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FACTORY ACCEPTANCE TEST PROCEDURE FOR THE EVN/Mark IV STATION UNIT

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This specification contains 47 pages.

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i AMENDMENT RECORD

Date	Issue	Description
18th August 1995	1	Initial Issue
23rd December 1996	2	Completely revised to use DPU based tests
22nd January 1997	3	Changes requested at IACC meeting.
24th January 1997	4	Changes agreed during SU Teleconference
10th March 1997	5	Corrections
1 September 1997	6	Test equipment list revised Phase Cal test removed X-Track parity test removed Misc TBD's evaluated
22 September 1997	7	Full test details added
29 October 1997	8	Minor corrections

ii TEST RECORD

SYSTEM SERIAL NUMBER.....

DATE TESTING COMMENCED.....

DATE TESTING COMPLETED .....

PLACE OF TEST.....

REMARKS:

FOR CUSTOMER	.....	(SIGNATURE)
	.....	(NAME)
FOR METRUM INFORMATION STORAGE LTD.	.....	(SIGNATURE)
	.....	(NAME)

iii TEST RESULTS SUMMARY

Test Number	Details of Failure	Corrective Action	Re-test	
			Date	Pass/Fail

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1 INTRODUCTION

1.2 Scope

This document details the tests to be applied to four prototype Station Units for VLBI reproduction to be delivered to The Radio Observatory, Dwingeloo, The Netherlands (EVN project 9301). The tests prove full compliance with the performance characteristics set out in Metrum document 1685030500, Station Unit Design Specification and module specifications referenced therein.

1.2 Applicability

The tests shall be applied in their entirety to all four prototype units

1.3 Derivation of Indicated Values

In all cases the quoted value is the actual value to be read and takes account of measurement errors for the specified instrument. The measurement performance of any alternative used must equal or exceed that of the recommended instrument.

1.4 Essential Conditions of Test

All tests are to be carried out under normal laboratory conditions.

1.5 Safety Requirements

There are no special safety requirements.

1.6 Glossary

SU	Station Unit.
UUT	Unit Under Test.
C^3	Correlator Control Computer.
PCCC	PC emulation of C^3
SUIM	Station Unit Interface Module
SUCC	Station Unit Control Computer
DPU	Data Playback Unit

2 EQUIPMENT AND FACILITIES

2.1 Facilities

2.2 Power Supplies

240 Vac 50 Hz single phase outlets are required to power the system under test and test equipment. All supplies are to be from the same phase.

2.3 Test Equipment

2.3.1 Calibration

All measurement equipment used in the performance of these tests must either carry a current calibration label traceable to national standards or in the case of variable range equipment's, be calibrated locally using instruments which have been calibrated to national standards.

2.3.2 Test Equipment

PC with the following installed and configured (PCCC):

- NE2000 compatible ethernet card, BNC output.
- PC/TCP^{R} Network software kernel for DOS 4.0
- AUTOEXEC.BAT and CONFIG.SYS files set up for tftp server.
- RAM.HEX - file to be downloaded to SUCC
- TFTPSERV.BAT - batch file to set-up PC as TFTP server.

2 off BNC “T” pieces

2 off BNC 50 Ohm terminations

1 off BNC - AUI transceiver e.g. Allied Telesis model AT-MX10

BNC - BNC, RG58 coax cable

Dumb Terminal

Insulation Tester - e.g. Megger

Logic Analyser: 50 channels (minimum) plus external clock,
“state” mode from an external clock at >36MHz.
Preferred instrument: H/P 1661C.

(Configuration files can be supplied for a compatible analyser)

Continuity tester

Oscilloscope: Any good analogue instrument
100MHz bandwidth
2 channels with invert & add
external trigger

MkIII Data Quality Analyser (DQA) - on loan from Haystack

Clock Recovery Box - METRUM STTE

SUIM Substitute module - METRUM STTE

MkIV DPU

2 off 40way DPU - SU signal cables

1 off RS232 serial cable, 25way/male to 25way/male wired 2-3, 3-2, 7-7.

2.3.3 Test Tapes

A VLBI approved thin tape (e.g. Sony D1-K) with the following passes recorded at 56kbit/in (9Mbit/s + 160ips). Where random data are required these should be truly random but identical on every track i.e. configure the formatter to route one sampler output to all tracks:

1. Forward pass: MkIII/IV random data
2. Reverse pass: as 1
3. Forward pass: MkIII/IV random data with barrel roll applied.
4. Reverse pass: as 3
5. Forward pass: MkIII/IV all zeros data with modulation applied.
6. Reverse pass: as 5
7. Forward pass: VLBA all zeros data with modulation applied
8. Reverse pass: as 7

2.3.4 Test Set Up

Fit the AUI transceiver to the Ethernet connector on the MVME712M Transition Module.

Using the coaxial cable connect the PC BNC Ethernet to the AUI module via the “T” pieces with 50 Ohm terminators at each end.

Connect Port 4 of the MVME712M Transition Module to the Serial Port of the DPU via a suitable RS232 cable.

Power up the PC, select TFTP server configuration from the boot menu (this will be the default which will come up after a few seconds).

Connect the MkIV DPU to the UUT as follows:

Headstack 2 even tracks to UUT HSC0

Headstack 2 odd tracks to UUT HSC2

DPU serial port to UUT serial port 4

2.4 Test Software

2.4.1 SU Software

The UUT is loaded with its normal operational software during testing.

(Host 192.9.200.7 c:\fatp\ram.hex Issue:succ4112)

2.4.2 C^3 Emulation

The C^3 is emulated for testing on a PC (known as the PCCC) using **SUTEST.EXE**

This programme issues commands and receives responses via the Ethernet, TCP/IP interface in accordance with EVN42.

The format of tests is:

SUTEST <menu_file_name>

Menu file actions are simple instructions to cause SUTEST.EXE to perform the following operations.

OPEN	Open a socket to a SU.
CLOSE	Close the currently open socket.
SEND	Transmit a **data file** to the SU.
RECV	Receive data from the SU into a file.
LOOP	Loop waiting for user to press a key.

The **data files** used for sending to the SU are ASCII HEX files containing the actual C^3 command plus a small header to define the input data format. The received data files are built using simple formatting which produces byte, word or long word ASCII HEX per line.

In general, tests are further simplified by the use of DOS batch files which, directly or via other batch files, call SUTEST.EXE with a specified menu file.

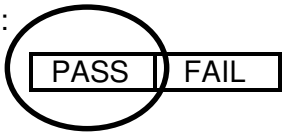
DPU configuration and set-up are not necessarily repeated for each test so the tests should be performed in the order given.

3 ACCEPTANCE TESTS.

3.1 General Instructions

- Provision is made to record test results within this document. Take a copy for this purpose and begin by entering the details requested on page 3. Record details of any failed test on page 4.

  Unless otherwise directed indicate a passed test thus:

- Ensure that all measurement equipment carries a current calibration label.
- Any repairs, shall be carried out in accordance with METRUM spec. W.I 802.
- Multilayer boards shall be handled in accordance with METRUM spec. W.I. 549.
- Electrostatic handling procedures shall be observed in accordance with METRUM spec. W.I. 917.
- Tests should be performed on a fully populated SU
- The SU should be booted at the start of the tests but not, if possible, between tests

3.2 Safety and Quality Checks

3.2.1 System Under Test

Confirm that all elements of the system under test are present, as listed in 1650010500, and correctly connected.

PASS	FAIL

3.2.2 Visual Inspection

Visually inspect the equipment and confirm that acceptable standards of quality and workmanship have been observed.

PASS	FAIL

3.2.3 Insulation Tests

Using a Megger, set to the 500 V range, measure the isolation between mains live and earth and neutral and earth and ensure that this is greater than 100 M Ohm.

3.2.3.1 Measured value. _____ MΩ | PASS | FAIL

3.2.4 AC Power

3.2.4.2 Confirm that the PSU is configured for 240 V ac. | PASS | FAIL

3.2.4.3 Check fuses and circuit breakers | PASS | FAIL

3.2.5 Grounding checks

Using a continuity tester check that the resistance between mains earth and exposed metal parts is less than 0.2Ω.

Measured value _____ Ω | PASS | FAIL

3.2.6 Firmware

Confirm that the correct programmable devices are fitted:-

Module	DEVICE	Part NO.	Issue
SUCC	XU1, XU2	1690020500	A
DIM	U21	1697020000	A
TRM	U33, U34	1690040005	A (TRM4139)
	U38	1695040005	A
	U178*	1696040005	A
	U40	1697040005	A
	U39	1698040005	A
CRM	U42, U43	1690020010	A (CRM4131)
	U48	1695020010	A
	U37	1697020010	A
	U52	1698020010	A
PCM	U54, U55	1690020020	A (PCMxxxx)
	U57	1697020020	A
DCM	U19, U20	1690020015	A (DCM4135)
	U51	1695020015	A
	U38	1697020015	A
DMM	U23	1695020016	A

*production TRM only

PASS	FAIL

3.3 SUCC Initialisation

Connect a dumb terminal to the Console port of the MVME 712 (set-up: 9600/8/n/1)

Apply power to the Unit Under Test

Hit a key on the terminal keyboard within 2 seconds.

Type M for modify and select the following:

Mode 4 [run ftp boot loader]

Do you want a LAN I/F [Y]

This board's IP address [...] set to 192.9.200.7

Subnet mask [N]

Shared memory network interface [N]

Default gateway [N]

Multiprocessor system [N]

Baud rate for serial channels [9600]

Bus address [1000000]

IP address of TFTP boot loader [192.9.200.130]

File name... [c:\fatp\ram.hex]

How long to delay... [2]

Then chose "C" to continue.

Observe the Server screen and confirm that the following messages are displayed:

a) PC/TCP TFTP server initialised

b) Host 192.9.200.7 reading file c:\fatp\ram.hex octet

.....

transfer successful

? bytes in ? seconds ?baud

Observe the DIM LED's and confirm that they sequence through red, yellow, green and off.

PASS	FAIL

3.4 DPU Interface

3.4.1 DPU Transparent Commands

Objective:

This test demonstrates that the SU is able to pass commands and status requests to the DPU and receive and return responses in accordance with the MCB protocol.

Method:

Mount the test tape on the DPU and ready the deck.

Run \TRANSP\TRANSP.BAT to:

- Set the tape speed to 135ips
- Play the tape
- Take three footage readings
- Stop the tape
- Rewind
- Set tape speed to 270 ips
- Select monitor track A
- Select monitor track B
- Set equalisation to 270ips/9Mbitps
- Enable low tape sense
- Rewind to start of tape
- Play, Stop and rewind

Confirm that the above commands are correctly obeyed.

PASS	FAIL

Check the footage reading responses in files: READ-30A.RSP
READ-30B.RSP
READ-30C.RSP

PASS	FAIL

3.4.2 DPU Initialisation

Objective:

This test sets up the DPU for other tests. In doing so the following functions are exercised:

- DPU Position Heads Command
- DPU Peak Heads Command
- DPU Position Tape To Footage Command

Method:

Connect an oscilloscope to Monitor A output of Read Mux 2 on the DPU.

Run \RT09M\INITDPU\INITDPU.BAT to prepare the DPU for 9Mbit/s replay of Pass 1, i.e.

- Set tape speed, equalisers, monitor tracks etc. (Monitor A track = 18)
- Position heads
- Peak up

Observe the oscilloscope trace during peaking and confirm that the monitored output changes in amplitude as the peaking movements are made and that the amplitude of the A channel is left at a maximum on completion

PASS	FAIL

3.5 Data Input and Routing

Note: Each DIM has full cross point switching capability across 36 DPU inputs. To avoid the necessity for a full set of DPU inputs the DIM is tested first so that in subsequent tests good tracks can be duplicated in the DIM's and used to test all paths through the SU.

3.5.1 DPU Head Signal Inputs

Objective:

To confirm that DIM data routing is correct.

Method:

Run this test following DPU Initialisation.

Run \RT09M\ROUTING\ROUTE.BAT to:

- Play the tape.
- Configure the UUT to receive data with various routings
- Read back header data to the PCCC

Run \RT09M\ROUTING\ROUTING ROUTE.TXT

Inspect ROUTE.TXT and confirm that all tracks are correctly routed.

PASS	FAIL

3.5.2 Test Signal Inputs

Connect a signal source to each Test signal input via the SUIM substitute. Exclusively enable each test signal input in turn . From the C3 send configuration commands to the SU to set up various routings through the DIM. Monitor the DIM outputs/TRM inputs using an oscilloscope and confirm that signal routing is correct. That is, the signal appears at the expected location only.

Repeat for all test signal inputs to both DIM0 and DIM1. Demonstrate that full cross point switching is correctly implemented on both DIM's

PASS	FAIL

3.6 Position Tape to TOT

Objective:

To check that the SU can control and monitor DPU activity in order to position the tape to a particular TOT. In so doing the following functions are exercised:

- DPU control
- Clock recovery
- Sync detection
- Reading of TOT
- Reading and reporting of DPU tape footage

Method:

Run \DT18M\INITDPU\INITDPU to prepare the DPU for 18Mbit/s replay of Pass 1.

Run \DT18M\POSTOT\POSTOT.BAT to:

- Configure the TRM's to extract data of the required type and clock rate.
- Position the tape to a nominal footage.
- Start replay in the current direction and read TOTs
- Stop the tape when TOT equals or exceeds the target TOT.
- Report back the footage at which the achieved TOT was detected.
- Re position the tape to a point which allows for the DPU to accelerate to speed and for the SU to achieve synchronisation just before the target TOT.

Inspect the contents of POSTOT.RSP to determine the footage of the target TOT.

Confirm that the DPU has stopped at a footage corresponding to the target TOT less 213 +/- 2 feet.

PASS	FAIL

3.7 Data De-skew

Objective:

To show that the SU can de-skew all tracks. The following functions are demonstrated in this test:

- Tape Servo
- All TRM Receive and Transmit functions
- Recovery from large scale disturbances

Method:

Connect an oscilloscope and a logic analyser to DMM: Sign, Magnitude and Validity outputs as required.

Run \DT18M\DESKEW\DESKEW.BAT to:

- Set Configuration:

  No barrel roll.
  18Mbit/s data from Tape
  No cross track parity
  Two bit data
  Mark IV Formatter Fan-out Mode1:1
  (i.e. 32 tracks map to 16 two bit channels.)

  If a full set of independent track signals is not available the DIM cross bar switch may be used to duplicate one or more signals for processing in the TRMs

- Position the tape to a footage corresponding to a known TOT
- Set ROT on the UUT to a time in advance of the above TOT.
- Start Play at a ROT calculated to allow for the deck acceleration time.
- Enable servoing
- Start a scan with a delay of 400 samples.
- Get error statistics at regular intervals.

Capture two outputs on the logic analyser and check bit alignment.

PASS	FAIL

Using invert and add facilities of the oscilloscope confirm that, barring errors and the header, all signals are identical.

PASS	FAIL

Disturb the transfer by stopping the tape briefly and by pulling the connection to the DPU head signals. Confirm that Tape servo operates to recover alignment and that de-skew is lost and then restored .

PASS	FAIL

3.8 Track Recovery Error Handling and Reporting

3.8.1 Error Statistics

Objective:

Using the DPU and the MkIV test tape running at 18 Mbit/s (9Mbit/s if the “Turbo DQA is not available), the SU status messages should confirm the playback quality that can be derived by playing the same tape into the DQA.

Method:

On completion of test 3.7 examine the **DATAn.RCV** files and confirm that error statistics agree with those measured using the MkIII DQA.

PASS	FAIL

3.8.2 Demonstration of SU Performance with High Error Rates

Objective

To demonstrate the ability of the SU to continue to process data reliably when parity error rates from tape are of the order of 1 in 10E3.

This test way be omitted if error rates in the previous test already exceed this level.

Method

Disconnect the SU RS-232 line to the DPU and substitute a dumb terminal or a PC running Telix for manual MCB control.

Monitor PER using the DQA and play the tape.

Using MCB command W_C7_nnnn move the headstack a small distance and check the PER which should degrade.

Re connect the SU serial DPU control and repeat test 3.7

Repeat in several slightly-off-track situations; error rates should remain more or less commensurate with the Mark3 decoder in almost any case up to at least 1.e-3 error rates.

PASS	FAIL

3.9 Data Modulation Mode

Objective:

To show that the SU can de-modulate a modulated recording.

Method:

Connect a logic analyser to DMM: Sign, Magnitude and Validity outputs as required.

Run \DT18M\DEMOD\SELMOD.BAT to switch demodulation OFF

Run \DT18M\DEMOD\INIT.BAT to prepare the DPU for 18Mbit/s replay of Pass 5.

Run \DT18M\DEMOD\DEMOD.BAT to run De-skew on pass 5.

Capture the DMM output on the logic analyser several times and confirm that the data pattern is de-skewed and the same on every frame. Locate the data immediately following the track frame header and confirm that these are the known pattern recorded by the VLBA formatter.

PASS	FAIL

Run \DT18M\DEMOD\SELMOD.BAT to switch demodulation ON

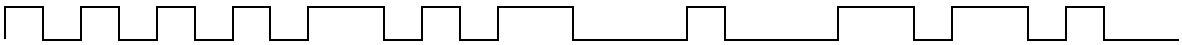
Run \DT18M\DEMOD\DEMOD.BAT to run De-skew on pass 5.

Capture the DMM output on the logic analyser several times and confirm that the data pattern is de-skewed and the same on every frame. Locate the data immediately following the track frame header and confirm that these are the XOR of the recorded pattern and the required demodulation sequence.

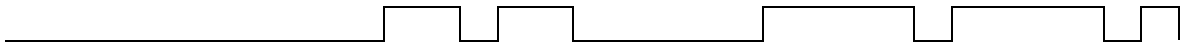
PASS	FAIL

Demod OFF

Demod ON



Demodulation applied



3.10 Non Data Replacement Mode

Objective:

To show that the SU can de-modulate a modulated VLBA recording.

Method:

Run \DT18MV\DESKEW\SELMOD.BAT to switch demodulation OFF

Run \DT18MV\DESKEW\INIT.BAT to prepare the DPU for 18Mbit/s replay of Pass 7.

Run \DT18MV\DESKEW\DESKEW.BAT to run De-skew on pass 7.

On the logic analyser capture the nominal junction between two consecutive frames.

Confirm that the data correctly match the start and finish of the known pseudo random sequence.

PASS	FAIL

Run \DT18MV \DESKEW\SELMOD.BAT to switch demodulation ON

Run \DT18MV\DESKEW \ DESKEW.BAT to run De-skew on pass 7.

Confirm that all-zero data are recovered.

PASS	FAIL

3.11 Channel Recovery Tests

These tests check the Mux/Demux modes of the SU.

Fan-out modes (i.e. one channel to several tracks) are tested at the maximum possible data rate.

Fan-in modes (i.e. several channels to one track) are tested at the minimum possible data rate.

In all tests the SU is configured for:

- No barrel roll.
- No cross track parity
- Two bit data
- Fixed delays

3.11.1 MkIV 1:4 Fan-Out Mode

Objective:

To show that The SU can recombine four tracks into a single channel.

Method:

Run \RT09M\MUX1_4\INIT.BAT to prepare the DPU for 9Mbit/s replay of Pass 1.

Run \RT09M\MUX1_4\SELTRAKS.BAT to set no tracks to logic 0

Run \RT09M\MUX1_4\MUX1_4.BAT to:

- Duplicate two tracks 32 times in the CRM and pair these off as sign and magnitude bits for two bit mode
- Configure the SU for 4 tracks to 1 channel multiplexing. Allocate all 64 tracks in this way to create 8 Channels.
- Run a scan at 9Mbit/s per track

Note: Only even numbered channels are valid in this mode.

Monitor the DMM outputs on the logic analyser. Confirm that the duration of all marks and all spaces are multiples of four bits.

PASS	FAIL

Run \RT09M\MUX1_4\SELTRAKS.BAT to set one of the four sign tracks to a constant logic 0.

Monitor the DMM output on the logic analyser. Confirm that the correct bit in the cycle of four multiplexed bits is now a zero. Repeat as necessary to confirm correct mutliplexing sequence and correct generation of the validity bit in two bit mode.

PASS	FAIL

3.11.2 MkIV 1:2 Fan-Out Mode

Objective:

To show that The SU can recombine two tracks into a single channel.

Method:

Run \DT18M\MUX1_2\INIT.BAT to prepare the DPU for 18Mbit/s replay of Pass 1.

Run \DT18M\MUX1_2\SELTRAKS.BAT to set no tracks to logic 0

Run \DT18M\MUX1_2\MUX1_2.BAT to:

- Duplicate two tracks 32 times in the CRM and pair these off as sign and magnitude bits for two bit mode
- Configure the SU for 2 tracks to 1 channel multiplexing. Allocate all 64 tracks in this way to create 16 Channels.
- Run a scan at 18Mbit/s per track

Monitor the DMM output on the logic analyser. Confirm that the duration of all marks and all spaces are even numbers of bits.

PASS	FAIL

Run \DT18M\MUX1_2\SELTRAKS.BAT to set one of the two sign tracks to a constant logic 0.

Monitor the DMM output on the logic analyser. Confirm that the correct bit in each pair is now a zero.

PASS	FAIL

3.11.3 MkIV 2:1 Fan-In Mode

Objective:

To show that The SU can decompose one track into two channels.

Method:

Run \HT045M\MUX2_1\INIT.BAT to prepare the DPU for 4.5Mbit/s replay of Pass 1.

Run \HT045M\MUX2_1\MUX2_1.BAT to:

- Configure the SU for 1 track to 2 channel de-multiplexing
- Run a scan at 4.5Mbit/s per track

Capture a Track Frame Header on the logic analyser. Confirm that the header data are correctly decomposed into the two channels.

PASS	FAIL

3.11.4 MkIV 4:1 Fan-In Mode

Objective:

To show that The SU can decompose one track into four channels.

Method:

Run \RT09M\MUX4_1\INIT.BAT to prepare the DPU for 9Mbit/s replay of Pass 1.

Run \RT09M\MUX4_1\MUX4_1.BAT to:

- Configure the SU for 1 track to 4 channel de-multiplexing
- Run a scan at 9Mbit/s per track

Capture a Track Frame Header on the logic analyser. Confirm that the header data are correctly decomposed into the four channels.

PASS	FAIL

3.11.5 VLBA Mux Modes

Objective:

Using the VLBA modulated zeros recording repeat test **3.11.1**

Method:

Procedure as **3.11.1** using:

\RT09MV\MUX1_4\INIT.BAT to prepare the DPU for 9Mbit/s replay of Pass 7.

\RT09MV\MUX1_4\SELTRAKS.BAT to set tracks to logic 0 as required.

\RT09MV\MUX1_4\MUX1_4.BAT to run the test.

Note: Only even numbered channels are valid in this mode.

PASS	FAIL

3.11.6 Barrel Roll

Objective:

To demonstrate correct operation of Barrel roll.

Method:

Run \DT18M\BARREL\INIT.BAT to prepare the DPU for 18Mbit/s replay of Pass 3.

Run \DT18M\ BARREL \ BARREL.BAT to load the Barrel roll table and run deskew as follows:

- No cross track parity.
- Two bit data.
- Mark IV Formatter Fan-Out Mode 1:1.

Capture headers on the logic analyser and confirm correct operation of the de-barrel roll by manually checking that the correct logical tracks appear on the correct Channel outputs.

PASS	FAIL

(Note: This test can be done with a non rolled MkIV tape with valid track idents in the Auxiliary field. Capture headers on the logic analyser and confirm correct operation of the de-barrel roll by manually checking for the correct sequence of logical tracks on any of the output channels.)

3.11.7 Track Regeneration (XTrack Parity)

Function not required. Test deleted

3.12 Delay Control

Objective:

Delay control is checked by setting delay parameters for one channel and comparing this with another channel with zero delays. Polynomials are selected to give zero offset between the two channels at a specific BOCF.

Method:

Run \DT18M\DELAY\INIT.BAT to prepare the DPU for 18Mbit/s replay of Pass 1.

Run \DT18M\DELAY\DELAY.BAT to configure the SU and start a scan as in test 3.7 but this time with the following delay parameters:

Channels 0,1,3,5,7,9,13,15:	Zero delays - used as reference
Channel 2:	Initial offset -40 samples Dynamic delay +10 samples per second
Channel 4:	Initial offset +40 samples Dynamic delay -10 samples per second
Channel 6:	Initial offset -400 samples Dynamic delay +100 samples per second
Channel 8:	Initial offset +400 samples Dynamic delay -100 samples per second
Channel 10:	Initial offset -428 samples Dynamic delay +32 samples per second
Channel 11:	Initial offset -300 samples Dynamic delay +0 samples per second
Channel 12:	Initial offset -236 samples Dynamic delay -16 samples per second
Channel 14:	Initial offset -656 samples Dynamic delay +64 samples per second

Programme the analyser to commence its trace on the 2nd SYSTICK after start of scan.

Adjust the analyser to view data captured immediately after the BOCF pulse.

Confirm that the traces for Channels 0,1,2,3,4,5,6,7,8,9,13,15 show identical and aligned data.

Adjust the analyser to view data captured 200-400 samples before the BOCF pulse.

Confirm that the traces for Channels 10,11,12 show identical and aligned data with a track frame header commencing at BOCF-300 samples.

Confirm also that Channel 14 shows the same data and track frame header at BOCF-400 samples.

PASS	FAIL

Note: preserve the logic analyser trace for the following test.

3.13 BOCF Header Generation

Objective:

To check the detail of the BOCF header

Method:

Inspect the BOCF header captured in the previous test and confirm that it conforms to the structure:-

- short int identity;

  ```
  /*bits 15..11: SU ID# (0-31)*/
  /*bits 10..06: channel ID# (0-31)*/
  /*bits 05..00: reserved for future use*/
  ```

- short unsigned frame_serial_num;

  ```
  /* incremental serial# for this correlator frame  */
  ```

- long int delay_error;

  ```
  /* initial delay error, in fractional samples (*2^32)*/
  ```

- long int delay_error_rate;

  ```
  /*initial delay error rate, in samples / sample (*2^32) */
  ```

- long int phase;

  ```
  /*initial phase, in rotations (*2^32) */
  ```

- long int phase_rate;

  ```
  /*initial phase rate, in rotations / k samples (*2^32) */
  ```

- long int phase_acc;

  ```
  /*initial phase acceleration, in rots/ k*n samp^2 (*2^32) */
  ```

- long int phase_periods;

  ```
  /*bits 31..27: unused                          */
  /*bits 26..24: k -- log2 of phase inc. period  */
  /*bits 23..00: n -- const. acc. segment length */
  ```

- short unsigned checkword;

  ```
  /* exclusive-or product of previous 14 unsigned words, */
  /* then exclusive or'ed with 0xAE51                    */
  ```

The SU ID# set should be 4, the frame serial number should be as calculated and channel number is as per the inspected channel.

PASS	FAIL

3.14 SUIM Interface

The SUIM will be present and operational in all of the forgoing tests and correct operation of the SU interface to this board is thereby implied.

The test signal paths have been verified during the DIM routing tests.

The Clock and astronomical data signal paths are checked during the Delay Module tests.

PASS	FAIL

3.15 Phase Calibration Module (PCM)

Phase Cal Module not available.

All other tests to be performed with a prototype PCM installed to provide representative loading of the VME and Data busses.

Appendix A Test result examples

Fig 3.4.1 DPU Footage Reading

READ-30A.RSP

```
0x00000100 ....
0x00000001 ....
0x00000001 ....
0xC8070000 ....
0x00000001 ....
0x00003901 ..9.
0x00000001 ....
0x00000000 ....
0x00000000 ....
0x00000000 ....
0x00000000 ....
0x00000000 ....
0x00000000 ....
0x00000058 ...X
0x00070300 ....
0x03020002 ....
0x03020002 ....
0x53554944 SUID
0x33300A00 30..
0x00000000 ....
0x30333538 0358     <---- Footage: Hex value in ASCII
0x0A000000 ....
```

Measurement attempted at displayed footage of 850’

358 hex = 856 dec.

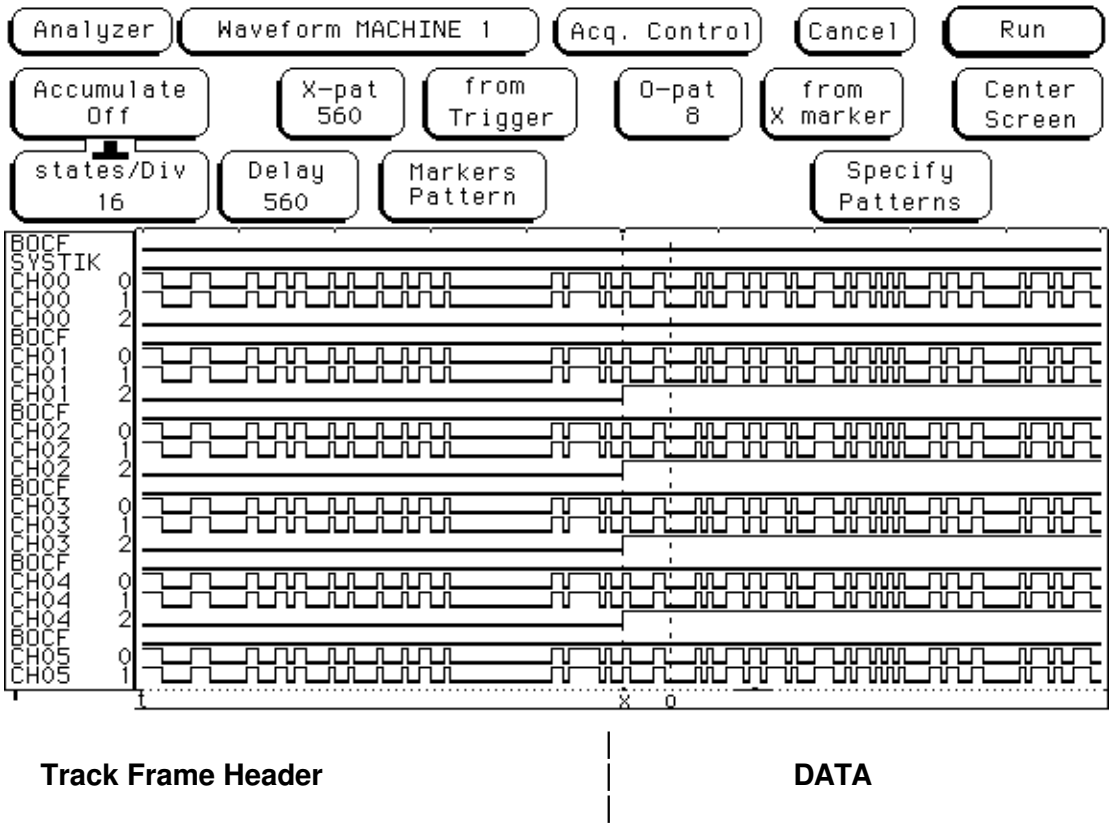
Fig 3.5.1 Routing

TR	Status				Timecode							ID	Other Aux					
00	00	00	e0	e0	63	61	21	06	06	23	73	7d	02	42	42	71	71	ff	05
01	00	00	e0	e0	63	61	21	06	06	61	76	4b	04	42	42	71	71	ff	05
02	00	00	e0	e0	63	61	21	06	06	98	06	3c	06	42	42	71	71	ff	05
03	00	00	e0	e0	63	61	21	06	07	34	7e	f5	08	42	42	71	71	ff	05
04	00	00	e0	e0	63	61	21	06	07	67	06	ef	0a	42	42	71	71	ff	05
05	00	00	e0	e0	63	61	21	06	08	01	5e	88	0c	42	42	71	71	ff	05
06	00	00	e0	e0	63	61	21	06	08	34	01	5d	0e	42	42	71	71	ff	05
07	02	00	e0	e0	63	61	21	06	08	69	59	bf	10	42	42	71	71	ff	05
08	00	00	e0	e0	63	61	21	06	09	02	72	cc	12	42	42	71	71	ff	05
09	00	00	e0	e0	63	61	21	06	09	35	2b	e3	14	42	42	71	71	ff	05
0a	00	00	e0	e0	63	61	21	06	09	70	02	1e	16	42	42	71	71	ff	05
0b	00	00	e0	e0	63	61	21	06	10	02	20	66	18	42	42	71	71	ff	05
0c	00	00	e0	e0	63	61	21	06	10	34	7e	53	1a	42	42	71	71	ff	05
0d	00	00	e0	e0	63	61	21	06	10	67	59	d4	1c	42	42	71	71	ff	05
0e	00	00	e0	e0	63	61	21	06	11	03	74	c7	1e	42	42	71	71	ff	05
0f	00	00	e0	e0	63	61	21	06	11	36	28	f5	20	42	42	71	71	ff	05
10	00	00	e0	e0	63	61	21	06	11	70	55	01	02	42	42	71	71	ff	05
11	00	00	e0	e0	63	61	21	06	12	01	2f	27	04	42	42	71	71	ff	05
12	00	00	e0	e0	63	61	21	06	12	38	0f	41	06	42	42	71	71	ff	05
13	00	00	e0	e0	63	61	21	06	12	71	79	d0	08	42	42	71	71	ff	05
14	00	00	e0	e0	63	61	21	06	13	02	75	b2	0a	42	42	71	71	ff	05
15	00	00	e0	e0	63	61	21	06	13	35	2c	9d	0c	42	42	71	71	ff	05
16	00	00	e0	e0	63	61	21	06	13	70	7d	53	0e	42	42	71	71	ff	05
17	00	00	e0	e0	63	61	21	06	14	04	05	d3	10	42	42	71	71	ff	05
18	00	00	e0	e0	63	61	21	06	14	36	51	63	12	42	42	71	71	ff	05
19	00	00	e0	e0	63	61	21	06	14	69	21	46	14	42	42	71	71	ff	05
1a	00	00	e0	e0	63	61	21	06	15	04	09	f5	16	42	42	71	71	ff	05
1b	00	00	e0	e0	63	61	21	06	15	36	2d	b8	18	42	42	71	71	ff	05
1c	00	00	e0	e0	63	61	21	06	15	68	72	96	1a	42	42	71	71	ff	05
1d	00	00	e0	e0	63	61	21	06	16	01	2f	a1	1c	42	42	71	71	ff	05
1e	00	00	e0	e0	63	61	21	06	16	36	01	02	1e	42	42	71	71	ff	05
1f	00	00	e0	e0	63	61	21	06	16	68	5d	cb	20	42	42	71	71	ff	05
20	00	00	e0	e0	63	61	21	06	17	01	07	e9	03	42	42	71	71	ff	05
21	00	00	e0	e0	63	61	21	06	17	35	77	37	05	42	42	71	71	ff	05
22	00	00	e0	e0	63	61	21	06	17	66	27	3c	07	42	42	71	71	ff	05
23	00	00	e0	e0	63	61	21	06	17	99	0c	67	09	42	42	71	71	ff	05
24	00	00	e0	e0	63	61	21	06	18	31	55	49	0b	42	42	71	71	ff	05
25	00	00	e0	e0	63	61	21	06	18	65	29	89	0d	42	42	71	71	ff	05
26	00	00	e0	e0	63	61	21	06	18	98	53	7b	0f	42	42	71	71	ff	05
27	00	00	e0	e0	63	61	21	06	19	35	05	e4	11	42	42	71	71	ff	05
28	00	00	e0	e0	63	61	21	06	19	68	73	3b	13	42	42	71	71	ff	05
29	00	00	e0	e0	63	61	21	06	20	01	58	57	15	42	42	71	71	ff	05
2a	00	00	e0	e0	63	61	21	06	20	34	07	82	17	42	42	71	71	ff	05
2b	00	00	e0	e0	63	61	21	06	20	70	06	05	19	42	42	71	71	ff	05
2c	00	00	e0	e0	63	61	21	06	21	07	50	c0	1b	42	42	71	71	ff	05
2d	00	00	e0	e0	63	61	21	06	21	40	57	d6	1d	42	42	71	71	ff	05
2e	00	00	e0	e0	63	61	21	06	21	73	23	d2	1f	42	42	71	71	ff	05
2f	00	00	e0	e0	63	61	21	06	22	06	77	38	21	42	42	71	71	ff	05
30	00	00	e0	e0	63	61	21	06	22	39	51	55	03	42	42	71	71	ff	05
31	00	00	e0	e0	63	61	21	06	22	72	01	e1	05	42	42	71	71	ff	05
32	00	00	e0	e0	63	61	21	06	23	04	77	90	07	42	42	71	71	ff	05
33	00	00	e0	e0	63	61	21	06	23	38	75	09	09	42	42	71	71	ff	05
34	00	00	e0	e0	63	61	21	06	23	69	7c	65	0b	42	42	71	71	ff	05
35	02	00	e0	e0	63	61	21	06	24	06	03	96	0d	42	42	71	71	ff	05
36	00	00	e0	e0	63	61	21	06	24	42	5a	fd	0f	42	42	71	71	ff	05
37	00	00	e0	e0	63	61	21	06	24	75	0a	41	11	42	42	71	71	ff	05
38	00	00	e0	e0	63	61	21	06	25	07	76	b5	13	42	42	71	71	ff	05
39	00	00	e0	e0	63	61	21	06	25	43	58	52	15	42	42	71	71	ff	05
3a	00	00	e0	e0	63	61	21	06	25	78	09	42	17	42	42	71	71	ff	05
3b	00	00	e0	e0	63	61	21	06	26	11	7b	15	19	42	42	71	71	ff	05
3c	00	00	e0	e0	63	61	21	06	26	45	20	7b	1b	42	42	71	71	ff	05
3d	00	00	e0	e0	63	61	21	06	26	79	5d	a0	1d	42	42	71	71	ff	05
3e	00	00	e0	e0	63	61	21	06	27	14	0d	20	1f	42	42	71	71	ff	05
3f	00	00	e0	e0	63	61	21	06	27	46	2e	5a	21	42	42	71	71	ff	05

Fig 3.6 POSTOT

```
0x00000100 ....
0x0000004A ...J
0x00000001 ....
0xC8070000 ....
0x00000001 ....
0x00003901 ..9.
0x00000001 ....
0x00000000 ....
0x00000000 ....
0x00000000 ....
0x00000000 ....
0x00000000 ....
0x00000000 ....
0x00000054 ...T
0x00070300 ....
0x03000007 ....
0x03000007 ....
0x53554944 SUID
0x0000079E ....        <---- Footage
0x430C5BA8 C.[.        <---- Timecode
0x497CB000 I|..        <---- Timecode


TOT Found:             361:21:06:30.99
@Footage:              1950'
Parked @:              1724

Target TOT:            361:21:06:30.00
Footage of Target:     1950 - .99 X 160
                                  12

                       = 1936.8
Less backup              -213
                         1723.8
```

Fig 3.7 Data deskew



Random data in the DATA field should be identical and vertically aligned.

Fig 3.8.1 Average statistics printout

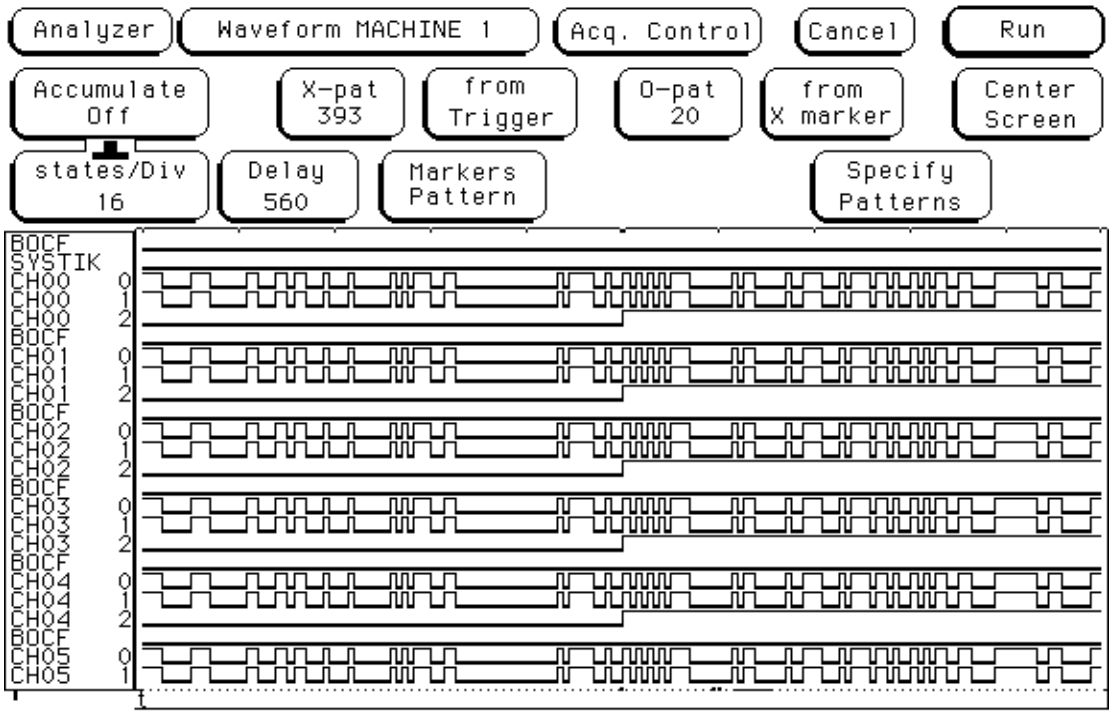
```
DATA11.RCV (PART OF)


           ...SNIP]
LINE 47    0x00000E81 ....    <---TRK 0 Detected Syncs
           0x0000BD74 ...t    <---TRK 0 Parity Errors
           0x00000001 ....    <---TRK 0 Unexpected Syncs
           0x00000000 ....    <---not used
           0x000007C6 ....    <---TRK 0 CRC Errors
           0x00000001 ....    <---TRK 0 Discarded Frames
           0x00000E6A ...j    <---TRK 1 Detected Syncs
           0x0000A978 ...x    <---TRK 1 Parity Errors
           0x00000004 ....    <---TRK 1 Unexpected Syncs
           0x00000000 ....    <---not used
           0x0000080C ....    <---TRK 1 CRC Errors
           0x00000004 ....    <---TRK 1 Discarded Frames
           0x00000E7F ....    etc.
           0x00009C54 ...T
           0x00000004 ....
           0x00000000 ....
           0x00000829 ...)
           0x00000003 ....
           0x00000E7C ...|
           0x00009BD4 ....
           0x00000003 ....
           0x00000000 ....
           0x00000845 ...E
           0x00000003 ....
```

Trk 0 Parity errors = BD74 = 48500 dec

10 second sample @ 9Mbit/s (ROT) = 4000 frames = 10Mbyte

PER = 4.85e-3

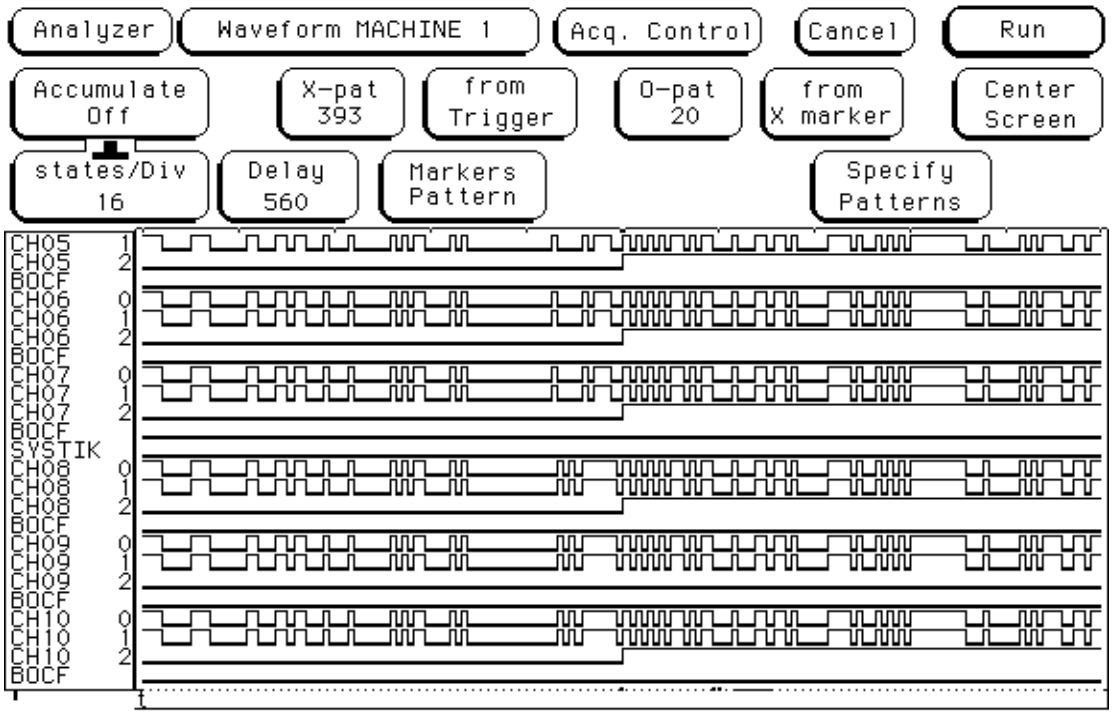
Fig 3.9a Demodulation MkIV - demod off



Track Frame Header | **DATA**

DATA should be identical to the above (bar errors)

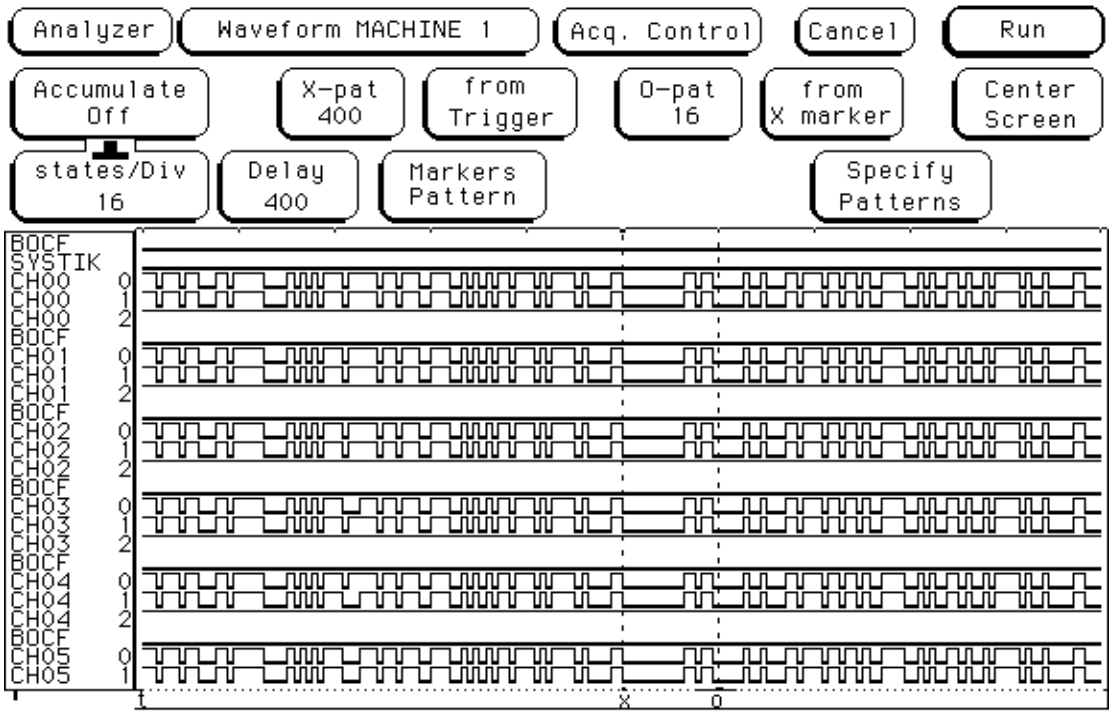
Fig 3.9b Demodulation MkIV - demod on



Track Frame Header | **DATA**

DATA should be identical to the above (bar errors)

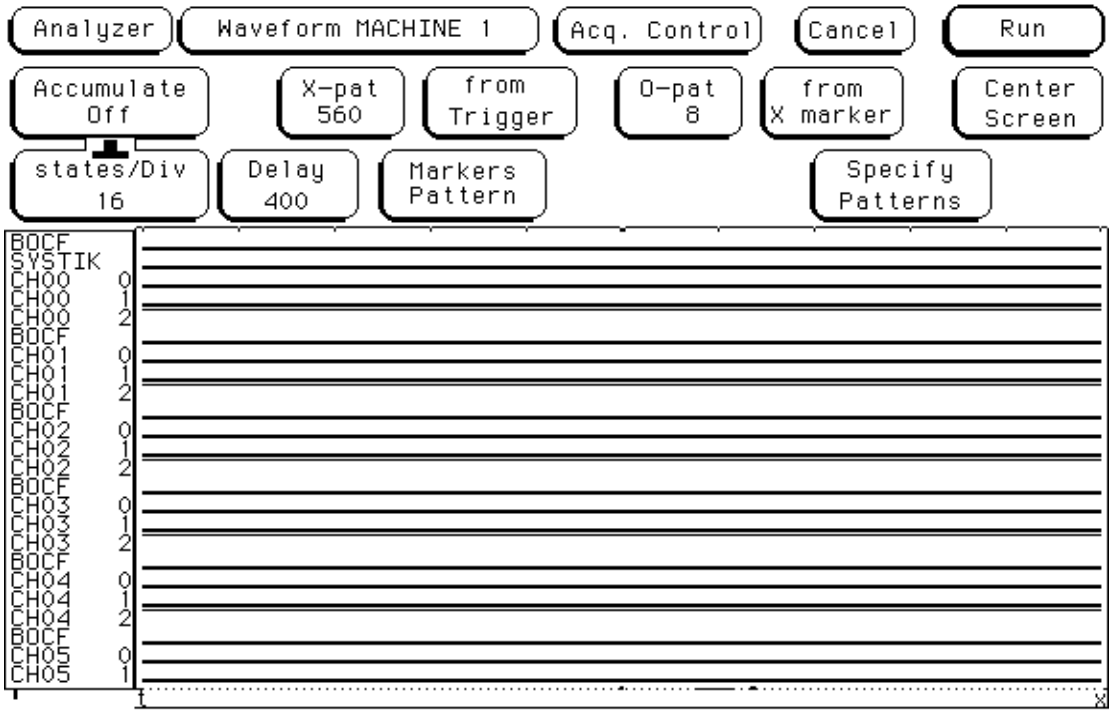
Fig 3.10a Demodulation VLBA - demod off



Junction of two frames ----------->

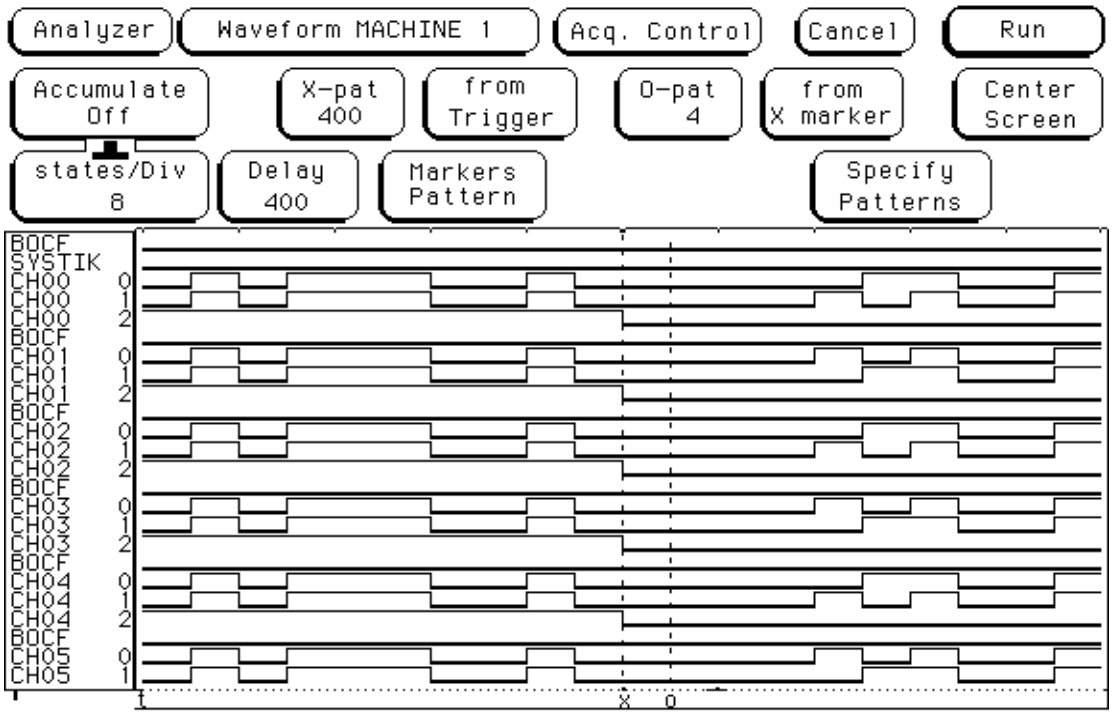
DATA should be identical to the above (bar errors)

Fig 3.10b Demodulation VLBA - demod on



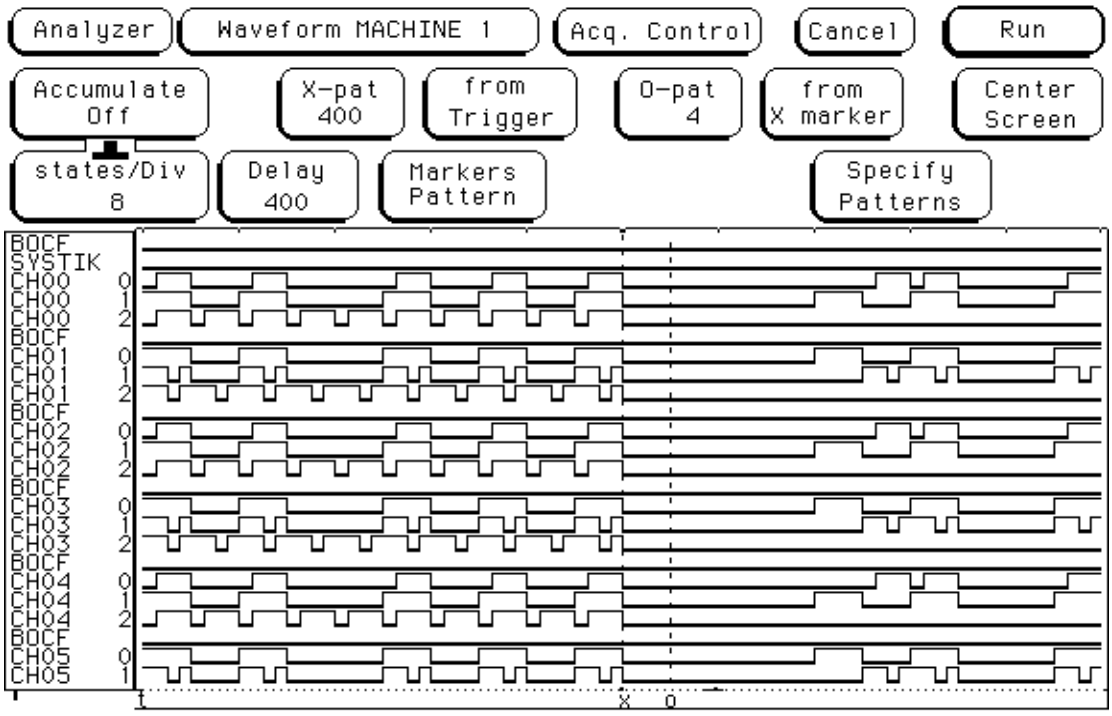
DATA should be identical to the above (bar errors)

Fig 3.11.1a Mux1_4 MkIV - all bits on



The length of every mark and every space should be a multiple of four samples.

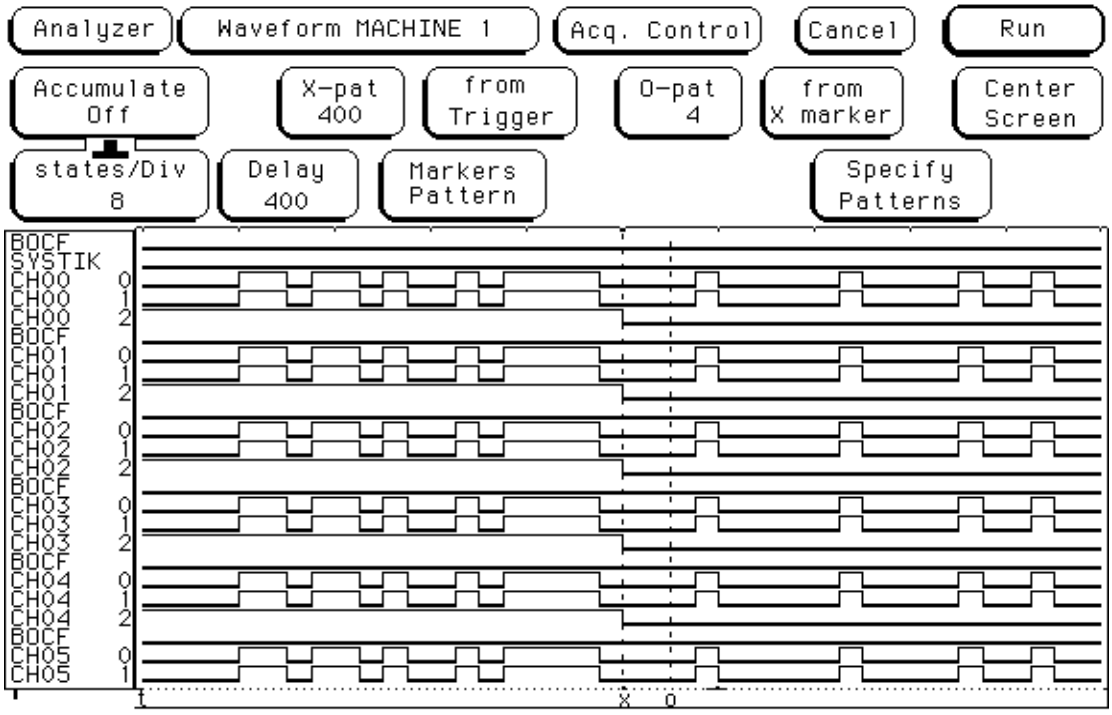
Fig 3.11.1b Mux1_4 MkIV - 1st bit set low



The first sign bit in every four bit group, and the corresponding validity, bit should be low.

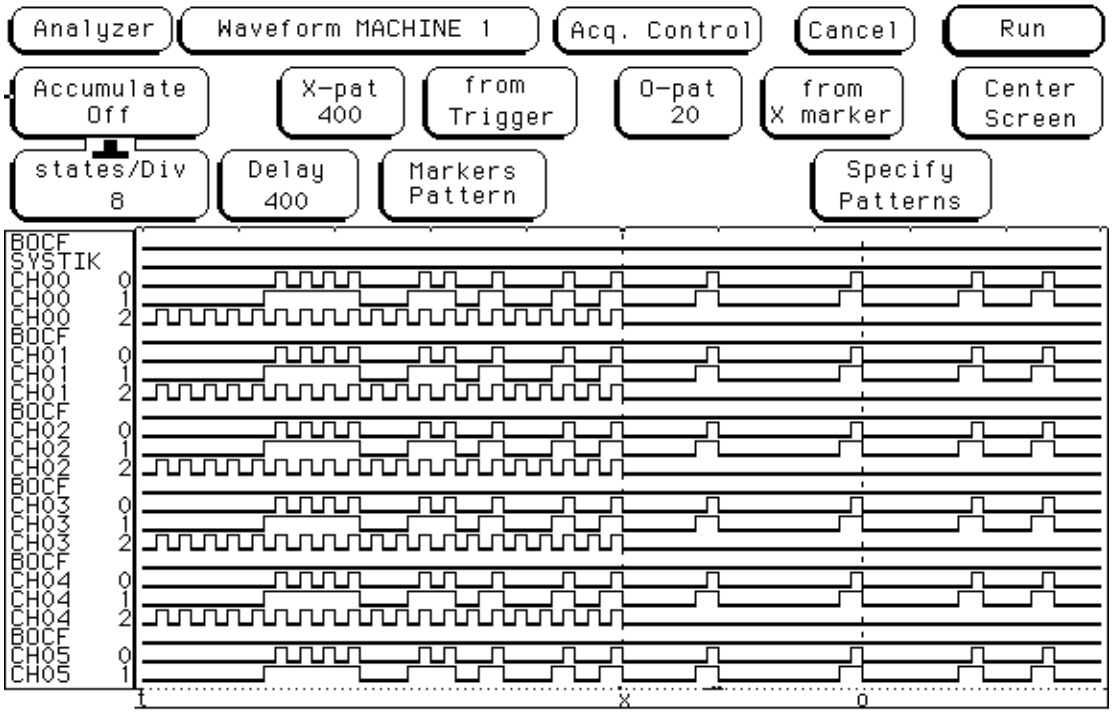
Note: Only even channels are valid in this mode

Fig 3.11.2a Mux1_2 MkIV - all bits on



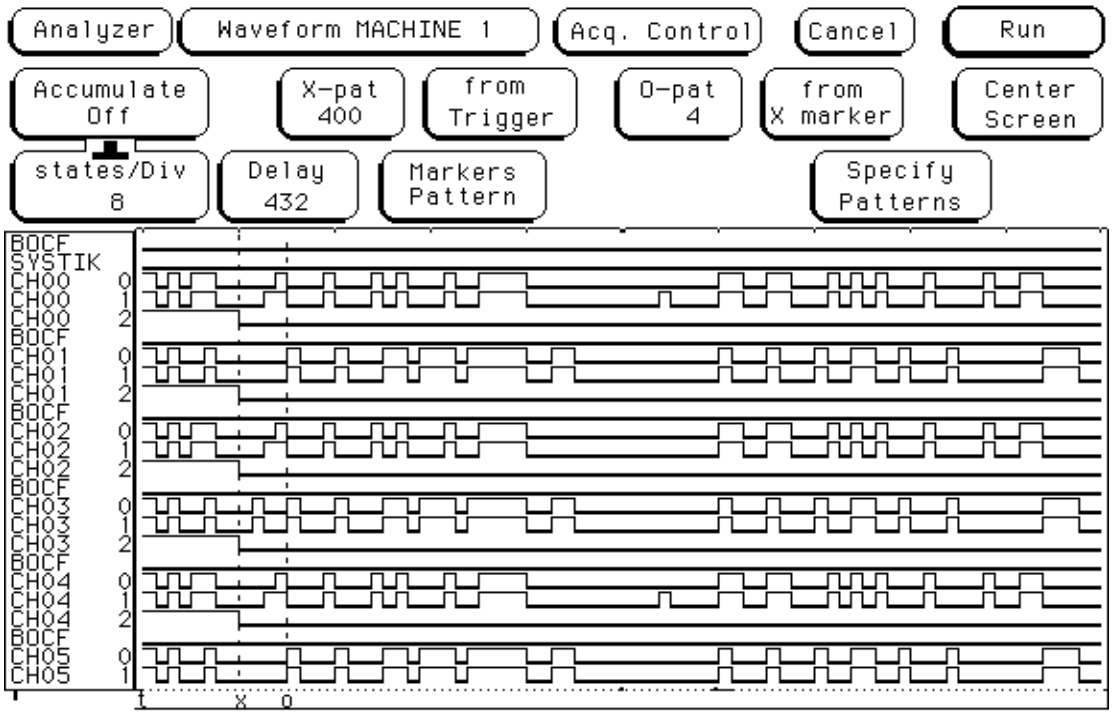
The length of every mark and every space should be an even number of samples.

Fig 3.11.2b Mux1_2 MkIV - 1st bit set low



The first sign bit in each pair, and the corresponding validity bit, should be low.

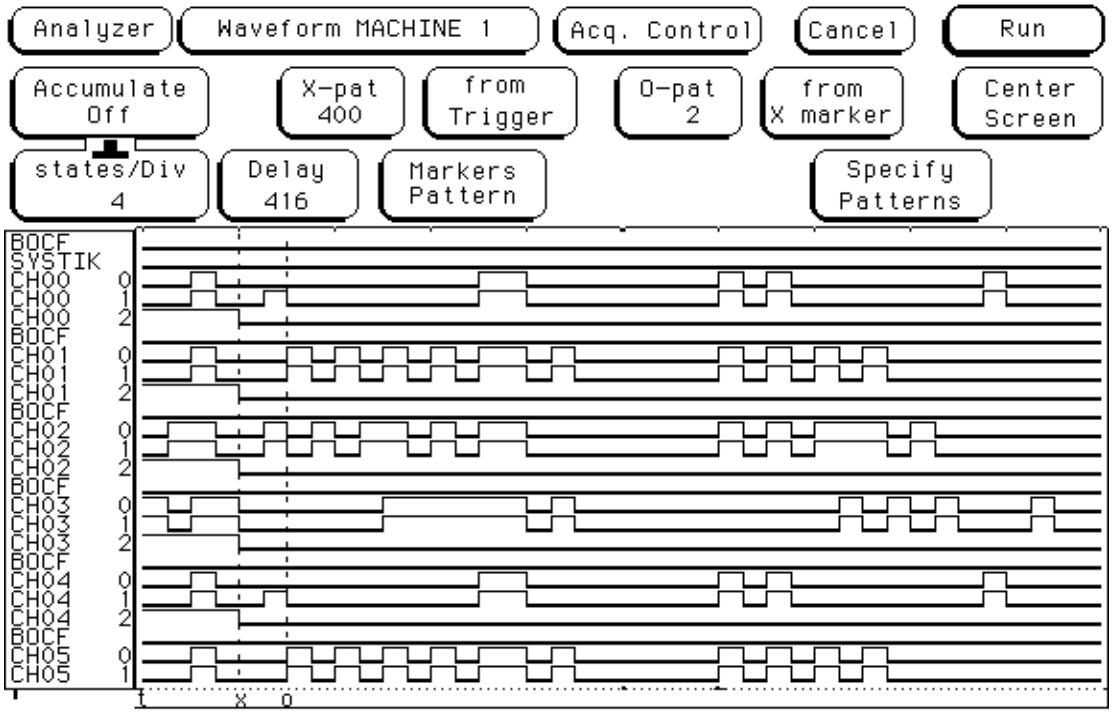
Fig 3.11.3 Mux2_1 MkIV



Check demultiplexed track ident (section x - o):

CH	Sign	Mag
0	00 01	00 11
1	00 00	00 00
	0 2	0 A

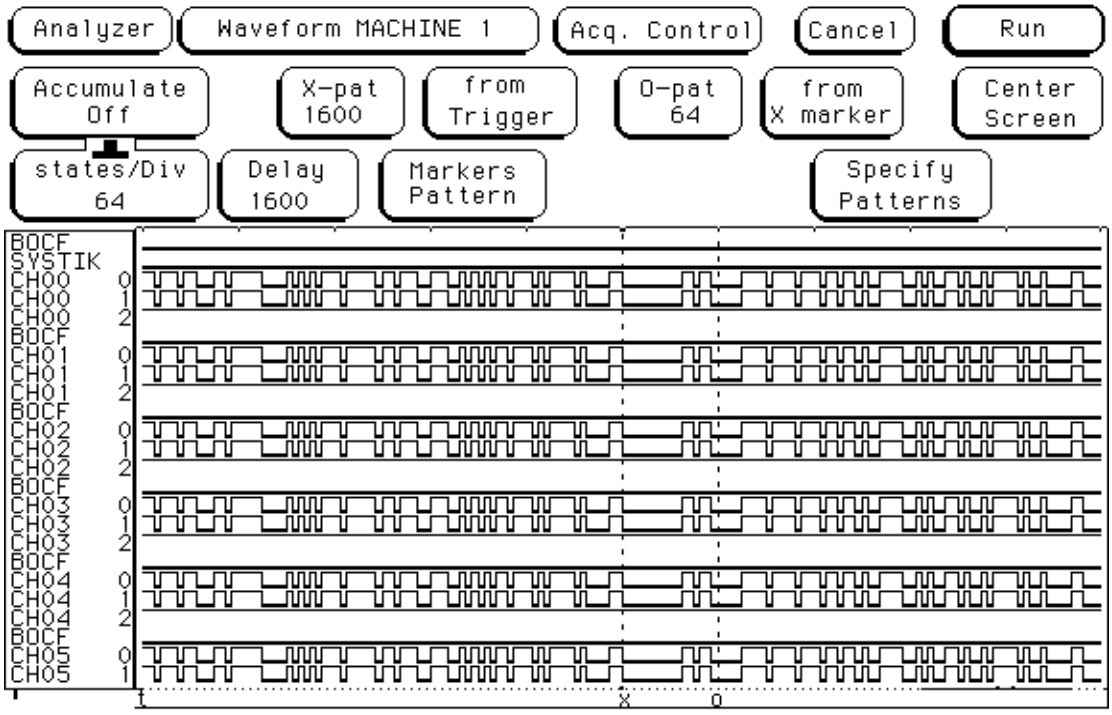
Fig 3.11.4 Mux4_1 MkIV



Check demultiplexed track ident (section x - o):

CH	Sign	Mag
0	00	01
1	00	00
2	01	01
3	00	00
	02	0A

Fig 3.11.5 Mux1_4 VLBA - all bits on



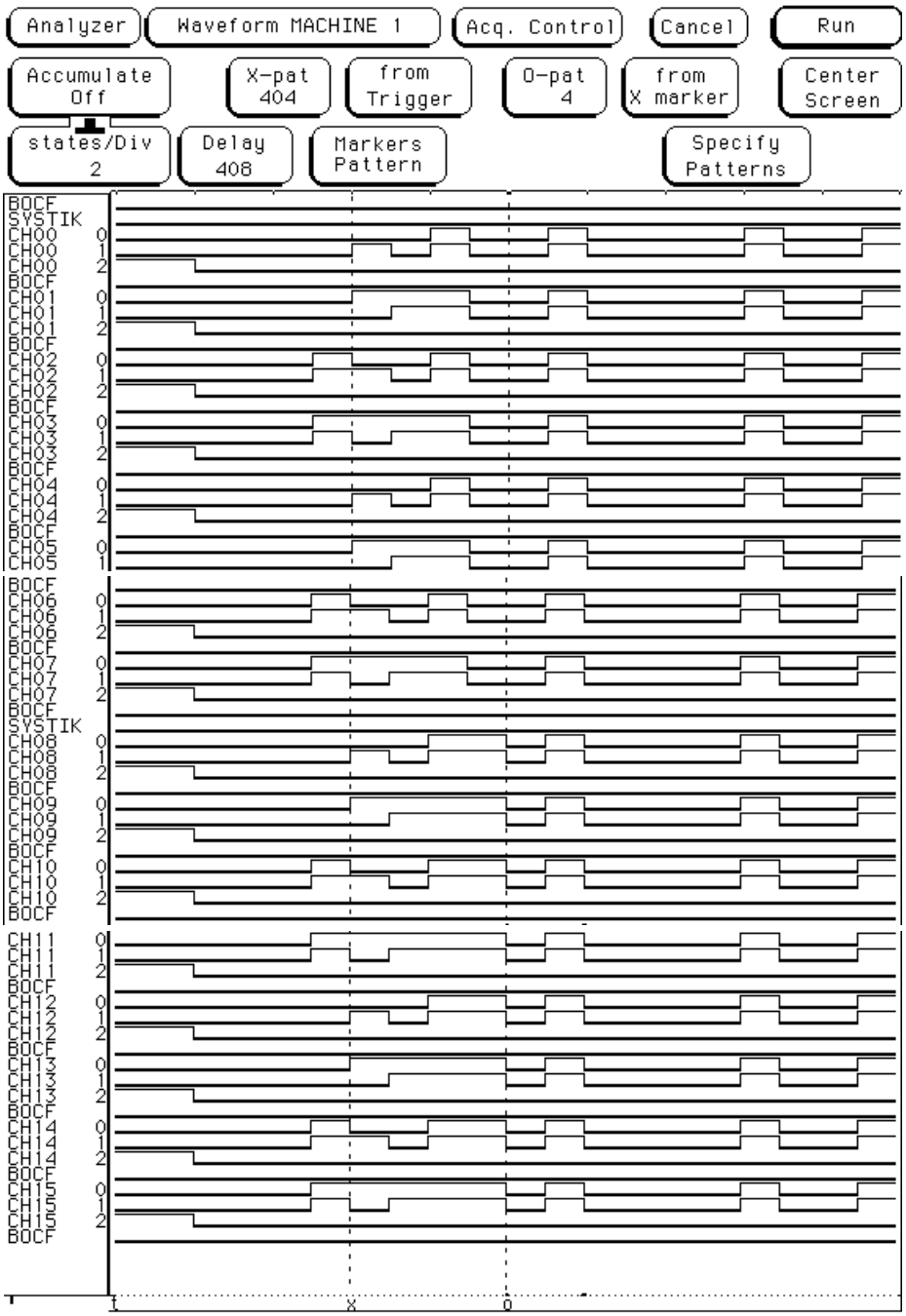
Junction of two frames ----------->

DATA should be identical to the above (bar errors)

(compare with 3.10a)

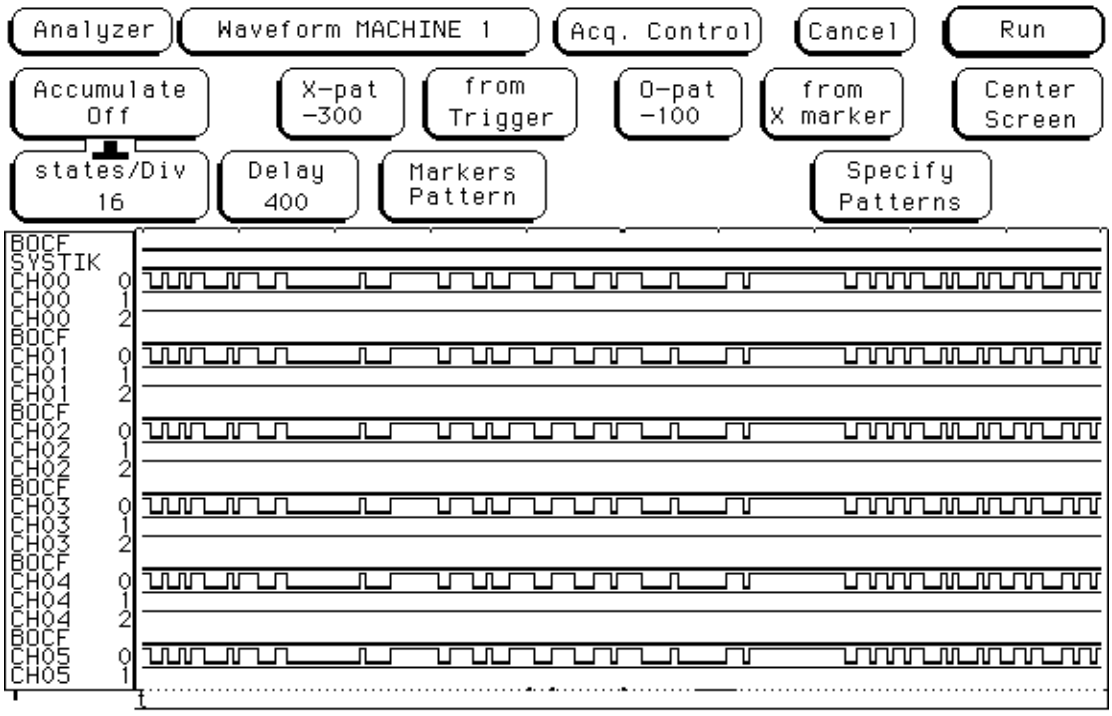
Expand trace and confirm that the length of any mark or space is a multiple of four.

Fig 3.11.6 Barrel Roll



CH/BIT	ID	CH/BIT	ID	CH/BIT	ID	CH/BIT	ID
0/0	02	4/0	02	8/0	03	12/0	03
0/1	0A	4/1	0A	8/1	0B	12/1	0B
1/0	0E	5/0	0E	9/0	0F	13/0	0F
1/1	06	5/1	06	9/1	07	13/1	07
2/0	12	6/0	12	10/0	13	14/0	13
2/1	1A	6/1	1A	10/1	1B	14/1	1B
3/0	1E	7/0	1E	11/0	1F	15/0	1F
3/1	16	7/1	16	11/1	17	15/1	17

Fig 3.12a Delays - Channels 0 to 9



Traces for channels 0 to 9 should be identical (0 to 5 shown).

Fig 3.12b Delays - Channels 10 to15

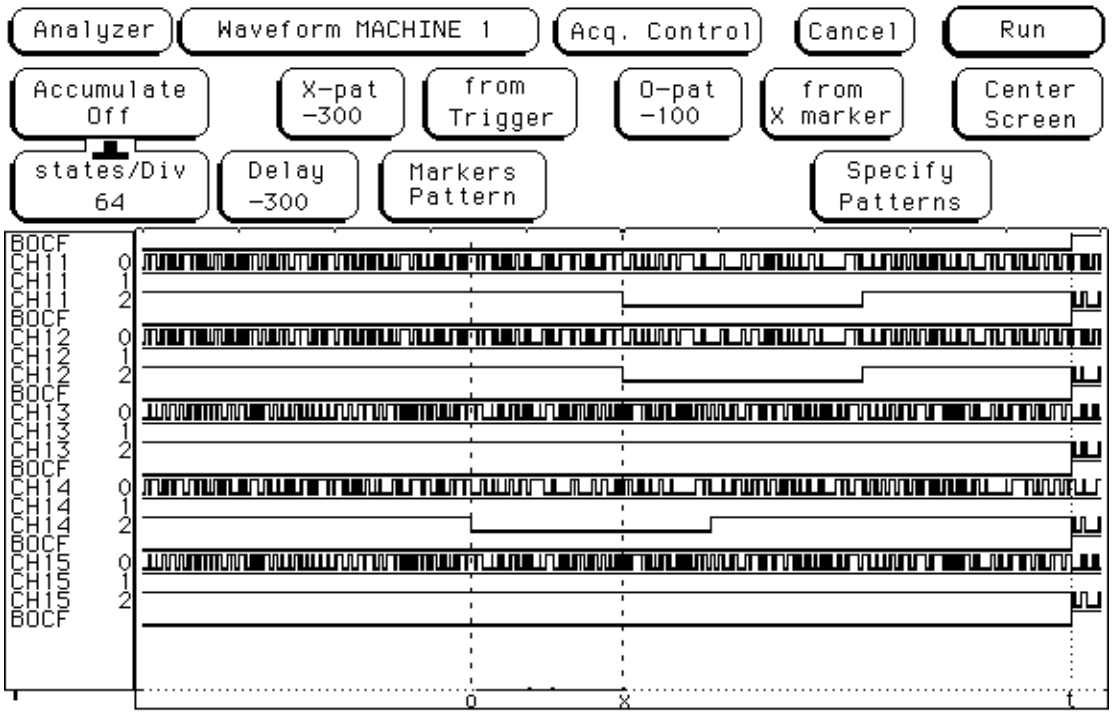
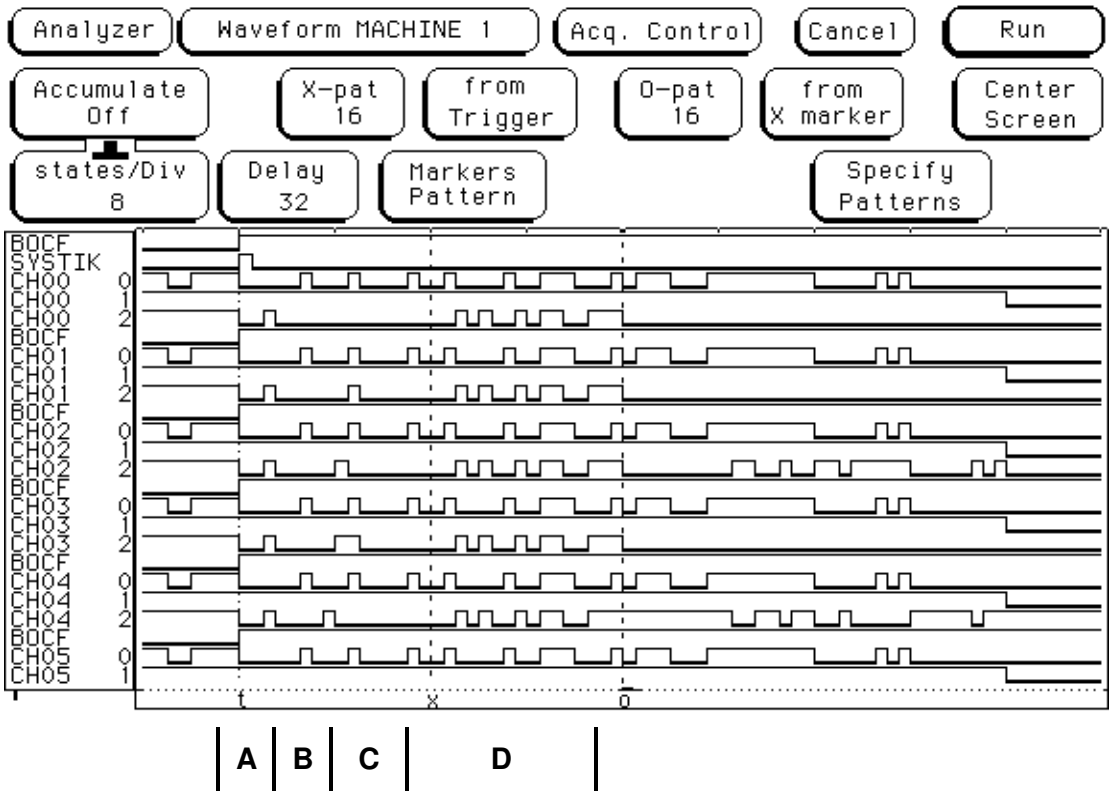


Fig 3.13a BOCF Header - SUID/Ch. No./CF Serial No.



e.g. Channel 3 (bit2, validity has the header))

A:-	SUID	5bits:	00100 = 4
B:-	Ch. No.	5bits:	00011 = 3
C:-	Reserved	6bits:	000000
D:-	CF Serial No.	16bits:	0010 1001 0110 0111 = 2967 hex = 10599 dec

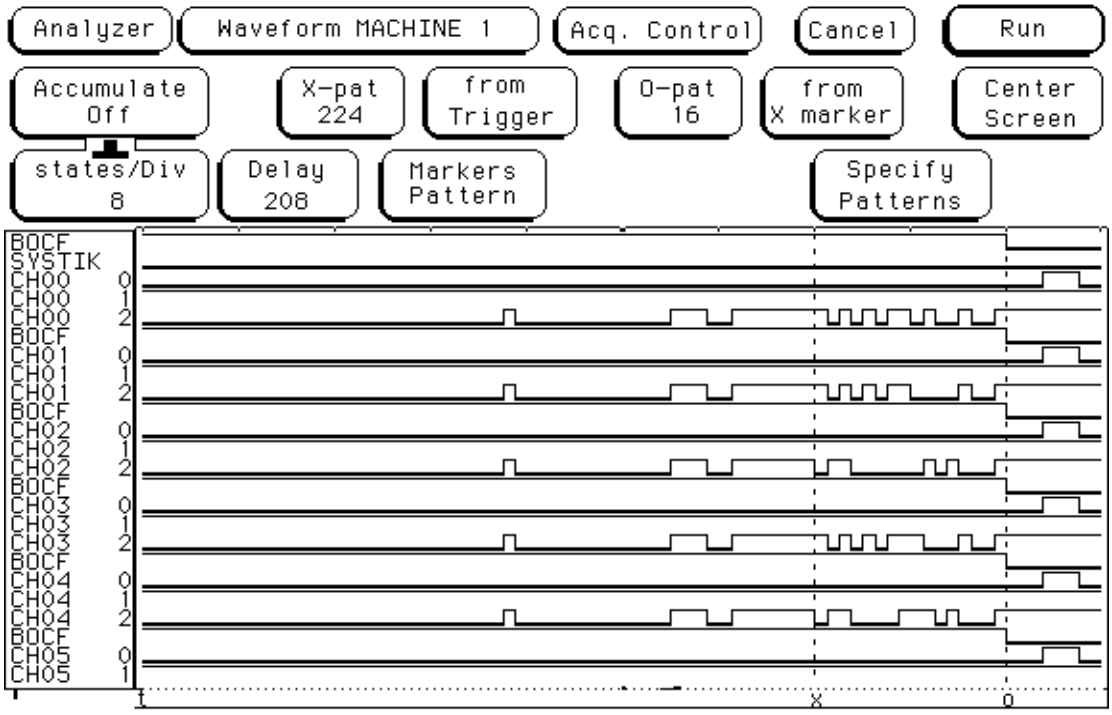
scan start time: 21:07:00

Corr. Frame Rate: 25/s

Trigger on 2nd SYSTICK = 4th BOCF

Therefore CF Serial No = 7 X 60 X 25 + 4 X 25 -1 = 10599

Fig 3.13b BOCF Header - Checksum Calculation



e.g. Channel 3 -> | 0 2 0 0 | 0 E 7 F | A B 8 9 |

SUID/Ch.No./Reserved (as hex):	**2 0 C 0**
Corr. Frame Serial No.:	**2 9 6 7**
Intervening bits all zero:	**0 0 0 0**
Last 4 bytes above:	**0 2 0 0**
	0 E 7 F
Check Sum:	**A B 8 9**
Exclusive OR:	**A E 5 1 = Valid Header**