VLBA Technical Report No. 14
REVISION A

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

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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.

If the operator finds the equipment does not operate as described, he should stop and seek assistance.

Shipping and Receiving:

1. Keep unloaded tapes in the shipping canister. Store tapes vertically unless they are in their shipping canisters. Thin tapes must be stored with the reel band installed. 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 can 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.

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

4. On receipt, inspect the tape for damage. If bumps, spokes, or bands are present, the tape may be damaged. Also note if there is a visible gap between the tape pack and one of the reel flanges. 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.

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). **Never dip a dirty swab into the bottle of alcohol**. 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.

5. Use a separate swab for the headstack. Use a wiping motion 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.

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.

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.

Haystack Observatory even recommends the use of a safety razor to remove tape deposits, but one must use extreme care not to scratch the hard points if this technique is attempted. At the VLA, this procedure should be referred to the Recorder Group.

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 mount 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. The screen selections PREPASS or MOUNT are commonly used to load tape. For test, enter the TDC command LOAD. If the recorder misoperates, check the PARM/RECPARM screen as explained in Appendix A.

8. If there is any strange noise when the tape runs, stop operation immediately. Check the tape path and PARM/RECPARM. If the problem persists, notify the Recorder Group.

9. The vacuum should be 10" as displayed on the gauge inside the back door of the recorder cabinet and on the Tape Motion Screen. If more than 1" off, do not run tape; notify the Recorder Group.

10. 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.

11. 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.

12. 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.

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 if it is not to be used immediately. Store the canisters on edge to avoid any possible edge damage. Keep prepassed tapes separate from un-prepassed tapes.

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. The TDC command LOAD should only be used for testing.

3. At the VLA site only, until a VLBA formatter is installed,

the output rate for the tape recorder is set by a Wavetek signal generator. At the VLA, check that the Wavetek output rate synthesizer is set at 94.5 MHz by inspecting the dial setting. There may be an experiment where it is to be set at 189 MHZ, but special instructions will have to be given if that is the case.

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, and place it in a shipping canister. 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.

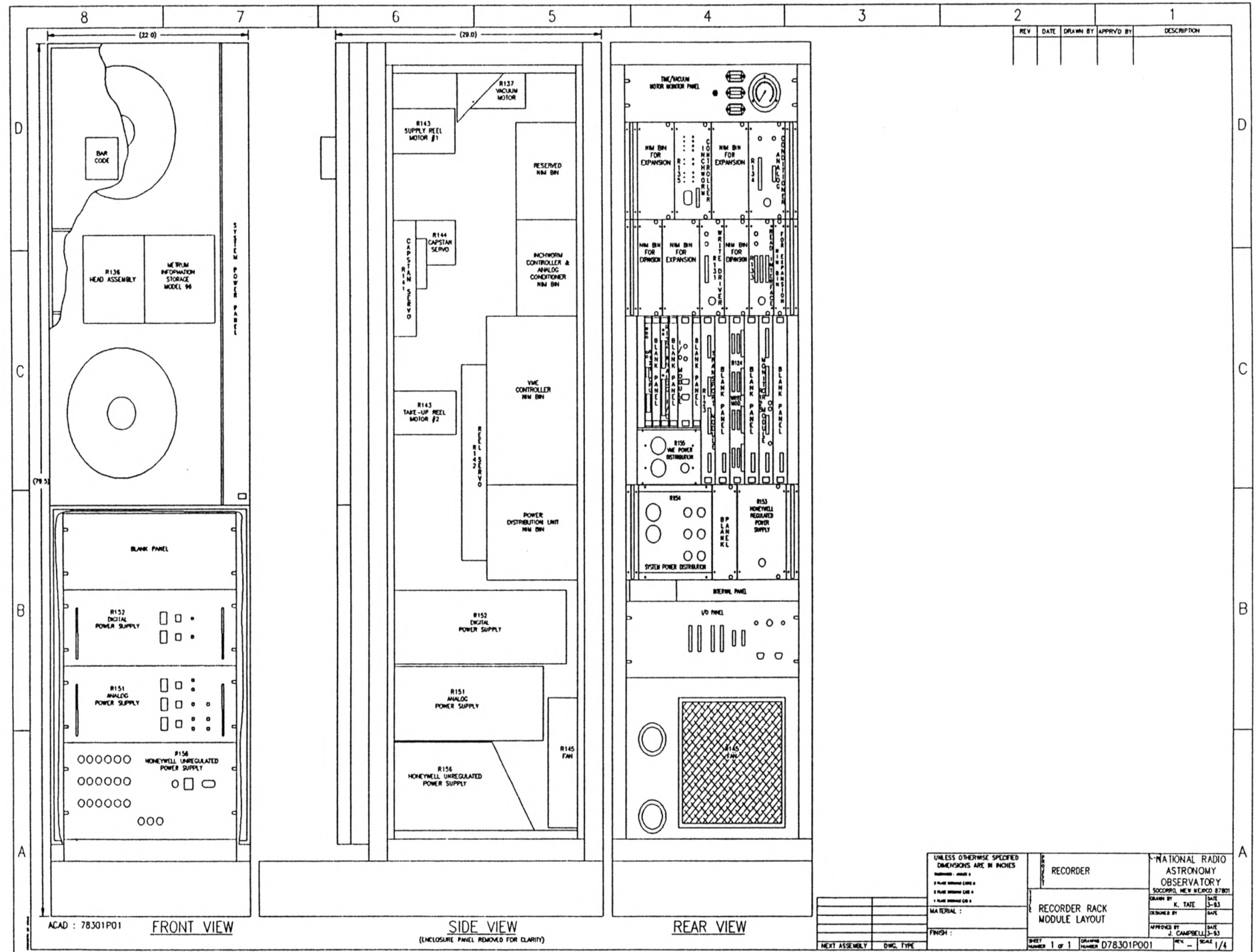
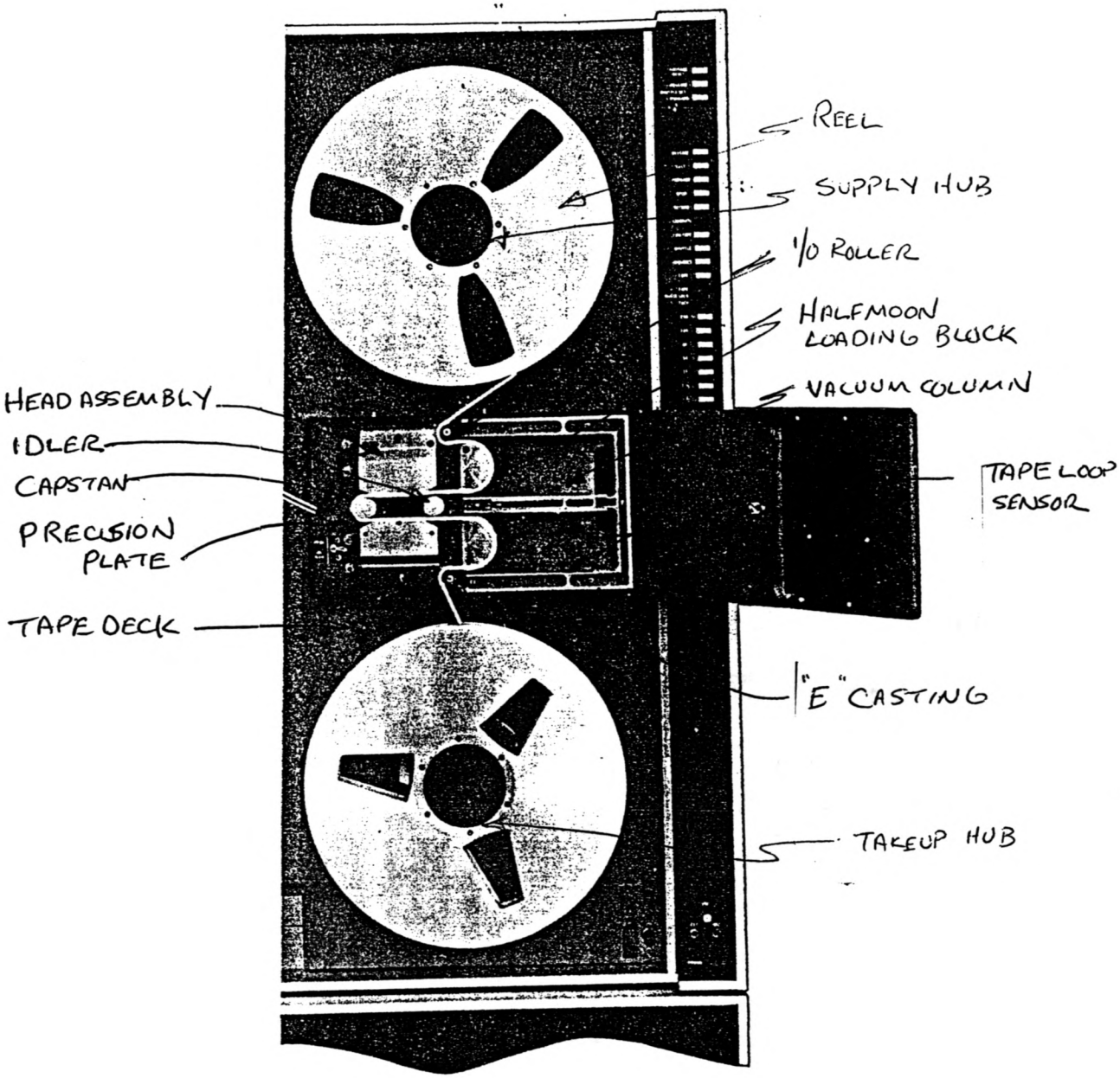

8
7
6
5
4
3
2
1
REV
DATE
DRAWN BY
APPRVD BY
DESCRIPTION
(22.0)
(29.0)
(79.5)
BAR CODE
R136 HEAD ASSEMBLY
METRUM INFORMATION STORAGE MODEL 96
SYSTEM POWER PANEL
BLANK PANEL
R132 DIGITAL POWER SUPPLY
R151 ANALOG POWER SUPPLY
R156 HONEYWELL UNREGULATED POWER SUPPLY
R137 VACUUM MOTOR
R143 SUPPLY REEL MOTOR #1
RESERVED NIM BIN
R144 CAPSTAN SERVO
CAPSTAN SERVO R131
INCH-WORM CONTROLLER & ANALOG CONDITIONER NIM BIN
R143 TAKE-UP REEL MOTOR #2
REEL SERVO R142
VME CONTROLLER NIM BIN
POWER DISTRIBUTION UNIT NIM BIN
R152 DIGITAL POWER SUPPLY
R151 ANALOG POWER SUPPLY
R156 HONEYWELL UNREGULATED POWER SUPPLY
R145 FAN
TAPE/VACUUM MOTOR MONITOR PANEL
NIM BIN FOR EXPANSION
R133 CAPSTAN CONTROLLER
R134 ANALOG CONDITIONER
WRITE DRIVER R131
R124
R155 VME POWER DISTRIBUTION
R154 SYSTEM POWER DISTRIBUTION
R153 HONEYWELL REGULATED POWER SUPPLY
INTERNAL PANEL
I/O PANEL
R145 FAN
ACAD : 78301P01
FRONT VIEW
SIDE VIEW
(ENCLOSURE PANEL REMOVED FOR CLARITY)
REAR VIEW
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. TATE 3-93
DESIGNED BY
APPROVED BY J. CAMPBELL 3-93
SHEET NUMBER 1 of 1
DRAWING NUMBER D78301P001
REV. –
SCALE 1/4

FIGURE 1



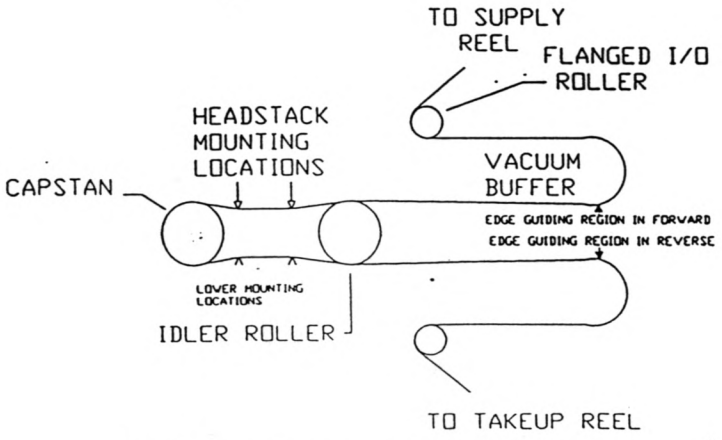


Fig. 2. Tape path in Honeywell Model 96 Transport.

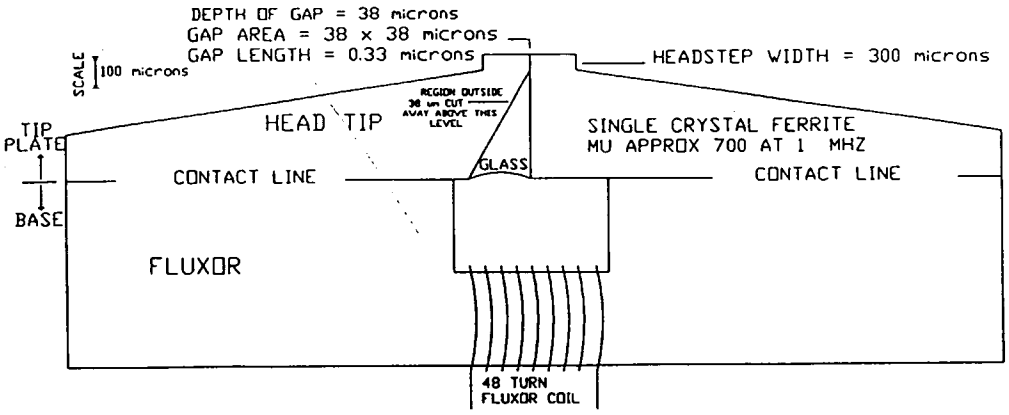


Fig. 3 Cross section of one head in the stack of 36.

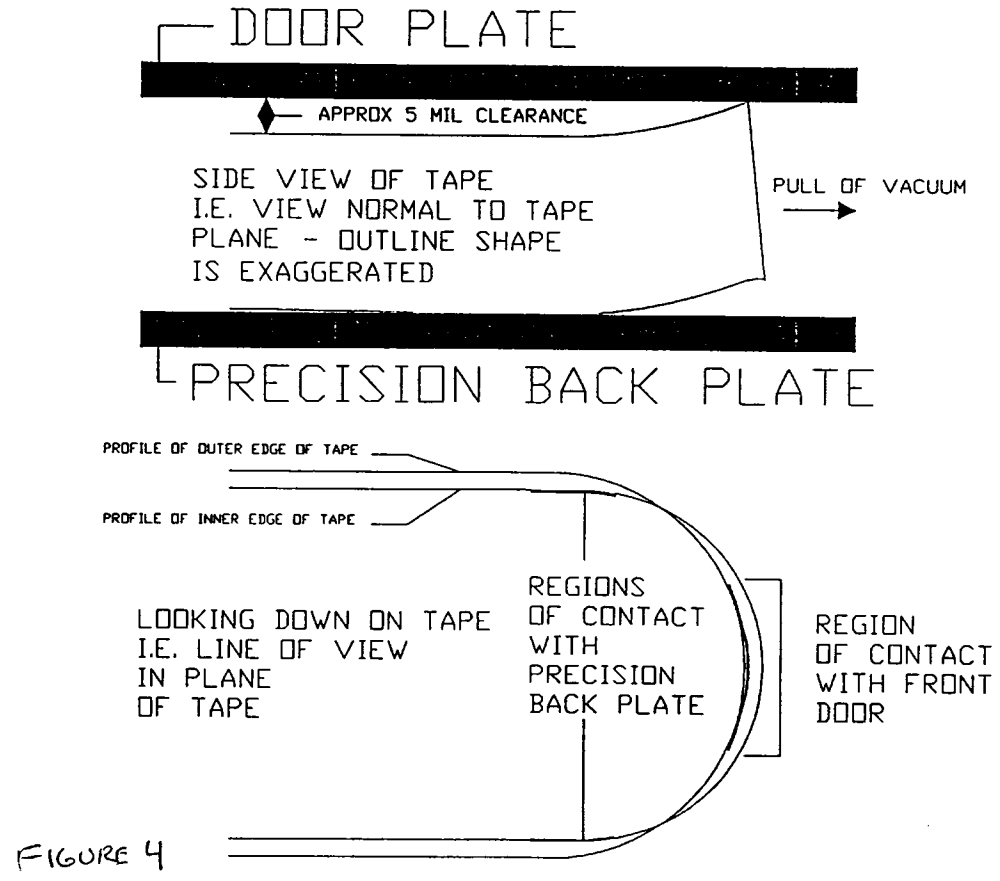


FIGURE 4

TAPE EDGE CONTACT REGIONS

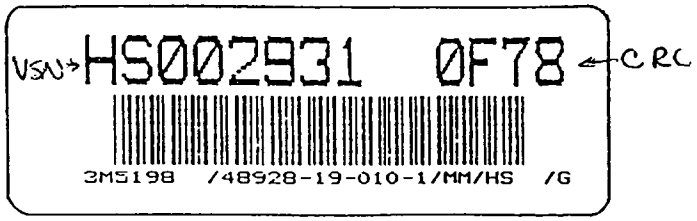


Figure 5 VSN Label Example

```
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
```

```
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
```

```
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
```

```
BBC IFDIST SYN MASER PWRSP SN LOMON
Strike <CR> to Kill This Screen
K          BASEBAND CONVERTER /
   IF B    LO FREQ  700.00    PERIOD  4
                    LSB         USB
         BANDWIDTH 62.5K         4M
     RAW BANDWIDTH #0028       #2410
        AUTO LEVEL   7.81        5.27
      TOTAL POWER  16182       16087
   SWITCHED POWER    381         404
```

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

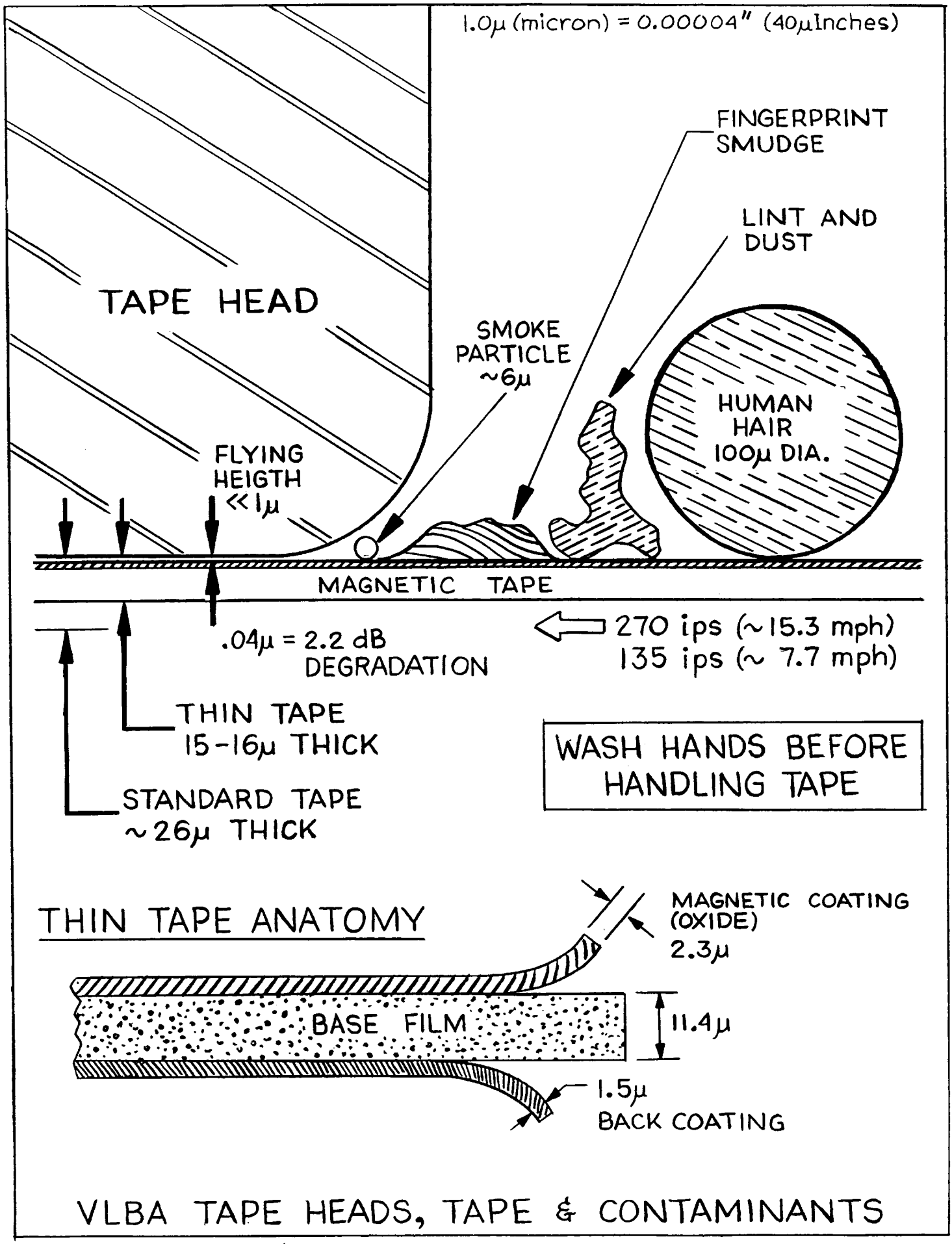
FOR LSB

```
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
```

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
```

FIGURE 7. SETUP FOR SITE TECH PROCEDURE III.

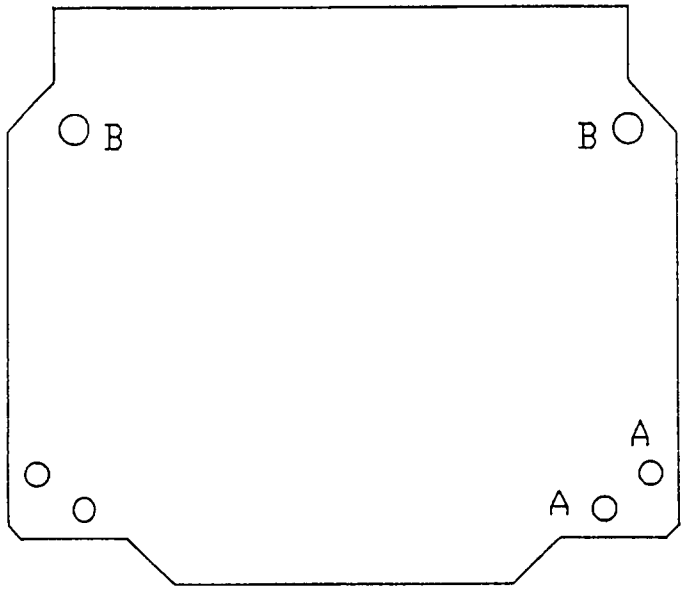


VLBA TAPE HEADS, TAPE & CONTAMINANTS

NRAO 3-93 P. HARDEN/C. JANES

FIGURE 8

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.

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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

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

NORTHEAST RADIO OBSERVATORY CORPORATION
HAYSTACK OBSERVATORY
WESTFORD, MASSACHUSETTS

VLBA RECORDER
HEAD ASSEMBLY
MOUNTING SCREWS SPECIFICATIONS

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

Appendix A

RESTORING RECORDER PARAMETERS IN THE RECPARM SCREEN

Access the RECPARM screen from PARM on the top menu bar. If you are on one of the tape recorder screens,

1. Enter <CONTROL> L to return to the TAPE menu bar,
2. Enter <CONTROL> T to return to the top menu bar,
3. Move the cursor to PARM and <ENTER>,
4. Move the cursor to RECPARM and <ENTER>.
5. Move the cursor to K on the screen and ENTER to kill the screen, when the inspection is completed.

Each recorder has different parameters, but the numbers should look something like those shown below. If the numbers are all 0 or look dramatically different from the sheet attached, it is necessary to restore the parameters on the hard disk.

In the case of the VLA, a floppy disk is kept nearby. The procedure for restoring the parameters is on a sheet folded up and stuck inside the floppy dust jacket.

```
FEPARM STATION RECPARM
Strike <CR> to Kill This Screen
<[K],,,,,RECORDER PARAMETERS, 1,,,,,,,,4
5         S/N **       CAP SIZE 54634     5
5    FAST OUT 2691       FAST IN 2568     5
5    SLOW OUT  279       SLOW IN  254     5
5    LVDT POS 1681      LVDT NEG 1705     5
5    FOR OFF -1261      REV OFF -1184     5
5      SLOPE    49    INTERCEPT   -57     5
5    SYSTRK0  2          SYSTRK1  3       5
5    SYSTRK34 18         SYSTRK35 19      5
5          --------------------           5
5  THICKNESS [268 ]WRITE VOLT 10000       5
5    VACUUM  5600         DENSITY  50     5
5  [SAVE]  [RESTORE]    [READ]  [SEND]    5
-,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,%
```

Figure 6
RECPARM Screen Example

Appendix B

SITE TECH TEST PROCEDURES

Three procedures are listed; the first to use the Tape Recorder to check the Formatter, the second to use the Formatter to check the Tape Recorder, and the third to use the Tape Recorder to check the Base Band Converters (BBC) and Samplers. SCREENS 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.

Diagnostic procedures are not presented; if the equipment does not operate as described, stop and seek assistance.

I. 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 TDC Command screen.

2. Enter the TAPE/TDC Command INIT.

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 1111 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 MARK III. 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.

6. Select FORMAT/TRAK to check that all tracks are enabled.

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. (Hint: Use <Shift>6 to move the cursor from TRAK to TDC Command).

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, 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. Enter the TDC Command AUX, and check that the 3rd and 4th hexadecimal digits of the printed screen are equal to the track number for Channel A.

11. Enter the TDC Command TIME, and check that the time on the printed screen is close to Formatter time.

12. Enter the TDC Command BS 1, and repeat steps 10 and 11 to check Channel B. Enter BS 0 to return to Channel A.

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

II. This test uses the Formatter to check the Tape Recorder. The test requires writing to a tape.

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 4 MHz and the ORATE (Output Rate) to 4.5 MHz. Check that the Formatter time is incrementing.

5. Select FORMAT/TRAK to check that all tracks are enabled.

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. (Hint: Use <Shift>6 to move the cursor from TRAK to TDC Command).

7. Enter the TDC Command SP 135 to set the Recorder speed to 135 ips.

8. Load a prepassed tape with a green dot.

9. Enter the TDC Command MOVEA 0 to move the Head Assembly to the 0 micron position.

10. Enter the TDC Command FOR to begin recording.

11. Enter the TDC Command STOP to stop recording after a few thousand feet of tape have been recorded. The Tape Record screen shows the footage.

12. Enter the TDC Command REV to rewind the tape to the starting point.

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

14. Enter the TDC Command FOR to begin tape motion.

15 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.

16. 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 0.0003 or less; NOSYNC, RESYNC, and CRC errors should be close to 0; the power indicated in the Tape Monitor Screen should be nonzero.

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

18. Unload the tape with the TDC Command UNLOAD.

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

III. This test uses the Tape Recorder to check that the BBCs and Samplers are working.

1. Select Base Band Converter (BBC) #1 as the reference oscillator by connecting its LO output to IF Distributor A Input. 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 AGC 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 Sign 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. For an output rate of 9 MHz, use SP 270. For 4.5 MHz, use SP 135.

6. Use the TAPE/TDC Commands INIT, BYPASS, and ENABLE 1111 to route formatter tracks to monitor channels A and B at the Tape Recorder.

7. Enter the Screen Command 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.

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.

APPENDIX C

VLBA TAPE HANDLING AND TAPE RECORDER CHECKSHEET

Revision date: March, 1993

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

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

__ Store the reels on their edge. Use a 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.

__ Remove the buildup of hard tape deposits on the tape edge guides in the vacuum column.

B. Tape Mounting and Loading:

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

__ Load 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 10, 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.

__ At the VLA, check the WAVETEK "Output Rate Synthesizer."

__ 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 D. IF A TAPE FAILS

Here are some things to do if a tape fails on the VLBA Tape Recorder; this list was prepared for the Thin Tape Test experiment, but is useful for any tape use:

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 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.

7. 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.

8. 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.

9. 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.

10. If the tape is broken, wrap the pieces back on the supply reel before shipping. Do not attempt to splice the tape at a VLBA site. Splicing is only done at the correlator for quality control and record keeping. Use only zebra tape when fastening tape ends. Try to just thread the broken end onto the rest of the pack on the supply reel so that there are not folded over ends or tape to introduce bumps into the tape pack.

11. If a tape edge had become exposed 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.

Appendix E. PRECAUTIONS WITH THIN TAPE

1. Dirt deposit must be cleaned off the hard points before any thin tape use; deposits are the most frequent culprit where thin tapes are damaged. A thorough scrubbing with alcohol will normally remove the deposit; if not, gently scrape the area with a razor blade. See Figure 2 and 5.

2. Take great care not to over-torque the mounting screws when replacing a head assembly. Use a maximum of 5 in-lb on the hex screws in the lower right-hand corner which use a 3/32" hex tool, and a maximum of 8 in-lb on the hex screws in the top two corners which use a 7/64" hex tool. Seat the head assembly firmly in place against the precision plate before tightening the head screws. Test with shim stock to be sure head assembly is flush. A torque screwdriver and bits are available from the Recorder Group.

The bottom-most screw of the four mounting screws on the head assembly also anchors the idler. This idler mounting screw screws into a post that, in turn, screws into the idler assembly. If the idler mounting screw is torqued down too hard, it may indent the head assembly which will in turn cant the mounting post. A bent or loose mounting post will misalign the idler and compromise tracking. As well, the mounting post can come loose from the idler housing, at which point the idler must be recalibrated or replaced. Idlers cost $1300.

3. Whenever the head assembly or other component in the tape path is exchanged, it is necessary for the Recorder Group to check out the operation of the tape recorder. Part of the check out is to have the site tech look at the eye pattern while playing back a recorded signal.

4. Wash your hands thoroughly before handling tape. Never eat or drink when handling tape. Thin tape is only 16 microns (640 microinches) thick, about the thickness of a finger print smudge, or 1/16 the thickness of a human hair. Dirt is deadly; follow the cleaning procedure elsewhere in this report religiously. Dirt introduced into the pack will "print through" many layers of tape and risk catastrophic failure from a bad pack. Thin tape costs about $1200 a reel. See Figure 8.

5. Remove the takeup reel and clean with an alcohol-soaked lint-free pad such as a Texwipe every 3 months. Although only the inside of the reel comes in contact with the tape, the outside of the flange should be clean to provide inspection of the tape pack and to reduce the possibility of contaminants migrating to the tape. Remember lint is 2 - 3 times larger in diameter than the tape thickness. Pay particular attention to the corner where

the hub joins the flange. Any debris in this area can cause a bumpy, ruined tape pack. To inspect the inside of the reel for bumps and dirt, mount the reel back on the recorder, release the brakes, turn the reel slowly and examine the inside surface with a flashlight. Clean out any particles with an alcohol-moistened cotton swab. Soap and water are not recommended for use because their long-term effect on the hub materials and epoxy bond between flange and hub is unknown and because water will lift the polyurethane coating from the glass reel flanges if left in the water too long.

6. When feeling for bumps on the tape in motion, use an orange stick instead of fingers. Use a feather-light touch to avoid distorting the pack and point the stick in the direction of motion to avoid snagging the tape.

7. Most gap measurements between tape pack and reel flange can be estimated visually with sufficient accuracy. If you need help, use the shim kit that has been issued to each VLBA site. Start with the smallest practical shim first, then advance to thicker ones. Never jam a shim between the tape pack and reel; when the shim begins to feel snug, just use that value. Only measure the first inch or so from the perimeter of the tape. When noting the gap measurements, the outside gap is the gap between the tape pack and the flange with the VSN and the inside gap is between the tape pack and the flange toward the drive. A chart relating shim color with thickness is included with the shim set.

Appendix F. Thin Tape Accelerated Test Procedure

SUMMARY

The purpose of the Accelerated Thin Tape Test is to identify problem areas with the use of thin tape before the full complement of thin tapes is deployed. The test is designed to simulate five years of normal usage, including shipping to a variety of sites, and having a variety of site techs run the tapes under normal site conditions. To be useful in identifying and correcting any problems, the test must be completed as soon as possible.

Besides the shipping and handling, the test includes shuttling the tape back and forth on the tape transport for 8 hours at 330 ips. The site tech is asked 1) to clean the tape path after one forward pass to check for tape debris that may have loosened during shipping, 2) to check the gap between tape pack and reel flange on receipt of the tape and after the shuttle test to separate shipping from shuttling as causes of tape pack shifting problems, and 3) to inspect the tape for damage. A check sheet and report form accompanies each tape to be tested. It is estimated that 35 test cycles will simulate 5 years use for a given tape.

VLBA Operations schedules the tests at the completion of each maintenance day, so that the test conflicts with neither daytime maintenance nor with scientific use. The site tech will mount the tape before leaving the site at the end of the maintenance day, the vlba operators will conduct the shuttle test, and the site tech will remove the tape the following day or when the next science run is scheduled.

Haystack will visually inspect the tape and tape pack for defect, perform a high tension "wind" test to uncover any latent tape problems, and perform pathology on damaged tapes. Both the sites and Haystack are using TRACK to follow the movement of the tapes.

For comparison with the Accelerated Thin Tape Test, Hans Hinteregger at Haystack is also performing a life time test on tape samples in which he runs a short piece of tape back and forth to simulate thousands of tape passes. This test serves as a baseline for the Accelerated Test, but does not test the use of the tape on the modified tape transports nor it does it test the variabilities of shipping and site handling.

The AOC Recorder Group monitors the progress of the test and serves as liaison between Haystack and the test sites.

VLBA SITE PROCEDURE--Accelerated Thin Tape Test

1] Receive tape and allow enough time for temperature of the tape to reach room temperature. About 3 hours should be enough. Enter receipt of the tape on TRACK.

2] Visually inspect the tape for any problems. Check for scatter, spokes, bumps, debris on the tape, or other damage to the tape or reel. Note all results of the test on the checksheet enclosed with the tape reel, answer all questions on the sheet.

3] Visually check the separation between tape pack and inside reel flange and between tape pack and outside reel flange. If a visible gap is present, estimate the width or measure it with the shim kit. Note the measurements and on which side of the pack the gap occurred on the checksheet.

4] Clean tape path and heads; see earlier notes. Examine hard points in the vacuum column with a flashlight and, if necessary, with a loupe to make sure all deposit is removed. Any deposits on the hard points may destroy the thin tape.

5] Load tape with the SCREEN command LOAD, move the head to its center position with the TDC command MOVEA 0, set the tape speed to 330 ips with the command SP 330, and run the tape forward with FOR. The vacuum should be set at 10". Thin tape may be run on a modified drive only. It is important to move the head to position 0; there is a chance that if the head motion is jammed against a stop, that the tape would be damaged.

6] At the end of the forward pass, enter TDC Commands VAC 0 and REL to drop vacuum and release brakes. Open the vacuum door, move the tape out of the way, and clean the heads and tape path. Inspect the hard points again, remove any deposits, and report action on the checksheet.

7] Load the tape and advise VLBA Operations that the drive is ready for the thin tape shuttle test. Operations will run the shuttle test for 8 hours. The head will automatically move occasionally during the test to even out head wear.

8] After the shuttle test, unload the tape and make a visual inspection of the tape and tape path; note any deposits in the vacuum column or problems with the tape on the checksheet. Inspect for a gap between the tape pack and the reel flanges and note the measurements and location of any gap large enough to be visible on the checksheet.

9] Return the tape and the completed checksheet to the shipping canister and ship to Haystack. Enter the shipment on TRACK.

Appendix G

DEFINITIONS

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.

Orange stick: A wooden stick with tapered ends, commonly used for tuning radio equipment, available from suppliers of electronic tools. Each VLBA site has been sent one.

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

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 nearly equal to 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.

Non-self-packing reel: Typically refers to a tape reel with 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.

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

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. Severe bumps will leave voids or "windows" in the tape pack.

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.

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.

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.

Flange separation: The gap between reel flange and tape pack.

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.

Cinching: One section of tape rotates with respect to another section inside the tape pack, causing the tape to bump up and spoke. Typically cause by angular shock to the shipping canister especially where the pack is loose. The tape reel is not permitted to rotate in the shipping container to reduce angular shock.

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

Hard points: The area on the side of the vacuum column and the vacuum column door that interfaces with the tape. These are the only surfaces that should be in contact with the tape edges. The tape loops at the hard points. See figure 4.

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.

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

Zebra tape: A black and white striped adhesive tape made by 3M used to hold down ends of the magnetic tape. Used because it does not leave a residue on the tape surface.

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, and the capstan.

"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.

Capstan: A roller in the tape path which is driven by a motor to move the tape.

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.

Tape loop sensor: There are two tape loop sensors, one in each of the two vacuum chambers. As the tape 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.

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.

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.

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

REFERENCES

1. VLBA Data Acquisition Memo #247, Mark III Tape-Labelling and Handling Procedures, Alan R. Whitney, Haystack Observatory, March 20, 1991.

2. VLBA Data Acquisition Memo #267, Tape (thin) and Transport Handling Procedures, Alan E. E. Rogers and Hans F. Hinteregger, Haystack Observatory, September 27, 1991.

3. A High Data Rate Recorder for Astronomy, Hinteregger et. al., IEEE Transactions on Magnetics, Vol. 27, No. 3, May 1991.

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