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CAVENDISH LABORATORY
MULLARD RADIO ASTRONOMY OBSERVATORY

MT/1.2

MT Project
MT Design Note 1.2

Issued by

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Revised

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General Single Dish Data Format System

1 PREFACE TO MTDN1.1

This note was formally CSDD. It is now being issued as a new note with some revisions for the new documentation scheme.

On Rachael Padman's suggestion, I have included a description of the basic set as the first chapter as an introduction to the concepts and also to ensure that extensions of the system can grow from a common core. The original "Full System" is now described in the second chapter. Many of the items are not properly defined yet and there is still redundancy to eliminate.

JHF

2 PREFACE TO MTDN1.2

Clarification and amendments to item description. The mapping parameter section has been revised to reflect the more general MRAO mapping scheme.

RP

CONTENTS

CHAPTER 1

INTRODUCTION

1.1 GENERAL

This document contains the specification and explanation of the General Single Dish Data Format System. This specification has been drawn up according to the requirements of the NRAO, IRAM, and UK/NL MT teams.

The specification defines a physical format for the storage of single dish data and for its transport between the computer systems participating in its definition.

The specification defines the meaning of the data items to be transported so that reduction software developed at any institution can be used on data produced by any of the telescopes.

The FITS format has not been chosen as the primary transport system because it would require:

- o A large amount of formatted header information giving overheads in the time taken to create it and to store it.
- o The DEC Backup Utility offers a more reliable method of reading and writing error free tapes.

It is important to note that this format can easily be converted to FITs.

1.2 TAPE DESCRIPTION

Data will be transported in DEC VAX/VMX RMS compatible files on DEC BACKUP tapes or on ANSI standard tapes.

BACKUP is a highly reliable facility for writing and reading tapes and should be used wherever possible.

1.3 FILE DESCRIPTION

The DEC VAX/VMS RMS file organisation is SEQUENTIAL with fixed length 512 byte records.

Such an organisation permits random access with VAX/RMS.

Files of this organisation are compatible with the ANSI standard, i.e disk files of this type can be directly copied to ANSI standard tape. Such files contain the minimum RMS control information (None?). The file definition is given below:

```
TITLE   "GSDD.DAT"

IDENT   " 6-JUN-1985 18:35:48   VAX-11 FDL Editor"

SYSTEM
        SOURCE                  VAX/VMS

FILE
        ALLOCATION              <->
        BEST_TRY_CONTIGUOUS     yes
        EXTENSION               <->
        NAME                    "GSDD.DAT"
        ORGANIZATION            sequential

RECORD
        BLOCK_SPAN              no
        CARRIAGE_CONTROL        carriage_return
        FORMAT                  fixed
        SIZE                    512
```

Users of the GSDD format on a VAX should copy the above information into an FDL file and use it for creating/converting files to the GSDD format.

The file consists of datasets. There are only two kinds of datasets, the "File Prolog" dataset and the "Scan" dataset. Each file will contain, one and only one File Prolog dataset. Each file will contain at least one Scan dataset. Datasets are positioned by record number.

Datasets are composed of "items". An item may a scalar(variable) or a vector(array). Items will be positioned in terms of 64 bit locations (quadwords). Items may not cross location boundaries. Locations are numbered from the start of each "Prolog". The permitted data types for a scalar or a vector element are:

Logical	L*1	(Unsigned byte)
Integer	I*4	(Signed longword)
Real	R*8	(Double precision)
Character	C*8	(8 byte character string)

If no value can be given to an item, the null value of the items should be:

Logical	256	
Integer	-2147483647	('FFFF'X - Minimum value of signed longword)
Real	-1E+37	(Lower range of double precision)
Character	' '	(Blank String)

The bytes 1-8 in a location are ordered left to right. The bit structure of the data types follows the rules for DEC machines. Where a location is occupied by a single integer the integer will be placed in bytes 1 to 4. The rest of the location must be padded with another integer.

CHAPTER 2

THE BASIC SYSTEM

This chapter describes a minimum format, as a way of introducing a practical data structure. This minimum format is intended primarily for reduced spectra. The information included in the header is regarded as a minimum complete set which will enable the data to be reduced and displayed.

2.1 THE NEED FOR A MINIMUM FORMAT

If we want observatories in general (many of which do not support computer professionals on their staffs) to adopt our proposed standard data format, we have to make it accessible. This means it must be possible to write a recognizable file without (1) requiring any specialist knowledge of data-base systems, and (2) without having to provide lots of data items which may be either unknown or unnecessary in most contexts. Furthermore, if we all decide to adopt this format as the basis of our data reduction system, then it must be possible to include data from other wavebands with a minimum of difficulty. In practice this means that we should not require radio-specific data (aperture efficiency etc). The data items selected here refer specifically to the spectrum, and not to the observation.

There is a second reason for wanting to define a minimum format. This is one of completeness. It is not always intuitively obvious just which parameters are required to specify an observation fully.

2.2 MINIMUM REQUIRED DATA

In order to identify a spectrum absolutely for later use the following items are required:

1. The time at which the spectrum was measured (by convention the start time)

2. The position on the sky at which the centre of the beam was pointing.

3. The X co-ordinate system of spectrum (e.g. centre frequency and channel spacing).

4. The noise level on the spectrum.

Any reduction system must be capable of operating on data which have only this information, even if not all possible operations in the reduction system can be carried out without further details. With the information given above it is always possible to:

1. Display the data with properly labelled axes.

2. Perform any 1-d data-type-independent operations (baseline removal, addition, subtraction, normalization by a control spectrum, etc).

3. Merge the data (via averaging or otherwise) with data from other instruments (subject to an intelligent understanding on the part of the observer).

2.3 FILE PROLOG DATASET DESCRIPTION

The File Prolog will appear at the beginning of the file which describes the structure of the file in terms of scans. The contents of the file prolog are as follows:

Item	Location	Format	Value
GSDD File Version Number	1	I*4	1
Number of scans in the file		I*4	N
Start record of scan 1	2	I*4	
Start record of scan 2		I*4	
:	:	:	
:	:	:	
Start record of scan N		I*4	

2.4 SCAN DATASET DESCRIPTION

A Scan Dataset consists of:

- o The Scan Dataset Prolog describing the structure of the rest of the dataset. The Scan Dataset Prolog starts in the first record of the Scan Dataset.

- o The Scan Header containing the quantities which are fixed in the time domain of the observation (i.e they are "parameters" of the scan). These quantities must be scalar items. The Scan Header starts on a new record of the Scan Dataset.

- o The Scan Data Tables containing the quantities which are variable in the time domain of the observation (e.g: raw data) or are dimensioned by parameters of the scan (e.g: the backend data). These quantities are vectors items. Each Scan Data Table starts on a new record of the Scan Dataset.

2.5 SCAN DATASET PROLOG

The first item is the GSDD structure version number. This is provided so that software processing the scan dataset can check if the structure is compatible with the program.

The next 2 items, the number of scalar and vector classes, give the number of subdivisions of header information and the the number of tables respectively.

The next 3 items of the prolog record the positions of the start of the Scan Header and Scan Data Tables.

The rest of the prolog describes the hierarchical structure of the header and table information. This information is provided to permit dynamic reading of the scan dataset. This facility is necessary so that addition of new items to the dataset can be automatically handled by programs processing scan dataset information. New items can be added logically to the dataset - i.e they can be added at the end of a group of related items, without modifications of the header processing programs.

Item Name	Value	Mnemonic	Location
GSDD Structure Version Number	1	SOVER	1
Number of Scalar Classes	2	SONSC	
Number of Vector Classes	2	SONVC	2
Start Record of Scalar Classes	2	SOSCS	
Start Record of Vector Class 1	< >	SOVC1	3
Start Record of Vector Class 2	< >	SOVC2	
Number of Scalar Class 1 Characters	1	S1NSC	5
Number of Scalar Class 1 Integers	0	S1NSI	
Number of Scalar Class 1 Logicals	0	S1NSL	6
Number of Scalar Class 1 Reals	1	S1NSR	
Number of Scalar Class 2 Characters	2	S2NSC	7
Number of Scalar Class 2 Integers	0	S2NSI	
Number of Scalar Class 2 Logicals	0	S2NSL	8
Number of Scalar Class 2 Reals	9	S2NSR	
Vector Class 1 Dimensionality	1	V1DIM	9
Number of Vector Class 1 Characters	3	V1NVC	
Number of Vector Class 1 Integers	1	V1NVI	10
Number of Scalar Class 1 Logicals	0	V1NSL	
Number of Vector Class 1 Real	5	V1NVR	11
Vector Class 2 Dimensionality	5	V2DIM	
Number of Vector Class 2 Characters	0	V2NSC	12
Number of Vector Class 2 Integers	0	V2NSI	
Number of Scalar Class 2 Logicals	0	V2NSL	13
Number of Vector Class 2 Reals	1	V2NSR	

The description of each table is prefixed by the parameters of the scan which dimensions them. The "dimensionality" of the table is the number of these parameters in front of the table.

2.6 SCAN DATASET HEADER

This is the regarded as the minimum header information required to identify the scan and process it.

2.6.1 Scalar Class 1 : Identity Parameters

The Identity Parameters award a scan a unique designation.

Item	Mnemonic	Location	Format	Unit
Telescope Descriptor	S1TEL	1	C*8	
Scan Number	S1SNO	2	R*8	

Telescope Descriptor
Identifies the telescope.
Examples: UKMT, NRAO-TUC, NRAO-GB, IRAM

Scan Number
Sequence number for the scan.
With the Telescope Descriptor it provides a unique identity tag. The integral value of the Scan Number defines the object observed in an observing run. The fractional part of the Scan Number defines the repeat number of the scan of the object.

2.6.2 Scalar Class 2 : Space-Time Parameters

The Space-Time parameters define the telescope and target locations in time and space.

Item	Mnemonic	Location	Format	Unit
Equinox Code	S2EQN	3	C*8	
Coordinate System Code	S2CSC	4	C*8	
Telescope Geographic Longitude	S2TLN	5	R*8	DEGREE
Telescope Geographic Latitude	S2TLA	6	R*8	DEGREE
Telescope Altitude	S2TAL	7	R*8	METER
Universal Time Date at scan start	S2UT1	8	R*8	YYYY.MMDD
Universal Time Hour at scan start	S2UT2	9	R*8	HOURS
Epoch of Lamda,Beta in Universal Time	S2EPH	10	R*8	YEAR
Source Lamda	S2KSL	11	R*8	DEGREE
Source Beta	S2KSB	12	R*8	DEGREE
Source Pi	S2KSX	13	R*8	DEGREE

Equinox codes
Possible values are 'B1950' and 'J2000'.
The Equinox Codes determine the time reference frame.

Coordinate System codes

0 = Galactic (lII, bII)
1 = 1950 RA,DEC
2 = Epoch RA, DEC
3 = Mean RA, DEC at the start of the scan
4 = Apparent RA, DEC
5 = Apparent HA, DEC
6 = 1950 Ecliptic
7 = Epoch Ecliptic
8 = Mean Ecliptic at the start of the scan
9 = Apparent Ecliptic
10 = Azimuth, Elevation
11 = Supergalactic

Times
Universal Time Hour is the fractional day of Universal Time Date.

Coordinates
Lambda, Beta and Pi depend on the Coordinate System. The Pi coordinate (e.g. Horizontal Parallax) is included to allow reduction of observations of solar system objects.

2.7 SCAN DATASET TABLES

2.7.1 Vector Class 1: Backend Table

Item	Mnemonic	Location	Format	Unit
Number of Backends	V1NBC		I*4	
Backend Descriptor	V1BKE	2	C*8	
Data Precision Code	V1DPC	2+V1NBC	C*8	
Data Calibration Code	V1CAL	2+2*V1NBC	C*8	
Number of Channels	V1NCH	2+3*V1NBC	I*4	
Reference Frequency	V1REF	2+4*V1NBC	R*8	MHZ
Observed Frequency	V1CF	2+5*V1NBC	R*8	MHZ
Frequency Resolution	V1BPP	2+6*V1NBC	R*8	MHZ
Thermal Noise Level	V1NOI	2+7*V1NOI	R*8	DN

Data Precision Codes

0 = L1
1 = I2
2 = I4
3 = R4
4 = R8

Data Calibration Codes
Units of data - e.g. 'K', 'Jy', etc

Reference Frequency
Frequency for which LSR velocity corrections etc have been applied. Usually this will be the rest frequency of the molecule being observed.

Observed Frequency
Frequency observed - i.e. frequency corresponding to centre channel of backend (centre channel defined by FLOAT(NCH+1)/2.). It represents the frequency to which the receiver front-end is actually tuned. The observed frequency, reference frequency and frequency increment (see below) are always sufficient to define the frequency scales, independent of which velocity reference is used for reduction.

Frequency Resolution
Channel width of spectrometer. May be positive or negative, depending on frequency conversions in the receiver and backend.

Thermal Noise level
Units are DN - Data numbers, i.e. same units as data values. This is a more useful measure than integration time and system temperature, as it is the only quantity required for averaging with optimal weighting.

****
We still don't know how to deal with non-linear frequency scales,
- as would be required for some Acousto-Optic spectrometers, or
possibly optical/IR data. I suggest that a zero frequency resolution be used
as a flag to indicate that a non-linear scale is in use, and that we find
a way to include the actual frequencies with the data - perhaps a frequency
table similar to the pointing history table.
****

2.7.2 Vector Class 2 : Data Table

Item	Mnemonic	Location	Format	Unit
Number of Backends	V2NBC	1	I*4	
Number of Integrations per Scan	V2NIS		I*4	
Number of Cycles per Integration	V2NCI	2	I*4	
Number of Phases per Cycle	V2PCC		I*4	
Number of Channels + 1	V2NCH	3	I*4	
Data(NCH, PCC, NCI, NIS, NBC)	V2DAT	4	R*8	

Definitions

1. PHASE - Particular combination of switched parameters. Thus a simple beam-switched observation would involve 2 phases (on- and off-source).

2. CYCLE - Complete observation, involving measurement of the power level for each channel for one complete set of phases.

3. INTEGRATION - Normally the data will be accumulated over a number of cycles before being reduced. An integration comprises this number of cycles.

4. SCAN - Complete observation of source. In general could include a number of integrations. Reasons for breaking up a scan into more than one integration include guarding against interference or loss of data due to a system failure.

Each set of channel values is tagged with the universal time of measurement offset from the start of the scan. This time is given in seconds. The time is the first item in the list of data numbers of each channel, hence the data array is dimensioned NCH+1. In the basic system all array dimensions except NCH would be equal to 1.

CHAPTER 3

THE FULL SYSTEM

The file prolog is the same as in the basic system. The full system has many more entries in the scan header and more data tables. Whereas the basic system is expected to be used with reduced data only, the full system is intended to contain all the information necessary to reduce the data.

The full system is expected to used by the institutions participating in the specification of the format. Explanations of items in the basic system are not repeated here.

Item Name	Value	Mnemonic	Location
GSDD Structure Version Number	1	SOVER	1
Number of Scalar Classes	9	SONSC	
Number of Vector Classes	5	SONVC	2
Start Record of Scalar Classes	2	SOSCS	
Start Record of Vector Class 1	4	SOVC1	3
Start Record of Vector Class 2	< >	SOVC2	
Start Record of Vector Class 3	< >	SOVC3	4
Start Record of Vector Class 4	< >	SOVC4	
Start Record of Vector Class 5	< >	SOVC5	
Number of Scalar Class 1 Characters	8	S1NSC	5
Number of Scalar Class 1 Integers	0	S1NSI	
Number of Scalar Class 1 Logicals	0	S1NSL	6
Number of Scalar Class 1 Reals	1	S1NSR	
Number of Scalar Class 2 Characters	2	S2NSC	7
Number of Scalar Class 2 Integers	0	S2NSI	
Number of Scalar Class 2 Logicals	0	S2NSL	8
Number of Scalar Class 2 Reals	16	S2NSR	
Number of Scalar Class 3 Characters	1	S3NSC	9
Number of Scalar Class 3 Integers	0	S3NSI	
Number of Scalar Class 3 Logicals	0	S3NSL	10
Number of Scalar Class 3 Reals	11	S3NSR	
Number of Scalar Class 4 Characters	0	S4NSC	11
Number of Scalar Class 4 Integers	0	S4NSI	
Number of Scalar Class 4 Logicals	16	S4NSL	
Number of Scalar Class 4 Reals	2	S4NSR	12
Number of Scalar Class 5 Characters	0	S5NSC	13

Number of Scalar Class 5 Integers	0	S5NSI	
Number of Scalar Class 5 Logicals	0	S5NSL	14
Number of Scalar Class 5 Reals	4	S5NSR	
Number of Scalar Class 6 Characters	1	S6NSC	15
Number of Scalar Class 6 Integers	0	S6NSI	
Number of Scalar Class 6 Logicals	0	S6NSL	16
Number of Scalar Class 6 Reals	10	S6NSR	
Number of Scalar Class 7 Characters	2	S7NSC	17
Number of Scalar Class 7 Integers	0	S7NSI	
Number of Scalar Class 7 Logicals	0	S7NSL	18
Number of Scalar Class 7 Reals	3	S7NSR	
Number of Scalar Class 8 Characters	0	S8NSC	19
Number of Scalar Class 8 Integers	0	S8NSI	
Number of Scalar Class 8 Logicals	0	S8NSL	20
Number of Scalar Class 8 Reals	3	S8NSR	
Number of Scalar Class 9 Characters	1	S9NSR	21
Number of Scalar Class 9 Integers	0	S9NSI	
Number of Scalar Class 9 Logicals	0	S9NSL	22
Number of Scalar Class 9 Reals	19	S9NSC	
Vector Class 1 Dimensionality	1	V1DIM	23
Number of Vector Class 1 Characters	3	V1NVC	
Number of Vector Class 1 Integers	1	V1NVI	24
Number of Scalar Class 1 Logicals	0	V1NSL	
Number of Vector Class 1 Real	16	V1NVR	25
Vector Class 2 Dimensionality	5	V2DIM	
Number of Vector Class 2 Characters	0	V2NSC	26
Number of Vector Class 2 Integers	0	V2NSI	
Number of Scalar Class 2 Logicals	0	V2NSL	27
Number of Vector Class 2 Reals	1	V2NSR	
Vector Class 3 Dimensionality	1	V3DIM	
Number of Vector Class 3 Characters	0	V3NSC	28
Number of Vector Class 3 Integers	0	V3NSI	
Number of Scalar Class 3 Logicals	0	V3NSL	29
Number of Vector Class 3 Reals	3	V3NSR	
Vector Class 4 Dimensionality	1	V4DIM	30
Number of Vector Class 4 Characters	1	V4NVC	
Number of Vector Class 4 Integers	0	V4NVI	31
Number of Scalar Class 4 Logicals	0	V4NSL	
Number of Vector Class 4 Reals	1	V4NVR	32
Vector Class 5 Dimensionality	2	V5DIM	
Number of Vector Class 5 Characters	0	V5NVC	33
Number of Vector Class 5 Integers	0	V5NVI	
Number of Scalar Class 5 Logicals	1	V5NSL	34
Number of Vector Class 5 Reals	0	V5NVR	

3.1 SCAN DATASET HEADER

3.1.1 Scalar Class 1 : Identity Parameters

Item	Mnemonic	Location	Format	Unit
Telescope Descriptor	S1TEL	1	C*8	
Frontend Descriptor	S1RCV	3	C*8	
Project Identification	S1PID	2	C*8	
Observer Name 1	S1ON1	4	C*8	
Observer Name 2	S1ON2	5	C*8	
Observer Name 3	S1ON3	6	C*8	
Source Name 1	S1SN1	7	C*8	
Source Name 2	S1SN2	8	C*8	
Scan Number	S1SNO	9	R*8	

<u>Frontend Descriptor</u>
Identifies the frontend.
Examples: <TBD>

<u>Project Identification</u>
Identifies the observing program.

<u>Observer Name</u>
Holds the name(s) of the observer(s).

<u>Source Name</u>
Holds the name of the object scanned,

3.1.2 Scalar Class 2 : Space-Time Parameters

The Space-Time parameters define the telescope and target locations in time and space.

Item	Mnemonic	Location	Format	Unit
Equinox Code	S2EQN	10	C*8	
Coordinate System Code	S2CSC	11	C*8	
Telescope Geographic Longitude	S2TLN	12	R*8	DEGREE
Telescope Geographic Latitude	S2TLA	13	R*8	DEGREE
Telescope Altitude	S2TAL	14	R*8	METER
Universal Time Date at scan start	S2UT1	15	R*8	YYYY.MMDD
Universal Time Hour at scan start	S2UT2	16	R*8	HOURS
Local Sidereal Time at scan start	S2LST	17	R*8	HOURS
Coordinate System Theta	S2THE	18	R*8	DEGREE
Coordinate System Phi	S2PHI	19	R*8	DEGREE
Coordinate System Epsilon	S2EPS	20	R*8	DEGREE
Epoch of Lamda,Beta in Universal Time	S2EPH	21	R*8	YEAR
Source Lamda	S2KSL	22	R*8	DEGREE
Source Beta	S2KSB	23	R*8	DEGREE
Source Pi	S2KSP	24	R*8	DEGREE
Reference Lamda	S2RL	25	R*8	DEGREE
Reference Beta	S2RB	26	R*8	DEGREE

Reference Pi	S2SP	27	R*8	DEGREE

3.1.3 Scalar Class 3 : Telescope Parameters

The Telescope Parameters are the constants for the dish.

Item	Mnemonic	Location	Format	Unit
Mounting Code	S3MNT	28	C*8	
Azimuth/RA Pointing Correction	S3HPC	29	R*8	ARCSEC
Elevation/Dec Pointing Correction	S3VPC	30	R*8	ARCSEC
Antenna diameter	S3DIA	31	R*8	METER
Collimation Error	S3CE	32	R*8	ARCSEC
Bend Error	S3BE	33	R*8	ARCSEC
Antenna Beam Width (FWHM)	S3HP	34	R*8	ARCSEC
Antenna Aperture Efficiency	S3AE	35	R*8	%
Antenna Beam Efficiency	S3ABE	36	R*8	%
Focus X Displacement	S3FOX	37	R*8	MM
Focus Y Displacement	S3FOY	38	R*8	MM
Focus Z Displacement	S3FOZ	39	R*8	MM

Telescope Mounting Code

1 = AZ/EL
2 = RA/DEC

Pointing corrections
Define a systematic correction to be applied to each value in the pointing history table (see below).

Antenna diameter
Nominal diameter of the dish.

Collimation error
Defines ...?

Bend error
Defines ...?

Antenna beam width
Full width half maximum of the antenna response.

Aperture efficiency
The ratio of the total power observed to the total power incident on the telescope.

Antenna beam efficiency
Roughly the fraction of the beam lying in a diffraction limited main beam. We could settle on Kutner'and Ulichs' definition of Eta-fss if there are no strong objections.

Focus Displacement
Given in a a right handed coordinate system with the origin at the focus, the Z-Axis pointing outwards along the primary principal axis, the X-Axis in the vertical plane pointing towards the Sky. The Focus Displacement records any scan dependent displacement of the focus from this origin.

3.1.4 Scalar Class 4 : Observing Parameters

The observing parameters define the type of scan and the switching frequencies.

Item	Mnemonic	Location	Format	Unit
Scan Type Flags	S4STC	40	L*1	
Length of Cycle	S4SRT	42	R*8	SECOND
Scan Integration Time	S4INT	43	R*8	SECOND

Scan Type Flags

1 Line (/continuum)
2 Total Power (/switched)
3 Position Switched
4 Frequency Switched
5 Load Switched
6 Beam Switched
7 Sky - Horn Switched
8 Polarization Switched
9 Correlation frontend
10 |
: | Spare
16 |

Scan Integration Time
Total integration time excluding blanking time, but including all phases of a switching cycle, including off-source phases.

3.1.5 Scalar Class 5 : Environment Parameters

The Environment parameters define the external physical conditions affecting the telescope.

Item	Mnemonic	Location	Format	Unit
Ambient Temperature	S5AT	44	R*8	C
Pressure	S5PRS	45	R*8	BAR
Relative Humidity	S5RH	46	R*8	%
Index of Refraction	S5IR	47	R*8	

3.1.6 Scalar Class 6 : Mapping Parameters

The Mapping Parameters define the pattern traced by the centre of the beam on the sky, excluding slews.

Item	Mnemonic	Location	Format	Unit
XY Reference frame code	S6AC	48	C*8	
Lambda at Origin	S6LZ	49	R*8	DEGREE
Beta at Origin	S6BZ	50	R*8	DEGREE
U unit vector lambda	S6UL	51	R*8	DEGREE
U unit vector beta	S6UB	52	R*8	DEGREE
V unit vector lambda	S6VL	53	R*8	DEGREE
V unit vector beta	S6VB	54	R*8	DEGREE
Number of Starting U Cell	S6SX	55	R*8	
Number of Starting V Cell	S6SY	56	R*8	
Number of U points	S6NXS	57	R*8	
Number of V points	S6NYS	58	R*8	

<u>XY Reference Frame Code</u>

1 = Cartesian
2 = Polar

Lamda and Beta as in class 2.

The u- and v- unit vectors define the mapping frame in terms of the chosen XY co-ordinate frame. The mapping cell is assumed to have dimensions (1,1) in the UV frame.

3.1.7 Scalar Class 7 : Spectral Line Parameters

Item	Mnemonic	Location	Format	Unit
Velocity Definition Code	S7VDEF	59	C*8	
Velocity Reference Code	S7VREF	60	C*8	
Velocity	S7VL	61	R*8	KM/S
Reference Scan Number	S7OSN	62	R*8	
Bad Channel Value	S7BCV	63	R*8	K

<u>Velocity Definition Code</u>

0 = Radio
1 = Optical

<u>Velocity Reference Code</u>

0 = Local Standard of Rest
1 = Heliocentric

2 = Geocentric
3 = Baricentric

3.1.8 Scalar Class 8 : Continuum Parameters

Item	Mnemonic	Location	Format	Unit
Source Temperature	S8ST	64	R*8	K
RMS of Mean	S8RMS	65	R*8	
Baseline Value	S8BAS	66	R*8	

3.1.9 Scalar Class 9 : Frequency Parameters

Item		Mnemonic	Location	Format	Unit
Local Oscillator Code		S9LOC	67	C*8	
L1	(NRAO-GB)	S9L1	68	R*8	
L1F1	(NRAO-GB)	S9L1F1	69	R*8	
L1F2	(NRAO-GB)	S9L1F2	70	R*8	
L2	(NRAO-GB)	S9L2	71	R*8	
L2F1	(NRAO-GB)	S9L2F1	72	R*8	
L2F2	(NRAO-GB)	S9L2F2	73	R*8	
LA	(NRAO-GB)	S9LA	74	R*8	
LB	(NRAO-GB)	S9LB	75	R*8	
LC	(NRAO-GB)	S9LC	76	R*8	
LD	(NRAO-GB)	S9LD	77	R*8	
Center Frequency Formula	(NRAO-GB)	S9CFF	78	R*8	
Synthesizer Frequency	(NRAO-TUC)	S9SYN	79	R*8	
Sideband & LO Factor	(NRAO-TUC)	S9SDB	80	R*8	
Harmonic	(NRAO-TUC)	S9HM	81	R*8	
Reference Name	(NRAO-TUC)	S9RN	82	R*8	
LO IF	(NRAO-TUC)	S9LOF	83	R*8	
First IF	(NRAO-TUC)	S9LOF	84	R*8	
Source Offsets	(NRAO-TUC)	S9SOF	85	R*8	
Reference Offsets	(NRAO-TUC)	S9ROF	86	R*8	

3.2 SCAN DATASET TABLES

3.2.1 Vector Class 1: Receiver Table

Item	Mnemonic	Location	Format	Unit
Number of Backends	V1NBC		I*4	
Backend Descriptor	V1BKE	2	C*8	

Spectral Data Precision Code	V1DPC	2+V1NBC	C*8	
Spectral Data Calibration Code	V1CAL	2+2*V1NBC	C*8	
Number of Channels	V1CH	2+3*V1NBC	I*4	
Reference Frequency	V1REF	2+4*V1NBC	R*8	MHZ
Observed Frequency	V1CF	2+5*V1NBC	R*8	MHZ
Frequency Resolution	V1BPP	2+6*V1NBC	R*8	MHZ
Thermal Noise Level	V1NOI	2+7*V1NBC	R*8	DN
Receiver Temperature	V1RT	2+8*V1NBC	R*8	K
Calibration Temperature	V1CT	2+9*V1NB	R*8	K
Calibration Factor	V1CF	2+10*V1NB	R*8	V/K
Source System Temperature	V1SST	2+11*V1NBC	R*8	K
Reference System Temperature	V1RST	2+12*V1NBC	R*8	K
Reference Point	V1RP	2+13*V1NBC	R*8	
Velocity at Reference Point	V1XV	2+14*V1NBC	R*8	KM/S
Delta Velocity	V1DX	2+15*V1NBC	R*8	KM/S
Opacity	V1TO	2+16*V1NBC	R*8	NEPERS
H2O Opacity	V1WO	2+17*V1NBC	R*8	NEPERS
H2O Temperature.	V1WT	2+18*V1NBC	R*8	C
O2 Temperature	V1OT	2+19*V1NBC	R*8	C

3.2.2 Vector Class 2 : Data Table

Item	Mnemonic	Location	Format	Unit
Number of Backends	V2NBC	1	I*4	
Number of Integrations per Scan	V2NIS		I*4	
Number of Cycles per Integration	V2NCI	2	I*4	
Number of Phases per Cycle	V2PCC		I*4	
Number of Channels + 1	V2NCH	3	I*4	
Data(NCH, PCC, NCI, NIS, NBC)	V2DAT	4	R*8	

Each set of channel values is tagged with the time of measurement as in the basic system. Cross-referencing with the pointing history table is therefore possible. The time is the first item in the list of data numbers of each channel, hence the data array is dimensioned NCH+1.

3.2.3 Vector Class 3 : Pointing History Table

(records offsets from commanded positions during source mapping)

Item	Mnemonic	Location	Format	Unit
Number of position measurements	V3MES	1	I*4	
Time of Measurement	V3MST	2	R*8	HOUR
Longitude Measurement offset	V3LNG	2+V3MES	R*8	DEGREE
Latitude Measurement offset	V3LAT	2+2*V3MES	R*8	DEGREE

The longitude and latitude offsets are given in the coordinate system of the mounting type (i.e AZ/EL or RA/DEC).

3.2.4 Vector Class 4 : Phase Control Table

Item	Mnemonic	Location	Format	Unit
Number of Switching variables	V4NSV	1	I*4	
Variable Descriptor Code	V4VDC	2	C*8	
Variable Amplitude	V4VAM	2+V4NSV	R*8	

3.2.5 Vector Class 5 : Phase Value Table

Item	Mnemonic	Location	Format	Unit
Number of Switching variables	V5NSV	1	I*4	
Number of Phases per Cycle	V5PPC		I*4	
Phase Values: PHV(PPC, NSV)	V5PHA	2	L*1	

3.2.6 Vector Class 6 : Phase Timing Table

Item	Mnemonic	Location	Format	Unit
Number of Phases per Cycle	V6PPC	1	I*4	
Fractional time per phase: TPP(PPC)	V5TPP	2	R*8	

Example Two switch variables (focus and position).
3 positions, 2 foci.
Implies 8 phases, assumed equal length.
Posn on   0   0 0 1 1 1 1 0 0

Posn Hi   +30"   1 1 0 0 0 0 0 0

Posn Lo   -30"   0 0 0 0 0 0 1 1

Focus Hi   +54mm   1 0 1 0 1 0 1 0

Focus Lo   -54mm   0 1 0 1 0 1 0 1
This switching arrangement would be described as:

```
Vector Class 4
NSV = 5
VDC = Posn on, Posn Hi, Posn Lo, Focus Hi, Focus Lo.
VAM = 0        +30      -30      +54       -54

Vector Class 5
NSV = 5
PPC = 8
PHV = 0, 0, 1, 1, 1, 1, 0, 0,
      1, 1, 0, 0, 0, 0, 0, 0,
      0, 0, 0, 0, 0, 0, 1, 1,
      1, 0, 1, 0, 1, 0, 1, 0,
      0, 1, 0, 1, 0, 1, 0, 1

Vector Class 6
PPC = 8
TPP = .125, .125, .125, .125, .125, .125, .125, .125
```