Research School of Astronomy and Astrophysics

Mount Stromlo and Siding Spring Observatories

RSAA
- Home
- About Us
- Research
- Technology
- Study@RSAA
- Observing
  - Telescope Schedules
  - Applying for Time
  - Observing Capabilities
  - Telescopes
    - 2.3m
    - 40inch
    - 24inch
  - Detectors
  - Computer Accounts
  - CICADA
  - Travel & Tourist info
  - SSO Accommodation Booking
  - Support & Reports
- Gemini
- News
- Jobs

Quick Links
- RSAA People
- Contacts
- RSAA Alumni

Public Information
- Public Information
- How to Adopt-a-Star
- Stromlo History Book
- Picture Gallery
- What's On

Intranet
- Webmail
- Administration
- Committees
- Colloquia & FoF
- Computing
- Library
- Staff/Student Guides
- Social
- Timesheets
- Local Picture Gallery
- Weekly Bulletins
- RSAA Grapevine

Search RSAA
Go

2.3m Telescope

Overview

The 2.3-m Telescope was built in the early 1980's, at the initiative of the then MSSSO Director, Don Mathewson. The entire project was managed by the Observatories' own technical staff, and a large amount of the construction was also undertaken in-house. The design of the 2.3-m, sometimes called the Advanced Technology Telescope, incorporated three radical features never before combined in a single instrument - an uncommonly thin mirror, an alt-az mount, and a rotating building.

Specifications

- 2.3m, f/2.05 primary mirror
  - 4715mm focal length
  - 2300mm outside diameter
  - 500mm diameter central hole
  - $3.973m^2$ collecting area
- 0.3m, f/7.85 secondary for Nasmyth
  - 18056mm focal length
  - Plate scale : 4.964 arcsec/mm
  - 80mm diameter (6.62 arcmin) unvignetted field of view
- 0.3m, f/7.85 tip-tilt secondary for Cassegrain (18056mm focal length)
- Alt-Azimuth telecope mount

Telescope Control Manual

Instruments

- Imager
- Double Beam Spectrograph (DBS)
- Cryogenic Array Spectrometer/Imager (CASPIR)
- Tiptilt Infrared Secondary

Page last updated: 07 January 2005
Please direct all enquiries to: Webmaster
Page authorised by: Director, RSAA

Mount Stromlo and Siding Springs Observatories

Telescope Command Reference Manual

Table of Contents

Created by Martin Mulligan & Gary Hovey.
Last updated 14 June 2000.

Telescope Command Reference Manual

1 Telescope System Commands

1.1 INTRODUCTION

The primary means of controlling MSSSO telescopes is a set of commands which are described in this manual. These commands are DCL commands, which means that they may be typed at the keyboard or included in command files in exactly the same way as standard VAX/VMS DCL commands. However, it is not essential to be familiar with DCL to use these commands.

1.1.1 Notation used in this manual

Although commands are always listed in this manual in full and in upper case, it is not necessary to type them this way. All commands (except STARTUP) may be abbreviated and they may be typed in either case. VMS input is not case sensitive.

Portions of commands shown enclosed in square brackets are optional parameters—they need not be typed. If you do not type such an item, a default value will be assumed, as described in the accompanying text. For example, TRACK/SHOW/NEXT [j]. In this case, if j is not supplied, it will be assumed to be 1. If you do type it, do not type the brackets. One exception to this rule is where a VMS directory specification has been included in the text (usually as part of a file specification, e.g. TEL_USER:[CATALOGUES].). In this case, the square brackets are part of the specification and must be typed.

An ellipsis (…) is used to indicate that additional items (of the same form as the item which precedes the ellipsis) may be supplied when entering this command.For example, the notation VIEW variable_name [,…] indicates that the following are all legal VIEW commands:
VIEW Apparent_RA
VIEW Apparent_RA, Apparent_Dec
VIEW Apparent_RA, Apparent_Dec, UTC
etc.

The notation <Ctrl/X means ‘hold down the "Control" (or "Ctrl") key on the keyboard and type "X"’. The Control key works like a Shift key.

1.1.2 Introduction to VAX VMS

For users unfamiliar with the VMS operating system, a good introduction may be found in the VMS manual *Introduction to VMS*. This section gives some additional information which should make that manual easier to understand.

(a) The 2.3 metre and 74 inch telescope console terminals are VT100 type terminals. The 50 inch terminal is a VT220 type.

(b) To log on to the terminals mounted in the 2.3 metre Console, the <BREAK key must be pressed. On other terminals (and at the other telescopes) simply press the <RETURN key, as described in *Introduction to VMS*.

(c) When entering commands, remember that they are generally not acted upon by the system until the <RETURN key has been pressed.

(d) To erase spelling mistakes during command entry, use the <DELETE (or <X]) key, not the <BACKSPACE key.

(e) <Ctrl/S freezes the terminal screen. This is commonly used when you wish to read something on the screen before it disappears off the top.

(f) <Ctrl/Q re-enables terminal output after <Ctrl/S.

(g) The <NOSCROLL key (on VT100s) or the <Hold Screen key (on VT200s) alternately freezes and re-enables the terminal (i.e. it alternately sends the <Ctrl/S and <Ctrl/Q sequences).

WARNING: This is a common trap for new users. If nothing is happening on your terminal when you expect action, you may have pressed <NOSCROLL. Try <Ctrl/Q before complete panic sets in.

(h) The <Ctrl/Y key combination interrupts a program and returns user to DCL command level.

(i) The <Ctrl/C key combination interrupts a program and may return user to a restart point in that program or to DCL.

(j) The <Ctrl/Z key combination is usually used as an exit command (i.e. as the normal way to terminate a program).

1.1.3 Introduction to Telescope System

When you log in to the telescope account, you will be asked for your observer's identification. Reply with your own computer account name (or 'VISITOR' if you are a visitor to this site). This information is used to set the default directory in which the telescope system will look for your files. Although it is possible to observe without any observer files set up, they do make observing runs easier. Files that you may wish to set up are described in the *Observer's manual* for your telescope.

The default directory that the telescope system uses is a subdirectory of your own account directory called OBSERVE i.e. it will be MSO_USER:[yourname.OBSERVE]. If you are a visitor to this site, it will be MSO_USER:[VISITOR.OBSERVE].

After login all DCL commands are available, but the only telescope command available to you is STARTUP. This must be typed in full to start the telescope control software and to make available the rest of the commands in this manual. When the startup sequence is complete, the system prompt changes from $ to TEL$ to indicate that the telescope commands are now available (in addition to the standard DCL commands). On the 74 inch and 50 inch telescopes, when the DISPLAY program is running, the prompt changes again: to TEL to indicate that you are no longer at the DCL command level. However, all telescope commands are still available, and DCL commands (with the exception of RUN, SPAWN and LOGOUT) may be entered. The DISPLAY program passes these commands to a DCL subprocess for execution. Do not enter any command which expects to prompt you for further input, because this will fail when inside the DISPLAY environment.

There are also three special commands which can be typed only at the TEL prompt:
EXIT OFFSET/GO QUIT.

The EXIT and QUIT commands exit the DISPLAY program and return you to the TEL$ prompt. The OFFSET/GO command is described in §1.3. Extensive on-line help is available: press the <Help key on your keyboard, or if there isn't one, press the <PF2 key. Help may also be obtained by typing the HELP command.

1.2 COMMAND QUEUEING

On MSSSO telescopes, it is possible to set up extra terminal lines to accept telescope commands or (on the 2.3 metre telescope) to establish a network connection to an instrument computer, which may then issue telescope commands. This means that commands could be sent to the telescope system from more than one source almost simultaneously. For this reason (among others) commands on all telescopes have been designed to queue themselves—each command waits until previously issued commands have finished executing before it can start. [If you are using only one terminal, this situation does not arise.]

However, commands which affect telescope motion e.g. TRACK, HALT, OFFSET, SLEW, are an exception to this rule. Each such command 'queue-jumps', and over-rides any previously issued motion command. Thus a HALT command issued after any other motion command will over-ride the other command and stop the telescope.

Each of these motion commands is provided with the command qualifier /WAIT. Normally when such a command is issued, terminal control is returned to the user immediately the motion request has been received by the telescope system—i.e. well before the axes arrive at the desired position. However, if the /WAIT qualifier is specified when the command is issued, the command will wait until the axes have arrived at the desired position before returning control to the user. If you wish to over-ride a command that is still waiting in this state, enter <Ctrl/C and then immediately type the new motion command.

1.3 COMMAND DESCRIPTIONS

APERTURE {2.3m only}

The APERTURE command is used to position the 2.3 metre telescope optic axis in an aperture (which has previously been. defined or calibrated). On an alt-azimuth telescope such as the 2.3 metre, you must observe using a properly calibrated aperture if you are to obtain reasonable tracking.

To define apertures, use the APERTURE/DEFINE command, the APERTURE/CALIBRATE command, or the APERTURE/HERE command. To erase an aperture definition, use the APERTURE/CLEAR command. Use the APERTURE/SHOW command to display information about the currently defined apertures. You may define up to 16 apertures. These commands are available on the 2.3 metre telescope only.

APERTURE aper_id
moves the telescope so that the optic axis is positioned in the aperture named aper_id. Aper_id is any one- or two-character name you created when you defined the aperture. In other words, the telescope moves so that the object being observed moves out of the current aperture and into the new one. The specified aperture becomes the current aperture.

APERTURE 0
moves the telescope optic axis to the instrument rotator centre. The aperture named 0 (zero) is pre-defined by the system to be this position. The name '0' is reserved for use by the system and cannot be re-defined.

APERTURE/CALIBRATE {2.3m only}

APERTURE/CALIBRATE aper_id
performs an interactive calibration sequence needed to define a particular aperture for the focal station currently in use. It is identical to the CALIBRATE APERTURE command. This command is available on the 2.3 metre telescope only. The telescope must be tracking before issuing this command.

Aper_idis any one- or two-character name you wish to give to the aperture. If you use the name of an existing aperture, the new definition will replace the existing one.

On an alt-azimuth telescope such as the 2.3 metre, you must properly calibrate an aperture and select that aperture before you start observing if you are to have reasonable tracking.

You may use the APERTURE/DEFINE command to by-pass this calibration sequence if you know the defining constants for your aperture, but **only if** you also know its position on the TV screen. Once you have calibrated one aperture, you may define further apertures more quickly using the APERTURE/HERE command. Alternatively, you may use the pre-defined aperture 0, (the centre of the rotator), so long as you know where on your screen this is.

For observers on the Double Beam Spectrograph, aperture 1 has been calibrated already. It represents the intersection of the slit and decker.

Calibration Sequence

Choose a star to use for the calibration and track it. Set the Rotator Reference to something other than "Not_In_Use" so that the program can move the rotator during calibration, otherwise it will ask you to move the rotator manually. Enter the APERTURE/CALIBRATE command.

You will be asked to centre the star at the desired aperture location using the jog/offset buttons. Then the rotator is moved to a new position and you will be asked to repeat the procedure. The program will use the offsets to calculate the aperture's location in the focal plane. If you wish to define the aperture as a slit with a particular orientation in the focal plane, you will be asked to do two further positionings of the object.

APERTURE/CLEAR {2.3m only}

APERTURE/CLEAR aper_id [focus]
clears the particular aperture definition i.e. removes it from the system aperture table. The aperture aper_id can no longer be selected. This command is available on the 2.3 metre telescope only. If focus is omitted it defaults to the current focal station.

APERTURE/CLEAR *
clears all apertures for the currently selected focal station, removing them from the aperture table. Only the pre-defined aperture '0' will remain defined for the focal station.

APERTURE/DEFINE {2.3m only}

APERTURE/DEFINE aper_id r [[focus]]

defines the aperture by the constants supplied. This command is available on the 2.3 metre telescope only.

aper_id	is any one-or two character name you wish to give the aperture. If you use the name of an existing aperture, the new definition will replace the existing one.
r	is the radius to the aperture from the rotator centre in arcseconds
	is the angular position of the aperture in degrees CW from the instrument fiducial
	(optional) is the orientation of a slit-like aperture in degrees measured as for
focus	(optional) is the name of the focal station and if omitted defaults to the currently selected focus

---

APERTURE/HERE {2.3m only}

APERTURE/HERE aper_id
defines an aperture to be at the current position of the optic axis in the focal plane of the currently selected focal station. It uses the current offsets to determine the new aperture position. For this to be meaningful, you must first position a star in a previously calibrated aperture and enter CALIBRATE POINTING or TRACK/ZERO to zero the accumulated RA and Dec offsets. Next you must jog the telescope to move the star to the position where the new aperture is to be. Finally, enter the APERTURE/HERE command. **Aper_id** is any one- or two-character name you wish to give to the aperture. If you use the name of an existing aperture, the new definition will replace the existing one. This command is available on the 2.3 metre telescope only.

The new aperture is automatically selected as the current aperture, so if all has gone well, the star will not move. If the offsets are not zeroed correctly in the previous aperture, or the object was not correctly centred in that aperture when the offsets were zeroed, or that aperture itself was not properly calibrated, the new aperture will be in the wrong place, and the star will be seen to jump when the APERTURE/HERE command is issued.

See also ‘Current Offset Aperture Definition’ in the *2.3 metre telescope Observer’s manual* .

APERTURE/SHOW {2.3m only}
shows all apertures for the currently selected focal station with their defining parameters and shows which one is currently selected. This command is available on the 2.3 metre telescope only.

CALIBRATE APERTURE {2.3m only}

CALIBRATE APERTURE aper_id
performs an interactive calibration sequence needed to define a particular aperture for the focal station currently in use; this command behaves identically to APERTURE/CALIBRATE. This command is available on the 2.3 metre telescope only. The telescope must be tracking before issuing this command. Aper_id is any one- or two-character name you wish to give to the aperture. If you use the name of an existing aperture, the new definition will replace the existing one.

Calibration Sequence
Choose a star to use for the calibration and track it. Set the Rotator Reference to something other than "Not_In_Use" so that the program can move the rotator during calibration, otherwise it will ask you to move the rotator manually. Enter the CALIBRATE APERTURE command.

You will be asked to centre the star at the desired aperture location using the jog/offset buttons. Then the rotator is moved to a new position and you will be asked to repeat the procedure. The program will use the offsets to calculate the aperture’s location in the focal plane. If you wish to define the aperture as a slit with a particular orientation in the focal plane, you will be asked to do two further positionings of the object.

CALIBRATE POINTING

CALIBRATE POINTING
corrects the telescope pointing by examining the current accumulated offsets, which are assumed to be the error in pointing, and using them to calculate new values of two collimation constants.

A star should be centred in the current aperture (which must itself be properly calibrated—2.3 metre telescope) or placed in the desired location (74 inch and 50 inch telescopes) before issuing this command. The new collimation values are applied immediately. The tracking coordinates change and become equal to the base coordinates—the accumulated offsets are zeroed—but the telescope should not actually move. (In fact, there is an approximation involved here. If the star does appear to move, re-centre it and re-issue the command.)

This correction should be useful for observing other objects in the same area of the sky, but will be less so for objects which are far away.

CALIBRATE POINTING x_c y_c
corrects telescope pointing using the collimation constants supplied. If you do supply values for x_c and y_c, the telescope pointing is corrected using these values directly. On the 2.3 metre telescope this will cause the telescope to move (but the tracking coordinates to remain the same); on the 74 inch and 50 inch telescopes it will change the tracking coordinates but the telescope will not move.

CALIBRATE POINTING/SHOW

CALIBRATE POINTING/SHOW
displays the current values of the collimation constants.

CFILE

The CFILE command is used to load telescope configuration (and other) information from a telescope Control file, or to save the current information to a file. If you have many configuration variables to set, it is quicker to load them from a Control file than it is to enter successive CONFIGURE commands. For information on the contents of a telescope Control file see the chapter 'Control of Telescope Configuration' in the *Observer's manual* for your telescope.

CFILE [filespec]
CFILE/LOAD [filespec]
loads the required telescope control file. The default file type for filespec is ".CFILE". If no file is specified, a system default control file called TEL_DEFAULT:DEFAULT.CFILE is loaded. (This file contains the standard pointing correction coefficients, among other things.)

CFILE/SAVE[=(option,...)] filespec
The CFILE/SAVE command records the current configuration and other telescope control information in a new control file with specification filespec. The default file type for filespec is ".CFILE". For most observers' purposes, the simple "CFILE/SAVE file-spec" command (without options) is sufficient to completely save the telescope state so that it may be restored at a later time. However, the information to be recorded in the file may be controlled using the save options. These are:

APERTURES	save all aperture definitions
CONFIGURATION	save telescope configuration
CALPOINT	save latest pointing calibration (a subset of option POINTING)
POINTING	save telescope pointing coefficients
OSCSEC	save oscillating secondary configuration
ALL	save all of the above

The 2.3 metre telescope ignores the CALPOINT option. On this telescope, the CFILE/SAVE command (without options specified) is equivalent to

CFILE/SAVE=(APERTURES, CONFIGURATION).

The 74 inch and 50 inch telescopes ignore the APERTURES and OSCSEC options. On these telescopes, the CFILE/SAVE command (without options specified) is equivalent to

CFILE/SAVE=(CONFIGURATION, CALPOINT).

Note**: there is usually no need for observers to save pointing coefficients. The set stored in the default control file contain the results of the latest pointing tests and should give the best results.**

CONFIGURE

CONFIGURE configuration_variable value
sets the telescope configuration. The configuration is controlled by a set of "Configuration Variables", each of which is set to a value. Each telescope has its own set of configuration variables. For information on your telescope's configuration variables, see the chapter 'Control of Telescope Configuration' in the *Observer's manual* for your telescope.

Each CONFIGURE command sets one configuration variable to the value you specify. If you have a lot of configuration changes to make, consider placing them in a telescope Control file and using the CFILE command to load them.

The configuration variables and their possible values are listed below:

configuration variable	possible values
Observers_name	*(string variable set at login time only)*
CFile	*(file specification for telescope control file)*
Instrument_ident	*string*
Secondary	(2.3 m) Nasmyth, IR_Cassegrain
Focal_Station	(2.3 m) Nasmyth_A, Nasmyth_B, Cassegrain, Stowed
Focal_Station	(74") Coude, Cassegrain
Focus_Control	(2.3 m & 50") Manual, Automatic, Compensated
Dome_Control	(50") Manual, Automatic
Windscreen_Control	(2.3 m) Open, Closed, Tracking, Vertical_Only_Tracking, Off
Windscreen_Aperture	(2.3 m) Normal, Wide_for_Finder
Windscreen_Normal_Clearance	(2.3 m)*(numeric value in metres)*
Default_File_Equinox	*string .. must be valid system equinox specification*
Tracking_Equinox	*string .. must be valid system equinox specification or the keyword FILE*
Default_Temperature	*temperature in degrees Celsius*
Default_Pressure	*atmospheric pressure in mBar*
Default_Humidity	(2.3 m)*relative humidity in %*
Effective_Wavelength	(2.3 m)*effective wavelength for detector and source in nm*
Rotator_Reference	(2.3 m) Not_In_Use, Position_Angle, Vertical_Angle, Stationary
Rotator_Orientation	(2.3 m) Slit, Radial, Apertures, Angle
Rotator_Ap1	(2.3 m)*aperture ident for first aperture*
Rotator_Ap2	(2.3 m)*aperture ident for second aperture*
Rotator_Orientation_Angle	(2.3 m)*angle in degrees*
Rotator_CCW_Limit	(2.3 m)*angle in degrees (software limit to rotator motion)*
Rotator_CW_Limit	(2.3 m)*angle in degrees (software limit to rotator motion)*

See the chapter 'Rotator Control' in the *2.3 metre telescope Observer's manual* for more information about the Rotator variables.

DIAGNOSE {2.3m only}

DIAGNOSE
invokes a telescope system test program to fully test the telescope hardware. It is available only on the 2.3 metre telescope.

The program reports on any faults or abnormalities in the hardware of the telescope systems. Included in its output are suggestions of actions you can take to correct any problems; these advisory messages appear in bold characters. Finally it writes a single summary message in reverse video; this will be one of the following messages:

```
Test sequence failed - TELESCOPE SYSTEM UNUSABLE

Telescope systems functioning and ready for observing

Telescope systems abnormal but observing may be possible
```

DIAGNOSE is run automatically at the time of telescope system startup.

DIAGNOSE/OUTPUT=filespec
causes the diagnosis to be written to the specified file instead of the terminal.

DISPLAY

See also DISPLAY/SHOW

DISPLAY
Provides control over the format and contents of the telescope display. On the 2.3 metre telescope, the display is normally maintained on the Display VDU in the console by a special display process. The DISPLAY commands communicate with this process. Multiple display VDUs may also be used. On the 74 inch and 50 inch telescopes, there is no separate display VDU, so the display program uses the Control VDU. The program only runs on demand i.e. when a DISPLAY command is entered, and supports one VDU only.

When the 74 inch or 50 inch display is running, it presents a prompt `TEL` which is only slightly different from the normal telescope `TEL$` prompt that is used at DCL command level. All the commands in this manual (except STARTUP) may be typed at the `TEL$` prompt. They may all be typed at the `TEL` prompt too (including these DISPLAY commands). Most VMS DCL commands may also be entered at the `TEL` prompt. Most of these commands are passed by the display program to a subprocess for execution. Do not enter any command which expects to prompt you for further input, because this will fail when inside the DISPLAY environment.

DISPLAY screen
causes the telescope display to change to the particular display screen specified.

The screens available are:

Configuration	lists all of the Telescope Configuration Information;
Status	shows the status or condition of all Telescope Systems and facilities; it is this screen which appears on the display at startup time.
Messages	an expanded version of the message area of the observer's display screen showing the telescope system messages which are current. Each message is tagged with the system time at which it was signalled. This display is available on the 2.3 metre telescope only.
Observer	the observer display (which is the one with coordinates and time usually needed by astronomers whilst the telescope is tracking) is modifiable by the observer. Its format and contents are defined in a Display Definition File. On the 2.3 metre telescope, up to 4 alternative observer screens (referred to here as subscreens) may be defined. The other telescopes offer only one observer screen.

DISPLAY OBSERVER
On the 74 inch and 50 inch telescopes this command brings up the observer screen. On the 2.3 metre, it re-displays the current observer subscreen. If no observer subscreen has previously been specified,

subscreen number 1 is displayed.

DISPLAY OBSERVER n {2.3m only}
(on the 2.3 metre telescope only) where n is between 1 and 4, displays the observer display subscreen number n and selects it as the current subscreen. If the specified subscreen is not defined by the most recently loaded Display Definition File, it is ignored.

DISPLAY/DEFINITION = filespec
loads the required Display Definition File which defines the contents and format of the observer screen(s). For information about the contents of Display Definition files, see the chapter 'Telescope Display' in your telescope *Observer's manual*. The default file type for display definition files is ".DSP".

DISPLAY/DEFINITION
loads the system default Display Definition File.

DISPLAY/FLAG = set_of_flag_values
is used to set the values of flags which control the operation of the display; in particular, the appearance of the observer screen. The parameter 'set_of_flag_values' can be a single flag value or it can be a set of such flag values separated by commas and included in parentheses. For example:

DISPLAY/FLAG=augment

DISPLAY/FLAG=(decimal_coords, noident, augment).

The control flags are initially defined in the Display Definition file or by system defaults, but options set by this command override these settings and remain in force for any particular Observer screen until a new Display Definition file is loaded.

The flags available are:

[no]augment selects whether the double height display header is augmented by a similar double height display of three other display variables. (On the 2.3 metre telescope, the contents of this augmented header are specified in the Display Definition File; on the 74 inch and 50 inch telescopes the contents are system determined.) The default is noaugment on the 2.3 metre; augment on the 74 inch and 50 inch.

[no]decimal_coords selects whether all the RA/Dec variables (and Az/alt variables where appropriate) are displayed as decimal degrees (or hours) or as degrees, arcminutes, arcseconds (hours, minutes, seconds of time). The default is nodecimal_coords.

[no]ident The current object name can be displayed just below the header as a reverse-video string centred in the top line of the display box. Setting this flag to noident will suppress it. (As an alternative to displaying the object name at the top of the screen, the display variable Short_Obj_Name can be specified in a Display Definition file, which allows the first 10 characters of the object name to appear as a normal field within the Observer screen.) The default is ident.

[no]g_format Decimal values may be displayed in a format similar to the FORTRAN G field specification using this flag. Values between 0.001 and 999.9 are displayed in nn.ddddd form; values outside that range are displayed in an exponent form.The default is nog_format. This flag is available on the 2.3 metre telescope only.

[no]rollover On the 2.3 metre telescope, up to 8 display variables may be grouped together so that they are displayed sequentially in the one observer display field. The display rolls over from one parameter to the next in the group with a period of about 5 seconds. Up to 9 fields may support rollover variables. The rollover grouping is defined by data in the appropriate Display Definition file. This flag enables/disables the rollover action. The default is rollover. This flag is available on the 2.3 metre telescope only.

[no]mimic A mimic of the programmable pushbuttons (see the PUSHBUTTON command) and their programmed functions can be displayed at the bottom of the display screen. Setting this flag to nomimic will suppress this display. The default is nomimic. This flag is available on the 50 inch telescope only. The mimic display is always present on the 2.3 metre telescope.

DISPLAY/KEYTABLE [= filespec] {74" & 50"only}
loads a key definition table from a file. This can define keyboard keypad keys for your use whilst you are within DISPLAY (i.e. at the TEL prompt). The default file type is ".COM", and the default directory is the one current at the time DISPLAY was started. This command is available on the 74 inch and 50 inch telescopes only. DISPLAY remembers the last key table file specification from one invocation to the next and uses it each time. If DISPLAY/KEYTABLE is entered without specifying a file, the system default file is loaded.

The key table file must contain valid DCL type DEFINE/KEY statements. If you create such a file, you should also create another file with the same name but with file type ".PAD", and place a diagram of your key definitions in it. Then the command HELP KEY (<PF1 <PF2) will display this file whenever you need to see what definitions you made.

DISPLAY/REFRESH
causes the currently displayed screen(s) to be completely redrawn and refreshed with data. This command is useful where a fault or system activity has corrupted the display.

DISPLAY/REMOVE=terminal {2.3m only}
removes the telescope display from the specified terminal. This command is available on the 2.3 metre telescope only.

DISPLAY/REMOVE {2.3m only}
removes the telescope display from all VDUs on which it is currently shown, except for the Display VDU. This command is available on the 2.3 metre telescope only.

The display is also removed from an individual terminal the moment someone types at that terminal. [This does not apply to the 74 inch and 50 inch telescopes—there, all telescope commands may be typed at the terminal showing the display without removing it.]

DISPLAY/UNITS
causes each of the value fields of the Observer screen to be temporarily replaced by a text string indicating the units in which that particular variable is displayed. The UNITS display reverts automatically after 5 seconds to the standard screen; the command does not change the screen selected. The UNITS display is prolonged if the command is re-issued whilst it is still active. If the current screen is not the Observer screen the command is ignored.

DISPLAY screen [subscreen] /TERMINAL [=terminal_name] {2.3m only}
displays the specified display screen on the nominated VDU. The displays on the Display VDU and any other VDUs remain unchanged, except in one case: if this command specifies a new Observer subscreen number, all VDUs showing the Observer screen will change to the new subscreen. VDUs showing other screens remain unaffected. The parameter terminal_name may be any valid logical name or may be the physical device name e.g. TXA2: If terminal_name is not a VDU, an error message is displayed and the command ignored. If no terminal name is supplied the display is generated on your own terminal. This command is available on the 2.3 metre telescope only.

DISPLAY/TERMINAL [=terminal_name] {2.3m only}
generates a copy of the display which is currently on the Display VDU, and displays it on the nominated VDU. The parameter terminal_name may be any valid logical name or may be the physical device name e.g. TXA2: If terminal_name is not a VDU, an error message is displayed and the command ignored. If no terminal name is supplied the display is generated on your own terminal. This command is available on the 2.3 metre telescope only.

DISPLAY/SHOW

DISPLAY/SHOW
lists information pertaining to the display definition. This includes:

- the file specification of the current Display Definition file;
- current KEYTABLE definition file; {74" & 50"only}
- the values of all user-accessible display control flags. {2.3m only}

ENLIST {2.3m only}

ENLIST controller
is used to

- Enable an instrument control program on an instrument computer to control the telescope.
- Set up another terminal as an additional telescope command VDU. Telescope (and other) commands may then be issued from the specified terminal.

This command is available on the 2.3 metre telescope only.

The **controller** parameter must specify either:

- an instrument name, as known to the telescope system, or
- a logical or physical terminal name.

The telescope system maintains a list of those instruments which are authorized to control it remotely. For an instrument control program to control the telescope, it must include telescope library (TELLIB) command routine calls. For information on TELLIB routines, see the *MSSSO Telescopes User Programming Manual*.

If controller specifies a terminal name, the telescope system will accept commands from that terminal, in addition to the Control VDU. All prompts and other telescope system output are returned to the respective terminal. Up to four terminals additional to the control VDU may be enlisted.

(Use the IGNORE command to cancel the enlistment of a terminal or instrument.)

FAULTS

FAULTS
causes the text file TEL_BULLETIN:FAULTS.TXT to be listed. This file contains a list of hardware or software faults and abnormal conditions which currently affect the telescope installation, and of which observers ought to be aware.

FOCUS {2.3m & 50"only}

The FOCUS command controls the telescope focuser assembly when the configuration variable Focus_Control is set to AUTOMATIC or COMPENSATED. In MANUAL mode this command does not function and the console focus jog pushbuttons operate the focuser motor directly. This command is available on the 2.3 metre and 50 inch telescopes only.

FOCUS position
moves the focuser setpoint to the position supplied; the position is interpreted as millimetres in the focal plane positive outwards from the instrument mounting flange. A warning is signalled if the focus drive is in manual mode.

FOCUS/WAIT position
functions similarly except that control is returned to the observer only after the required focus position has been reached. The default qualifier is /NOWAIT.

FOCUS/SHOW {2.3m & 50" only}

FOCUS/SHOW
lists on the observer's VDU the current focuser position, the current setpoint and the focus drive configuration setting (control mode). If this setting is 'Manual', the focuser setpoint is not displayed.

HALT

HALT
brings the telescope axes (and instrument rotator—2.3 m) to a stationary state interrupting any other motion which was requested. Control is returned to the observer immediately; motion may persist for a short while afterwards as the telescope decelerates.

HALT/WAIT
functions similarly except that control is returned to the observer only after axis and rotator motion has ceased. The default qualifier is /NOWAIT.

HELP

HELP [topic …]
invokes the VMS HELP utility. Help information on telescope topics is contained in help library TELHELP. The <PF2 key on the Control VDU keyboard (and also the <Help key, if the keyboard has one) has been pre-programmed with the command "HELP @TELHELP", so just press either of these keys to obtain help information.

HELP @TELHELP
displays a list of telescope-related topics and the prompt`@TELHELP Topic?`. Enter a topic name (or an abbreviation of a topic name) to obtain help information on that topic. After the help text for that topic is displayed, a further list of subtopics might be presented, and the prompt`@TELHELP TOPICNAME Subtopic?` appears. You may type an abbreviation of one of the subtopic names to see the subtopic text. At any of these prompts, you may just press <Return to back out to the previous prompt. Pressing <Return enough times will get you right out of the HELP utility. You may also quit the utility by typing <Ctrl/Z.

If you type a question mark (?) at any prompt, the help text for that level is re-displayed. If you type an asterisk (*) in place of any keyword, information is displayed on all topics. If you type a topic name followed by an ellipsis (...), information on that topic and all its subtopics will be displayed. For more information on using the VMS HELP utility, see the VMS *DCL Dictionary*.

HORIZON {2.3m only}

HORIZON
drives telescope to the altitude horizon limit; control is returned to the observer immediately. The azimuth axis and the instrument rotator are not moved. This command is available on the 2.3 metre telescope only.

HORIZON/WAIT
functions similarly except that control is returned to the observer only after altitude motion has ceased

and the telescope is stationary at the horizon. The default qualifier is /NOWAIT.

IGNORE {2.3m only}

IGNORE controller
disables an instrument or terminal previously set up with the ENLIST command. If the IGNORE command specifies an instrument, the link between the telescope and instrument computers is severed, and the instrument can no longer control the telescope. If the IGNORE command specifies a terminal, that terminal can no longer be used to issue telescope commands, and it becomes unused. (This is equivalent to logging out at that terminal.) This command is available on the 2.3 metre telescope only.

METSYS {2.3m only}

The METSYS command invokes a program which displays the status of the meteorological system. The information is presented in the form of a menu. Technical staff may use this menu to control the Met system, but this is not available to observers. All users may use this program to view the meteorological log file. This command is available on the 2.3 metre telescope only.

The Meteorological system is made up of six sensors (which will eventually be expanded to eight sensors), and a rain detector. In addition, the Meteorological MTEC station and the data handling process on the VAX (called METDATA) calculate a number of derived quantities, and some of these are displayed on the the METSYS screen also.

The METSYS menu screen appears as follows:

channel	sensor	current value	units	control	status
1	wind speed	13.1	m/s	ENABLED	normal
2	wind dir to bldg	126	degrees	ENABLED	normal
3	ext temperature	15.1	Celsius	ENABLED	normal
4	rel humidity	67.4	%	ENABLED	normal
5	bar pressure	883.2	mBar	ENABLED	normal
6	int temperature	17.2	Celsius	ENABLED	normal
(7)	rain detector	NotRaining		ENABLED	normal
(8)	tube truss temp	17.1	Celsius	DISABLED	error
(9)	pri mirror temp	16.9	Celsius	DISABLED	error

DERIVED QUANTITIES

true wind direction	228	degrees
wind gusting to	16.2	m/s
barometer (QNH)	1012.2	mBar
dew point	3.1	Celsius
automatic shutter control		

Enter **"L"** to view log

Each sensor name is displayed along with its current reading and the units which apply to the value. The control column indicates whether each sensor has been enabled or disabled by technical staff. The readings of a disabled sensor are ignored by the telescope control system. If a sensor is disabled, it is generally because it has been found to be unreliable or faulty. The status column may read either "normal" or "error". Disabled sensors will be in "error". Enabled sensors will also be in "error" if the external Met electronics system signals that their readings are out of range.

To view the log file, type the letter "L". This will invoke the TPU text editor in ‘read-only’ mode to display the Met data log file. The editor is set up with the standard EDT editor keypad defined, so EDT keypad commands may be used to move around through the file. The data file contains hourly recordings of data, interspersed with daily weather summaries. To terminate viewing of the log file, type <Ctrl/Z (as usual for the editor). This will return you to the METSYS menu screen.

To exit from the METSYS menu screen itself, type <Ctrl/Z.

The hourly data records in the log file consist of: Recording Time, Wind Speed, Wind Gusting, External Temperature, Relative Humidity, Barometric Pressure, and minutes of Rain.

The daily summary consists of 3 lines. The first line contains the minimum Wind Speed encountered during the past day, the maximum Wind Speed, the minimum and maximum Temperature readings, the minimum and maximum Relative Humidity readings, and the minimum and maximum Pressure readings. The second line contains the times at which the readings in the first line occurred. The third line contains the average day-time temperature (over the hours 0600–1800), the average night-time temperature, the total wind run for the day, and the number of minutes of rain for the day.

NOTE {2.3m only}

NOTE is a utility for logging information about the current object to a file for printing. However, it is expected that observers will have differing requirements for a program such as this, so the source files for the program are all made available for observers to modify. These source files also provide a useful guide to those wishing to write other programs to access telescope data. They may be found in directory TEL_BULLETIN:, and the files required are: NOTE.PAS, NOTE_CMD_TABLE.CLD and NOTE.OPT. The comments at the start of NOTE.PAS give instructions on compiling and linking your own version of NOTE. This command is available on the 2.3 metre telescope only.

NOTE
causes an entry comprising

- a sequentially increasing entry number
- the object name of the object currently being tracked
- date and time
- object coordinates (RA, Dec and Equinox)
- zenith distance

to be added to the current log file. This file is OBSERVER.LOG unless another file has been selected with the NOTE/LOGFILE command. The telescope must be tracking at the time this command is issued.

NOTE/LOGFILE=filespec
specifies a file for future NOTE commands to log data to. The specified file remains in force until another NOTE/LOGFILE command is issued, or until you log out. If the file exists, future NOTE commands will append data to the end of the existing data. If it does not exist, it will be created. The default file type is .LOG. If no NOTE/LOGFILE command has been issued before the first NOTE command is issued, data is logged to file OBSERVER.LOG.

This command selects the log file, but does not log the current object to it. The telescope need not be tracking when this command is issued.

NOTE/LOGFILE=filespec/OBJECT
both specifies a file for logging and logs the current object to it. The telescope must be tracking.

OFFSET

See also OFFSET/GO, OFFSET/SHOW, OFFSET/STEPSIZE

The OFFSET command moves the telescope relative to the current tracking or base positions.

OFFSET

The telescope must be tracking when the OFFSET command is issued. The qualifiers which apply to the offset command fall into distinct categories, and these are described below.

Coordinate Frame qualifiers{2.3m only}
/RA_DEC (default)
/AZ_ALT
/TV
/SLIT
These qualifiers specify the coordinate frame in which the offsets are to be applied. They are available on the 2.3 metre telescope only.

OFFSET [/RA_DEC]

If /RA_DEC is specified (or none of these four qualifiers are specified) the parameters specify offsets in Right Ascension and Declination respectively.

OFFSET/AZ_ALT A a

If /AZ_ALT is specified, the parameters specify offsets in Azimuth and Altitude respectively. The /RA_TIME qualifier cannot be specified with this qualifier.

OFFSET/TV x y (not yet available)

If /TV is specified, the parameters specify offsets in the X and Y directions of the TV screen. This requires the TV system to have been calibrated first. As yet, this facility is not available. The /RA_TIME and /COORDINATE qualifiers cannot be specified with this qualifier.

OFFSET/SLIT x y

If /SLIT is specified, the parameters specify offsets parallel to and perpendicular to the current "Selected Orientation". (This behaves the same way as the SLIT button on the console.) The /RA_TIME and /COORDINATE qualifiers cannot be specified with this qualifier.

Offset mode qualifiers
/BASE
/INCREMENT (default)
If /BASE is specified, the supplied offsets move the telescope relative to the base position, replacing any existing offsets.

If /INCREMENT is specified or neither qualifier is specified, the supplied offsets are applied relative to the current tracking position, i.e. they are added to the existing accumulated RA and Dec offsets.

RA offset Unit of Distance qualifiers
/RA_TIME
/ARCSEC (default)
If /RA_TIME is specified, the parameter is interpreted in seconds of time. (This qualifier cannot be specified with the /AZ_ALT, /TV or /SLIT qualifiers.) is always interpreted in arcseconds.

If /ARCSEC is specified or neither qualifier is specified, both parameters are interpreted as arcseconds.

Sky scaling qualifiers
/SCALE
/COORDINATE
If /SCALE is specified, the offsets are applied in the gnomonic projection on the sky, and not directly

to the RA and Dec coordinates (or the Az and Alt coordinates if /AZ_ALT is specified). That is, is multiplied by sec before addition to RA (or the equivalent is done in Az/Alt coordinates). This is the default qualifier when using the /AZ_ALT, /TV or /SLIT qualifiers.

If /COORDINATE is specified in /RA_DEC mode, the offsets are added directly to the RA and Dec coordinates (and produce sec scaling on the sky). In /AZ_ALT mode, the offsets are effectively added directly to Azimuth and Altitude (producing secZ scaling on the sky). This qualifier is the default qualifier when in /RA_DEC mode. It cannot be specified with the /TV or /SLIT qualifiers).

Other qualifiers
/NOWAIT (default)
/WAIT
If /WAIT is specified, control is not returned until the new position has been acquired and the telescope is tracking again. Otherwise, control returns immediately.

Note that the command OFFSET (without any qualifiers) is equivalent to:

OFFSET/RA_DEC/INCREMENT/COORDINATE/ARCSEC

and so produces arcsecond offsets in the coordinates and with respect to the current tracking position.

OFFSET/GO {74" & 50"only}

OFFSET/GO direction
This command is used to simulate console offset buttons, for those telescopes which do not have the hardware implemented. It is available on the 74 inch and 50 inch telescopes only, and it is available from DISPLAY's TEL prompt only, not from the DCL TEL$prompt. Direction is one of the keywords NORTH, SOUTH,EAST or WEST.

In the DISPLAY program's default keyboard keypad definition, the four command directions have been assigned to keypad keys, in order to mimic hardware buttons. Keypad key 8=NORTH, 4=EAST, 6=WEST and 2=SOUTH. Pressing one of these keys moves the telescope in the specified direction by the current step size (i.e. the step size previously established with the OFFSET/STEPSIZE command).

OFFSET/SHOW

OFFSET/SHOW
lists on the observer's VDU the current accumulated RA and Dec offsets, the offset stepsize and the coordinates of the current tracking and base positions; the telescope is not moved.

OFFSET/STEPSIZE

OFFSET/STEPSIZE

sets the stepsize used by the motion-control pushbuttons when they are in offset mode to ? arcseconds; the telescope is not moved. Thereafter, pressing a motion control button in offset mode will cause the telescope to step ? arcseconds in the appropriate direction. If you are observing on the 74 inch telescope (which is not equipped with an offset mode for its console buttons) you must use the OFFSET/GO command to step the telescope instead.

PARK

PARK
drives the telescope to the standard park position:

2.3 metre telescope:	Altitude vertical, Azimuth approx. 233 degrees Rotator halted but not otherwise moved.
74 and 50 inch telescopes:	Hour Angle approx. 0h, Declination approx. –85 degrees

Control is returned to the observer immediately leaving the telescope in motion.

PARK/WAIT
functions similarly except that control is returned only after all motion has stopped. The default qualifier is /NOWAIT.

PLANET

The PLANET command displays information about the current positions of the moon and the planets: Zenith Distance, Sun Distance, Moon Distance, status (above horizon or set), and rise, culmination and set time are listed in tabular format for each of the objects.

Equatorial telescopes (74" & 50") cannot guarantee that all planets listed as ‘above horizon’ can actually be acquired. This is particularly the case for planets low in the East with the telescope East of the Pier (or West with telescope West of pier).

This command is useful when selecting a planet for a telescope demonstration. The calculations are based on the planets’ current coordinates (that is, they assume that the planets are not moving) so the times given will be approximate only.

PUSHBUTTON {2.3m & 50"only}

The PUSHBUTTON command associates the console programmable pushbuttons with particular commands or command procedures (see also PUSHBUTTON/SHOW). This command is available on the 2.3 metre and 50 inch telescopes only. The 2.3 metre telescope supports 16 programmable pushbuttons; the 50 inch supports 8 (eventually—not available yet) .

PUSHBUTTON n ["command_string" ["label_string"]]
associates the command string with pushbutton number n.

Whenever that pushbutton is depressed, the associated command or command procedure is executed. The mimic on the display VDU is labelled with 2 lines of 8 characters from the label string or, if this is not supplied, the first 16 characters of the command string. If both strings are omitted the pushbutton is undefined and any previous association it might have had is lost. The double quotes around command_string and label_string must be supplied if either string contains spaces or special characters (such as ‘/’).

For example:
`PUSHBUTTON 5 "TRACK/NEXT" " Next Object "` causes pushbutton #5 to be labelled as shown here. When that button is pressed the next object in the observer’s coordinate file is selected.
`PUSHBUTTON 1` clears the existing association of pushbutton #1 leaving it undefined and its mimic label blank.

PUSHBUTTON/SETBIT n ["command_string" ["label_string"]]
functions similarly except that, instead of executing a command string, depressing a pushbutton causes a bit to be set in the TELESCOPE_DATA area which is accessible to observer programs.

Command_string is ignored (unless label_string is missing, in which case command_string is used for the button label).

PUSHBUTTON/SETBIT/DCL_COMMAND n ["command_string" ["label_string"]]
causes a button, when pressed, to both set a bit in the TELESCOPE_DATA area and execute a command string.

PUSHBUTTON/CLEAR_ALL
undefines all of the programmable pushbuttons.

PUSHBUTTON/COMMAND_MODE
This command has been introduced to allow command files to define multiple pushbuttons much more quickly. The long delays in defining multiple buttons can be attributed to slow image activation under VMS. This qualifier allows you to invoke the command image once only, and it will prompt you for all button definitions. The prompt is PUSHBUTTON . In response to this prompt, enter normal pushbutton commands exactly as if you were typing them at the DCL command line (including the command PUSHBUTTON at the front). For example:

```
TEL$ pushbutton/command_mode
PUSHBUTTON pushbutton 1 "track" " track "
PUSHBUTTON pushbutton 2 "track/next" " track next "
PUSHBUTTON pushbutton 3/SETBIT " next frame "
PUSHBUTTON <Ctrl/Z
TEL$
```

However, the main speed advantage occurs when this is used in a command file. For example:

```
$! Define programmable pushbuttons
$ pushbutton/command_mode
pushbutton 1 "track" " track "
pushbutton 2 "track/next" " track next "
pushbutton 3/SETBIT " next frame "
pushbutton 4 "halt" " halt "
pushbutton 9 "display" " display "
pushbutton 10 "display configuration" " display config "
pushbutton 11 "display status" " display status "
$ WRITE SYS$OUTPUT "Startup file completed"
$ exit
```

PUSHBUTTON/SHOW

PUSHBUTTON/SHOW
lists all programmable pushbuttons on the observer’s VDU together with their command strings and mimic labels.

RATE {2.3m, 74" & 50"only}

See also RATE/SHOW

RATE sets up differential tracking rates which are superimposed on the normal diurnal rate used for tracking. This command is supported on the 2.3 metre telescope and partially supported on the 50 inch telescope.

RATE

sets up differential tracking rates arcsec/sec in RA and arcsec/sec in Declination.

These rates take effect immediately if the telescope is tracking and subsequently whenever the TRACK/RATE command has been issued. On the 2.3 metre telescope only, rates may also be entered

in coordinate frames other than RA/Dec. Rates entered in other coordinate frames are converted internally to RA/Dec before being applied.

RATE
the command alone without any qualifiers or parameters re-establishes the differential tracking rates which were last entered
The qualifiers which apply to the Rate command fall into distinct categories, and these are described below.

Coordinate Frame qualifiers{2.3m only}
/RA_DEC (default)
/AZ_ALT
/TV
/SLIT
These qualifiers specify the coordinate frame in which the rates are to be applied. They are available on the 2.3 metre telescope only.

RATE [/RA_DEC]

If /RA_DEC is specified (or none of these four qualifiers are specified) the parameters specify rates in Right Ascension and Declination respectively.

RATE/AZ_ALT A a

If /AZ_ALT is specified, the parameters specify rates in Azimuth and Altitude respectively. The /RA_TIME qualifier cannot be specified with this qualifier. However, you should note that rates are applied internally in RA and Dec only, and are converted to this form at the time of command entry. Therefore, as the Parallactic Angle changes, the RATE/AZ_ALT command needs to be re-issued to maintain the desired direction of drift.

RATE/TV x y (not yet available)

If /TV is specified, the parameters specify rates in the X and Y directions of the TV screen. This requires the TV system to have been calibrated first. As yet, this facility is not available. The /RA_TIME qualifier cannot be specified with this qualifier.

RATE/SLIT x y

If /SLIT is specified, the parameters specify rates parallel to and perpendicular to the current "Selected Orientation". (This behaves the same way as the SLIT button on the console.) The /RA_TIME qualifier cannot be specified with this qualifier. However, you should note that rates are applied internally in RA and Dec only, and are converted to this form at the time of command entry. Therefore, if the Position Angle changes, the RATE/SLIT command must be re-issued to maintain the desired direction of drift.

Unit Time qualifiers {2.3m, 74" & 50"only}
/SECOND (default)
/MINUTE
/HOUR
/DAY
These qualifiers determine the unit of time used to specify the two rates. The default unit is seconds (i.e. the two rate values are assumed to be per second, unless one of the other time qualifiers is specified).

RA rate Unit of Distance qualifiers{2.3m, 74" & 50"only}
/RA_TIME
/ARCSEC (default)
If /RA_TIME is specified, the parameter is interpreted in {seconds of time per unit time},

where the unit of time is determined by the Unit Time qualifiers (described below). (This qualifier cannot be specified with the /AZ_ALT, /TV or /SLIT qualifiers.) is always interpreted in

{arcseconds per unit time}.

If /ARCSEC is specified or neither qualifier is specified, both parameters are interpreted in {arcseconds per unit time}.

RATE/ZERO {2.3m, 74" & 50"only}
sets both rates and to zero.

The qualifiers may be combined in any way which is consistent e.g.
RATE/RA_TIME/HOUR -16.3 22.2

Normally the TRACK command automatically clears the differential tracking rates, and so the RATE command should be issued after the telescope is already tracking an object. This action can be overridden by using the command TRACK/RATE which will leave any pre-defined differential tracking rates in effect.

RATE/SHOW {2.3m, 74" & 50"only}

lists on the observer's VDU the current tracking coordinates, the current differential tracking rates (or the previous values used if the telescope is no longer tracking), and whether they are in use.

ROTATOR {2.3m only}

ROTATOR gives control of the Instrument Rotator including the setting of its various modes and control options. This command is available on the 2.3 metre telescope only.

ROTATOR
will in future paste on the observer's VDU a menu showing the current rotator mode and parameter settings, the current position angle, vertical angle and (physical) rotator angle. This has not yet been implemented.

The rotator control parameters are:

Rotator_Reference	Not_In_Use, Position_Angle, Vertical_Angle, Stationary
Rotator_Orientation	Slit, Radial, Apertures, Angle
Rotator_Ap1	*aperture ident for first aperture*
Rotator_Ap2	*aperture ident for second aperture*
Rotator_Orientation_Angle	*angle in degrees*
Rotator_CCW_Limit	*angle in degrees (software limit to rotator motion)*
Rotator_CW_Limit	*angle in degrees (software limit to rotator motion)*

For more information about these rotator parameters, see the chapter 'Rotator Control' in the *2.3 metre telescope Observer's manual* .
In the absence of a menu–based control program, the rotator may be configured directly by using the CONFIGURE command or by commands such as:

```
ROTATOR/REFERENCE=Position_Angle/ORIENTATION=Slit
ROTATOR/Ap1=A3
```

etc.

ROTATOR/CW_LIMIT = cw

sets the rotator clockwise software limit to the value specified. The limit value must lie in the range -1440? to +1440?. Note that the rotator limits may also be set interactively by dedicated pushbuttons on

the relevant rotator handset.

ROTATOR/CCW_LIMIT = ccw

sets the rotator counter-clockwise software limit to the value specified. The limit value must lie in the range -1440? to +1440?. Note that the rotator limits may also be set interactively by dedicated pushbuttons on the relevant rotator handset.

ROTATOR

drives the rotator via the shortest path to a reference angle of .

The reference angle may be the physical rotator angle measured by the rotator encoder or scale, or

the position angle on the sky measured from north through east, or the vertical angle measured counter-clockwise from the upward vertical. This interpretation and thus the precise effect of this command depends on the rotator reference mode:

rotator_reference = Stationary the command drives the physical rotator angle to the value which may be anywhere between the CCW and CW limits which, in turn, must lie in the range -1440? to +1440?.

rotator_reference = Position_Angle **normalizes** to the range 0? to 360? and drives the position angle to this value.

rotator_reference = Vertical_Angle **normalizes** to the range 0? to 360? and drives the vertical angle to this value.

ROTATOR/CCW

drives the rotator counter-clockwise to the required reference angle. The angle is first normalized to

0?–360?.

ROTATOR/CW

drives the rotator clockwise to the required reference angle. The angle is first normalized to

0?–360?.

ROTATOR/WAIT

In this case control is returned to the observer only after the rotator has arrived at the requested position and is stationary. The default qualifier is /NOWAIT.

SCAN (not yet implemented)

SCAN defines and controls scanning motion.
SCAN pastes a scan menu on the observer's VDU to enable specification of the required scan motion and subsequent control of that motion. The menu also displays the current telescope tracking position, offsets from the base position and status of the scan.

A scan must be specified by the following parameters:

Scan_Type	Raster, Radial, Spiral
scan offset	in either rectangular coordinates or polar coordinates
Scan_Orientation	position angle of primary scan direction
scan dimensions	four quantities for Raster and Radial scans, three for Spiral

Instead of using the menu, a scan can be directly specified by using commands of the form:

SCAN/TYPE=Raster/XLENGTH=x/Xtime=t/XSPEED=x'/YDIST=y/NUMLINES=n/YINC= y

SCAN/TYPE=Radial/LENGTH=l/TIME=t/SPEED=s/ANGLE=q/NUMLINES=n/INC=

SCAN/TYPE=Spiral/RINC=DR/RMAX=R/SPEED=s
SCAN/ORIENTATION =

SCAN/RA_OFF= /DEC_OFF=

SCAN/RAD_OFF= R/THETA_OFF =

Only sufficient of the parameters need to be supplied to uniquely define the particular scan.

SCAN/START
causes the telescope to move to the start point of the scan and commence scanning.

SCAN/STOP
the telescope stops scanning and is left tracking the current position on the sky.

SCAN/RESUME
the telescope resumes the scan where it left off but the first few seconds of motion may involve larger than normal tracking errors.

SCAN/CLEAR
clears all of the scan parameter settings and returns the telescope to the scan fiducial position.

Note that a scan can only be started if the telescope is already tracking i.e. after a TRACK command has been issued and acquisition completed.

SHUTDOWN

SHUTDOWN shuts down the telescope control system in an orderly fashion. The exact sequence of operations can be controlled by a /OPTIONS qualifier.

SHUTDOWN
The basic command (without any qualifier) starts the standard shutdown sequence for your telescope. Normally this will cover all your requirements.

SHUTDOWN/OPTIONS [= (option[,...])]

Specifies shutdown options to be carried out as part of the shutdown sequence. Use this form of the command if you wish to vary the shutdown sequence. The options available are:

All	All of the following options are to be included in the shutdown sequence, unless you explicitly negate them in the options list.
None	None of the following options are to be included in the shutdown sequence, unless you explicitly include them in the options list. However, the telescope control software will be shut down, and telescope control commands will become unavailable.
[No]Park	Park the telescope before shutting down.
[No]Tertiary	Drive the Tertiary mirror to the STOWED position.
[No]Oscsec	Shut the Oscillating Secondary mirror down.
[No]Ventilation_Fans	Switch the ventilation fans off.
[No]Mirror_Cover	Close the primary mirror cover.
[No]Shutter	Close the building (dome) shutter. Please note that the shutter must be closed before leaving the telescope unattended. Please do not include this option unless the mirror cover option is also included. (i.e. please do not close the

	building shutter without having the primary mirror cover already closed. If both options are included in the list, the mirror cover will close first.)
[No]Telescope_Systems	Switch the telescope systems off.
[No]Logout	Log out at the end of the shutdown sequence.

Any option not explicitly mentioned in the options list will be assumed to take the value specified in the following list:

2.3 metre	74 inch	50 inch
Park	Park	Park
Tertiary	NoTertiary	NoTertiary
Oscsec	NoOscsec	NoOscsec
Ventilation_Fans	NoVentilation_Fans	NoVentilation_Fans
Mirror_Cover	NoMirror_Cover	Mirror_Cover
Shutter	NoShutter	Shutter
Telescope_Systems	NoTelescope_Systems	Telescope_Systems
Logout	Logout	Logout

The All and None options override these assumptions. The command

SHUTDOWN/NOOPTIONS is equivalent to SHUTDOWN/OPTIONS=NONE
As the shutdown sequence proceeds you will be informed about the actions being executed by the system and will be asked to wait for them to complete. When the shutter has closed the system advises:

```
Telescope safe to leave unattended; remainder of shutdown sequence will proceed automatically.
```

and you are free to leave.

NOTE THAT, DESPITE THE AUTOMATED SHUTDOWN SEQUENCE, IT IS ALWAYS THE RESPONSIBILITY OF THE OBSERVER TO CHECK THAT THE TELESCOPE IS IN A SAFE STATE AND THE BUILDING SHUTTER IS CLOSED BEFORE LEAVING AFTER AN OBSERVING SESSION.

SLEW

SLEW drives the telescope to a specified topocentric position in azimuth and altitude coordinates and leaves it stationary. The instrument rotator (2.3 m telescope) is not moved. (This command is primarily intended for engineering purposes; to set on a celestial object the command TRACK is used.)
SLEW Az Alt (2.3 m telescope)
SLEW HA Dec (74" & 50" telescopes)
drives the telescope axes to the required azimuth and altitude (or Hour Angle and Declination) topocentric coordinates and then halts; control is returned to the observer immediately leaving the telescope in motion.

An asterisk (*) may be used for either coordinate to prevent any motion in that axis. For example:
SLEW * 60.4 moves the telescope only in altitude(declination).
SLEW/WAIT Az Alt (2.3 m telescope)
SLEW/WAIT HA Dec (74" & 50" telescopes)
functions similarly except that control is returned only after motion in both axes has ceased. The default qualifier is /NOWAIT.

Note that all the time the telescope is halted or in motion because of any of the commands HORIZON, PARK, SLEW or ZENITH (as distinct from TRACK), the motion-control pushbuttons function so as to provide jog control at slew rates. On the 2.3 metre telescope this control is in the Azimuth/Altitude coordinate system.

STARTUP

STARTUP
initializes the telescope logical names, database, starts the necessary telescope control processes, and readies the telescope software for observing. At the 2.3 metre telescope it also aligns the VAX time with UTC derived from a precise time clock. This command must be used first in order for any of the other telescope commands (except FAULTS and UPDATE) to become available. The startup sequence takes about two minutes. The final stage of the startup sequence is the execution of the observer's Startup Command file STARTUP.COM, if one exists. When this is complete, the prompt `TEL$` appears to indicate that telescope commands are now available in addition to the normal VMS DCL commands.

The STARTUP command must be typed in full—it cannot be abbreviated, unlike all other telescope commands. The startup command cannot be typed at the `TEL$` prompt; if some system fault has caused you to wish to re-start the telescope system, you must issue the SHUTDOWN command before you can re-issue the STARTUP command.

Startup Command file

When the STARTUP command is executed, the telescope system looks for a file called STARTUP.COM (a DCL command file) in your [.OBSERVE] subdirectory. This file may include any DCL and Telescope commands that you wish to have executed at startup time. Typically this includes command symbol definitions, logical name assignments and key-definitions used to customize your operating environment. The usual rules for VMS DCL command files apply.

Note that STARTUP.COM must be found in the directory MSO_USER:[yourname.OBSERVE] in order to be executed; there is no way for you to specify a different directory. If you want to execute a command file in another directory, you must include a specific command to do so in MSO_USER:[yourname.OBSERVE]STARTUP.COM.

SWITCH {2.3m & 50" only}

SWITCH provides control of auxiliary systems and telescope functions from the observer's keyboard. This command is available on the 2.3 metre and 50 inch telescopes only.

SWITCH subsystem state
switches the nominated subsystem to the required state; control is returned immediately. In most cases the change of state is immediate subject only to the response time of the relay logic used; however where mirror-cover or shutter motion is involved, control is returned leaving the relevant mechanism in motion. The available subsystems and states are listed below.

subsystem	available states or commands	
Telescope_Systems	on, off, reset	
Ventilation_Fans	on, off	{2.3m only}
Shutter	open † , closed	
Mirror_Cover	open, closed	
Flatfield_Illumination	on, off	(No hardware is at present provided for Flatfield Illumination)
Incandescent_Lights	Off	{50" only}
Fluorescent_Lights	Off	{50" only}

† Opening the building shutter by program or from the keyboard is not implemented for reasons of telescope safety.

TPDATA

TPDATA establishes a file for pointing error measurements and facilitates the logging of pointing error data. It is mainly used by technical staff when performing pointing tests.

TPDATA/FILE = filename
opens a sequential text file with the specified name and with the extension ".DAT" in the user's area, and writes three control records to the file. The resultant file complies with the STARLINK TPOINT specifications for an INDAT pointing error data file of format type 2 as given in Starlink User Note number 100.1 dated 12-Oct-87. The three control records correspond to the NOTES, :equinox OPTION and RUN PARAMETERS records of that specification.

TPDATA
writes a single OBSERVATION record in INDAT format type 2 with the following information:

star mean coordinates	equinox
telescope mean coordinates	
local apparent sidereal time	(hours minutes)
auxiliary data	(two items as yet unspecified)

Thus for each pointing observation, the file coordinates (catalogue mean place) of the star are recorded along with the J2000.0 mean coordinates at which the telescope has acquired the object.

TPDATA/CLOSE
Closes the currently open pointing data file and reports on the total number of observations it contains.

TPDATA/COUNT
Displays the number of observation records that have been added to the file so far. The file remains open for further additions.

The measurement and modelling of pointing errors is the responsibility of Engineering staff and it will not, in general, be necessary for observers to concern themselves with pointing measurements. You should consult Engineering staff and ensure that you are quite familiar with the way in which the system handles pointing correction before endeavouring to take pointing data. At startup time default values of the pointing coefficients are installed and it will be rare that observers need to re-define them.

TRACK

TRACK is the motion-control command most needed by observers. It drives the telescope to the required celestial coordinates and commences tracking there. See also the TRACK/SHOW, TRACK/PRINT and TRACK/SAVE commands, which are concerned with information about celestial objects and do not effect any change in the motion of the telescope.

TRACK can accept celestial coordinates typed in at the keyboard or alternatively coordinates can be read from a Coordinate File, the format of which is discussed in §2 'Celestial Coordinates'.

TRACK/FILE = filespec
selects the Coordinate File to be used as the source of celestial objects. The parameter filespec may be a complete VMS file specification and so refer to a file in any directory to which the observer has read access; if it is simply a file-name then the observer's default directory, usually MSO_USER:[yourname.OBSERVE], is searched for a file of that name and with file type ".COORD". Coordinate Files must comply in format with the specifications of §2.3.

TRACK/EQUINOX = eqnxspec
sets the value of the tracking equinox; this is used to specify the coordinate system in which the telescope is controlled and is used for the coordinates displayed at the top of the Observer screen on the display. The parameter eqnxspec must be a valid system equinox specification as defined in §2.1. This command is equivalent to the command CONFIGURE TRACKING_EQUINOX eqnxspec.

The following commands enable the selection of objects from the currently selected Coordinate File.

TRACK n
tracks the **n**th entry in the selected coordinate file. The parameter n is interpreted as a decimal integer and the file entries are numbered beginning at 1.

TRACK/NEXT j
tracks the {current + j }th entry in the selected coordinate file; j must be a decimal integer.

TRACK/NEXT
tracks the object after the current one in the selected coordinate file.

TRACK/PREVIOUS j
tracks the {current - j }th entry in the selected coordinate file.

TRACK/PREVIOUS
tracks the object prior to the current one in the selected coordinate file.

TRACK obj_name
tracks the object with that name in the selected coordinate file. For the purpose of comparing the template obj_name with file entries, multiple spaces and tabs are ignored and the case is forced to upper case.

TRACK/NAME obj_name
this form of the command is used when it is necessary to force the system to accept a parameter string commencing with a numeric as an object name and not a file entry index.

The following commands define, modify or redefine the position on the sky which the telescope is tracking.

TRACK
re-establishes tracking at the current tracking coordinates leaving the current accumulated offsets and rates intact. This may be used after a HALT command has been issued in order to re-acquire the object. Note, however, that any scan in progress is stopped.

TRACK/BASE
tracks the current base coordinates by zeroing any accumulated offsets and rates. Any scan in progress is stopped. Note the distinction between this command and TRACK/SOURCE below: if the base coordinates have been changed since the commencement of tracking (using the TRACK/ZERO command) the telescope will move to the new base position not the original file coordinates of the object.

TRACK/SOURCE
re-acquires the current object by recalculating the base coordinates from the original file coordinates and re-initializing the tracking process. Any scan in progress is stopped.

TRACK/HERE
commences tracking wherever the axes happen to be pointing on the sky. This command is primarily intended for engineering purposes; note that it may initiate motion of the Instrument Rotator if that system is configured other than Not_In_Use.

TRACK/ZERO
replaces the base coordinates by the current tracking coordinates and zeros the accumulated offsets. The telescope is not moved and the effect is to redefine the current tracking coordinates as a new base position.

TRACK/COORDINATE coordinate_specification_string
tracks the object whose coordinates are supplied in the command string. The contents and format of the coordinate specification string are specified in detail in §2.1 but a resumé is given below in brief:

Coordinates are specified by the format:

["obj-name"] [equinox[(epoch)]] [[? [Vr]]] [!comment]

where square brackets indicate optional fields in the usual fashion. The object name, enclosed in double quotes, may appear anywhere; all other items must appear in the order shown here, if they appear at all. An absolute minimum specification is just the RA and Dec of the object. If no equinox is specified, the current value of the telescope configuration variable Default_File_Equinox is used.

TRACK/EPHEMERIS = ephemeris_name{2.3m only}
tracks an object whose coordinates are tabulated for equally spaced intervals of time in a text file in System Ephemeris Format. This command is supported on the 2.3 metre telescope only. The parameter 'ephemeris_name' may be a complete VMS file specification and so refer to a file in any directory to which the observer has read access; if it is simply a file-name then the observer's default directory, usually MSO_USER:[yourname.OBSERVE], is searched for a file of that name and the extension ".EPHEM". Ephemeris Files must comply in format with the specifications given in the 2.3 metre telescope Observers' manual. Basically the entries in this file consist of a time (JD or MJD) followed by RA and Dec.

TRACK/PLANET planet_name
This command enables setting on most of the planets and the moon. This is really for demonstration purposes; the telescope does not follow the planet's proper motion. For serious planetary observation (and for other objects of high proper motion) observers should generate an ephemeris file, and use the TRACK/EPHEMERIS command.

A number of qualifiers can be appended to any of the above TRACK commands which result in motion:

/RATE
leaves the differential tracking rates, previously established by a RATE command, in operation. Normally a TRACK command which results in a new object being selected will cancel any RATE request. This command is available on the 2.3 metre and 50 inch telescopes only. (All TRACK commands which result in motion cancel any SCAN which was in progress.)

/CW{2.3m only}
forces the telescope to turn clockwise in Azimuth when acquiring a new object; otherwise it takes the shortest path to the new position. This qualifier is supported on the 2.3 metre telescope only.

/CCW{2.3m only}
forces the telescope to turn counter-clockwise in Azimuth when acquiring a new object; otherwise it takes the shortest path to the new position. This qualifier is supported on the 2.3 metre telescope only.

/WAIT
returns control to the observer only after the telescope has acquired the object and is tracking properly; normally control is returned immediately, leaving the telescope slewing towards acquisition.

/RISING{2.3m only}
causes the telescope to set on the horizon limit and await the rise of an object which is below the horizon, whereon proper tracking is commenced. Normally an error message is generated for objects below the horizon limit and the telescope does not move. This qualifier may also be used to await the emergence of an object from within the zenithal cone of avoidance. This qualifier is supported on the 2.3 metre telescope only.

TRACK/SAVE

TRACK/SAVE=TRACKING [obj_name]
saves the current tracking coordinates by appending an entry to the currently selected coordinate file; the name supplied is used as the object name. The recorded coordinates of the object will incorporate the accumulated offsets at the time the command is issued.

The coordinate system used is that of the (currently displayed) tracking coordinates. If the parameter 'obj_name' is omitted the current object name known to the system is used.

TRACK/SAVE=BASE [obj_name]
saves the current object's file coordinates by appending an entry to the currently selected coordinate file; the name supplied is used as the object name. The recorded coordinates of the object do not include the accumulated offsets at the time the command is issued but represent the original coordinates typed in or obtained from a Coordinate File entry.

The coordinate system used is that of the (currently displayed) tracking coordinates. If the parameter 'obj_name' is omitted the current object name known to the system is used.

TRACK/SHOW

TRACK/SHOW obj_name
lists on the observer's VDU the file coordinates, auxiliary data (optional), and other information about the nominated object. The coordinate information is obtained from the entry in the currently selected Coordinate File but the additional information is calculated at the time the command is issued; the latter includes: zenith angle, hour angle, parallactic angle, distance from sun and moon, rise-time, set-time and the components of the earth's barycentric position and velocity in the direction of the object.

TRACK/SHOW n
lists on the observer's VDU the file coordinates, auxiliary data (optional), and other information about about the object specified by entry number n.

TRACK/SHOW/NEXT [j]
TRACK/SHOW/PREVIOUS [j]
These commands list on the observer's VDU the file coordinates, auxiliary data (optional), and other information about about the object specified by its relative file address 'j'. If 'j' is omitted it defaults to 1.

TRACK/SHOW *
TRACK/SHOW/ALL
These commands function identically and list the entire contents of the selected Coordinate File on the observer's VDU. Unless overridden by the /FULL qualifier (see below) only the coordinate information is listed, one object per line.

TRACK/SHOW
This command *(without any parameters)* shows the information for the current object being tracked.

/BRIEF
/FULL
The choice between a single line giving coordinate information only and a full listing which includes auxiliary data and derived information is made with the qualifiers /BRIEF and /FULL thus:

TRACK/SHOW/BRIEF output a single line containing only the File Coordinate information;

TRACK/SHOW/FULL output the File Coordinate information, any auxiliary records following the coordinate record in the file and the derived quantities set out above.

The listing defaults to /FULL in cases where information on a single object is being sought, but to /BRIEF when more than one object (as in TRACK/SHOW /ALL) is to be listed.

TRACK/PRINT

TRACK commands with the /PRINT qualifier function identically to TRACK/SHOW in all cases except that the output goes to the system line printer instead of the observer's VDU.

TRACK/PRINT

TRACK/PRINT obj_name

TRACK/PRINT n

TRACK/PRINT/NEXT [j]
TRACK/PRINT/PREVIOUS [j]

TRACK/PRINT *
TRACK/PRINT/ALL

Either command prints the entire contents of the selected Coordinate File on the system line printer.

/BRIEF
/FULL
The TRACK/PRINT command supports the qualifiers /BRIEF and /FULL in exactly the same way as the TRACK/SHOW command.

UPDATE

UPDATE
causes the text file TEL_BULLETIN:UPDATE.TXT to be listed on the observer's VDU. This file contains descriptive comment on minor upgrades of, and changes to, the telescope control software of which observers ought to be aware.

VIEW

The VIEW command permits an observer to see the value of any telescope display variable (even if it is not currently featured on one of the display screens).

VIEW variable_name [,…]
causes the names, values (and units where appropriate) of the specified display variable(s) to be typed on the observer's VDU. A list of display variable names for your telescope can be found in the chapter 'Telescope Display' in your telescope *Observer's manual* .

VIEW/CONTINUOUS[=period] variable_name [,…]
causes the display of the specified variable(s) to be repeated every period seconds. If the period is not specified, it defaults to 5 seconds. This display can be terminated by typing <Ctrl/Y.

ZENITH

ZENITH
moves the telescope to the zenith; control is returned to the observer immediately leaving the axes in motion. (On the 2.3 metre telescope the azimuth axis and the instrument rotator are not moved.)

ZENITH/WAIT
functions similarly except that control is returned to the observer only after axis motion has ceased and the telescope is stationary at the zenith.

Telescope Command Reference Manual

2 Celestial Coordinates

2.1 SPECIFICATION OF COORDINATES

This section describes the format to be used when specifying equatorial polar coordinates of astronomical objects for:

(i) the entry of coordinates for the telescope TRACK/COORDINATE command;

(ii) the format of individual records in a telescope Coordinate File;

(iii) general usage throughout Mt Stromlo and Siding Spring Observatories.

Observers are strongly advised to use this format in their own programs wherever equatorial polar coordinates (right ascension and declination) are needed in the interests of uniformity and convenience. To this end the two parsing routines TEL_Parse_Coordinate_String and TEL_Parse_Equinox_String are available in the TELLIB library; see the *MSSSO Telescopes User Programming Manual* .

Equatorial coordinates should always be thought of as an ordered triplet- where specifies the particular equatorial system (equator and equinox). The first two quantities are meaningless without the third which must either be present or default to some appropriate coordinate system specification. The order of the three quantities differs here from some other standards and telescope projects, but this is necessary in order that unnecessary information can be ommitted simply without the need for place-holders in the record or command line. The use of double quotation marks (") to delimit the name field has been dictated by the need to provide flexibility in the length of object names and to overcome the clumsy command-line handling strategy imposed on us by the VMS operating system.

The data required for complete specification of a celestial position are listed below; in a particular instance many of them can be omitted in which case they default to sensible values as discussed.

Object name	
R.A.	
Declination	
Coordinate system specification	FK4, FK5 or Apparent Place.
Equinox	(the epoch of the mean equator and equinox)
Epoch	(time zero for the proper motion correction)
Proper motion in RA	
Proper motion in Declination	
Parallax	
Radial Velocity	Vr

A coordinate string in general takes the format:

["object name"] [equinox [(epoch)]] [[[Vr]]] [!comment]

where the square brackets indicate optional parameters in the usual fashion.

2.1.1 Object Name

The object name is an optional string of printable characters and, if present, it must be enclosed in double quotation marks. The case (upper or lower) of alphabetic characters is preserved and the name may contain embedded spaces or tabs . It may occur anywhere in the coordinate string and is excised from the string before the string is parsed for the other fields or subfields; it is the only field which does not have a preassigned position.

The object name field may have any length provided the length of the entire coordinate string does not exceed the system

parameter *TEL_K_Coord_Length* (132 characters).

```
"^^NGC 2516^offset^by 2 arcsec"

"^^+163, -67.3$^"

"SN1987A 'if it is still there' <TAB> 29/4/87"
```

are all valid object names.

The system stores and handles an object name exactly as it was supplied by the observer. However, when trying to match object names in a file with a name supplied in a TRACK command, all spaces and tabs are ignored, and the case of alphabetic characters is ignored.

2.1.2 Right Ascension

The right ascension field comprises one, two or three subfields specifying the hours, minutes and seconds of time for the coordinate.

The minutes and/or seconds subfield(s) may be omitted by decimalizing the preceding field; the last subfield is defined as the one with the decimal point or the third one encountered.

One or more spaces or tabs or a comma in conjunction with spaces and tabs are assumed to separate the subfields. Thus the following strings specify valid R.A. coordinates:

```
13 46 52

13 46 52.20

13 46.87

13.781167

13, 46.87,
```

The following are not valid R.A. fields:

```
13 47

13
```

Right Ascension is a mandatory parameter.

2.1.3 Declination

The declination field comprises one, two or three subfields specifying the degrees, arcminutes and arcseconds for the coordinate. Normally three subfields are expected but the field may be prematurely terminated by decimalizing the arcminutes or degrees field (just as for the R.A. field).

A sign character + or - should preceed the degrees subfield and is applied to the coordinate as a whole. The + sign is not mandatory for coordinates of northern declinations but its use is strongly recommended because it makes coordinate lists more easily readable. Thus the following strings are valid specifications for a (southern) declination:

```
-0 26 21.6

-0 26.36

-0.439333

-0 26 22
```

The following are not valid Declination fields:

```
-0 26

-1

-^0 26 21.6
```
(space between sign and degrees)

Declination is a mandatory parameter.

2.1.4 Equinox

The equinox parameter defines two items of data:

(i) the coordinate system: FK4 mean place, FK5 mean place, or apparent place;

(ii) the epoch of the equinox and equator (for FK4 or FK5).

It takes one of the following forms:

[B]yyyy[.y..]

[J]yyyy[.y..]

A[PPARENT]

Examples of valid equinox specifications are:

FK4 :	**B1950**	**B1950.0**	**1950**	**1921.31**	**B1988**
FK5:	**J2000**	**J2000.0**	**2007**	**2008.217**	**J1920**
Apparent:	**A**	**AP**	**APP**	**APPAR**	etc

If the leading B or J character does not appear the coordinate system defaults to FK5 for epochs 1984.0 and later, and to FK4 for epochs before 1984.0

Apparent coordinates are interpreted as the geocentric position of the object with respect to the true equinox and equator of date.

If the equinox parameter is omitted both the equinox and epoch parameters (see below) default to the value of the configuration variable Default_File_Equinox which can be set by the observer using the CONFIGURE command; see §1.3.

2.1.5 Epoch

In some circumstances it is necessary to distinguish between the epoch defining the equinox and equator of the mean coordinate system and the epoch which is used as the zero point for proper motion calculations. If the two are not the same the epoch is appended to the equinox parameter in parentheses thus:

equinox(epoch) *for example* `J2000.0(1985.31)` *or* `B1950(1975)`

A leading B or J character is permitted in the epoch string e.g. `J2000(J1987.1)` but the difference in the resultant epoch time value is negligible for most purposes.

Where the epoch parameter is omitted it defaults to the equinox value.

2.1.6 Proper Motions

The proper motion fields and are optional but, if supplied, must both be present. Each may be any valid numeric (real or integer) string and are interpreted thus:

proper motion in R.A. (d /dt) in seconds of time per century.

proper motion in Declination (d /dt) in arcseconds per century.

The century referred to is the Besselian century (taken to be the length of the tropical year at B1900.0) of 36524.2198781 days for FK4 positions, and the Julian century of 36525 days for FK5 positions.

Proper motions are only relevant for the mean place FK4 and FK5 systems. If the proper motions are omitted they default to zero for the FK5 system and to a small fictitious proper motion for an FK4 system. This means that in both cases the object is assumed to have zero space motion with respect to an inertial frame.

The proper motion fields must be present if the parallax and radial velocity fields (which follow them) are specified.

2.1.7 Parallax

The annual parallax ? is specified as a real or integer value in units of arcseconds.

Parallax is optional but must be present if the radial velocity (which follows it) is specified.

2.1.8 Radial Velocity

The radial velocity Vr is specified as a real or integer value in units of km/second (positive for velocities outward).

Radial velocity is an optional parameter.

2.1.9 Comment Field

The exclamation mark character ! can be used to include information of a comment nature in the coordinate record. It must be placed after all of the coordinate fields which are used by the telescope control system and signifies that the remainder of the record is comment.

The system makes no use of the comment field.

2.1.10 Field Delimiters

The fields of a coordinate specification may be separated by the following means in any combination:

(i) one or more spaces;

(ii) one or more tab characters;

(iii) any combination of spaces and tab characters;

(iv) a single comma;

(v) a single comma combined in any order with one or more spaces and/or tabs.

The above applies equally well to the subfields of RA and declination. It is not necessary to adhere to the one form of delimiter throughout a coordinate record; for example a common form might be to have commas separating the fields but spaces between the hours, minutes, seconds of RA and degrees, arcminutes, arcseconds of declination.

2.1.11 Auxiliary Data Records

When used as the first character of a record, the sharp character # indicates to the telescope control system that that particular record does not contain coordinate data. Any number of such Auxiliary Data records may be included in telescope coordinate files. They are not used in any way by the telescope control system (just like comment fields) but in the case of the 2.3 metre telescope they are made available to observer or external programs in the following manner: Any Auxiliary Data records immediately following a coordinate record are assumed to be associated with that object; the first four such records for the current object are stored in a user-accessible area of the telescope database and may be parsed or interpreted in any way desired.

2.1.12 Continuation of a Command Line

Although not part of this Coordinate Specification, it should be noted here that the minus sign is used to indicate continuation of a DCL or TELESCOPE command onto subsequent lines. The VAX Command Language Interpreter interprets a minus (-) as a continuation indicator only if it is the last character in the line; it will not misinterpret negative declinations or proper motions, nor will minus signs in object names affect the correct decoding of the coordinate string.

Note, however, that a minus sign inside a quoted string intended as an object name cannot function as a continuation character. An object name which is very long should simply be allowed to wrap on the screen; alternatively terminate the coordinate values with a continuation (-) and start the object name on a fresh line.

For example if one tried to enter the command lines:

TEL$ **TRACK/COORD "This supernova SN1987A is a partic- <RET>**

_TEL$ ularly interesting object" 5 23.7 - <RET>

_TEL$ -69 46.0 1987.4 <RET>

a DCL error would be signalled at the first line; but the following command lines:

TEL$ **TRACK/COORD 5 23.7- <RET>**

_TEL$ -69 46.0 1987.4 - <RET>

_TEL$ "This supernova SN1987A is a particularly interesting object" <RET>

will be correctly decoded to:

object name	This supernova SN1987A is a particularly interesting object
RA	5 23 42.0
Dec	-69 46 00
coord system	FK5
equinox	J1987.4

epoch	J1987.4
	0
	0
	0
Vr	0

2.2 COORDINATE TRANSFORMATIONS

The MSSSO Telescope control systems are designed to handle coordinates in equatorial polar form with considerable flexibility and accuracy. Other forms of celestial coordinate input such as galactic latitude and longitude or geocentric or heliocentric rectangular coordinates have not been implemented because of their reduced usefullness. The various coordinate transformations involved in controlling the telescope are described below and reference should be made to Figure 2.1 or 2.2 Celestial Coordinate Transformations (for your telescope).

2.2.1 Equatorial Coordinate Systems

Equatorial coordinate systems differ in their equator and equinox which establish the reference plane and a particular fiducial point on it. The FK4 system of a particular Bessellian epoch is denoted by the letter B before the epoch year thus B1950.0, B1975, B1981.3 etc. The new FK5 system and epochs referred to the Julian century of 36525 days have been in use since the beginning of 1984 and are denoted by the letter J before the epoch year e.g. J2000.0, J1975, J1988.6 etc. If you omit the B or J prefix the system will assume a sensible default (see §2.1.4); however it is desirable to use this convention because it is a universally accepted means of avoiding any confusion of which epoch or coordinate system is meant. For more information on this subject see The Supplement to *The Astronomical Almanac 1984* -'The Improved IAU System of Astronomical Constants, Time Scales and Reference Frame'.

As well as mean place coordinate systems discussed above, it is possible to use a geocentric coordinate system referred to the true equinox and equator of date. This Geocentric Apparent system is specified by using the word APPARENT (or any abbreviation of it) in lieu of the normal *equinox* specification. Please ignore the semantic anomaly-you supply the word APPARENT when the system expects a mean equinox and equator specification; we did not wish to unnecessarily complicate the data entry requirements.

2.2.2 File Coordinates

It is important to understand the distinction between the FILE COORDINATES which are the observer's original source of coordinate information and the CONTROL COORDINATES (BASE or TRACKING COORDINATES) which are the coordinates in which the virtual telescope is being controlled, in which all observer jog, offset, scan and rate control is executed, and which are displayed in the double-height heading on top of the display VDU(s). The observer has independent control over both coordinate systems. The FILE coordinate system can be an FK4 catalogue mean place, an FK5 catalogue mean place or Geocentric Apparent and likewise the CONTROL coordinates in the following combinations:

file coordinate system tracking coordinate system

FK4	FK4
FK5	FK5
FK4	FK5
FK5	FK4
APPARENT	APPARENT

Note the restricted manner in which apparent coordinates are handled-if the file coordinates are an apparent place then the displayed tracking coordinates must be apparent too. In this case the display variables J2000_RA and J2000_Dec may be useful; these give the tracking position of the telescope in the J2000.0 FK5 mean coordinate system at the current epoch i.e. date.

Coordinate data entered directly at the control VDU using the TRACK/COORDINATE command is also referred to as 'File Coordinates' and is handled similarly to data read from a Coordinate File.

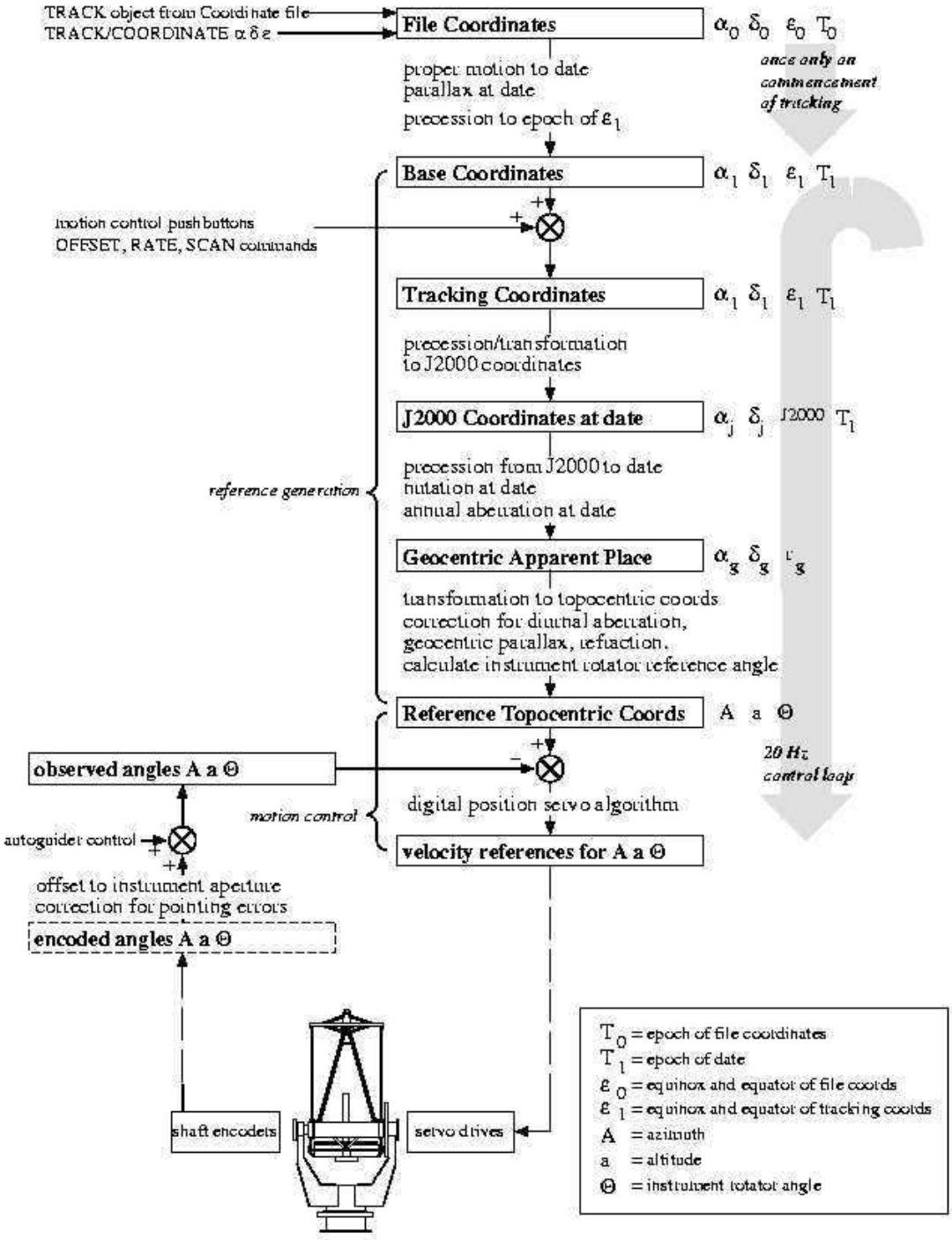

Figure 2.1 Celestial Coordinate Transformations
(2.3 metre telescope)

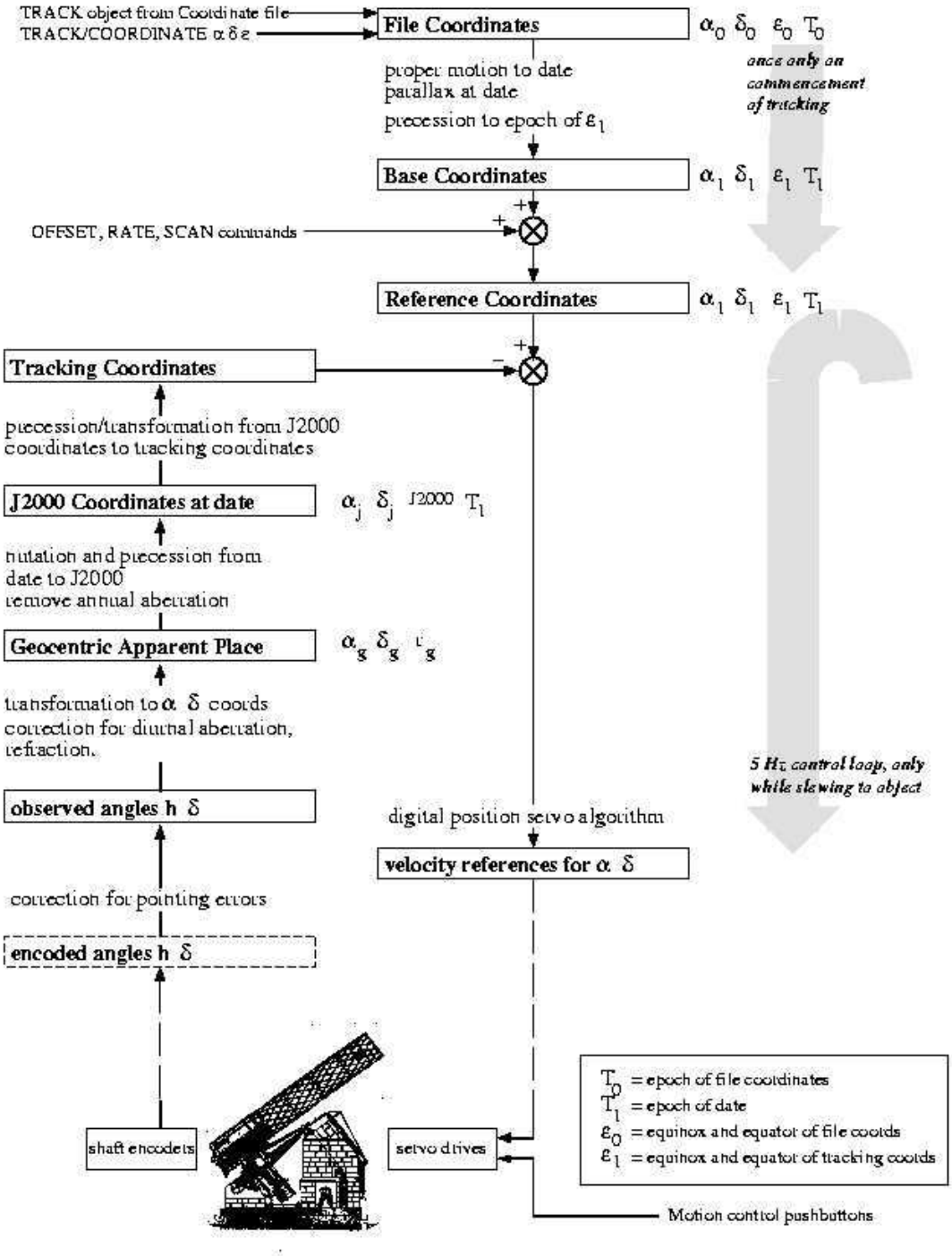

Figure 2.2 Celestial Coordinate Transformations
(74" and 50" telescopes)

2.2.3 Base Coordinates

The BASE COORDINATES represent the geocentric position of the selected object at date (i.e. with space motion and parallax corrected for the current epoch) in the coordinate system specified by the configuration variable Tracking_Equinox; see §2.2.4 below. They are calculated once only from the File Coordinate information whenever a new object is tracked or when the command TRACK/SOURCE is issued.

2.2.4 Tracking Coordinates

The TRACKING COORDINATES (at the top of the observer's display) represent the instantaneous position of the telescope optic axis (currently selected aperture) in the coordinate system specified by the configuration variable Tracking_Equinox. On the 2.3 metre telescope they are obtained from the Base Coordinates above by adding the accumulated offsets due to jog, offset, scan and rate generation; this process takes place continuously at the control loop frequency of 20 Hz. On the 74 inch and 50 inch telescopes, they are calculated from the axis position encoder readings.

The observer may change the Tracking Equinox at any time (even whilst tracking) with the command:

CONFIGURE TRACKING_EQUINOX equinox_spec

There may be a momentary 'glitch' in the position of the star whilst the tracking calculations are re-initialized but the final position on the sky will remain unchanged, even though its displayed coordinates will have changed and the route by which it is calculated may have changed radically.

2.2.5 The Distinction between Equinox and Epoch

As discussed in §2.2.1, the equinox parameter specifies the coordinate system whereas epoch denotes the absolute time for which the object's position is specified i.e. time 'zero' for the space motion calculation. For a position obtained from a catalogue the equinox and epoch are usually the same but in some cases, such as radio source positions where no proper motion information is determinable, they may be the position at 1975.0 (epoch=1975.0) referred to the 1950.0 coordinate system (equinox=B1950.0) or similar combination.

2.2.6 E-terms (FK4)

The elliptic motion of the earth in its orbit is responsible for the small components (less than 0.35 arcseconds) of annual aberration called elliptic aberration or e-terms. These terms are approximately constant for a particular star and before 1976 the published mean place was augmented by these elliptic terms and the conventional correction for annual aberration included only terms for circular motion. Thus all published FK4 catalogue positions are affected by elliptic aberration.

Star positions in the FK5/J2000 system do not include the elliptic aberration terms and the correction for annual aberration now employs the total velocity of the earth with respect to the barycentre.

The telescope system takes this difference into account rigorously by removing the e-terms from FK4 coordinates before attempting to correct for space motion or precession to a different epoch. It must be noted that, when the Tracking Equinox is set to a FK4 system, the appropriate e-terms are not added back in. Thus any FK4 tracking coordinates read from the display are "true" mean places unaffected by aberration of any kind and may differ from the equivalent catalogue mean place by an error not exceeding 0.343 arcseconds. Only the displayed FK4 coordinates are affected; the eventual conversion of FK4 positions to the J2000 system and thence apparent place is accurate to a few milliarcseconds.

2.2.7 Transformation between FK4 and FK5

The rigorous conversion of positions from the FK4 system to the FK5 system requires:

(i) removal of the e-terms

(ii) precession within the FK4 system to B1950.0

(iii) transformation from B1950.0 to J2000.0 using a 6x6 matrix to account for the relative motion between the two frames and its effect on space motion, and finally

(iv) precession to the required FK5 equinox and equator.

The transformation from B1950.0 to J2000.0 and (from J2000.0 to B1950.0) is given in "recipe" form in section B of the Astronomical Almanac and discussed in detail in:

Standish E. M., (1982) *Conversion of Positions and Proper Motions from B1950.0 to the IAU System at J2000.0* Astronomy and Astrophysics 115, 20-22, 1982.

Aoki S., Sôma H., Kinoshita H., Inoue K. (1983)*Conversion matrix of epoch B1950.0 FK4-based positions of stars to epoch J2000.0 positions in accordance with the new IAU resolutions* Astronomy and Astrophysics 128, 263-267, 1983.

These transformations are implemented for the convenience of observers as TELLIB library routines TEL_B1950_to_J2000 and TEL_J2000_to_B1950. The telescope control system does not call these routines whilst

tracking because of time constraints but instead employs simplified versions of the transformations. Nevertheless, the pointing errors so caused are only a few hundreths of an arcsecond.

2.3 COORDINATE FILES

Coordinate Files are text files which contain the celestial coordinates of objects to be observed and are an important aid to observational efficiency. They have the default file type ".COORD" and can be edited, listed or printed just like any other text file.

A Coordinate File is selected for use by the command:

TRACK/FILE=coordfilespec

and the file specification can, as usual, be abbreviated to just the filename if the file is of type ".COORD" and resides in the current default directory MSO_USER:[yourname.OBSERVE].

The system responds with a message showing the full file specification of the Coordinate File selected.

Two system files may be of interest to observers. The file TEL_DEFAULT:CATALOGUE_J2000 contains 438 stars whose positions and proper motions are known to be accurate for use in pointing calibration tests. They are evenly distributed on the sky and are all about 4th magnitude.

The current position of the telescope may be saved using one of the commands:

TRACK/SAVE=TRACKING objectname

TRACK/SAVE=BASE objectname

These cause the Tracking Coordinates (current position of the telescope) or the Base Coordinates (the coordinates of the currently selected object) to be appended as a new record to the currently selected Coordinate File; see the description of the TRACK command in §1.3.

2.3.1 Format of Coordinate Files

Coordinate Files consist of coordinate records, auxiliary data records, and comment records as described below.

Any number of Coordinate records may be present. Each contains the equatorial polar coordinates of one object and must comply with the format described in §2.1 above. An absolute minimum specification is the RA and Declination of the object; if no equinox is specified the current value of the configuration variable Default_File_Equinox is used. When all fields are present the format appears thus:

"object name" equinox(epoch) Vr !comment

Note that the object name may appear any where in the record but must be enclosed in double quotation marks. See §2.1 for an itemized description of the format.

2.3.2 Comment Records

An entire record may be used for the purpose of comment or annotation by using an exclamation mark (!) as the first character. Any number of these lines may occur in any position in the file and they are completely ignored by the system.

2.3.3 Auxiliary Data Records

Auxiliary Data records can be used to include in a Coordinate File information for an instrument or user program. Auxiliary Data records are identified by a sharp character (#) in the first character position, are up to 80 characters in length and there may be any number in the file. They are not used in any way by the telescope control system but are made available to observer or an external program in the following manner: Any Auxiliary Data records immediately following a Coordinate record are assumed to be associated with that object; the first four such records for the current object are stored within the telescope system so that user programs which call TELLIB routines may access them. See the *MSSSO Telescopes User Programming Manual* for more details.

2.4 EPHEMERIS FILES

Ephemeris files are text files which are used by the TRACK/EPHEMERIS command to enable tracking of objects with high proper motion. By default, they have the file type ".EPHEM".

Ephemeris files consist of single line records, each containing a time followed by an apparent Right Ascension and Declination for the object. The RA and Dec. fields are formatted as specified in §2.1.2 and § 2.1.3, and the time field is a Julian Date or Modified Julian Date (where MJD = JD-2 400 000.5).

Times must be monotonically increasing with each file record, and should preferably be evenly spaced.

For example, an ephemeris file may contain lines as follows:

```
49833.45 01 23 31.2 -42 15 21.1
49833.46 01 23 31.7 -42 15 20.9
49833.47 01 23 32.2 -42 15 20.7
```

Telescope Command Reference Manual

3 Glossary

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

Altitude: angle measured positive from the horizon toward the zenith, with a range of -90^0 to $+90^0$. On the 2.3 metre telescope, Altitude is a **display variable.**

Aperture: A location in the focal plane known to the 2.3 metre telescope system, which it uses for tracking. The **tracking coordinates** are the coordinates of the object which appears in the currently selected aperture. Changing the selected aperture (with the APERTURE command) causes the telescope to move to place the object in the new aperture, but the tracking coordinates DO NOT change.

If the field rotates throughout observing, it will appear to rotate about the currently selected aperture, even when this is not the centre of the field. Observing an object which is not located in the current aperture will result in poor tracking.

Apparent Coordinates: The geocentric apparent place of the current object is calculated by taking the J2000 coordinates, applying precession to today and nutation for today, and correcting for annual aberration for today. The apparent place comprises Apparent_RA and Apparent_Dec.

Apparent_Dec: Declination portion of apparent Coordinates. Apparent_Dec is a display variable.

Apparent_RA: Right Ascension portion of apparent Coordinates. Apparent_RA is a display variable.

Azimuth: On MSSSO telescopes, azimuth is measured positive eastwards from north (i.e. like a traditional compass bearing). On the 2.3 metre telescope, Azimuth is a display variable, with a range of -180? to +340?.

Base Coordinates: are the coordinates obtained from the file coordinates after applying precession (and possible coordinate system transformation) from the file equinox to the track equinox, proper motion from the file epoch to now, and correcting for annual parallax. The base coordinates comprise the base RA, the base Dec and the track equinox. They may be changed to a new position during tracking with the TRACK/ZERO command if desired.

When a new object is first acquired, before any offsets have been added, the telescope points to the base coordinates. That is, the tracking coordinates are equal to the base coordinates.

Base_Dec: Declination portion of base coordinates. Base_Dec is a display variable.

Base_RA: Right Ascension portion of base coordinates. Base_RA is a display variable.

CFILE: Shorthand for telescope Control file

Configuration Variable: The telescope configuration is set by modifying a number of configuration variables. This can be done directly from the keyboard with the CONFIGURE command, or the variables may be loaded from a control file with the CFILE command. To see the current telescope configuration, use the DISPLAY CONFIGURATION command.

Each telescope has its own set of configuration variables. To see a list of the variables appropriate to your telescope and the values each may take, see the chapter ‘Control of Telescope Configuration’ in your telescope *Observer’s manual* .

Control File: Telescope Control files (also known as CFILEs) may contain telescope configuration information, aperture definitions and instrument rotator settings (on alt-azimuth telescopes), oscillating secondary mirror control settings (where relevant) and pointing correction coefficients. [Observers’ Control files do not normally contain pointing correction coefficients; these are contained in a system default Control file.]

When many aspects of telescope configuration are to be changed, it is quicker to load them from a Control file with the CFILE command than it is to enter successive CONFIGURE commands. For more information on the contents of a telescope Control file see the chapter ‘Control of Telescope Configuration’ in your telescope *Observer’s manual* .

Coordinate File: A file containing celestial coordinate specifications, one object per line. Coordinate files are used by the TRACK command. For more information on the contents of a coordinate file see §2.3.

Default_File_Equinox: The equinox which is assumed by the system when coordinates are supplied to it without any equinox specification. It then becomes the file equinox.

Default_File_Equinox is a configuration variable. For more information on the syntax of Equinox strings, see §2.1.4

Default_Humidity: This value is used in refraction calculations when the humidity sensor is faulty or disabled. The closer you set this value to the actual value of relative humidity, the better your pointing and tracking will be. Default_Humidity is a

configuration variable.

Default_Pressure: This value is used in refraction calculations when the barometric pressure sensor is faulty or disabled. The closer you set this value to the actual value of atmospheric pressure, the better your pointing and tracking will be. Default_Pressure is a configuration variable.

Default_Temperature: This value is used in refraction calculations when the temperature sensor is faulty or disabled. The closer you set this value to the actual value of temperature, the better your pointing and tracking will be. Default_Temperature is a configuration variable.

Delta_Dec: The offset in Declination. Delta_Dec is a display variable.

Delta_RA: The offset in Right Ascension. Delta_RA is a display variable.

Display Variable: A variable which may be displayed on the observer's display screen. The selection of variables to be displayed on the screen is controlled using a display definition file. The current value of any display variable may be examined with the VIEW command, whether or not that variable currently appears on the display screen. See the chapter 'Telescope Display' in your telescope *Observer's manual* to see a list of valid display variable names.

Display Definition File: A file controlling the layout and appearance of the telescope display screen. In particular, it specifies which display variables are to be displayed and where. The format for a display definition file is different for each telescope. For information on the file format, see the chapter 'Telescope Display' in your telescope *Observer's manual* .

Effective_Wavelength: Wavelength (in nanometres) used in atmospheric refraction calculations. Set this value to one appropriate to your instrument. Effective_Wavelength is a configuration variable.

Ephemeris File: File containing time-stamped celestial coordinates used for tracking objects with high proper motion, such as comets. This file type is used with the TRACK/EPHEMERIS command. The telescope interpolates between the coordinates to track the object. Unlike normal coordinate files, each ephemeris file can contain coordinates for only one object. For more information on the contents of ephemeris files, see §2.4.

File Coordinates: The current object's coordinates as they were read from the coordinate file with the TRACK command, or were entered directly with the TRACK/COORDINATE command. They comprise the file RA, file Dec, file equinox and file epoch.

File_Dec: Declination portion of file coordinates. File_Dec is a display variable.

File_RA: Right Ascension portion of file coordinates. File_RA is a display variable.

File_Epoch: The epoch which is used as the zero point for proper motion calculations. This is only specified in input coordinates when it is necessary to distinguish between this epoch and the file equinox. When not specified, it is set equal to the file equinox.

File_Epoch is a display variable. See §2.1.4 for more information on the syntax of Equinox strings.

File_Equinox: The epoch of the equinox and equator of the file coordinates for FK4 or FK5 mean places, or the string "APPARENT" for apparent place. If it is not specified in an input coordinate string, the control system sets it to the current default file equinox.

File_Equinox is a display variable. See §2.1.4 for more information on the syntax of Equinox strings.

J2000 Coordinates: These are the current tracking coordinates after precession from the track equinox to J2000.0 and transformation to the FK5 coordinate system. J2000 coordinates comprise the J2000 RA and the J2000 Dec.

J2000_Dec: Declination portion of J2000 coordinates. J2000_Dec is a display variable.

J2000_RA: Right Ascension portion of J2000 coordinates. J2000_RA is a display variable.

Offsets: The difference difference between the base coordinates and the current tracking coordinates. When a new object is acquired, the offsets are zero. Offsets accumulate when the jog/offset buttons at the console are pressed, and when differential tracking rates are established with the RATE command. They may also be modified with the OFFSET command. The offsets in RA and Dec are Delta RA and Delta Dec respectively.

Oscsec: Shorthand for the Oscillating Secondary mirror of the 2.3 metre telescope. It is a servo-controlled Cassegrain secondary designed for beam-switching and synchronous detection at IR wavelengths. The frequency and amplitude of the chop and the direction of the chop axis can all be controlled.

Osc_Chop_Mode: The action of the oscillating secondary mirror. It has seven operating modes, as follows:

Beam_A	mirror is stationary at its Beam A position.
Beam_B	mirror is stationary at its Beam B position.
Axis	mirror is stationary at its neutral position.
Centre	mirror is stationary mid-way between beam A and beam B.
Chop	mirror oscillates between Beam A and Beam B.
Ext_Freq	frequency of oscillation is controlled by an external source.

Ext_Waveform	mirror position is controlled by an external source.

Osc_Reference: The control mode of the Oscsec. It can take one of the following values:

Not_In_Use	the Oscsec is shut down and is ignored by the telescope control software.
Position_Angle	Chop axis is controlled to hold constant position angle on the sky.
Coupled Chop	axis is controlled to hold a constant offset from the cassegrain rotator position.
Stationary Chop	axis is controlled, and may be moved by setting a new angle with the OSC command. It does not otherwise move.

Parallactic_Angle: The angle between the hour circle and the vertical circle measured from north through east to the upward vertical, measured 0? to 360?. On the 2.3 metre telescope, Parallactic_Angle is a display variable.

Position_Angle: The angle between the hour circle and the projection of the selected orientation on the sky, measured from north through east, with a range of 0? to 360?. On the 2.3 metre telescope only, Position_Angle is a display variable.

Rotator_Orientation: The mode for specifying the selected orientation. It can take one of the following values:

Slit	selected orientation is the direction of a line drawn along the slit of a specified aperture.
Radial	selected orientation is the direction of a line drawn from the rotator centre through the centre of a specified aperture.
Apertures	selected orientation is the direction of a line drawn from the centre of a specified aperture through the centre of a second aperture.
Angle	selected orientation is the direction of a line specified directly as an angle from the instrument fiducial.

Rotator_Orientation is a configuration variable. For more information, see the chapter 'Rotator Control' in the *2.3 metre telescope Observer's manual* .

Rotator_Reference: The control mode of the instrument rotator. It can take one of the following values:

Not_In_Use	the rotator is ignored by the telescope control software and it cannot be controlled from the console.
Stationary	the rotator is controlled, and may be moved with the console buttons or the ROTATOR command. It does not otherwise move.
Position_Angle	the rotator is controlled to maintain constant position angle-i.e. to remove field rotation.
Vertical_Angle	the rotator is controlled to maintain constant angle to the zenith-i.e. constant vertical angle.

Rotator_Reference is a configuration variable. It may also be set with the ROTATOR/REFERENCE command.

Selected Orientation: An orientation in the focal plane which is used within the 2.3 metre telescope system for control of the instrument rotator. You define the selected orientation to be some direction of interest to you (e.g. the orientation of your aperture slit) and thereafter the telescope takes the projection onto the sky of this direction and uses it to calculate the telescope position angle and vertical angle.

There are a number of alternative ways of specifying the selected orientation (see the chapter 'Rotator Control' in the *2.3 metre telescope Observer's manual* for more information) but ultimately it is an angle in the focal plane measured from the instrument fiducial. Its value may be viewed on the Configuration Display as the value of ROTATOR_ORIENTATION_ANGLE.

Slit Coordinates: Slit coordinates are those used by the jog/offset buttons on the console of the 2.3 metre telescope when the SLIT coordinate selection button is pressed. They are also used by the OFFSET/SLIT and RATE/SLIT commands.

Currently, slit coordinates are defined by the Selected Orientation, which means that they may or may not relate to any actual aperture slit (depending on how the Selected Orientation was defined) and if they do relate to a slit, it may not be the currently selected aperture's slit. It is our intention to change this in the future, so that slit coordinates will be defined by the slit orientation of the currently selected aperture.

For information on specifying the Selected Orientation, see the chapter 'Rotator Control' in the *2.3 metre telescope Observer's manual* .

Startup Command File: A DCL command file which is executed as the final stage of telescope system startup. Typically it is used to define programmable pushbuttons or set the telescope configuration. For information about how to set up a startup command file, see the description of the STARTUP command in §1.3.

Tracking Coordinates: When the telescope is tracking, the tracking coordinates indicate the telescope's current sky position. They differ from the base coordinates by any offsets which have been added using the jog buttons or by telescope command. They comprise the tracking RA, the tracking Dec and the track equinox.

Tracking_Dec: Declination portion of the tracking coordinates. Tracking_Dec is a display variable.

Tracking_Equinox: A configuration variable used to specify the telescope's track equinox. It may be a normal equinox specification string or it may be the special string "FILE", in which case the track equinox is set to the object's file equinox.

See §2.1.4 for more information on the syntax of Equinox strings.

Tracking_RA: Right Ascension portion of the tracking coordinates. Tracking_RA is a display variable.

Track_Equinox: The equator and equinox of the mean place coordinate system that the telescope is using for calculations and display. A star's input file coordinates are precessed from the file equinox to the track equinox as part of transforming them to base coordinates before commencing tracking. The track equinox is set to the value of the configuration variable tracking_equinox unless that variable has the value "FILE", in which case it takes the value of the file equinox.

Track_Equinox is a display variable. It appears on the top line of the display whenever the telescope is tracking.

Vertical_Angle: The angle between the vertical circle and the projection of the selected orientation on the sky, measured counter-clockwise from the upwards vertical. It has a range of 0? to 360?. On the 2.3 metre telescope only, Vertical_Angle is a display variable.