Final Project: Additional Comments

- Report should
  - Use theory from course (in non-trivial manner)
    - DT SSM, ADC and computation delay, quantization, synchronization, limit cycling, generalized state space
  - Detail analysis beyond/distinct from posted homework solutions
- Validation requires detailed, direct, quantitative comparison and discussion
  - Just running a simulation doesn't complete verification
- Be clear on what you did using ECE692 theory

Compensator Implementation

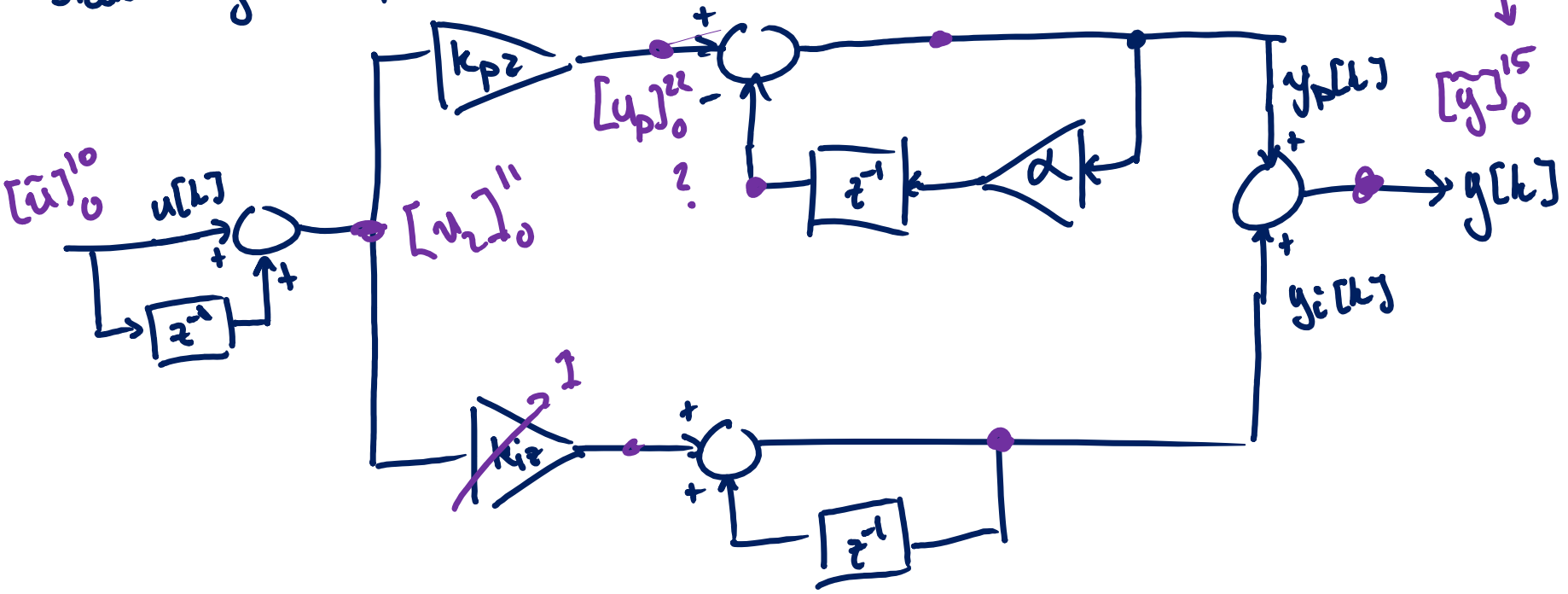
$$G_c(z) = \frac{Y(z)}{U(z)} = \underbrace{k_{pz}\frac{1+z^{-1}}{1+\alpha z^{-1}}}_{G_{pz}(z)} + \underbrace{k_{iz}\frac{1+z^{-1}}{1-z^{-1}}}_{G_{iz}(z)}$$

$$y_p[k] = k_{pz}(u[k] + u[k-1]) - \alpha y_p[k-1]$$

$$y_i[k] = k_{iz}(u[k] + u[k-1]) + y_i[k-1]$$

Block Diagram (parallel realization)

DPWM resolution



Software vs. Hardware Coding

Generally, floating point hardware too expensive/slow for f_s-rate control loops

- fixed point calculations preferred

Software: DSP/μC, embedded processor & defined word length

Hardware: FPGA/PLD/ASIC, variable bit-length

6.2-6.3 HW & SW

- Coefficient Scaling → Incorporating K_{ADC} & K_{DPWM}
- Coefficient Quantization → Need small bit-length versions of constants

6.4-6.6 — Fixed-point implementation → Determine bit-lengths of all signals & resolution

- focused on HW imp.

Coefficient Scaling and Quantization

$k_{iz} = 1$ $\quad\quad$ $\alpha = 0.6111$

$k_{pz} = 435.4478$

k_{pz} & α need a binary digital representation

bit length

$$k_{pz} \approx \tilde{k}_{pz} = 435 = 110110011_2 \rightarrow \left[\tilde{k}_{pz}\right]_0^{10=9+1}$$

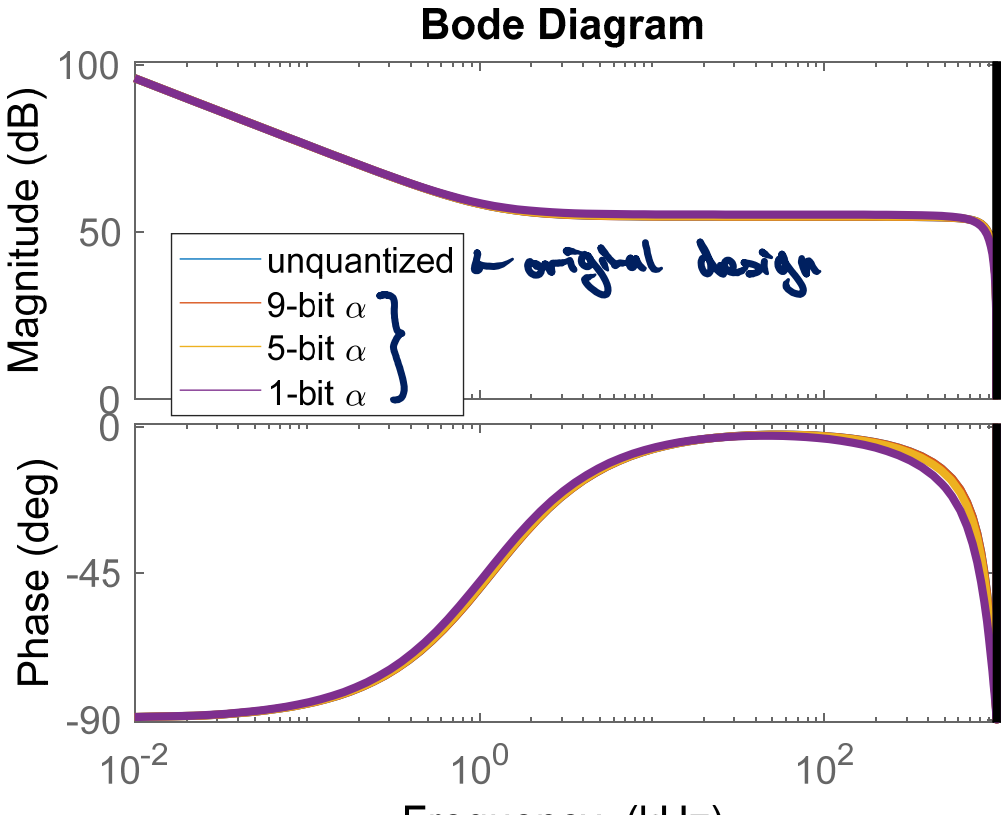
resolution

$$\alpha \approx \tilde{\alpha} = \left(\frac{1}{2} + \frac{1}{2^4} + \frac{1}{2^5}\frac{1}{2^6} + \frac{1}{2^9}\right) = 0.6113$$

$$= \left(100111001_2\right)\frac{1}{2^9} \rightarrow \left[\tilde{\alpha}\right]_{-9}^{10=9+1}$$

Fixed-Point Storage

Quantized $G_c(z)$



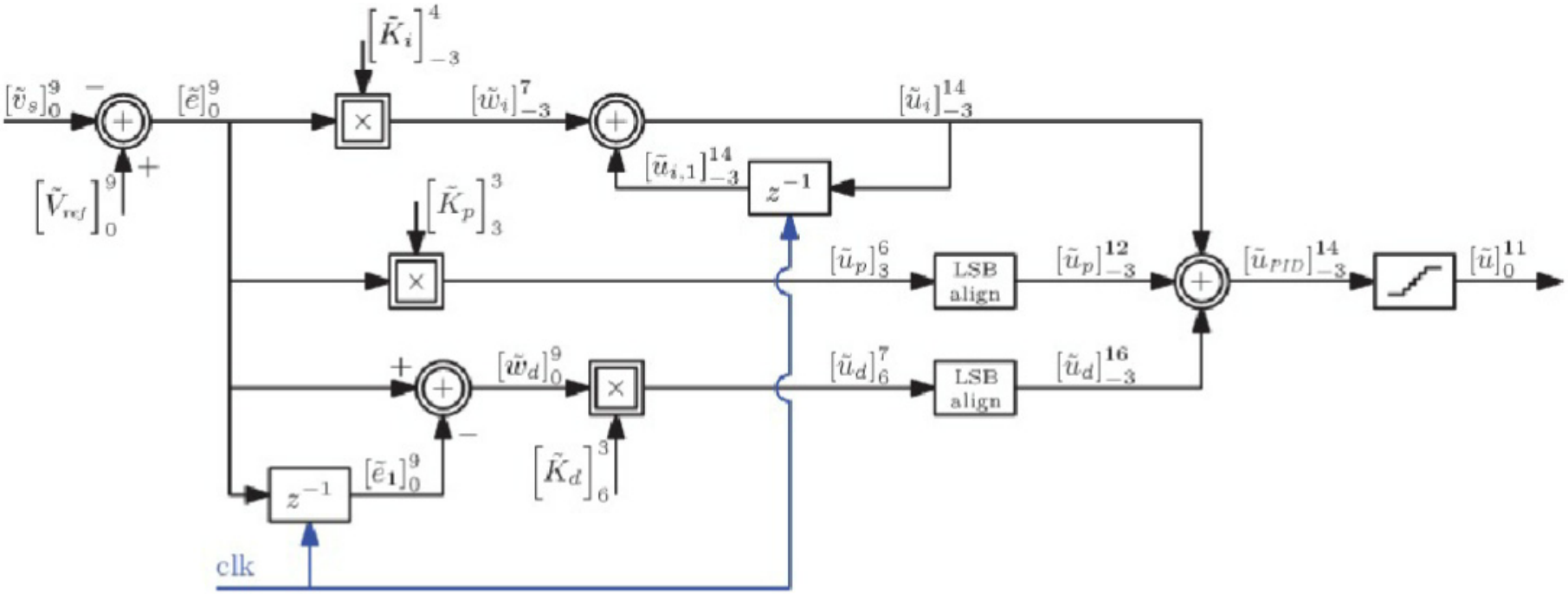
original

$\phi_m = 71^\circ$ @ 250kHz

1-bit α

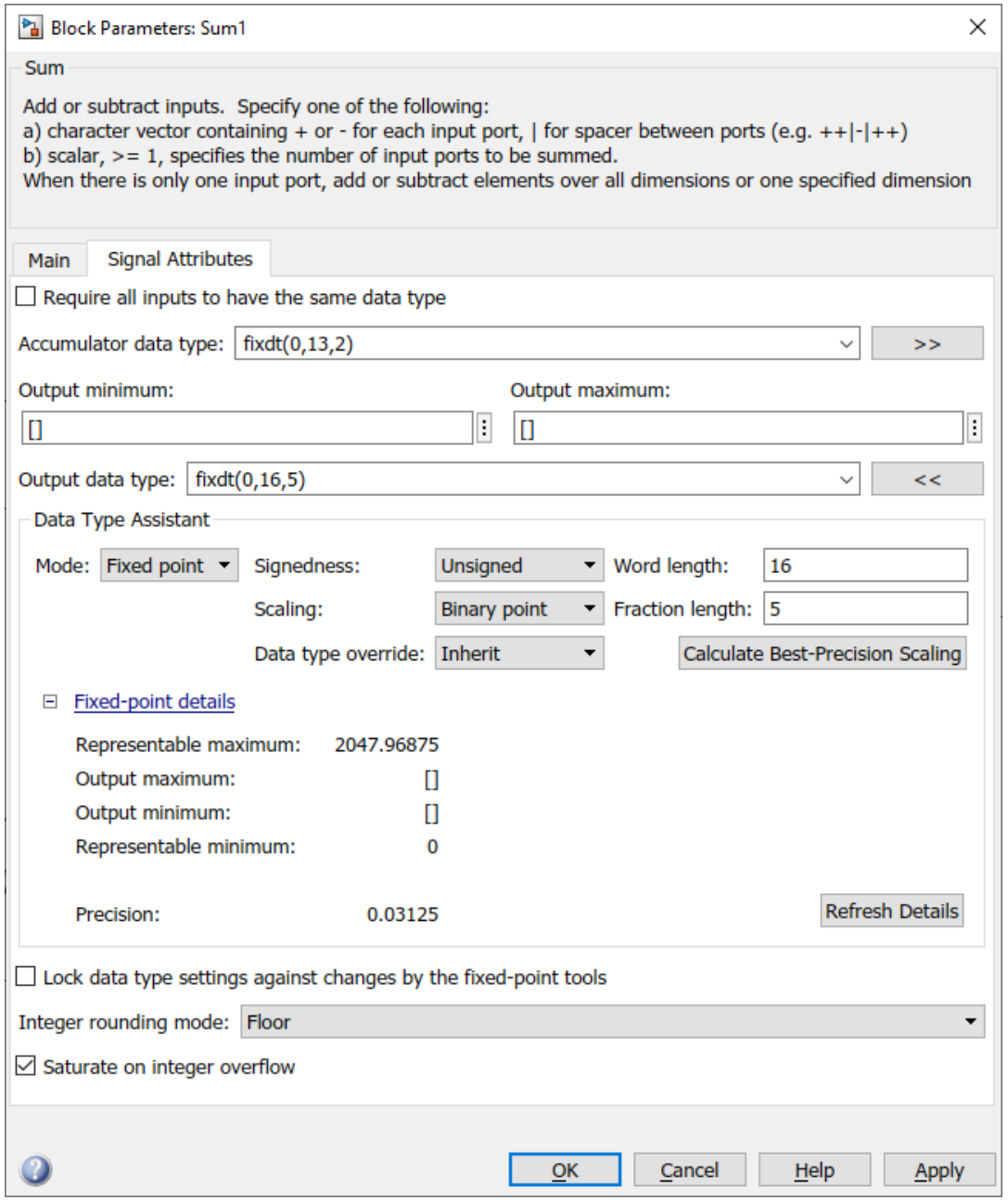
$\phi_m = 68^\circ$ @ 268kHz

Example Implementation



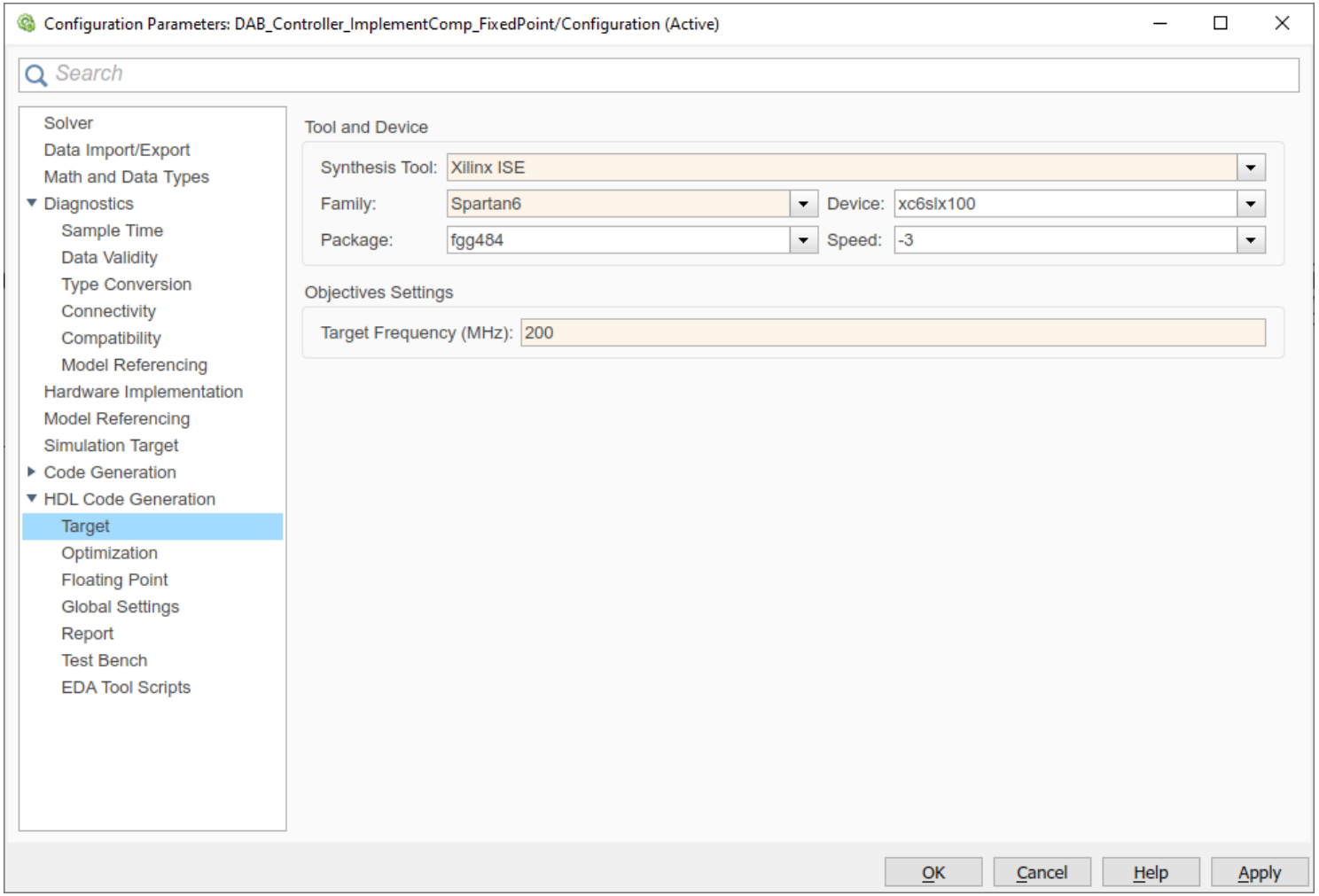
MATLAB Tools

Fixed Point Arithmetic



MATLAB Tools

VHDL Coder



MATLAB Tools

Fixed Point Tool