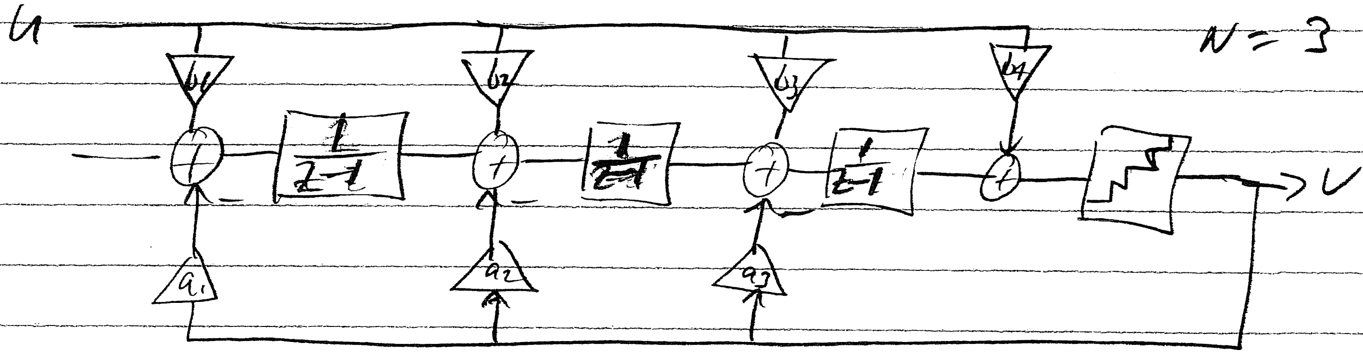
4.3 NTF ZERO + POLE OPTIMIZATION (READ)

4.4 LOOP FILTER ARCHITECTURES

CASCADED INTEGRATOR + DISTRIBUTED FEEDBACK (CIFB)



$$L_0(z) = \frac{b_1 + b_2(z-1) + b_3(z-1)^2 + \ldots + b_{N+1}(z-1)^N}{(z-1)^N}$$

$$L_1(z) = -\frac{a_1 + a_2(z-1) + \ldots a_N(z-1)^{N-1}}{(z-1)^N}$$

$$H(z) = \frac{1}{1-L_1(z)} = \frac{(z-1)^N}{D(z)}$$

$$D(z) = a_1 + a_2(z-1) + \ldots + a_N(z-1)^{N-1} + (z-1)^N$$

ALL ZEROS OF $H(z)$ AT $z=1$ (DC)

+ $H(\infty) = 1$

a_i CHOSEN TO MAKE STABLE SYSTEM.

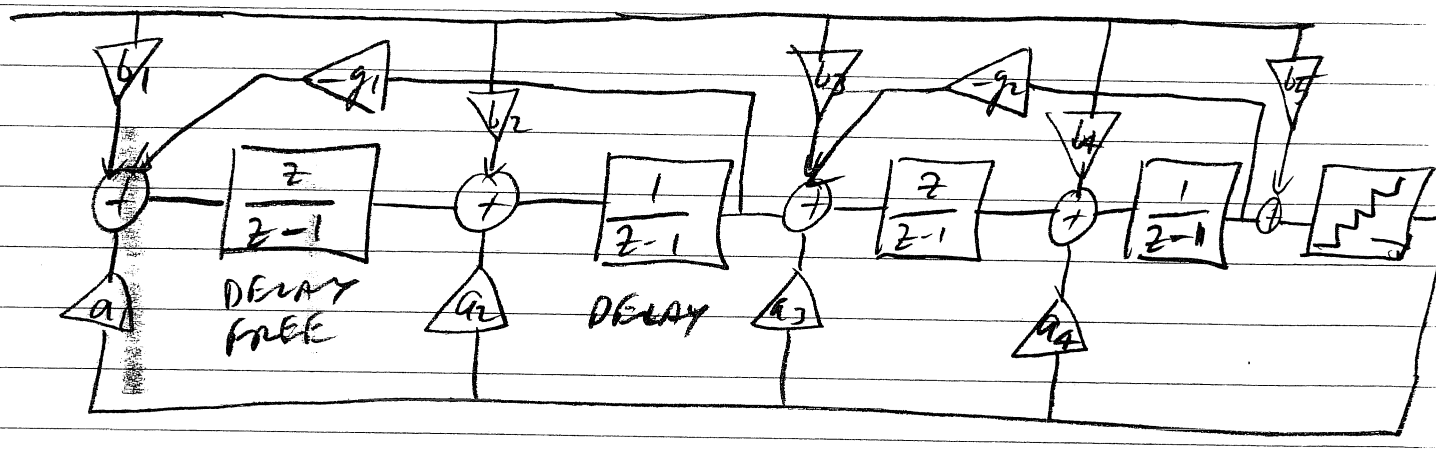
FLEXIBILITY IN b_i

IF $b_i = a_i$ FOR $i \leq N$ & $b_{N+1} = 1$

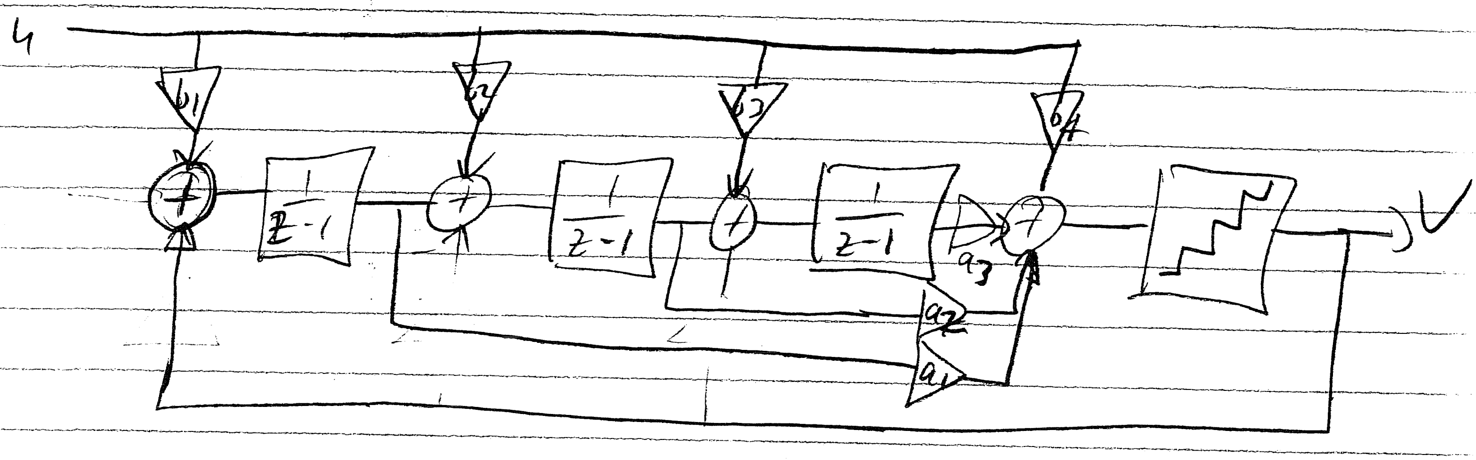
THEN STF = **1** & INPUT TO **EACH**

INTEGRATOR HAS NO SIGNAL COMPONENT!

TO PLACE NTF ZEROS NOT AT dc CAN USE RESONATORS



CASCADED INTEGRATOR WITH WEIGHTED FEED-FORWARD (CIFF)

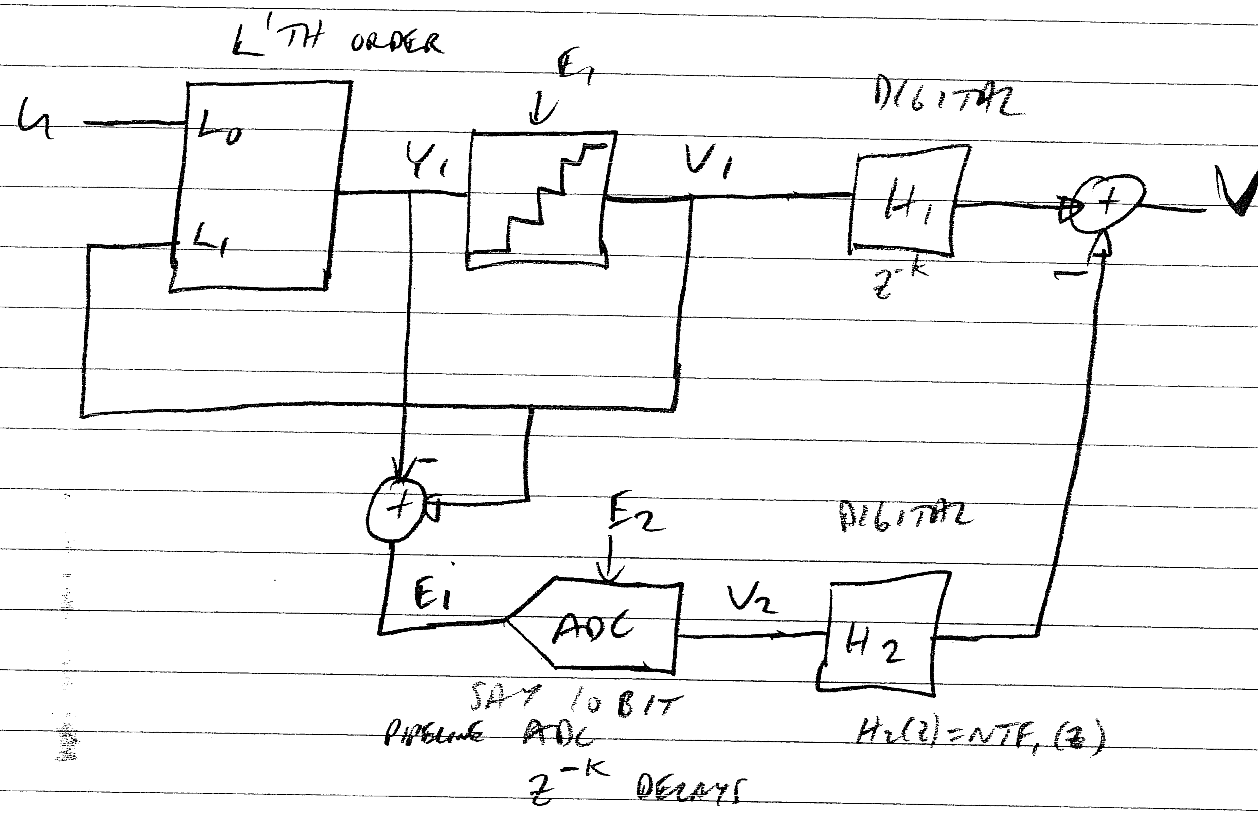


IF $b_1 = b_4 = 1$ & $b_2 = b_3 = 0$

THEN NO SIGNAL COMPONENT INTO LOOP FILTER!

4.5 MULTI-STAGE MODULATORS (OR CASCADE)

L-0 CASCADE (LESLIE SINGH)



$$V = H_1(z) V_1(z) - H_2(z) V_2(z)$$

$$= z^{-k}\left[STF_1(z) U(z) + NTF_1(z) E_1(z)\right] - z^{-k} NTF_1(z) \left[E_1(z) + E_2(z)\right]$$

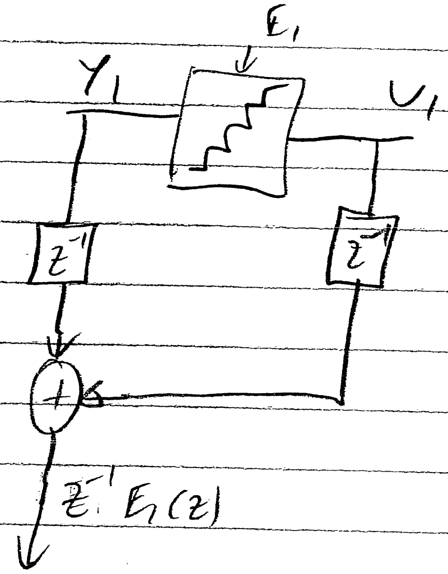
$$= z^{-k}\left[STF_1(z) U(z) - NTF_1(z) E_2(z)\right]$$

$E_2(z) \ll E_1(z)$ SINCE MULT BIT & LATENCY UNIMPORTANT

PERHAPS 1 BIT FOR Q_1 FOR LINEARITY

REQUIRES MATCHING BETWEEN ANALOG $NTF_1(z)$ + DIGITAL $H_2(z)$

ACTUALLY



SINCE NOT PRACTICAL TO HAVE DELAY FREE V_1 FROM Y_1

ALSO CAN ELIMINATE NEED FOR E_1 ALTOGETHER BY APPLYING Y_1 DIRECTLY INTO ADC

$$Y_1(z) = V_1(z) - E_1(z) = STF_1(z)\,U(z) + (NTF_1(z) - 1)\,E_1(z)$$

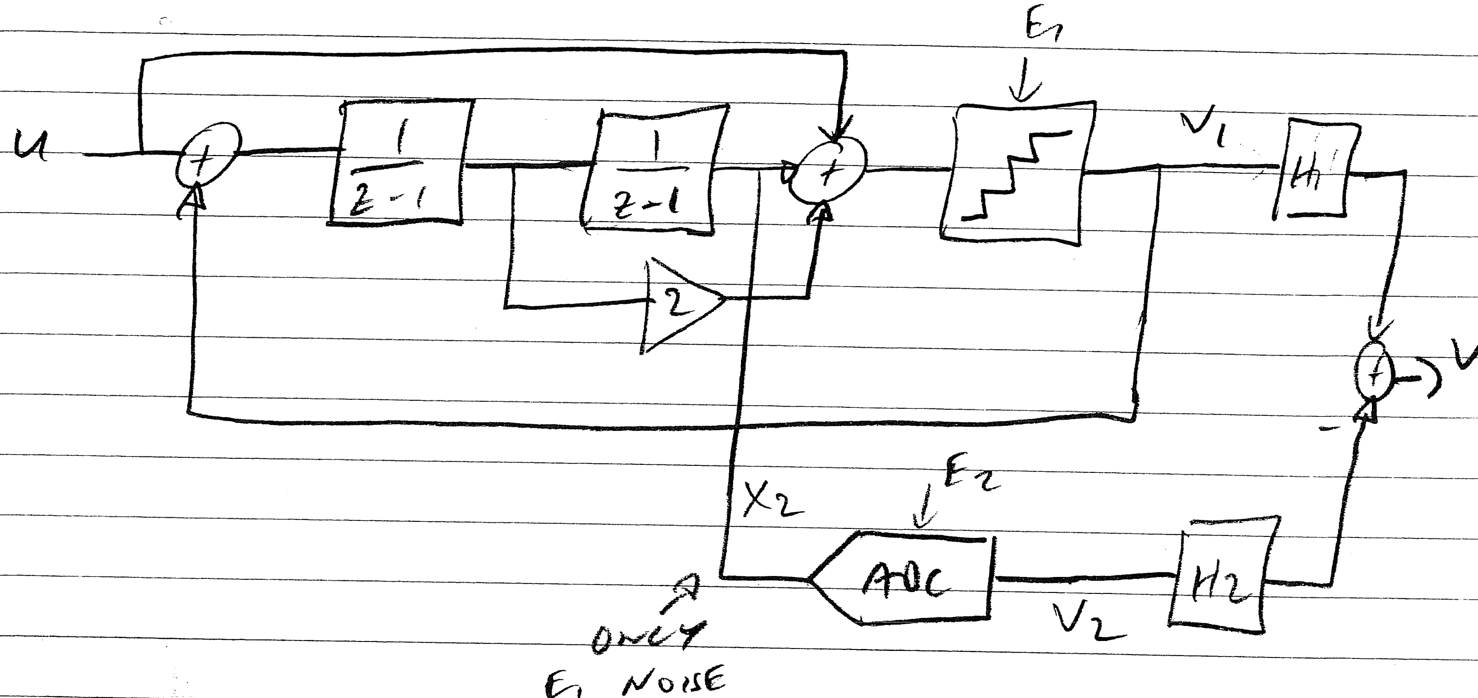
$$H_1(z) = z^{-(k+1)} \quad \text{BUT} \quad H_2(z) = \left[\frac{NTF_1(z)}{NTF_1(z) - 1}\right](z^{-1})$$

EXTRA z^{-1} REQUIRED TO MAKE $H_2(z)$ NON-CAUSAL

$$V(z) = \frac{z^{-(k+1)}\,STF_1(z)}{1 - NTF_1(z)}\,U(z) + \frac{z^{-(k+1)}\,NTF_1(z)}{1 - NTF_1(z)}\,E_2(z)$$

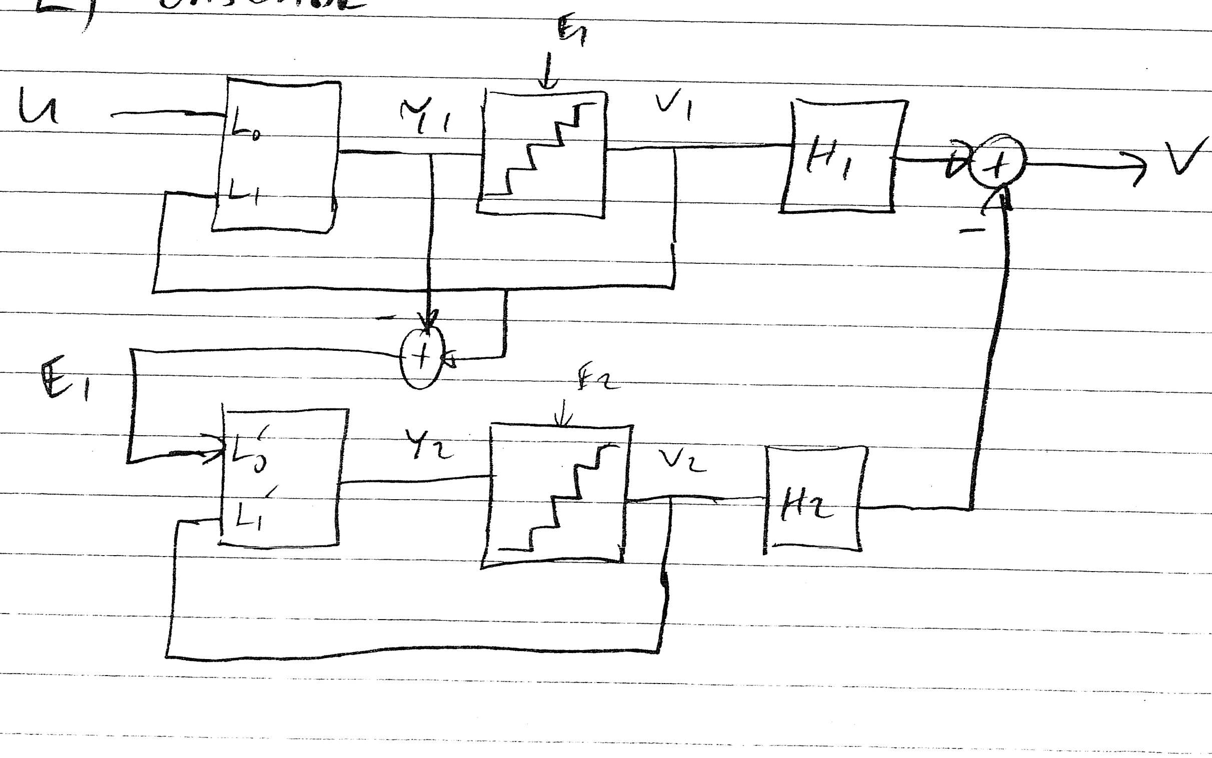
HOWEVER HERE ADC HAS INPUT SIGNAL $E_1(z)$ + $U(z)$ (SIGNAL) SO LARGER INPUT SIGNAL & LINEARITY OF ADC IMPORTANT.

CAN USE LOW-DISTORTION CIFF AS FIRST STAGE



CASCADE (MASH) MODULATORS

(L-L') CASCADE



$$V_2(z) = STF_2(z)\, E_1(z) + NTF_2(z)\, E_2(z)$$

CHOOSE $H_1(z)$ & $H_2(z)$ TO CANCEL $E_1(z)$

$$H_1(z)\, NTF_1(z) - H_2(z)\, STF_2(z) = 0$$

NORMALLY $H_1(z) = STF_2(z)$ & $H_2(z) = NTF_1(z)$

$$V = H_1 V_1 - H_2 V_2$$

$$= STF_1(z)\, STF_2(z)\, U(z) - NTF_1(z)\, NTF_2(z)\, E_2(z)$$

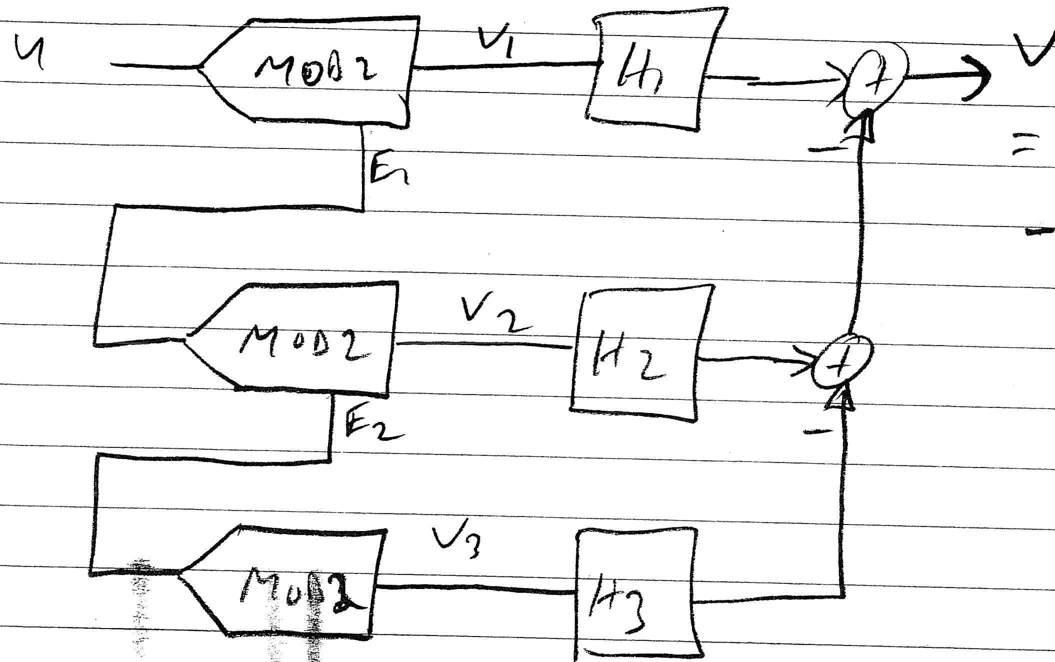
EX 2-2 MASH

$STF_1 = STF_2 = z^{-2}$ & $NTF_1 = NTF_2 = (1-z^{-1})^2$

$$V = z^{-4} U(z) - (1-z^{-1})^4 E_2(z)$$ 4'TH ORDER!

CAN USE LOW DISTORTION CIFF SO NO SUBTRACTION NEEDED & LOWER ANALOG REQUIREMENTS

2-2-2 MASH



$$= z^{-6} u(z) - (1-z^{-1})^6 E_3(z)$$

MATCHING BETWEEN ANALOG NTF & H_i IMPORTANT OR ELSE NOISE "LEAKS" THROUGH