Davenport 10/7/91

AN FFT BASED

POWER

SPECTROMETER

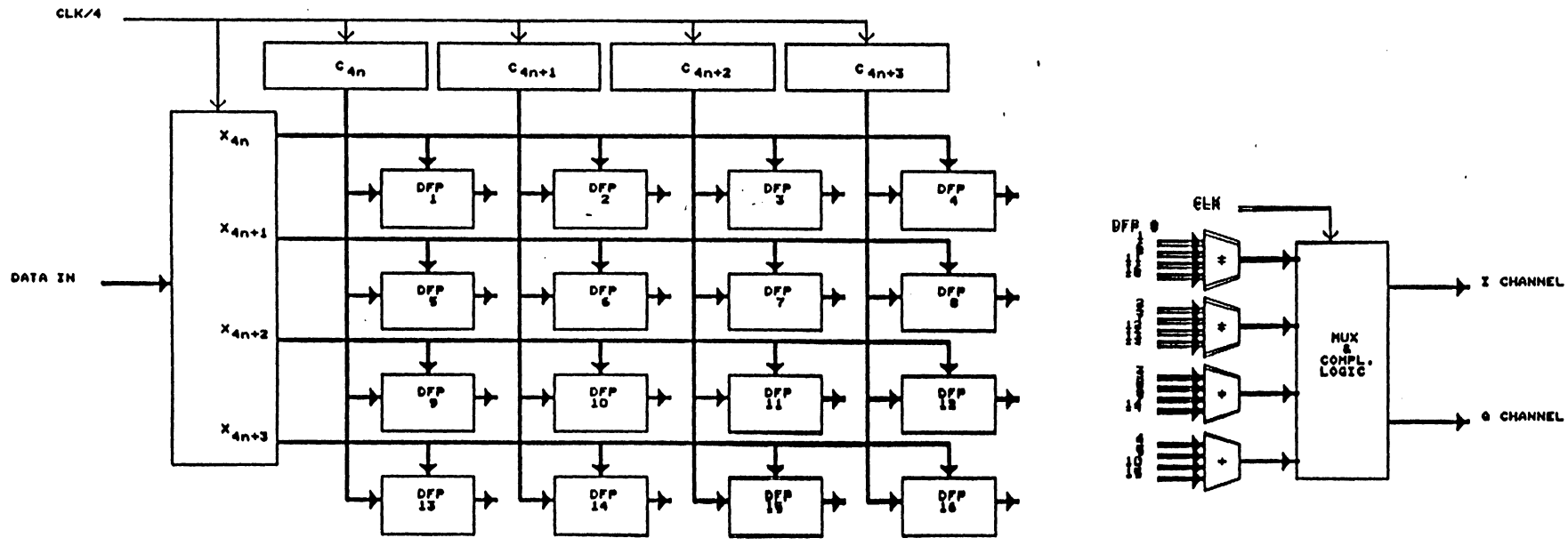
SPECTROMETER FEATURES

- USES MODERN DIGITAL SIGNAL PROCESSING TECHNIQUES
  - DECIMATING DIGITAL FIR ANTI-ALIASING FILTERS.
  - DIGITAL IQ SAMPLING ELIMINATES ANALOG COMPONENTS.
  - FAST FOURIER TRANSFORM FOR FLEXIBILITY AND HIGHER COMPUTATIONAL EFFICIENCY.
- USES LOW-COST/MATURE TECHNOLOGY
  - DSP COMPONENT COST IN UNDER $5000.00 PER IQ CHANNEL.
  - DEVICES HAVE BEEN MANUFACTURED SINCE MID-EIGHTIES.
  - 88/84 PGA OR LCC PACKAGING.
- FIR FILTER AND BASIC DSP MODULE CAN BE USED FOR A VARIETY OF FREQUENCY DOMAIN PROCESSING TASKS.

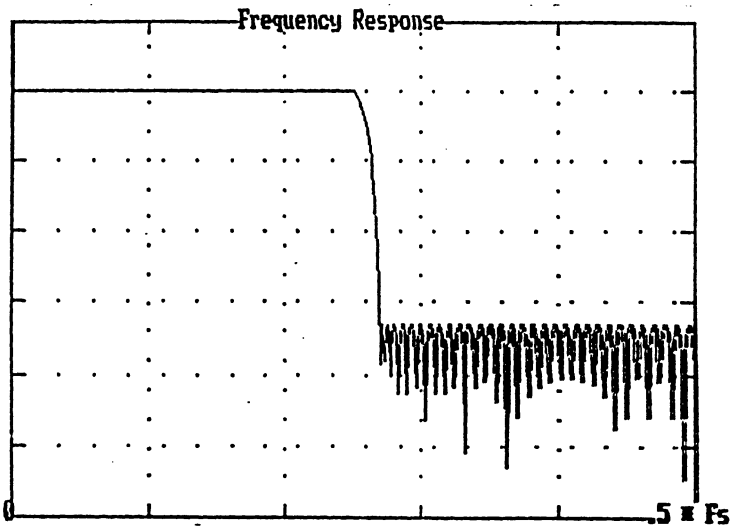
SPECTROMETER PERFORMANCE

- OPERATES AT 160 MHz SAMPLE RATE.
- COMPUTES 16384 POINT FFT OF 40 MHz BANDWIDTH IN REAL TIME.
- IMPLEMENTS POWER SPECTRUM CALCULATION SUGGESTED BY MIKE SULZER OF NAIC.
  - FFT IS CHOSEN TO BE MUCH LONGER THAN DESIRED RESOLUTION BW.
  - LONG FFT POWER SPECTRUM IS AVERAGED LIKE A PERIODOGRAM.
  - COMPUTATION BURDEN IS NOT EXCESSIVE (ONE 16K FFT ONLY REQUIRES 1.2X BUTTERFLIES AS EIGHT 2048 PT FFTS).
  - DESIRED SPECTRUM/CORRELATION CAN BE CALCULATED IN NON-REAL TIME.

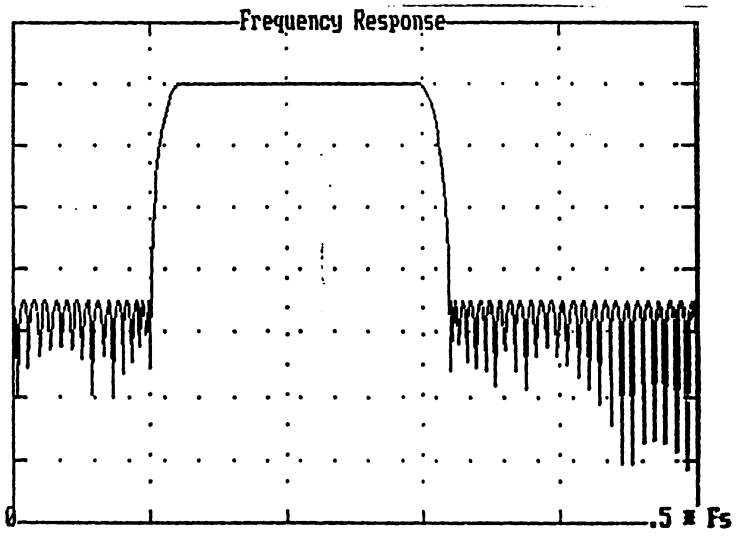
160 MHz BW
IF MIXER
ANTI-ALIASING
ANALOG IF
BANDPASS FILTER
2ND
IF AMP
8-BIT
A/D
DIGITAL
PRE-FILTER
ZORAN ZR33891 DFP
(4 - 16)
(32) TMC2310
16 K PT.
FFT
POWER SPECTRUM
PROCESSOR
OUTPUT
(BLOCK FLOATING POINT)
1st L.O.
SYNTHESIZER
SAMPLE CLOCK
160 MHz
COMPUTER CONTROL BUS



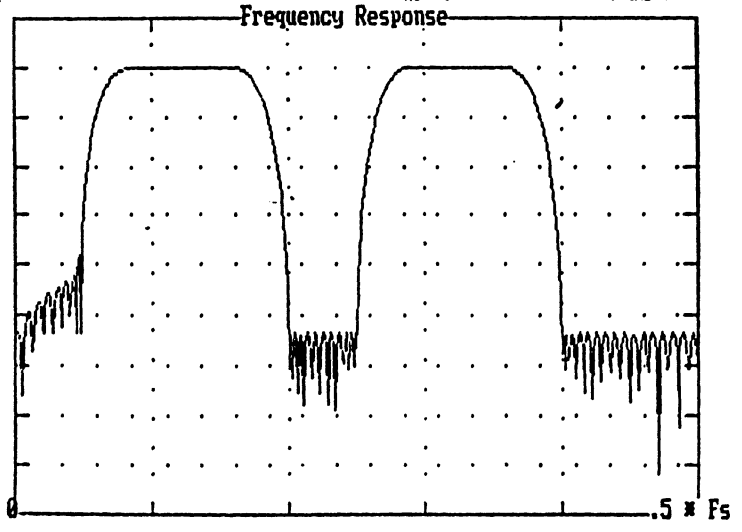
Title	4X DIGITAL FILTER	
Size B	Document Number	REV A
Date: October 3, 1991	Sheet 1 of 1	



128 TAP LOW-PASS FILTER



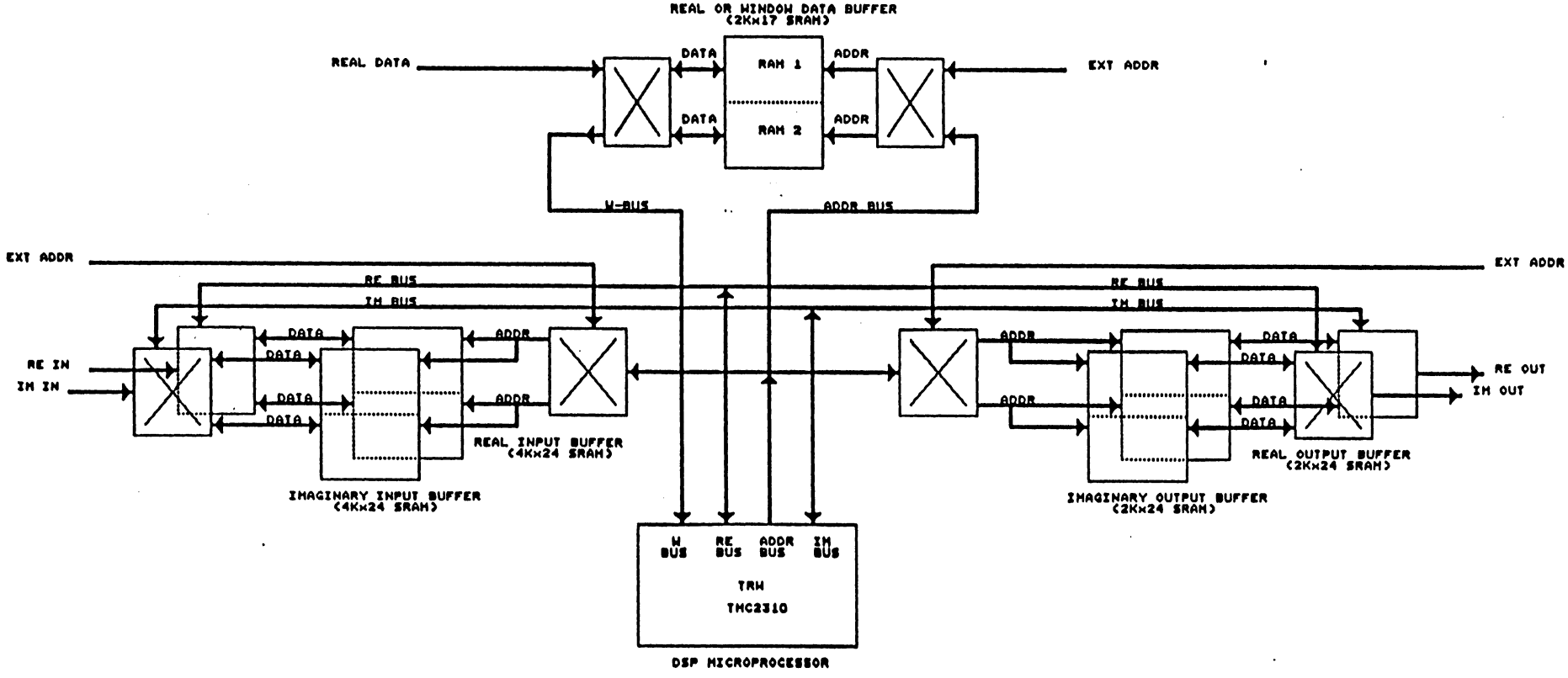
128 TAP BAND-PASS FILTER



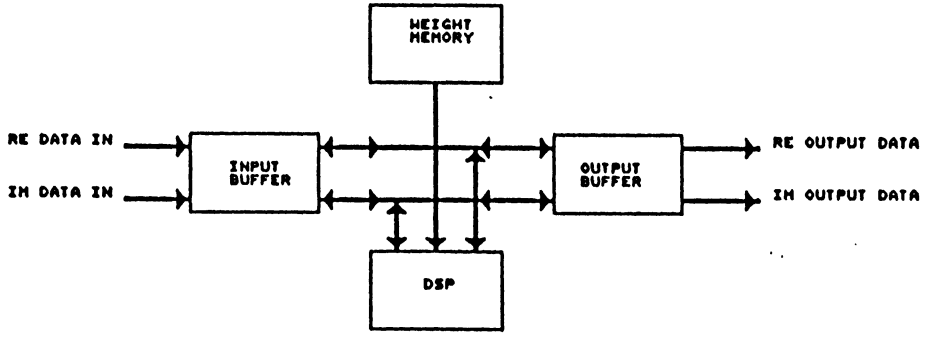
128 TAP MULTI-BAND FILTER

TMC2310 FEATURES

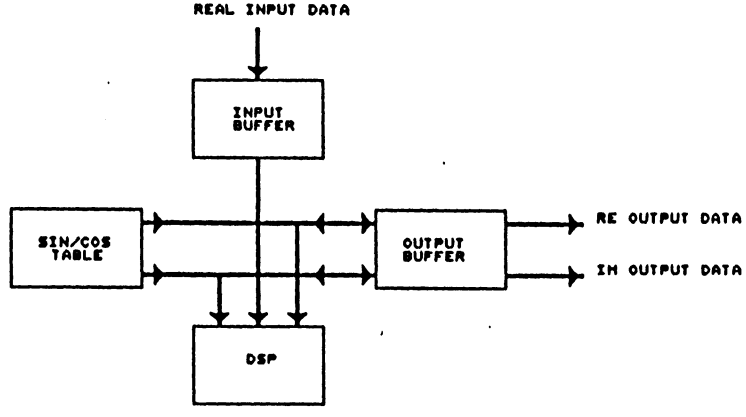
- 16 BIT INPUT DATA WIDTH.
- 19 BIT BLOCK FLOATING POINT (6 BIT EXPONENT) OUTPUT DATA.
- FFT SIZE 16 POINTS MIN / 1024 POINTS MAX.
- 19 BIT INSTRUCTIONS IN TWO CONFIGURATION REGISTERS.
  - FFT OR MULTIPLE FFT
  - IFFT OR MULTIPLE IFFT
  - WINDOW FFT/IFFT
  - MAGNITUDE SQUARED
  - FIR
  - ADAPTIVE FIR
  - MULTIPLY REAL/COMPLEX
  - MULTIPLY ACCUMULATE
- BIT REVERSE ADDRESSING MODE



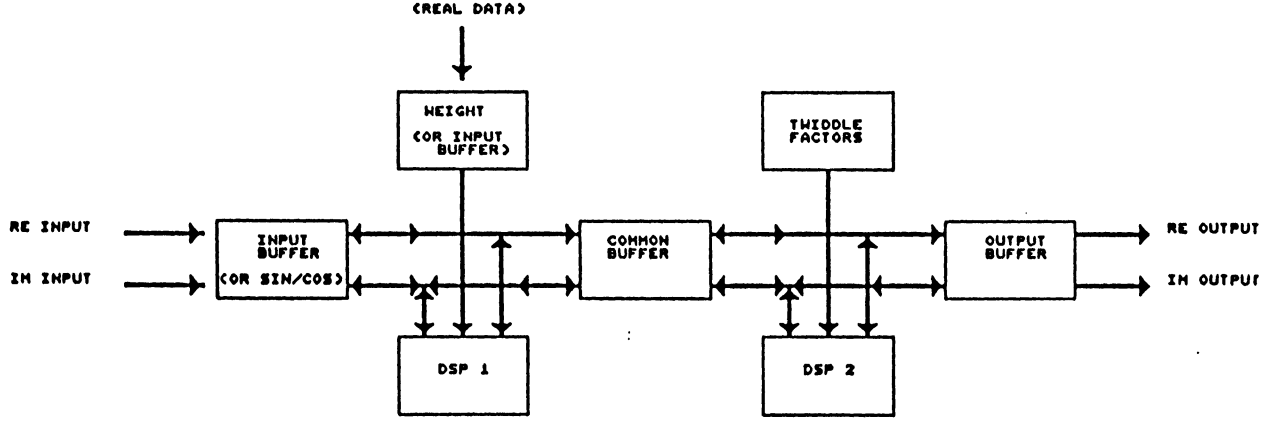
ARECIBO OBSERVATORY		
Title: DSP MODULE BLOCK DIAGRAM		
Size: B	Document Number: 910920A	REV: A
Date: October 3, 1991	Sheet 1 of 1	



STAND-ALONE COMPLEX FFT



STAND-ALONE REAL INPUT FFT



PIPELINE CONFIGURATION (EITHER STRUCTURE)

ARECIBO OBSERVATORY		
Title: DSP MODULE CONFIGURATIONS		
Size: B	Document Number: 910208	REV: A
Date: September 23, 1991	Sheet 1 of 1	

16K FFT TECHNIQUE

- A 1024 POINT TRANSFORM CAN BE ARRANGED AS 32 ROWS BY 32 COLUMNS:

0	1	2 ...	31
32	33	34 ...	63
64	65	66 ...	95
.	.	. ...	.
.	.	. ...	.

- IF THIRTY-TWO, 32 PT TRANSFORMS ARE COMPUTED ON THE ROWS, THE TRANSFORM IS RE-ORDERED AS FOLLOWED:

0	32	64 ...	992
1	33	65 ...	993
2	34	6 ...	994
.	.	. ...	.
.	.	. ...	.
31	63	9 ...	1023

- THUS THE 1024 POINT TRANSFORM CAN BE COMPLETED BY COMPUTING 32 PT. TRANSFORMS ON THE COLUMNS, HOWEVER, THE DATA MUST FIRST BE "TWIDDLED" (MULTIPLIED WITH A PHASE FACTOR) FOR THE RESULTS TO BE CORRECT.

16K PT. FFT TECHNIQUE (CONTINUED)

- AT 40 MHz, 16384 SAMPLE POINTS CAN BE STORED IN 409.6 µSEC.

- THIRTY-TWO, 32 PT. TRANSFORMS CAN BE COMPUTED BY THE TMC2310 IN 329 µSEC (INCLUDING TWIDDLE TIME).

- THUS 32 DEVICES (CONNECTED AS A 16 X 2 PARALLEL PIPELINE ARRAY) CAN COMPUTE A 16K POINT FFT IN 329 µSEC.

- BY USING A SWINGING BUFFER MEMORY, WHERE ONE BANK IS BEING PROCESSED WHILE THE OTHER IS BEING LOADED, THE PROCESSOR ARRAY CAN COMPUTE A TRANSFORM IN THE TIME REQUIRED TO FILL A BUFFER MEMORY, ONCE THE PIPELINE IS LOADED.