VEX Parameter Tables

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Each VEX primitive $block is allowed to specify only parameters which are defined for that type of $block. The VEX Parameter Tables define in detail these parameters for each type of $block.

Each table lists the allowed parameter names and the associated fields. Field numbers in parenthesis are optional. Parameter type '&link' is a VEX linkword as defined in the VEX documentation. If 'units' are specified, the field must have a units label of the proper type; 'units' enclosed in parenthesis are assumed and should not be labeled.

Not all parameters need to be specified for a given experiment, only those which are 'relevant'. This listing does not attempt to specify the set of 'relevant' parameters, but is instead left to the assumed expertise of the scheduling-software writer.

This listing is not to be regarded as necessarily complete, either with regard to $blocks or the set of native parameters within the $blocks. Many $blocks, particularly the '$XXXX_OBS' blocks, are not yet specified. These $block will be defined in the near future. Additional parameters will undoubtedly be added as the need arises.

$ANTENNA Block

The $ANTENNA block specifies the detailed characteristics of the antenna itself, including the type of mount and pointing characteristics.

Parameter	Field	Description	Type	Allowed values	Units	Comments
antenna_diam	1	Antenna diameter	real	>0	length	
antenna_name	1	Antenna name	char			Useful, if needed, to distinguish particular antenna from site (portable antenna, for example)
axis_type	1	Primary axis type (i.e. moves the most structure and, usually, changes orientation of secondary axes)	char	az| ha| x| fixed		Typically, 'axis_type=az:el;' or 'axis_type=ha:dec;' or 'axis_type=x:yns;' (N/S orientation) 'axis_type=x:yew;' (E/W orientation) etc..
	(2)	Secondary axis type (if relevant)	char	el| dec| yns|yew		Pairing of parameters 1 and 2 must make sense (see comment immediately above)
	2	axis orientation	char		angle	0 deg - north/south orientation; 90 deg - east/west orientation
axis_offset	2	Axis offset	real		length	
antenna_motion	1	Axis type	char	(axis type)		Must be one 'ant_motion=' statement for each motion axis.
	2	Slew rate	real		ang/time	
	3	Settling time	real		time	
pointing_sector	1	Sector ID/cable-wrap zone ID;	&link			May be used to specify pointing sector in $SCHED block
	2	Axis type	char	(axis type)		
	3	Lower limit	real		angle	Upper limit > Lower limit
	4	Upper limit	real		angle	
	(5)	Axis type	char	(axis type)		
	(6)	Lower limit	real		angle	Upper limit > Lower limit
	(7)	Upper limit	real		angle	

$BBC Block

The $BBC block connects physical BBC's to the 'logical' BBC's defined in the $FREQ section, and also specifies the connection of the BBC to a 'logical ' IF.

Parameter	Field	Description	Type	Allowed values	Units	Comments
BBC_assign	1	Logical BBC 'link' with 'chan_def-' statement in $FREQ block	&link			
	2	Physical BBC#	int	1-16		
	3	Logical IF 'link' with 'if_def' statement in $IF block	&link			

Notes:

1. All logical BBC's defined in the selected $FREQ 'def' must be present in the selected $BBC 'def', but not necessary vice versa.
2. The $BBC block is ignored by the correlator.

$CLOCK Block

The $CLOCK section specifies the necessary clock parameters for proper correlation of the data. Normally, this information will be taken from the station logs, transcribed manually or, as a last resort, determined from a fringe search at the correlator. Obviously, the $CLOCK section is needed only by the correlator.

Parameter	Field	Description	Type	Allowed values	Units	Comments
clock_early	(1)	Starting epoch for validity of this clock model	epoch		epoch	Model in this statement assumed valid until next specified epoch, if any. May be null of model is valid for entire experiment.
	2	'clock_early' - offset of formatter 1-pps tick with respect to UTC	real		time	>0 for formatter tick early
	(3)	Epoch of origin of clock model	epoch		epoch	Needed if clock rate or acceleration specified
	(4)	Clock rate	real		time/ time	For example, 'usec/sec'

Note:
In case of 'clock breaks', where multiple sets of clock parameters must be specified for a station during a single experiment, multiple 'clock=' statements may be used, each specifying the starting epoch of validity for the model in the corresponding statement.

$DAS Block

The $DAS block is intended to define the recording *hardware* present at a station. Because of the many combinations possible, various elements of the hardware are separately specified.

Parameter	Field	Description	Type	Allowed values	Units	Comments
record_transport_type	1	Transport type	char	Mark3A|Mark4| VLBA|VLBAG| S2|K4|Mark5A		Additional types may be added
	(2)	Revision level	char			Example: '1.0'
electronics_rack_type	1	Type of electronics rack	char	Mark3A| Mark4| VLBA| VLBAG| S2|K4		
number_drives	1	Number of tape drives (transports)	int			Number of physical drives connected to system

headstack	1	Headstack#	int	1-4		Specifies correspondence between physical headstack and logical drive. Relevant for MkIIIA, MkIV, VLBA, Mark 5A.
	2	Headstack function	char	read| write| read/write		
	3	Drive-number offset with which this headstack is associated	int			Added to drive# specified in 'station-' statement in $SCHED block to determine physical drive#. Normally =0 for single-drive systems.
record_density	1	Longitudinal bit density along track	int		(bpi)	Usually 33,333 or 56,000 (bpi unit is assumed).. Used to compute tape speed.. Relevant only for MkIII, MkIV, VLBA systems.
tape_length	1	Tape length	int		length| time	For Mark IIIA, Mark IV, VLBA: actual tape length. For S2, K4: recording time at data rate specified in field 2.
	(2)	S2 tape speed	char	slp|ep	(Mbps)	Relevant only for S2
	(3)	Number of S2 cassettes	int	1-8		Must be consistent with total date rate (each S2 cassette records 16 Mbps)
recording_system_ID	1	Recording-system serial number	int			Must be unique for each system of a given type within an experiment. This information is often recorded on tape and used at the correlator. See Notes below.
record_transport_name	1	Recording-transport name	char			Identifies a particular recording transport. Mostly useful for transportable recording systems.
electronics_rack_ID	1	Electronics rack serial number	int			Identifies particular electronics rack
electronics_rack_name	1	Electronics rack name	char			Like a serial number, but a name
tape_motion	1	Specifies how tape is to be controlled	char	start&stop| continuous| adaptive		
	2	Tape early-start time	int	>=0	time	Relevant on for 'start&stop' and 'adaptive' motion; specifies how soon tape should start *before* expected good data.
	(3)	Late stop time	int		time	Relevant for S2 only. Specifies length of time tape should continue running after end of valid data. Typically 0.5 minutes.
	(4)	Minimum gap for stopping tape	int		time	Relevant for S2 only. Specifies minimum valid-data time gap during which tape will be stopped. Typically 3 minutes.
tape_control	1	Define master station in cluster	char	master		Relevant only in antenna cluster where data from more than one station is recorded on a single recording system. Defines which antenna controls tape motion. Others are assumed to be slaves.

Notes:

1. The DAS parameters are intended to be sufficient to describe any of the many variants of Mark3A, Mark4, Mark5 and VLBA systems currently deployed. Additional parameters may have to be added in the future as systems evolve.
2. For Mark IIIA, Mark IV, VLBA and Mark 5A systems, the 'headstack=' statement indicates which 'headstack outputs' from the formatter are connected to the recording system(s). There must be one 'headstack=' statement for each formatter 'headstack output' to be recorded. Multiple recording systems may be connected to a single formatter.
3. If multiple headstacks on same drive, each headstack must have a different headstack# (e.g. Mark IV). Systems with multiple simultaneously-recording headstacks on 2 drives (e.g. VLBA with 2 drives) must have two 'headstack=' statements with a different headstack# and logical drive linkword. The headstack #'s must correspond to the headstack #'s in the $TRACKS block.
4. The 'recording_system_ID' identifies the particular DAS used, akin to a serial number, which is usually written in the aux-data field of the recorded data. The 'recording_system_ID' of each DAS within a given type (i.e. Mark4, VLBA, K4, etc) must be different for each DAS within an experiment; the 'recording_system_ID' of a particular DAS is usually assigned at the time of

manufacture. The 'recording_system_ID' can be used by the correlator to positively identify the particular DAS upon which a tape was written. The parameter 'electronics_rack_ID' is similar.

5. If two or more antennas share the same DAS, the $STATION 'defs' for the corresponding antennas must have 'refs' to exactly the same set of $DAS keywords, including particularly the 'recording_system_ID' parameter, except that one (and only one) of the stations must declare itself as the tape-control master with the inclusion of a 'tape_control=master;' statement within the referenced $DAS 'defs' for that station.

$EOP Block

The $EOP block specifies the earth-orientation parameter to be used by the correlator; not needed for scheduling or data-taking.

Parameter	Field	Description	Type	Allowed values	Units	Comments
TAI-UTC	1	Ephemeris TAI-UTC	real		time	Normally fixed for entire experiment
A1-TAI	1	Ephemeris A1-TAI	real		time	Normally fixed for entire experiment
eop_ref_epoch	1	Epoch of first 'EOP point'	epoch		epoch	
num_eop_points	1	Number EOP points	int			Number of points over which interpolation is done
eop_interval	1	Time space of EOP points	real		time	Typically 24 hrs
ut1-utc	num_ eop_ points	Time series of ut1-utc values	real		time	Must be 'num_eop_points' values in this statement. Units specification may be omitted after first field.
x_wobble	num_ eop_ points	Time series of x-pole values	real		angle	Must be 'num_eop_points' values in this statement. Units specification may be omitted after first field.
y-wobble	num_ eop_ points	Time series of y-pole values	real		angle	Must be 'num_eop_points' values in this statement. Units specification may be omitted after first field.

$EXPER Block

The $EXPER block contains general information useful for the success of the VLBI administrative process.

Parameter	Field	Description	Type	Allowed values	Units	Comments
exper_name	1	Experiment name	char			Typically will be the standard 6-char experiment designator (example. 'RDWPS1')
exper_description	1	Experiment description	char			
exper_nominal_start	1	Epoch of nominal experiment start	epoch			
exper_nominal_stop	1	Epoch of nominal experiment end	epoch			
PI_name	1	PI name	char			
PI_email	1	PI e-mail address	char			
contact_name	1	Contact name	char			
contact_email	1	Contact e-mail address	char			
scheduler_name	1	Scheduler name	char			
scheduler_email	1	Scheduler e-mail address	char			
target_correlator	1	Target correlator	char	VLBA| VSOP| JIVE| Haystack| etc		Others may be added.

$FREQ Block

The $FREQ block describes the signal and sampling characteristics the channels recorded on the tape, where a 'channel' is defined as a single USB or LSB output from a BBC. This includes such information as total RF sky frequency, sideband, channel bandwidth, sampling rate and bits/sample. The $FREQ block does not attempt to describe the recording mode, since the same set of channels may be recorded in different recording modes (or on different equipment) at different stations. Each frequency channel is defined by a 'chan_def=' statement with at least 8 fields in each statement.

The capability of specifying frequency switching is also built into the 'chan_def=' statement by assigning each frequency channel to one or more numbered 'states'. The 'switching_cycle=' statement then specifies the length of time spent in each of the states.

Parameter	Field	Description	Type	Allowed values	Units	Comments
chan_def	1	'Band_ID': RF band name	&link			Link to selected $SOURCE 'def' where it may be used to describe source-structure characteristics for scheduling purposes. May be omitted if not relevant.
	2	RF sky frequency at 0Hz in the BBC output	real		freq	This frequency, in combination with the LO frequency specified in the $IF block allows computation of the BBC LO frequency for this channel.
	3	Net sideband of this BBC channel	char	U|L		Note that this will be opposite the labeling on the BBC itself if the IF going into the BBC is net LSB
	4	BBC Channel bandwidth	real		freq	
	5	'Chan_ID': Logical channel name	&link			Must be different for each channel. Used as link to selected $TRACKS 'def'.
	6	'BBC_ID': Logical BBC name	&link			Link to selected $BBC 'def where connection to physical BBC is made.
	7	'Phase-cal_ID': Logical phase-cal name	&link			Link to selected $PHASE_CAL 'def' block to specify details of phase-cal tone(s). Null specifies no phase-cal to be detected.
	(8,9,.. ...)	Frequency-switched state numbers in which this channel is active	int			Used only with frequency switching. Specified state numbers are separated by colons. States must be ordered 1,2,....
switching_cycle	1	Phasing of frequency-switch cycle	char	wrt_obs_start| wrt_min_mark		Relevant only if frequency-switching being used. Timing of switching cycle begins according to this specification.
	2	State 1 period	real		time	Interval over which state 1 is active
	3...	State 2 period, etc	real		time	Interval over which state 2 is active, etc
sample_rate	1	Sample frequency	real		sample rate	Ignored for S2.

Notes:

1. There must be one 'chan_def=' statement for each BBC channel to be recorded.
2. If one or more stations in an experiment observe different sets of frequency channels, there must be a separate 'def' for each different set of channels.
3. A resolved link must exist for every specified 'linkword' in each 'chan_def=' statement.

$HEAD_POS Block

The $HEAD_POS block defines the headstack positioning as a function of 'headstack-position reference number' for Mark IIIA, Mark IV, and VLBA systems; the $HEAD_POS block is irrelevant for other types of recording systems.. One 'headstack_pos=' statement is required for each potential headstack position (or set of positions if multiple simultaneous recording headstacks).

Parameter	Field	Description	Type	Allowed values	Units	Comments
headstack_pos	1	Position reference number	int	>0		
	2	Headstack 1 position	int	range of headstack motion	length	Allowed range depends on system, but is typically -1000 to +1000 um.
	(3)	Headstack 2 position	int	range of headstack motion	length	Required only if headstack 2 is being used.
	(4)	Headstack 3 position	int	range of headstack motion	length	Required only if headstack 3 is being used.
	(5)	Headstack 4 position	int	range of headstack motion	length	Required only if headstack 4 is being used.

$IF Block

The $IF block defines the IF bands used in the observations and is linked to the $BBC block (which specifies the detailed BBC-to-IF connections). An 'if_def=' statement must be defined for each of the IF 'links' specified in the selected $BBC 'def'.

Parameter	Field	Description	Type	Allowed values	Units	Comments
if_def	1	'IF_ID' link word	&link			One 'if_def=' statement must be present for each separate IF.
	2	Physical IF name	char			System dependent. Used to create procedures to select proper IF. See Notes.
	3	Polarization	char	R|L		
	4	Total effective LO of IF (just before signal enters BBC)	real		freq	Positive number
	5	Net sideband of IF	char	U|L		
	(6)	Phase-cal frequency interval	real		freq	Typically 1 MHz. Null or omission indicates no phase-cal.
	(7)	Phase-cal base frequency	real		freq	Usually =0, in which case may be null or omitted.

Notes:

1. The 'total effective LO' is used in conjunction with the total sky frequency specified for each channel in the $FREQ block to calculate the local-oscillator setting in each individual BBC.
2. The 'Physical IF Name' is a system-dependent designation specifying which IF is selected. For the VLBA system, IF's A,B,C,D may each be selected with either a 'Normal' or 'External' input, leading to designations 'AN','AE','BN', 'BE', 'CN', 'CE', 'DN', 'DE'. For the Mark III system, IF's 1,2,3 may each be selected with either a 'Normal' or 'Alternate' input, leading to the designations '1N', '1A', '2N', '2A', '3N', '3A'.

$PASS_ORDER Block

The $PASS_ORDER block defines pass and group ordering relevant for Mark IIIA, Mark IV, VLBA and S2 systems. For Mark IIIA, Mark IV and VLBA system, each pass is defined by a two-part field composed of a numeric 'headstack-position reference' (defined in the selected $HEAD_POS 'def') followed by an alphabetic 'subpass identifier' (defined in the selected $TRACKS 'def'), example '2A'. For S2, the 'S2_group_order=' statement defines the order of usage of tape groups.

Parameter	Field	Description	Type	Allowed values	Units	Comments
pass_order	1	First pass ID	char			e.g. '1A'. First pass assumed to be in 'forward' direction. For S2, specified group#.
	2	Second pass ID	char			e.g. '2A'
	...	etc				
S2_group_order	1	First group number	int			Specifies order in which S2 groups are to be recorded.
	2	Second group number	int			
	...	etc				

Notes:

1. The number of fields present in the 'pass_order=' or 'S2_group_order=' statements specifies the number of tape passes or groups. Number of cassettes per group is defined by recording mode specified in $TRACKS section. S2 groups are numbered starting at 0.
2. First pass is assumed to be in the forward-tape-motion direction (Mark IIIA, Mark IV, VLBA).

$PHASE_CAL_DETECT Block

The $PHASE_CAL_DETECT block is used to specify the phase-cal tones to be detected at the observing station.

Parameter	Field	Description	Type	Allowed values	Units	Comments
phase_cal_detect	1	pcal_ID	&link			Links to a 'chan_def=' statement in selected $FREQ def.
	2	Tone number (from DC edge of BBC output)	int			Tone number of first tone to be detected. See tone-number definition in Notes.
	(3)	Tone number	int			Tone number of second tone to be detected
	...	etc				

Note:

1. The actual phase-cal frequencies are determined by the LO frequencies specified in the $IF and $FREQ blocks.
2. The phase-cal frequency spacing are specified in the $IF block.
3. Tone number 1 is defined as first tone *above* 0Hz in the BBC output channel, etc. Phase-cal detection will be done on the set of specified 'tone#'s, which are listed in order of preference in case more tones are specified than can be detected by the hardware. The tones are numbered positively from the low (DC) edge of the BBC output band, with tone number '1' being the first tone *above* DC. Tones may also be specified as negative numbers corresponding to their position from the nominal bandedge, with tone number '-1' being the first tone *below* nominal bandedge. A tone number of '0' specifies state counting, rather than phase-cal detection, should take place.

$PROCEDURES Block

The $PROCEDURES block specifies parameters relevant to various procedures at an observing station. Timing parameters are to be used as constraints to the scheduling program. The set of timing parameters listed is for the NASA 'sked' program. Other scheduling programs may use these and/or other parameters.

Parameter	Field	Description	Type	Allowed values	Units	Comments
tape_change	1	Tape-change time	real		time	Required parameter
headstack_motion	1	Time to complete headstack motion	real		time	Required parameter
new_source_command	1	Time to initiate pointing to new source	real		time	Required parameter
new_tape_setup	1	Time to setup system for new tape	real		time	Required parameter
setup_always	1	Setup system for each observation	char	on|off		Optional procedure
	2	Time to setup system	real		time	
parity_check	1	Do parity check	char	on|off		Optional procedure
	2	Time needed to do parity check	real		time	
tape_prepass	1	Do tape prepass	char	on|off		Optional procedure
	2	Time needed to do tape prepass	real		time	
preob_cal	1	Pre-observation calibration	char	on|off		Optional calibration procedure
	2	Time needed for procedure	real		time	
	3	Procedure name	char			
midob_cal	1	Mod-observation calibration	char	on|off		Optional calibration procedure
	2	Time needed for procedure	real		time	
	3	Procedure name	char			
postob_cal	1	Post-observation calibration	char	on|off		Optional calibration procedure
	2	Time need for procedure	real		time	
	3	Procedure name	char			
procedure_name_prefix	1	Specify standard procedure library	char			Specifies that a 'standard' procedure library is to be used.

Notes:

The 'procedure_name_prefix' parameter is intended to allow the specification of frequently-used procedure libraries that individual stations may have honed to their particular requirements. For instance, the geodesy community frequently uses the same station setup over and over again (e.g. so-called 'SX2C' setup). The specification of the 'standard_procedures' for a station relieves the requirement of creating a new set of procedures for an experiment.

$ROLL Block

The $ROLL block defines the barrel-rolling sequence that may be used in VLBA and Mark4 recording systems. It is intentionally defined in a very general way, but for the most part will probably be confined to a few 'canned' modes.

The roll sequence is specified with a 'roll=' statement for each track participating in the barrel roll, plus statements defining the roll period and reinitialization interval.

Parameter	Field	Description	Type	Allowed values	Units	Comments
roll	1	Roll on/off	char	on|off		Optional. See Notes.
roll_def	1	Headstack #	int	1-4		
	2	Home track	int	track #		Track# that would be written in the absence of barrel-roll.

	3	Step 0 destination track				Track to which home track is written when barrel-roll is initialized (step 0)
	4	Step 1 destination track	int	track #	-	Track to which home-track is 'switched' on first increment of barrel-roll.
	5	Step 2 destination track	int	track #	-	Track to which home-track is 'switched' on second increment of barrel-roll.
	etc					
	n+2	Last-step destination track in n-step sequence	int	track #	-	Track to which home-track is 'switched' on last step of barrel-roll. Returns to Step 0 as next step.
roll_inc_period	1	Roll increment period in frames	int		(frames)	
roll_reinit_period	1	Roll-sequence reinitialization period in seconds (at recording)	real	any	time	Fixed at 2 sec for VLBA. Mark4 can be specified.

Notes:

1. Barrel-roll is confined to tracks 2-33 within a given headstack. For cases of barrel-roll using multiple headstacks, the roll sequence definition must include all headstacks.
2. Barrel-roll is applied in the formatter as the last step before the data are written to tape.
3. System tracks do not participate in barrel-roll.
4. The number of fields in the 'roll=' statements defines number of positions in the roll sequence. All 'roll=' statements must specify the same number of positions in the roll sequence.
5. Note that all track# references elsewhere in the VEX file are to the 'home track#'.
6. 'roll=off;' is default. Presence of any 'roll_def=' statements implies 'roll=on;'.

$SCHEDULING_PARAMS Block

The $SCHEDULING_PARMS block specifies various parameters needed for the scheduling program. Since each scheduling program may have its own unique set of parameters, the $SCHEDULING_PARAMS' block is specified strictly as a literal block which must be parsed and interpreted by the relevant scheduling program. The parameters listed are some of those for the current version of the NASA 'sked' program. Other scheduling programs may use these and/or other parameters.

Note: These parameters are examples only!

Parameter	Field	Description	Type	Allowed values	Units	Comments
sched_program	1	Scheduling program name	char			
	2	Revision	char			
default_scan_length	1	Default scan length			time	
lookahead	1	Lookahead for source rise/set			time	
min_scan_length	1	Minimum scan length			time	
minimum_between_scans	1	Minimum time between scans			time	
modular_scan_length	1	Schedule on minute marks			time	
max_display_width_col	1	Display screen width			(columns)	
confirm	1	Confirm new scans		on|off		
mutual_vis	1	Force all stations to see source, or allow subnet		all|subnet		
low_SNR_reject	1	Reject stations if SNR too low		auto|man		Primarily for geodesy
variable_scan_length	1	Use SNR calculation to set scan length		on|off		Primarily for geodesy
min_sun_angle	1	Min angle between source and sun			angle	
tape_usage_sync	1	Synchronize tape usage		on|off		
sked_optimize	1	Type or optimization for auto-scheduling		sky_coverage| covariance		Primarily for geodesy
window	1	Sliding window for optimization			time	Primarily for geodesy

maximize_num_obs	1	Maximum total # of observations		on|off		Primarily for geodesy
minimize_idle	1	Minimize idle time between scans		on|off		Primarily for geodesy
minimize_slew	1	Minimize antenna slew time		on|off		Primarily for geodesy

$SEFD Block

The optional $SEFD block allows the sensitivity of each IF to be modeled and used for a crude calculation of expected SNR when used with specified observing modes an d scan-length times. For geodesy, these calculations can be used to automatically adjust scan times for minimum-acceptable SNR in order to densify the schedule as much as possible. The particular SEFD model to be used can be specified, along with the model parameters.

Parameter	Field	Description	Type	Allowed values	Units	Comments
sefd_model	1	SEFD model name	char	Shaffer|?		Models may be added
sefd	1	IF_ID 'linkword'	&link			Link to 'IF_ID' in selected $IF 'def'
	2	Zenith SEFD	real		flux-density	
	3,...	Model parameters				

$SITE Block

The $SITE block describes the location of an antenna and may be either earth-based or earth-orbiting. Horizon masks for earth-based sites may be specified as an aid in scheduling.

Parameter	Field	Description	Type	Allowed values	Units	Comments
site_type	1	Type of site	char	fixed| earth_orbit		
site_name	1	Full site name	char	<=16chars		
site_ID	1	Standardized 2-char site name	char	2 chars		
site_position	1	x	real		length	
	2	y	real		length	
	3	z	real		length	
site_position_epoch	1	Epoch of site_position	epoch		epoch	
site_position_ref	1	Reference for site position	char			
site_velocity	1	x-velocity	real		speed	
	2	y-velocity	real		speed	
	3	z-velocity	real		speed	
horizon_map_az	1..n	List of azimuth values corresponding to values in horizon_map_el	real		angle	Units specification may be omitted after first field.
horizon_map_el	1..n	List of elevation limits at azimuths specified in horizon_map_az	real		angle	Units specification may be omitted after first field.
zen_atmos	1	Zenith atmosphere added delay	real		time	Typically on order of 7 nsec
ocean_load_vert	1	Ocean-loading vertical amplitude	real		length	
	2	Phase	real		phase	
ocean_load_horiz	1	Ocean-loading horiz amplitude	real		length	
	2	Phase	real		phase	
occupation_code	1	4-char occupation code	char			Primarily used for geodetic experiments

inclination	1	Earth-orbit parameter	real		angle	
eccentricity	1	Earth-orbit parameter	real		-	
arg_perigee	1	Earth-orbit parameter	real		angle	
ascending_node	1	Earth-orbit parameter	real		angle	
mean_anomaly	1	Earth-orbit parameter	real		angle	
semi-major_axis	1	Earth-orbit parameter	real		length	
mean_motion	1	Earth-orbit parameter	real		-	
orbit_epoch	1	Earth-orbit epoch	epoch		epoch	

$SOURCE Block

The $SOURCE block defines the sources to be observed and specifies their relevant characteristics, particularly position. A single source is defined in each 'def' block. A crude source model may be specified for each observed 'Band_ID' specified in the $FREQ block for purposes of auto-scheduling (primarily geodesy).

Parameter	Field	Description	Type	Allowed values	Units	Comments
source_type	1	Generic source type	char	star| earth_satellite		Specifies coordinate system in which position of object will be specified. Other types may be added.
	2	Experiment source type	char	target| calibrator| dummy		'dummy' may be declared if the source if specified for pointing purposes only. Station field system may use this information.
source_name	1	Source name	char	<=16 char		Typically same as 'def' label name (e.g. '3C273B')

For 'source_type=star':

IAU_name	1	Standard IAU source ID	char	9-char		Example: '0102-0304'
source_position_ref	1	Origin of source position	char	<=16-char		For traceability of source position
ra	1	Right-ascension	RA		RA	Example: 01h02m03.456s
dec	1	Declination	dec		dec	Example: -03d04'05.678"
ref_coord_frame	1	Source-position reference frame	char	B1950/ J2000		
ra_rate	1	RA proper motion	real		ang rate	Typically asec/yr
dec_rate	1	Declination proper motion	real		ang rate	Typically asec/yr
source_position_epoch	1	Epoch of stated position	epoch		epoch	Needed only if non-zero ra_rate or dec_rate
source_model	1	Component number	int			One 'source_model=' statement for each major source component for each 'Band_ID' link to the selected $FREQ 'def'
	2	'Band_ID' linkword to selected $FREQ 'def'	&link			
	3	Component flux-density	real		flux-densit y	
	4	Component major axis	real		angle	Angle subtended on sky
	5	Component axis ratio	real			
	6	Component position angle	real		angle	
	7	Component RA offset wrt specified source position	real		angle	
	8	Component dec offset wrt specified source position	real		angle	

For ‘source_type=earth_satellite’:

inclination	1	Orbit inclination	real		angle	
eccentricity	1	Orbit eccentricity	real			Unitless
arg_perigee	1	Argument of perigee	real		angle	
ascending_node	1	Longitude of ascending node	real		angle	
mean_anomaly	1	Orbit mean anomaly	real		angle	
semi-major_axis	1	Orbit semi-major axis	real		length	
mean_motion	1	Orbit mean motion	real			
orbit_epoch	1	Epoch of stated orbit	epoch		epoch	

$TRACKS Block

The $TRACKS block defines the various multiplex (fan-in and fan-out) modes that can be used to record data on the Mark3A, Mark4, and VLBA DAS’s. In cases where a mode uses fewer than the full number of heads in a single pass, alphabetical ‘sub-passes’ are defined (tape passes with the headstacks in a fixed position).

For purposes of multiplex definitions, the sample data from each channel are separated into a ‘sign’ bitstream and (for 2-bit sampling) a ‘magnitude’ bitstream.

The fan-out modes (single bitstream to 1, 2 or 4 tracks) are defined with a set of ‘fanout_def=‘ statements, one such statement for each bitstream and subpass, which defines the destination tracks and bit ordering among the tracks. In this way a complete definition of the multiplex format is specified. The ‘ChanID’ linkword in each ‘fanout_def=‘ statement connects a particular bitstream to the selected ‘def’ in the $FREQ block.

The fan-in modes (1, 2 or 4 bitstreams to a single track) are defined by a set of ‘fanin_def=‘ statements. Each such statement defines the bitstreams written to a single track in a specified subpass. The set of ‘ChanID’ linkwords in each ‘fanin_def=‘ statement connects the particular bitstreams to the selected ‘def’ in the $FREQ block. and specifies their multiplex order on the track.

Within each ‘fanout_def=‘ or ‘fanin_def=‘ statement is a field which specifies the ‘sub-pass’ to which it applies. A ‘subpass’ is defined as a single tape pass for which the headstack(s)s are held at a fixed position. Typically, for example, 16 of 32 tracks may be written in a single tape pass; for this case there are 2 sub-passes with a given headstack position. By convention, the subpasses are labeled A, B, C, ...,etc.

Note that, except for the ‘VLBA_trnsprt_sys_trk=‘ statement, all references to ‘track numbers’ in the $TRACKS block are more properly labeled as ‘home tracks’ since barrel-rolling in the formatter (Mark 4 and VLBA) and track switching within the recorder (VLBA only) may lead to modified physical track assignments. Normally, the actual physical track numbers (pre-barrel-rolled) correspond identically to ‘home track’ numbers.

Parameter	Field	Description	Type	Allowed values	Units	Comments
fanout_def	1	Sub-pass ID	char	single char		One ‘fanout_def=‘ statement required for each bitstream. By convention, subpass_ID uses characters A,B,C,...etc. Null for Mark 5A.
	2	‘Chan_ID’ linkword	char	-		Link to ‘Chan_ID’ in selected $FREQ def
	3	Sign or magnitude bitstream	char	sign|mag		Fields 2 and 3 uniquely define a single bitstream
	4	Headstack number	int	1-4		
	5	First multiplex track	int	track#		Track # within headstack
	(6)	Second multiplex track	int	track#		Required for fanout 1-to-2 or 1-to-4
	(7)	Third multiplex track	int	track#		Required for fanout 1-to-4
	(8)	Fourth multiplex track	int	track#		Required for fanout 1-to-4. Number of fields specifies fan-out ratio.
fanin_def	1	Sub-pass number	int	single char	-	By convention, uses characters A,B,C,...etc.
	2	Headstack number	int	1-4		
	3	Track number	int	track#		

	4	'Chan_ID' linkword for multiplex bitstream 1	char			Link to 'Chan_ID' in selected $FREQ def
	5	sign or magnitude bitstream (of 'Chan_ID')	char	sign| mag		Fields 4 and 5 uniquely define the bitstream which occupies bit position 1 on the specified track.
	(6)	'ChanID' linkword for multiplex bitstream 2	char			Fields 6 and 7 required if fanin is 2-to-1 or 4-to-1
	(7)	sign or magnitude bitstream	char	sign|mag		Fields 6 and 7 uniquely define the bitstream which occupies bit position 2 on the specified track.
	(8)	'ChanID' linkword for multiplex bitstream 3	char	-		Fields 8 and 9 required if fanin is 4-to-1
	(9)	sign or magnitude bitstream	char	sign|mag		Fields 8 and 9 uniquely define a bitstream which occupies bit position 3 on the specified track.
	(10)	'ChanID' linkword for multiplex bitstream 4	char			Fields 10 and 11 required if fanin is 4-to-1
	(11)	sign or magnitude bitstream	char	sign|mag		Fields 10 and 11 uniquely define a bitstream which occupies bit position 4 on the specified track.
track_frame_format	1	Frame format on tape track	char	Mark3A| Mark4| VLBA		'Mark3A' and 'Mark4' are slightly different data-replacement formats. 'VLBA' is non-data-replacement format. VLBA can write 'Mark3A' and 'Mark4' formats.
data_modulation	1	Pseudo-random data modulation	char	on|off		Default is 'off'.
VLBA_frmtr_sys_trk	1	Formatter 'system' track# to be written with specified data	int	0|1|34|35		Applicable to VLBA formatter only. Specifies data to be written to a particular 'system' track formatter outputs.
	2	Data type to be written to system track specified in Field 1	char	xtk_parity| duplicate		'xtk_parity' if cross-track parity to be written; 'duplicate' is this track is to duplicate one of the normal data tracks.
	3A	If Field 2 is 'xtk_parity: First track# of contiguous set of tracks covered	int	2|10| 18|26		Limited to specified set of 'first track #'s'
	4A	If Field 2 is 'xtk_parity: #tracks covered by cross-parity	int	8|16		
	3B	If Field 2 is 'duplicate': 'home track#' of data to be written to specified 'system' track#	int	2-33		Will always be 'home track' data; is not barrel-rolled
VLBA_trnsprt_sys_trk	1	Physical 'system' track (head#) to be written as a duplicate of specified formatter output track (recorder input track)..	int	0|1|34|35		This is a duplication within the transport itself, so includes all barrel-roll
	2	Formatter output track (recorder input track) to be duplicated	int	2-33		
S2_recording_mode	1	Recording mode ID	char	See Notes		Example: '32x4-2'
S2_data_source	1	Define S2 data source	char	Mark4_formatter| VLBA_BBC_1-4| VLBA_BBC_5-8		Relevant for S2 only
	2	Define BBCx selection from Mark 4 formatter	&link			For Mark IV only: Link to 'BBC_ID' in $FREQ. See Notes.
	3	Define BBCy selection from Mark 4 formatter	&link			For Mark IV only: Link to 'BBC_ID' in $FREQ. See Notes.

Notes:

1. Reference to Mark IV Memo 230 (aka VLBA Acquisition Memo 393) may help to clarify the details of multiplex and signal switching in the Mark IV and VLBA systems.
2. The actual fanin/fanout ratio is implied by the number of subfields in the 'fanout_def' or 'fanin_def' statements, as indicated in the above table.

3. For a fanin/fanout ratio of 1-to-1 (i.e. one bitstream to one track), either 'fanout_def' or 'fanin_def' statements may be used.
4. Cross-track parity is computed after barrel-rolling as the last step before writing to tape.
5. The 'S2_recording_mode' parameter specifies the recording mode to which the S2 system is to be set. The available modes are documented in 'S2-RT User's Manual, Version 3.0 (162)', October 1996, ISTS-SGL-TR96-033, available at ftp://s2.sgl.ists.ca. The selected mode defines the number of recording 'groups' and recorded inputs. The 'S2_group_order' parameter in the $PASS_ORDER section specifies the order in which the groups are to be recorded.
6. The 'S2_data_source' parameter specifies the origin of the sampled data recorded by the S2 recording system. Typical data sources are either through the so-called 'phase-cal' outputs of the Mark IV formatter or direct sampler outputs from the VLBA system.

Mark IV formatter: the sampled data from the USB and LSB outputs of each of two selected BBC's can be directed to the 'phase-cal output'. The data available to the S2 are unformatted 2-bit samples at 32 Msamples/sec, regardless of the sample rate chosen for output to the Mark IV recording system. If we designate the two selected Mark IV BBC's as BBCx and BBCy, the Canadian VIA (VLBI Interface Adapter) implements a fixed mapping to S2 inputs as follows:

S2 Input	IN0	IN1	IN2	IN3	IN4	IN5	IN6	IN7
Mk4 bit stream	Lx/sign	Lx/mag	Ux/sign	Ux/mag	Ly/sign	Ly/mag	Uy/sign	Uy/mag

VLBA samplers: The input to the Canadian VIA box may be taken either from BBC's 1-4 or BBC's 5-8, depending on the physical connector to which it is attached. The mapping within the VIA is fixed, as follows:

S2 Input	IN0	IN1	IN2	IN3	IN4	IN5	IN6	IN7	IN8	IN9	IN10	IN11	IN12	IN13	IN14	IN15
BBC1-4	U1/s	U1/m	L1/s	L1/m	U3/s	U3/m	L3/s	L3/m	U2/s	U2/m	L2/s	L2/m	U4/s	U4/m	L4/s	L4/m
BBC5-8	U5/s	U5/m	L5/s	L5/m	U7/s	U7/m	L7/s	L7/m	U6/s	U6/m	L6/s	L6/m	U8/s	U8/m	L8/s	L8/m

The information in the above tables is taken from the 'VLBI System Interface Adapter (VIA) User's Manual, Ver. 1.3', ISTS/SGL, October 25, 1996, available at ftp://s2.sgl.ists.ca.