

Delta-Sigma ADC MATLAB/Simulink Models and Scripts

Inter-IIT ISRO-VLSI Project – Code Overview

Inter-IIT ISRO-VLSI Team

Overview

This folder contains all MATLAB and Simulink models used for the Inter-IIT ISRO-VLSI Delta-Sigma ADC project. It is the main software package corresponding to the MATLAB/Simulink part of the end-term submission: modulator models, ENOB trade-off study, noise modelling and digital decimation filter reference.

All `.m` and `.slx` files are named to clearly indicate their function, modulator order, and whether noise or filtering is included.

Folder Structure (Top Level)

- **1. Modulator models/**
Discrete-time $\Delta\Sigma$ modulator Simulink models for different loop orders.
- **2. ENOB vs Sampling Rate trade-off scripts/**
ENOB-vs-sampling-rate sweep script with its text output and summary plot.
- **3. Noise modeling (Flicker Noise)/**
Modulator models including $1/f$ (flicker) noise and related simulations.
- **4. Digital Decimation filter floating-point reference/**
Floating-point MATLAB reference implementation of the digital decimation chain.

Modulator Models

Path: 1. Modulator models/

This directory contains separate folders for each modulator order:

- ORDER_2/
- ORDER_3/
- ORDER_4/

Each order-specific folder typically contains:

- One or more Simulink models (`*.slx`) of the $\Delta\Sigma$ modulator for that order (for example a second-order model named `INTER_IIT_2ndorder_without_noise_DSM.slx`).
- A MATLAB script used to run the model and move signals/metrics into the workspace (for example `MATLAB_FILTER_to_workspace.m`).
- A `figures/` subfolder with simulation plots:

- **PNG/**: PNG versions of key plots (PSD, bitstream, filtered output, performance metrics).
- **EPS/**: EPS versions of the same plots for inclusion in the report.
- Optional PNG snapshots of the Simulink diagram.

These models are used as the baseline *noiseless* modulators for the rest of the study.

ENOB vs Sampling Rate Trade-off Scripts

Path: 2. ENOB vs Sampling Rate trade-off scripts/

This directory contains a compact, self-contained setup for the ENOB vs sampling-rate / OSR study:

- **ENOB_vs_Sampling_Rate_trade-off_scripts.m**: MATLAB driver script that runs the complete sweep, calls the required modulator and decimation models, and prints/saves the ENOB results.
- **OUTPUT.txt**: plain-text output file generated by the script, containing the numerical ENOB / SNDR values for each tested sampling rate.
- **enob_sampling_tradeoff_plot.png**: summary figure showing the ENOB vs sampling-rate trade-off (and related curves) for inclusion in the report or slides.

Noise Modeling (Flicker Noise)

Path: 3. Noise modeling (Flicker Noise)/

This directory extends the base modulator models to include noise sources, with separate subfolders for each order:

- **ORDER_2/**
- **ORDER_4/**

Each order folder typically includes:

- Simulink models of the $\Delta\Sigma$ modulator with flicker noise inserted at appropriate nodes (for example **INTER_IIT_2ndorder_with_noise_DSM.slx** or **INTER_IIT_order_4_with_noise_DSM.slx**).
- Optional “before/after” versions of the models to document design evolution.
- Subfolders such as **noise_at_1_input/** and **noise_at_3_input/** containing simulations where the same noise profile is injected at different positions in the loop.
- PNG snapshots of the Simulink diagrams and representative waveforms or spectra, for quick visual inspection and for use in the report.

These files are used to compare flicker noise behaviour, chopping options and general noise sensitivity across orders and injection points.

Digital Decimation Filter Floating-Point Reference

Path: 4. Digital Decimation filter floating-point reference/

This folder contains the reference digital decimation chain used to process the modulator bitstream:

- `MATLAB_FILTER_to_workspace.m`: main MATLAB script that implements the floating-point decimation filter chain (e.g. SINC/CIC and FIR stages), runs example test cases and exports signals and metrics to the workspace.
- `README_Digital_Decimation_Filter.md`: detailed description of the decimation filter architecture, usage and parameters.
- `README_Digital_Decimation_Filter.pdf`: PDF version of the same README for convenience.

These files serve as the golden model for validating RTL / fixed-point implementations of the digital filter.

Usage Notes

1. Open MATLAB and set the current folder to 1. `MATLAB Simulink Code/`.
2. Add subfolders to the MATLAB path (e.g. `addpath(genpath(pwd))`).
3. For a quick demo:
 - (a) Go to a specific order in 1. `Modulator models/ORDER_X/`.
 - (b) Open the main `.slx` modulator model and run the associated MATLAB script (for example `MATLAB_FILTER_to_workspace.m`).
 - (c) Inspect the signals in the workspace and the plots saved in `figures/`.
4. For ENOB trade-off or noise studies, run the corresponding scripts in folders 2 and 3, following the comments at the top of each script or the local READMEs.

Environment and Confidentiality

These models are intended to be run with MATLAB + Simulink, using the tool versions specified in the main project environment file. Before sharing this folder externally, verify that file paths, comments and image metadata do not contain institute-specific identifiers.