General Single Dish Data Format

The following format is a very general description of header and data values associated with spectral line and continuum single dish data*. This format has been produced with the combined efforts of NRAO, IRAM, Cambridge University and the University of Arizona. Its purpose is to standardize what header parameters may be included in single dish data as well as their names and units. Header parameters are grouped by class where the first n words of each class are defined. A prolog to the format declares the number of header classes and the starting location of each class. Each class may expand or contract as necessary as long as the order of the first n words in the class remains unchanged. A class may be omitted altogether or a subset of words in a class may appear in the format, but parameters may only be deleted from the bottom of a class. Implementation of the format as the internal representation of data in the analysis programs will facilitate easy merging of data from different observatories around the world.

All values in the header are eight-byte entities, either double precision real values (R*8) or character strings that are multiples of eight bytes (C*8). In the following table the first field names the data parameter, the second is a FITS keyword with a maximum of eight characters, the next field defines the data pointer name for each variable, the fourth field indicates the word location of the data parameter as a multiple of eight bytes, followed by the type of data (double precision real numbers or ASCII characters), the units of the parameters and lastly any comments.

Class 9 is an open area to be defined by each telescope for parameters unique to itself. Class 10 is an area to be defined by the observer when reducing the data.

Following the format table is a glossary of terms to describe each of the parameters in detail.

* A single entity of data may represent more than one receiver polarization or more than one frequency range, but it may not represent more than one position on the sky.

General Single Dish Data Format

Number of Header Classes	HEADCLS	C0HCL	0	R*8		
Starting Location of Class One	ONEPTR	C01P	1	R*8		
Starting Location of Class Two	TWOPTR	C02P	2	R*8		
Starting Location of Class Three	THRPTR	C03P	3	R*8		
Starting Location of Class Four	FOURPTR	C04P	4	R*8		
Starting Location of Class Five	FIVEPTR	C05P	5	R*8		
Starting Location of Class Six	SIXPTR	C06P	6	R*8		
Starting Location of Class Seven	SEVPTR	C07P	7	R*8		
Starting Location of Class Eight	EIGPTR	C08P	8	R*8		
Starting Location of Class Nine	NINEPTR	C09P	9	R*8		
Starting Location of Class Ten	TENPTR	C010P	10	R*8		
Starting Location of Class Eleven	ELVPTR	C011P	11	R*8		
Starting Location of Class Twelve	TWLPTR	C012P	12	R*8		

Class 1 : Basic Information

All word locations are offsets from Class 1 Starting Location

Length of Header	HEADLEN	C1HLN	0	R*8	Bytes	No. bytes in header
Length of Data	DATALEN	C1DLN	1	R*8	Bytes	No. bytes in data
Scan Number	SCAN	C1SNO	2	R*8		
Observer Initials	OBSID	C1OBS	3	C*8		
Observer Name	OBSERVER	C1ONA	4-5	2C*8		
Telescope Descriptor	TELESCOP	C1TEL	6	C*8		
Project Identification	PROJID	C1PID	7	C*8		
Source Name	OBJECT	C1SNA	8-9	2C*8		
Type of Data and Observing Mode	OBSMODE	C1STC	10	C*8		
Frontend Descriptor	FRONTEND	C1RCV	11	C*8		
Backend Descriptor	BACKEND	C1BKE	12	C*8		
Data Precision of Spectrum	PRECIS	C1DP	13	C*8		

Class 2 : Pointing Parameters

All word locations are offsets from the Class 2 Starting Location

Total Az/RA Pointing Correction	XPOINT	C2XPC	0	R*8	Arcsec	
Total El/Dec Pointing Correction	YPOINT	C2YPC	1	R*8	Arcsec	
User Az/RA Pointing Correction	UXPNT	C2UXP	2	R*8	Arcsec	
User El/Dec Pointing Correction	UYPNT	C2UYP	3	R*8	Arcsec	
Pointing Constants(4)	PTCON	C2PC	4-7	R*8		
Receiver Box or Secondary Orientation	ORIENT	C2ORI	8	R*8	Deg	
Radial Focus	FOCUSR	C2FR	9	R*8	MM	
North-South Focus	FOCUSV	C2FV	10	R*8	MM	
East-West Focus	FOCUSH	C2FL	11	R*8	MM	

Class 3 : Observing Parameters	All word locations are offsets from the Class 3 Starting Location					
Universal Time Date	UTDATE	C3DAT	0	R*8		YY.MMDD
Universal Time	UT	C3UT	1	R*8	Hours	
LST	LST	C3LST	2	R*8	Hours	
Number of Receiver Channels	NORCHAN	C3NRC	3	R*8		
Number of Switching Variables	NOSWVAR	C3NSV	4	R*8		
Number of Phases per Cycle	NOPHASE	C3PPC	5	R*8		
Length of Cycle	CYCLLEN	C3CL	6	R*8	Sec	
Length of Sample	SAMPRAT	C3SRT	7	R*8	Sec	

Class 4 : Positions	All word locations are offsets from Class 4 Starting Location					
Epoch	EPOCH	C4EPH	0	R*8	Years	
Commanded Source X	XSOURCE	C4SX	1	R*8	Deg	
Commanded Source Y	YSOURCE	C4SY	2	R*8	Deg	
Commanded Reference X	XREF	C4RX	3	R*8	Deg	
Commanded Reference Y	YREF	C4RY	4	R*8	Deg	
Commanded Epoch Right Ascension	EPOCRA	C4ERA	5	R*8	Deg	
Commanded Epoch Declination	EPOCDEC	C4EDC	6	R*8	Deg	
Commanded Galactic Longitiude	GALLONG	C4GL	7	R*8	Deg	
Commanded Galactic Latitude	GALLAT	C4GB	8	R*8	Deg	
Commanded Azimuth	AZ	C4AZ	9	R*8	Deg	
Commanded Elevation	EL	C4EL	10	R*8	Deg	
Indicated X Position	INDX	C4IX	11	R*8	Deg	
Indicated Y Position	INDY	C4IY	12	R*8	Deg	
Descriptive Origin(3)	DESORG	C4DO	13–15	R*8		
Coordinate System Code	COORDCD	C4CSC	16	C*8		

Class 5 : Environment	All word locations are offsets from the Class 5 Starting Location					
Ambient Temperature	TAMB	C5AT	0	R*8	Deg C	
Pressure	PRESSURE	C5PRS	1	R*8	MM HG	
Relative Humidity	HUMIDITY	C5RH	2	R*8	%	
Index of Refraction	REFRAC	C5IR	3	R*8		
Dew Point	DEW_PT	C5DP	4	R*8	Deg C	
MM H2O	MMH2O	C5MM	5	R*8	MM	

Class 6 : Map Parameters	All word locations are offsets from the Class 6 Starting Location					
Map Scanning Angle	SCANANG	C6MSA	0	R*8	Deg	
X Position at Map Reference Position Zero	XZERO	C6XZ	1	R*8	Deg	
Y Position at Map Reference Position Zero	YZERO	C6YZ	2	R*8	Deg	
Delta X or X Rate	DELTAX	C6DX	3	R*8	Arcsec	or Arcsec/sec
Delta Y or Y Rate	DELTAY	C6DY	4	R*8	Arcsec	or Arcsec/sec
Number of Grid Points	NOPTS	C6NP	5	R*8		
Number of X Grid Points	NOXPTS	C6XNP	6	R*8		
Number of Y Grid Points	NOYPTS	C6YNP	7	R*8		
Starting X Grid Cell Number	XCELL0	C6XGC	8	R*8		
Starting Y Grid Cell Number	YCELL0	C6YGC	9	R*8		
XY Reference Frame Code	FRAME	C6FC	10	C*8		

Class 7 : Data Parameters	All word locations are offsets from the Class 7 Starting Location					
Beam Fullwidth at Half Maximum	BFWHM	C7FW	0	R*8	Arcsec	
Off Scan Number	OFFSCAN	C7OSN	1	R*8		
Bad Channel Value	BADCHV	C7BCV	2	R*8		
Velocity Correction	RVSYS	C7VC	3	R*8	KM/S	
Velocity with respect to Reference	VELOCITY	C7VR	4	R*8	KM/S	
Velocity Definition and Reference	VELDEF	C7VRD	5	C*8		
Type of Calibration	TYPECAL	C7CAL	6	C*8		

Class 8 : Engineering Parameters	All word locations are offsets from the Class 8 Starting Location					
Antenna Aperture Efficiency	APPEFF	C8AAE	0	R*8		
Antenna Beam Efficiency [ETA(MB)]	BEAMEFF	C8ABE	1	R*8		
Antenna Gain	ANTGAIN	C8GN	2	R*8		
ETAL Rear Spillover & Scattering Efficiency	ETAL	C8EL	3	R*8		
ETAFSS Forward Spillover & Scattering Eff	ETAFSS	C8EF	4	R*8		

Class 9 : Telescope Dependent Parameters	All word locations are offsets from the Class 9 Starting Location					
Parameters Unique to Given Telescope	UNITEL	C9UTL	0-9	R*8		See Extended Telescope Format

Class 10 : Open Parameters (Data Reducation) All word locations are offsets from the Class 10 Starting Location

Open Parameter Values(10)	OPENPAR	C10PV	0-9	C*8	

Class 11 : Phase Block
Repeated for the Number of Switching Variables (NOSWVAR)
All word locations are offsets from the Class 11 Starting Location

Variable Value	VARVAL	C11VV	0	R*8	
Variable Descriptor	VARDES	C11VD	1	C*8	
Phase Table	PHASTB	C11TP	2	C*8	

Class 12 : Descriptor Block for Each Receiver Channel
Repeated for Number of Receiver Channels (NORCHAN) times.
All word locations are offsets from the Class 12 Starting Location

Observed Frequency	OBSFREQ	C12CF	0	R*8	MHz
Rest Frequency or Total Power Calibration	RESTFREQ	C12RF	1	R*8	MHz
Frequency Resolution or SP Calibration	FREQRES	C12FR	2	R*8	MHz
Bandwidth	BW	C12BW	3	R*8	MHz
Receiver Temperature	TRX	C12RT	4	R*8	Deg K
Calibration Temperature	TCAL	C12CT	5	R*8	Deg K
Source System Temperature	STSYS	C12SST	6	R*8	Deg K
Reference System Temperature	RTSYS	C12RST	7	R*8	Deg K
Source Temperature	TSOURCE	C12ST	8	R*8	
RMS of Mean	TRMS	C12RMS	9	R*8	
Reference Point Number	REFPT	C12RP	10	R*8	
X Value at the Reference Point	X0	C12X0	11	R*8	
Delta X	DELTAX	C12DX	12	R*8	
Total Integration Time	INTTIME	C12IT	13	R*8	Sec
Number of Integrations	NOINT	C12NI	14	R*8	
Starting Point Number	SPN	C12SPN	15	R*8	
H2O Opacity	TAUH2O	C12WO	16	R*8	
H2O Temperature	TH2O	C12WT	17	R*8	Deg K
O2 Opacity	TAUO2	C12OO	18	R*8	
O2 Temperature	TO2	C12OT	19	R*8	Deg K
Polarization	POLARIZ	C12SP	20	C*8	

The first twelve classes and the parameters in each class are defined as described above. More words may be added to each class at the end and more classes may be added after class twelve. Spectral values will follow starting at byte location LENGTH OF HEADER + 1.

Spectral Values {Ph1(ch1), Ph2(ch1), ...	SPECT			PRECIS	

Extended Telescope Dependent Format

Class 9 : Telescope Dependent Parameters — Green Bank

L1	L1	C9L1	0	R*8	MHz
L1F1	L1F1	C9L1F1	1	R*8	MHz
L1F2	L1F2	C9L1F2	2	R*8	MHz
L2	L2	C9L2	3	R*8	MHz
L2F1	L2F1	C9L2F1	4	R*8	MHz
L2F2	L2F2	C9L2F2	5	R*8	MHz
LA	LA	C9LA	6	R*8	MHz
LB	LB	C9LB	7	R*8	MHz
LC	LC	C9LC	8	R*8	MHz
LD	LD	C9LD	9	R*8	MHz
Level Correction	LEVCORR	C9LVC	10	R*8	
Pointing Fudge(2)	PTFUDGE	C9PF	11	R*8	
RHO	RHO	C9RHO	12	R*8	Deg
THETA	THETA	C9THE	13	R*8	Deg
Center Frequency Formula (4)	CFFORM	C9CFF	14–21	C*8	

Class 9 : Telescope Dependent Parameters — 12M

Synthesizer Frequency	SYNFREQ	C9SYN	0	R*8	MHz
LO Factor	LOFACT	C9LOF	1	R*8	MHz
Harmonic	HARMONIC	C9HM	2	R*8	MHz
LO IF	LOIF	C9LOI	3	R*8	MHz
First IF	FIRSTIF	C9FIF	4	R*8	MHz
Reference Azimuth Offset	RAZOFF	C9RAO	5	R*8	Arcsec
Reference Elevation Offset	RELOFF	C9REO	6	R*8	Arcsec
Beam Throw	BMTHROW	C9BT	7	R*8	Arcsec
Beam Orientation	BMORENT	C9BOR	8	R*8	Deg
Baseline Offset	BASEOFF	C9BO	9	R*8	Deg K
Observing Tolerance	OBSTOL	C9OT	10	R*8	Arcsec
Sideband	SIDEBAND	C9SB	11	R*8	

General Single Dish Data Format Glossary

The general single dish data format is divided into thirteen classes where the thirteenth is the spectral values. Each parameter is discussed in its class below.

Class 1 : Basic Information

These parameters are used to identify the block of data with a particular Observer/Project/Telescope.

1. Length of header -
   Number of bytes to describe this header. The spectral values start at byte address length of header + 1.

2. Length of data -
   Number of bytes to describe the spectral values.

3. Scan Number -
   A number assigned at the telescope to be associated with this scan.

4. Observer Initials -
   A data ID used to segregate each observer's data.

5. Observer Name -
   Name of the primary Observer.

6. Telescope Descriptor -
   A field of eight characters to describe where the data are taken.

NRAO 12M	NRAO 42M	NRAO 93M
MPI 100M	IRAM 30M	NRO 45M
PMO 14M	OSO 20M	MASS 14M
UTX 5M	UK-D 15M	IRAM 15M

7. Project Identification -
   The program ID associated with the proposal as it appears on the telescope schedule.

8. Source Name -
   As provided by the observer.

9. Type of Data and Observing Mode -
   Field of 8 characters where four describe the type of data and four describe the observing mode.

Type of Data	Observing Mode	
LINE	PSSW	PLSW
CONT	FQSW	SHSW
FSAM	BMSW	LDSW
PULS	TLPW	

10. Frontend Descriptor -
    A field of 8 characters to describe the receiver used.
    Typical NRAO frontends are:

2C3MMSIS	140CASS	2.7-1.2M
2C3MMSHM	21CM 4CH	1.2-0.6M
2MM	11CM3CH	100-30CM
.8MM	6/25 6CM	25-20 CM
BOLOMETR	23-17CM	6/2525CM
	15-0.6CM	

11. Backend Descriptor -
    A field of 8 characters to describe the backend used.
    Typical NRAO backends are:

DIGITAL	STD A/D	FABRITEK
384ACIII	1024ACIV	1536HYSP
.03MHZFB	.1MHZ FB	.25MHZFB
.5MHZ FB	1.MHZ FB	2.MHZ FB

12. Data Precision of the Spectrum -
    The specification of the nuber of bits and data type used to represent the data. It may be one of the following:
    L*1 I*2 I*4 R*4 R*8 R*16 C*8 C*16

Class 2: Pointing Parameters

This group of parameters refers to the telescope pointing, both those offsets and terms provided by the observer and those computed by the online program.

1. Total Az/RA Pointing Correction -
   The total pointing correction applied in the X (horizontal) direction.

2. Total El/Dec Pointing Correction -
   The total pointing correction applied in the Y (vertical) direction.

3. User Az/RA Pointing Correction -
   Additional X pointing correction supplied by the observer.

4. User El/Dec Pointing Correction -
   Additional Y pointing correction supplied by the observer.

5. Pointing Constants(4) -
   Up to four constants to describe a secondary pointing correction.
   At the 12M these are A0, C, B0 and EL0 in the expressions below:
   Delta Az = A0 * COS(EL) + C
   Delta El = B0 * COS(EL) + EL0
   At the 42M these constants refer to the PVAL's.

6. Receiver or Secondary Orientation -
   Rotation or polarization angle orientation of the receiver or reflector at the prime focus.

7. Radial Focus -
   Radial focus position.

8. North-South Focus -
   Vertical focus offset.

9. East-West Focus -
   Horizontal focus offset.

Class 3 : Observing Parameters

A group of parameters that characterize the when and how of the observations.

1.-3. UT Date; UT Time: LST -
   Date and time at the start of the observation.

4. Number of Receiver Channels -
   The number of independent polarizations or channels of this frontend. When receiver channels refer to different positions in the sky, they are expressed as separate scans.

The following parameters are defined as a very general description of observations made with one ore more of the observing variables being switched. For example, in beam-switched observations one variable, sky position, is switched (via subreflector motion or a comparision of two feed horns). One could also imagine beam switching at the same time that polarization was switched -- in this case 2 variables are switched. IF "phase" of a switched variable is used to describe one state of the switch, then a 2-position subreflector nutation, for example, would be a switch with "2 phases" per cycle. Similarly, if one switches between a center frequency and 2 offset frequencies, then this switch has "3 phases" per cycle and so forth.

5. Number of Switching Variables -
   A simple integer count of the number of variables being switched.

6. Number of Phases per Cycle -
   An integer count of the number of different states of the switched variables.

7. Length of Sample -
   The time required to complete a single sample. A sample may be composed of multiple cycles. Also known as the SAMPLE RATE.

Class 4 : Positions

For each scan the telescope is given, or computes following the observer's instructions, a position at a particular epoch. The right ascension of that position is "Epoch Right Ascension" and the declination is "Epoch Declination". At the time of the observation, however, the telescope is directed to a position corresponding to horizontal coordinate "xcoord", which may be either RA(date) or AZ(date), and corresponding to vertical coordinated "ycoord", which may be DEC(date) or EL(date). The actual position that the telescope points to differs from "xcoord" and "ycoord" by whatever are the current pointing offsets. This position, i.e., the position at which the telescope actually points, is the "indicated" position described by horizontal coordinate "indicated x telescope position" and vertical telescope coordinate "indicated y telescope position". Finally, using RA(epoch) one calculates the Galactic coordinates "longitude and latitude". For all observations the above parameters have meaning and are computed. If the observer wishes to define his own coordinate system relative to one of the standard coordinate systems defined above, he does so with the descriptive coordinate array.

1. Epoch -
   As specified by the observer.

2. Epoch Right Ascension -
   RA at "Epoch" of the source or position specfied.

3. Epoch Declination -
   Dec at "Epoch" of the source or position specified.

4. Galactic Longitude -
   Longitude of the source or position specified.

5. Galactic Latitude -
   Latitude of source or position specified.

6. Azimuth -
   Azimuth of the source or position specified.

7. Elevation -
   Elevation of the source or position specified.

8. Source Xcoord -
   Horizontal coordinate of source or position in the coordinate system specified by the observer.

9. Source Ycoord -
   Vertical coordinate of source or position in the coordinate system specified by the observer.

10. Reference Xcoord -
    Horizontal coordinate of the reference position in the coordinate system specified by the observer.

11. Reference Ycoord -
    Vertical coordinate of the reference position in the coordinate system specified by the observer.

12. Indicated Xcoord -
    Horizontal telescope coordinate of the position actually observed, i.e. position measured by horizontal encoder.

13. Indicated Ycoord -
    Vertical telescope coordinate of the position actually observed, i.e., position measured by vertical encoder.

14. Descriptive Origin(3) -
    An orthogonal 2-dimensional coordinate system defined by the observer by means of
    - a. - horizontal position
    - b. - vertical position
    - c. - position angle describing the orientation on the sky, of the "horizontal axis".

15. Coordinate System Code -
    An eight character field which specifies in which coordinate system the observations are commanded:

```
GALACTIC = Galactic (LII,BII)
1950RADC = 1950 RA, Dec
EPOCRADC = Epoch RA, Dec
MEANRADC = Mean RA, Dec at start of scan
APPRADC  = Apparent RA, Dec
APPHADC  = Apparent HA, Dec
1950ECL  = 1950 Ecliptic
EPOCECL  = Epoch Ecliptic
MEANECL  = Mean Ecliptic at start of scan
APPECL   = Apparent Ecliptic
AZEL     = Azimuth, Elevation
USERDEF  = User defined coordinate system
2000RADC = 2000 RA, Dec
INDRADC  = Indicated RA, Dec
```

Class 5 : Environment

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

1. Ambient Temperature
2. Pressure
3. Relative Humidity
4. Index of Refraction
5. Dew Point
6. MM H2O

Class 6 : Map Parameters

The purpose here is to store an entire map as a single entity. The map is understood to be rectangular with dimensions "xpoints" by "ypoints" where these parameters simply count the number of map cells along the two orthogonal axes of the rectangular map. The orientation on the sky of the rectangle is defined by "map scanning angle", with this angle referring to the orientation of the horizontal, x, axis. A reference point for the map on the sky is specified by means of the horizontal and vertical telescope coordinates "xposition at zero" and "yposition at zero", respectively. The reference point need not be the center of the rectangle and, in fact, need not even be within the region mapped. The rectangle to be mapped is fully described by the parameters "starting xcell" and "starting ycell", together with the total number of points to be sampled in each coordinate "xpoint" and "ypoint", respectively.

For example, suppose we wish to construct a square map with 41 points on a side centered on the reference position. In this case,

starting xcell = -20
starting ycell = -20
xpoints = 41
ypoints = 41

On the other hand, suppose we wish to make the same map near, but not including, that same reference position. Then, perhaps

starting xcell = 20
starting ycell = -61
xpoints = 41
ypoints = 41

and the region from (x,y) = (20,-61) to (x,y) = (61,-20) will be mapped.

1. Map Scanning Angle -
   Orientation on the sky in the reference frame specified by "XY Reference Frame Code" of the rectangle to be mapped. It is not the angle through the rectangle that the telescope is driven. This provides an alternate capability to that of using descriptive coordinates.

2. Xposition at Zero -
   Horizontal telescope coordinate at the map reference position. Together with "Yposition at Zero", this defines the cell (X,Y) = (0,0) at the map reference position.

3. Yposition at Zero -
   Vertical telescope coordinate at the map reference position.

4. Delta X or X Rate -
   The cell size or distance (in minutes of arc/minutes of time) between cells on the x axis.

5. Delta Y or Y Rate -
   The cell size or distance between cells on the y axis.

6. Number of Xpoints -
   Map sample points along the "x-edge" of the rectangle.

7. Number of Ypoints -
   Map sample points along the "y-edge" of the rectangle.

8. Number of Points -
   Total number of cells in the map. This should be (x*y).

9. Starting Xcell -
   Cell number. May be positive, negative or zero. It is used to define the position of the rectangle to be mapped with respect to the reference position which, by definition is (x,y) = (0,0).

10. Starting Ycell -
   Cell number as above.

11. XY Reference Frame Code -
   An eight character code which states whether the grid is polar (POLR) or cartesian (CART) and whether items 3 and 4 refer to STEP sizes or SCANning rates.

Class 7 : Observing Parameters

1. Beam Full Width at Half Maximum -
   Telescope main beamwidth at the observing frequency.

2. Off Scan Number -
   Scan number of the last designated total power off scan.

3. Bad Channel Value -
   The antenna temperature to be assigned to those filterbank channels that are noted as defective.

4. Velocity with respect to the Reference -
   The source velocity specified by the observer relative to the velocity reference frame.

5. Doppler correction for the earth's motion in the source direction with respect to the velocity reference frame chosen.

6. Velocity Definition and Reference -
   An eight character field to describe the velocity system.
   The velocity definition may be:
   RADI OPTL RELV
   The velocity reference may be:
   LSR HELO EART BARI OBS

Class 8 : Engineering Parameters

This is an area for describing the physical aspects of the telescope.

1. Antenna Aperture Efficiency -
   The ratio of total power observed to the total power incident on the telescope.

2. Antenna Beam Efficiency -
   The fraction of the beam lying in a diffraction limited main beam.

3. Antenna Gain

4. ETAL -
   Rear Spillover and Scattering Efficiency

5. ETAFSS -
   Forward Spillover and Scattering Efficiency

Class 9 : Telescope Dependent Parameters

This is an area of 24 R*8 words reserved for those parameters that are unique to a given telescope.
For the Green Bank telescopes they are:
the LO values - L1, L1F1, L1F2, L2, L2F1, L2F2, LA, LB, LC, LD , the level correction, the pointing fudge(2), and the center frequency formula(4). See addendum to format table.
For the 12M telescope they are:
synthesizer frequency, LO Factor, Harmonic LOIF, first IF, reference azimuth offset, reference elevation offset, beam throw, beam orientation, baseline offset, sideband and observing tolerance.

Class 10 : Open Parameters

An area of 10 R*8 words are reserved for the observer to describe his data reduction of the current scan.

Class 11 : Phase Block

This block describes what variables are switched in the scan. For instance, a scan may be position switched, beam switched, frequency switched, load switched, focus switched, polarization switched, or any combination of the above or simply a measure of total power. The variable value is value of one switch state. For example, to switch high and low about a center frequency requires three variable values. A total power observation requires one value.

Associated with each variable value is a variable descriptor of eight characters and a 32 bit phase table which reflects when that particular state is on with a one and when it is off with a 0. These three parameters are repeated for as many times as there are switching states. Also note that the phases appear in the description of the spectrum in the same order as they appear here.

1. Variable Value -
   The value of a single switch state.

2. Variable Descriptor -
   An 8 character descriptor of the switching variable.

3. Phase Table -
   A bit-map description of when each switch state is on and off. An integration can have a maximum of 32 states.

An example of a phase block is shown below:
An observation is made by switching the telescope position and the focus. There are five switching states. The table would look like

```
Variable Values - 0, +30, -30, +54, -54
Variable Descriptors - POSN ON, POSN HI, POSN LO, FOCUS HI, FOCUS LO
Phase Table - 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
```

Class 12 : Descriptor Block for each Receiver Channel

Certain parameters vary with an individual receiver channel. When multiple polarizations are used, this block must be repeated for each channel.

1. Observed Frequency -
   The center frequency of the observation.

2. Rest Frequency/Total Power Calibration -
   In the spectral line observation the rest frequency of the observation or in the continuum observation the total power calibration.

3. Frequency Resolution/Switched Power Calibration
   In the spectral line observation the frequency spacing of the spectral line backend or in the continuum observation the switched power calibration.

4. Bandwidth -
   The total bandwidth in MHz of this receiver channel.

5. Receiver Temperature -
   The receiver temperature measured for a given channel.

6. Calibration Temperature -
   The value of the noise tube diode or other calibration temperature used to calibrate the data.

7. Source System Temperature -
   The system temperature measured on source.

8. Reference System Temperature -
   The system temperature measured on reference.

9. Source Temperature -
   Source temperature computed for a series of on-off samples.

10. RMS -
    RMS value about the mean source temperature.

11. Reference Point Number -
    The position in the spectral line device for which the observer enters a freqency and/or velocity. It is usually the first or center channel.

12. X value at the Reference Point -
    Value of the x-axis at the reference point.

13. Delta X -
    The step size along the x-axis.

14. Total Integration Time -
    The total integration time for this receiver channel.

15. Number of Integrations -
    The number of data points for this receiver channel.

16. Starting Point Number -
    The starting point location of this receiver channel in the data area.

17. H2O Opacity -
    The opacity of water as computed by a model.

18. H2O Temperature -
    The temperature of water.

19. O2 Opacity -
    The opacity of oxygen as computed by a model.

20. O2 Temperature -
    The temperature of oxygen.

21. Polarization Description -
    An eight character field to describe the type of polarization and the angle. The type may be RC, LC or LIN. The angle can be expressed to the nearest tenth of a degree.

Class 13 : Spectral Values

The spectral values (n phases for m channels) appear in an array where the data precision is defined in the first class.