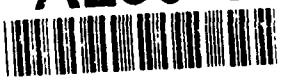
AL-TR-1992-0154



ARMSTRONG LABORATORY

DESIGN, FABRICATION, AND TESTING OF A THREE-DIMENSIONAL ACOUSTIC ORIENTATION INSTRUMENT (3-D AOI)--DRAWINGS, ENGINEERING, AND ASSOCIATED LISTS (CONCEPTUAL AND DEVELOPMENT DESIGN)

Dan D. Fulgham
Jeffrey Gabelmann

Southeastern Center for Electrical Engineering Education
1101 Massachusetts Avenue
St. Cloud, FL 34769

CREW SYSTEMS DIRECTORATE
2504 D Drive, Suite 1
Brooks Air Force Base, TX 78235-5104

December 1992

Final Technical Report for Period 1 May 1989 - 15 April 1991

Approved for public release; distribution is unlimited.

AIR FORCE MATERIEL COMMAND
BROOKS AIR FORCE BASE, TEXAS

NOTICES

This technical report is published as received and has not been edited by the technical editing staff of the Armstrong Laboratory.

When Government drawings, specifications, or other data are used for any purpose other than in connection with a definitely Government-related procurement, the United States Government incurs no responsibility or any obligation whatsoever. The fact that the Government may have formulated or in any way supplied the said drawings, specifications, or other data, is not to be regarded by implication, or otherwise in any manner construed, as licensing the holder, or any other person or corporation; or as conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

The Office of Public Affairs has reviewed this report, and it is releasable to the National Technical Information Service, where it will be available to the general public, including foreign nationals.

This report has been reviewed and is approved for publication.

KENT K. GILLINGHAM, M.D., Ph.D.
Project Scientist

RONALD C. HILL, Lt Col, USAF, BSC
Chief, Flight Motion Effects Branch

RICHARD L. MILLER, Ph.D.
Chief, Crew Technology Division

December 1992 Final - 1 May 1989 – 15 April 1991

Design, Fabrication, and Testing of a Three-Dimensional Acoustic Orientation Instrument (3-D AOI)--Drawings, Engineering, and Associated Lists (Conceptual and Developmental Design)

C - F33615-87-D-0609
(Task 0031)
PE - 62202F
PR - 7930
TA - 20
WU - 02

Dan D. Fulgham
Jeffrey Gabelmann

Southeastern Center for Electrical Engineering
Education (SCEEE)
1101 Massachusetts Avenue
St. Cloud, FL 34769

SwRI Project No. 12-3384
SCEEE-ARB/90-0031

Armstrong Laboratory
Crew Systems Directorate
2504 D Drive, Suite 1
Brooks Air Force Base, TX 78235-5104

AL-TR-1992-0154

Armstrong Laboratory Technical Monitor: Dr. Kent K. Gillingham, (210) 536-3521

Subcontractor (Southwest Research Institute) provides a description of the hardware assembled and software created to develop the 3-D AOI. A Macintosh IIx computer is the heart of the system, acting as a general controller and processor of data flowing from the Flight Information Package to the Audio Localization Cue Synthesizer, audio mixer, headphones, and data recording equipment. A National Instruments NB-DSP2300 digital signal processing board and NB-A2100 audio I/O board generate the audio signals, and National Instruments LabView software is used to control the auditory display. The majority of this report is a description of the 18 LabView software modules created to control the 3-D AOI display.

Acoustic orientation
Auditory localization
Aural displays

Flight instrumentation

129

Unclassified | Unclassified | Unclassified | UL

SYSTEM FUNCTIONAL BLOCKS

The AOI3 system performs the following basic tasks:

- o flight parameter data acquisition and storage,
- o flight parameter to acoustic parameter conversion (i.e., generation of audio cues),
- o user interface maintenance, and
- o presentation of audio cues for localization.

Figure 1 shows a block diagram overview of the AOI3 system. A MAC IIx is the heart of the system and acts as a central controller to perform the required system tasks. The following paragraphs describe how each task is implemented.

FLIGHT PARAMETER DATA ACQUISITION

The MAC IIx is connected to the flight instrument package (FIP) via the Macintosh internal serial printer port. The MAC periodically polls the FIP for the flight parameter information which is formatted and converted to acoustic parameter information by the MAC. This data can also be time tagged and archived on the MAC's hard or floppy drive for later analysis.

FLIGHT PARAMETER TO ACOUSTIC PARAMETER CONVERSION

A National Instruments NB-DSP2300 digital signal processing board, in conjunction with an NB-A2100 audio I/O board is used to generate the audio cues. These boards are compatible with the MAC Nu-bus architecture and are supported by the National Instruments instrumentation software system, LabView. The LabView package provides the low level driver routines required to control the digital signal processor (DSP) and audio boards. In addition, LabView allows for high level graphical type programming which makes the system easy to program, flexible, and expandable.

USER INTERFACE MAINTENANCE

The AOI3 software allows an operator to monitor the flight and acoustic conversion parameters during each flight test. The user has the ability to update specific mapping parameters, thresholds, or system gains simply by changing the program front panel constants. The software also provides a menu driven user interface to collect and save the flight test results to the MAC hard drive.

LOCALIZATION OF AUDIO CUES

The previous phase of the AOI program (AOI2) involved the development of a flight capable system which lateralized the audio cue across the pilot subject's head. The primary goal of the AOI3 program was to develop a flight capable system which can be used to localize the audio cue in three dimensional space. This localization is accomplished through the use of a system referred to as the Audio Localization Cue Synthesizer (ALCS) provided by a third party vendor. The ALCS accepts serial azimuth and elevation commands from a host and localizes an input audio signal to these coordinates.

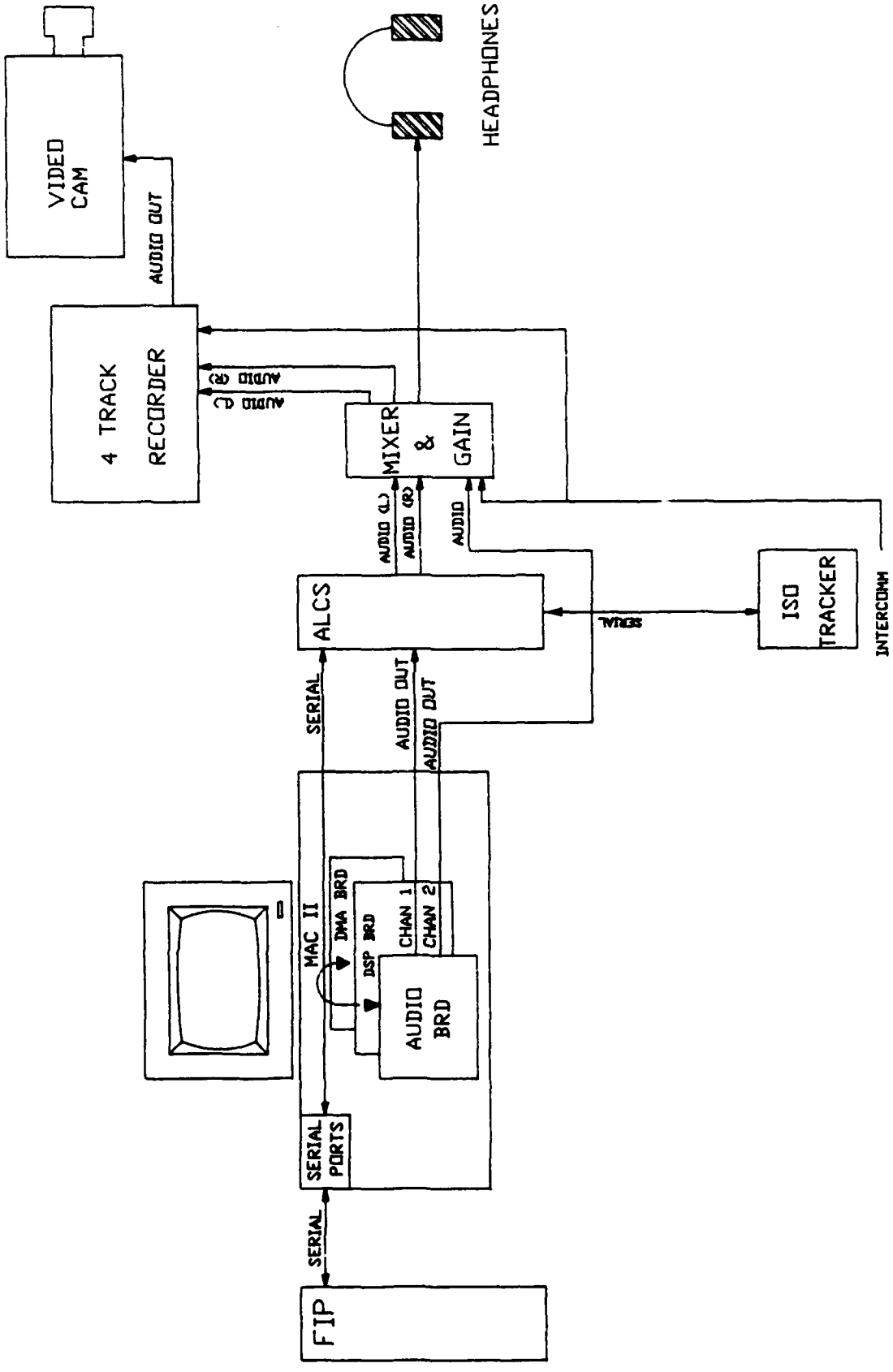


FIGURE 1. AO13 BLOCK DIAGRAM

A final item to note regarding the AOI3 system block diagram is the mixer block. This mixer allows the localized sound to be mixed with a lateralized sound. The mixer also allows the operator to quickly change the overall volume of the AOI3 signal.

SYSTEM HARDWARE

The following is a listing of the AOI3 system hardware:

- MAC IIx
- NB-DSP2300 DSP Board
- NB-A2100 Analog I\O Board
- NB-DMA2800 DMA Board
- Audio Mixer
- RS232 to RS422 Convertor Boxes
- ALCS and Headtracker Unit
- 4 Track Tape Recorder

The system components are mounted in a standard 19" equipment rack which is mounted to the seat rails in the Queen Air. A 1 KVA power invertor is used to supply 115 VAC to the equipment in the rack. Figure 2 shows the wiring schematic for the system.

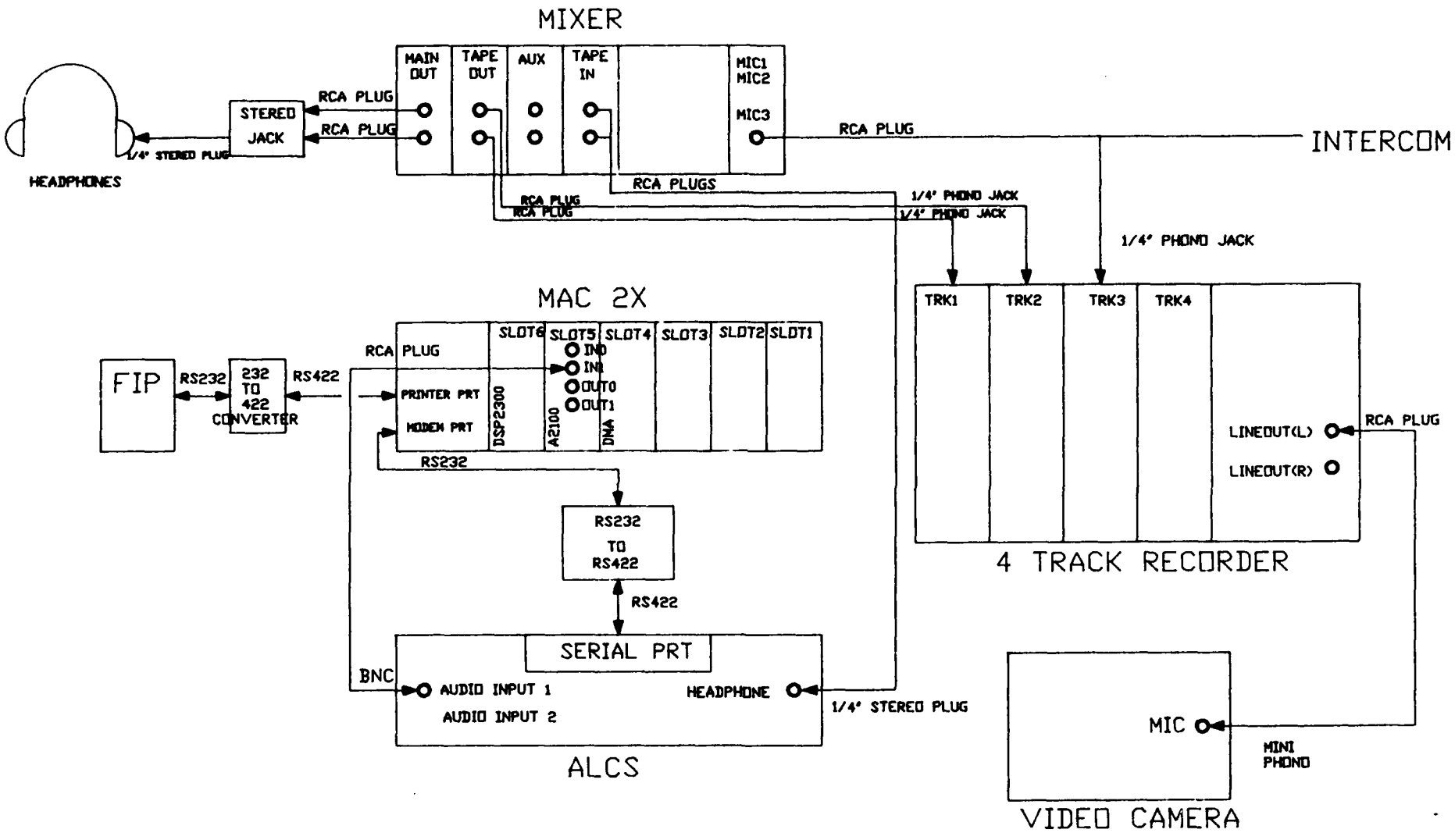


FIGURE 2. SYSTEM WIRING DIAGRAM

SOFTWARE MODULE DESCRIPTIONS

The following is a module by module listing of the AOI3 software. For the purposes of this document, a module is defined as a custom written section of code and thus no LabView Virtual Intruments (VIs) appear on the structure diagram nor are they specified as parent or child modules (refer to the LabView users manual for a complete description of the LabView VIs).

Each module description contains:

(1) a section of text which describes the module's function,

(2) a listing of the module's inputs and outputs with a brief explanation of each, and

(3) a list of the calling (parent) and called modules (child).

The text section is followed by a graphical print out of the module's icon, the front panel, and the LabView code. A structure diagram (Figure 3) has been included to quickly show the interrelationship of all the AOI3 modules.

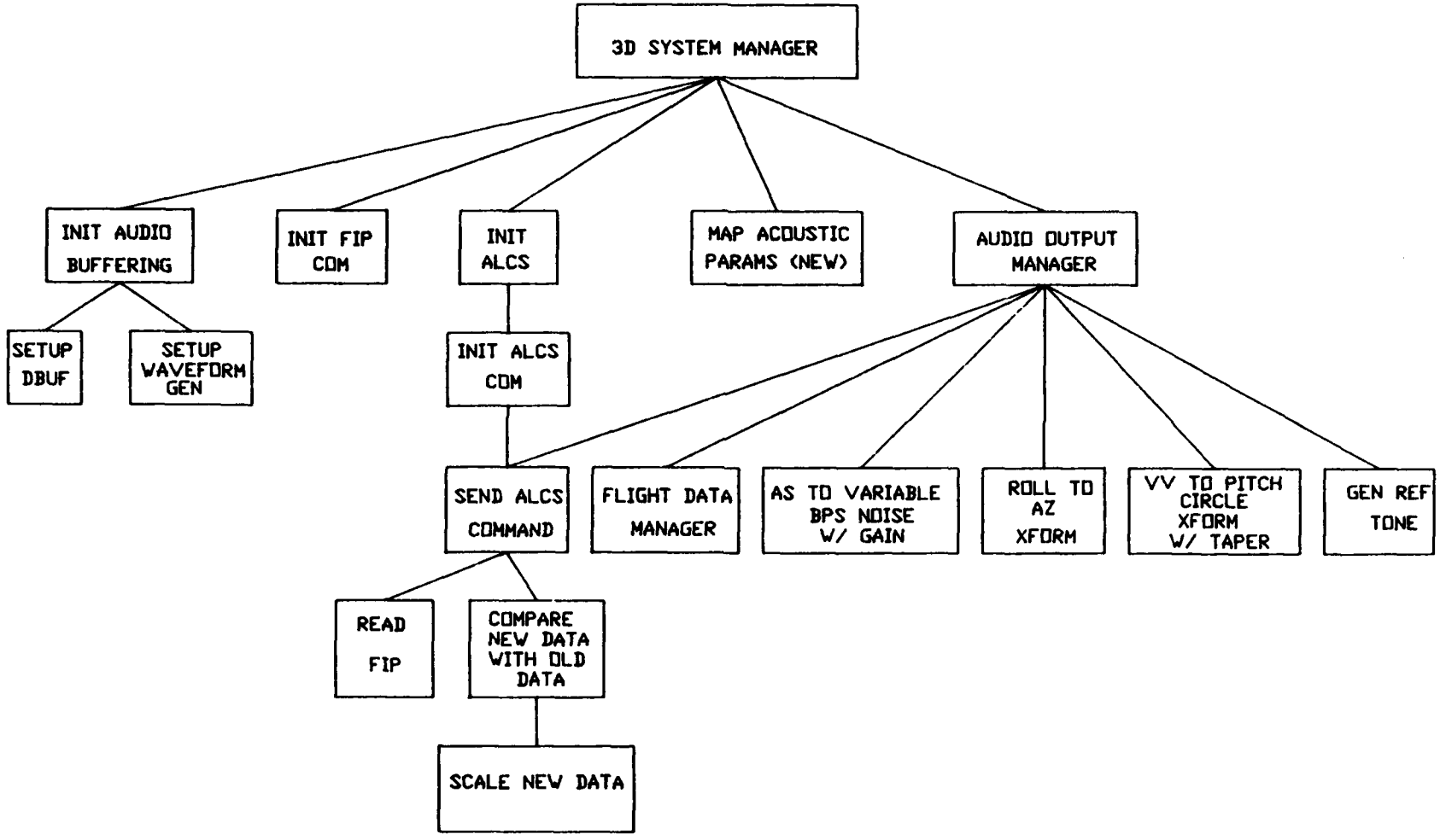


FIGURE 3. AOI3 STRUCTURE DIAGRAM

AS TO VAR FREQ
BPS W/GAIN

MODULE DESCRIPTION

FUNCTION NAME

AS TO VAR FREQ BPS W/GAIN

FUNCTION DESCRIPTION

This module converts the airspeed flight parameter to a variable bandpass white noise generator acoustic cue. The center frequency of the bandpass filter is proportional to the aircraft's airspeed. Additionally the volume of the white noise acoustic cue is proportional to the airspeed.

FUNCTION INPUTS

AIRSPEED OFFSET: This user updated input can be used to correct for DC errors in the FIP airspeed reading.

FILTER ORDER: Order of the Butterworth bandpass filter.

LOW and HIGH CUT-OFF: These two inputs are used to set the width (in Hz) of the Butterworth bandpass filter.

FUNCTION OUTPUTS

AIRSPEED: Aircraft airspeed as reported by the FIP.

CENTER FREQ: Mapped acoustic cue white noise center frequency.

AS ATTN VALUE: Mapped acoustic cue white noise attenuation value.

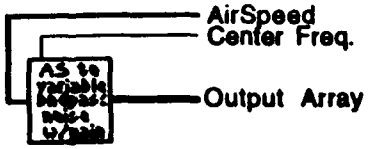
PARENT FUNCTIONS

AUDIO OUTPUT MANAGER

CHILD FUNCTIONS

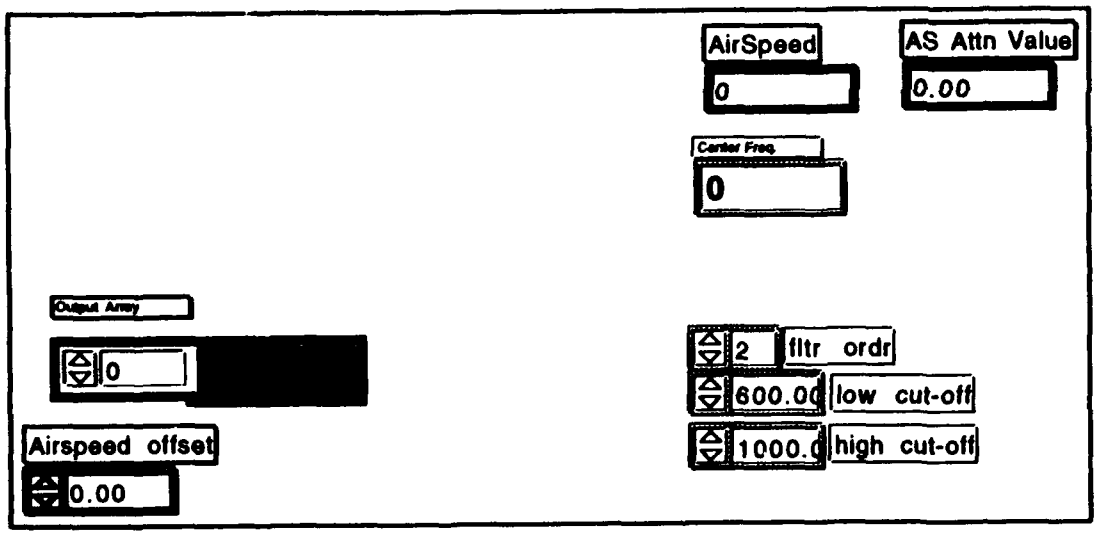
NONE

Connector Pane



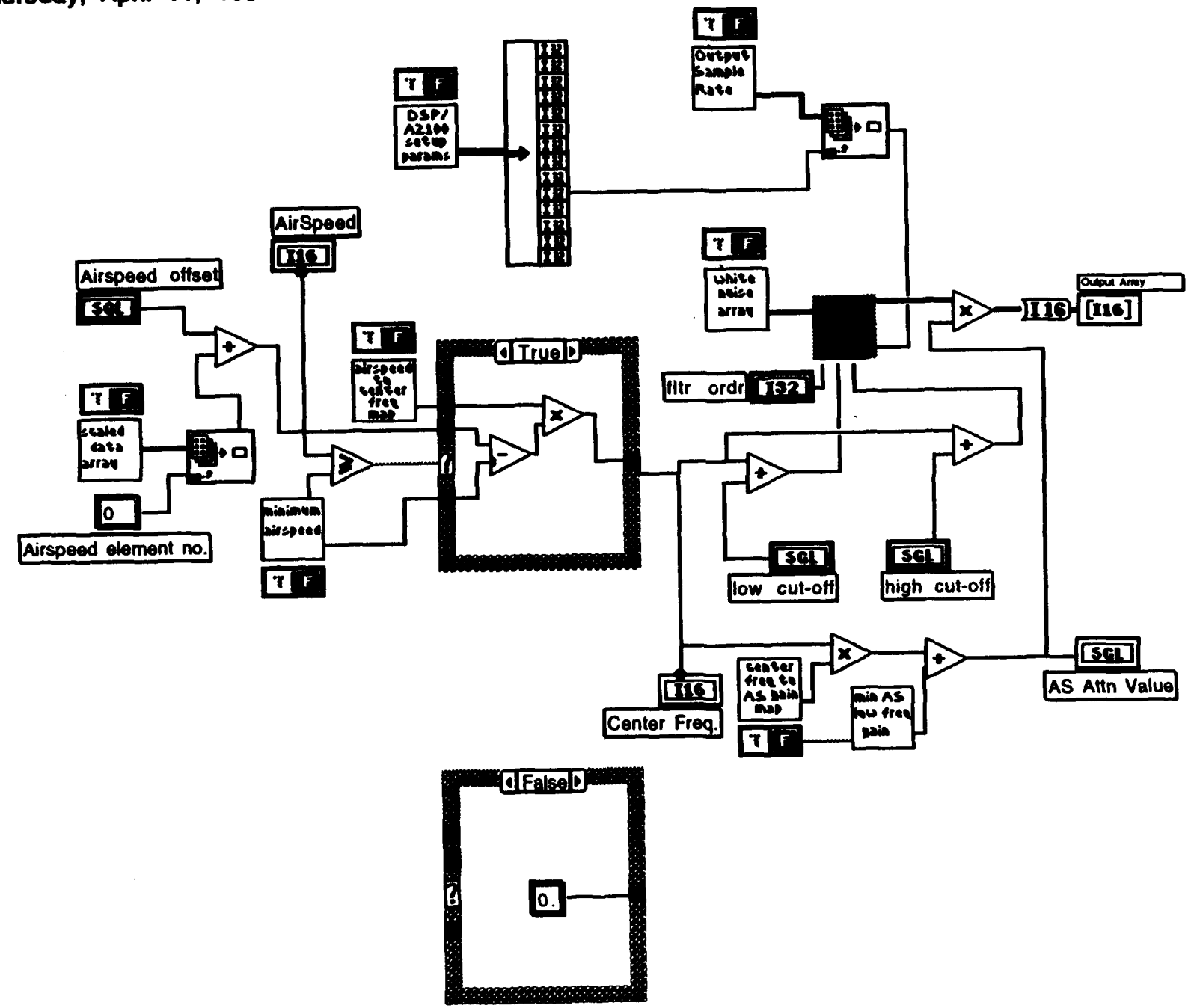
AS to Var Freq BPS w/gain

Front Panel



Block Diagram

AS to Var Freq BPS w/gain
Thursday, April 11, 1991 12:31



3D SYSTEM MANAGER

MODULE DESCRIPTION

FUNCTION NAME

3D SYSTEM MANAGER

FUNCTION DESCRIPTION

The 3D system manager is the top level software module for the 3D system code. Upon start up, the system manager calls the software modules which initialize the AOI system peripheral hardware. These hardware initializations include the FIP and ALCS serial communications ports and the direct memory access (DMA), digital signal processor (DSP), and audio output boards. Next, the system manager initializes its data storage arrays and loads the pitch circle tone array from the hard drive into system random access memory (RAM). The final start up operation is the mapping of the flight parameter user inputs to acoustic parameter constants.

Upon completion of the initialization routines, the system manager calls the audio output manager. The audio output manager retains control of the system operation until the program is terminated by the user at which time control reverts back to the 3D system manager. The system manager then de-allocates DMA resources and terminates the program.

FUNCTION INPUTS

NAME OF PITCH CIRCLE ARRAY FILE TO PLAY: This input is entered by the user. It is the name of the pitch circle tone array file created using the *RECORD PITCH CIRCLE* LabView file.

Tmax: This input is entered by the user. It is the front panel value entered on the *GENERATE PITCH CIRCLE* LabView file front panel during the operation of the *RECORD PITCH CIRCLE* algorithm. Tmax is the number of elements in the pitch circle tone array. The Tmax entered here must be the same as that entered when the pitCh circle tone array was generated and stored.

PITCH CIRCLE ARRAY DATA TYPE SPECIFIER: This input should not be changed. It informs the system manager software of the pitch circle array type. This type specifier is used when accessing the pitch circle tone array from the hard disK.

FUNCTION OUTPUTS

ERROR CODES: These codes inform the user of an error condition encountered while accessing the pitch circle tone array from the hard disc. An error of zero indicates a successful operation. Refer to the LAbView users manual for a description of all other error codes.

PARENT FUNCTIONS

NONE

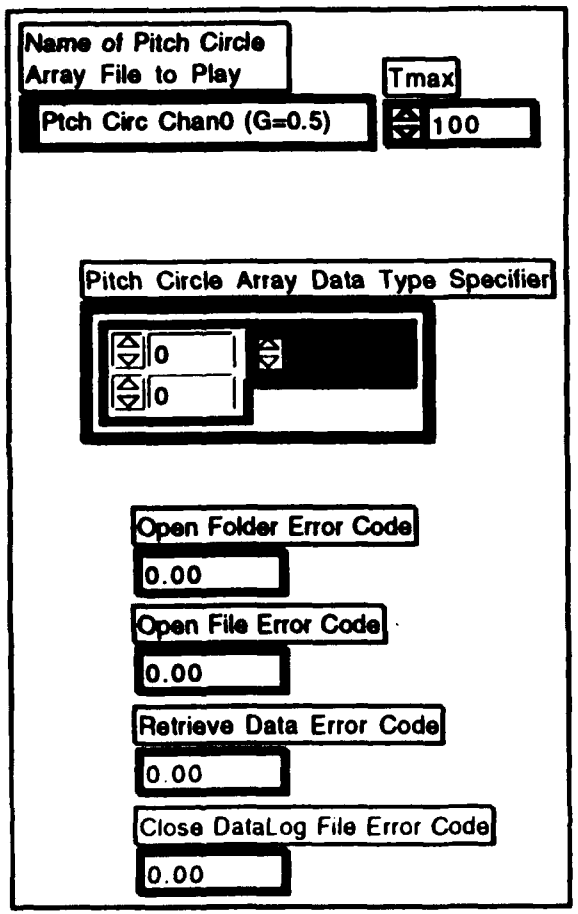
CHILD FUNCTIONS

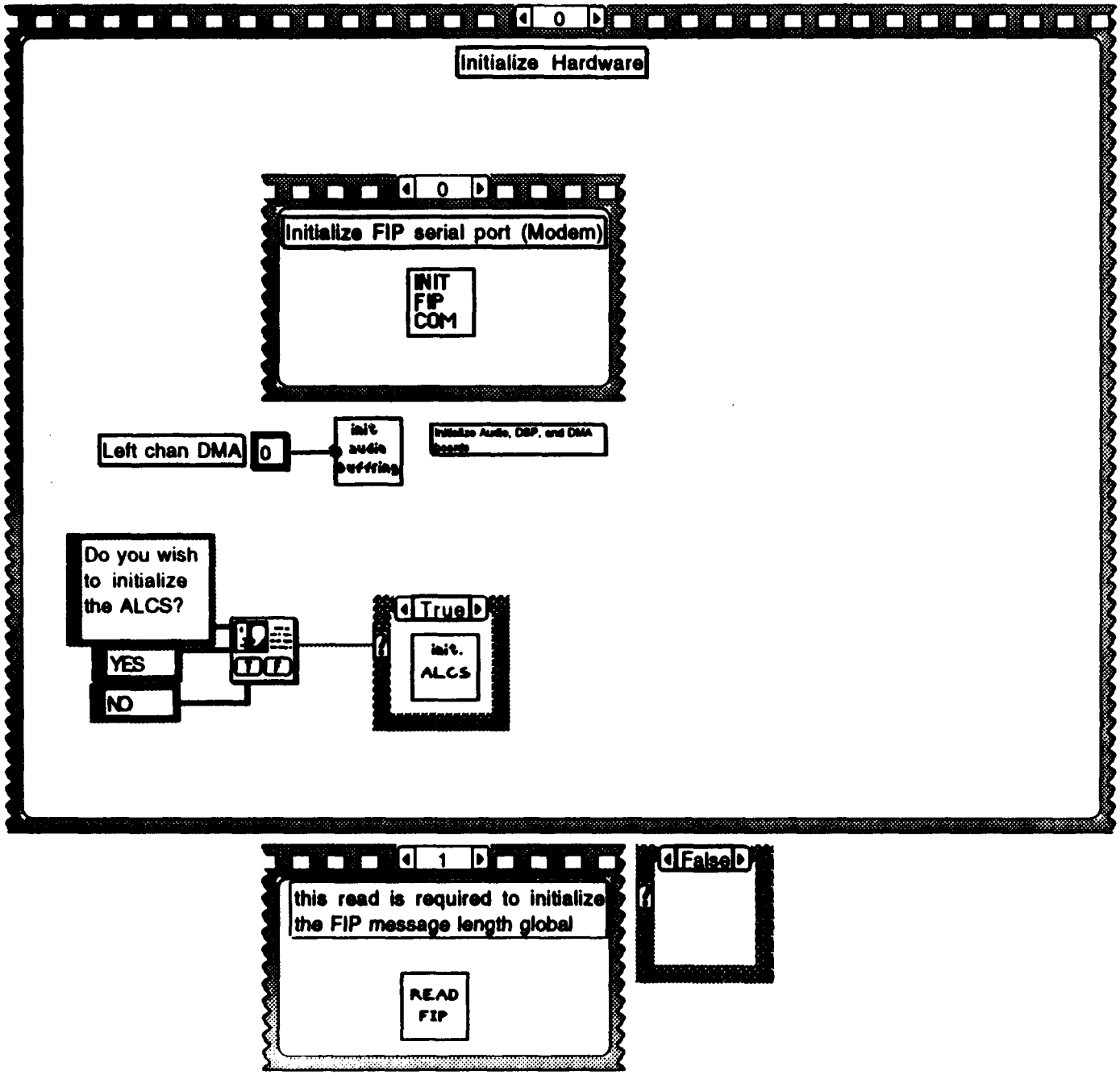
INIT AUDIO BUFFERING
INIT FIP COM
INIT ALCS
MAP ACOUSTIC PARAMS(NEW)
AUDIO OUTPUT MANAGER

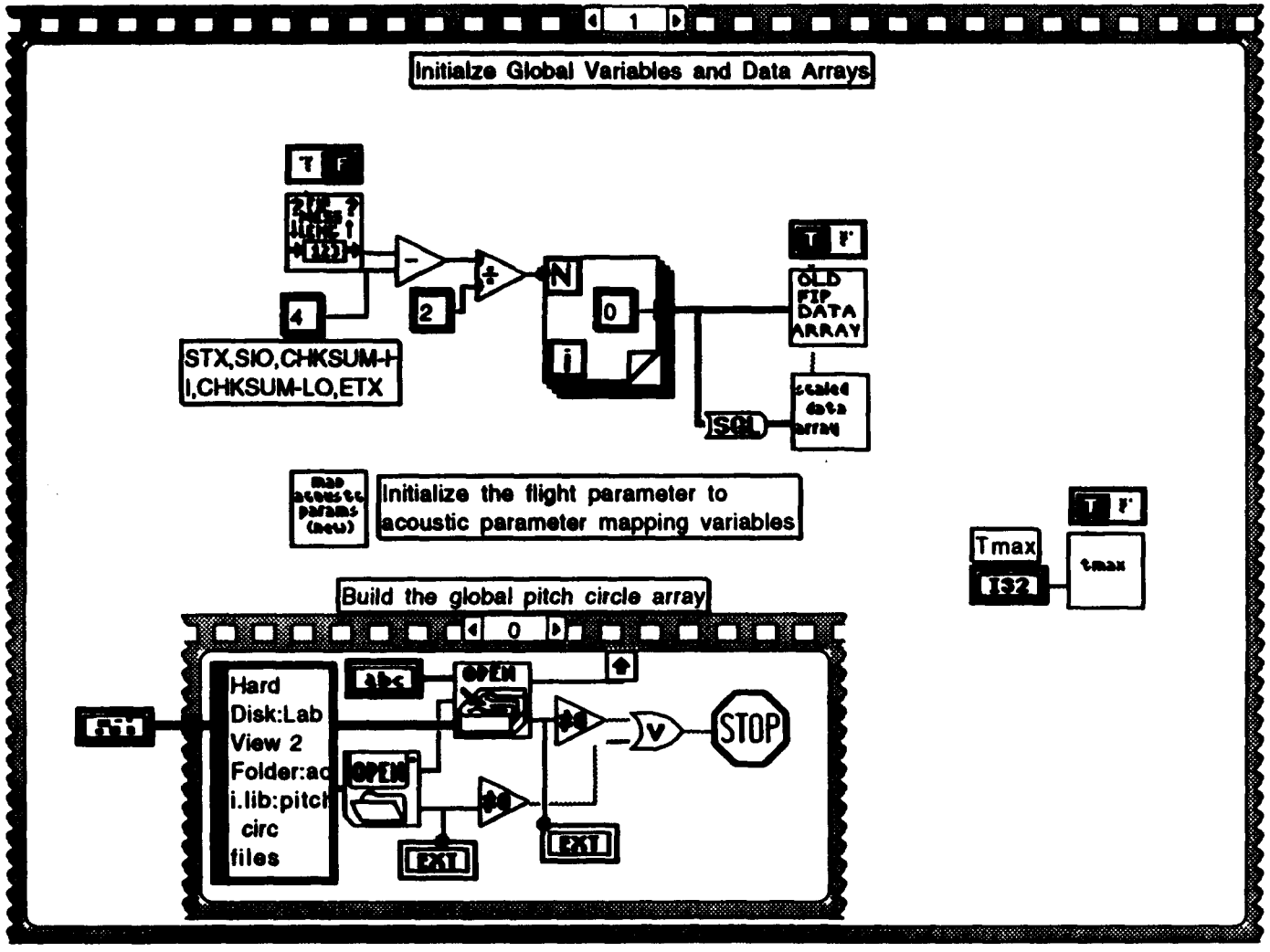
Connector Pane

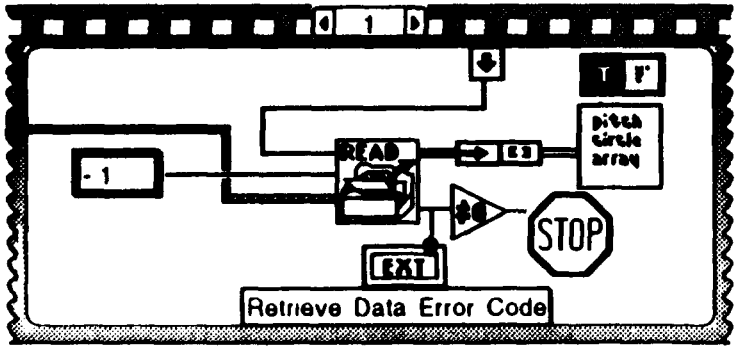
3-D Sys Mngr (VV Taper)

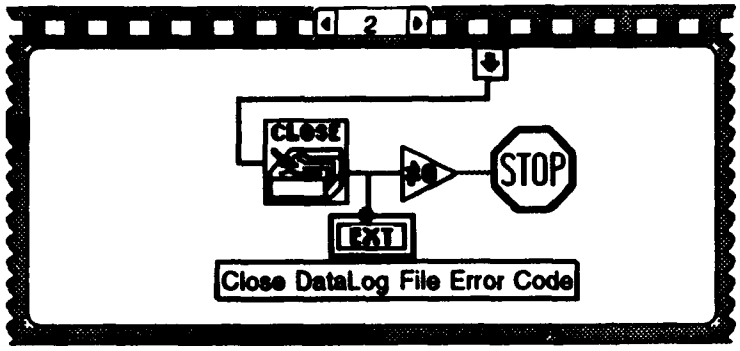
Front Panel

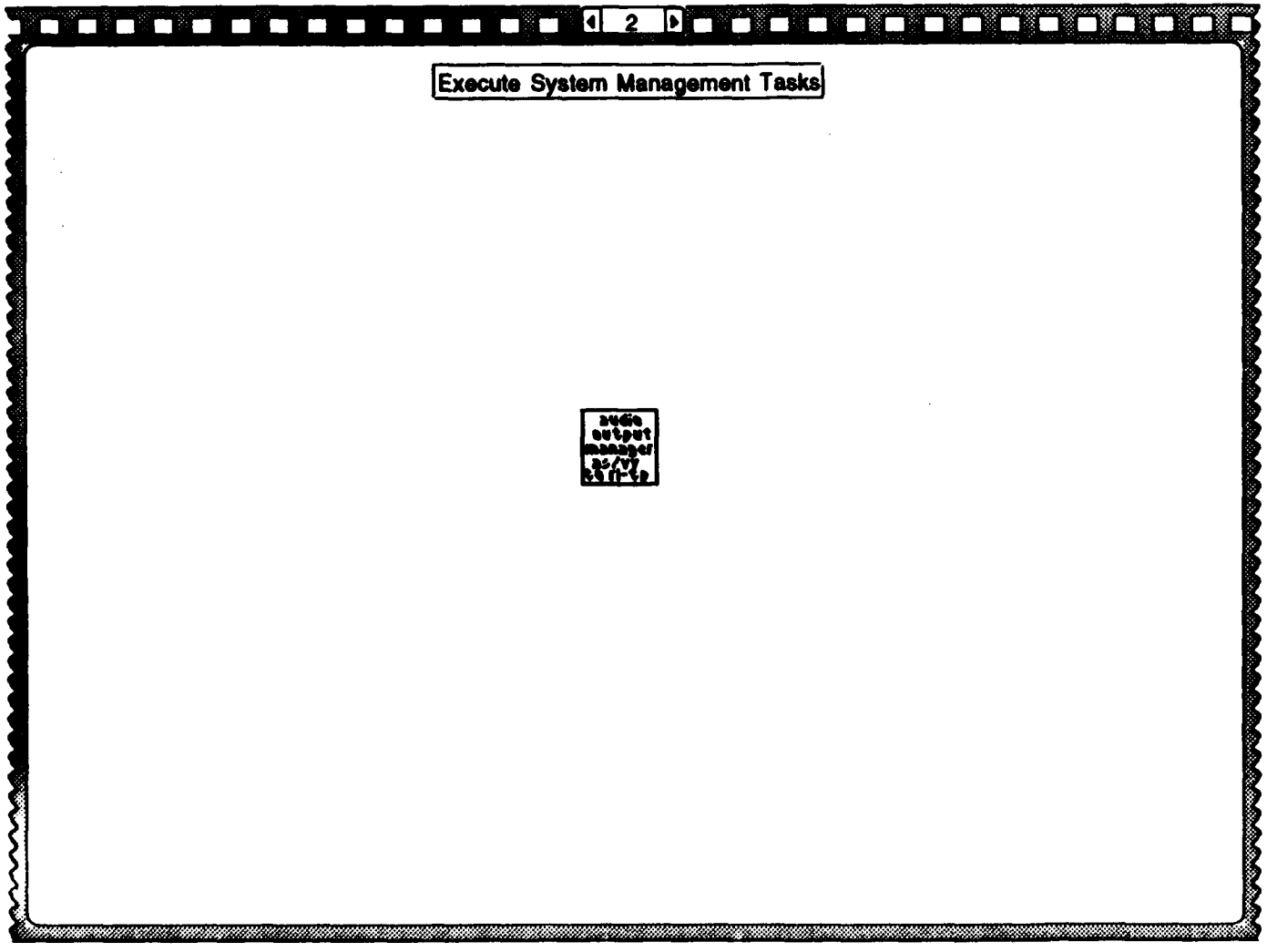



0
Initialize Hardware
0
Initialize FIP serial port (Modem)
INIT
FIP
COM
Left chan DMA
0
init
audio
buffring
Do you wish
to initialize
the ALCS?
YES
NO
True
init.
ALCS
1
this read is required to initialize
the FIP message length global
READ
FIP
False

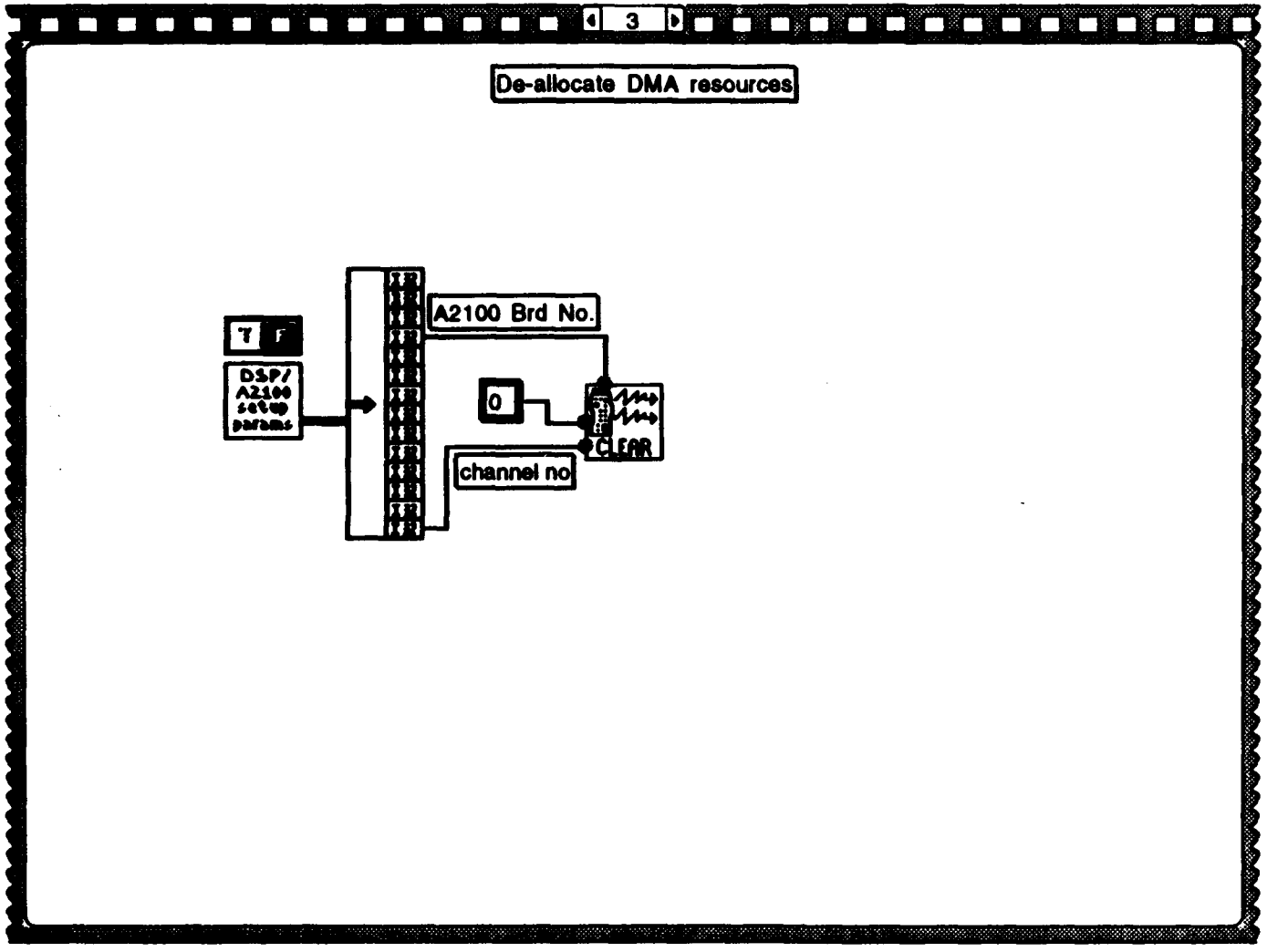

1
Initialze Global Variables and Data Arrays
T F
4
2
N
0
i
STX,SIO,CHKSUM-HI,CHKSUM-LO,ETX
T F
OLD FIP DATA ARRAY
scaled data array
SCL
Initialize the flight parameter to acoustic parameter mapping variables
Tmax
I32
T F
tmax
Build the global pitch circle array
0
Hard Disk:Lab View 2 Folder:acoustic.lib:pitch circ files
OPEN
OPEN
STOP
EXT
EXT


1
T F
-1
READ
pitch circle array
STOP
EXT
Retrieve Data Error Code


2
CLOSE
STOP
EXT
Close DataLog File Error Code


2
Execute System Management Tasks

Block Diagram



L1

AUDIO OUT MNG
(ASW-RL tpr)

MODULE DESCRIPTION

FUNCTION NAME

AUDIO OUT MNG (ASW-RL tpr)

FUNCTION DESCRIPTION

The main function of the audio output manager module is to control the generation of the acoustic cues. Specifically, the module calls sub modules which asynchronously poll the FIP, scale the received flight data, and convert the flight data to acoustic cues. The audio output manager also controls the logging of the flight parameter data to the hard disc.

FUNCTION INPUTS

RUN/STOP: Front panel control which interrupts the algorithm operation. The software will prompt the user to either continue operation or terminate the AOI program. If continued operation is selected, the software will ask the user if he wishes to log data to the hard disc. If the data logging option is selected, the software prompts the user for the logged file name.

DATA LOGGING TIME BASE(SECS): Sets the sample rate for the data logging operation.

FUNCTION OUTPUTS

CALCULATED ROLL AZIMUTH: The audio output manager calls a sub module called ROLL TO AZ X-FORM which converts the FIP bank angle parameter to an ALCS azimuth angle. This indicator displays the converted roll azimuth angle.

FIP ROLL: FIP bank angle flight parameter.

VERTICAL VELOCITY: FIP vertical velocity flight parameter.

AIRSPEED: FIP airspeed flight parameter.

PITCH ARRAY DEVIATION: Number of elements skipped in the pitch array acoustic cue. This value is mapped from the vertical velocity.

CENTER FREQ(airspeed): Center frequency of the airspeed white BPS noise acoustic cue. This value is mapped from the airspeed flight parameter.

ERROR MESSAGES: Associated with the manipulation of the data log file (refer to the LabView manual for specific error codes).

LOGGED DATA TYPE SPECIFIER: Specifies the type of data to be logged to the hard drive by the data logging algorithm.

PARENT FUNCTIONS

3D SYSTEM MANAGER

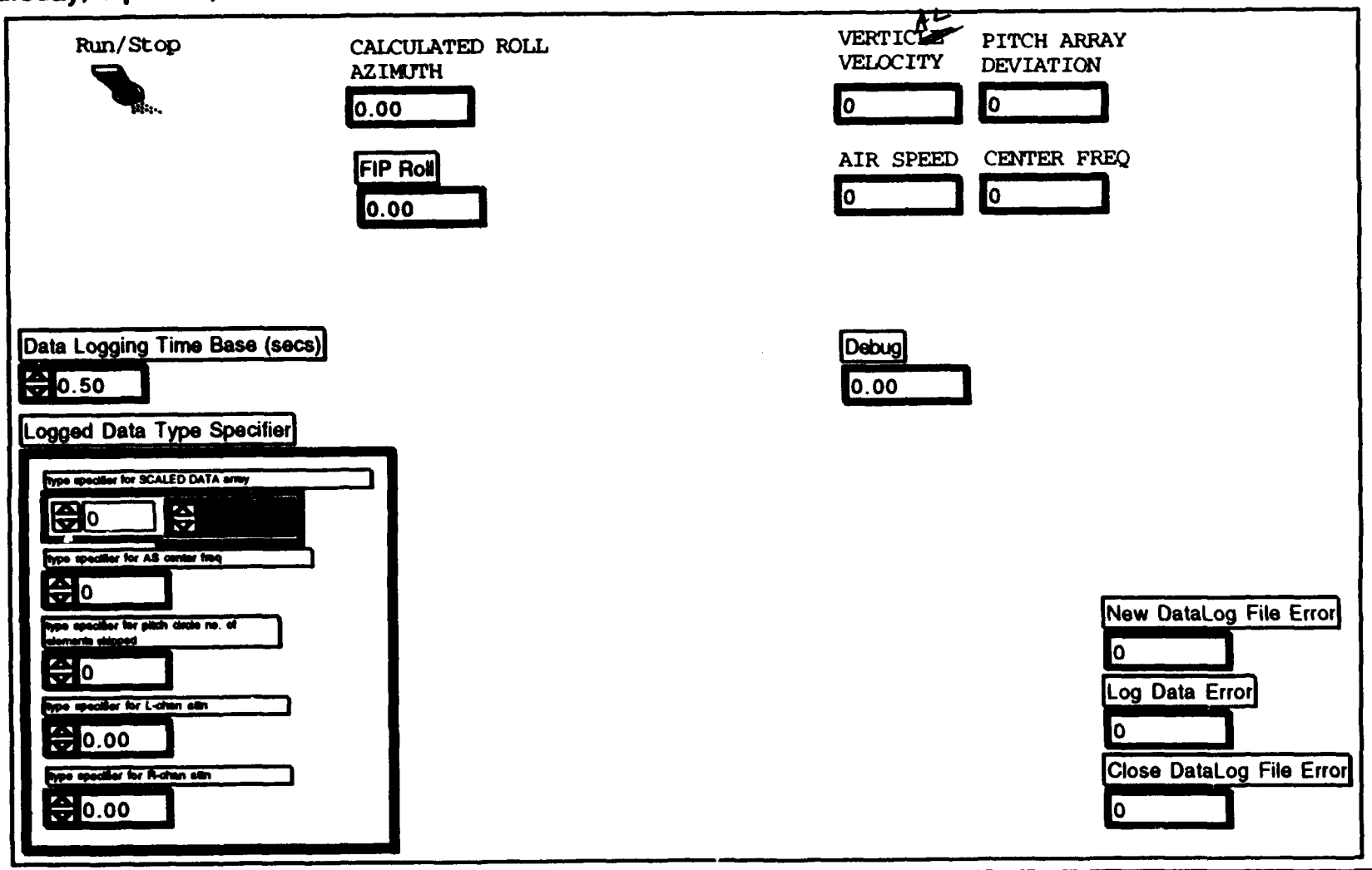
CHILD FUNCTIONS

FLIGHT DATA MANAGER
AS TO VARIABLE BPS NOISE (W/GAIN)
ROLL TO AZ X-FORM
VV TO PITCH CIRC X-FORM (W/TAPER)
GEN REF TONE

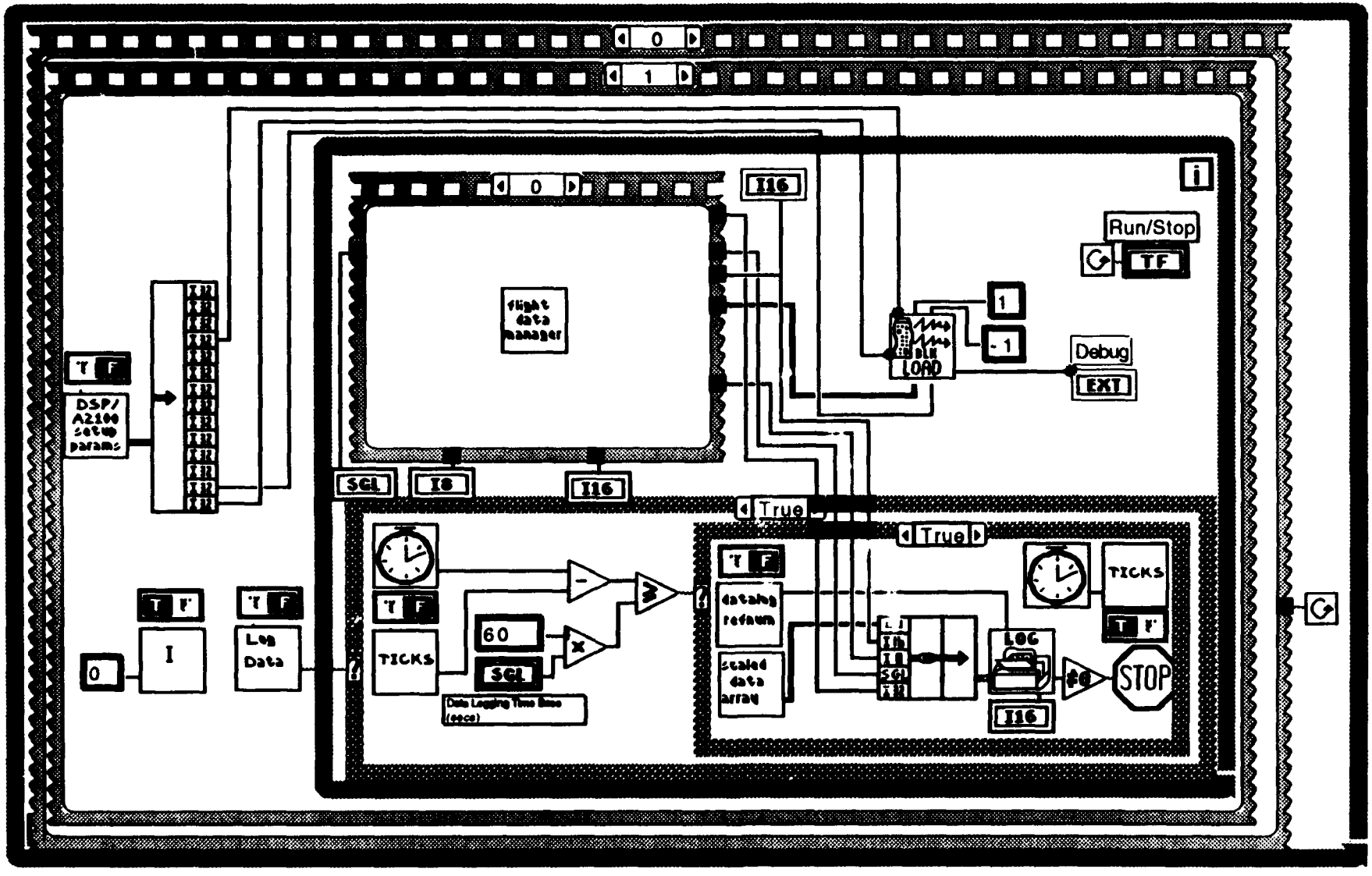
Connector Pane

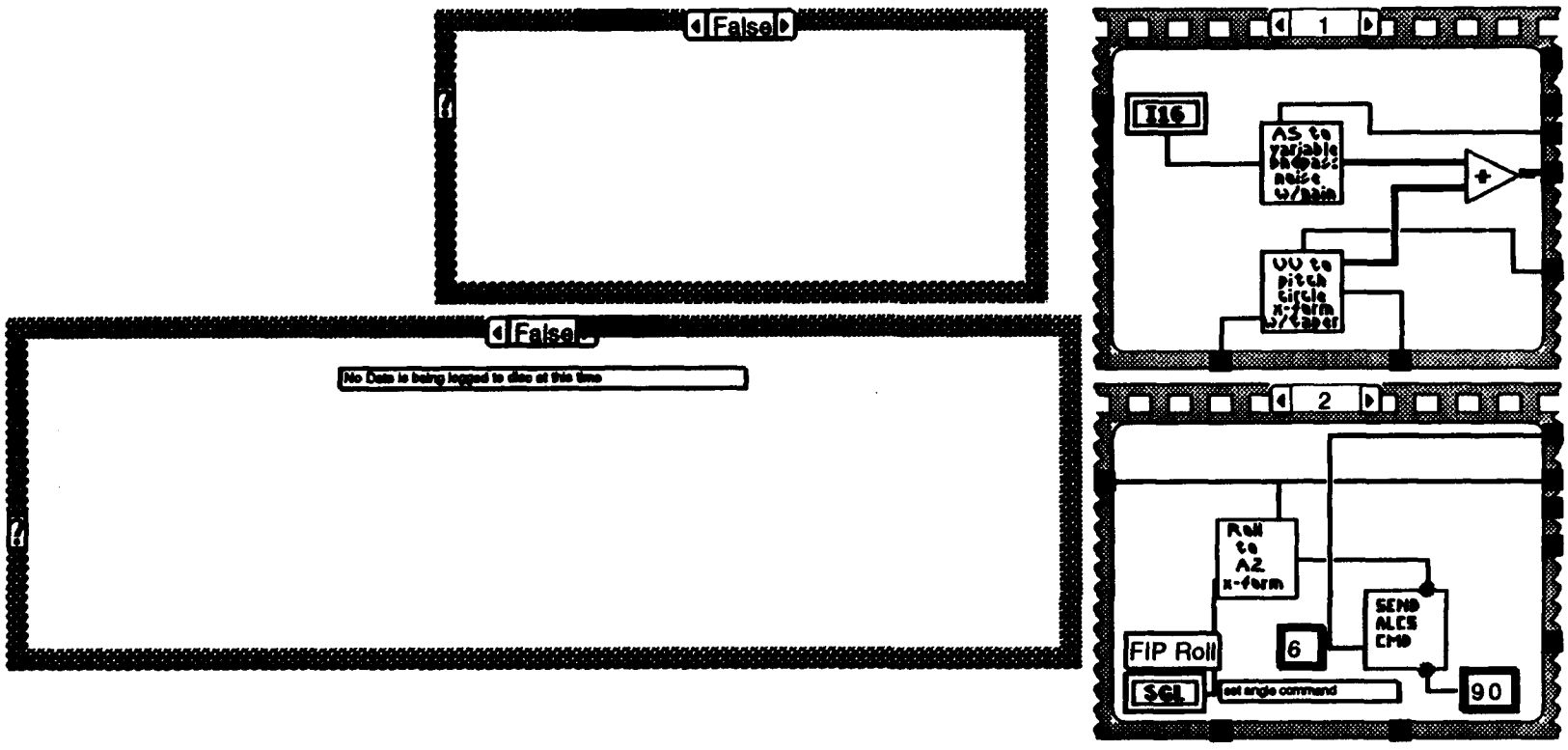
Audio Out Mng (ASVV-RL tpr)

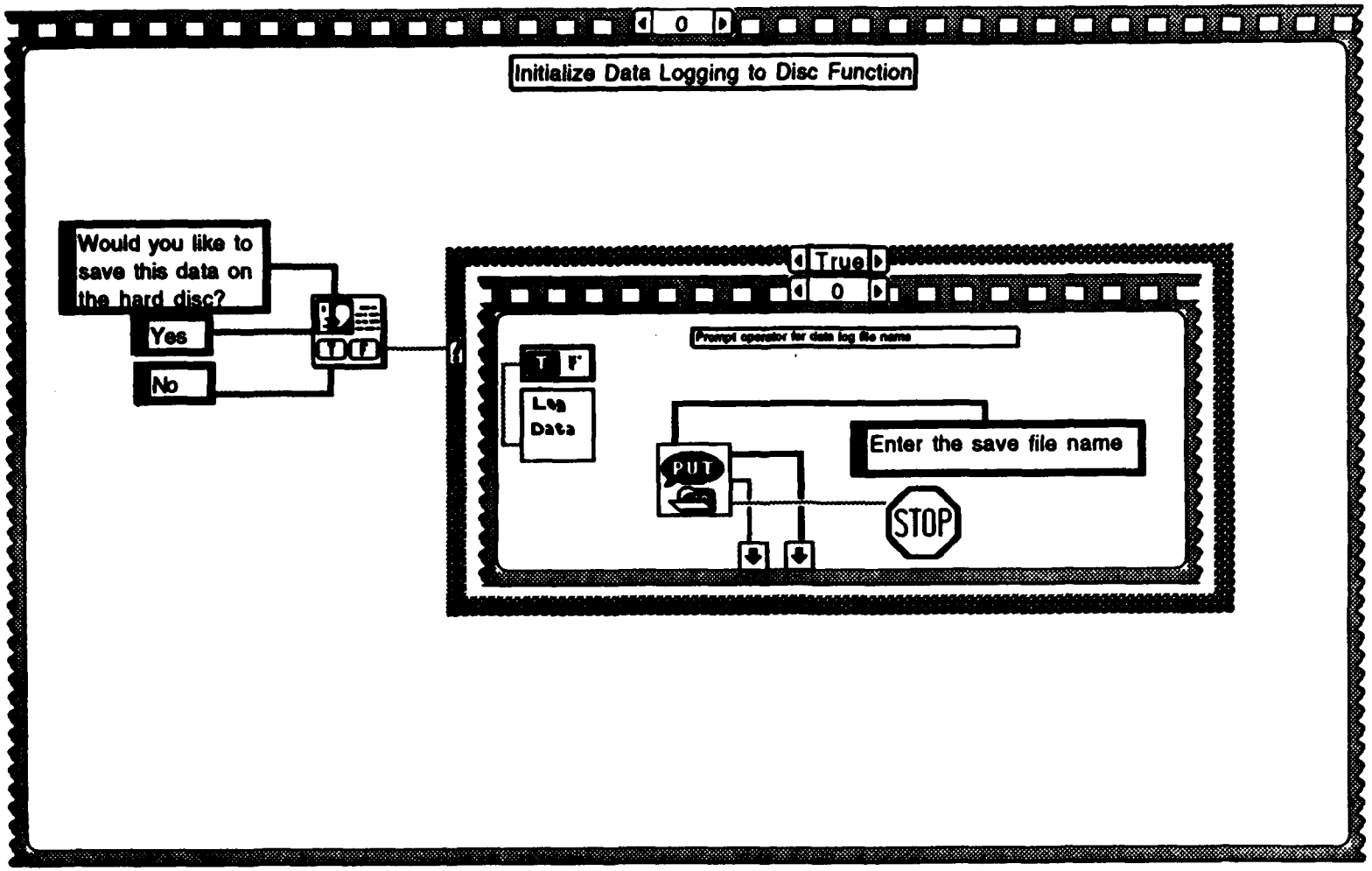
Front Panel



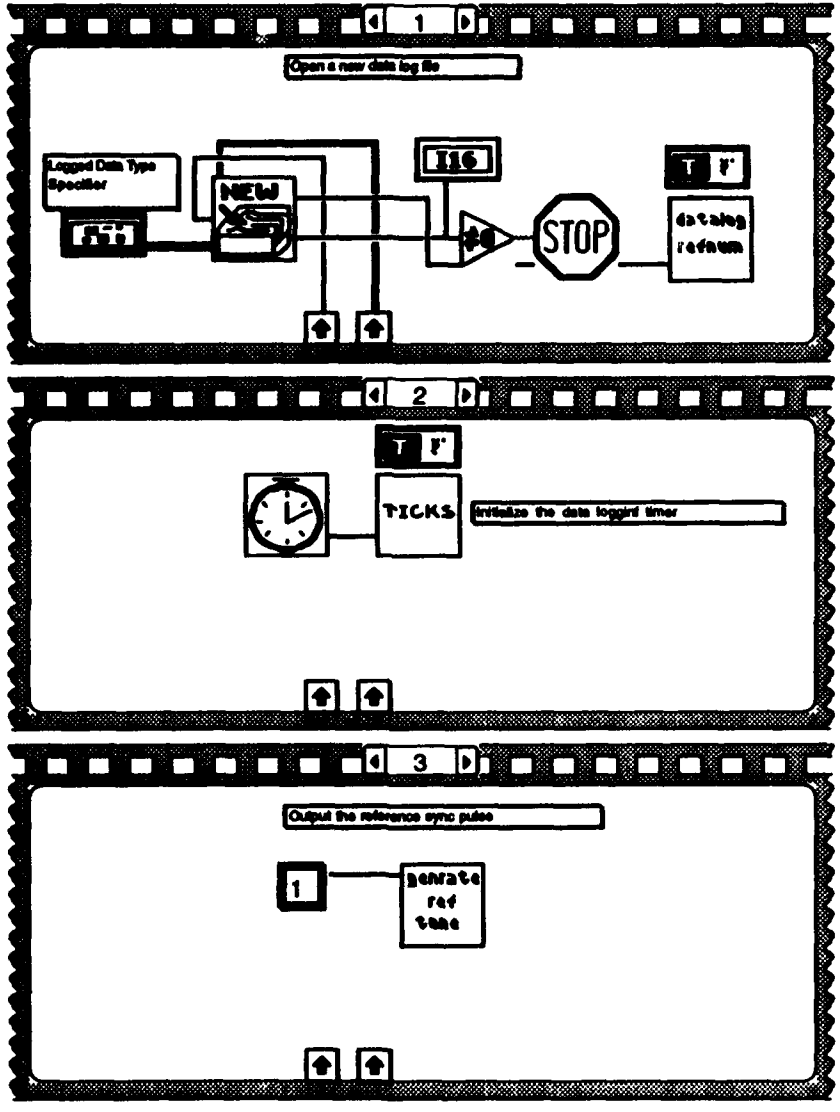
Block Diagram

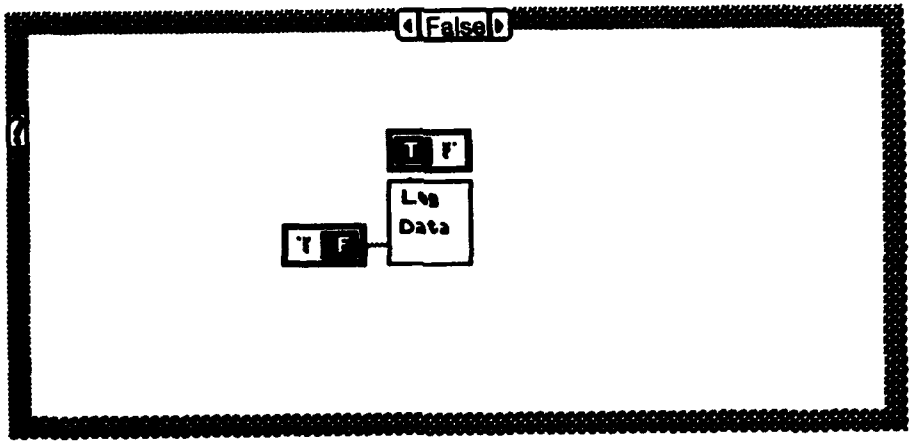

0
1
0
I16
i
Run/Stop
TF
flight data manager
1
-1
Debug
EXT
DSP/ A2100 setup params
SGL
I8
I16
True
True
TICKS
60
SGL
TICKS
Log Data
I
0
datalog refnum
scaled data array
LOG
I16
STOP

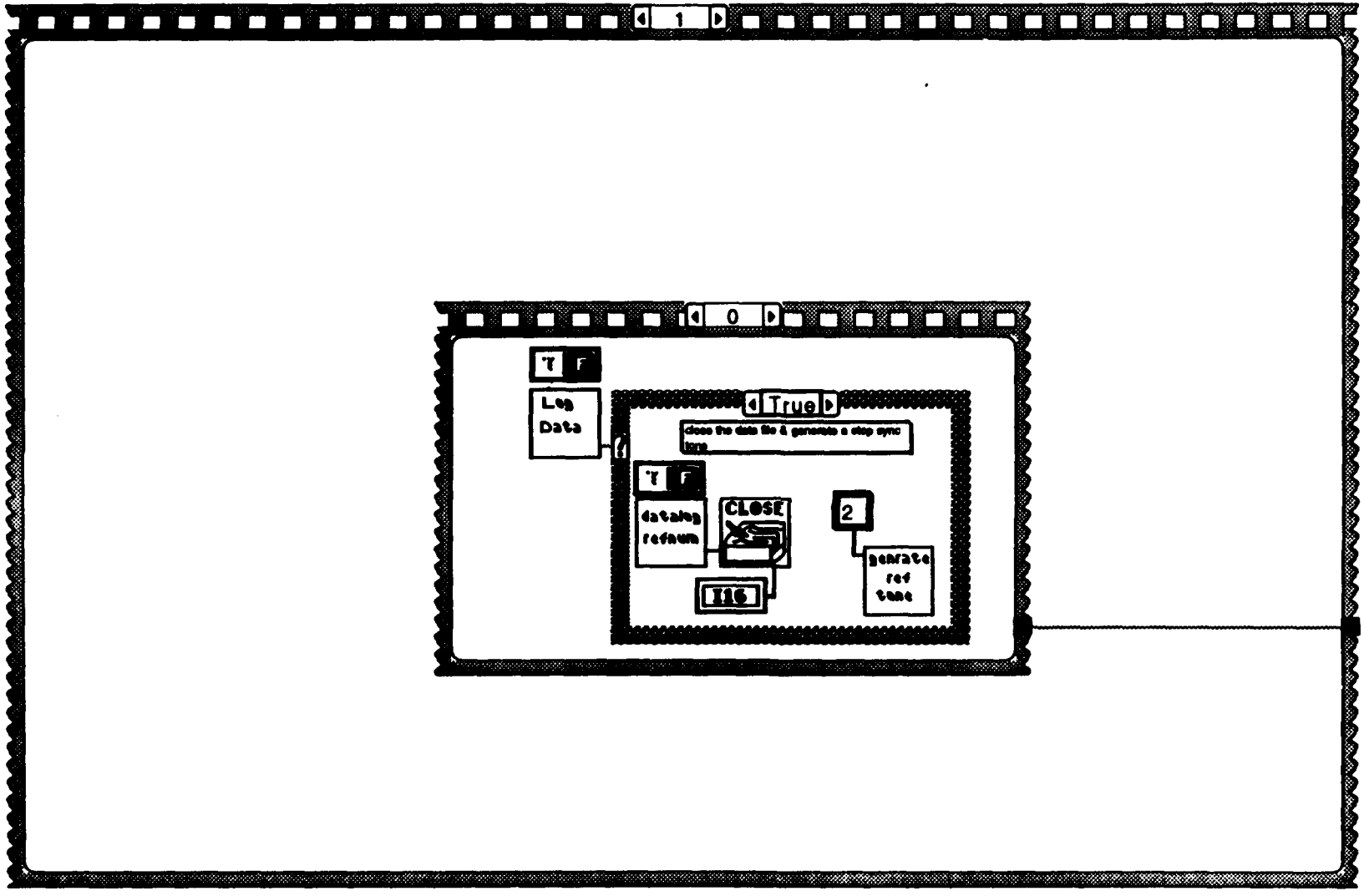

False
False
No Data is being logged to disc at this time
1
I16
AS to variable
UU to pitch circle x-form
2
Roll to A2 x-form
SEND ALCS CMD
FIP Roll
6
SGL
set angle command
90

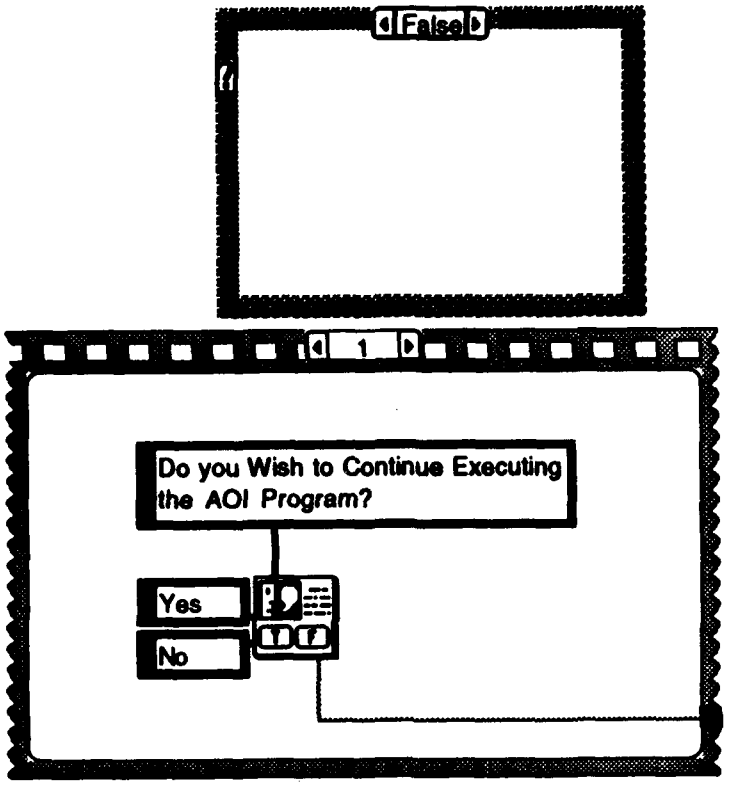

0
Initialize Data Logging to Disc Function
Would you like to save this data on the hard disc?
Yes
No
True
0
Prompt operator for data log file name
T F
Log Data
Enter the save file name
PUT
STOP

25


1
Open a new data log file
Logged Data Type Specifier
NEW
I16
STOP
T F
data log refnum
2
T F
TICKS
Initialize the data logging timer
3
Output the reference sync pulse
1
generate ref tone


False
T F
Log Data
T F


1
0
T F
Log Data
True
close the data file & generate a stop sync tone
T F
datalog refnum
CLOSE
116
2
generate ref tone


False
1
Do you Wish to Continue Executing the AOI Program?
Yes
No

COMPARE NEW WITH
OLD DATA

MODULE DESCRIPTION

FUNCTION NAME

COMPARE NEW WITH OLD DATA

FUNCTION DESCRIPTION

Compares most recently received FIP flight data with the previously received values. If a difference is detected, this module calls a sub module which scales and stores the appropriate flight parameters. This module then reports which values have been updated to the calling module.

FUNCTION INPUTS

NONE

FUNCTION OUTPUTS

NEW DATA: Flag is set true if new data has been received.

SCALED DATA ARRAY ELEMENTS THAT HAVE BEEN UPDATED: Element numbers of the flight data parameters that have been updated.

PARENT FUNCTIONS

FLIGHT DATA MANAGER

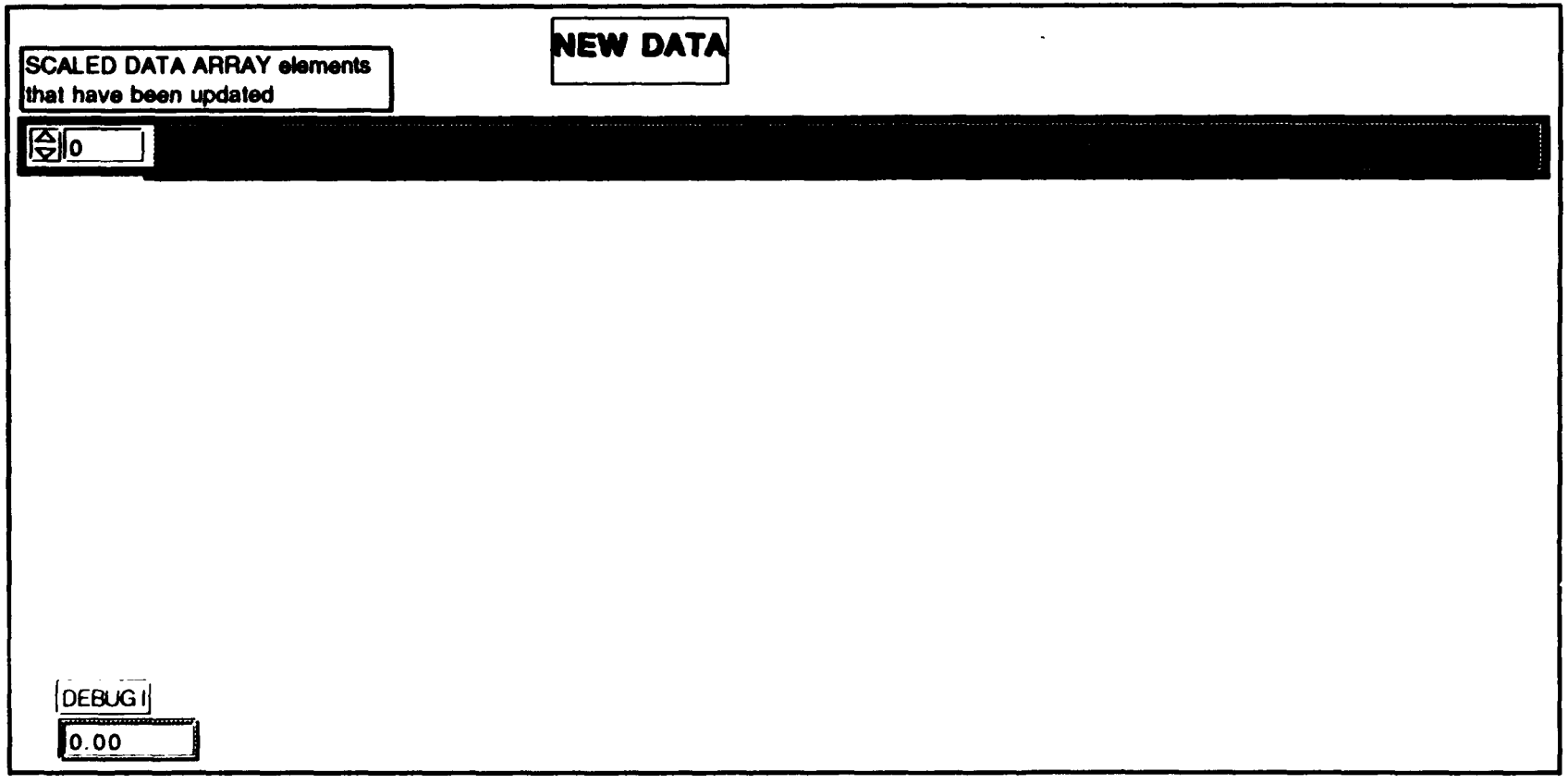
CHILD FUNCTIONS

SCALE NEW DATA

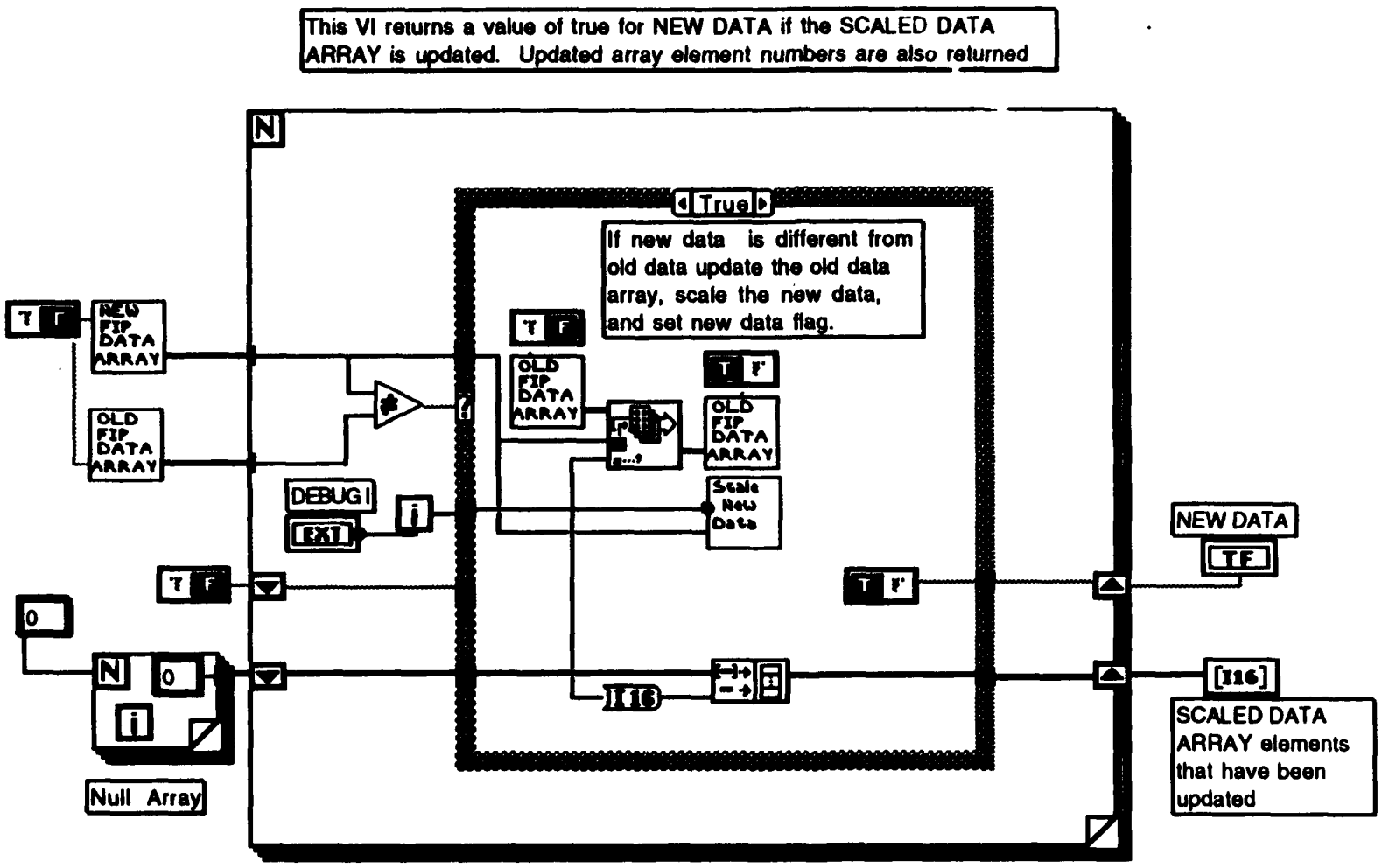
Connector Pane

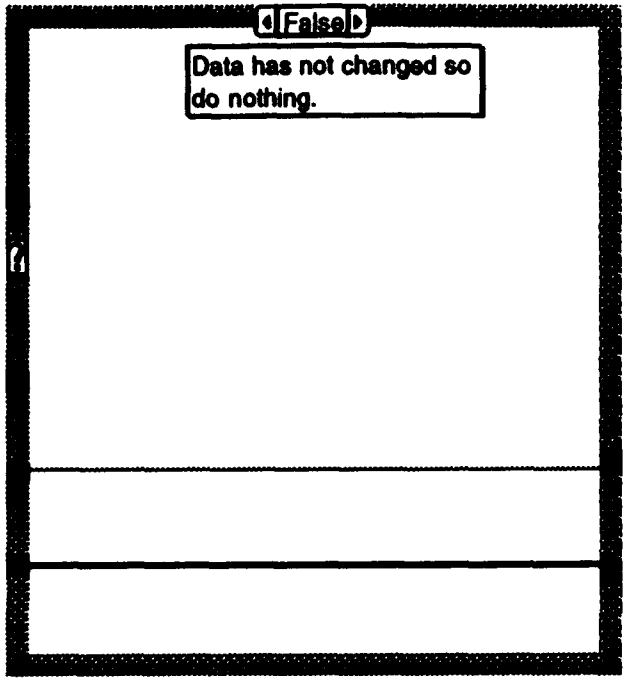
Compare New with Old Data

Front Panel



Block Diagram




False
Data has not changed so do nothing.

MODULE DESCRIPTION

FUNCTION NAME

FLIGHT DATA MANAGER

FUNCTION DESCRIPTION

This function calls sub modules which asynchronously poll the FIP for flight parameters and which scale and store the flight data.

FUNCTION INPUTS

NONE

FUNCTION OUTPUTS

FLIGHT DATA HAS BEEN UPDATED: The sub module *COMPARE NEW WITH OLD DATA* checks to see if the most recent flight data obtained from the FIP is different from the previously received data. If differences exist, the sub module scales and saves the appropriate parameters and reports that the data has been updated.

SCALED DATA ARRAY ELEMENTS THAT HAVE BEEN UPDATED: The sub module COMPARE NEW WITH OLD DATA reports the element numbers of the scaled data array which have been updated.

PARENT FUNCTIONS

AUDIO OUTPUT MANAGER

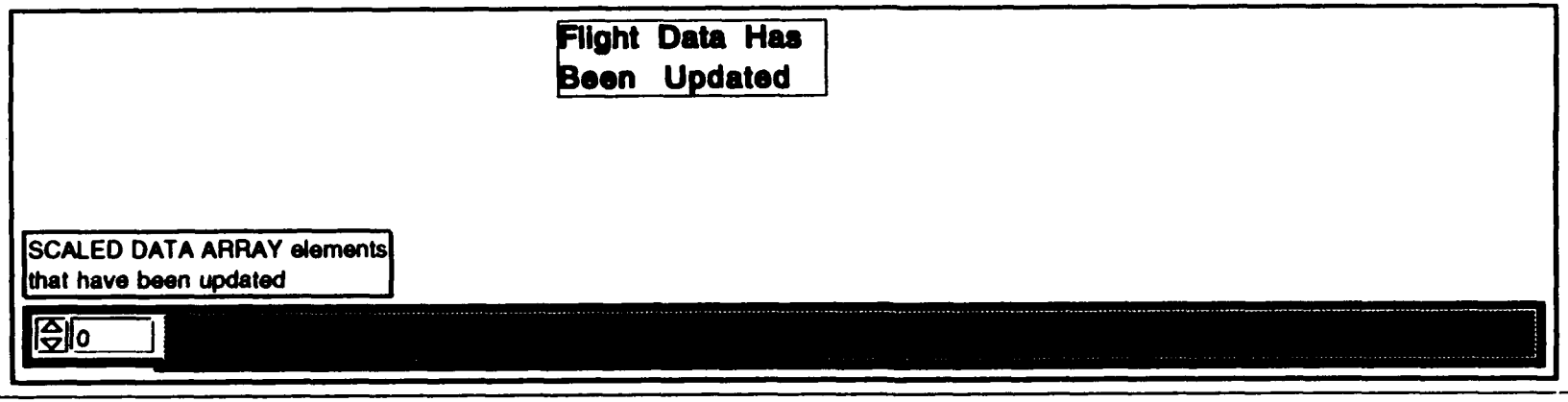
CHILD FUNCTIONS

COMPARE NEW DATA WITH OLD DATA
READ FIP

Connector Pane

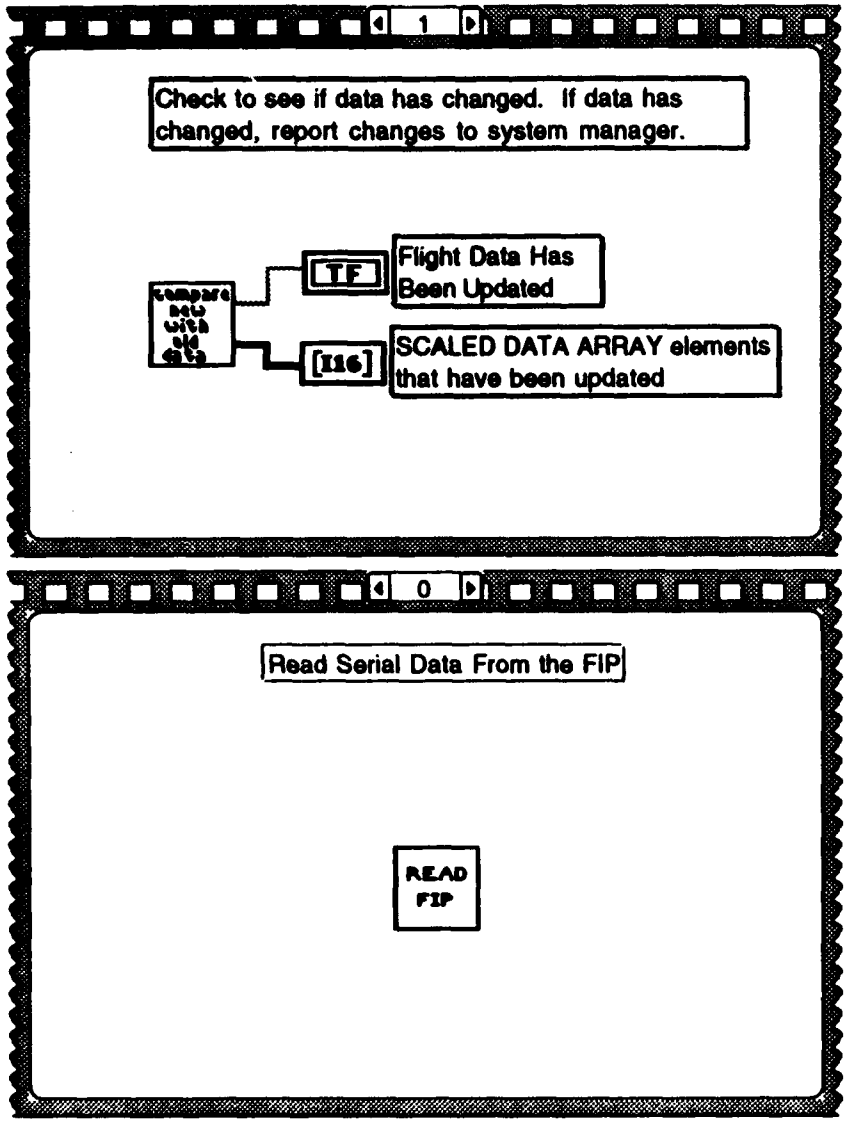
Flight Data Manager

Front Panel



37

Block Diagram


1
Check to see if data has changed. If data has changed, report changes to system manager.
compare data with old data
TF
Flight Data Has Been Updated
[116]
SCALED DATA ARRAY elements that have been updated
0
Read Serial Data From the FIP
READ FIP

GENERATE REFERENCE
TONE

MODULE DESCRIPTION

FUNCTION NAME

GENERATE REFERENCE TONE

FUNCTION DESCRIPTION

Generates an audio reference tone that is mixed into the AOI output. This tone serves as an audible reference mark on the analog flight data recordings to locate the beginning and ending of each logged data set.

FUNCTION INPUTS

NUMBER OF TIMES TO PLAY TONE: Tone is played once to mark the beginning of a data set and twice to mark the end.

FUNCTION OUTPUTS

NONE

PARENT FUNCTIONS

AUDIO OUTPUT MANAGER

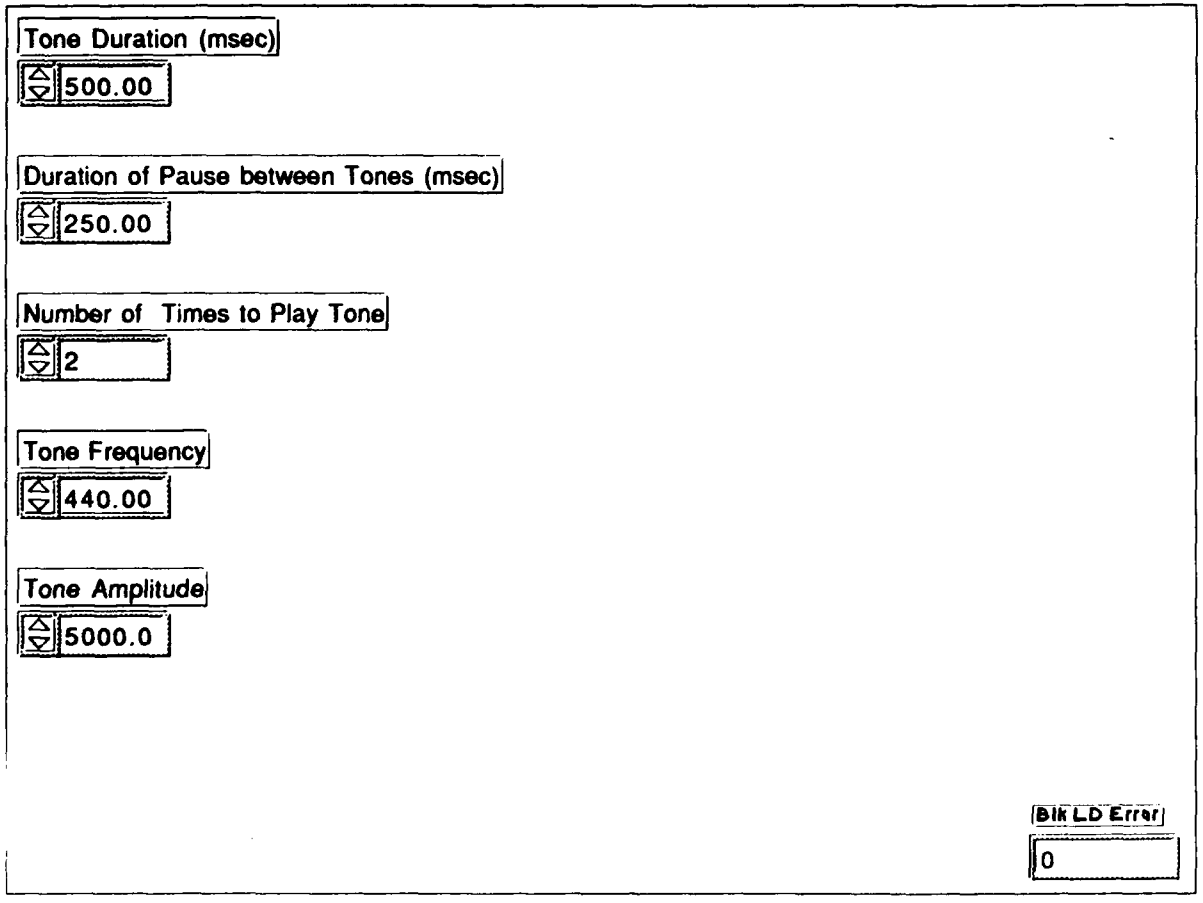
CHILD FUNCTIONS

NONE

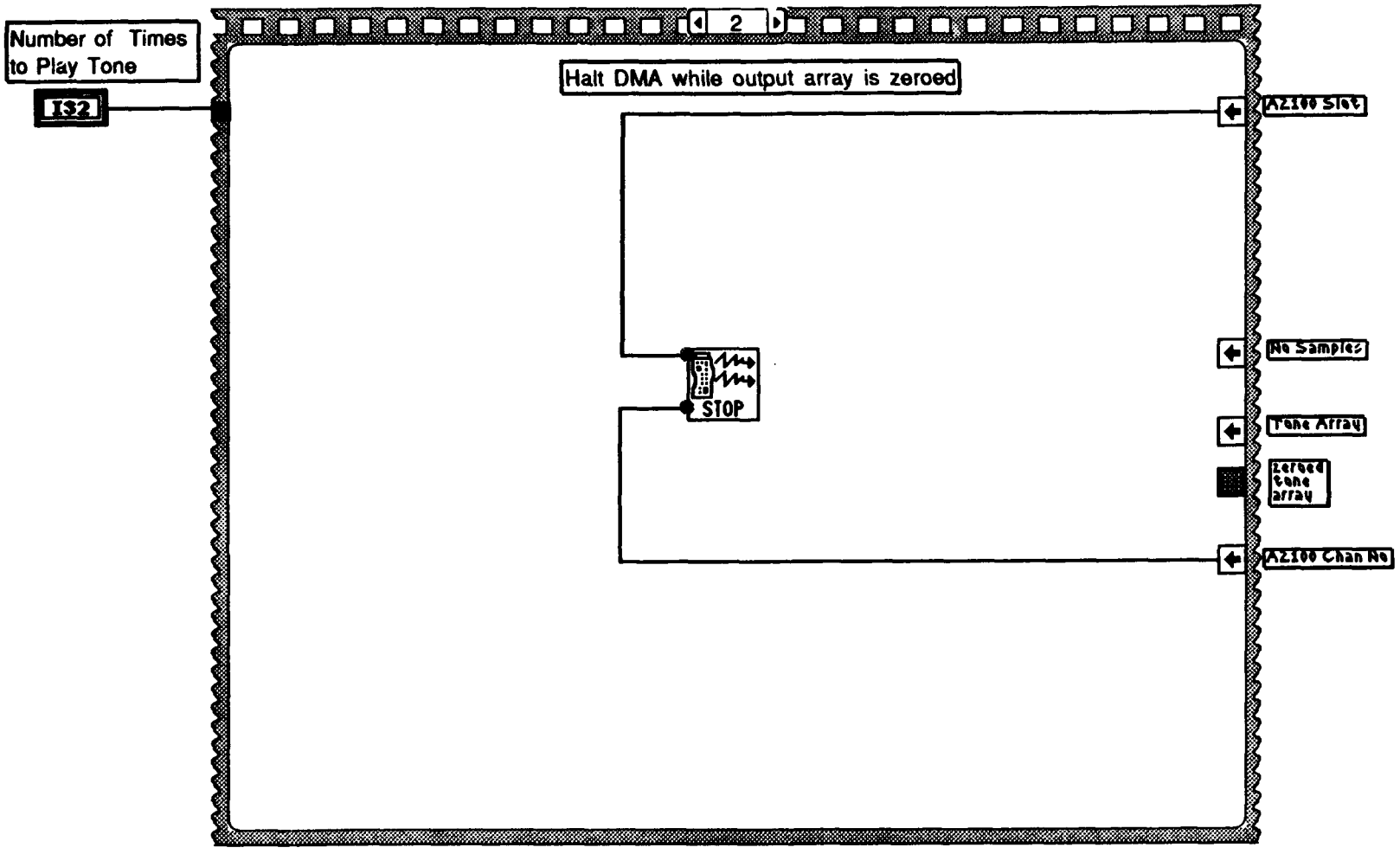
Connector Pane

Generate Reference Tone

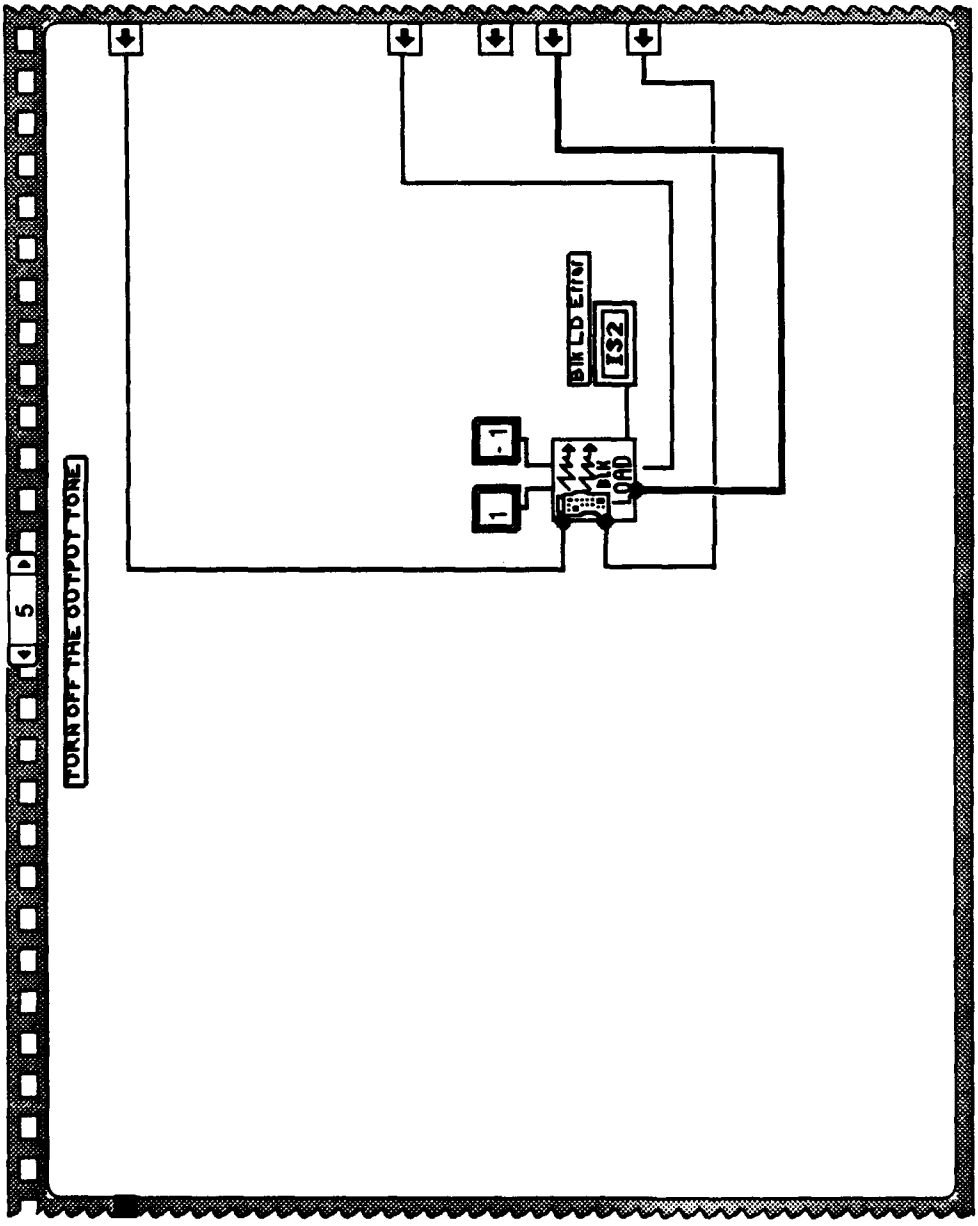
Front Panel

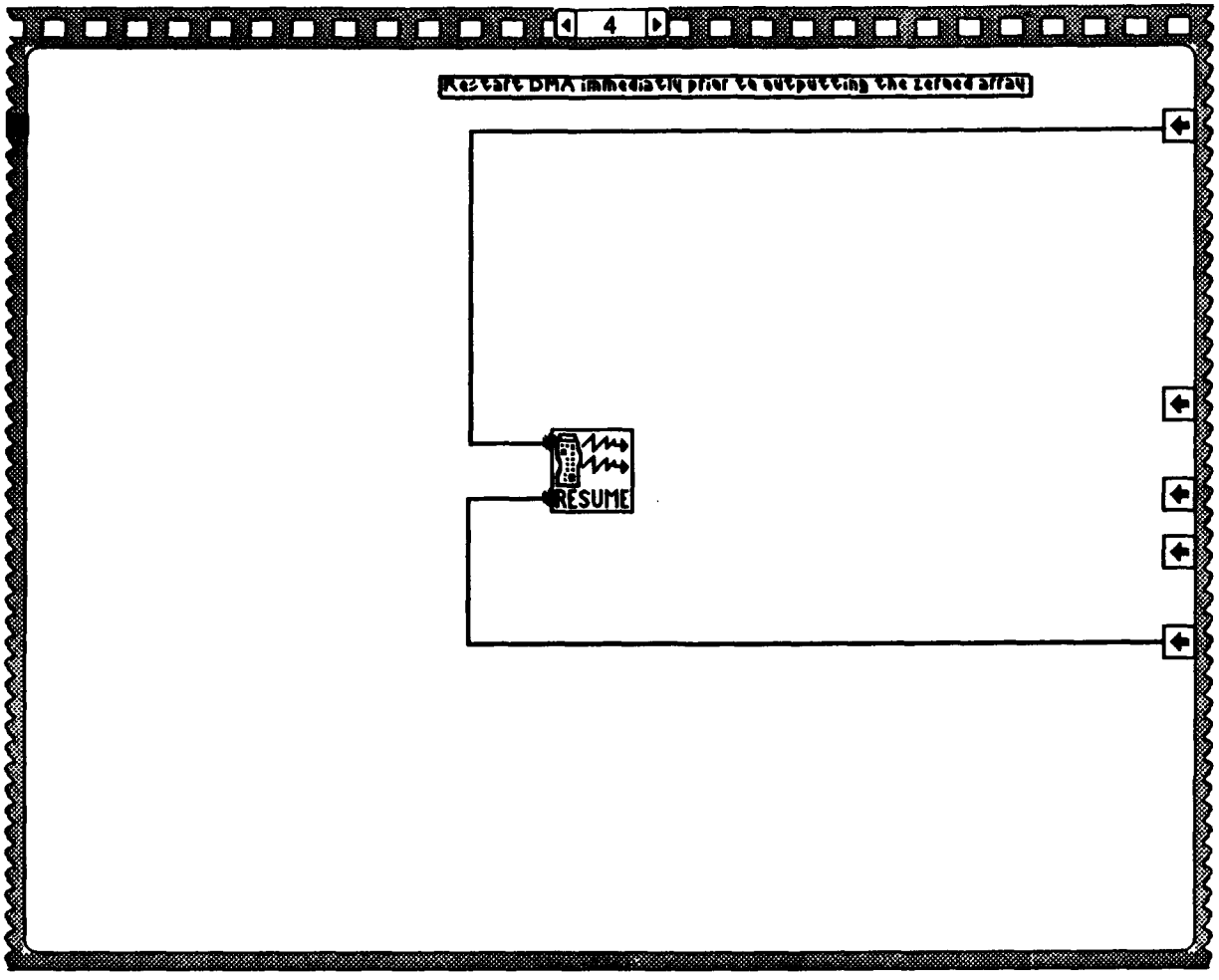


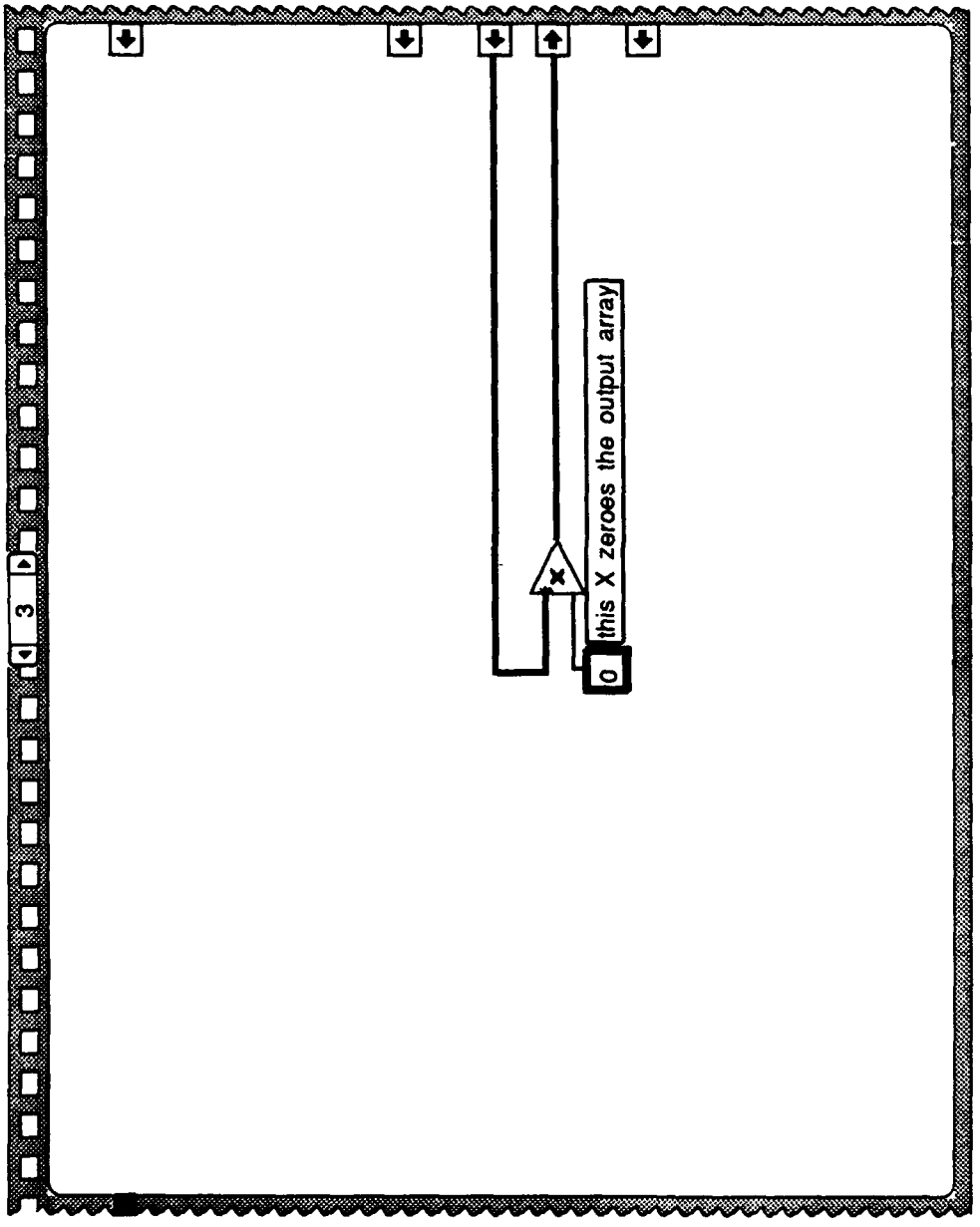
Block Diagram

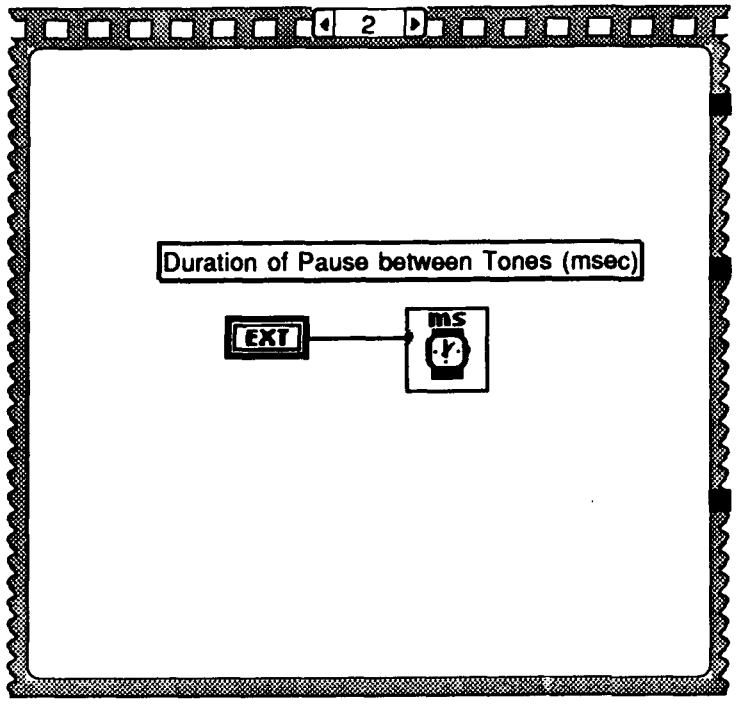


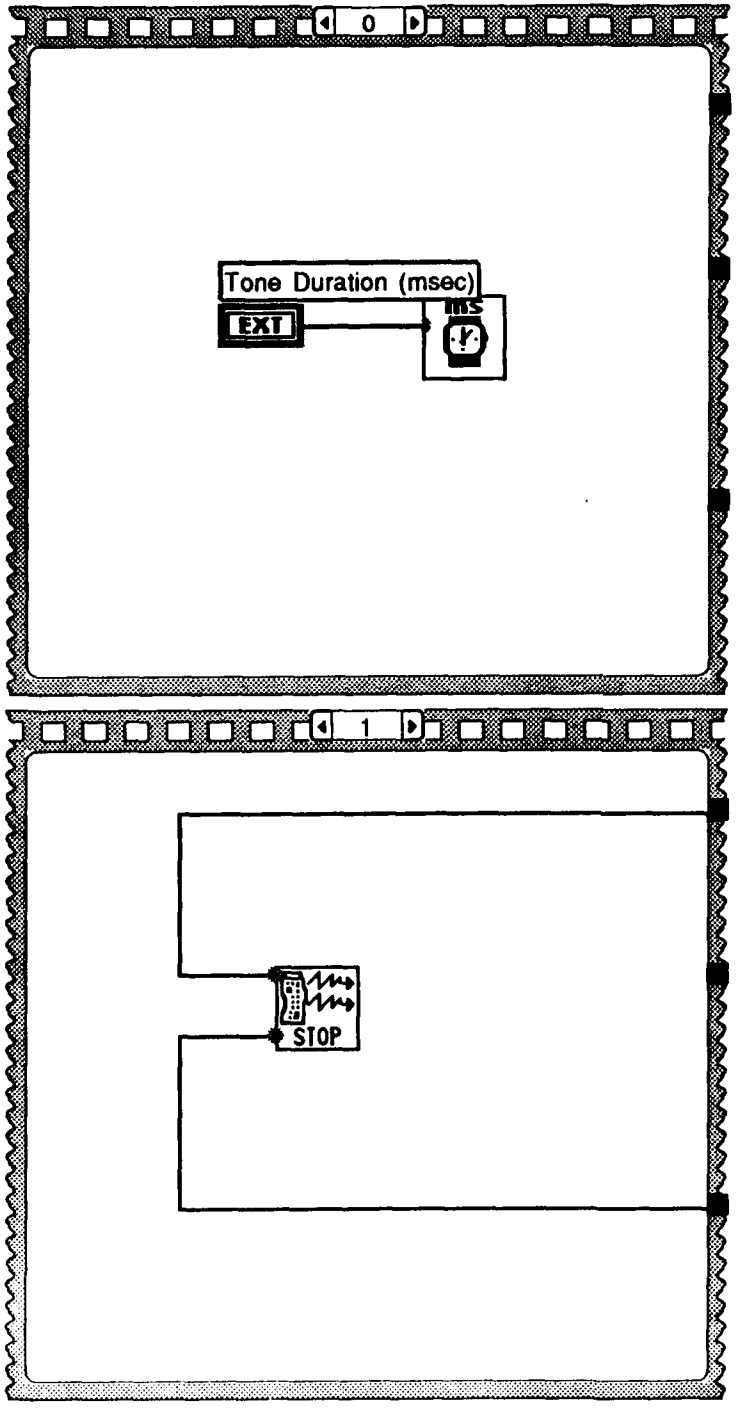
74

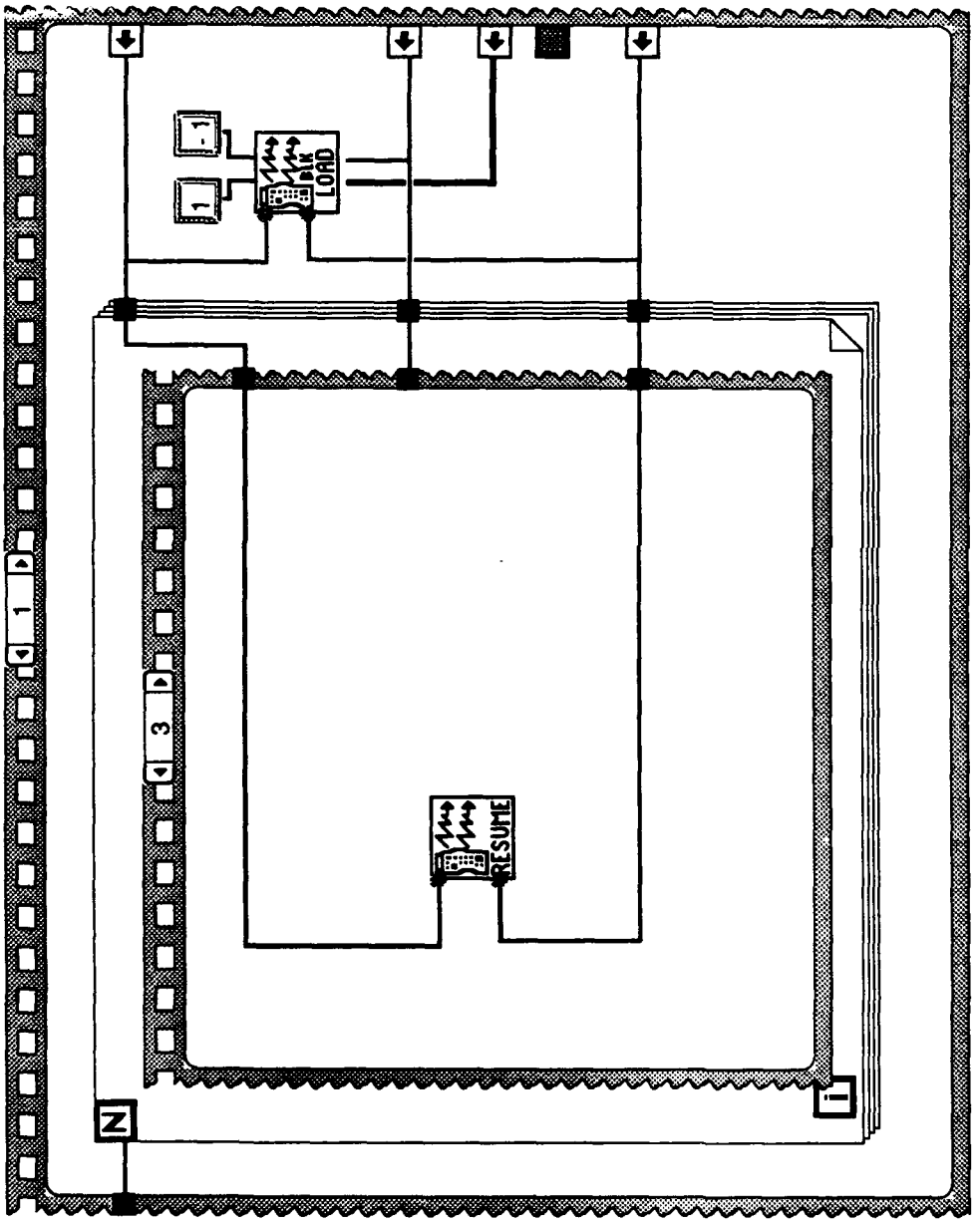

TURN OFF THE OUTPUT TONE
5
I32
DIK
LOAD

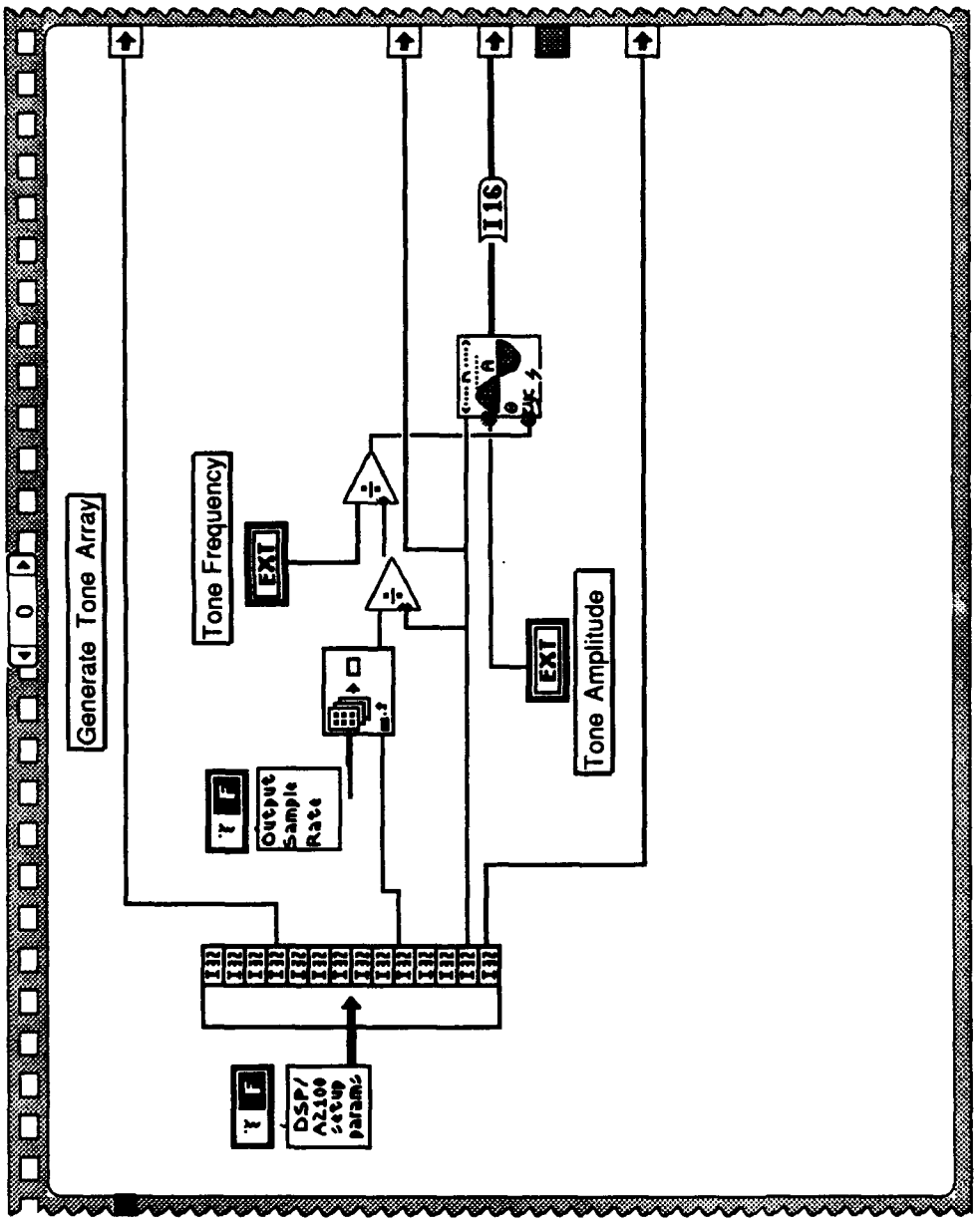

4
Restart DMA immediately prior to outputting the zeroed array
RESUME


3
this X zeroes the output array
0


2
Duration of Pause between Tones (msec)
EXT
ms


0
Tone Duration (msec)
EXT
ms
1
STOP


1
3
2
i
LOAD
RESUME


Generate Tone Array
0
Tone Frequency
EXT
Output Sample Rate
Tone Amplitude
EXT
I16
DSP/A2100 setup params

INIT ALCS

MODULE DESCRIPTION

FUNCTION NAME

INIT ALCS

FUNCTION DESCRIPTION

This module initializes the ALCS. Initialization includes:

1) initializing the serial port,
2) sending 3Space tracker set up command,
3) sending headphone mode command, and
4) bore-sighting the iso-tracker unit.

Please refer to the ALCS manual for a description of each of these commands and their related timing constraints.

FUNCTION INPUTS

NONE

FUNCTION OUTPUTS

NONE

PARENT FUNCTIONS

3D SYSTEM MANAGER

CHILD FUNCTIONS

SEND ALCS COMMAND

Connector Pane

Init ALCS

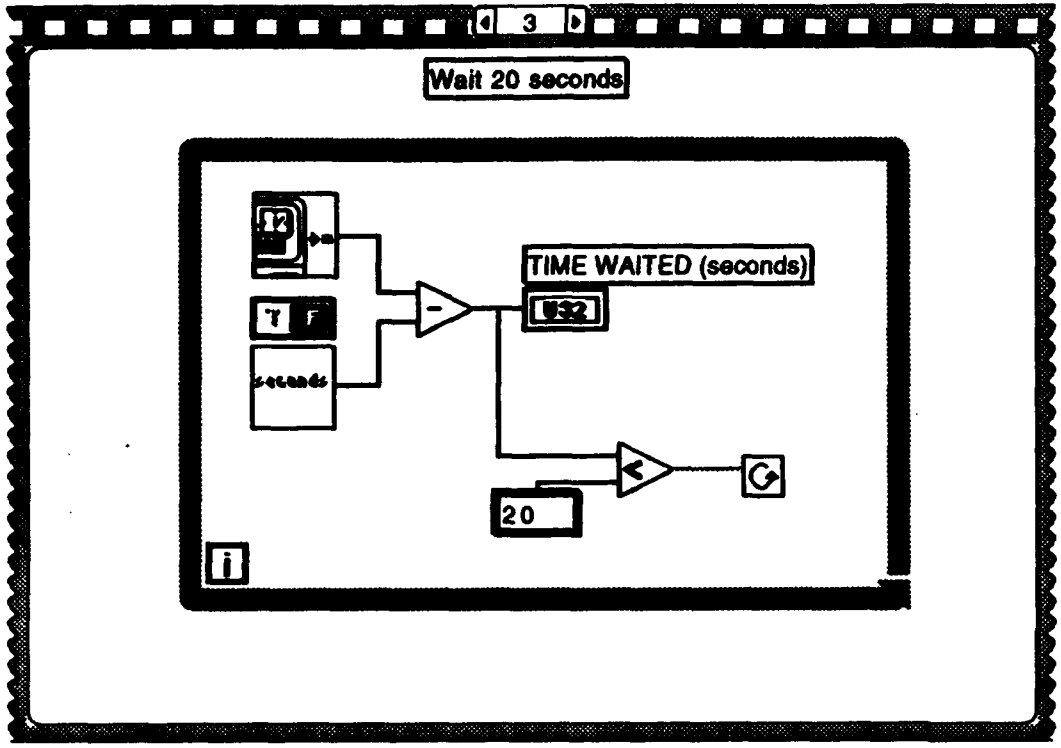
Front Panel

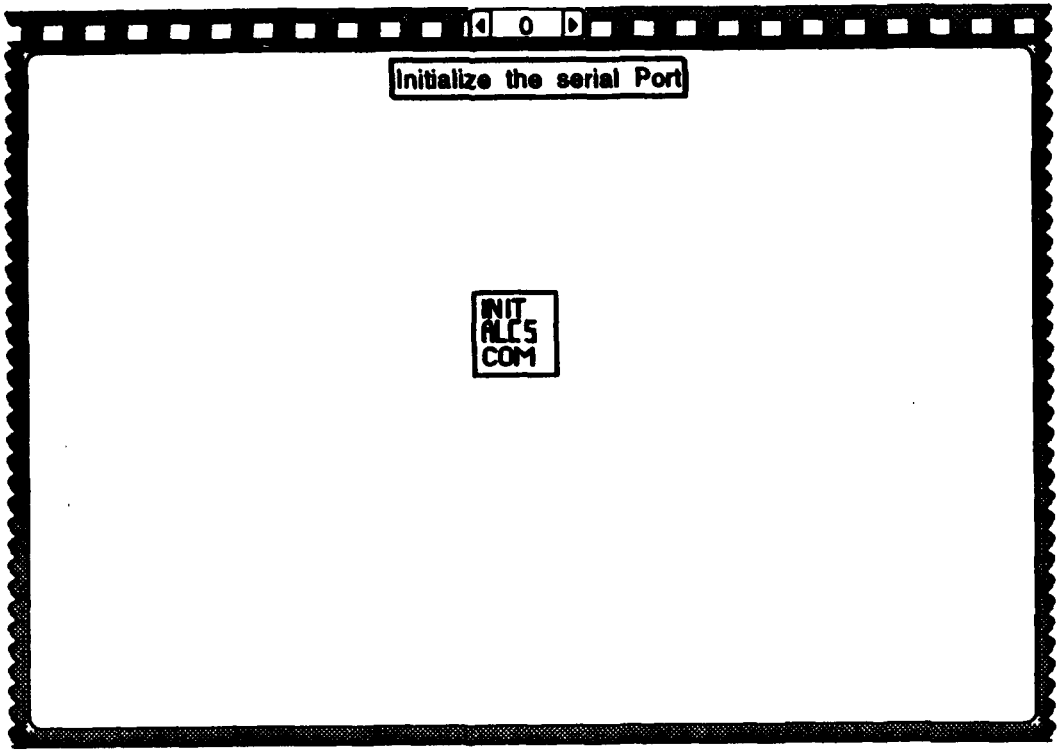
TIME WAITED (seconds)

0

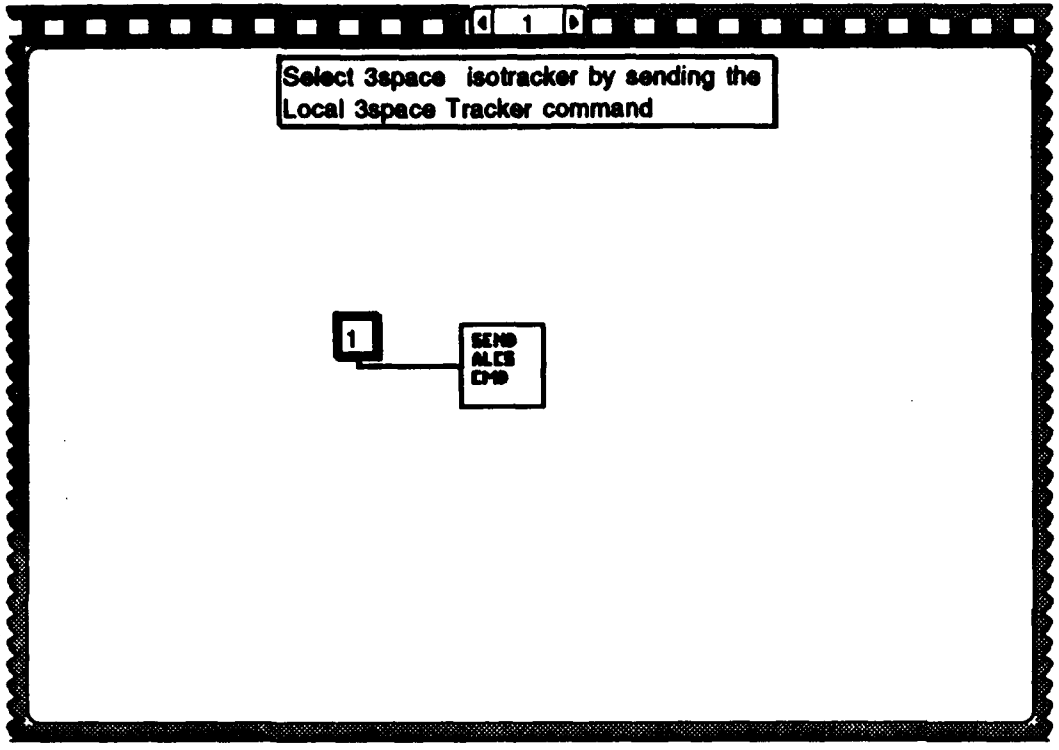
Block Diagram

57

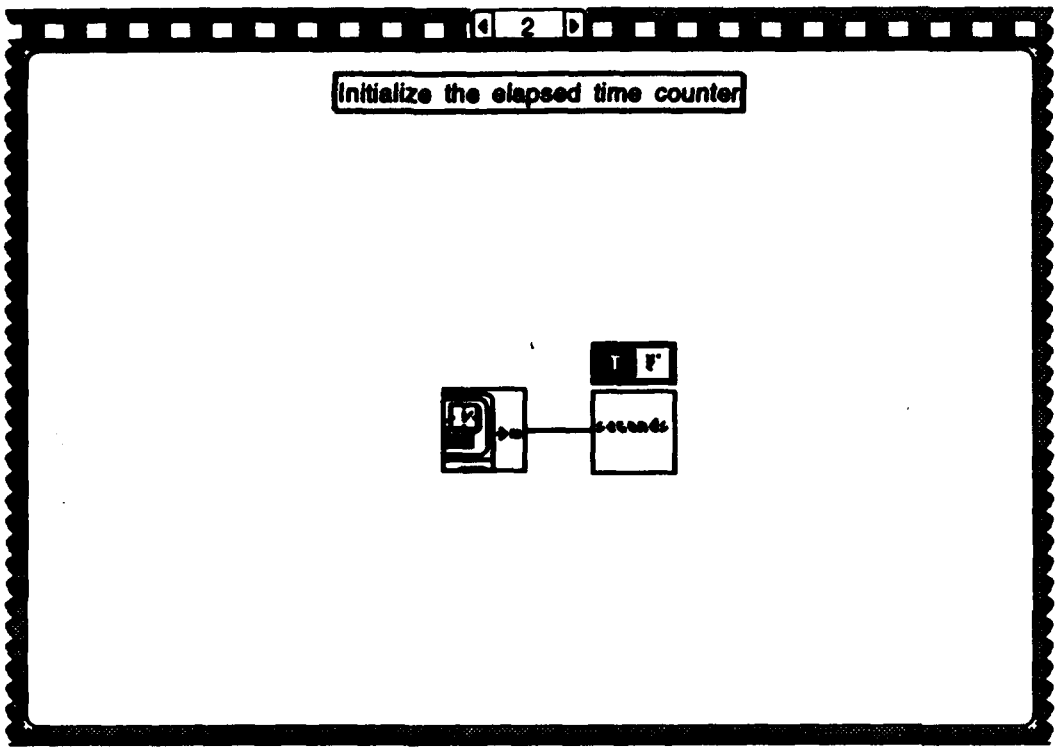

3
Wait 20 seconds
TIME WAITED (seconds)
T F
seconds
20
i

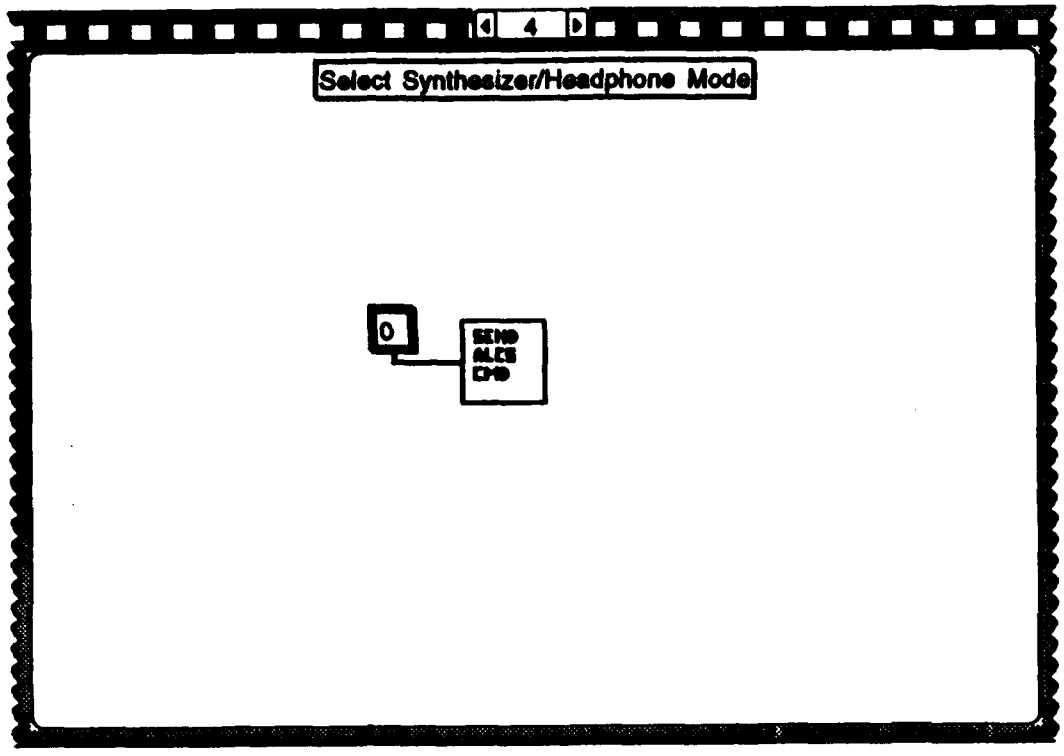


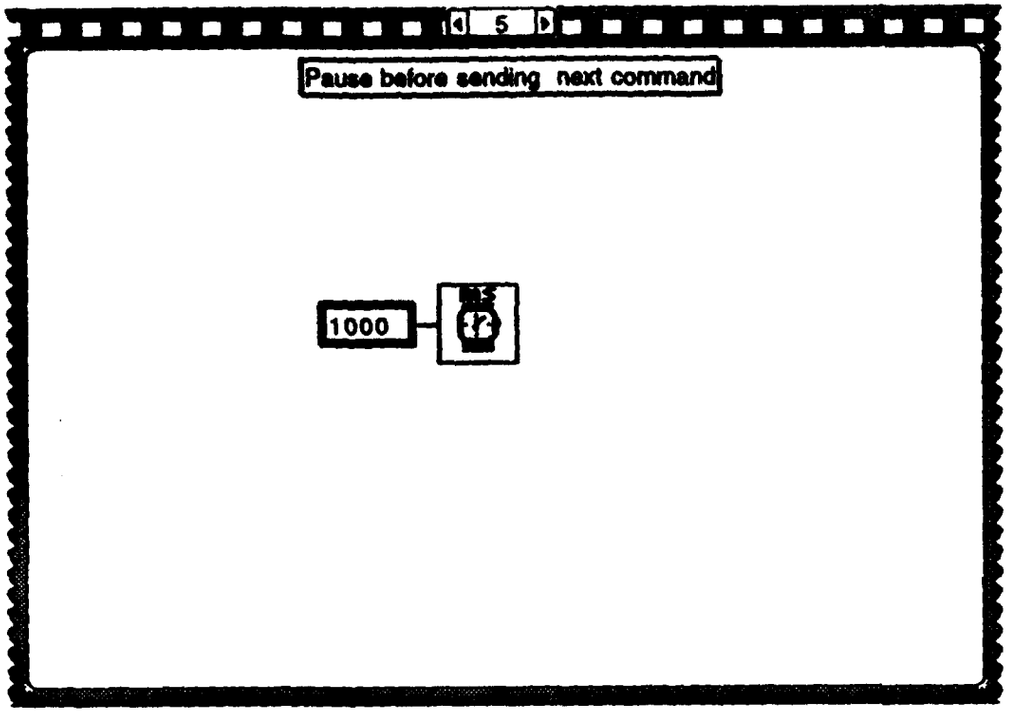
5 of 11

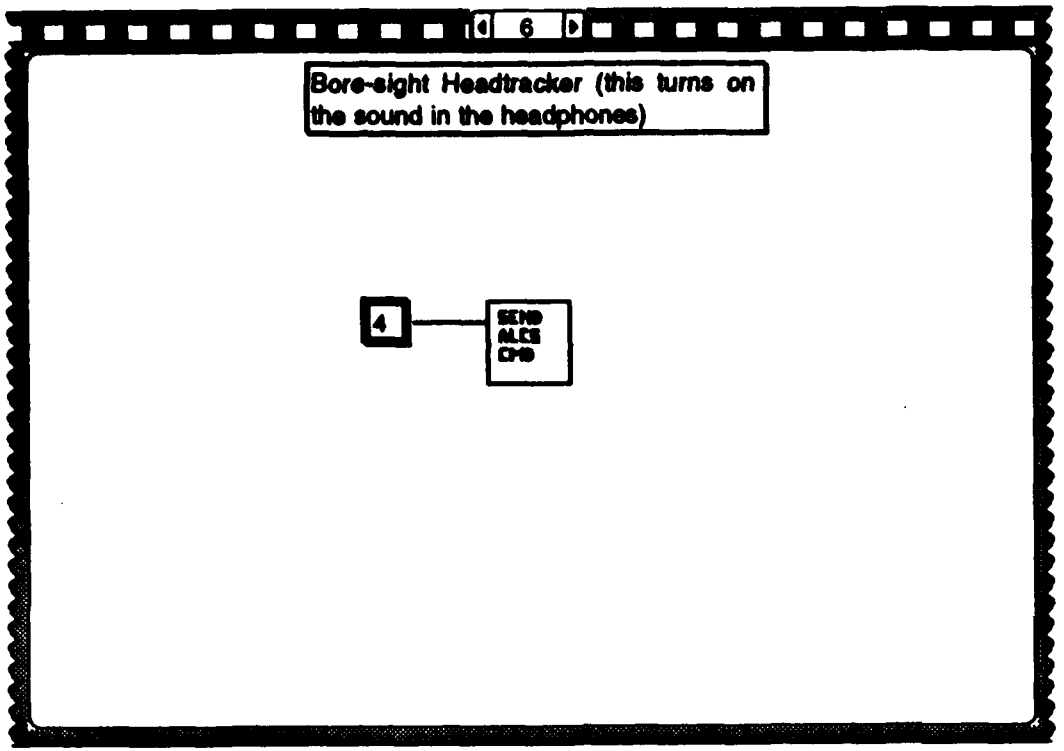

1
Select 3space isotracker by sending the
Local 3space Tracker command
1

55


2
Initialize the elapsed time counter
T
F
seconds


4
Select Synthesizer/Headphone Mode
0


5
Pause before sending next command
1000
ms


6
Bore-sight Headtracker (this turns on the sound in the headphones)
4
SEND ALCS CMD

57

INIT ALCS COM

MODULE DESCRIPTION

FUNCTION NAME

INIT ALCS COM

FUNCTION DESCRIPTION

This module initializes the ALCS serial port.

FUNCTION INPUTS

BUFFER SIZE: Size of serial buffer

ALCS SERIAL PORT NUMBER: Modem (0) or printer (1) port.

BAUD RATE: Serial baud rate.

DATA BITS: Number of data bits.

STOP BITS: Number of stop bits.

PARITY: Odd, even, none.

FUNCTION OUTPUTS

NONE

PARENT FUNCTIONS

3D SYSTEM MANAGER

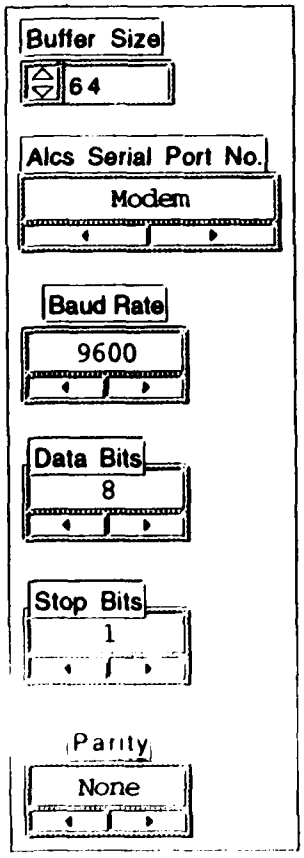
CHILD FUNCTIONS

NONE

Connector Pane

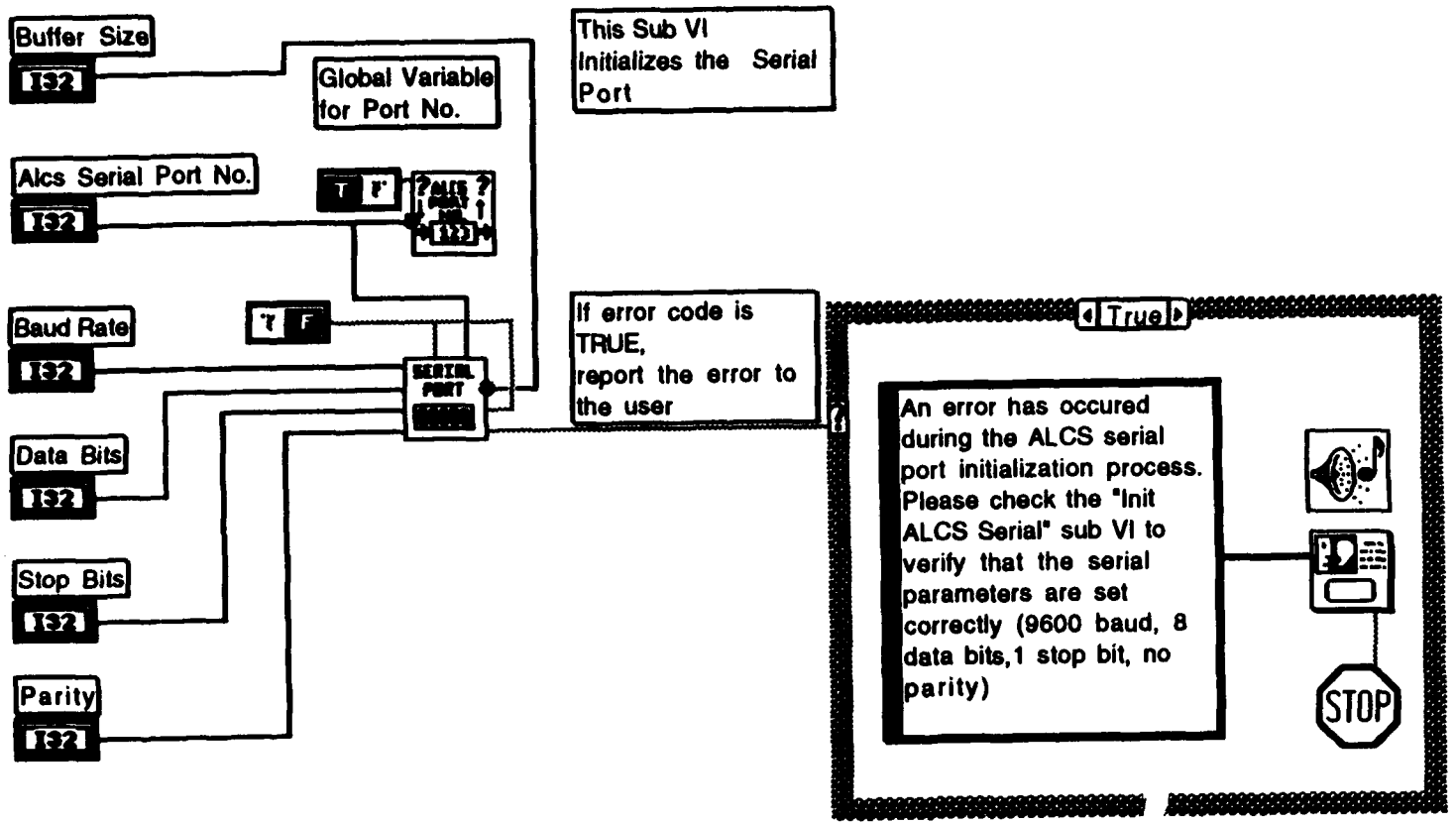
Init ALCS Serial

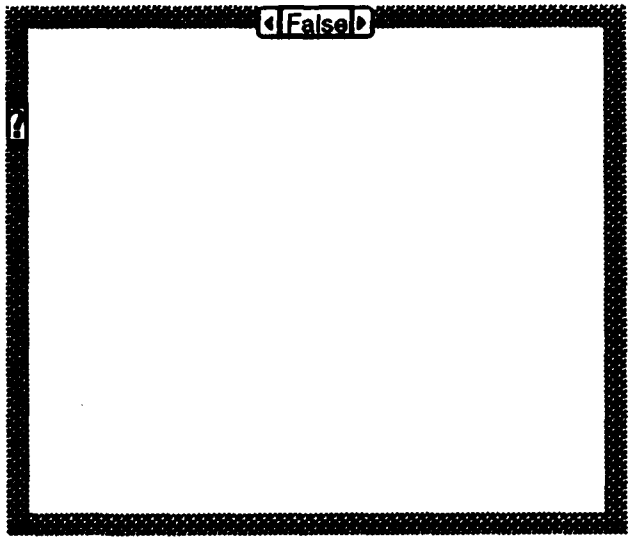
Front Panel



Init ALCS Serial
Thursday, April 11, 1991 12:34

Block Diagram





C-4

INIT AUDIO
BUFFERING

MODULE DESCRIPTION

FUNCTION NAME

INIT AUDIO BUFFERING

FUNCTION DESCRIPTION

This module performs the following functions:

1) sets the audio output channel number,
2) sets the audio board DAC sample rate,
3) allocates DMA resources, and
4) generates the white noise array (airspeed audio cue).

FUNCTION INPUTS

CHANNEL NUMBER: This input is passed from the calling function. The legal values are: 0 = left channel, 1 = right channel, and 2 = both channels. For AOI3 this input should be set to 0.

DURATION: This user selected input determines the update rate of the DMA process. This value multiplied by the audio board sample frequency must produce a DMA buffer size which is an even multiple of 4 (due to the way in which the DMA card allocates and updates its memory blocks).

SAMPLE FREQUENCY ARRAY: Sets DAC sample frequency selections. Do not change this input.

SAMPLE FREQUENCY: This user selected input determines the sampling frequency of the audio board 16 bit DAC.

GAIN: Amplitude multiplier for the airspeed audio cue white noise array. This array is generated during run time and saved in system RAM. A typical value for this input should be in the 200 to 300 count range.

ST. DEV: Standard deviation for the white noise array. Changing this value has little effect.

FUNCTION OUTPUTS

DMA BUFFER SIZE: Indicates calculated size of the DMA buffer. Must be a multiple of 4.

ERROR MESSAGES: DMA initialization error messages. Refer to LabView manual for a complete description.

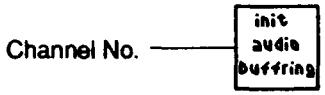
PARENT FUNCTIONS

3D SYSTEM MANAGER

CHILD FUNCTIONS

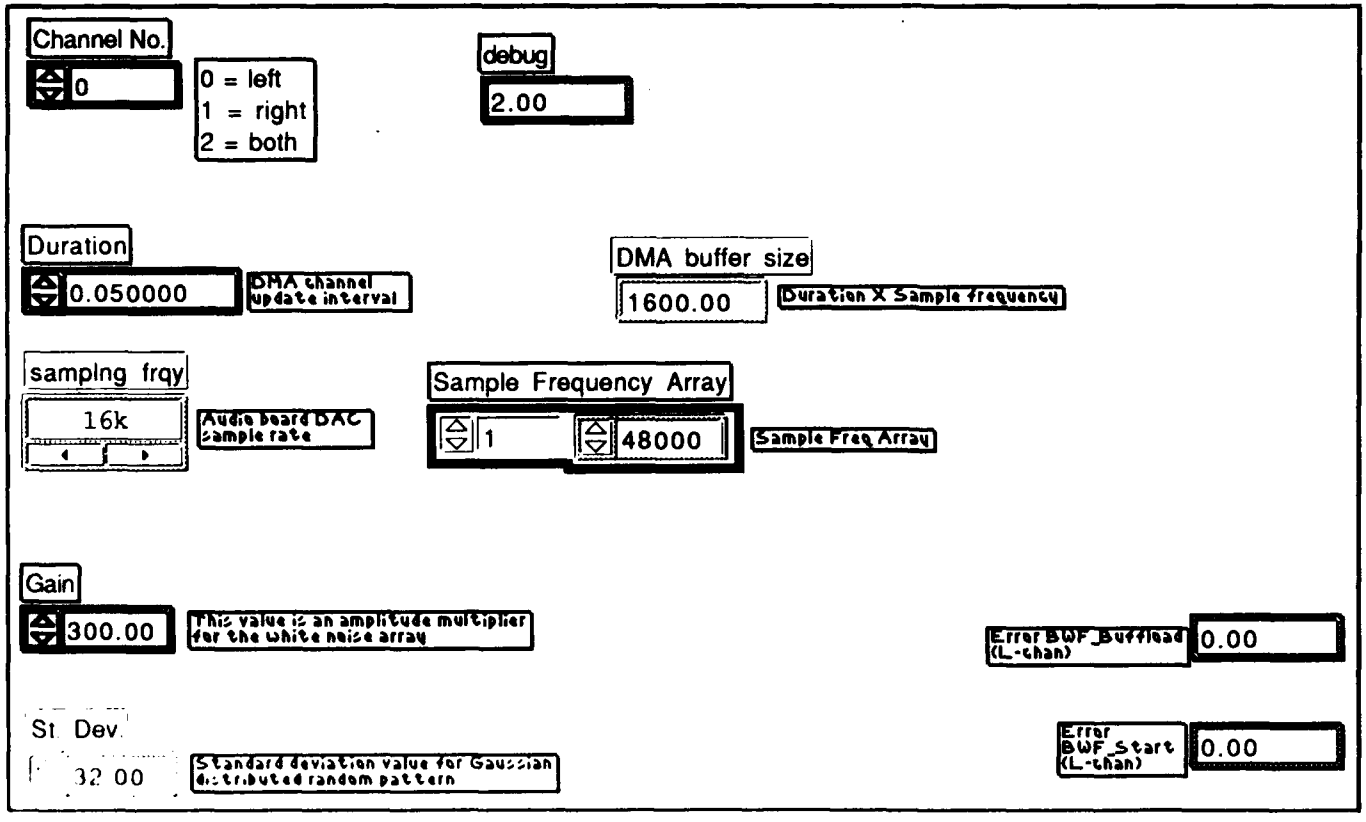
SETUP DBUF
SETUP WAVEFORM GEN

Connector Pane

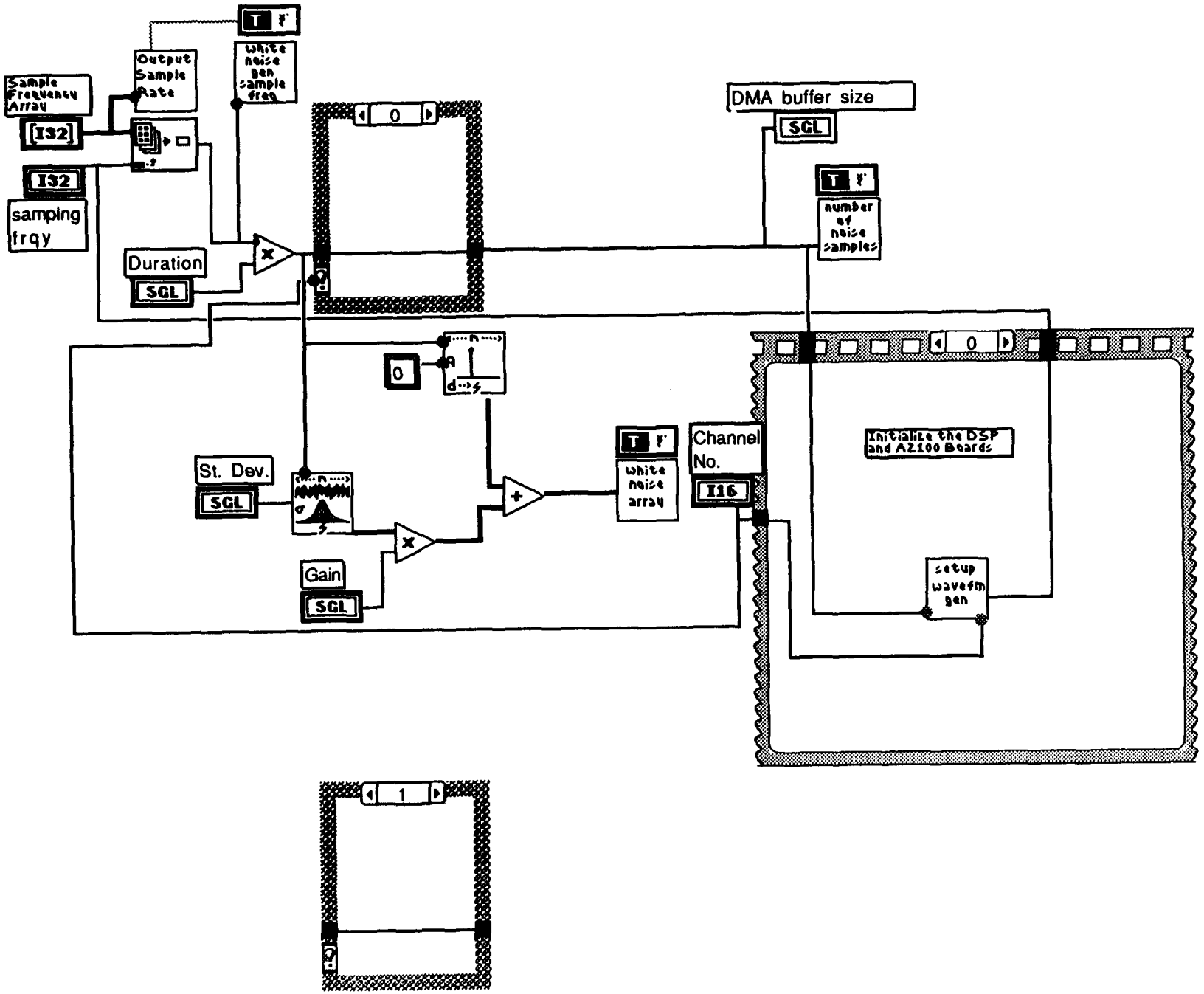


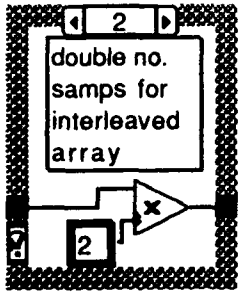
Init Audio Buffering

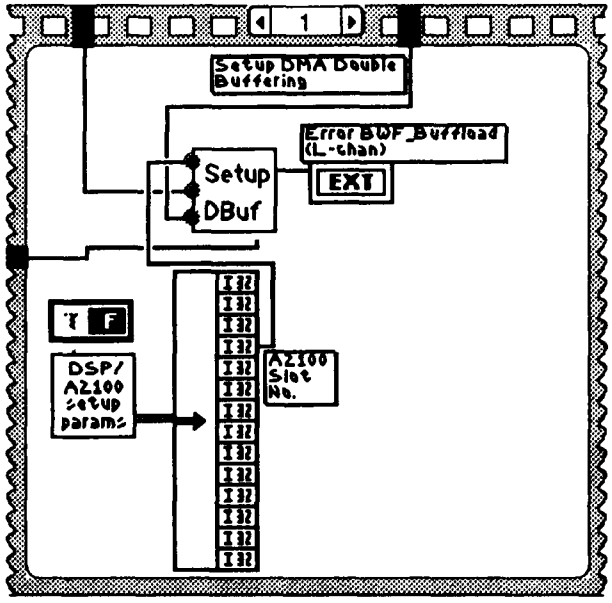
Front Panel

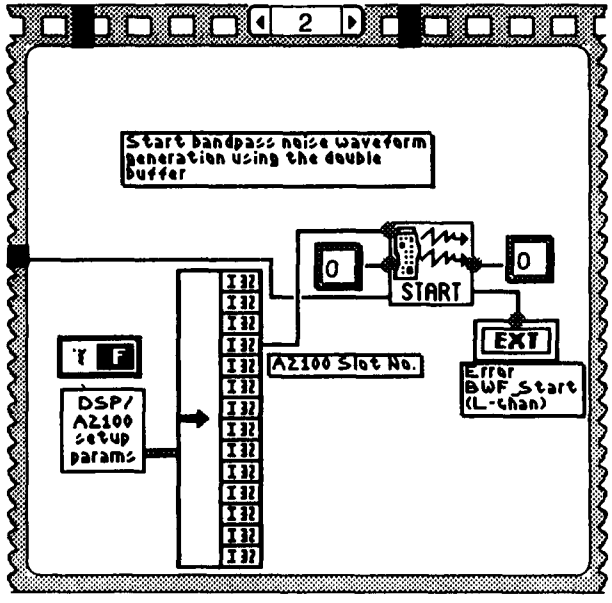


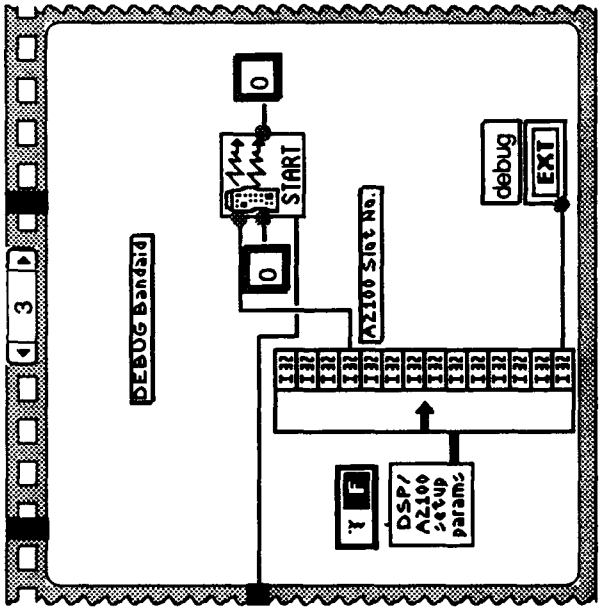
Block Diagram


Sample Frequency Array
I32
Output Sample Rate
I32
samping frqy
White noise gen sample freq
Duration
SGL
0
DMA buffer size
SGL
number of noise samples
0
St. Dev.
SGL
Gain
SGL
white noise array
Channel No.
I16
Initialize the DSP and A2100 Boards
setup wavefm gen
1


2
double no. samps for interleaved array
2


1
Setup DMA Double Buffering
Error BUF_Buffload (L-chan)
Setup
DBuf
EXT
T F
DSP/ AZ100 setup params
AZ100 Slot No.
I32


2
Start bandpass noise waveform generation using the double buffer
0
START
0
EXT
Error BUF_Start (L-chan)
T F
DSP/ AZ100 setup params
AZ100 Slot No.
I32


DEBUG Bandaid
START
AZ100 Site No.
debug
EXIT
DSP/
AZ100
setup
params

INIT FIP SERIAL

71

MODULE DESCRIPTION

FUNCTION NAME

INIT FIP SERIAL

FUNCTION DESCRIPTION

This module initializes the FIP serial port.

FUNCTION INPUTS

BUFFER SIZE: Size of serial buffer.

FIP SERIAL PORT NUMBER: Modem (0) or printer (1) port.

BAUD RATE: Serial baud rate.

DATA BITS: Number of data bits.

STOP BITS: Number of stop bits.

PARITY: Odd, even, none.

FUNCTION OUTPUTS

NONE

PARENT FUNCTIONS

3D SYSTEM MANAGER

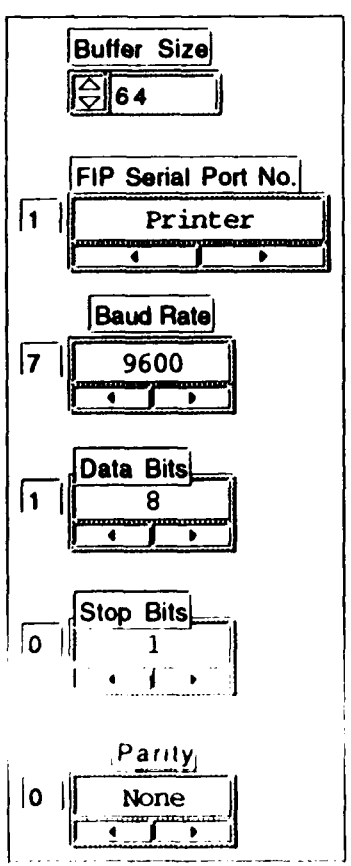
CHILD FUNCTIONS

NONE

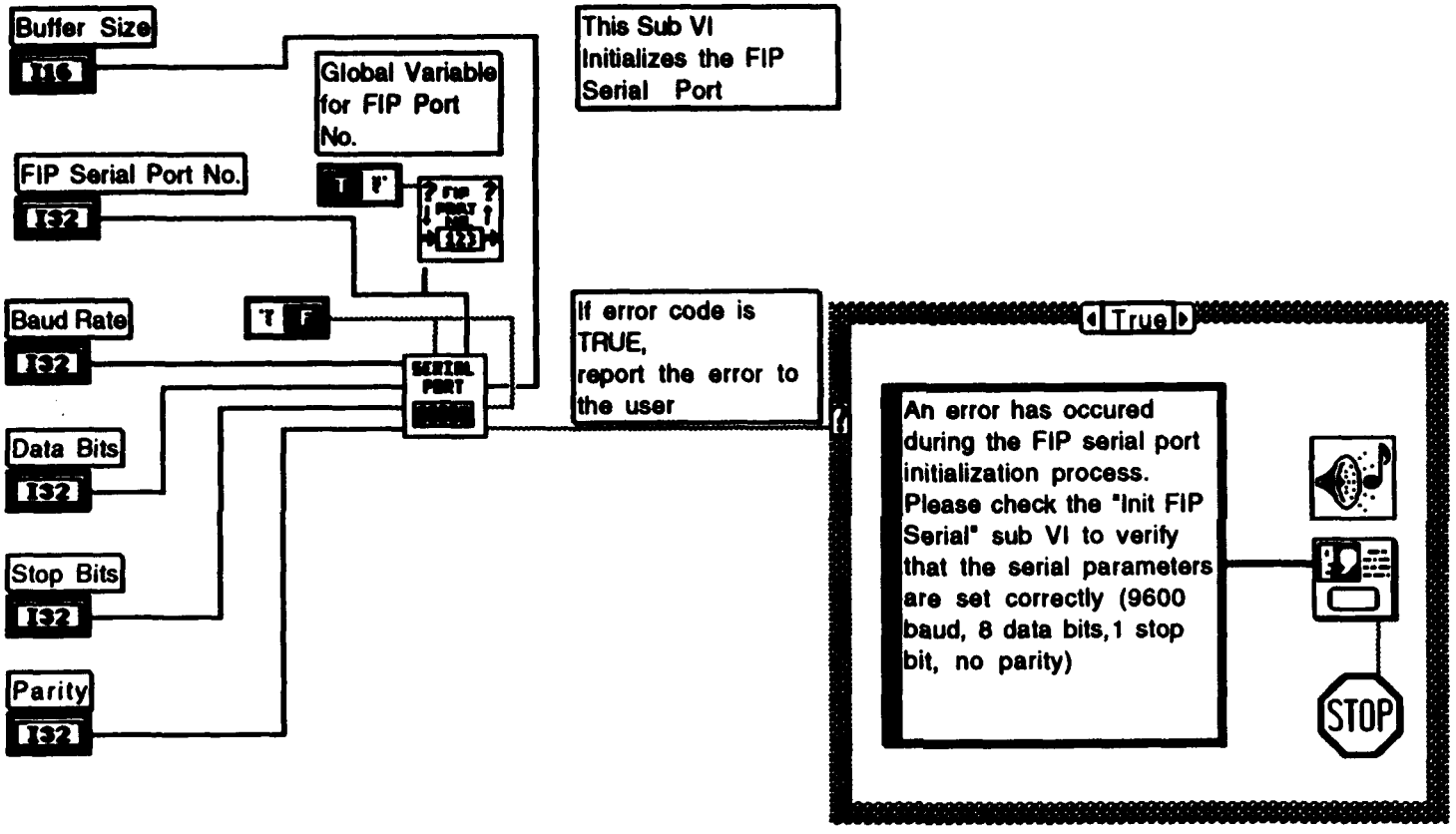
Connector Pane

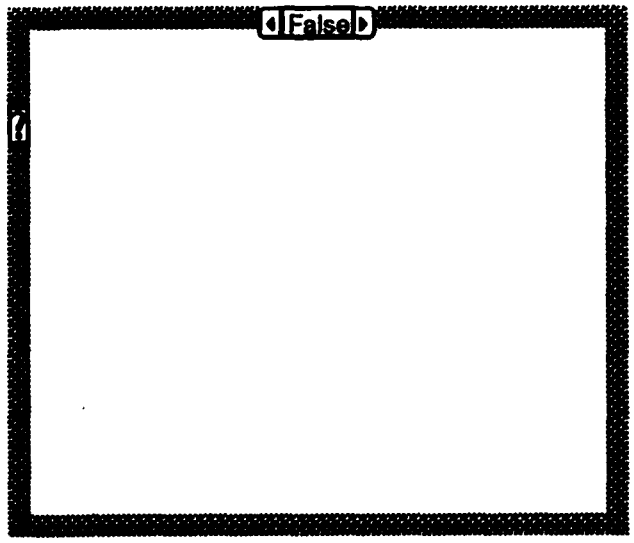
Init FIP Serial

Front Panel



Block Diagram




False

MAP ACOUSTIC
PARAMS (NEW)

MODULE DESCRIPTION

FUNCTION NAME

MAP ACOUSTIC PARAMS (NEW)

FUNCTION DESCRIPTION

The purpcse of this module is to allow the user to quickly and easily update the AOI mapping variables. This module creates flight parameter to acoustic parameter mapping multipliers and stores these values in global memory. Changes must be made to these parameters prior to run time. Changes made while the program is running have no effect because this module is called only once during initialization.

FUNCTION INPUTS

MIN AIRSPEED VALUE: Sets the lowest airspeed for which the airspeed acoustic cue will respond. Airspeeds below this value will cause no change in the airspeed white noise center frequency.

MAX AIRSPEED VALUE: Sets the highest airspeed for which the airspeed acoustic cue will respond. Airspeeds above this value will cause no change in the airspeed white noise center frequency.

MIN NOISE PASS BAND CENTER POINT: Determines minimum airspeed acoustic cue passband center frequency. When airspeed is less than or equal to *MIN AIRSPEED VALUE* the airspeed acoustic cue center frequency is equal to this input value.

MAX NOISE PASS BAND CENTER POINT: Determines maximum airspeed acoustic cue passband center frequency. When airspeed is greater than or equal to MAX AIRSPEED VALUE the airspeed acoustic cue center frequency is equal to this input value.

MAX W ROLL ANGLE: Sets the largest roll angle for which the airspeed and vertical velocity acoustic cues will be lateralized. Roll angles above this value will cause no change in the lateralization of the cues.

MAX AS ROLL ANGLE: This input is used for the AOI2 system only. It has no effect on the AOI3 system.

MIN AS LOW FREQ GAIN: This is the minimum gain value for the airspeed white noise acoustic cue. When airspeed is less than or equal to the *MIN AIRSPEED VALUE*, the airspeed cue is multiplied by the *MIN AS LOW FREQ GAIN*. The gain linearly approaches unity as the airspeed approaches the *MAX AIRSPEED VALUE*.

MIN VERTICAL VELOCITY: Must be set to zero for the AOI3 system.

MAX VERTICAL VELOCITY: Sets the largest vertical velocity for which the vertical velocity pitch circle acoustic cue will respond. Vertical velocities above this value will cause no change in the acoustic cue.

MAX PITCH CHANGE RATE: Determines the maximum number of tones to be skipped in the pitch circle tone array when vertical velocity is greater than or equal to *MAX VERTICAL VELOCITY*.

MAX TONE DURATION: Not used.

FUNCTION OUTPUTS

NONE

PARENT FUNCTIONS

SYSTEM MANAGER

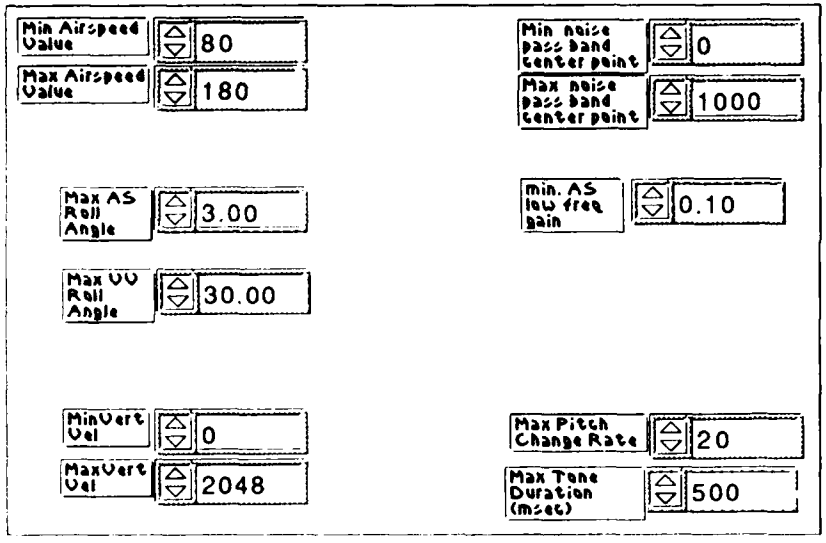
CHILD FUNCTIONS

NONE

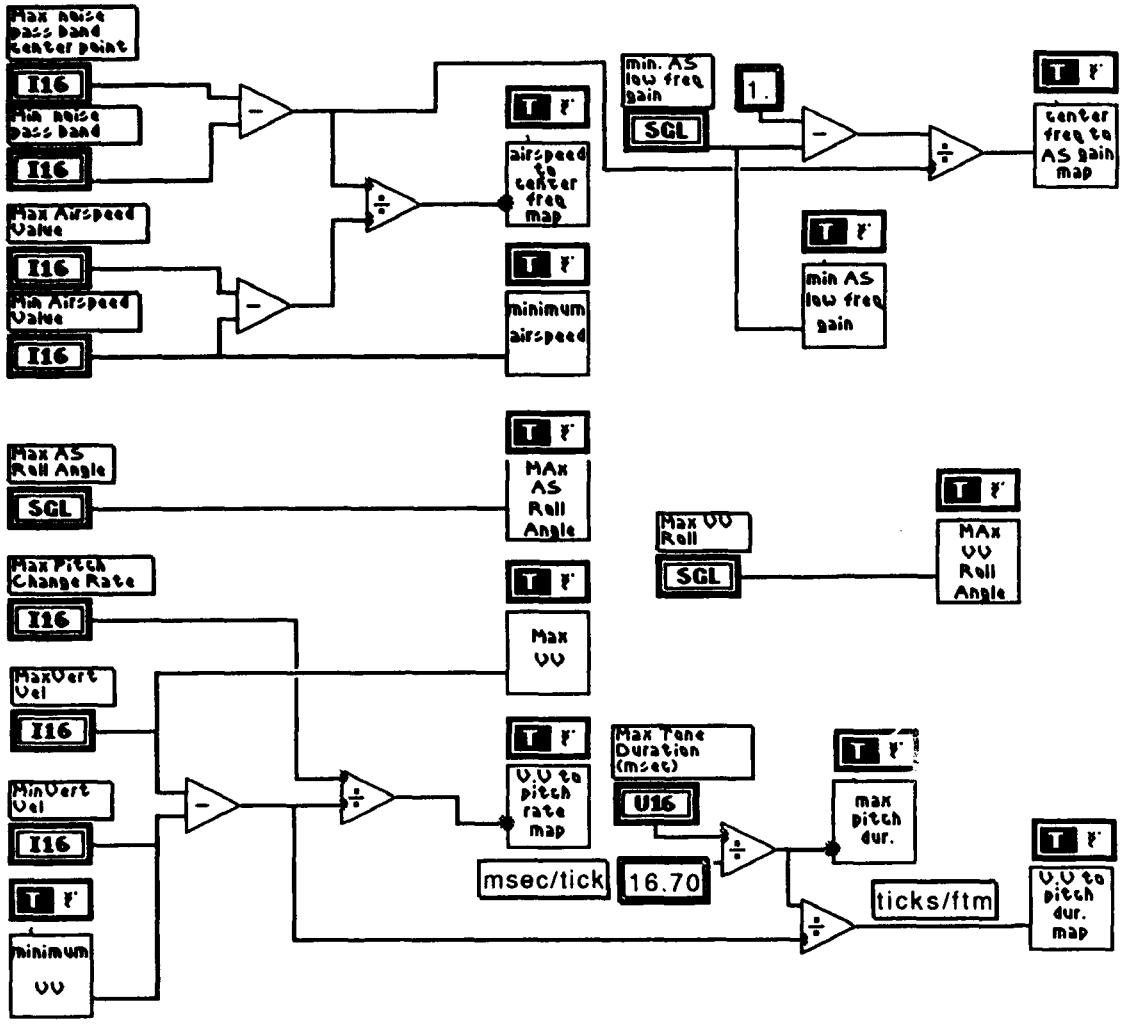
Connector Pane

Map Acoustic Params (new)

Front Panel



Block Diagram


Max noise pass band center point
I16
Min noise pass band
I16
Max Airspeed Value
I16
Min Airspeed Value
I16
airspeed to center freq map
minimum airspeed
min. AS low freq gain
SGL
1.
center freq to AS gain map
min AS low freq gain
Max AS Roll Angle
SGL
MAx AS Roll Angle
Max UU Roll
SGL
MAx UU Roll Angle
Max Pitch Change Rate
I16
Max UU
MaxVert Vel
I16
MinVert Vel
I16
minimum UU
U.U to pitch rate map
Max Tone Duration (msec)
U16
msec/tick
16.70
max pitch dur.
ticks/ftm
U.U to pitch dur. map

READ FIP

MODULE DESCRIPTION

FUNCTION NAME

READ FIP

FUNCTION DESCRIPTION

This module polls the FIP for the flight parameters. The FIP looks for STX (decimal 02) to initiate the serial communications sequence. Upon receipt of STX the FIP sends SIO (decimal 01) then 18 data bytes (9 two-byte flight parameters) then two check-sum bytes then ETX (decimal 03). The READ FIP module calculates the check-sum and if it is valid concatenates the data bytes and stores the results.

FUNCTION INPUTS

FIP MESSAGE LENGTH: Number of bytes in the FIP serial message string.

SERIAL TIME OUT VALUE: Number of system clock ticks (one tick equals 16.7ms) the algorithm waits for an FIP message after sending STX. Once this limit is exceeded the algorithm reports an error and returns control to the calling module.

FUNCTION OUTPUTS

NUMBER OF BYTES IN THE SERIAL INPUT BUFFER: Number of bytes received from the FIP in the serial message string.

FIP SERIAL MESSAGE RECEIVE BUFFER: Contents of serial receive buffer. These are raw concatenated values.

FIP NEW DATA ARRAY: Concatenated FIP serial values.

PARENT FUNCTIONS

FLIGHT DATA MANAGER

CHILD FUNCTIONS

NONE

Connector Pane

Read FIP (new)

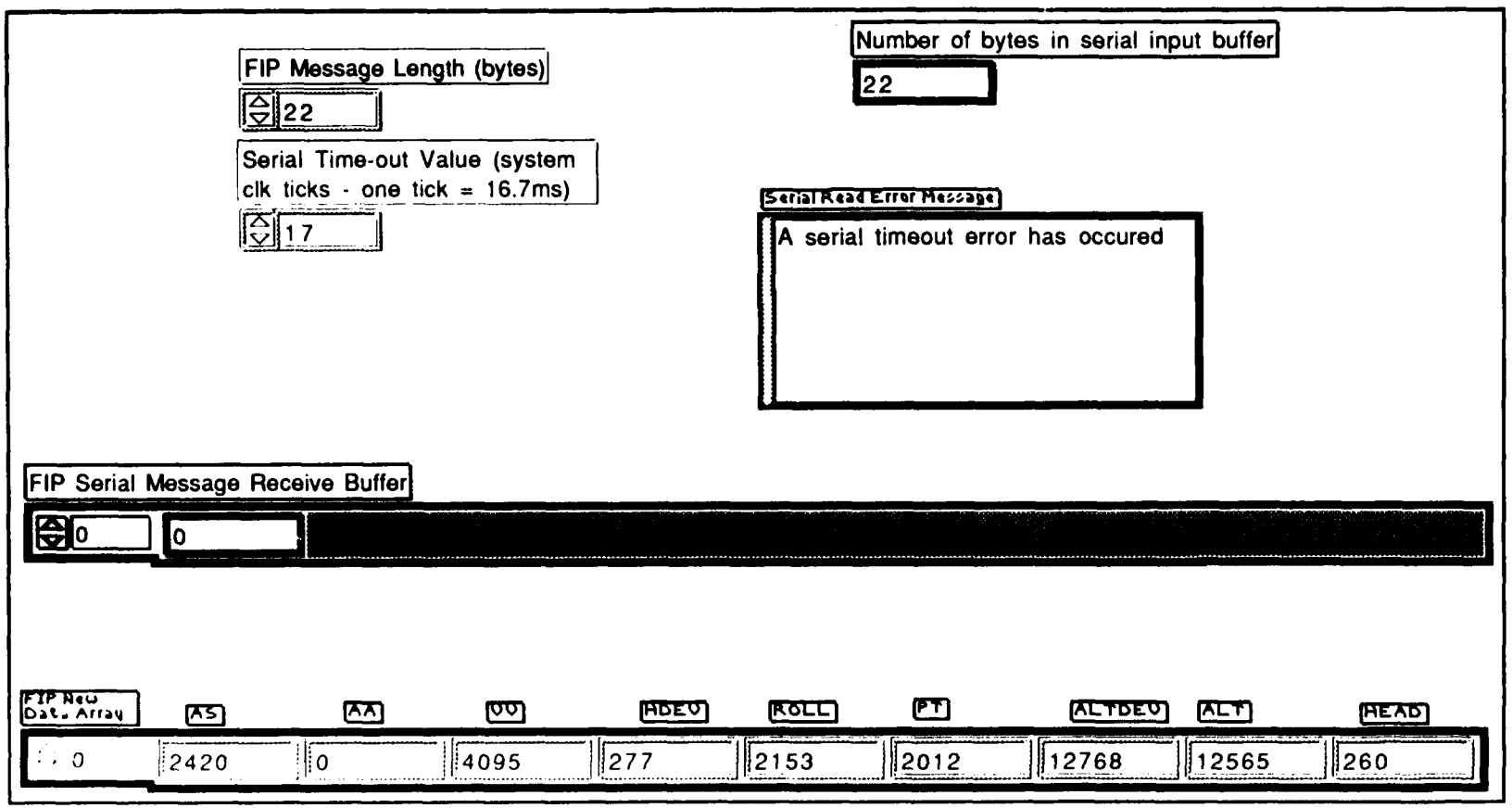
Front Panel

Connector Pane

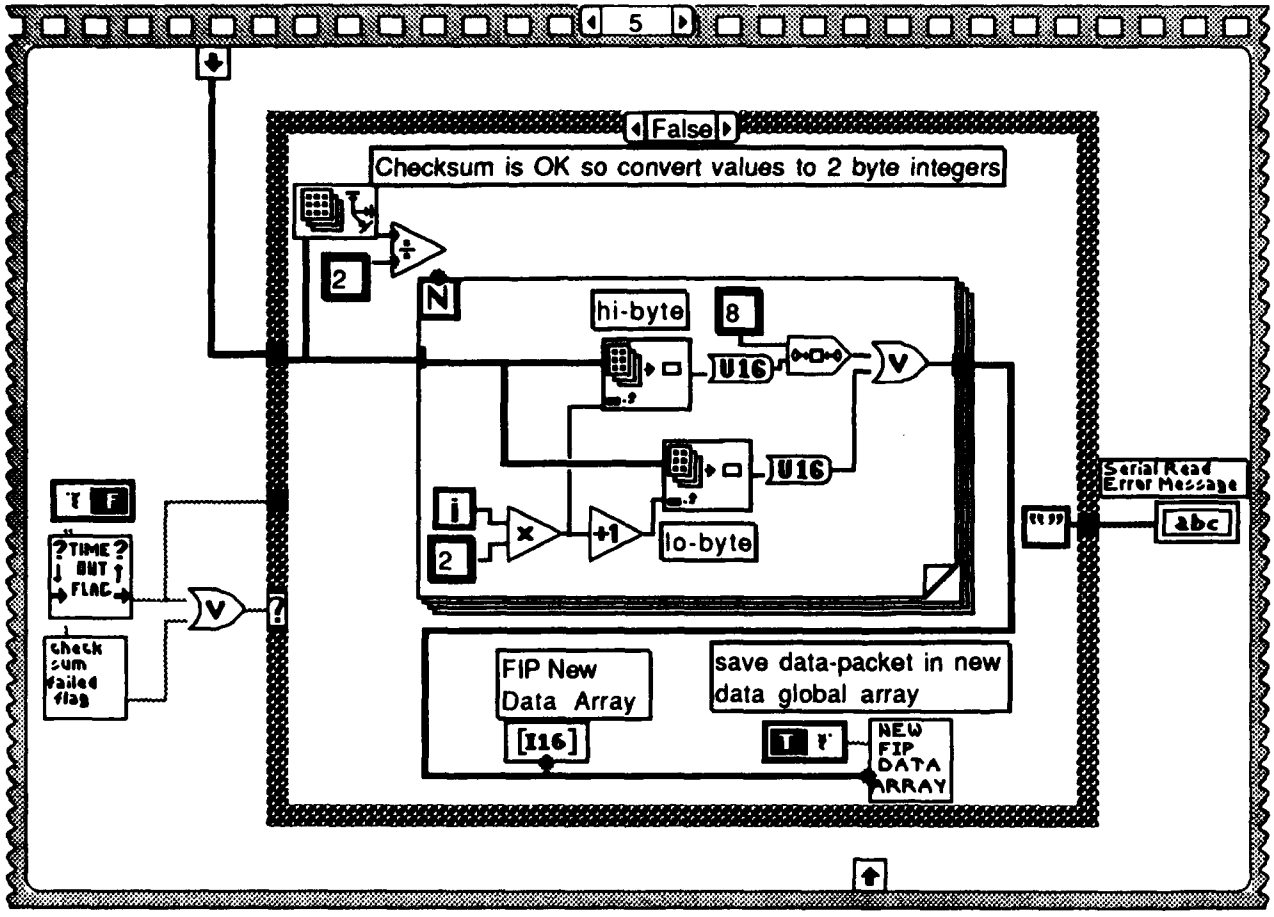
READ FIP

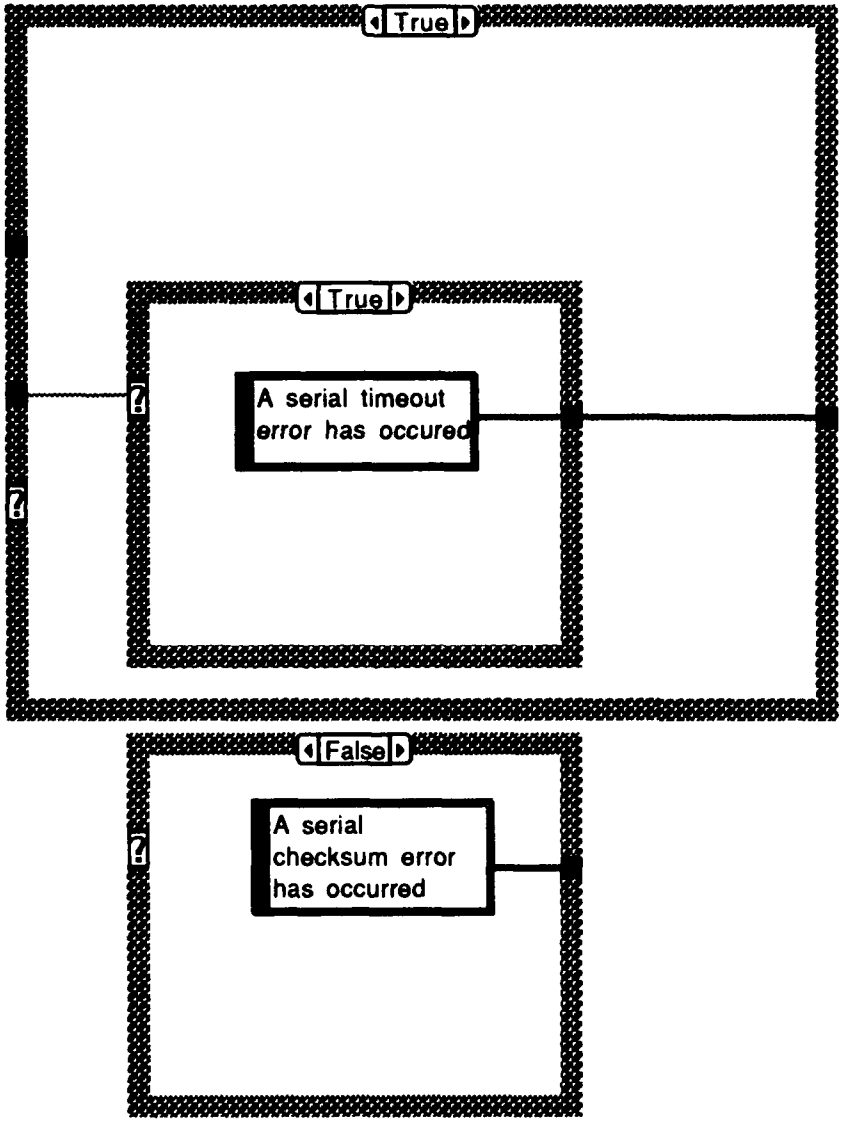
Read FIP (new)

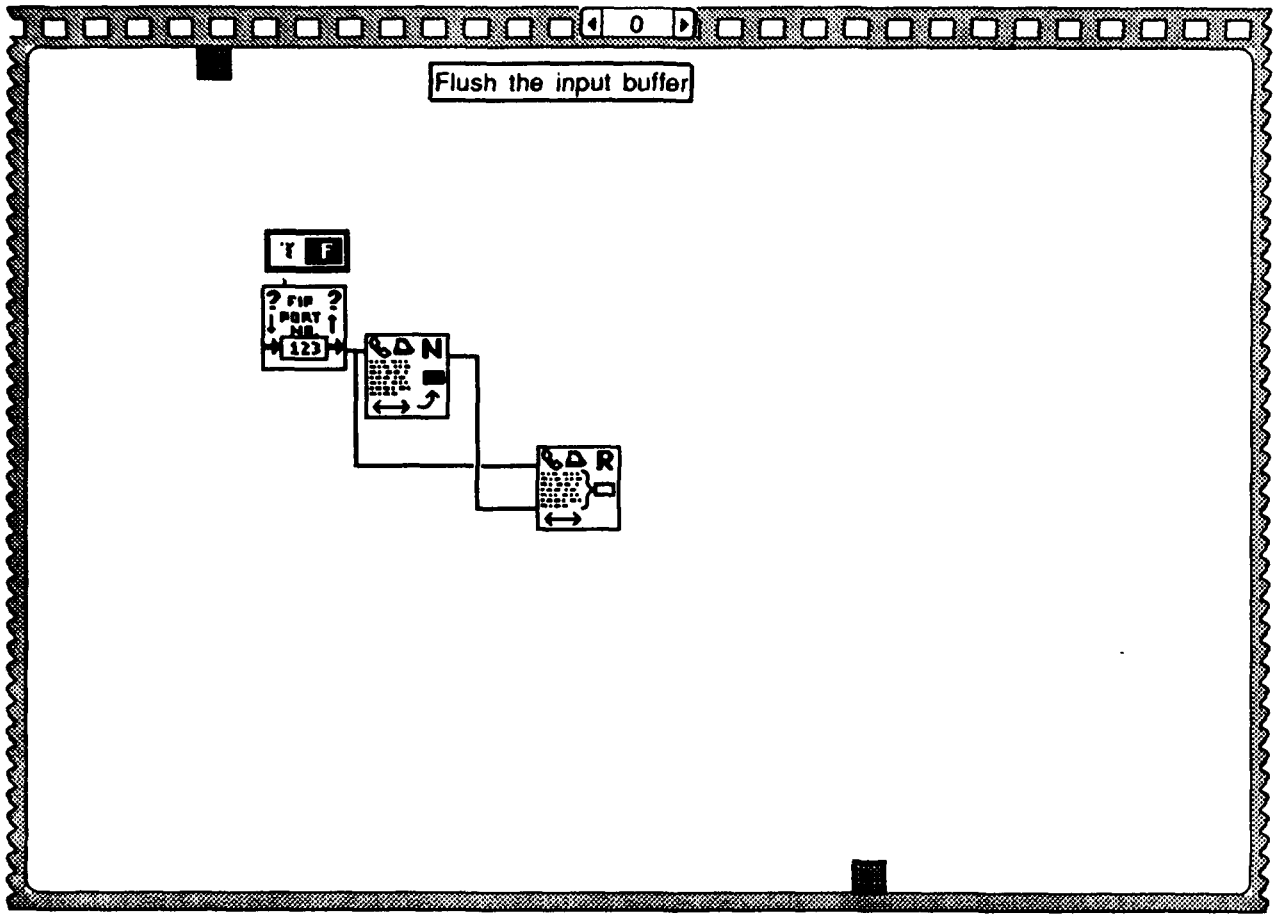
Front Panel

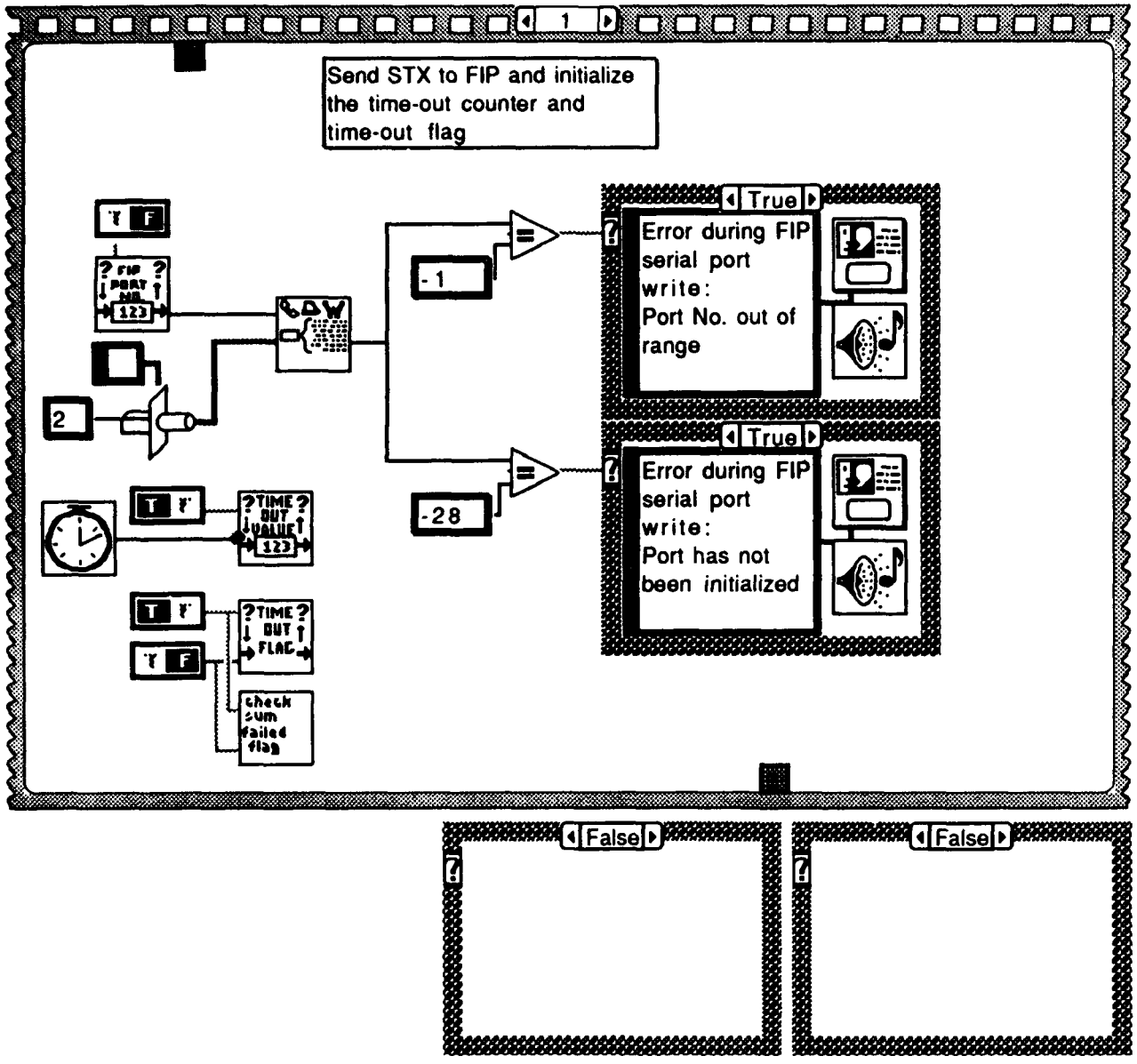


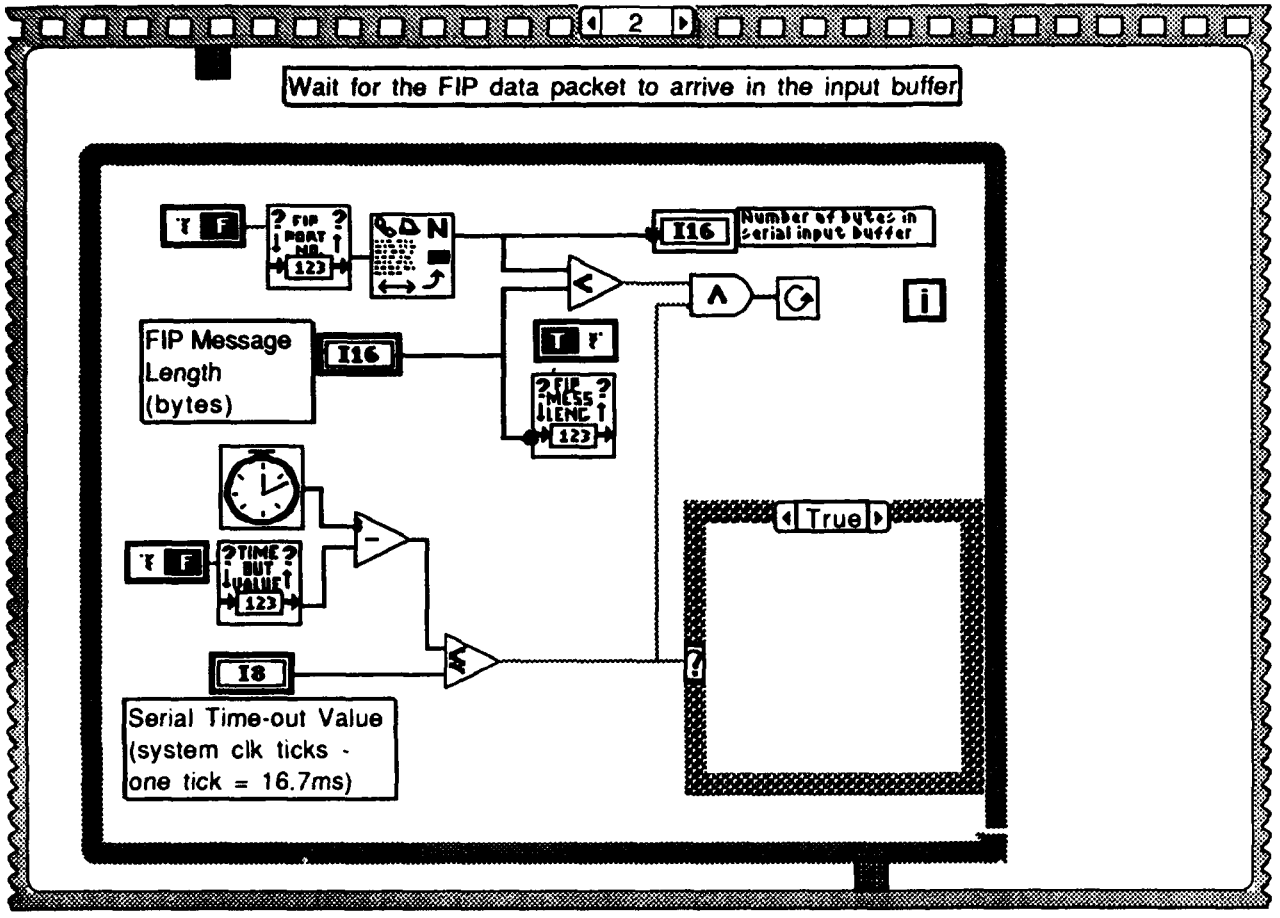
Block Diagram

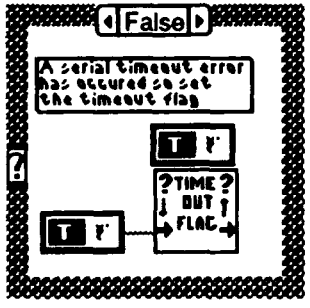


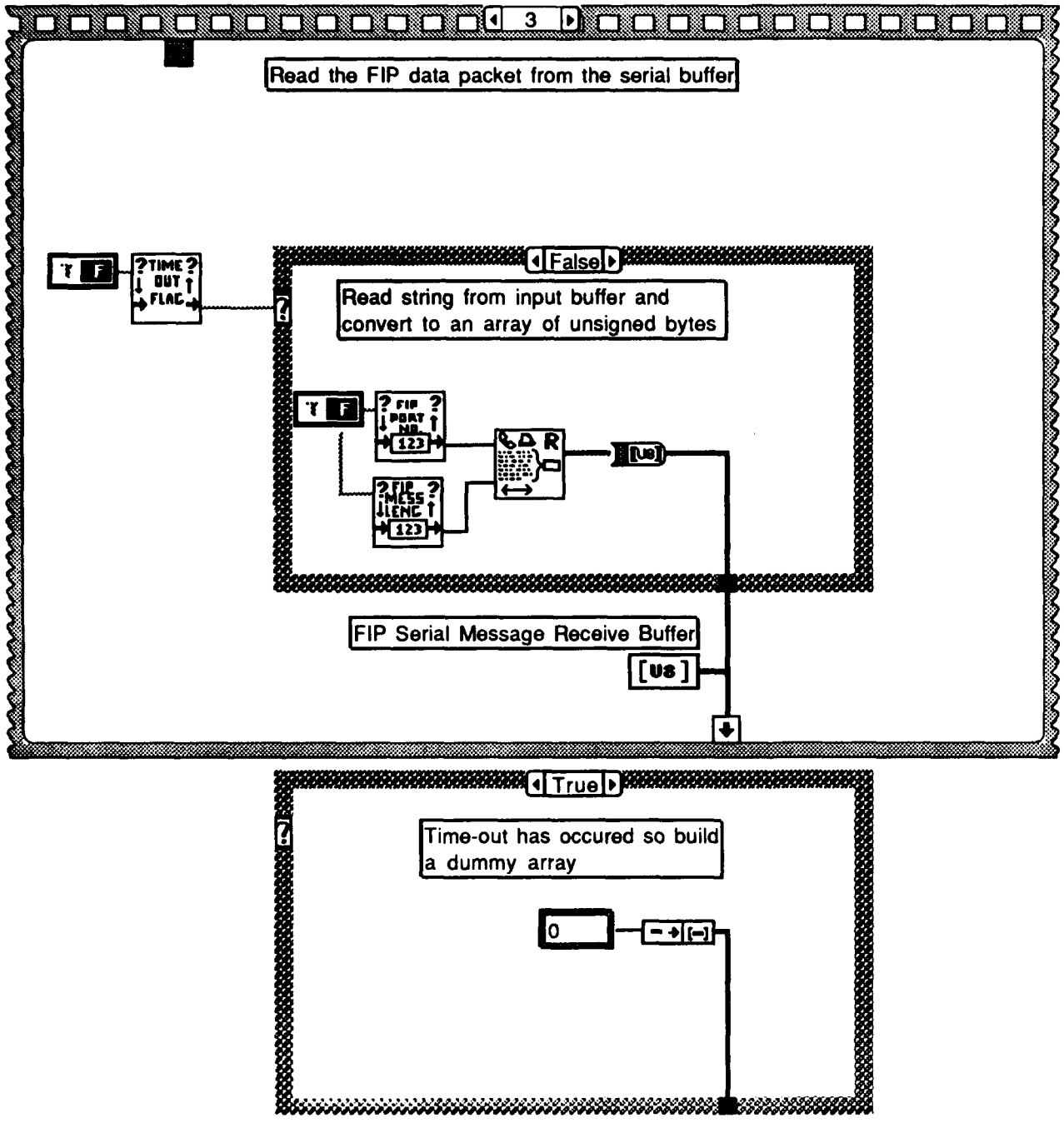

True
True
A serial timeout error has occured
False
A serial checksum error has occurred

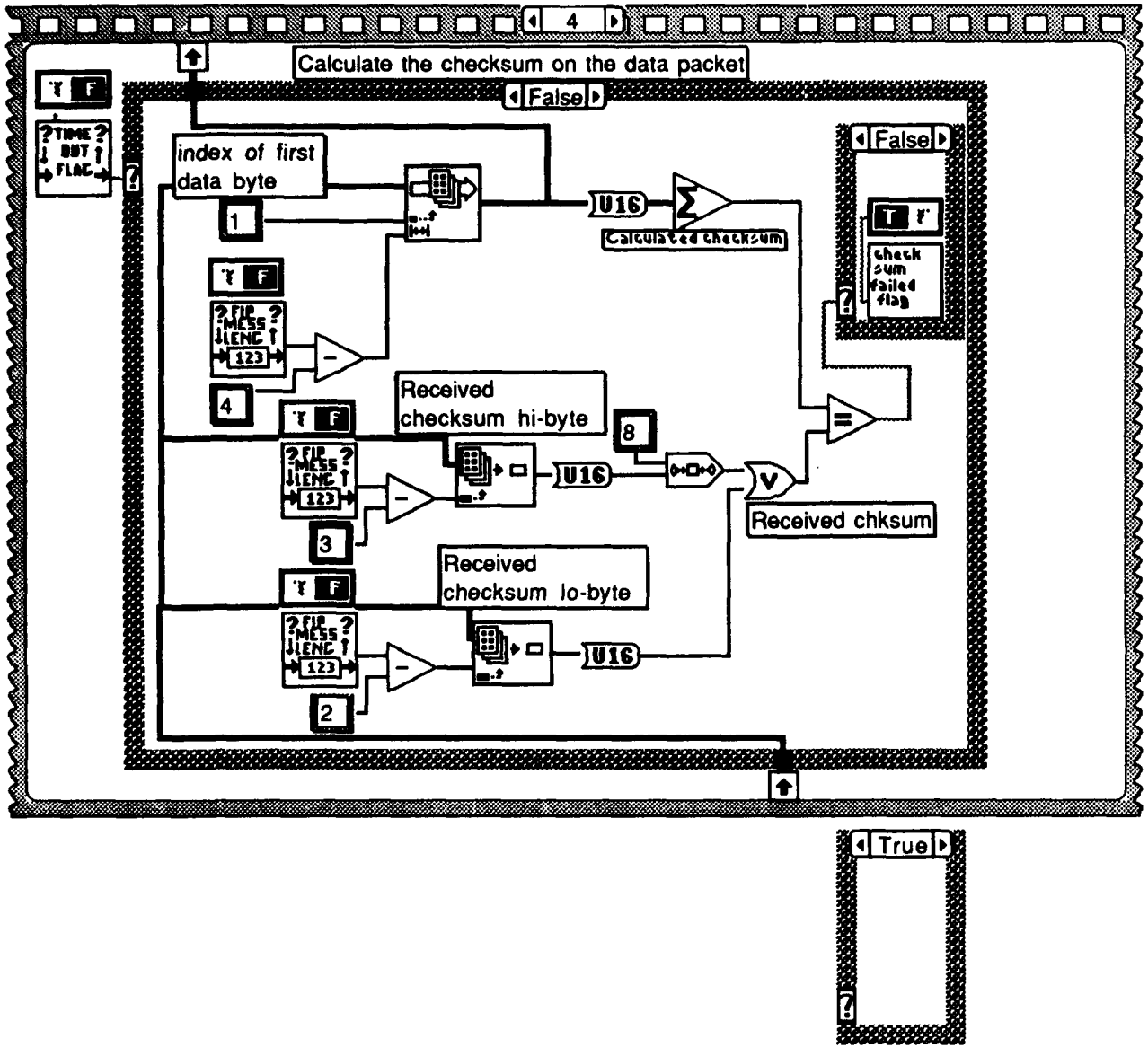

0
Flush the input buffer
T
F
FIP PORT NR
123
N
R


1
Send STX to FIP and initialize the time-out counter and time-out flag
T F
FIP PORT NO. 123
2
-1
-28
TIME OUT VALUE 123
TIME OUT FLAG
check sum failed flag
True
Error during FIP serial port write: Port No. out of range
True
Error during FIP serial port write: Port has not been initialized
False
False

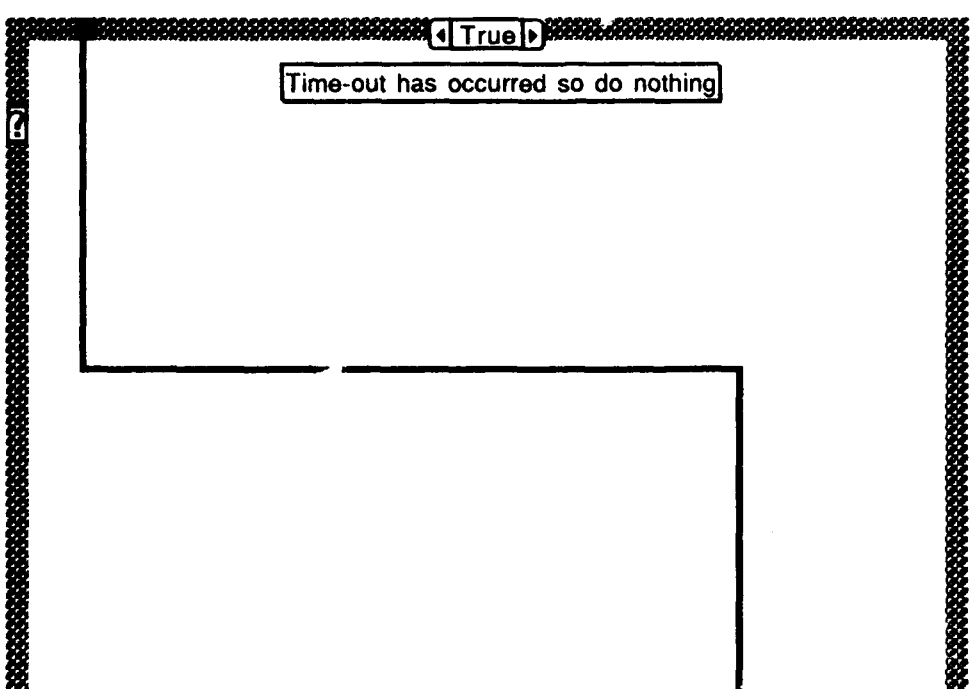

2
Wait for the FIP data packet to arrive in the input buffer
I16
Number of bytes in serial input buffer
FIP Message Length (bytes)
I16
I8
Serial Time-out Value (system clk ticks - one tick = 16.7ms)
True


False
A serial timeout error has occured so set the timeout flag


3
Read the FIP data packet from the serial buffer
TF
?TIME? OUT FLAG
False
Read string from input buffer and convert to an array of unsigned bytes
TF
?FIP PORT NB 123
?FIP MESS LENG 123
R
[U8]
FIP Serial Message Receive Buffer
[U8]
True
Time-out has occured so build a dummy array
0


4
Calculate the checksum on the data packet
False
index of first data byte
1
U16
Calculated checksum
False
check sum failed flag
Received checksum hi-byte
8
U16
Received chksum
3
Received checksum lo-byte
U16
2
True

16


True
Time-out has occurred so do nothing

ROLL TO AZ X-FORM

MODULE DESCRIPTION

FUNCTION NAME

ROLL TO AZ X-FORM

FUNCTION DESCRIPTION

Converts the aircraft bank angle to an ALCS azimuth angle. Refer to the ALCS manual for a complete description of the ALCS azimuth angle.

FUNCTION INPUTS

NONE

FUNCTION OUTPUTS

FIP ROLL: Aircraft bank angle as reported by the ALCS.

CALCULATED ROLL AZIMUTH: Calculated ALCS azimuth angle.

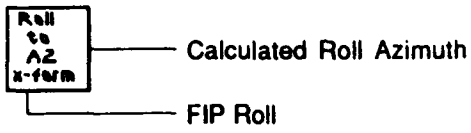
PARENT FUNCTIONS

AUDIO OUTPUT MANAGER

CHILD FUNCTIONS

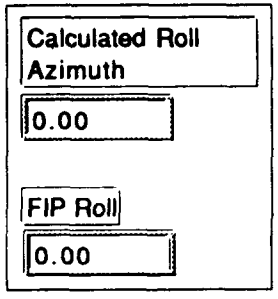
NONE

Connector Pane

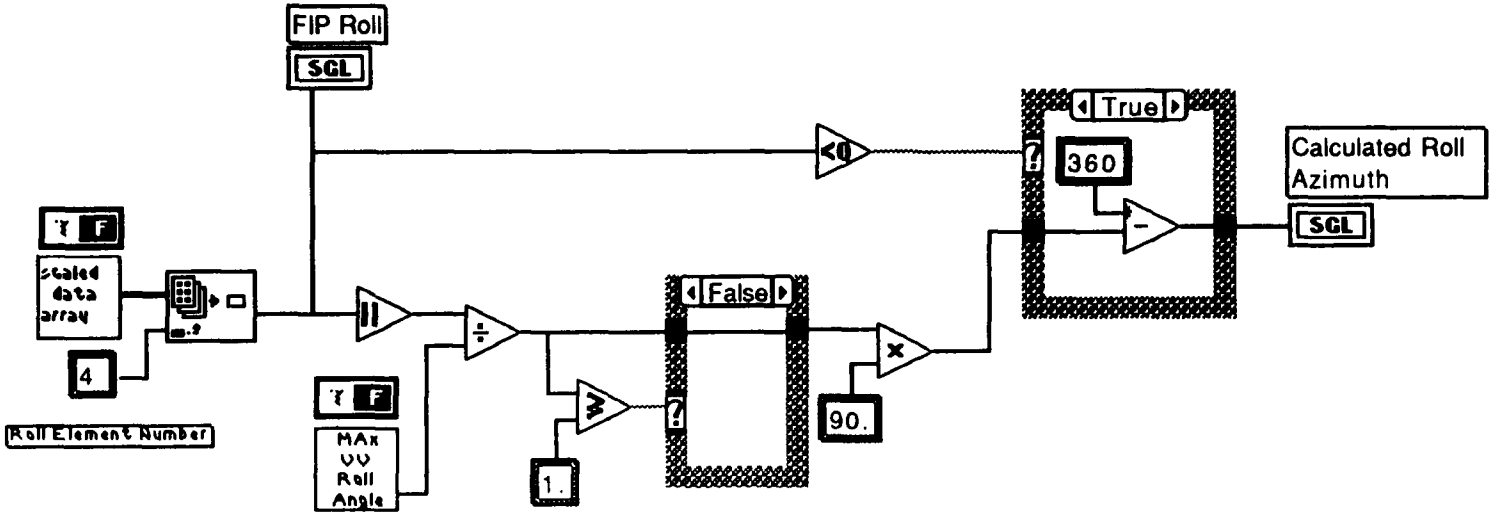


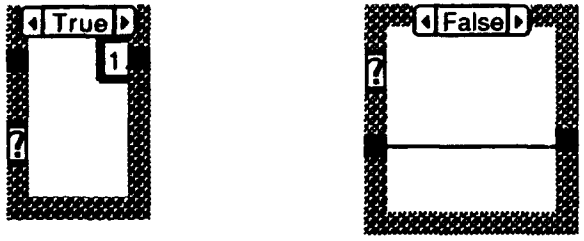
Roll to AZ X-form

Front Panel



Block Diagram




True
1
False

SEND ALCS COMMAND

MODULE DESCRIPTION

FUNCTION NAME

SEND ALCS COMMAND

FUNCTION DESCRIPTION

Sends the indicated *ALCS COMMAND* via the serial port selected by INIT ALCS COM. This module includes a user configurable command array which pairs command numbers with the appropriate command serial message string. This array can be updated as new ALCS commands are added by the vendor.

FUNCTION INPUTS

AZIMUTH ANGLE: Angle between 0 and 359 degrees which locates an audio cue in the horizontal plane. Zero azimuth is defined as straight ahead with azimuth angle increasing in the clockwise direction.

ELEVATION ANGLE: Angle between 0 and 180 degrees which locates an audio cue in the vertical plane. Zero elevation is defined as straight up with 180 degrees of elevation being straight down.

ALCS COMMAND ARRAY ELEMENT NUMBER: The index number of the desired ALCS command message string. The command/index pairing are as follows:

0	Synthesizer/Headphone Mode
1	Local 3-Space Tracker
2	Free-Field Mode
3	System Reset
4	Zero Queue
5	Request Angle
6	Set Angle
7	Re-transmit Response

For a complete description of these commands refer to the ALCS users manual.

FUNCTION OUTPUTS

NONE

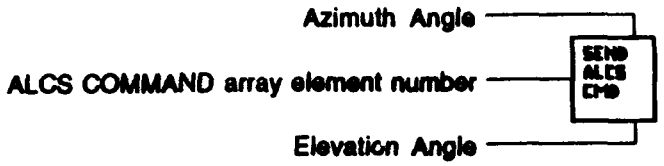
PARENT FUNCTIONS

INIT ALCS COMM
AUDIO OUTPUT MANAGER

CHILD FUNCTIONS

NONE

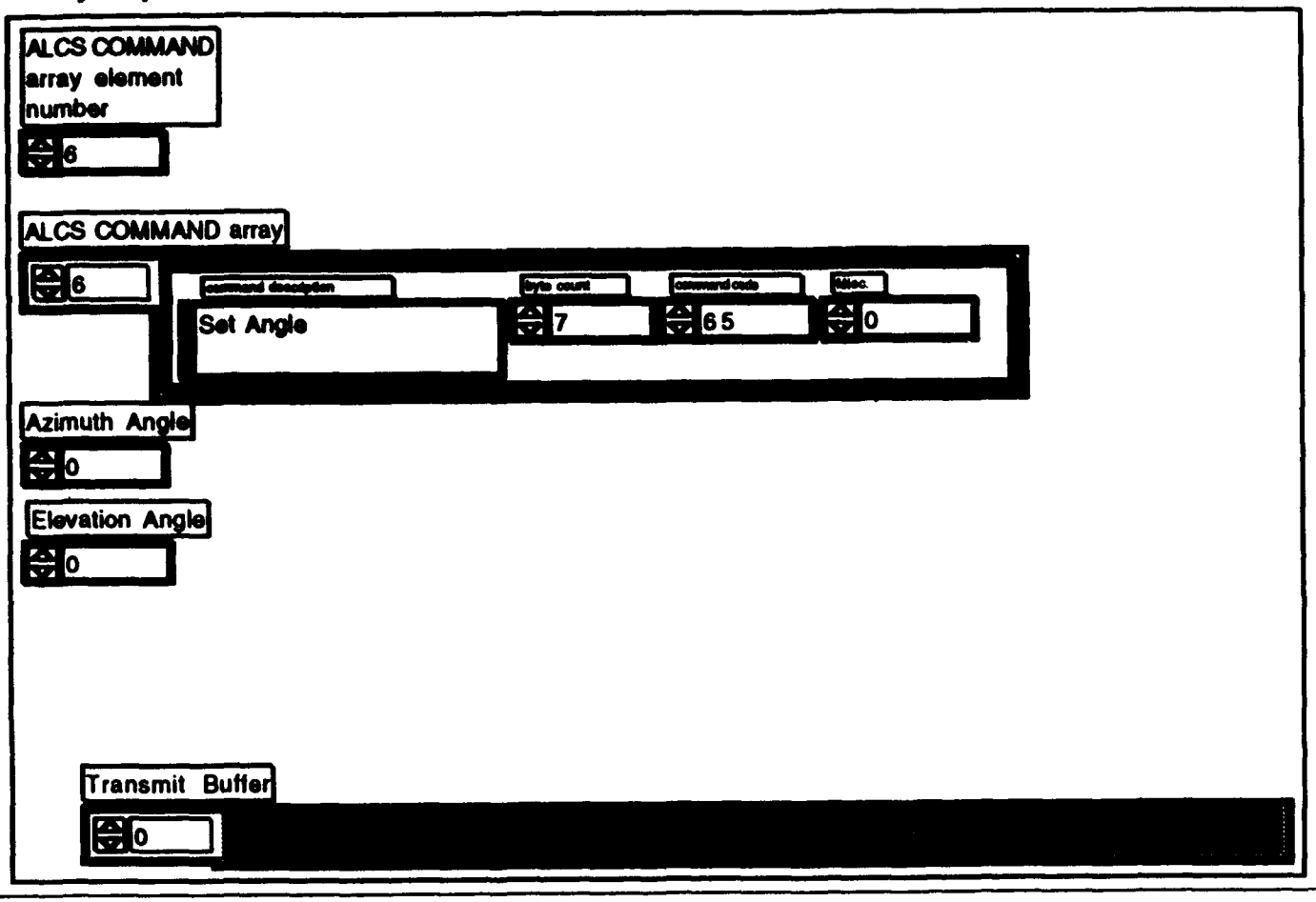
Connector Pane



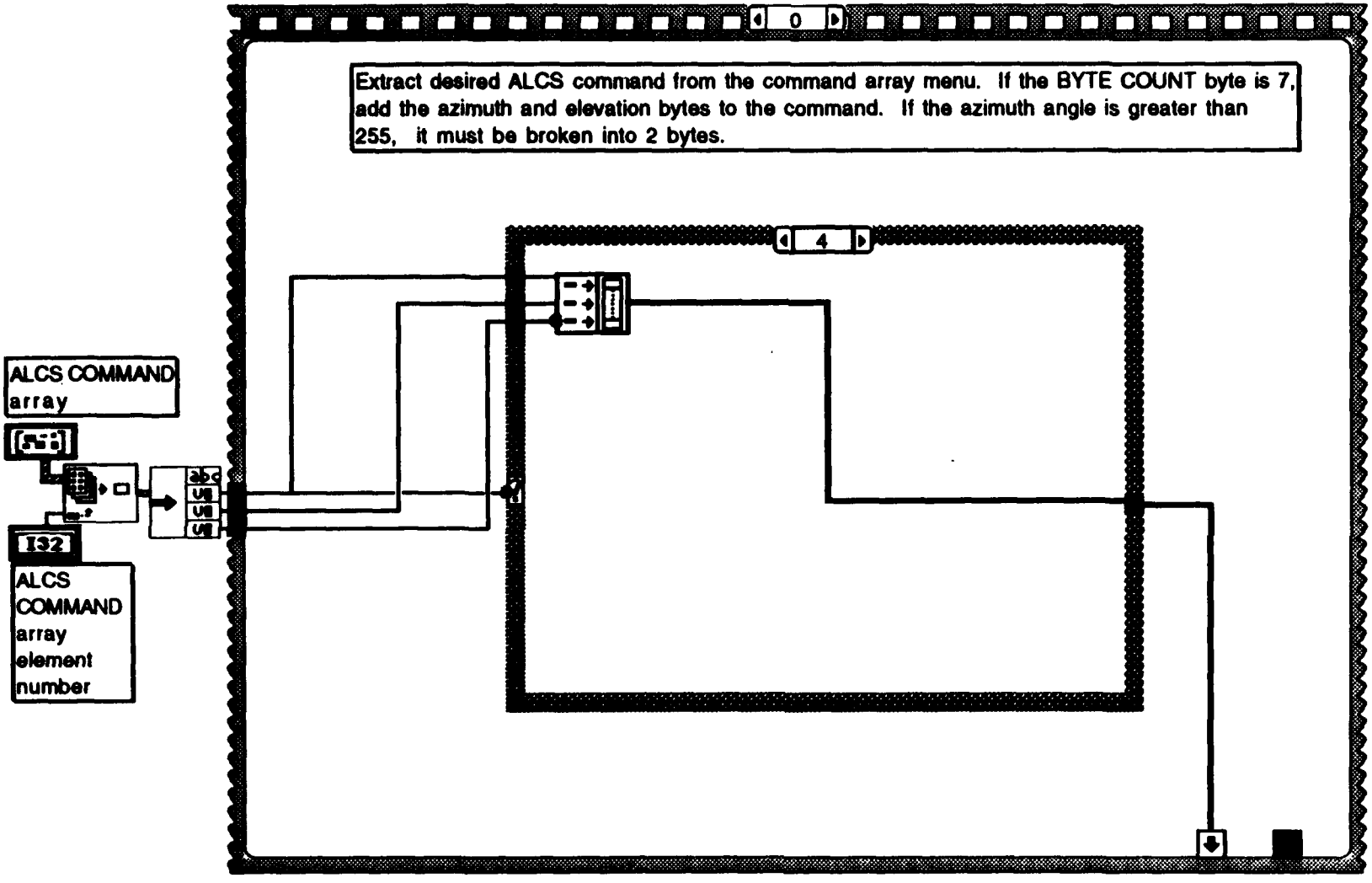
Send ALCS Command

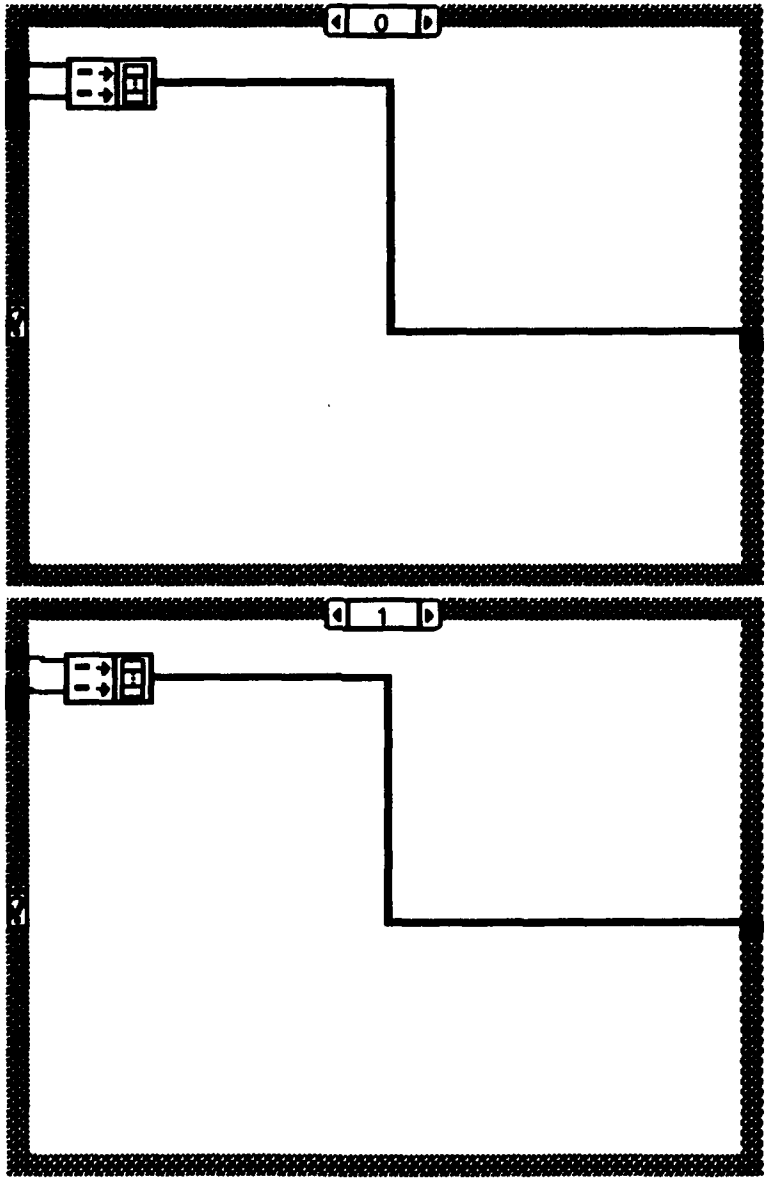
Front Panel

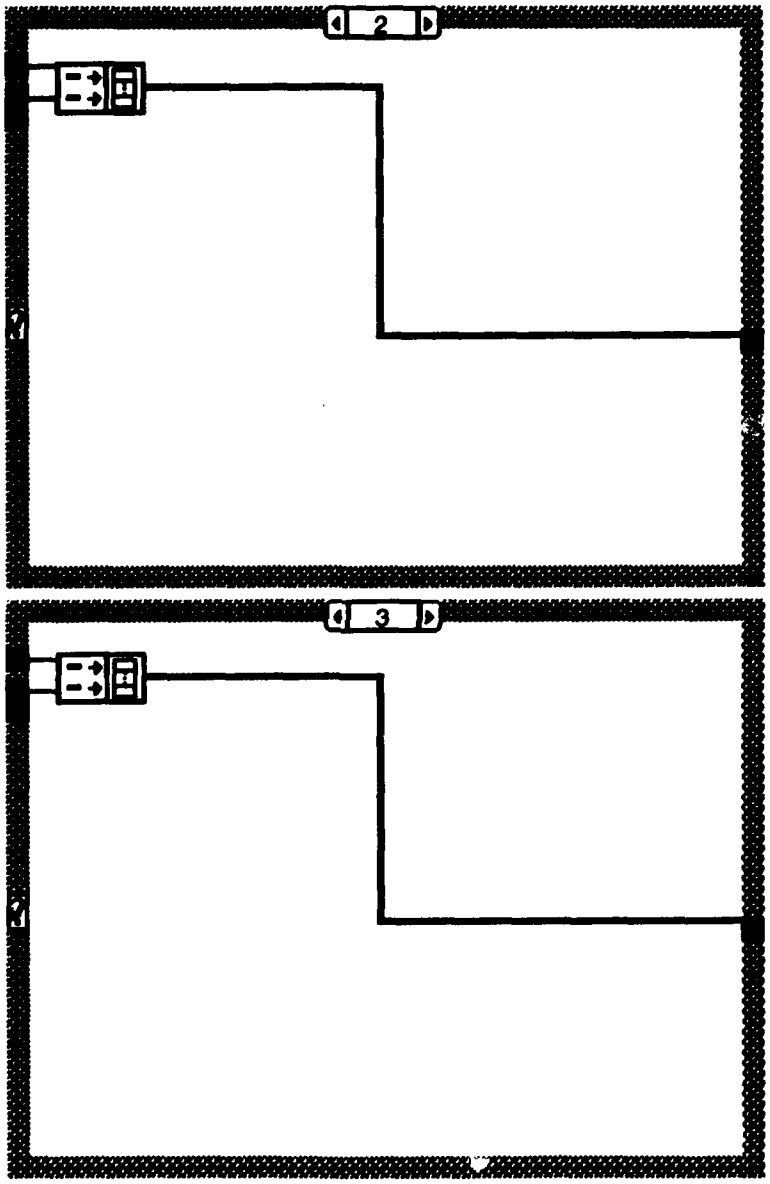
Send ALCS Command
Thursday, April 11, 1991 12:34

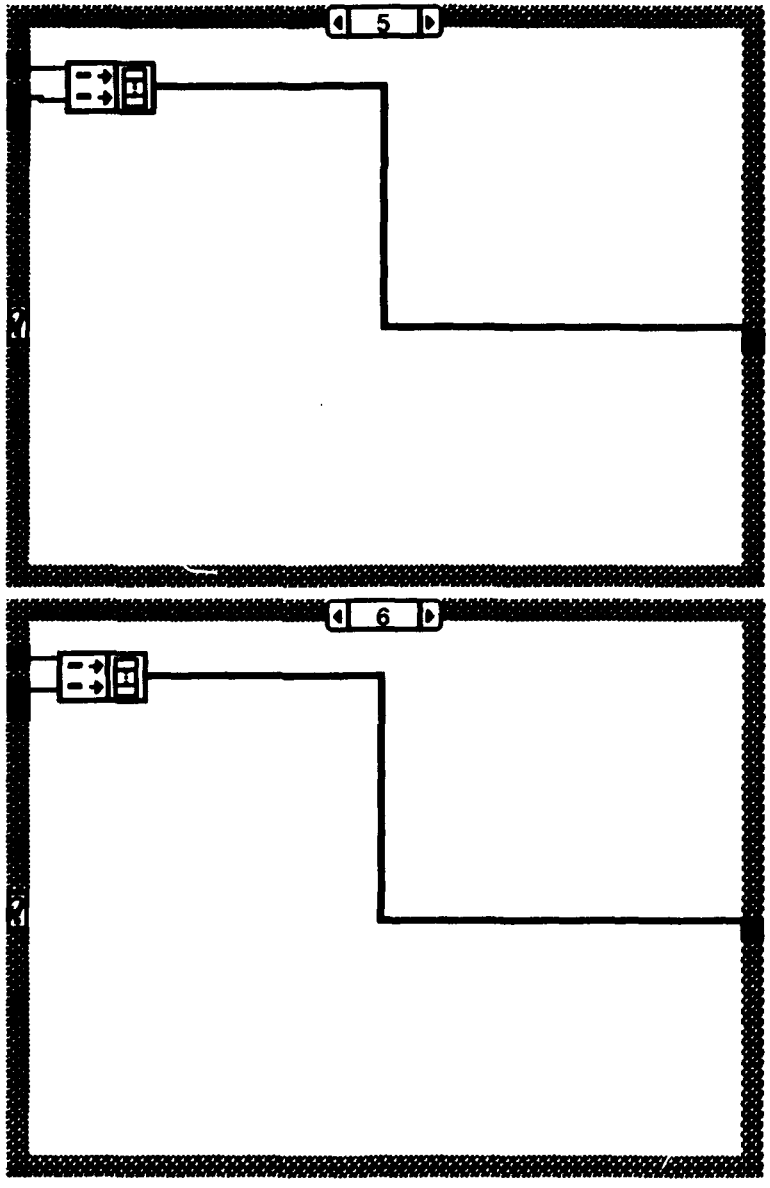


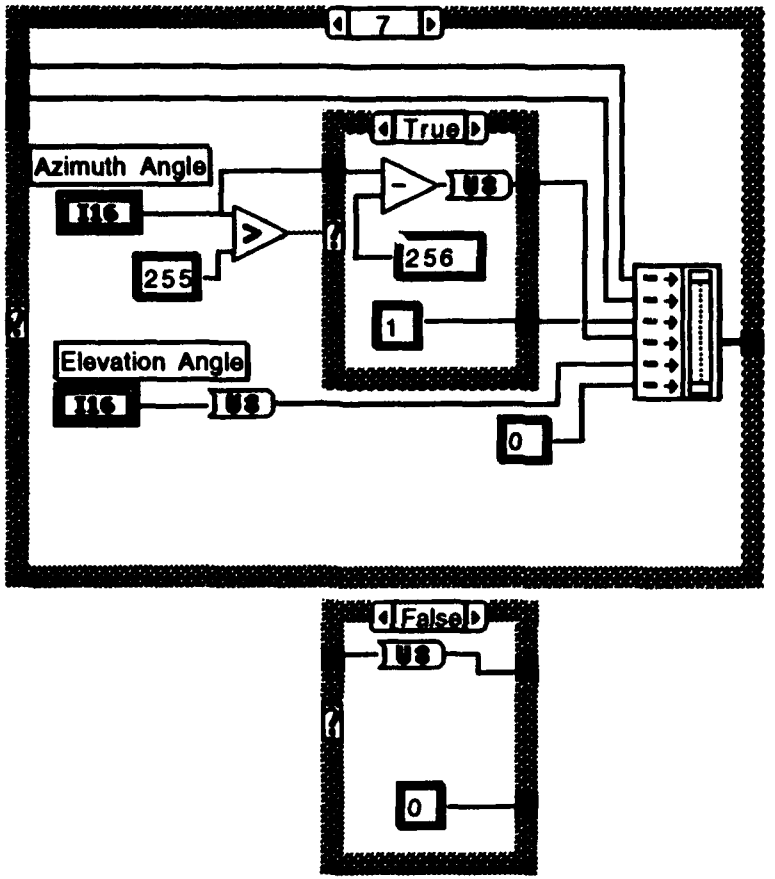
Block Diagram

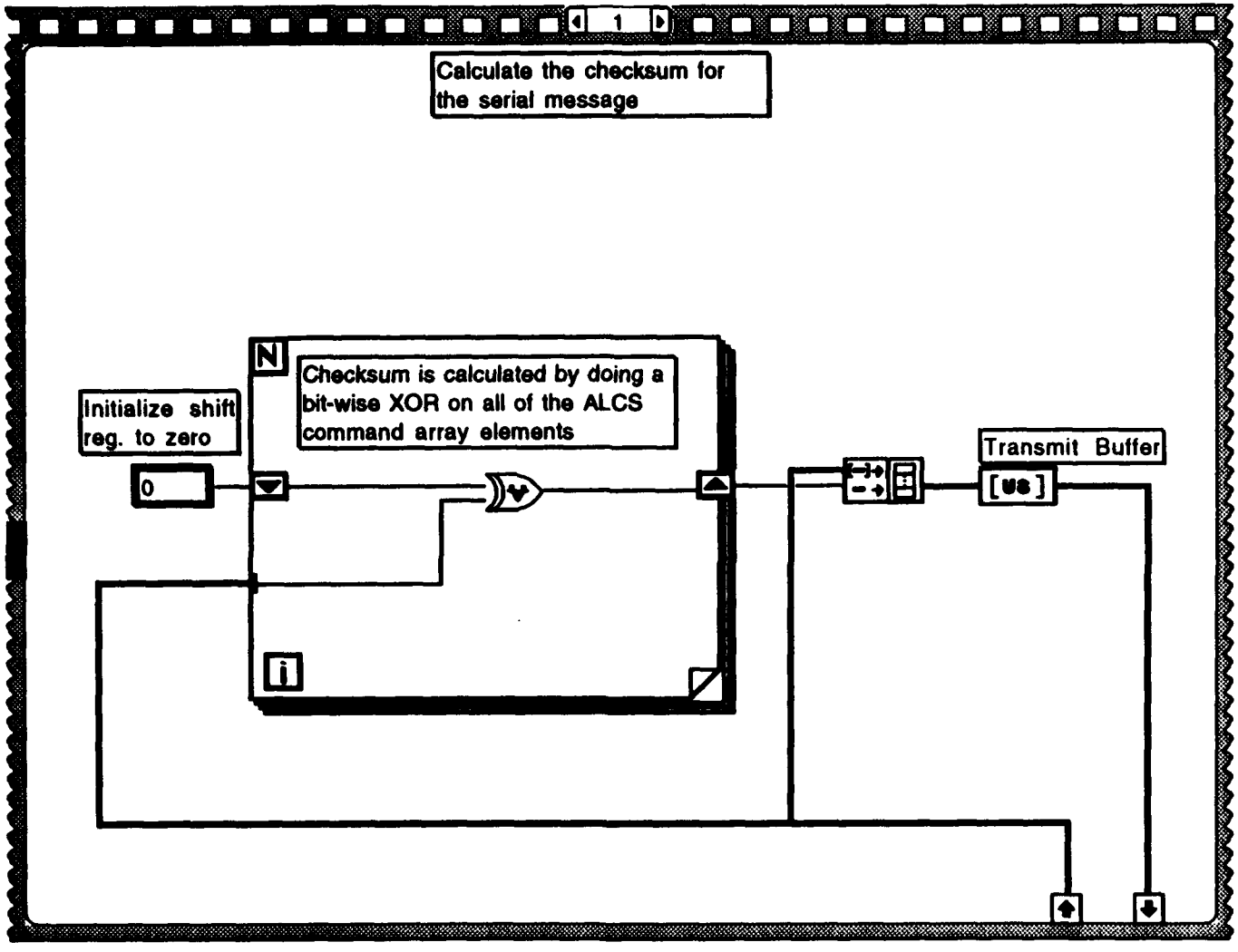

0
Extract desired ALCS command from the command array menu. If the BYTE COUNT byte is 7, add the azimuth and elevation bytes to the command. If the azimuth angle is greater than 255, it must be broken into 2 bytes.
4
ALCS COMMAND array
I32
ALCS COMMAND array element number

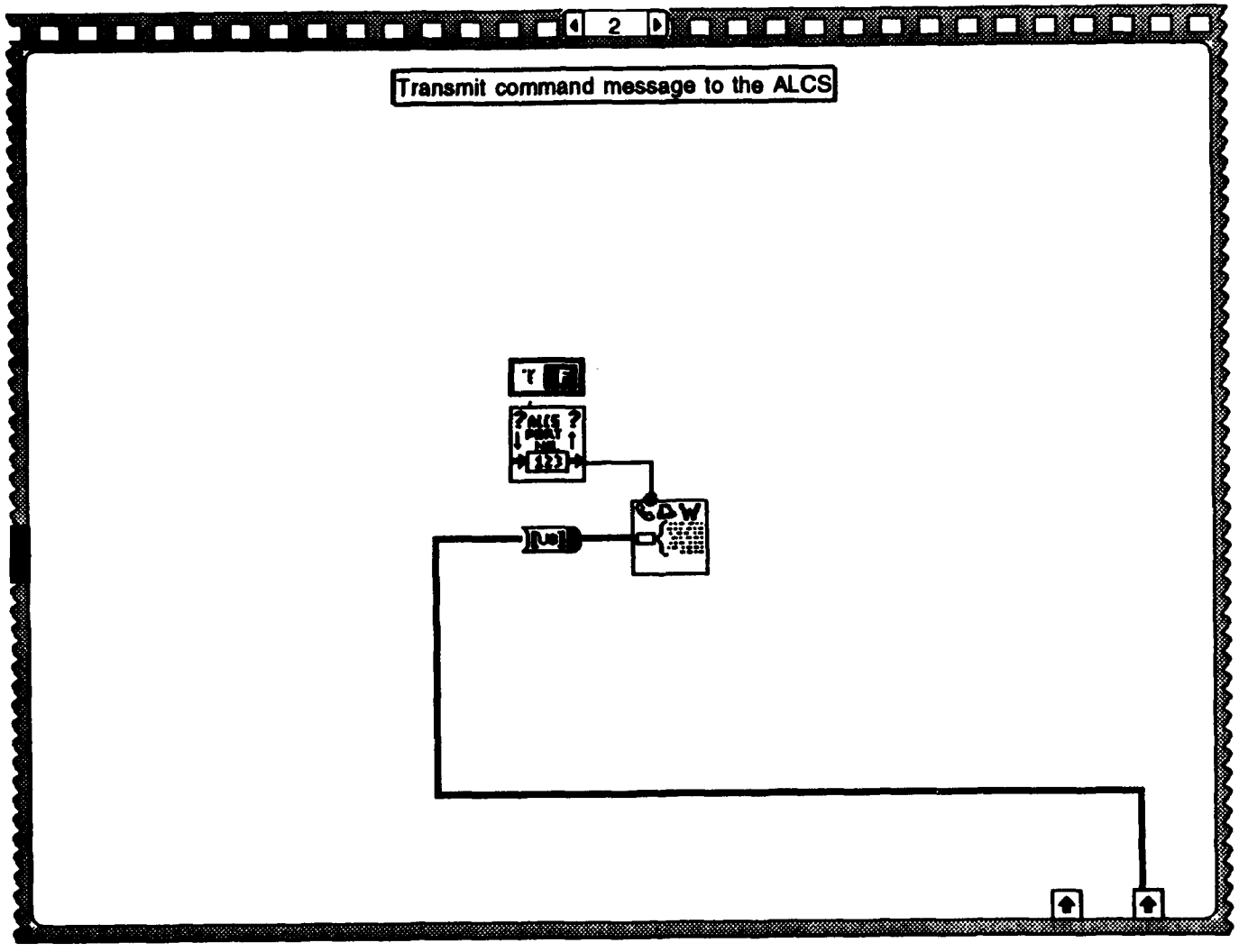

0
1


2
3


5
6


7
True
Azimuth Angle
I16
>
255
-
U8
256
1
Elevation Angle
I16
U8
0
False
U8
0


1
Calculate the checksum for the serial message
N
Checksum is calculated by doing a bit-wise XOR on all of the ALCS command array elements
Initialize shift reg. to zero
0
i
Transmit Buffer
[U8]


2
Transmit command message to the ALCS
T
F
?ALCS?
CDW

SCALE NEW DATA

107

MODULE DESCRIPTION

FUNCTION NAME

SCALE NEW DATA

FUNCTION DESCRIPTION

Scales the raw 12 bit A to D convertor data received from the FIP to the appropriate flight parameter data. Scaling values can be updated by the user on the front panel prior to run time.

FUNCTION INPUTS

ARRAY ELEMENT NUMBER: New FIP *DATA ARRAY* element number. This is the element number of the value to be scaled.

ARRAY ELEMENT VALUE: This is the actual value to be scaled.

FUNCTION OUTPUTS

NONE

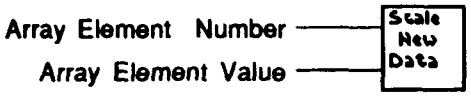
PARENT FUNCTIONS

COMPARE NEW DATA WITH OLD DATA

CHILD FUNCTIONS

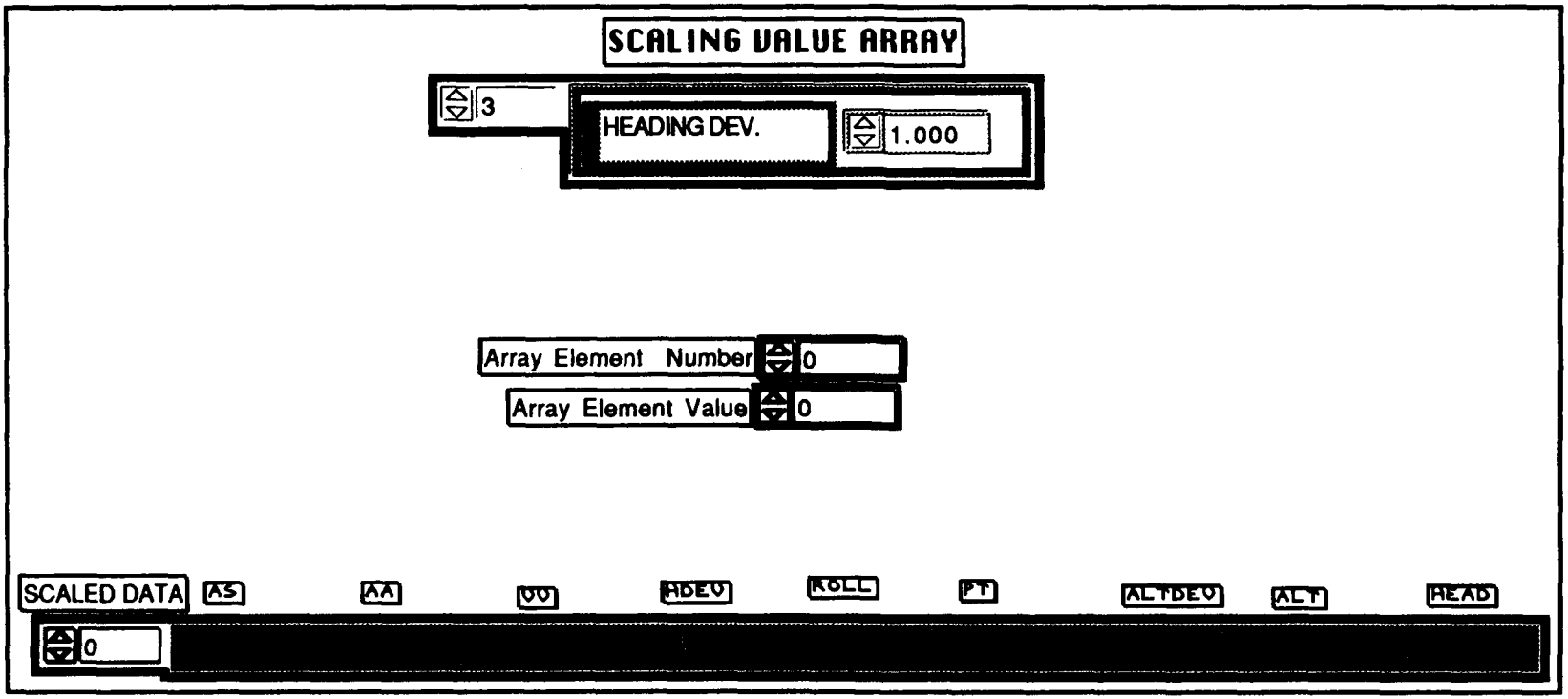
NONE

Connector Pane

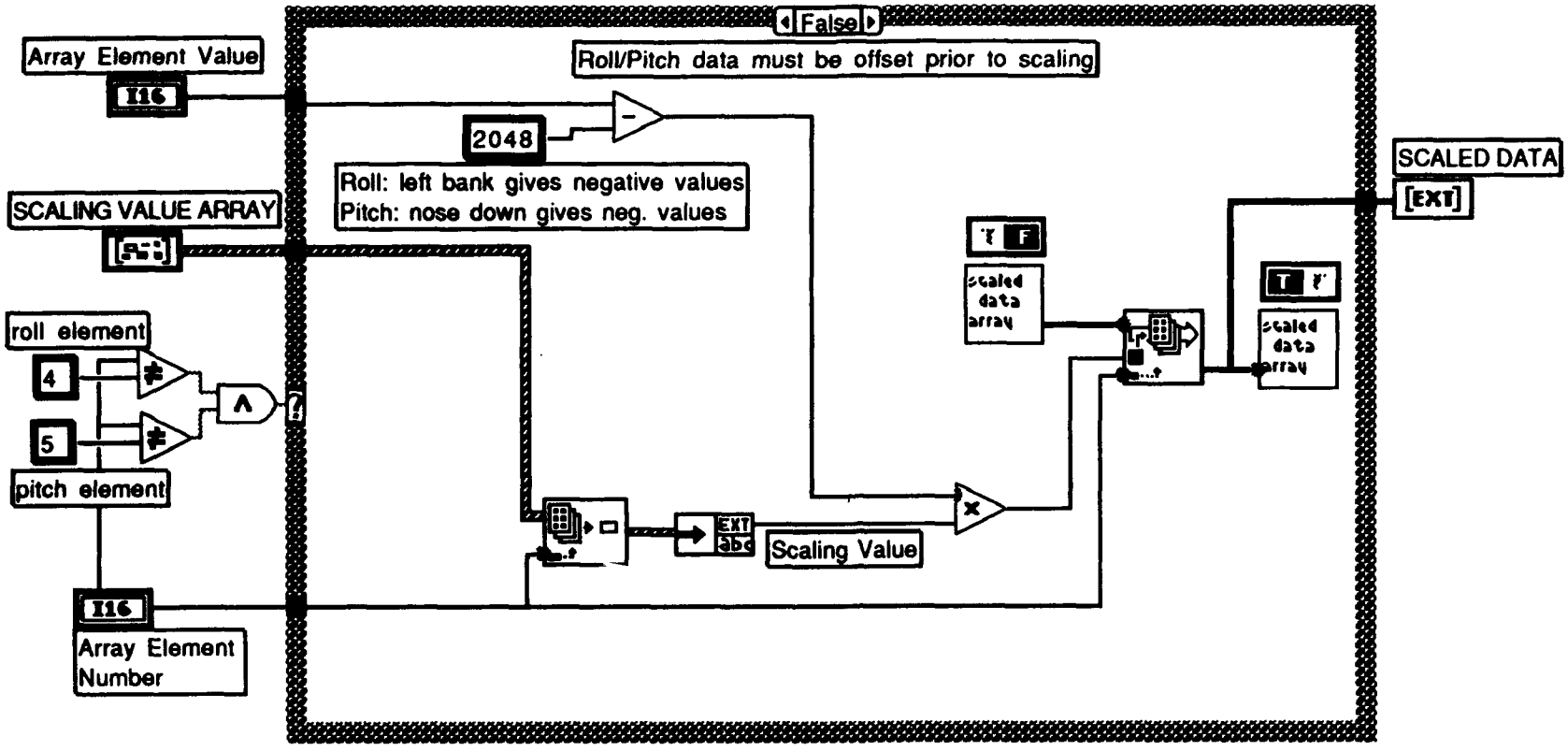


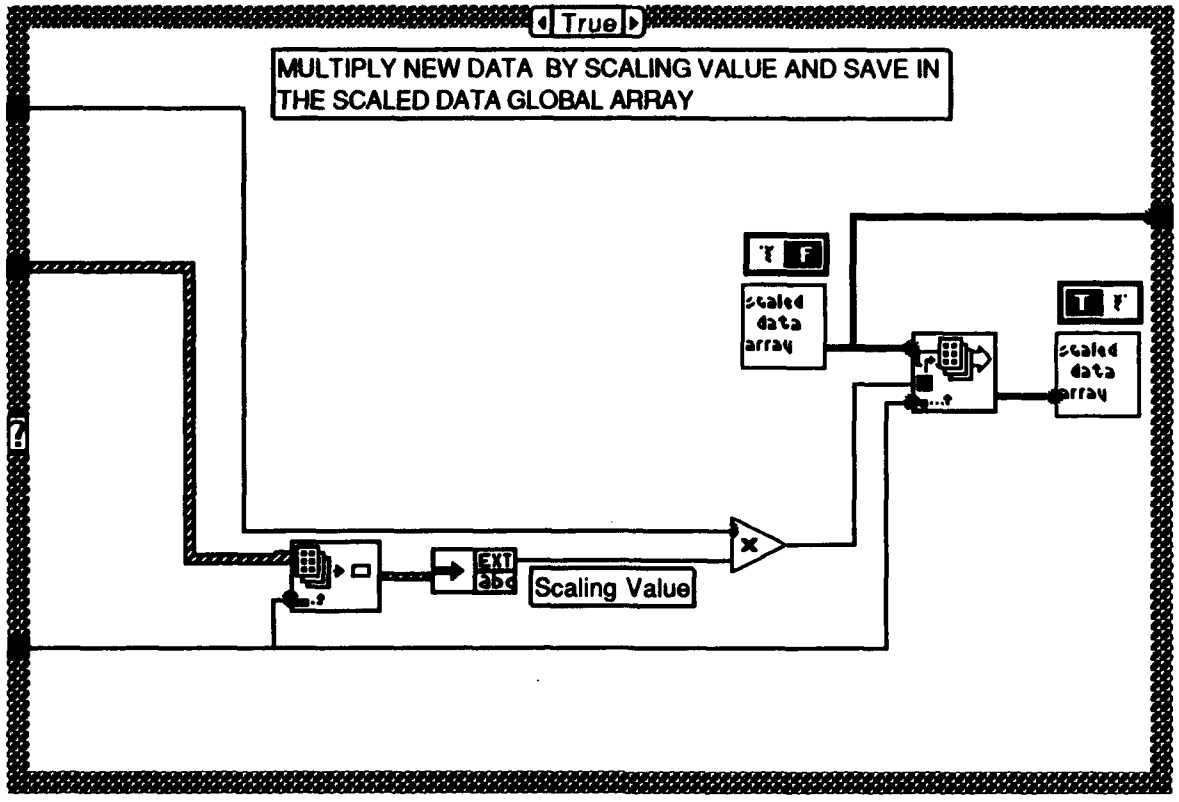
Scale New Data

Front Panel



Block Diagram


False
Array Element Value
I16
Roll/Pitch data must be offset prior to scaling
2048
Roll: left bank gives negative values
Pitch: nose down gives neg. values
SCALING VALUE ARRAY
SCALED DATA
[EXT]
roll element
4
5
pitch element
T F
scaled data array
T F
scaled data array
EXT abc
Scaling Value
I16
Array Element Number


True
MULTIPLY NEW DATA BY SCALING VALUE AND SAVE IN THE SCALED DATA GLOBAL ARRAY
scaled data array
scaled data array
Scaling Value

SETUP DBUF

MODULE DESCRIPTION

FUNCTION NAME

SETUP DBUF

FUNCTION DESCRIPTION

Initializes a DMA buffer for waveform generation. Sets rate at which the waveform buffer will be output and enables the block update DMA mode.

FUNCTION INPUTS

BOARD NUMBER: DMA board slot number.

NUMBER OF POINTS: Number of data points in waveform data, (i.e. the DMA buffer size).

SAMPLE RATE: Element number of desired sample rate (refer to *INIT AUDIO BUFFERING* module description).

CHANNEL NUMBER: Analog output channel number.

FUNCTION OUTPUTS

ERROR MESSAGE: Error code returned from buff load process. Refer to LabView manual for complete description.

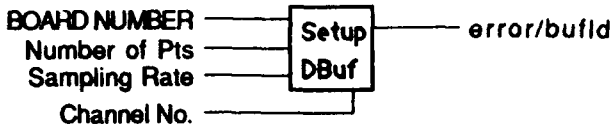
PARENT FUNCTIONS

INIT AUDIO BUFFERING

CHILD FUNCTIONS

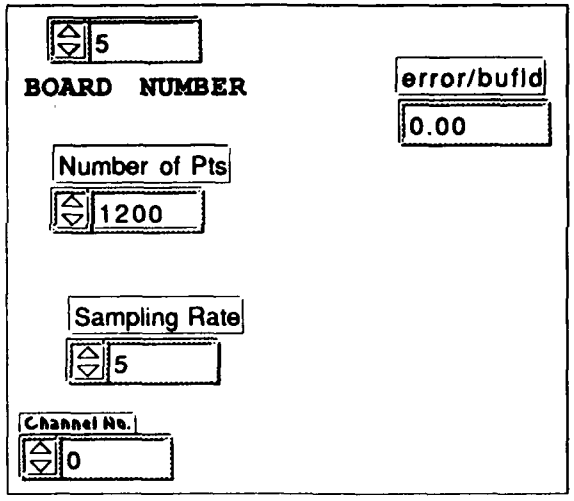
NONE

Connector Pane

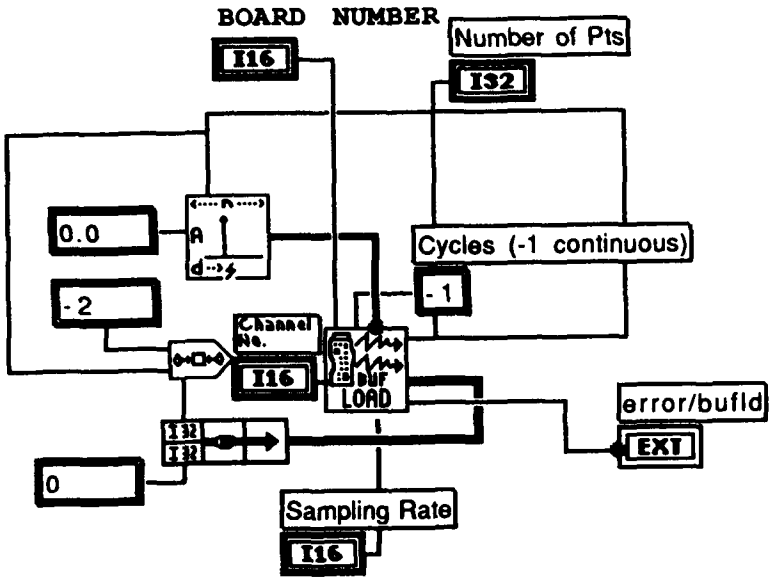


Setup Double Buffering

Front Panel



Block Diagram


BOARD NUMBER
I16
Number of Pts
I32
0.0
-2
Cycles (-1 continuous)
-1
Channel No.
I16
BUF LOAD
error/bufId
EXT
I32
I32
0
Sampling Rate
I16

115

SETUP WAVEFORM
GENERATION

MODULE DESCRIPTION

FUNCTION NAME

SETUP WAVEFORM GENERATION

FUNCTION DESCRIPTION

This module initializes the A2100 Audio output board and the DSP2100 DSP board. Initialization parameters include slot numbers, sample rates, and input/output coupling. All of the initialization parameters are stored in a global variable for subsequent access from other modules.

FUNCTION INPUTS

A2100 SLOT: Slot number of audio output board.

DSP2300 SLOT: Slot number of DSP board.

INPUT SAMPLE RATE: Element number of desired input sample rate (refer to LabView users manual for details).

INPUT COUPLING: A2100 input coupling (AC, DC, or Ground).

A/D SERIAL LINK: Sets serial line connection between the A2100 and the DSP2300 boards.

D/A SERIAL LINK: Sets serial line connection between the A2100 and the DSP2300 boards.

GROUP SELECT: Set to 0.

INPUT SETUP: A2100 input link action (connect, disconnect, no action).

OUTPUT SETUP: A2100 output link action.

DMA BUFFER SIZE: Passed from calling function.

A2100 CHANNEL NUMBER: Passed from calling function.

FUNCTION OUTPUTS

NONE

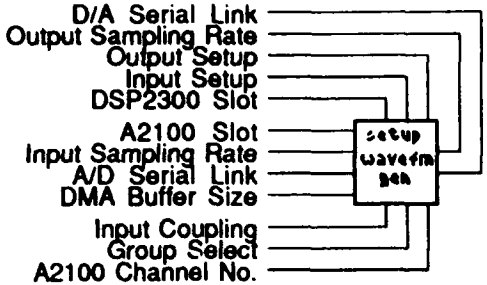
PARENT FUNCTIONS

INIT AUDIO BUFFERING

CHILD FUNCTIONS

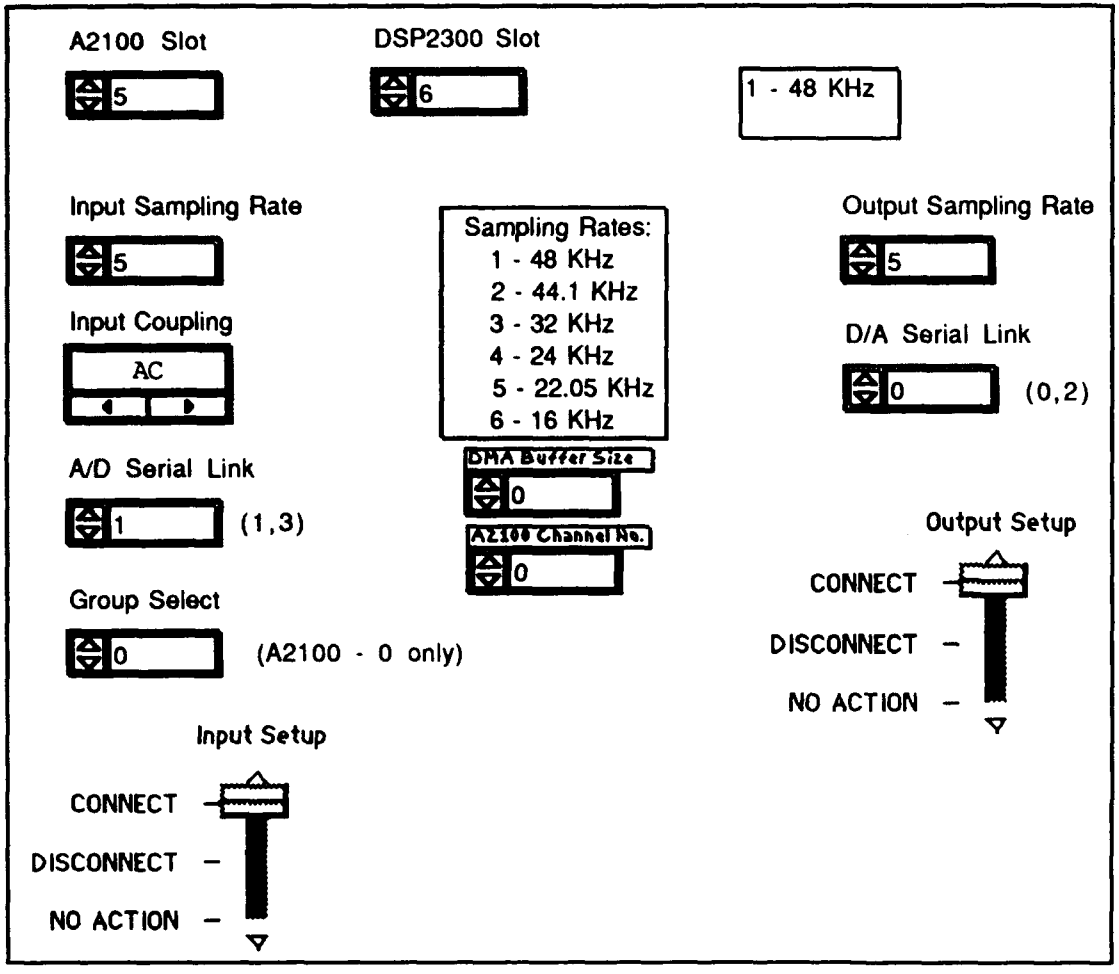
NONE

Connector Pane

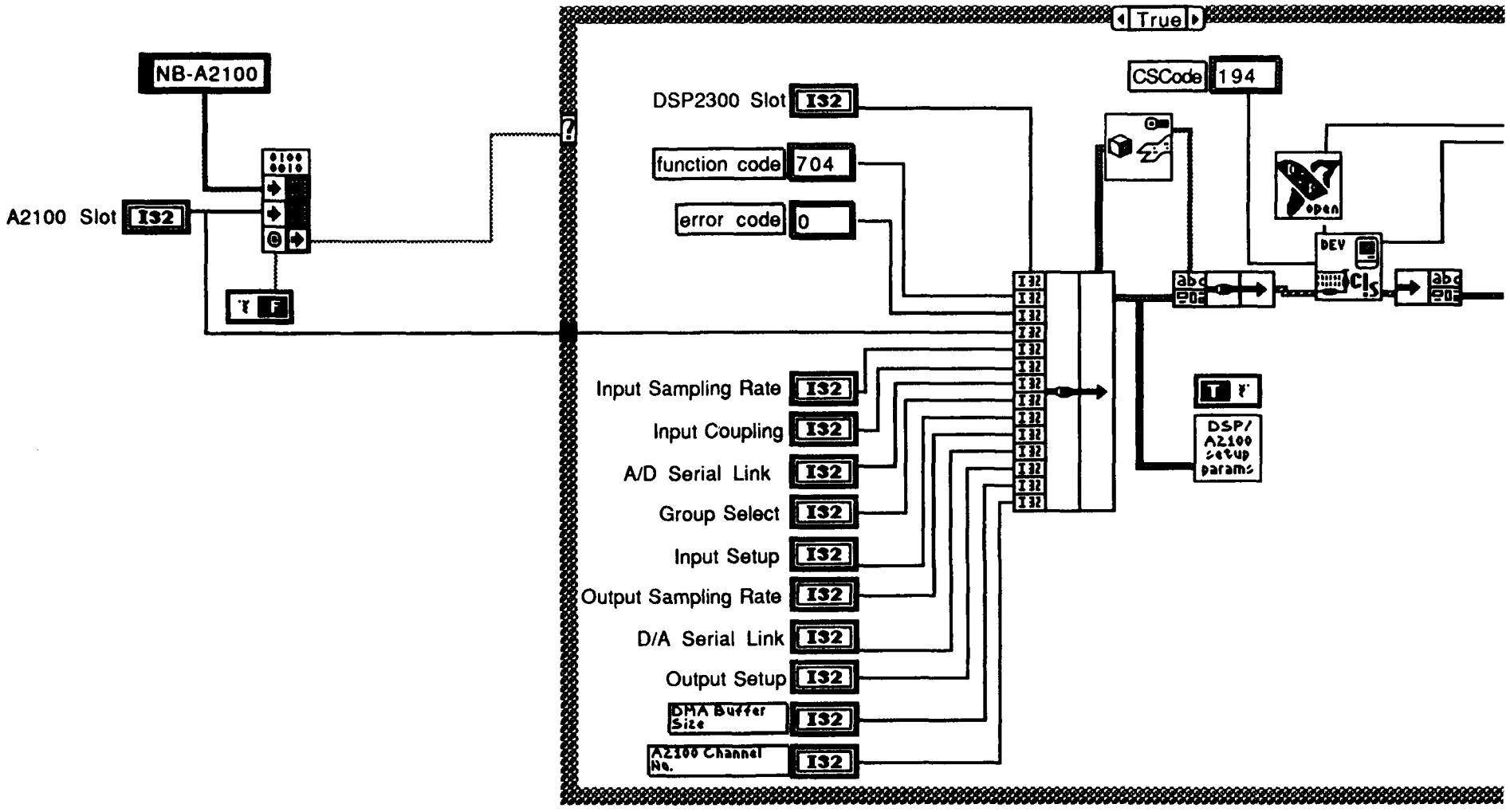


Setup Waveform Generation

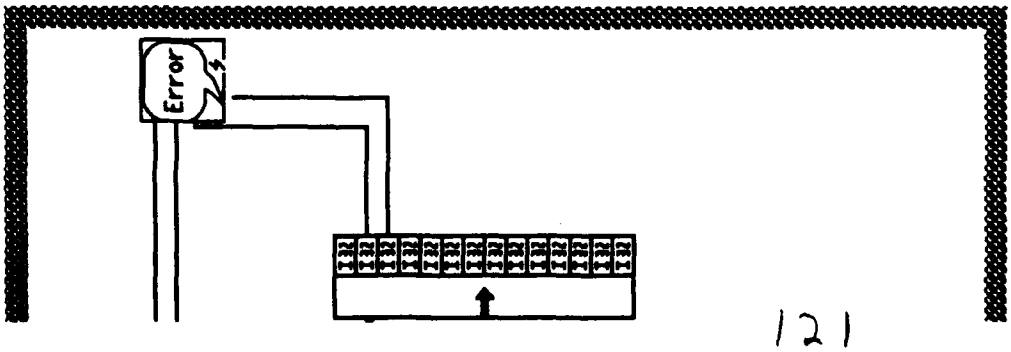
Front Panel

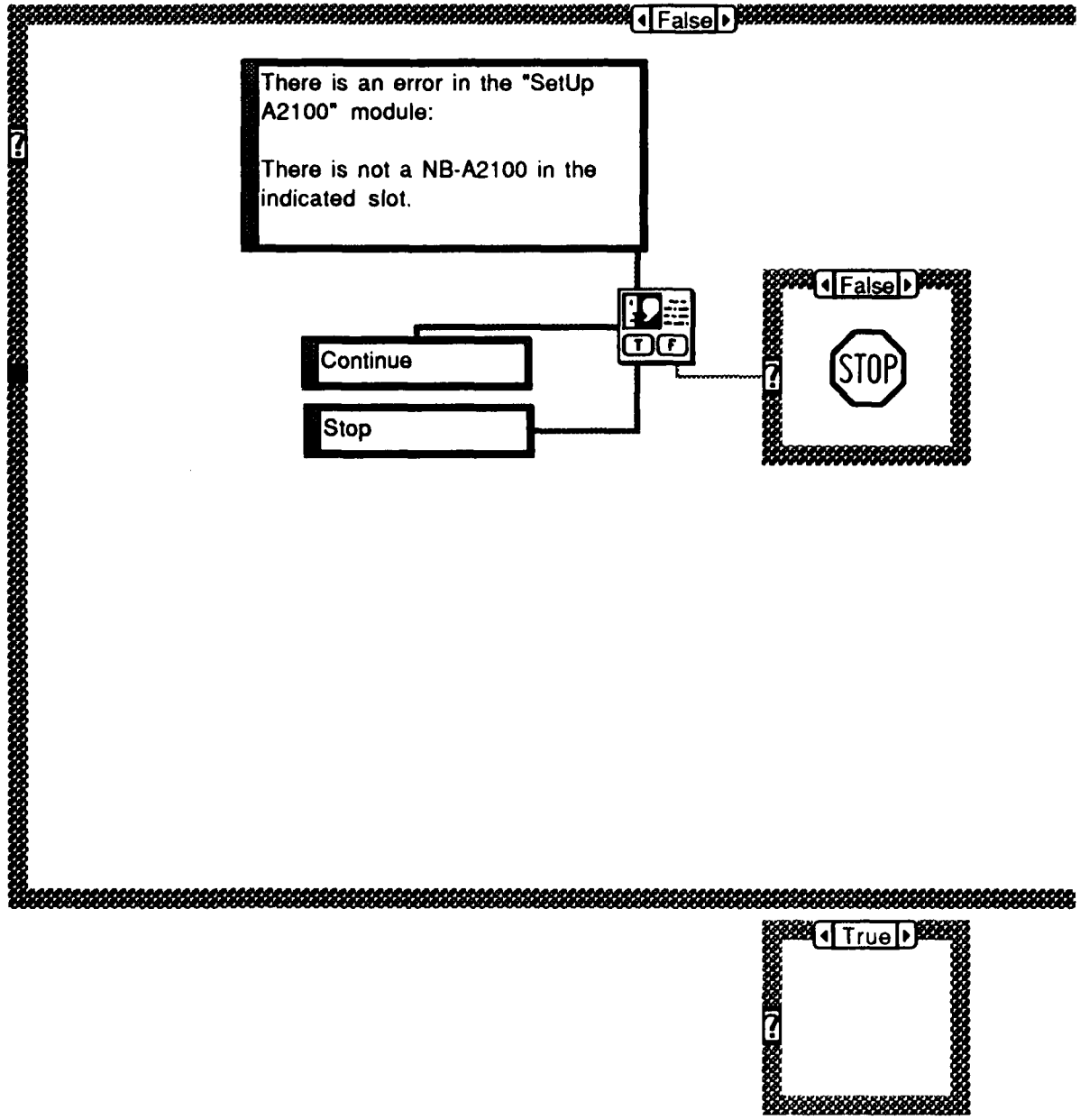


Block Diagram


NB-A2100
A2100 Slot
I32
TF
True
DSP2300 Slot
I32
function code
704
error code
0
CSCode
194
open
DEV
Input Sampling Rate
Input Coupling
A/D Serial Link
Group Select
Input Setup
Output Sampling Rate
D/A Serial Link
Output Setup
DMA Buffer Size
A2100 Channel No.
DSP/ A2100 setup params

021


Error


False
There is an error in the "SetUp A2100" module:
There is not a NB-A2100 in the indicated slot.
Continue
Stop
False
STOP
True

W TO PC X-FORM
W/TAPER

MODULE DESCRIPTION

FUNCTION NAME

VV TO PC X-FORM W/TAPER

FUNCTION DESCRIPTION

This module converts the vertical velocity flight parameter to a pitch circle audio cue. The array of tones used to generate the pitch circle is pre-recorded and stored on the hard drive. The *AOI SYSTEM MANAGER* module accesses the tone array from the hard drive and saves it in global memory during run time. This module skips elements in the tone array based on the mapped value of the vertical velocity flight parameter, thus giving the illusion of the pitch circle speeding up for higher values of vertical velocity.

FUNCTION INPUTS

PITCH CIRCLE ARRAY ELEMENT TO BE PLAYED: Array of tones to be played from the pitch circle tone array (the tone array is an array of arrays).

FUNCTION OUTPUTS

VERTICAL VELOCITY: Vertical velocity flight parameter obtained from the FIP.

PITCH ARRAY DEVIATION: Number of elements to skip in the pitch circle tone array.

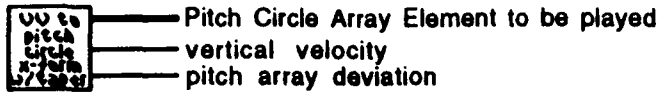
PARENT FUNCTIONS

AUDIO OUTPUT MANAGER

CHILD FUNCTIONS

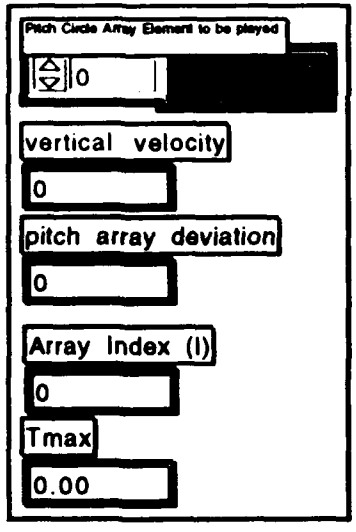
NONE

Connector Pane

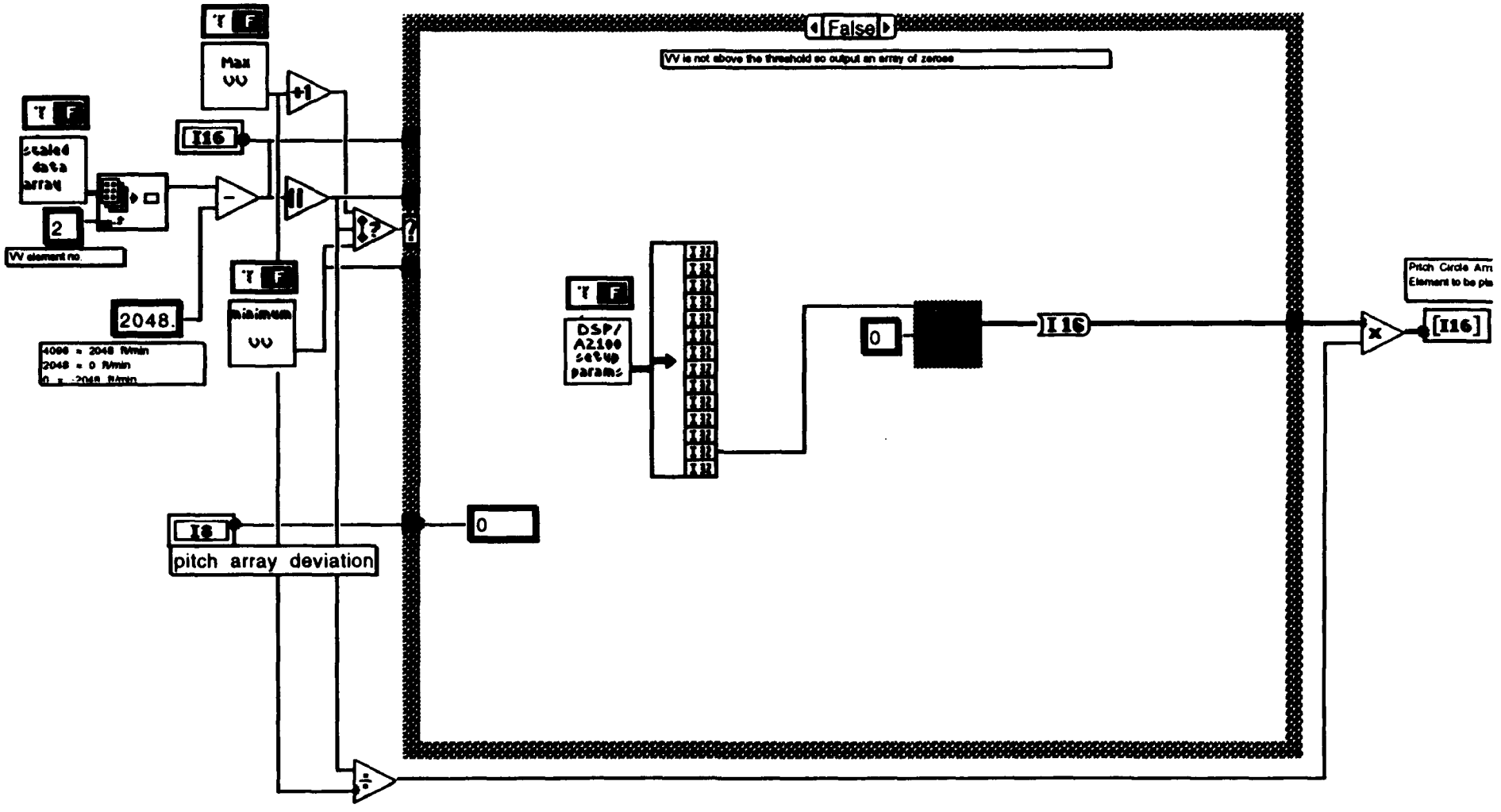


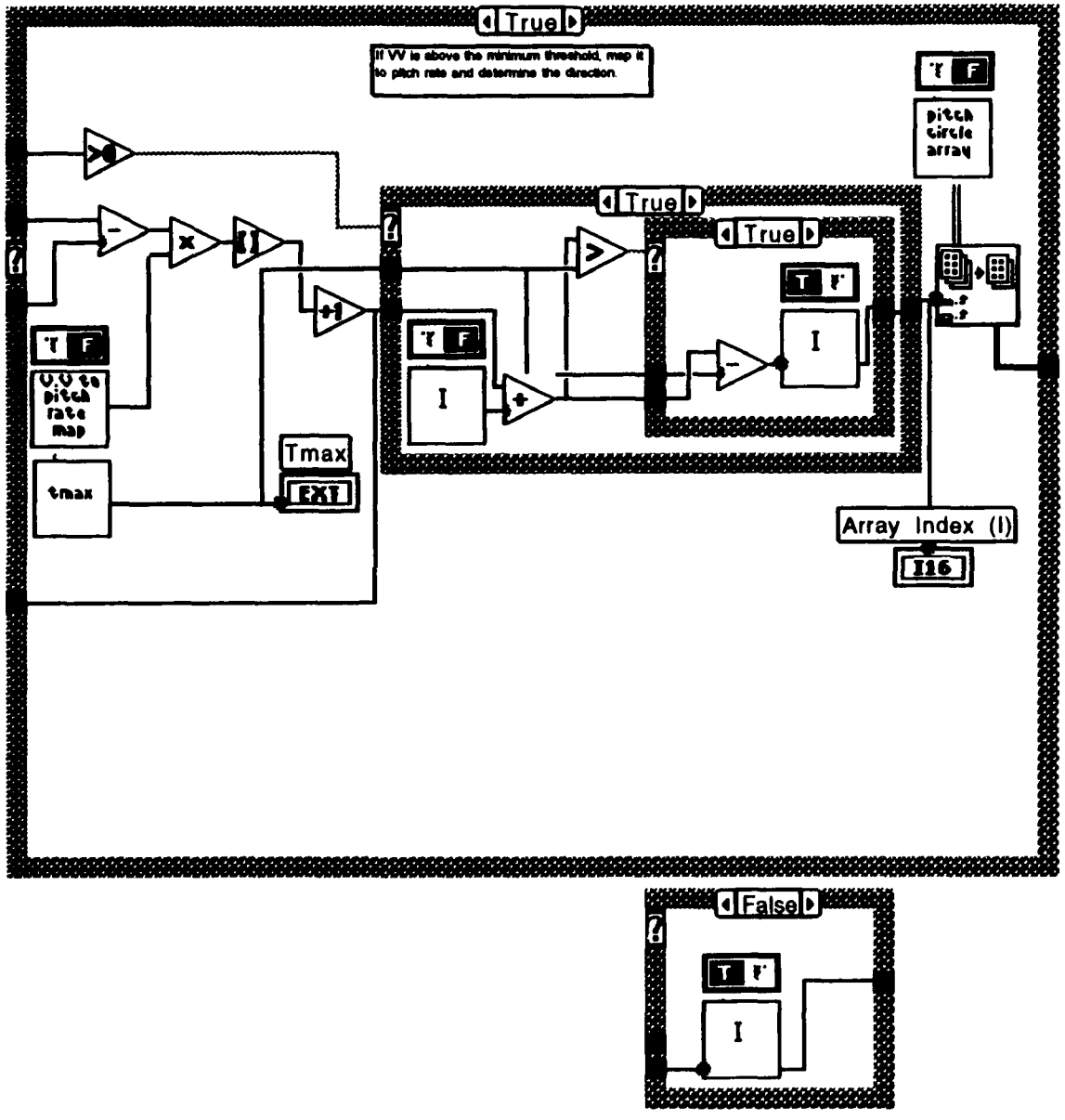
VV to PC X-form w/taper

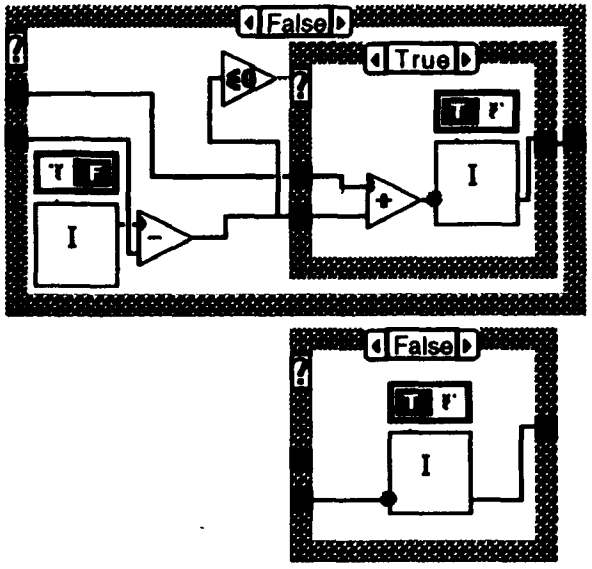
Front Panel



Block Diagram


False
VV is not above the threshold so output an array of zeroes
Max VV
I16
scaled data array
2
VV element no.
2048.
4096 = 2048 ft/min
2048 = 0 ft/min
0 = -2048 ft/min
minimum VV
DSP/ A2100 setup params
0
I16
Pitch Circle Arr
Element to be pla
[I16]
I8
pitch array deviation
0


True
If VV is above the minimum threshold, map it to pitch rate and determine the direction.
T F
pitch circle array
True
True
T F
I
T F
I
V-V to pitch rate map
tmax
Tmax
EXT
Array Index (I)
I16
False
T F
I


False
True
T F
I
T F
I
False
T F
I