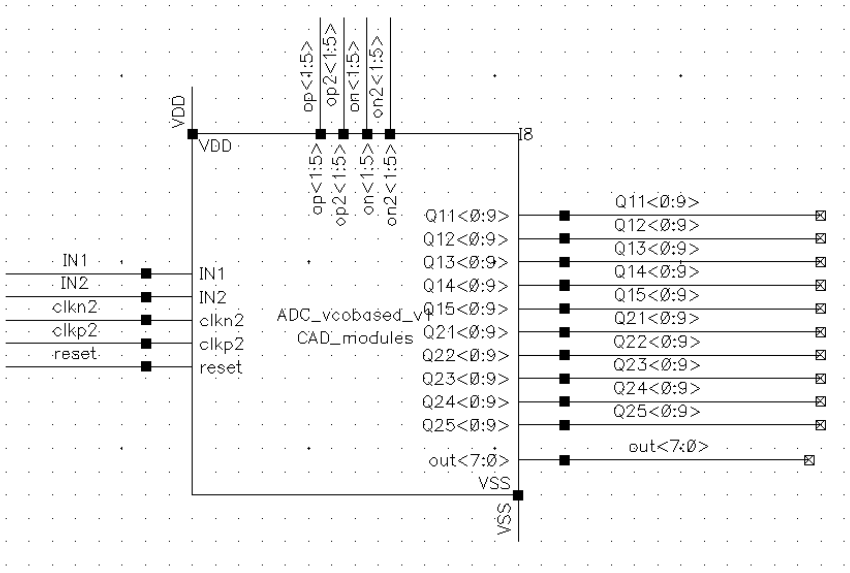
The main analog modules in this design are:

- VCO
- Track and Hold
- Buffers

The regression models for analog part:

- VCO (model_vco65.json, model_vco65.h5, scY_vco65.pkl, scX_vco65.pkl)
- Track and Hold (model_th65.json, model_th65.h5, scY_th65.pkl, scX_th65.pkl)
- Buffers (model_inv65.json, model_inv65.h5, scY_inv65.pkl, scX_inv65.pkl)

Description:



The Top-level cell: ADC_vcobased_v1.scs

Pin Configuration:

Pin Name	Specification	Pin Type
VDD	Power Supply, 1.0 V	Supply
VSS	Ground	Ground
clkn, clkp	Input Clock	Input
IN1, IN2	Differential Analog Input	Input
reset	Reset	Input
out<7:0>	Output digital codes	Output
Qii<0:9>	Test points output	Output

Description of the Cell Library:

The tabular description below corresponds to design hierarchy.

#	Category	CellName	Description	Figure
1		ADC_vcobased_v1	Top level	VCO_01.png
2	ADC_vcobased_v1	VCO_Dtype1_65	Pseudo differential VCO	VCO_02.png
3		TH65_TG_v1	Track and Hold	VCO_03.png
4		counter_vco_v2	10-bit Counter	VCO_04.png
5		INV65_v3	Track and Hold's driver	VCO_05.png
6		diff2sing_v1	Differential to single ended output.	VCO_06.png
7	VCO_Dtype1_65	VCO_type1_65	VCO single output	VCO_07.png
8	counter_vco_v2	counter_onehot2bit	2-bit counter for up to 20GHz clock frequency	VCO_08.png
9		counter_bin4bit	4-bit counter for up to 10GHz clock frequency	VCO_09.png
10		delay_vco_v2	60ps delay	VCO_10.png
11	counter_onehot2bit	delay_vco_v1	130ps delay	VCO_11.png
12	Testbench	test_VCO65_v1	Testbench for VCO based ADC	VCO_12.png

Test Bench:

Locking time evaluation:

1. test_VCO65_v1(cell_name): Testbench for VCO-based ADC operation

Simulation Results:

Design Corners: Process Corner TT, 27 C, Vdd nominal 1V
Typical Current consumption specifications from 1V supply at room temperature:

Measurement Result.pptx