NATIONAL RADIO ASTRONOMY OBSERVATORY
Socorro, New Mexico

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VLA Computer Memorandum #126

DATA FORMAT FROM SYNCHRONOUS SYSTEM

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Once every ten seconds, a record set will be written from BOSS to the fixed-head disk to be read by the DEC-10, and also stored on an archive tape. This set consists of one logical record, as described below, per active subarray.

The record written on the tape will be divided into units 1024 words long, a convenient buffer length. The format will be DEC-Magtape format (DMF), of which more will be said later. The record written on the FHD will be divided into segments 128 words long, the width of a sector. The format will be MODCOMP non-standard binary; a hardware conversion will read this into the DEC-10 as left-adjusted halfwords, with unused bits set to zero. The first sector (sector 0) of the FHD contains the following: Halfword 0 = number of first sector of current 10-second data; Halfword 1 = number of next available sector. Only 2047 of the 4096 sectors are used for this data; when sector 2047 is written, the pointer is reset to sector 1.

In either case, spanned records will be written. No blocking will be done. The first word of the tape record contains, right adjusted, the physical record length of each record on the tape. The first word of the disk record and the second word of the tape record contain information about the spanning. The leftmost sixteen bits will contain, right adjusted, a spanning sequence number (1 for the first block, 2 for the second, etc.). The leftmost sixteen bits of the right halfword will contain, right adjusted, the number of blocks in this logical record. Thus, end-of-record is detected by left halfword=right halfword. Having described these control words, we shall omit all further reference to them, That is, we shall refer to the first halfword following the first spanning control word as Halfword 0, the right halfword of that word as Halfword 1, etc.; and if, say, the first block is 1000 halfwords counting the spanning control word, the first halfword following the spanning control word of the second block will be called Halfword 998 of the record. From now on, the word "record" will mean "logical record."

A record will be divided into several areas, described below. Items marked with an asterisk (*) are not yet implemented, as of September, 1975; items marked with a plus sign (+) are only partially implemented. Partially implemented items will contain harmless but unmeaningful data, but unimplemented items should be entirely ignored until further details are available. First comes the Record Control Area (RCA), beginning with Halfword 0 of the record:

Halfword	Description
0	Logical record length, halfwords
1	Unused
2	Format type (description below is format 1)
3	Format revision level
4,5	Date--MJAD
6,7	Time--count of 19.2 Hz. interrupts
8	Control program I.D. *
9	Unused
10	Pointer to Subarray Data Area (SDA)
11	Length of antenna entry
12	Pointer to Antenna Data Area (ADA)
13	Number of antennas
14	Pointer to Bad Correlator Area (BCDA) + (zero if not present)
15	Number of bad correlators +
16	Pointer to first correlator data area
17	Number of correlators
18	Pointer to second correlator data area
19	Number of correlators

The format of the Subarray Data Area (SDA) is given below. Those values which are suffixed by "FP" are in MODCOMP single-precision floating point; those suffixed by "DP" are in MODCOMP double-precision floating point. This will require some minor manipulation to make it sensible to the DEC-10, chiefly the shifting left of the characteristic one place, and the elimination of the surplus zeros generated by the different word lengths. MODCOMP extended precision floating point is three words (48 bits) but for convenience is expanded into DEC-10 double words. The SDA begins in the halfword pointed to by the number in Halfword 10 of the RCA, and continues as described below:

Halfword	Description
0	Subarray I.D.
1	Unused
2 to 5	Source name (7-bit ASCII with leftmost bit 0)
6	Source name numeric qualifier
7	Unused
8,9	Observer and program I.D. (ASCII) +
10	Observer and program I.D. (numeric) +
11	Unused
12,13	Observation mode descriptors (columns 60-62 of source input card)
14	Array status byte *
15	Gain code +
16	Number of complex correlators per tensor correlator (two or four) +
17	Unused
18 to 19	Stop time, LST, radians (FP)
20 to 21	Start time, LST, radians (FP) *
22 to 25	Source position (1950) RA, radians (DP)
26 to 29	Source position (1950) DEC, radians (DP)
30 to 33	Source position (now) RA, radians (DP)
34 to 37	Source position (now) DEC, radians (DP)
38 to 41	LO 1, GHz (DP)
42 to 45	LO 2, GHz (DP)
46 to 49	LO 3, GHz (DP)
50 to 53	LO 4, GHz (DP)
54 to 57	IAT time, end of interval, radians (DP)
58 to 61	LAS time, end of interval, radians (DP)
62 to 63	N-1 (FP)
64 to 65	Zenith atmospheric phase path, nsec. (FP)
66	Sin(h), end of interval
67	Cos(h), end of interval
68	Cos(A), end of interval
69	Sin(A), end of interval
70	Cos(η), end of interval
71	Sin(η), end of interval

A separate logical record will be written for each subarray active.

The Antenna Data Area (ADA) has the format described below;

0	Antenna I.D., antenna address (right byte of each)
1	U, nsec. 1950 (precession not yet implemented)
2	V, nsec. 1950
3	W, nsec. 1950
4	IF status (IF A in first nibble, etc.) +
5,6,7,8	Nominal sensitivity (IF A,B,C,D) *
9,10,11,12	IF peculiar phase (IF A,B,C,D) +
13 to 20	Polarization information (IF A,B,C,D) *

This data group appears once for each antenna in this subarray. Finding the correlator data associated with a given antenna is a rather clumsy process, so the usual procedure will be to process the correlator data in sequence, and determine the antennas from which it arises by, for example, the following loop:

```
N = 0;
Do for I = 0 to NANT-1 by 1;
     Do for J = 1 to NANT-1 by 1;
        N = N + 1;
        Comment correlator data is located in the address given by
            (correlator data area pointer) + (N-1)*(number of complex
            correlators per tensor correlator)*3
        Comment this correlator is associated with the two antennas whose
            antenna data groups are addressed by
            (ADA pointer) + I*(antenna entry length)
            and
            (ADA pointer) + J*(antenna entry length)
        Comment correlator data area 1 contains data from correlator
            bank 1, associated with LO 1 and LO 2 (which will be iden-
            tical if crossed polarization data is present), and corr-
            elator data area 2 contains data from correlator bank 2,
            associated with LO 3 and LO 4.
     end;
end;
```

The data group for a tensor correlator is comprised of complex correlator data groups as follows:

correlator for IF 1 of antenna 1 times IF 1 of antenna 2
correlator for IF 2 of antenna 1 times IF 2 of antenna 2

and optionally the crossed polarization correlators

correlator for IF 1 of antenna 1 times IF 2 of antenna 2
correlator for IF 2 of antenna 1 times IF 1 of antenna 2

Each complex correlator data group consists of the following halfword numbers:

real part
imaginary part
modified variance

The modified variance is the computed variance modified to take account of the source amplitude scattered into the variance by the atmospheric phase fluctuations. This process of modification has not yet been defined, but the intent is to make a single comparison detect high variances due to interference or malfunction. The correlator data area actually appears after the Bad Correlator Data Area (BCDA).

A bad correlator entry consists of two halfwords for each faulty correlator. The first is the correlator status byte and a bit saying which correlator set the error refers to. The second is the correlator number (pointer to the correlator data group). In fact, the whole set of bad correlators appears in each subarray record whether they are connected to that subarray or not. The distinction is not yet implemented.

DEC-MAGTAPE FORMAT

Two MODCOMP sixteen-bit words will be packed into each DEC 36-bit word; each MODCOMP word is left-adjusted and is placed in a DEC halfword with the unused bits set to 0. However, 36 bits do not fit easily onto 9-track tapes. Therefore, the tapes are written in DMF, viz.:

Track Byte	1	2	3	4	5	6	7	8	9
1	F0	F1	F2	F3	F4	F5	F6	F7	P
2	F8	F9	F10	F11	F12	F13	F14	F15	P
3	F16*	F17*	R0	R1	R2	R3	R4	R5	P
4	R6	R7	R8	R9	R10	R11	R12	R13	P
5	0	0	0	0	R14	R15	R16*	R17*	P

* usually 0
Fx is the x'th bit of the left halfword; Rx is the x'th bit of the right halfword. P is parity

Since it is easier for the MODCOMP to handle words instead of bytes, the record length will be rounded up to the nearest multiple of four halfwords. Therefore, four MODCOMP words will be converted to five MODCOMP words in DMF and written onto tape. The tape is now directly readable by the DEC-10.

A program exists on the MODCOMP, DMCOPY, that converts a tape written in DMF back to binary; a subroutine, DMCSUB, converts a buffer passed to it.

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VLA COMPUTER MEMORANDUM #126 ADDENDUM

FORMAT CHANGES TO DATE

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Since Memo #126 was written specifying Format Type 1, Revision 1, we have created two new revisions and a new format type. The changes from Revision 1 are:

Revision 2 (December 8, 1975)

RCA:	Word 11	- Originally, this word gave the total length of the antenna data; it now gives the length of the ADA for each antenna. This is the way it should have been done in the first place. I apologize for blowing it.
ADA:	Word 22	- This added word is the high-order azimuth (ACB 8) used for determining the amount of cable wrap.

Revision 3 (June 28, 1976)

SDA:	Words 72, 73	- The bandwidth codes (SCB 158, 159) have been added.
	Word 74	- The array control bits (ARACB 7) have been added.
ADA:	Word 4	- The IF status now has the antenna, front end, and preamp status ORed into it.
	Word 21	- This word has been changed to be the antenna control bits (ACB 3).

Format 2 was invented to put elements from a source library onto tape. Specifically, we use it to dump certain elements of the observing library onto the correlator data output tape for later reference.

The following files are dumped, if present in the library; or else they are ignored:

1) file ARRAY.
2) file ANTENNAS.
3) files SUB1, SUB2, SUB3, SUB4, SUB5.
4) files containing observation request cards mentioned on the first card of SUBx.
5) files mentioned in columns 61 or 71 of the default LO cards in SUBx.
6) files mentioned in columns 61 or 71 of the frequency set (//LO) cards in the files containing the observation request cards.