VLBA Technical Report No. 14
REVISION B

Operation of the VLBA Tape Recorder at the VLA and the VLBA Sites

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November 1993

All previous versions of this document are obsolete.

CONTENTS

OPERATION OF THE VLBA TAPE RECORDER
at the VLA and the VLBA Sites

Introduction

The VLBA tape recorder is currently used to record data taking sessions in the MKIII and VLBA formats at the VLA and VLBA sites. In this report we will describe procedures for the site operator to follow when using the recorder. Figures 1 - 5 show the location and nomenclature of recorder parts.

The operator's functions are divided into the following categories:

1. Shipping and Receiving.
2. Cleaning the Tape Path.
3. Tape Mounting and Loading.
4. Prepassing Tapes.
5. Data Recording.

Some of the procedures require the use of SCREEN, a computer program used to monitor and command the antenna. SCREEN is accessed through a terminal connected to the Station Computer. In this document, menu selections and SCREEN commands are shown all in capital letters. Menu selections are named starting from the top menu selection; for example, TAPE/TDC means to move the cursor to TAPE on the top menu bar, ENTER, move the cursor to TDC on the TAPE menu bar, and ENTER. For additional information, select HELP from the top most menu bar. Refer to the Glossary at the back of the manual for more information on special terms.

If the operator finds the equipment does not operate as described, he should stop and seek assistance, and/or file a MAINT report.

Shipping and Receiving:

1. Keep unloaded tapes in the shipping canister or on a storage shelf. Store tapes vertically unless they are in their shipping canisters. Thin tapes must be stored with the reel band installed. Use only the special black reelband on thin tapes. Stacking tapes horizontally or excessive handling by the flange might damage a tape edge.

2. Use "zebra" tape to fasten down the tape end. Other tapes may be more likely to leave a sticky deposit which can distort the tape pack. Fold over one end of the zebra tape to form a "pull

tab", and attach this end to the magnetic tape end to simplify removing the zebra tape later. It is important to fasten down the magnetic tape end to help keep the tape pack from cinching during shipment. Even in the case of zebra tape, check the tape end for debris and clean it as necessary.

3. Wash hands before handling tape; never eat, drink, or smoke when handling tape.

4. On receipt, inspect the tape pack and reel for damage. If bumps, spokes, or bands are present in the tape pack, the tape may be damaged. For thin tape, if there is a visible gap between the tape pack and one of the reel flanges, it should be less than 10 mils. Some times prepassing can alleviate these problems. If after prepassing, the problems still exists, seek assistance.

5. Allow a few hours in the control room after shipment before using tapes. Moisture will condense on a cold tape and make it sticky, which increases friction with the head.

6. After recording, apply the label provided with the observing schedule. If the preprinted label is not available, attach a label specifying the station, wavelength, date/time range of the recorded date, and project code. Place a red dot over the green dot.

7. Label tape canister with the project code, and the tape number of the sequence (i.e. "Tape 1 of 5").

8. Use TRACK to receive and ship tape.

9. Install a reel band on thin tape before shipping. Use only the special black reel band. Thin tape may be shipped only in a 2" blue canister.

Cleaning the Tape Path:

1. Wash hands before handling tape; never eat, drink, or smoke when handling tape.

2. Use only high quality (190 Proof or better) isopropyl or denatured alcohol to clean the tape path. 91% alcohol is available from the VLA warehouse.

3. Use cotton swabs to clean the head, capstan, and idler (see Fig. 2). <u>Never dip a dirty swab into the bottle of alcohol</u>. Pouring a little alcohol into a separate container for each cleaning operation will help prevent the alcohol supply from becoming contaminated. Swabs and alcohol are available from the VLA warehouse.

4. Do not drip alcohol onto the magnetic tape or onto the inside of the reel flanges. It can remove the coating and cause tape layers to adhere. Swab should not be dripping wet; shake excess alcohol off before using.

5. Use a separate swab for the headstack. Use a wiping motion with minimal pressure perpendicular to the direction of tape motion for head cleaning. Clean only the tip plate and not the sides of the headstack, as the connections on the side can be broken with too much cleaning. Wipe from back to front only. Do not scrub. Frequent cleaning of the tape head maintains performance, but scratches or other damage to the highly polished precision surface can cause loss of output, so use only a clean moistened cotton swab saturated but not dripping.

6. Hold a wetted swab firmly against the capstan and turn the capstan by hand to insure a deep cleaning of all surfaces including the corners of the grooves. Continue cleaning until the swab comes clean. Do the same to the idler, though it is not possible to scrub as hard because of the abrasivity of the surface. Pick loose cotton fibers from the idler.

Whenever tape slips on the capstan or idler, the surface tends to become glazed; unprocessable off-speed recordings may result. Alcohol restores the grip of the polyurethane-impregnated surfaces.

7. Clean the optical tape loop sensor windows, all surfaces of the vacuum column, I/O rollers, guides and other surfaces in the tape path with alcohol; a lint free alcohol-soaked pad such as TexWipe will do. Use a cotton swab or an orange stick and TexWipe to clean out the corners between the precision plate and the "E" casting. TexWipes are available from the VLA warehouse. The sensor windows are only glued on, so avoid pressing hard on them. If a window comes loose, report on MAINT.

8. Remove any build-up of hard deposits in the tape edge contact regions of the precision plate and the front door using alcohol, a swab, and persistent scrubbing. The deposits can increase tape edge heating and damage the tape.

Tape Mounting and Loading:

1. Wash hands before handling tape; never eat, drink, or smoke while handling tape.

2. Turn on the Recorder power. Start the SCREEN Program. Select TAPE/TDC. This will bring up several tape screens and the cursor will be in a screen called "TAPE DRIVE CONTROL"; this screen is used to send commands to the tape recorder. To initialize the tape recorder after power up, enter the TDC Command INIT. If the vacuum motor is on, turn it off by entering the TDC Command VACUUM 0.

3. If the reels do not turn freely, enter the TDC Command RELEASE to release the reel brakes.

4. Be sure to install the reel firmly against the motor flange so that there is no wobble when the reel is rotating. A misaligned reel can cause excessive dragging of the tape against the reel flange and/or fold-over at the I/O rollers. Check for tightness of the reel on the hub; if the reel is loose, tighten the hub by holding the outside of the hub with one hand and turning the center of the hub clockwise using the tape release lever. A reel flying off the hub can do a lot of damage.

5. Fasten the tape to the hub of the glass take-up reel using static-cling. The cling may be developed by laying the tape end on the take-up reel hub and spinning the reel. Never allow a tape end to fold under when loading a tape. A bump on the take-up reel produced by a folded end propagates up through the whole pack and can damage the tape. If necessary, wet the end of the tape with a wet sponge. Do not spit on or lick the tape.

6. Be careful to thread the correct path without catching the tape on the triangular piece near the idler or inadvertently bypassing either I/O roller. If the edge of the magnetic tape protrudes past the "half moon" loading block at the mouth of the vacuum chamber, bump it toward the tape recorder with a tap of a clean finger. Careful double checking to make sure the tape is threaded properly will save tapes. As always, avoid contact between the tape surface and your fingers to prevent skin oils from attracting foreign particles to the tape.

7. Close the vacuum door firmly to insure it catches and that air does not leak between the door and the E castings, but do not slam. If the door is loose or is leaking, file a MAINT report.

8. The screen selections PREPASS or MOUNT are commonly used to load tape. If the recorder misoperates, check the PARM/RECPARM screen to be sure it contains values and enter TDC command INIT.

9. If there is any strange noise when the tape runs, stop operation immediately. Check the tape path and PARM/RECPARM. If the problem persists, seek assistance and/or file a MAINT report.

10. The vacuum should be 7.5" for thin tape and 15" for thick as displayed on the gauge inside the back door of the recorder cabinet and on the Tape Motion Screen. If the gauge is more than 1" off, do not run tape; notify the Recorder Group, and/or file a MAINT report. If the screen display disagrees with the gauge by more than 0.5", file a MAINT report.

11. Avoid contact of the tape with the floor. Operations will unload the tape after a recording session to prevent the tape from being overwritten. Occasionally, tape will fall from an unloaded

reel. To reduce the possibility of tape falling from a reel, keep the plastic dust door closed. Adjust the latch if necessary so that the door stays closed. If the tape does touch the floor, try to remove dirt and dust with a lint-free material or an air-duster to preserve the tape. Do not touch the tape with your hands. If the tape cannot be cleaned satisfactorily, carefully cut the end off, and throw the dirty end away.

12. Keep the front dust cover closed when operating the drive. Clean out the tape handling area with an alcohol-soaked pad such as a TexWipe.

13. If the end of the tape gets wrinkled and/or mangled, cut the end off straight with a sharp scissors.

Prepassing Tapes:

The first time a tape is played after shipment there is often a small tracking difference compared with subsequent passes. This is because at normal tape speeds there is insufficient time for the tape to relax after being relieved from the stresses of the reel pack. The tracking shift of the initial pass can be eliminated by prepassing the tape. The prepass can be done well in advance of use since no strains of consequence are built up on a tape reel pack unless the tape is subjected to large environmental changes. Prepassing also removes debris from the tape that may have been loosened during shipment. Prepassing takes about 20 minutes with thick tape and 50 minutes with thin tape.

It is important that the heads not be on during Prepass. Check that write enable is off on the Tape Record Status screen.

1. Clean the head and tape path as explained in the previous section. Wash hands first; never eat, drink, or smoke while handling tape.

2. Select TAPE/PREPASS.

3. The tape will load and move from the supply reel to the takeup reel. When the tape stops, remove the tape from the tape path to avoid getting alcohol on it and reclean the tape path and headstack so that debris collected on the leading edge of the head step during the forward pass won't be redistributed on the tape during the reverse pass.

4. Continue the prepass in the reverse direction. Normally, the Volume Serial Number (VSN) and Cyclical Redundancy Check (CRC) numbers are entered automatically by the barcode reader. Enter VSN and CRC at the prompt if the barcode reader is not working. Figure 5 shows where to find VSN and CRC on the reel.

5. Replace the tape in the shipping canister or on a storage shelf if it is not to be used immediately. Keep prepassed tapes separate from unprepassed tapes. Install a black reel band on thin tape reels.

Data Recording:

1. Clean the head and tape path as instructed earlier.

2. Load a prepassed tape using the TAPE/MOUNT screen. Unrecorded tapes are marked with a green tag. The operators in Socorro will know that the tape is ready if the tape is loaded. The footage counter is set automatically and VSN and CRC are read by the barcode reader.

3. Check the FORMAT/FMTERR screen and the TAPE/RECERR screen for errors. Report any unexpected error messages that cannot be cleared.

4. The operation of the tape recorder is controlled by the Socorro operators and by the observing system file during the data taking session.

5. At the end of the experiment or to change a tape during an experiment, enter UNLOAD as a TDC command to wind all of the tape on to the supply reel.

6. Remove the reel from the hub, label it, tape the loose end with zebra tape, install a black reel band if it is a thin tape, and place it in a shipping canister or on a storage shelf. Use only the 2" wide blue canister for shipping thin tape. Place the used tape in a separate location from unused tapes until it is shipped. Put a red sticky dot on top of the green dot on both tape and canister to show that the tape has recorded data. Also, put the project code and tape number in sequence (i.e. BG7, tape 1 of 5) on the canister.

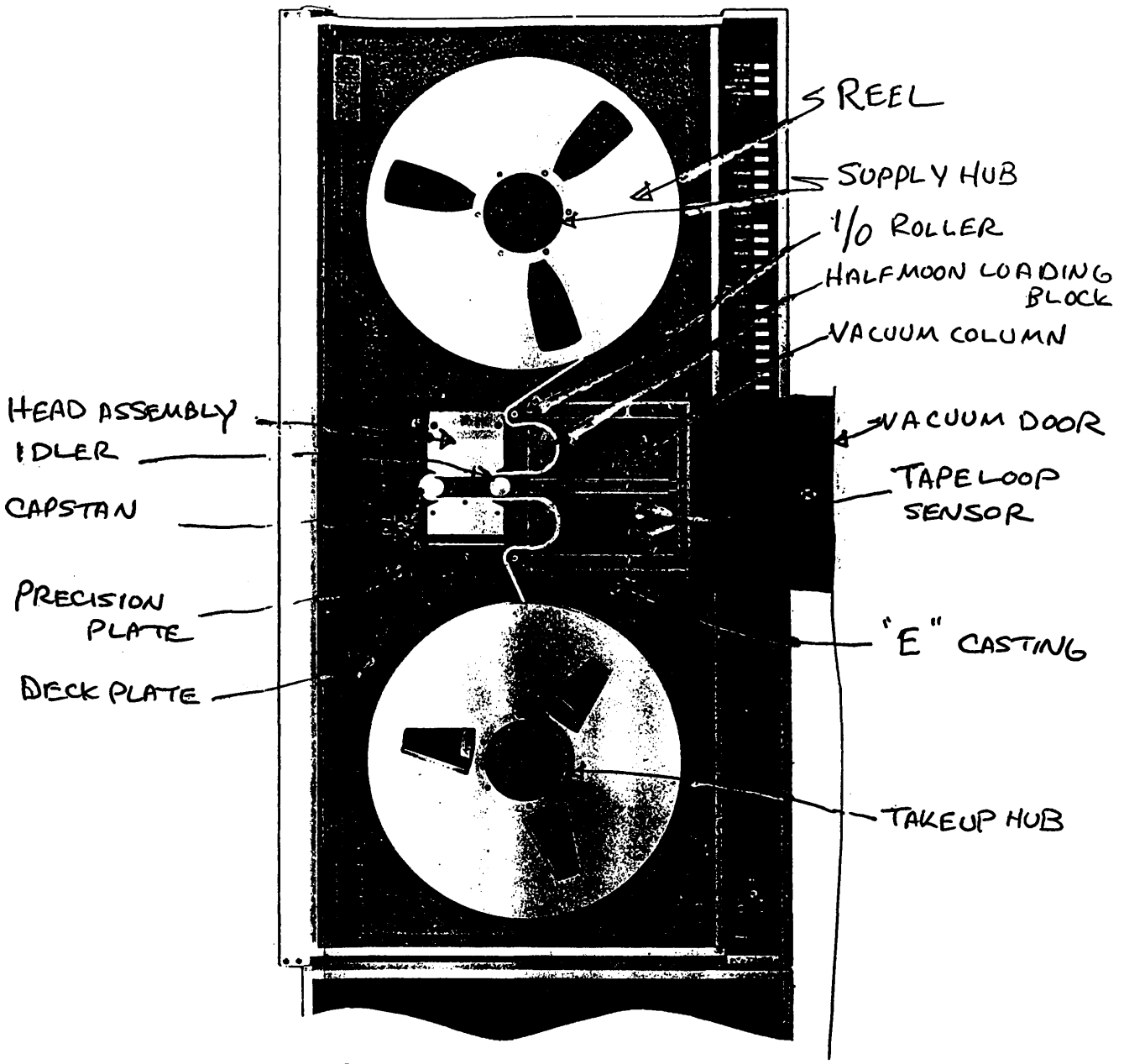


FIGURE 1 METRUM 96 TAPE DRIVE

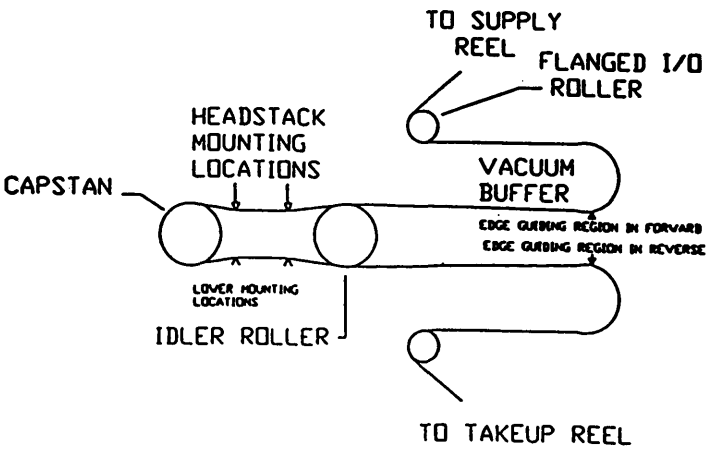


Fig. 2. Tape path in Honeywell Model 96 Transport.

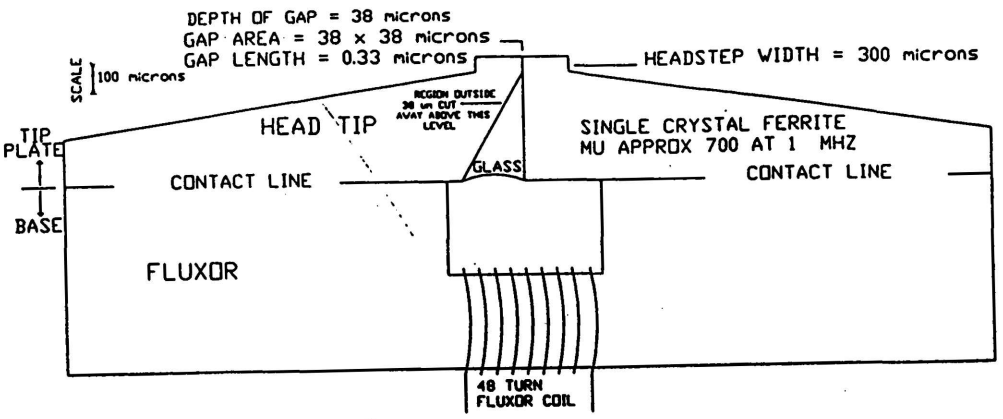


Fig. 3 Cross section of one head in the stack of 36.

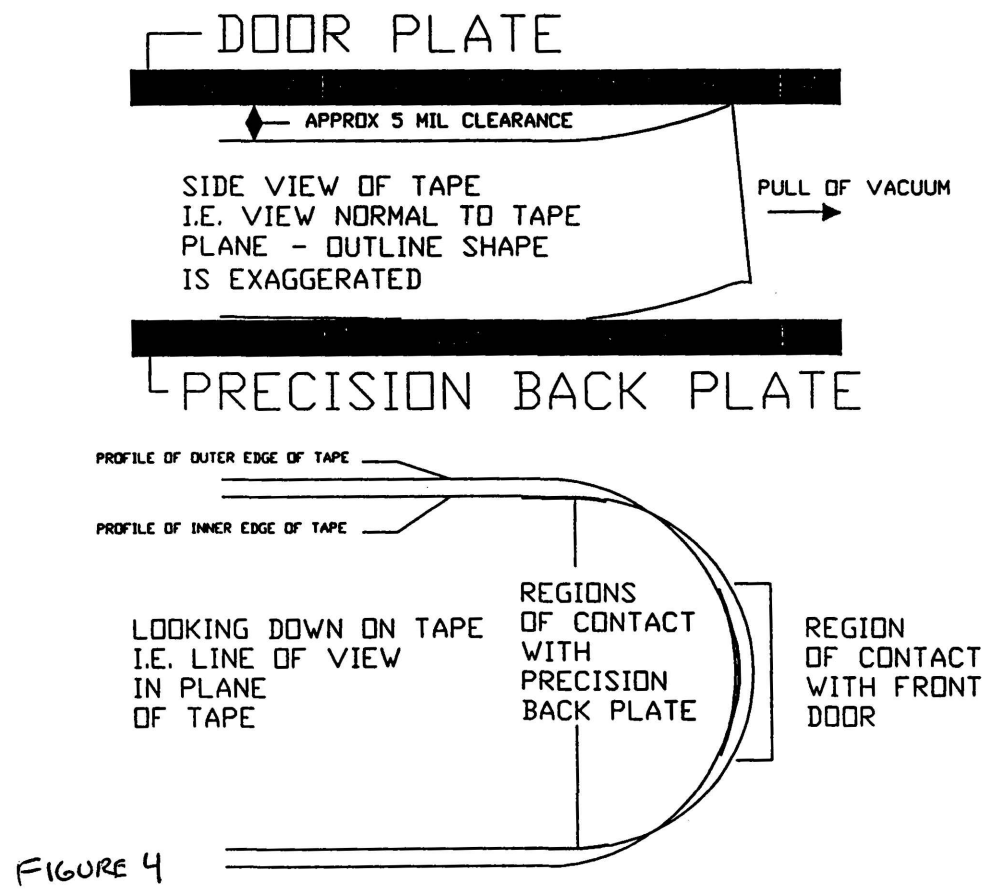


FIGURE 4

TAPE EDGE CONTACT REGIONS

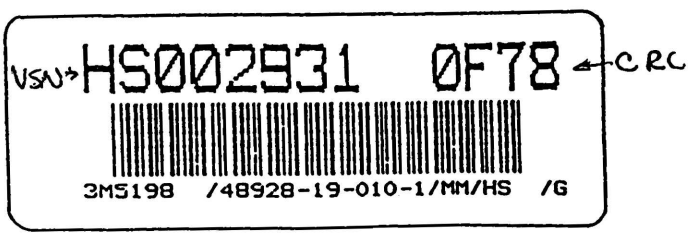


Figure 5 VSN Label Example

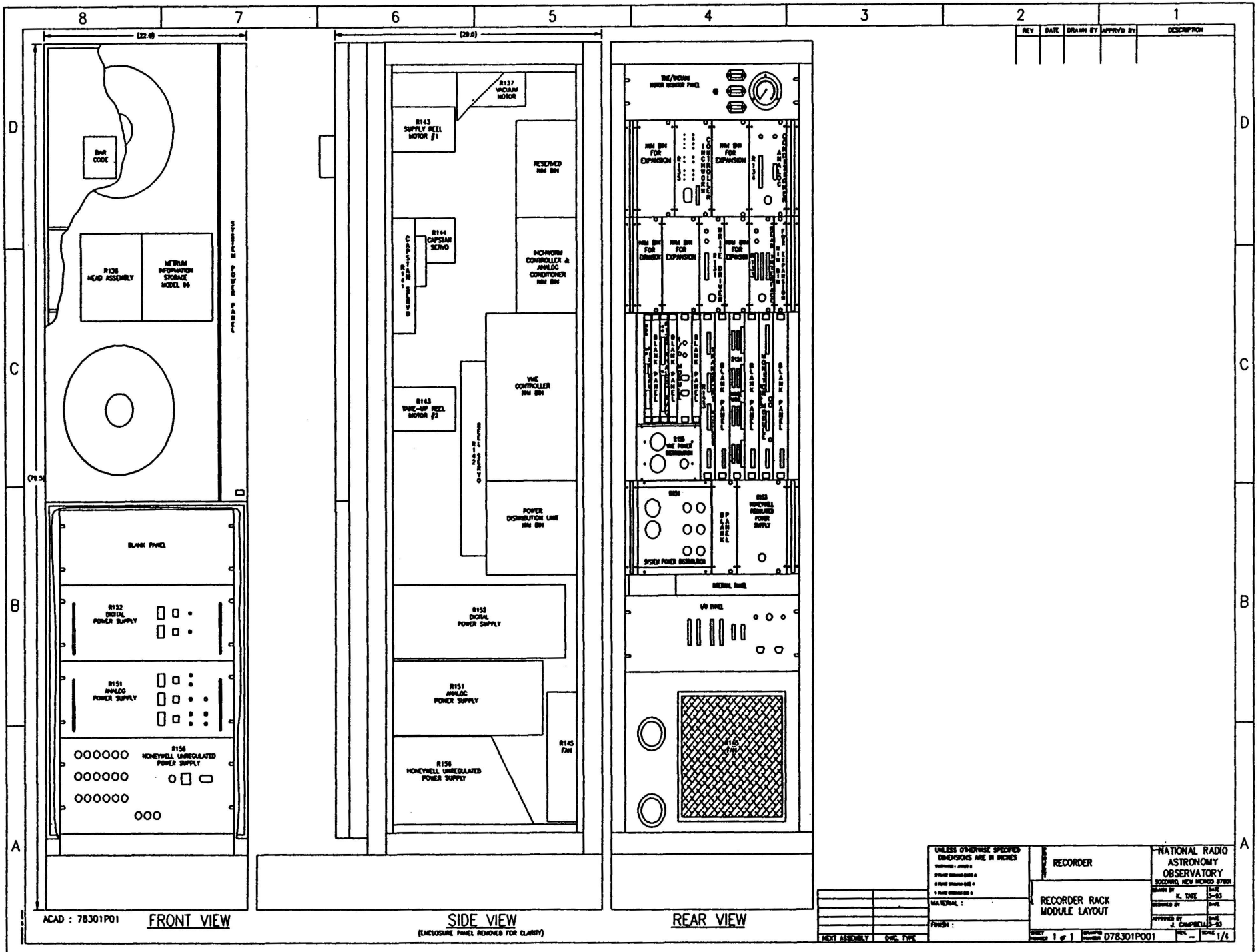

8
7
6
5
4
3
2
1
D
C
B
A
(22.6)
(29.8)
(79.3)
BAR CODE
R136 HEAD ASSEMBLY
METRUM INFORMATION STORAGE MODEL 96
BLANK PANEL
R152 DIGITAL POWER SUPPLY
R151 ANALOG POWER SUPPLY
R156 HONEYWELL UNREGULATED POWER SUPPLY
R137 VACUUM MOTOR
R143 SUPPLY REEL MOTOR #1
RESERVED MM BIN
R144 CAPSTAN SERVO
MOTHERBOARD
MOTHERBOARD CONTROLLER & ANALOG CONDITIONER MM BIN
VME CONTROLLER MM BIN
R143 TAKE-UP REEL MOTOR #2
POWER DISTRIBUTION UNIT MM BIN
R152 DIGITAL POWER SUPPLY
R151 ANALOG POWER SUPPLY
R156 HONEYWELL UNREGULATED POWER SUPPLY
R145 FAN
MM BIN FOR EXPANSION
R155 VME POWER DISTRIBUTION
R154
R153 HONEYWELL REGULATED POWER SUPPLY
SYSTEM POWER DISTRIBUTION
BP SCSI BACKPLANE
I/O PANEL
R135 FAN
ACAD : 78301P01
FRONT VIEW
SIDE VIEW
(ENCLOSURE PANEL REMOVED FOR CLARITY)
REAR VIEW
REV
DATE
DRAWN BY
APPRV'D BY
DESCRIPTION
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
MATERIAL :
FINISH :
NEXT ASSEMBLY
DWG. TYPE
RECORDER
RECORDER RACK MODULE LAYOUT
NATIONAL RADIO ASTRONOMY OBSERVATORY
SOCORRO, NEW MEXICO 87801
DRAWN BY K. TAPE 3-93
DESIGNED BY
APPROVED BY J. CAMPBELL 3-93
SHEET 1 of 1
D78301P001
REV -
SCALE 1/4

FIGURE 6

```
TRAK FORMAT FMTERR PCAL MARK2 SPAN
Enter Track Write Enable/Disable Mask
K+++++++++++TRACK ASSIGNMENTS++++++++++
             ON/OFF 044444444
   2  1LS    3  OFF    4  OFF    5  OFF
   6  2LS    7  OFF    8  OFF    9  OFF
  10  3LS   11  OFF   12  OFF   13  OFF
  14  4LS   15  OFF   16  OFF   17  OFF
  18  5LS   19  OFF   20  OFF   21  OFF
  22  6LS   23  OFF   24  OFF   25  OFF
  26  7LS   27  OFF   28  OFF   29  OFF
  30  8LS   31  OFF   32  OFF   33  OFF
  S0 OFF    S1 OFF  S34 OFF  S35 OFF
++++++++++++++ 44444444++++++++++++++N
```

```
TRAK FORMAT FMTERR PCAL MARK2 SPAN
Enter Track 16 Assignment
K++++++++++TRACK ASSIGNMENTS++++++++++
             ON/OFF 111111110
   2  OFF    3  OFF    4  1US    5  OFF
   6  OFF    7  OFF    8  3US    9  OFF
  10  OFF   11  OFF   12  5US   13  OFF
  14  OFF   15  OFF   16  7US   17  OFF
  18  OFF   19  OFF   20  5US   21  OFF
  22  OFF   23  OFF   24  6US   25  OFF
  26  OFF   27  OFF   28  7US   29  OFF
  30  OFF   31  OFF   32  8US   33  OFF
  S0 OFF    S1 OFF  S34 OFF  S35 OFF
++++++++++++++++++++++++++++++++++++++N
```

```
TRAK FORMAT FMTERR PCAL MARK2 SPAN
Enter Track Write Enable/Disable Mask
K++++++++++TRACK ASSIGNMENTS++++++++++
             ON/OFF 155555554
   2  1LS    3  OFF    4  1US    5  OFF
   6  2LS    7  OFF    8  2US    9  OFF
  10  3LS   11  OFF   12  3US   13  OFF
  14  4LS   15  OFF   16  4US   17  OFF
  18  5LS   19  OFF   20  5US   21  OFF
  22  6LS   23  OFF   24  6US   25  OFF
  26  7LS   27  OFF   28  7US   29  OFF
  30  8LS   31  OFF   32  8US   33  OFF
  S0 OFF    S1 OFF  S34 OFF  S35 OFF
++++++++++++++++++++++++++++++++++++++N
```

```
BBC IFDIST SYN MASER PWRSP SN LOMON
Strike <CR> to Kill This Screen
K++++++++BASEBAND CONVERTER / 1++++++++-
  IF B    LO FREQ  700.00    PERIOD  4
                     LSB        USB
         BANDWIDTH 62.5K         4M
     RAW BANDWIDTH #002B       #2410
        AUTO LEVEL   7.81        5.27
      TOTAL POWER  16182       16087
   SWITCHED POWER    381         404
++++++++++++++++++++++++++++++++++++++N
```

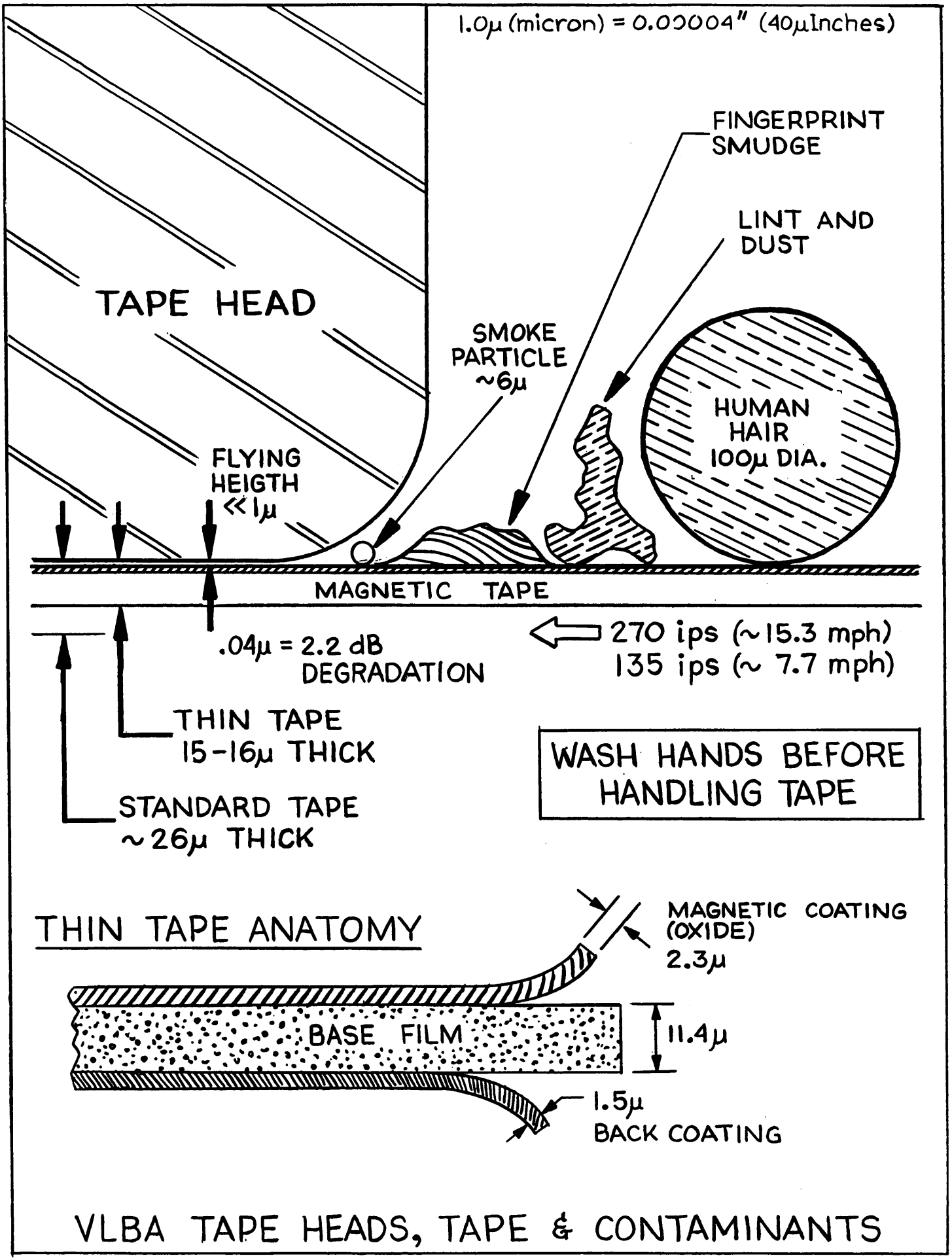
```
K++++++++++IF DISTRIBUTOR/1++++++++++
    PERIOD  0   CHANNEL 1     CHANNEL 2
     ATTENUATION   20              0
        IF INPUT EXTERN         NORMAL
      TOTAL POWER    208           416
   SWITCHED POWER      0             0
++++++++++++++++++++++++++++++++++++++N
```

FOR LSB.

```
K++++++++BASEBAND CONVERTER  5++++++++
  IF A    LO FREQ  700.01    PERIOD  0
                     LSB        USB
         BANDWIDTH 62.5K      62.5K
     RAW BANDWIDTH #002B      #002B
        AUTO LEVEL  -5.79      11.97
      TOTAL POWER  16224       4212
   SWITCHED POWER     -1          0
++++++++++++++++++++++++++++++++++++++N
```

FOR USB

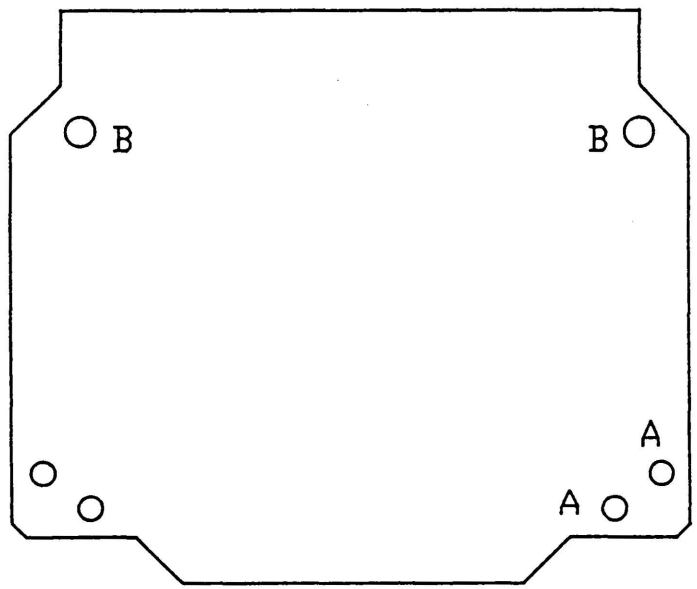
```
K++++++++BASEBAND CONVERTER  4++++++++
  IF A    LO FREQ  699.99    PERIOD  1
                     LSB        USB
         BANDWIDTH 62.5K      62.5K
     RAW BANDWIDTH #002B      #002B
        AUTO LEVEL  11.97      -8.93
      TOTAL POWER   4019      15158
   SWITCHED POWER     16        -19
++++++++++++++++++++++++++++++++++++++N
```



VLBA TAPE HEADS, TAPE & CONTAMINANTS

NRAO 3-93 P. HARDEN/C. JANES

CHANGE LETTER	D'WN BY	CHK'D BY	APP'D BY	DATE	D.C.N. & DESCRIPTION



HEAD BLOCK
FRONT VIEW

SPECIFICATIONS

A LOCATIONS - #4-40 x 9/16" L'NG, S.S. SOCKET HEAD CAP SCREWS.

*TORQUE - 4.5 TO 5 IN/LBS. (NOTE: 9/16" LENGTH IS NOT A STOCK ITEM. -USE A 5/8" LENGTH SCREW AND GRIND TO 9/16" LENGTH.

B LOCATIONS - #6-32 x 5/8" L'NG, S.S. SOCKET HEAD CAP SCREWS.

*TORQUE - 7.5 TO 8 IN/LBS.

MAR 15 1993

SHOP NOTES: UNLESS OTHERWISE SPECIFIED

1. DIMENSIONS ARE IN INCHES
2. TOLERANCE ON DIMENSIONS
   FRACTIONAL ± 1/64
   DECIMAL .XX ± .01
   DECIMAL .XXX ± .005
   ANGULAR ± 0°30'
3. SURFACE ROUGHNESS PER MIL-STD-10 ✓
4. REMOVE BURRS AND BREAK SHARP EDGES 1/64 MAX.
5. SCREW THREADS PER MIL-STD-9
6. ALL DIMENSIONS TO APPLY BEFORE PLATING OR CONVERSION COATING.

USED ON

NEXT ASSEMBLY

WEIGHT

SCALE FULL

CLASSIFICATION

APPROVALS		
DRAWN FOR D.W.FIELDS		3/10/93
DRAWN BY R.J.CADY		3/10/93
CHECKED BY D.W.Fields		3/15/93
	PROJECT V. Trail	3/15/93
	ENGINEER V. Trail	3/15/93
	MATL. & PROCESS	
	STRUCTURES	
	THERMAL	
	MECH. ANALYSIS	

NORTHEAST RADIO OBSERVATORY CORPORATION
HAYSTACK OBSERVATORY
WESTFORD, MASSACHUSETTS

VLBA RECORDER HEAD ASSEMBLY MOUNTING SCREWS SPECIFICATIONS

A330M023	A	54330M023	
CAD FILE	DWG. SIZE	DWG. NO.	REV.

APPENDIX A

VLBA TAPE HANDLING AND TAPE RECORDER CHECKSHEET

Revision date: November, 1993

Wash hands before handling tape; no eating, drinking, or smoking when handling tape.

A. Shipping, receiving and care of VLBA/Mark III tapes & recorder:

__ Store the reels on their edge. Use a black reel band on thin tape.

__ Use "ZEBRA" tape to hold down the ends.

__ Apply pre-printed label and a "recorded" red-dot sticker AFTER data collection and cleaning.

__ Use only 91% ISOPROPYL alcohol to clean the tape recorder.

__ Using a perpendicular movement to the tape motion, (wiping back to front), clean the recorder head with a cotton swab.

__ Scrub capstan and idler.

__ Clean the tape path, rollers and sensors, vacuum column with TexWipe. Clean out the corners with a cotton swab. Remove deposits on hard points.

B. Tape Mounting and Loading:

__ On the terminal use the TAPE/TDCCMD command INIT to initialize the recorder when powering up.

__ Install the tape reel: make sure it is tight and the reel does not wobble.

__ Use static cling to start tape on take-up reel; DO NOT FOLD THE TAPE OVER OR UNDER ITSELF! Do not spit or lick on tape.

__ Load the tape using the TAPE/MOUNT or TAPE/PREPASS screen.

__ Check the Vacuum for value of 7.5 for thin, 15 for thick, and if necessary, the RECPARM screen.

C. Pre-passing the tapes:

__ Clean the tape path.

__ Load the tape using TAPE/PREPASS.

__ Clean the tape path when the tape has all moved to take-up reel.

__ Store separately from un-prepassed tapes.

D. Data Recording

__ Clean the tape path and load a pre-passed tape using the TAPE/MOUNT screen.

__ Check for errors on TAPE/RECERR and FORMAT/FMTERR screen.

__ At the end of the experiment, unload the tape, label it, and place in a canister separate from the unused tapes. Tag the tape and canister with a red dot to identify the tape as written. Place the project code and tape number in sequence on the canister.

Appendix B

SITE TECH TEST PROCEDURES

Seven Procedures are Listed:

I. Formatter Test
II. Tape Recorder Test
III. BBC and Sampler Test
IV. Calibration of Vacuum Settings and Vacuum Display
V. Head Care and Replacement
VI. Calibrating LVDT and Offsets.
VII. Required Procedures When Swapping Modules

SCREEN menu selections are shown starting from the top menu bar; for example, FORMAT/TRAK means to move the cursor to FORMAT on the top menu bar, enter, select TRAK on the FORMAT menu bar, and enter. Commands available to the TAPE/TDCCMD screen may be listed by entering the TDC Command HELP. More information about SCREEN is available by selecting HELP in the top menu bar, or by selecting ENTER and entering the command HELP.

Diagnostic procedures are not presented for the most part; if the equipment does not operate as described, stop and seek assistance and/or file a MAINT report.

The responsibility for maintaining error rates and calibration within specified limits rests with the Recorder Group, but procedures to check the equipment are covered here so that problems can be expeditiously identified and reported.

I. Formatter Test

This test checks all 36 Formatter tracks to the Tape Recorder and Monitor Channels A and B from the Tape Recorder back to the Quality Analysis Module in the Formatter.

1. Select TAPE/TDC to access Recorder monitor screens and to access the TDC Command screen.

2. Enter the TAPE/TDC Command INIT. INIT must be entered whenever powering up the tape drive.

3. Enter the TDC Command BYPASS to bypass the Recorder Heads. The Tape Monitor Screen will show "bypass" for channels A and B.

4. Enter the TDC Command ENABLE llll to enable the Recorder Head Write circuits. The Tape Record Screen will show all 4 groups of heads "on."

5. Select FORMAT/FORMAT to check that the ratio of SRATE (Sample Rate) to ORATE (Output Rate) is 8:9, that the time is incrementing and

that MODE is #8003. #8003, "pseudo-random" mode, is a MKIII mode with simulated data instead of BBC output; #8003 must be typed in under MODE on the Formatter screen. For an output rate of 9 MHz, set the recorder speed to 270 ips with the TDC command SP 270; for 4.5 MHz, use SP 135. The speed must be set even though a tape is not being used in order to set the clock recovery chip on the tape monitor board to the correct bandwidth. The current speed is displayed in the Tape Motion screen.

For 270 ips, the clock recovery range for the monitor board is CR #24 as displayed in the Tape monitor status screen and for 135 ips, the range is CR #34.

6. Check to be sure the Formatter does not have any error conditions by selecting FORMAT/FMTERR. Clear errors with RESET or by reconfiguring. Reconfiguring can be done by selecting any field on the Formatter screen.

7. Enter the TAPE/TDC Command FENABLE FFFFFFFFF to enable all Formatter tracks shown on the TRAK screen. No track should be OFF at this point. For #8003 mode, the FORMAT/TRAK screen will show all tracks with no connection to a BBC or "NOC."

8. Enter the TDC Command RP 0 1 to assign track 0 to Monitor Channel A and track 1 to Monitor Channel B. The Tape Monitor Status Screen will show tracks 0 and 1 selected for channels A and B.

9. Enter the TDC Command ERROR to view the Parity (PER), CRC, RESYNC, and NOSYNC errors detected by the Formatter Q/A module in track 0 and track 1. All errors must be 0 or there is a problem; the power indicated in the Tape Monitor Screen should be 9.99.

10. From the top menu bar, select ENTER and type the command MINI. Once in the Mini-decoder screen, select the drive and MK3 mode. From the MINI screen, check that the time, date, and head selected are decoded correctly for Channel A. To check the Channel B track, enter the TDC command BS 1, or use the RP command to move that track to Channel A. If you use BS 1, use BS 0 to return to Channel A. Note that if a VLBA mode was the last Formatter mode used, barrel roll may be "on" changing the head assignments every second. Select RESET in the FORMAT/FORMAT screen to stop the roll.

11. Check the remaining tracks by selecting them two at a time using the RP command, entering ER to check error rates, and using the Mini-decoder screen to check for correct decoding of the auxiliary data field. There are 36 tracks, 0 - 35.

II. Tape Recorder Test

This test uses the Formatter to check the Tape Recorder. The test requires writing to a tape. Before writing to a tape, clean the heads and tape path of the drive, and prepass the tape.

The Formatter should be checked before this test.

1. Select TAPE/TDC to access Recorder monitor screens and to access the TDC Command Screen.

2. Enter the TAPE/TDC Command INIT.

3. Enter the TDC Command EN 1111 to enable the Recorder Head Write circuits. The Tape Record Screen will show all 4 groups of heads "on."

4. Use the FORMAT/FORMAT Screen to set the SRATE (Sample Rate) to ORATE (Output Rate) ratio to 8:9 MHz and the mode to #8003 as explained in step 5, Procedure I. Check that the Formatter time is incrementing. If the previous mode was VLBA, clear barrel roll by selecting RESET.

5. Check the FORMAT/FMTERR screen for errors and clear them, if any, by resetting or reconfiguring the formatter. Also check for recorder errors with the TAPE/RECERR screen, and clear if necessary.

6. Enter the TAPE/TDC Command FENABLE FFFFFFFFF to enable all Formatter tracks shown on the TRAK screen. No track should be OFF at this point.

7. Enter the TDC Command SP 270 to set the Recorder speed to 270 ips.

8. This procedure assumes that you have checked the Formatter tracks using Procedure I, but to double check while recording, enter the TDC command BYPASS and use ENTER on the top menu bar to select MINI and monitor the tracks.

9. Load a prepassed tape with a green dot. Using the TDC Command LD will avoid the barcode read routine.

10. So that you can easily find the recorded tracks on a different drive, position the head indexed to the forward offset. To do this, enter the TDC Command INDEX 1 0. This defines index 1 as head position 0 microns + offset. The forward and reverse offsets are shown in the PARM/RECPARM screen. To record in the forward direction, enter the TDC Command MOVEF 1 which will position the head at 0 microns + forward offset.

11. Enter the TDC Command FOR to begin recording.

12. Enter the TDC Command STOP to stop recording after at least 6000 feet of tape have been recorded. The Tape Record screen shows the footage. The footage counter can be set equal to the take-up reel footage with the TDC Command FC <footage>.

13. Record all the tracks in the reverse direction by changing

head position. Define a second index with the TDC Command INDEX 2 55, and position the head with the command MOVER 2. The head will position to 55 microns + reverse offset. Index positions must be at least 55 microns apart to avoid overwriting.

14. Enter the TDC Command REV to record in the REV direction. If you are not recording in the reverse direction, rewind the tape with the TDC Command RW. Notice that RW turns off the heads and changes the speed to 330 ips.

15. Prepare a sheet of paper to record the PER and other errors for each head. Noting the date, drive, and index position will be helpful later in reconstructing tests performed. File this sheet for future reference and to track patterns of performance.

16. Enter the TDC Command READ to route read signals to monitor channels A and B.

17. Position the head with the MOVEF 1 command.

18. Select the Mini-decoder screen with ENTER and MINI to monitor head and time decoding. See Procedure I.

19. Check to be sure the speed is still 270 ips and that the heads are off; then enter the TDC Command FOR to begin tape motion.

20. Enter the TDC Command RP 0 1 to assign track 0 to Monitor Channel A and track 1 to Monitor Channel B. The Tape Monitor Status Screen will show tracks 0 and 1 selected for channels A and B.

21. Enter the TDC Command ER to view the Parity, CRC, RESYNC, and NOSYNC errors detected by the Formatter Q/A module in track 0 and track 1. In the resulting display, parity errors should be 0.000300 or less, CRCC errors should be less than 20, and NOSYNC and RESYNC errors should be less than 10. If the error rates are high and MINI does not decode head position and time, the head is dead. Dead and weak heads should be substituted by a system track using the PARM/RECPARM screen. See notes.

22. The power indicated in the Tape Monitor Screen should be nonzero. Move the head to a blank part of the tape and read to determine the "baseline" for no signal. Signal recovery will result in some value higher than the baseline up to 9.99. At 9.99, the total power circuit is saturated so that the peaking command will not give best results. Scale the total power signal by changing the attenuator in the coax line between the Read and Analog Conditioning modules.

23. Check the remaining tracks by selecting them two at a time using the RP command, entering ER, and checking for errors. Double

check PER by repeating the procedure in the reverse direction. Remember to reposition the heads to MOVER 2 for reading in reverse.

24. Before doing the next step, check the calibration of the inchworm motor control with the INCH command to the ENTER screen. Selecting GO on the INCH screen will cause measured motor parameters to be printed out. Compare the new parameters with those in the PARM/RECPARM screen; if they agree within 10% go on. If not, change them and file a report. If the new parameter numbers are much smaller than the previous ones, the motor is slowing down possibly indicating an incipient problem.

The inchworm parameters must be updated in RECPARM anytime the Inchworm Controller (IWC) or the Head Assembly is swapped.

25. A linear variable differential transformer (LVDT) is used to encode head position. To check the scaling of the LVDT, position the head over a recorded track, say 18, by selecting RP 18 and issuing the TDC Command PEAK 20. The head will move back and forth over the track, measuring total power, and stop over the center of the track. Now move the head one head pitch, 698.5 microns, with the command MOVEREL 699. Select track 17 with the RP 17 command and peak on it with PE 20. Head 17 is now positioned over track 18. The difference in the head positions should be 698.5 microns + or - 5 microns. Check scaling in the opposite direction with the commands MOVEREL -1398, RP 19, and PE 20. Head 19 is now positioned over track 18. Again, the difference between the first head position and the current one should be 698.5 microns + or - 5 microns.

The LVDT scaling must be calibrated any time the Head Assembly or the Analog Conditioner module is swapped.

26. Check the reverse offset by rewinding the tape (RW), resetting the speed to 270 ips (SP 270), and positioning the head to MOVEF 2. Note the head position in microns from the Tape Head screen. Command FOR and peak on a track (PE 20). The difference between the head position reached with MOVEF 2 and the head position found with peak is the error in the reverse offset. Report errors greater than 10 microns. Double check by repositioning the head with MOVER 1 and commanding the tape to reverse with the REV command. Note the new head position and peak on a track (PE 20). The difference should be the same as the first mentioned, only opposite in sign. Note that the tracks cannot be decoded when reading in reverse.

The forward and reverse offsets must be recalibrated using the calibration tape anytime the Head Assembly or any other component in the tape path is loosened and replaced or swapped.

27. To check edge track 0 set INDEX N -320, do MOVEF N, and record approximately 1000'. Advance the tape forward and write in reverse at MOVER N for about the same distance. Do not overwrite. N is an integer, your choice. Playback the data at MOVEF N and at MOVER N and check that the PER for track 0 is close to what you measured at the center of the tape. Check edge track 35 by setting INDEX N 320 and repeating the procedure.

Report problems.

28. Unload the tape with the TDC Command UNLOAD and move it to the other drive. Check the forward offset by setting up the index positions on the new drive. Command INDEX 1 0 and INDEX 2 55; then MOVEF 1, SP 270, READ, and FOR. Peak on any track (PE 20). Report errors greater than 10 microns. Double check by repositioning the head with MOVER 2, command the tape to read in reverse (REV), and peak (PE 20).

29. The same tape may be used to check the second drive by selecting new index positions such as INDEX 3 -55 and INDEX 4 -110 and repeating the procedures 1 - 26.

30. Return the tape to the AOC for bulk erasure. The hand-held degausser can be used in an emergency, but bulk erasure is preferred before tape is used for collecting data.

Notes:

1. At this writing, limited resources forces us to allow PER to vary up to 0.001000 without alarm and to allow the other errors to exceed limits by a factor of 2. Higher than that, the head should be reported and substituted if a system track is available. Although tracks do not have to be substituted by group for decoding at the correlator; only 1 track per group may be substituted. Groups are: even tracks 0 - 16, odd tracks 1 - 17, even tracks 18 - 34, and odd tracks 19 - 35.

2. To determine whether the PER problem is occurring during read or write, move the head one head pitch = 698.5 microns. To do this, enter the TDC Command MOVEREL 699. Head 0 will now be positioned over the track recorded by head 1, head 17 will be over track 18, and so on. Use ER and the Mini-decoder screen to determine if the suspected head can read a good track, and if a good head can read the suspected track. Another method to check whether PER problems are occurring during record or readback is to check the tape on a second drive.

3. Check the write voltage by writing all tracks at increasing voltages, then checking PER on playback for the different voltages. Select the lowest write voltage with the best PER: increasing write voltage improves PER to a point beyond which the signal recovery may actually deteriorate, because of saturation and/or crosstalk.

To do this, set the formatter and drive up to record following earlier procedures, enter the TDC Command WVOLT 8, record 1000', enter WVOLT 10, record 1000', and continue to increase WVOLT in 2 volt steps through WVOLT 20, writing 1000' with each step. Rewind and check PER on a sample of tracks for each voltage. Circle the lowest PER for each track the first time the low rate appears. Chose the write voltage with the most circles. Set WRITE in the RECPARM screen.

4. The vacuum must be correct for the best PER results, as well. There are two different vacuum levels, one for thick and one for thin. The vacuum voltage for each is expressed in millivolts for each type of tape in the RECPARM screen. Check that the vacuum is 7.5" for thin tape and 15" for thick. Check to see that vacuum displayed on the TAPE MOTION screen is the same within 0.5" of the vacuum gauge inside the back door of the drive for both vacuum settings. Report problems or follow Procedure VI.

5. Check the groove depth on the aluminum insert on the vacuum column door. If the depth is 5 mil or greater, rotate or replace the door.

6. A further diagnostic technique is to look at the eye pattern. See the glossary.

III. BBC and Sampler test

This test uses the Tape Recorder and Formatter to check that the BBCs and Samplers are working. For a complete check of both sign and magnitude outputs of the BBCs, use the Weimer test jig and an oscilloscope. Before executing this test, perform Procedure I to make sure that the Formatter is working.

This test does not use the pulse insertion circuitry at the vertex used for the so-called "PCAL Startup Test."

1. Select Base Band Converter (BBC) #1 as the reference oscillator by connecting its LO output to IF Distributor A external input with a coaxial cable. Using SCREEN, set MODULE/BBC #1 LO output to 699.99 MHz.

2. Distribute the 699.99 MHz to all BBCs by selecting the IF Distributor with MODULE/IFDIST. Set IFA input to EXTERNAL and IFA attenuation to 20 db. This use of BBC #1 and IFA substitutes for the use of PCAL insertion at the front end.

3. Select MODULE/BBC and establish a 10 KHz signal on each LSB BBC output by setting the LO Frequency on BBC #2 through BBC #8 to 700.00 MHz, IF to A, Bandwidth to 62.5 KHz, and gain control to Auto Level. (700.00 MHz - 699.99 MHz = 10 KHz LSB.) For this setup, Auto Level will seek a value around - 6 db that will servo the BBC total power output to about 16,000 counts. An auto level of +5 db would more closely simulate observing conditions, but the wider bandwidth required to achieve that level with this test setup would result in poorer, more ambiguous correlator results.

4. Assign BBC LSB outputs to formatter tracks with the FORMAT/TRAK Screen. BBC #2 LSB Sign output is 2LS, BBC #3 LSB Sign output is 3LS, etc. Select a hexadecimal mask word on the TRAK Screen to enable tracks in use. Figure 7 shows an example setup.

5. Use the FORMAT/FORMAT Screen to check that the ratio of SRATE (Sample Rate) to ORATE (Output Rate) is 8:9, that MODE is MARK III and that the Formatter time is incrementing. Do not use the #8003 mode because it will disconnect the BBC outputs from the Formatter. For an output rate of 9 MHz, use SP 270. For 4.5 MHz, use SP 135. The speed must be set even though a tape is not being used in order to set the clock recovery chip on the tape monitor board to the proper bandwidth.

6. Use the TAPE/TDC Command INIT to initialize the tape recorder on power up and BYPASS to route formatter tracks to monitor channels A and B from the Tape Recorder to the formatter.

7. Select FORMAT/PCAL to perform a correlation between the tracks enabled on TRAK and a 10 KHz reference signal developed on the Formatter Quality Analysis Module. The PCAL output shows the track number (TRK), the correlation amplitude in percent (AMP), and the phase (PHASE). Use the TRAK screen to determine which BBC is assigned to which track; then for the signals 2LS through 8LS, the correlation amplitude should be 70% or better. Do PCAL two more times. The phase for a given track should remain constant within 1 count. PCAL enables write current to the tape drive heads and will write on a tape if one is in motion at the time. Never use PCAL while prepassing or rewinding a tape. There is also a TDC command PCAL which will perform a check on channels A and B only.

8. Establish a 10 KHz signal on each USB BBC output by setting the LO frequency on BBC #1, to 700.01 MHz, IF to A, Bandwidth to 62.5 KHz, and gain control to Auto Level. (700.01 - 700.00 MHz MHz = 10 KHz USB.)

9. Assign BBC USB Sign outputs to formatter tracks with the TRAK Screen. BBC #2 USB Sign output is 2US, BBC #3 USB Sign output is 3US, etc. Select a hexadecimal mask word on the TRAK Screen to enable tracks in use (see example).

10. Enter the Screen Command PCAL. For the signals 2US through 8US, the correlation amplitude measured by PCAL should be 70% or better. Do PCAL two more times and check that the phase is constant within 1 count.

11. Check BBC #1 by connecting BBC #2 as the reference oscillator, and check BBC #1 LSB and USB following the steps above.

12. Remove the coax cable from IFA when the test is completed.

IV. Calibration of vacuum settings and screen vacuum display

The vacuum sensor in the Analog Conditioner (A/C) Module must be calibrated whenever the vacuum motor is changed or adjusted, or whenever the A/C Module is swapped.

1. With a tape loaded, find the vacuum voltage to command 15" of vacuum and the voltage to command 7.5" of vacuum. To do this, enter the TDC command VVOLT N.nnn where N.nnn is a

voltage between 0 and 10.000. VVOLT 9.5 to VVOLT 10 will normally command 15" and a VVOLT between 6.5 v and 7.5 v will normally command 7.5". Use the vacuum gauge inside the back door of the drive to read the vacuum for this step.

2. Enter the voltage for 7.5" vacuum in millivolts under thin tape VAC in RECPARM and the voltage for 15" in millivolts under thick tape VAC in RECPARM; i.e., if the voltage is 9.725 v, enter 9725 in RECPARM. Select SEND in RECPARM to send the new values to the drive.

3. Record the vacuum display on the Tape Motion screen when the gauge reads 15" and when the gauge reads 7.5". If the difference between the two readings is greater than 7.5, decrease SLOPE in RECPARM; if the difference is less, increase SLOPE. Send the new SLOPE value to the drive and select the voltages found for 7.5" and 15" using VVOLT. Recheck the difference in the vacuum display. Try different values of SLOPE until the difference in the vacuum display between the two settings is 7.5". SLOPE is normally around 30.

4. With the difference in the vacuum display readings at 7.5", make INTERCEPT in RECPARM more positive if the vacuum display is lower than the gauge, more negative if the display is higher. Send the new value of INTERCEPT to the drive and try VVOLT for 7.5" and 15" to see if the vacuum display agrees with the gauge within 0.2". Try different values of INTERCEPT until the gauge and display agree. INTERCEPT is normally around -59. If the values you find for SLOPE and INTERCEPT are widely divergent from normal, seek assistance.

5. Select SAVE in RECPARM to save the new values for VAC, SLOPE, and INTERCEPT on disk. Unload the tape.

V. Head Care and Replacement

Important precautions.

The tape head is one of the most costly components of the tape drive. The tape contact surface of the head is most susceptible to damage, but the mounting surface and cables are also easily damaged.

Head alignment is a critical factor in controlling head wear. When a new head stack is installed in the head assembly, the mounting surface and tape contact surface are held perpendicular to each other. If the head is tilted relative to the tape path, one side of the head will wear faster than the other, and the head will fail prematurely.

Tape must be handled to avoid the transfer of contaminants to the head that would accelerate wear. The head stack used in the VLBA tape recorder includes a sharp edge that cleans the tape as it passes over the head. A tape must be cleaned by prepassing after shipping. Frequent cleaning of the tape head and tape path extends head and tape

life. See Figure 8.

The tape contact surface of the head is a smooth, precision surface. The smooth surface is necessary to reduce friction between the tape and head and to allow intimate head/tape contact. Scratches or other damage to the surface may allow microscopic oxide particles and other contaminants to accumulate on the surface causing air gap loss. Use only cotton swabs wetted with 90% isopropyl alcohol for cleaning the head surface. Shake off excess alcohol so that the swab does not drip. Use only minimal pressure; do not scrub. Clean only from back of the head stack forward perpendicular to the tape motion to avoid accumulation of debris at the back of the stack.

One of the major causes of surface damage to tape heads is mishandling. If the surface of a tape head is even lightly bumped against a hard surface, the head may be damaged or misaligned. Do not touch the head stack or allow it to touch any surface except the foam cushioning in the fitted suitcase. Do not lift the head assembly by the cables; support the cables when removing or installing. Never tap or pry, however lightly, on any part of the headstack.

The aluminum housing for the head assembly can be warped if the mounting screws are overtorqued. One of the mounting screws is shared with the idler roller; overtorqueing that screw can misalign the idler and cause bad tracking as well. Use only the torque screwdriver provided to each VLBA site and follow the torque specification in Fig. 9.

Clean the head assembly mounting surfaces carefully on both the precisim plate and the head assembly with a TexWipe to insure no debris will misalign the assembly.

Head replacement

1. Remove the head assembly from its fitted suitcase. Inspect for damage; immediately report any problem.
2. With the power off, gently remove the old assembly. At the back of the deck plate, ease the grey cable through the slot in the strain relief, remove the cabling harness from the Read and Write modules, and remove tie wraps.
3. Loosen the 4 captive hex screws on the front of the assembly.
4. Gently ease the assembly forward and support the cables as they pass through the hole.
5. Place the assembly on a surface so that nothing can come in contact with the headstack.
6. Clean the interfacing surfaces of the replacement head assembly and the precision plate with a TexWipe.
7. Ease the cables of the replacement assembly through the hole in the deck plate and wiggle the head assembly into place by pressing on the front face. Do not touch the headstack or allow it to come in contact with any surface. Do not tug on the cables; support the cables so that their full weight does not pull on the electronics boards. Keep the cables supported until they are tied in place.
8. Use the torque screwdriver and follow the torque restrictions in Figure 9. Do not use the screws to pull the assembly tight against the precision plate. The assembly must be wiggled

by hand until the surfaces are flush. Use a shim if necessary to check that the surfaces are flush and the assembly is not cocked.

9. Fasten the cables to the Read and Write modules. Support the cables with tie wraps so that they are not pinched when the deck plate is closed and so that they do not pull on the head assembly. Ease the grey cable through the slot in the strain relief; the cabling must be loose at the head assembly to permit motion of the inchworm motor: it has a minimal torque margin.

10. The ground straps on the head assembly data cables have been a source of noise. To find out whether or not to connect the ground straps on your head assembly, execute the following procedure:

a. Connect the oscilloscope up the same as for watching an eye pattern; see "eye pattern" in the glossary.

b. Connect the ground straps at the head assembly end of the cables.

c. Use the trial and error method to find which combination of the remaining 4 ground strap connections cause the least amount of noise, as seen on the oscilloscope. (Usually, the best results are obtained by connecting only one of these ground straps.) The goal is to get less than 25 mV of noise as displayed on the oscilloscope.

d. If it is not possible to reduce the noise sufficiently with step c, remove the ground straps one at a time at the head assembly end of the cable and repeat step c.

e. Use electrical tape to tape any unused ground straps out of the way. Be sure to leave the labels which identify the cables visible.

f. Seek assistance if you are unable to sufficiently reduce the noise using this procedure.

11. Check each head by recording and playing back the resulting tracks, checking for correct track locations and PER. Recalibrate the IWC, LVDT, forward and reverse offsets, (Procedure VI) and write voltage. See Procedure II, note 3. Use the eye pattern to check tracking.

VI. Calibrating LVDT and offsets

The LVDT and the offsets must be recalibrated whenever a head assembly or other item in the tape path is moved or replaced. This calibration should also be checked if the Analog Conditioner Module is swapped.

1. Clean the tape path, and prepass the calibration tape if the tape has not been prepassed before shipment to the station.

2. Load the calibration tape. Use the TDC command SP 270 to set the speed at 270 ips. Use the TDC command EN 0000 to make sure the heads are "off." Enter the TDC command READ to read the tape, and enter the TDC command RP 18 to look for track 18. The calibration tape has only a single track, track 18, recorded in MKIII format at 270 ips in the forward direction.

3. In the RECPARM screen, set the LVDT positive and negative scale factors to 1000. Use SEND in RECPARM to send the new parameters to the drive. This calibrates the head position readout in volts x 100 instead of microns.

4. Measure the new inchworm motor parameters using INCH, accessible from ENTER. Enter the new parameters in RECPARM and send them to the drive by selecting SEND in the RECPARM screen.

5. Select MINI from ENTER to decode the track on the calibration tape when found.

6. Use the TDC command MOVEA 200 to move the headstack to 200.

7. Start the tape moving with the TDC command FOR.

8. Find track 18. A TDC command PEAK 200 will normally find the track by searching 200 +/- 200. If not, try peaking over a wider range. The POWER display on the Tape Motion screen, near 0 when no track is present, should increase to some nonzero value less than 10.0 when head 18 is over the track. Also, the minidecoder screen will show track 18 when decoding the calibration track. Make a note of the track position when found.

9. Move head 19 over the track with the TDC commands MOVEREL -400, RP 19, and PEAK 50. Check the minidecoder screen -- it will still show track 18 -- and note the new position.

10. Rewind the tape to 1000 ft. with the TDC command RW and reset the speed to 270 ips after the tape has stopped.

11. Reposition the head to read the calibration track with head 18 with the MOVEA command, select head 18 with the RP 18 command, and advance the tape with FOR.

12. Use the TDC command PE 10 to find the position of track 18. Record the result as V18.

13. Rewind repeating step 10.

14. Reposition the head to read the calibration track with head 19, using the MOVEA command. Select head 19 with the RP 19 command and advance the tape with FOR.

15. Use PE 10 to find the position of the track and record the result as V19.

16. Rewind repeating step 10.

17. Take the absolute value of the difference between V18 and V19, multiply by 2, and MOVEREL that amount. Select head 17 with the RP 17 command and advance the tape with FOR.

18. Use PE 10 to find the track position and record the result as V17.

19. Rewind repeating step 10.

20. Calculate the new LVDT scale factors:

    LVDT POS = {(6985 kA) / (V17 - V18 cv)} * 100 cv/kA
    LVDT NEG = {(6985) / (V18 - V19)} * 100

21. Enter the new LVDT scale factors in RECPARM, and SEND to the drive. The scale factors will be in the neighborhood of 1600 to 1700; if the numbers you get are widely different from that, seek assistance.

22. Recalibrate the inchworm motor with INCH and enter the new values in RECPARM. SEND to the drive.

23. Move head 18 over the calibration track, select RP 18, and move the tape forward. Continuously peak on track 18 with the PE command and record the head positions as the tape advances all the way to the end.

24. Find the midpoint by taking the difference between the lowest and highest readings, multiply by 10, and enter this result as the FOR OFFSET in RECPARM. The offsets are in kilo Angstroms. The forward offset should fall between +/- 7000 kA; outside that range there is a risk that the head motion will encounter a stop or restriction in its +/- 3200 kA swing during a recording session.

25. Move the tape in reverse and continuously peak on track 18 until all the tape is back on the supply reel. Again, find the midpoint and multiply by 10. Enter the result as the REV OFFSET in RECPARM. The reverse offset should differ from forward offset by no more than about +/- 200 kA; larger values may indicate a problem in the tape path.

26. Save the results to disk with SAVE and send the results to the drive with SEND, both commands accessed from RECPARM. Unload the tape.

27. Correct LVDT scaling and a correct reverse offset are essential to keep different recording passes from overwriting, and a correct forward

offset is essential to make the recorded tape interchangeable with the playback drives. Verify the results with step 26 in Procedure II.

VII. Required procedures when swapping modules

Module	Nomenclature	Checkout
R121	MVME117	Load a tape, move it forward and reverse, unload.
R122	VME Analog I/O	Load a tape and check vacuum, total power, and head position screen displays; check write voltage level and vacuum voltage commands.
R123	VME Transport	Load a tape, move it forward and reverse, check operation of low vacuum sensor, head positioning, elapsed time meters, MCB. Unload.
R124	VME Write	Write a tape, read it back. Check all tracks. Substitute tracks with system tracks, check for correct operation. Use mini-decoder to check track assignments.
R125	VME monitor	Use MINI screen to test mini-decoder, channels A & B. Use formatter Q/A module to check PER on channels A & B.
R131	Read	Use MINI screen to test mini-decoder, channels A & B. Use formatter Q/A module to check PER on channels A & B. Check Total Power display on Tape Monitor screen. Use mini-decoder to check track assignments.
R133	Write	Test tracks with Procedure I. Write a tape, read it back. Check all tracks. Use mini-decoder to check track assignments. Check write voltage; see Procedure II, note 3.
R134	Analog cond.	Check head position, vacuum, and total power screen displays. Calibrate IWC using INCH. Calibrate vacuum display; see Procedure IV.
R135	IWC	Calibrate IWC using INCH.
R136	Head assy	See Procedure V.
R137	Vac motor	Calibrate slope, intercept and VAC settings in RECPARM. See Procedure IV.
R141	Capstan servo	Load a tape, move forward and reverse, unload.
R142	Dual reel servo	Load a tape, move forward and reverse, unload.
R143	Reel motor	Mechanical alignment for thin tape.
R144	Capstan	Load a tape, move forward and reverse, Use eye pattern to check tracking, unload.
R145	Fan	Visually check that blades turn.
R151	Anal PS	Check 12 VDC and 15 VDC indicators. Check operation of Write voltage. Load a tape, write and playback.
R152	Digital PS	Check +/- 5 VDC indicators. Load a tape, write and playback.
R153	HW Reg PS	Check MCB, elapsed time, low vacuum sensor operation.

R156	Unreg PS	Load a tape, move forward and reverse, unload.
	I/O roller	Mechanical alignment for thin tape.
	Tape loop sensor	Procedure in Metrum Technical Manual for sensor calibration.
	Vac col door	Use eye pattern to check tracking, forward and reverse. Check tracking with 10 mil shim. Check offsets. See Procedure VI.
	Aluminum hard point	Use eye pattern to check tracking, forward and reverse. Check tracking with 10 mil shim.
	Alumina hard point	Mechanical alignment for thin tape. Check offsets See Procedure VI.
	E casting	Mechanical alignment for thin tape. Check offsets. See Procedure VI.
	Tape wrap angle adj	Use eye pattern to check tracking, forward and reverse. Check offsets; see Procedure VI.
	Idler	Use eye pattern to check tracking, forward and reverse. See Procedure V for installation procedure and important precautions.

Appendix C. IF A TAPE FAILS

Here are some things to do if a tape fails on the VLBA Tape Recorder. A tape fails when it or its reel show sign of damage.

Before changing anything or commanding anything call a representative of the Recorder Group, or

1. Go to MCB internal and read the address and data for the latest command to the tape recorder. The ID byte for recorder #1 is #2A and for the recorder #2, #3A. This will only work if you do NOT access the Tape SCREENs first.

2. Printout the RECPARM, RECERR, MOTION, HEAD, RECORD, and MONITOR screens. Of particular interest is the footage counters, the vacuum reading, the head position, and any error message screen overprints.

3. Read and record the contents of addresses 73, 74, and 75 (#22xx for recorder #1 and #2Bxx for recorder #2). This information is the status, error flags, and software error code, respectively.
See VLBA Technical Report 5 for more information on recorder addresses.

4. Note the following:
   a. Is the tape still loaded and on vacuum?
   b. Was there a power outage?
   c. What is the temperature and humidity in the computer room?
   d. What are the states of the LED indicators on the MVME117 and analog I/O boards? On the recorder power supplies? On the Station Computer?
   e. What are the surrounding circumstances: the other tape recorder in use, UPS problems, smoke, tape recorder intermittently stopping, some module just replaced, etc.
   f. About how long has the shuttle test/data-taking session been in progress?
   g. What is the time and date?

5. Inspect the vacuum column and tape path for debris and/or damage.

6. If the tape stopped for unexplained reasons and the tape is undamaged, try passing the tape past the point of failure again to see if the tape is stretched. Return stretched tapes to the Correlator with a note. If you need the tape right away and the stretch is near an LTSENSE, cut off enough of the end of the tape to move the stretch to the other side of LTSENSE. If a tape is stretched, it no longer will be 1" wide.

7. Another possible reason for a tape to lose vacuum is the wear

grooves in the aluminum hard point on the vacuum door. If the grooves are more than 5 mil deep, rotate the insert, or replace it.

8. Rewind the tape and inspect the gap between inside tape edge and the precision plate with the tape in motion. To do so, shine a flashlight at the edge on one side of the tape and look for light between tape edge and precision plate. Note any wobble of the reels and scraping of the tape on the reel flange as well, though light scraping of the tape on the flange is normal for a self-packing reel. Make a note of any unusual noises or movement.

9. Inspect for a visible gap between the tape pack and the two reel flanges, and note the measurements and the side of tape pack where the gap appears. Estimate the gap width or measure with the shim kit.

10. Describe the tape damage. Note bumps, spokes, bands, and scatter. Some scatter on the take-up reel is normal; much less scatter should be evident on the supply reel, if it is a self-packing reel.

11. If the tape is broken, return both the backup reel and the supply reel in separate shipping containers. Put reel bands on glass reels before shipping; use the black reel band on glass self-packing reels. Ship all glass reels in the wide body blue shipping canisters. Do not attempt to splice the tape at a VLBA site. Splicing is only done at the correlator for quality control and record keeping.

12. If a tape edge slides loose from the pack and folds over on a self-packing reel, that edge is most likely damaged. Return the reel to the correlator where the damaged part will be removed and the tape spliced.

13. In cases where tape comes off the reel, winds around the reel motor capstan in a nasty tangle, cut the tape in two and follow step 10.

Appendix D

GLOSSARY

Bands: Deformation of the tape pack causing unevenness at the perimeter of the tape pack that is detected in a direction perpendicular to tape motion.

Bumps: Deformation of the tape pack causing unevenness at the perimeter of the tape pack that is detected in the direction of tape motion. Caused by debris in the pack, burred tape edges, or cinching of the tape during shipment. The bumps can be detected during tape motion with an orange stick or on a full pack with a clean finger. Use a feather-light touch to avoid distorting the tape pack and point the stick in the direction of motion to avoid snagging the tape. Severe bumps will leave voids or "windows" in the tape pack.

Capstan: A roller in the tape path which is driven by a motor to move the tape. It includes an incremental encoder for precise measurement of capstan motion.

Cinching: One section of tape rotates with respect to another section inside the tape pack, causing the tape to bump up and spoke. Typically caused by angular shock to the shipping canister especially where the pack is loose. The tape reel is permitted to rotate in the shipping container to reduce angular shock.

Deck Plate: The vertical hinged casting on which is mounted the reel hubs, precision plate, head assembly, capstan and other assemblies used in the tape path.

E casting: An E-shaped casting used to form the two vacuum columns on the tape drive.

Eye Pattern: With an oscilloscope it is possible to look at the Channel A output of the READ module. Since only discrete frequencies are recorded, the resulting waveform will have empty areas in it called eyes. The more open the eye, the better the signal quality. A varying amplitude indicates poor tracking, either during record or playback. The oscilloscope should be triggered with the CLOCK output of the VME Monitor module for best results.

Flange separation: The gap between reel flange and tape pack. Should be less than 10 mil for self-packing glass reels.

Gap: A gap can appear between a thin tape pack and the flanges of a self-packing reel. To measure, use the plastic shim kit issued to each VLBA site. Start with a shim smaller than the gap first,

then advance to thicker ones. Only measure the first inch or so from the perimeter of the tape pack. Never jam a shim between the tape pack and flange. The outside gap is between the tape pack and the flange with the VSN; the inside gap is between the tape pack and the flange toward the tape drive.

Hard points: The points in the vacuum column where the edges of the tape loop makes sliding contact with the alumina plate on the E casting and the aluminum plate on the vacuum column door. These are the only surfaces that should be in contact with the tape edges. See figure 4.

Head Assembly: An assembly at the front of the drive which includes the headstack, the preamplifier boards, and a cable harness to connect the assembly to the Read and Write modules, and to the Analog Conditioner module

Head pitch: The distance between adjacent heads on a head stack, 698.5 microns in the case of the VLBA tape recorder. 36 tracks x 698.5 microns = 1".

Headstack: An assembly of 36 heads about 1" wide in the Head Assembly. The heads are 698.5 microns apart; each contains a 0.3 micron gap perpendicular to the tape path.

Idler: A roller in the tape path between the vacuum column and the head assembly. A slight misalignment can result in tracking problems.

Load: A procedure wherein a tape reel is installed on the drive and a screen command such as LOAD, MOUNT, or PREPASS is issued to bring the tape up on vacuum.

Non-self-packing reel: Typically refers to a tape reel with flat glass reel flanges spaced farther apart than on the self-packing reels. This type of reel is used for a take-up reel where scatter is not a problem. Non-self-packing reels have blue labels. The outside surface of the reel flanges are coated with polyurethane.

Orange stick: A wooden stick with tapered ends, commonly used for tuning radio equipment, available from suppliers of electronic tools. The intended use here is to feel for bumps in the tape pack. Orange sticks are stocked at the VLA warehouse.

PCAL: A screen command to measure correlator % amplitude and phase for all formatter tracks not off. Also a TDC command to measure correlator % amplitude and phase for the two tracks selected on channel A & B. Also a startup procedure to test all data channels by inserting a weak pulse at the vertex.

Precision plate: A casting on the front of the tape drives that provides a mounting surface for the E casting, the I/O rollers,

the idler, the capstan, and the head assembly.

"Half moon" loading block: A semicircular metal piece at the mouth of the vacuum column. Used to hold the magnetic tape in place during loading.

Reel flange: The side of the tape reel. The outside flange is the one with the VSN label.

Reel motor: There are two reel motors on a tape drive to feed and gather tape from the vacuum column. The top one is the supply reel motor; the bottom one is the take-up reel motor. The reel motors are servoed to the tape loop sensor.

Rollers: There are 2 I/O rollers, one in the tape path between the supply reel and the vacuum column, and one in the tape path between the take-up reel and the vacuum column.

Scatter: Unevenness in the side of the tape pack looking at the pack through the reel flanges. Scatter is common on a non-self-packing reel, but should be minor or absent on a self-packing reel. Severe scatter can result in damage to tape edges during shipment, especially if the reel band is not installed.

SCREEN: A computer program on the VME system computer accessed by the command SCREEN. it is used for control of equipment at the VLBA antenna.

Self-packing reel: A tape reel with glass reel flanges that are curved toward each other so that at the perimeter of the reel, the distance between the flanges is less than the width of the tape. The reel forms a less scattered pack which is preferred for shipping. Self-packing reels have green labels. The outside surface of the reel flanges are coated with polyurethane.

Shipping canister: A plastic container used for shipping a magnetic tape; green for thick tape, blue for thin tape.

Spokes: Deformation of the tape pack usually in conjunction with bumps that can be seen looking at the side of the tape pack through the reel flanges. The spokes look like lines in the tape pack radiating from the reel hub.

Tape loop sensor: There are two tape loop sensors, one in each of the two vacuum chambers. As the tape loop moves in the vacuum chamber, it interrupts the light emitted from an array of LEDs on one side of the chamber from reaching an array of photosensitive diodes on the opposite side of the chamber. The resulting signal is used to servo the reel motor.

Tape pack: The body of magnetic tape on the tape reel.

Tape reel: A glass or metal wheel-like assembly with 2 flanges and a hub used for storing magnetic tape.

Thick tape: A magnetic tape that is 25 micron thick and 8500' long.

Thin Tape: A magnetic tape that is 16 micron thick and 18,500' long. It is shipped on glass self-packing reels only.

Tip plate: The top surface of the headstack exposed to the tape. See Figure 3.

Unload: A procedure wherein a loaded tape is rewound until all the tape is on the supply reel and the servo and vacuum is off.

Wind test: A mechanical test for latent tape problems done by running the tape at low speed; i.e., 80 ips or less. The tape packs tighter at lower velocities because the air is squeezed out between each layer of tape. The test is normally done at a higher vacuum, as well, to further increase the tension. Any edge damage is more likely to show up bumps during a wind test.

Zebra tape: A black and white striped adhesive tape made by 3M used to hold down ends of the magnetic tape. Used because it is less likely to leave a residue on the tape surface.

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Ask Betty Trujillo for a list of VLBA Data Acquisition Memos for more information on the VLBA recording system.