Telescope Control Interfaces

G. Chiozzi, R. Karban

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Contents

INTRODUCTION

VLT Instrument Control Software has the need of interacting with the VLT Telescope Control Software (TCS)

The VLT Telescope Control Software provides:

- A set of public interfaces to be used for this purpose.
- A TCS Simulation Package to be used during INS Control Software development to test the interface.

This presentation is a guide to:

- The basic functionalities provided by the TCS Public Interface.
- How applications interface to TCS.
- The role TCS Simulation Package to test applications.

The basic manual referenced here is:

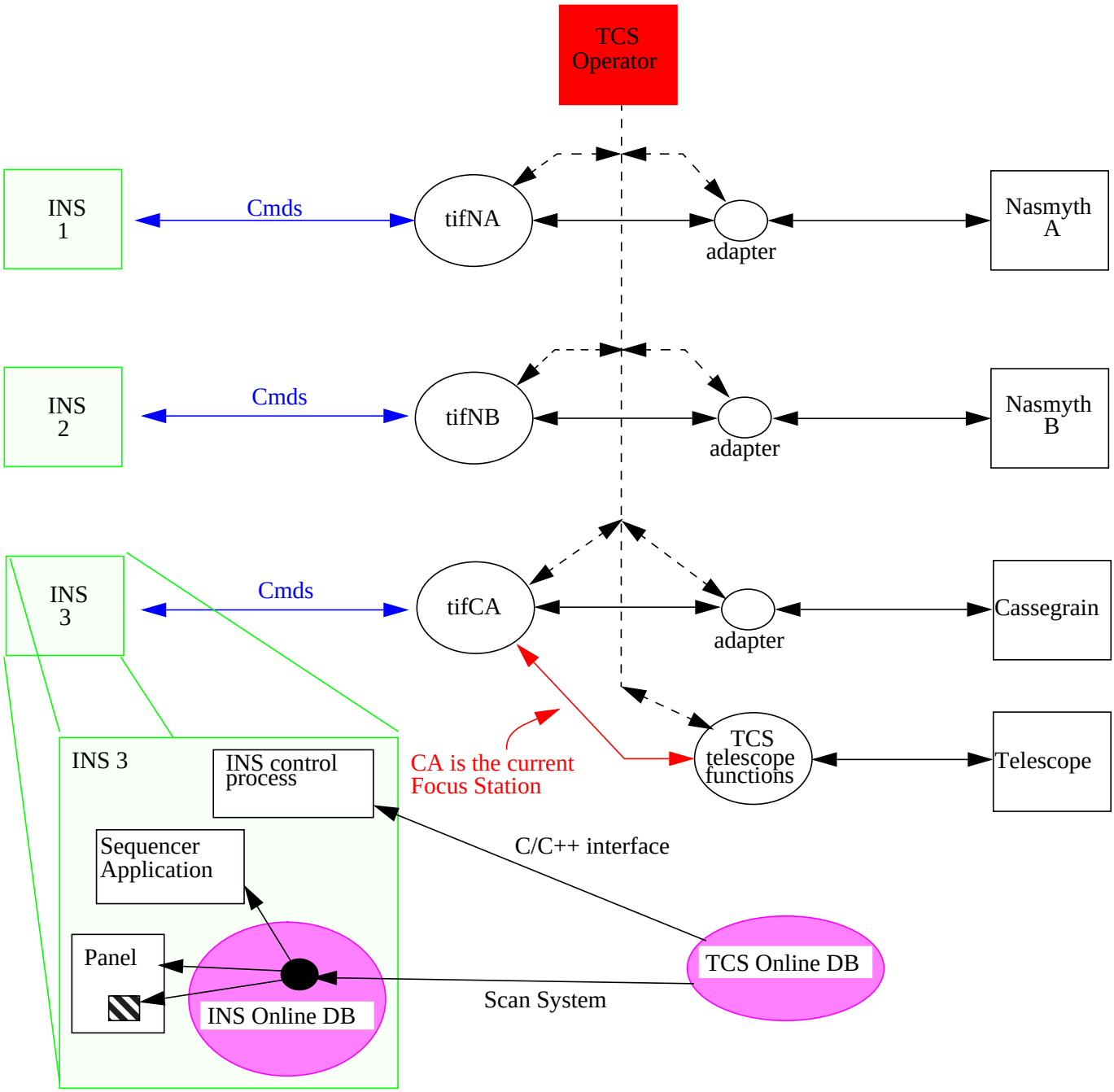
Telescope Control System User Manual, Issue 1.5
VLT-MAN-ESO-17230-0942

TCS Public Interfaces

TCS provides 3 different types of public interfaces (TCS User Manual par. 2.1):

- **Command interface (par. 2.2).**
  It is used mainly to request actions from TCS.
  INS Applications communicates with TCS sending commands to a tif process in the TCS environment.
  - There is one tif process for each Focus Station.
  - The booking system provides protection.
- **C/C++ Interface (par 2.3).**
  It is used by C/C++ Applications to retrieve information from TCS and to get triggered on TCS events.
  It consist of 3 components:
  - Data Query Library (par. 2.3.1)
  - FITS Header Data Functions (par. 2.3.2)
  - Event Configuration Library (par. 2.3.3)
- **Online Database Classes (par 2.4)**
  Used by non C/C++ Applications (Sequencer, Panels) to retrieve information from TCS.
  Panel Editor Classes (par. 2.5) make easier the development of INS panel that also display TCS data.

TCS Public Interfaces (cont.)



The VLT TCS Packages

The VLT TCS Packages are distributed as part of the VLT Common Software. It currently includes (par. 4.1):

- **the TCS simulation and development package:**
  - all TCS interfaces (libraries, database classes, CDTs) for development.
  - processes and database to simulate a running TCS.
- **the TCS interface to the ESO Star Catalogue Interface**

The TCS Simulation allows to test software that must interface with the VLT TCS, by means of a special database configuration and the tcssim software module.

In order to switch between the communication with a TCS Simulation and the real TCS, it is only necessary to properly set environment variables.

The Installation is clearly described in section 2.6 of the user manual.

... general considerations

The steps to get running a full TCS Simulation are described in section 2.6.2 of the User Manual.

- The TCS Simulation consists of:
  - A set of TCS Simulation specific processes
  - A set of TCS real processes
  - A TCS Simulation specific database
- The TCS Simulation database can be instantiated in:
  - An independent RTAP environment (suggested)
  - The INS environment itself (in case of a system with limited resources).
- The TCS software can be used both for VLT and NTT: it is very important to specify what telescope we want to use (par. 2.6.2.2)

Using the command interface

Any application capable of sending commands via the CCS message system can send commands to TCS.

The commands must be sent to the tif process corresponding to the desired focus station (tifNA, tifNB, tifCA).

The CCS Booking System is responsible for access control and security.

Section 2.2 of the User Manual describes the available commands (more details are provided in the specific man pages in section 3.2).

The command definition table (par. 5.4) provides a detailed description of command parameters.

From the instrument point of view the most important command is the command:

SETUP

It is used to PRESET the telescope to a new target, setting at the same time all configuration parameters and support subsystems (Auto Guiding, Active Optics and so on).

No action is actually executed unless a new target is provided in the SETUP command.

The list of setup keywords interpreted by TCS with the command SETUP is described in the default setup file in section 5.5.2.

Available commands

Command	Description
ADCMIN	Preset ADC to minimum prism separation
BOX2GS	Move guide box to actual position of selected guide star, then start guiding.
CLRSTP	Clear ready SETUP file with default values
CYCLAO	Start active optics. The same as STARTAO. Provided for backward compatibility.
FFIN	Move Cassegrain Flat Field screen IN
FFOUT	Move Cassegrain Flat Field screen OUT
FGETAO	Retrieves the furrent m2 focus offset along Z axis in mm.
FINDGS	Find an appropriate guide star using the given configuration
FSREL	Release Rapid Guiding Permission
FSREQ	Request permission for performing Rapid Guiding
DMSMODE	Select the operational mode for dome rotation. auto: automatic position update semi: position reference calculated every second but preset only on request command: position reference calculated and preset only on request
GETINS	Get currently selected instrument
GETINSD	Get instrument configuration parameters
OBJROT	Modify image orientation with respect to deafult. Angle given in degrees
OFFSAA	Issue an ALT/AZ offset step
OFFSAD	Issue an RA/DEC offset step
OFFSADG	Issue an RA/DEC combined offset step
OFFSFAD	Absolute or differential adapter focus position setting.

Command	Description
OFFSFM2	Absolute or differential M2 position settings along Z axis. Provided for backward compatibility, should not be used. Use SETINSD instead.
OFFSROT	Issue a rotator offset step in degrees
OFFSXY	Issue an offset step in defined X/Y coordinates.
ONECAL	Active Optics calibrated mirror corrections, based on current telescope altitude.
PRGS	Select the next suitable guide star in the internal catalogue and position the probe to it. If no more un-tried entry is available an error is returned.
PRSALAZ	Preset telescope to given ALT/AZ position (fixed)
PRSCOOR	Preset telescope to given RA/DEC coordinates (tracking)
PRSNAME	Preset telescope to named fixed position
ROTTRK	Set rotator tracking mode. One of: normal, altaz, none.
SAVCSTP	Save a copy of the current setup file with the given name
SAVRSTP	Save a copy of the ready setup file with the given name
SELINS	Select the logical observing instrument
SEQAO	Start a set of full active optics corrections.
SETADC	Set ADC separation
SETAV	Set additional velocity
SETBAFF	Retract/deploy sky baffles
SETLAM	Set observed wavelength
SETINSD	Set instrument configuration parameters
SETRLIM	Set limit value for remaining tracking time warning
SETUP	Define a new setup configuration (standard format, as defined in [7], for FITS keywords see section 5.5)
STARTAG	Start autoguiding.

Command	Description
STARTAO	Start active optics. The same as CYCLAO.
STOPAG	Stop autoguiding
STOPAO	Stop active optics
STOPCHP	Stop chopping
STOPTRK	Stop tracking and stay at actual position
STRTCHP	Start chopping
WSMODE	Select the operational mode for the windscreens. auto: automatic position update semi: position reference calculated every second but preset only on request command: position reference calculated and preset only on request

Using the C/C++ interfaces

The TCS public programmatic interface provides a set of C/C++ library. They can be used to retrieve TCS status and data.

The following functions are available (par 2.3):

- TCS query routines (2.3.1):
  - tifGetByName(): general routine to query data items by name
  - tifGetPosition(): the telescope position in various coordinates.
  - tifGetStates(): the states of TCS modules.
  - tifGetStatus(): the status of the TCS
- TCS FITS headers routines (2.3.2):
  - tifGetFitsStart(): Generate the TCS FITS keywords at start of exposure
  - tifGetFitsEnd(): Generate the TCS FITS keyword at end of exposure and dump in file
- TCS Events Handling (2.3.3):
  - tifAttachEvent(): attach to a TCS event
  - tifDetachEvent(): detach from a TCS event
- TCS M2 Communication Library (2.3.5):
  - m2comConnect(): connect to M2
  - m2comSend(): send corrections
  - m2comDisconnect(): disconnect from M2

TCS Named Data Items

Name	Type	Unit	Description
LST	vltDOUBLE	HMS	Local Sidereal Time Format: HHMMSS.F, Range: 0 - 240000.0
UTC	vltDOUBLE	MJD	Universal Time Coordinated as modified julian date
HA	vltDOUBLE	HMS	actual Hour Angle Format: HHMMSS.F, Range: 0 - 240000.0
RA	vltDOUBLE	HMS	actual Right Ascension (apparent places ‘now’) Format: HHMMSS.F, Range 0 - 240000.0
DEC	vltDOUBLE	DMS	actual Declination (apparent places ‘now’) Format: +/-DDMMSS.F, Range: -900000.0 - 900000.0
RA2000	vltDOUBLE	HMS	actual Right Ascension at mean place of J2000 Format: HHMMSS.F, Range 0 - 240000.0
DEC2000	vltDOUBLE	DMS	actual Declination at mean place of J2000 Format: +/-DDMMSS.F, Range: -900000.0 - 900000.0
RA2000DEG	vltDOUBLE	deg	actual Right Ascension at mean place of J2000 Range 0 - 360.0
DEC2000DEG	vltDOUBLE	deg	actual Declination at mean place of J2000 Range: -90.0 - 90.0
ALT	vltDOUBLE	deg	actual Altitude position Range: 0.0 - 90.0
AZ	vltDOUBLE	deg	actual Azimuth position Range: -180.0 - 360.0 (South=0, Est=90)
ALT_REF	vltDOUBLE	deg	Reference Altitude position Range: 0.0 - 90.0
AZ_REF	vltDOUBLE	deg	actual Azimuth position Range: -180.0 - 360.0 (South=0, Est=90)
AIRMASS	vltDOUBLE	none	actual airmass
PRLTIC	vltDOUBLE	deg	actual parallactic angle Range: 0.0 - 360.0
DVELRA	vltDOUBLE	arcsec /sec	actual differential velocity in RA with respect to normal sidereal rate, Range: -15.0 - +15.0
DVELDEC	vltDOUBLE	arcsec /sec	actual differential velocity in Declination with respect to normal sidereal rate, Range: -15.0 - +15.0
LONGI	vltDOUBLE	rad	telescope site Longitude, west is positive
LATI	vltDOUBLE	rad	telescope site Latitude, south is negative
LEVEL	vltDOUBLE	m	telescope site Height above sea level

Name	Type	Unit	Description
REMTIME	vltDOUBLE	sec	actual remaining tracking time
REMLIMIT	vltDOUBLE	sec	limit value for event triggering of remaining tracking time
TRACK	vltLOGICAL	BOOL	flag, indicating if currently in tracking state
FOCUS	vltINT32	focus ID	Current focus station. Can be one of (see mswDefines.h): mswUNDEFINED_FOCUS 0 mswNASMYTH_A_FOCUS 2 mswnNASMYTH_B_FOCUS 3 mswCASSEGRAIN_FOCUS 4 mswCOUDE_FOCUS 5 mswINTERMEDIATE_D_FOCUS 6
FOCULEN_NA	vltDOUBLE	m	Focal length for Nasmyth focus
FOCULEN_CA	vltDOUBLE	m	Focal length for Cassegrainfocus
FOCULEN_CO	vltDOUBLE	m	Focal length for Coude'focus
FOCUSCALE_NA	vltDOUBLE	arcsec/mm	Focal scale for Nasmyth focus
FOCUSCALE_CA	vltDOUBLE	arcsec/mm	Focal scale for Cassegrainfocus
FOCUSCALE_CO	vltDOUBLE	arcsec/mm	Focal scale for Coude'focus
TELESCOP	vltBYTES20	string	Telescope name
VERSION	vltBYTES80	string	Version of TCS software
INSTALLED	vltBYTES80	string	TCS Installation date and information
OPER	vltBYTES32	string	Name of telescope operator
FOCU_VALUE	vltDOUBLE	mm	Position of mirror 2 in z-axis
DOME_STATUS	vltINT32	status ID	Status of dome. Always 0 in the current VLT implementation. See NTT specific documentation for NTT values.
AG_STATUS	vltINT32	status ID	Autoguiding substate (see agwsDefines.h): evhSTATE_UNK 0 agwsSTATE_IDLE 7 agwsSTATE_ERROR 6 agwsSTATE_OPERATING 121 agwsSTATE_GUIDING 122 agwsSTATE_MANUAL 123
AG_RA	vltDOUBLE	HMS	actual Right Ascension for current Guide Star (J2000 coordinates) Format: HHMMSS.F, Range 0 - 240000.0
AG_DEC	vltDOUBLE	DMS	actual Declination for current Guide Star (J2000 coordinates) Format: +/-DDMMSS.F, Range: -900000.0 - 900000.0

Name	Type	Unit	Description
ROT_ANGLE	vltDOUBLE	deg	Rotator angle in Degrees (DD.ddd)
ADA_POSANG	vltDOUBLE	deg	Adapter pos angle, i.e. Rotator on sky (DD.ddd)
CCD_ON_SKY	vltDOUBLE	deg	Angle on sky og Guide Probe TCCD
ADA_ANGLE	vltDOUBLE	deg	Adapter angle (DD.ddd)
PROBE_RA	vltDOUBLE	HMS	Guide probe RA J2000 coordinate (HMS)uide probe X coordinate.
PROBE_DEC	vltDOUBLE	DMS	Guide probe DEC J2000 coordinate (DMS)
PROBE_X	vltDOUBLE	mm	Guide probe X coordinate.
PROBE_Y	vltDOUBLE	mm	Guide probe Y coordinate.
PROBE_IN_POS	vltLOGICAL	0/1	Guide probe in position
ASM_SEEING	vltDOUBLE	arcsec	Seeing reported from asm
ADC_SEP	vltDOUBLE	mm	ADC separation in mm
TEMP_SER_1	vltDOUBLE	Celsius	serrurier strut lower end N quadrant NasA side temperature sensing system
TEMP_SER_2	vltDOUBLE	Celsius	serrurier strut upper end N quadrant NasB side temperature sensing system
TEMP_SER_3	vltDOUBLE	Celsius	tserrurier strut lower end S quadrant NasA side emperature sensing system
TEMP_SER_4	vltDOUBLE	Celsius	serrurier strut upper end S quadrant NasB side temperature sensing system
TEMP_CNT_1	vltDOUBLE	Celsius	centerpiece N quadrant temperature sensing system
TEMP_CNT_2	vltDOUBLE	Celsius	centerpiece S quadrant temperature sensing system
TEMP_FLX_1	vltDOUBLE	Celsius	flexure bar upper end N quadrant NasA side temperature sensing system
TEMP_FLX_2	vltDOUBLE	Celsius	flexure bar lower end N quadrant NasB side temperature sensing system
TEMP_FLX_3	vltDOUBLE	Celsius	flexure bar upper end S quadrant NasA side temperature sensing system
TEMP_FLX_4	vltDOUBLE	Celsius	flexure bar lower end S quadrant NasB side temperature sensing system
ASM_WINDSPEED	vltDOUBLE	m/sec	Wind speed as reported from the ASM
ASM_WINDDIR	vltDOUBLE	deg	Wind direction as reported from the ASM (0 - 360) (0 = north, 90 = east)
M1_CORRECTED	vltINT32	count	no of corrections applied to M1
M2_CORRECTED	vltINT32	count	no of corrections applied to M2

Name	Type	Unit	Description
AO_CMD_STATE	vltINT32	ID	state of command: actconCMD_NUM_IDLE ... 200 actconCMD_NUM_INITAO ... 201 actconCMD_NUM_INITIA ... 202 actconCMD_NUM_INITCOR ... 203 actconCMD_NUM_TERMCOR ... 204 actconCMD_NUM_STPWAIT ... 205 actconCMD_NUM_SHUTDWN ... 206 actconCMD_NUM_CORM1 ... 207 actconCMD_NUM_CORM2 ... 208 actconCMD_NUM_ONECOR ... 209 actconCMD_NUM_ONECAL ... 210 actconCMD_NUM_CYCLCAL ... 211 actconCMD_NUM_REFIA ... 212 actconCMD_NUM_ONEIA ... 213 actconCMD_NUM_SEQIA ... 214 actconCMD_NUM_SEQAO ... 215 actconCMD_NUM_CYCLAO ... 216
AO_TARGET	vltINT32	ID	corrections are applied to M1,M2 or both: actconNUM_SET_NONE ... 0 actconNUM_SET_M2 ... 1 actconNUM_SET_M1_M2 ... 2
AO_CUR_IND_AVG	vltINT32	count	current analyses averaged
CHOP_STATUS	vltINT32	status ID	chop status: chopwsCHOP_INACTIVE ... 0 chopwsCHOP_ACTIVE ... 1 chopwsCHOP_UNDEFINED ... 2
CHOP_STRT_TIME	vltDOUBLE	UTC	chop start time in ISO format: yyyy-mm-ddThh:mm[:ss.[uuuuuu]]
CHOP_STOP_TIME	vltDOUBLE	UTC	chop stop time in ISO format: yyyy-mm-ddThh:mm[:ss.[uuuuuu]]
CHOP_FREQ	vltDOUBLE	Hz	chop frequency
CHOP_THROW	vltDOUBLE	arcsec	chop throw (amplitude)
CHOP_POI	vltINT32	ID	chop position of optimum image: chopwsOPTIMUM_IMAGE_OFF ... 0 chopwsOPTIMUM_IMAGE_ON ... 1 hopwsOPTIMUM_IMAGE_CENTRE ... 2
CHOP_PVR	vltDOUBLE	ratio	chop peak to valley ratio

Name	Type	Unit	Description
CHOP_TPA	vltINT32	ID	chop telescope pointing axis: chopwsTEL_POINTING_AXIS_OFF ... 0 chopwsTEL_POINTING_AXIS_ON ... 1 chopwsTEL_POINTING_AXIS_OPTIMUM ... 2 chopwsTEL_POINTING_AXIS_INDEPENDENT ... 3
CHOP_POSANG	vltDOUBLE	deg	chop orientation
CHOP_OFFSET	vltDOUBLE	arcsec	chop offset

FITS Header Keywords

FITS Keyword	Unit	Description
TELESCOP	string	Telescope name
RA	degrees	Right Ascension in mean J2000 (DD.ddd)
DEC	degrees	Declination in mean J2000 (DD.ddd)
EQUINOX	years	Always 2000
RADECSYS	string	Always FK5
LST	seconds	Local Sidereal Time. Seconds since midnight
UTC	seconds	Universal Time. Seconds since midnight
TEL DID	string	Data dictionary name for TCS
TEL ID	string	TCS version string
TEL DATE	string	TCS release version and date
TEL ALT	degrees	Altitude angle at start
TEL AZ	degrees	Azimuth angle at start (S=0, W=90 !!!)
TEL GEOELEV	meters	Telescope elevation above sea level
TEL GEOLAT	degrees	Telescope geographic latitude (+=North)
TEL GEOLON	degrees	Telescope geographic longitude (+=East !!!)
TEL OPER	string	Name of telescope operator
TEL FOCU ID	string	Focus station (NA, NB, CA or CO)
TEL FOCU LEN	m	Focal len for the current focus
TEL FOCU SCALE	arcsec/mm	Scale for the current focus
TEL FOCU VALUE	mm	M2 absolute position in Z-axis
TEL PARANG END	degrees	Parallactic angle at end
TEL PARANG START	degrees	Parallactic angle at start
TEL AIRM END		Airmass at end

FITS Keyword	Unit	Description
TEL AIRM START		Airmass at start
TEL AMBI FWHM END		Observatory seeing at end
TEL AMBI FWHM START		Observatory seeing s at start
TEL TRAK STATUS	string	OFF, NORMAL or DIFFERENTIAL
TEL TRAK RATEA	arcsec/sec	Absolute tracking rate in RA (only if DIFFERENTIAL)
TEL TRAK RATED	arcsec/sec	Absolute tracking rate in DEC (only if DIFFERENTIAL)
TEL DOME STATUS	string	FULLY-OPEN, PART-OPEN, CLOSED or VIGNETTING
ADA ABSROT START	deg	Absolute rotator angle at start
ADA ABSROT END	deg	Absolute rotator angle at end
ADA POSANG	deg	Rotator on sky
ADA GUID STATUS	string	ON or OFF
ADA GUID RA	deg	Guide star RA in J2000 (only if GUID ON)
ADA GUID DEC	deg	Guide star DEC in J2000 (only if GUID ON)

Using the libraries

In order to use the libraries, it is necessary:

- To have TCS Simulation and Development Package installed and configured
- Environment variables properly set
- **A running environment with TCS or TCS Simulation database branch**
- The code should be written in C++ or at least compiled with the C++ compiler, i.e. the files should have the .C (capital C) filename extension.
- The Makefile must contain proper definitions for the TARGET_TCS to be built
- The following libraries must be linked with the code:
  tifLibs msw tcs tcsVcc oslx slx misc evh eccs fnd C++ CCS
- The include file tif.h contains all the necessary definitions and function prototypes.

Section 5.1 contains three complete and working sample programs, two using the Data Query Library and the other one using the Event Configuration Library.

The second Data Query Library example demonstrates how to use the tifGetFitsStart() and tifGetFitsEnd() to generate a complete FITS header.

Building INS panels to monitor TCS

Two TCS Public Database classes have been implemented to provide access to TCS data for UIF instrument panels and Sequencer scripts.

The two classes have identical structure and differ only in the way they internally access TCS information (par. 2.4):

- tifTCS_PUBLIC can be instantiated in any user (instrument) database to provide a local image of the TCS public data items. This class is used when the TCS database, real or simulated, is NOT in the same environment as the user (instrument) database. In this case, the scan system is used to update the user database with values from the TCS environment (real or simulated).

- tifTCS_LOCAL provides the same items, but can be instantiated in the same environment where TCS itself is running, i.e. when simulated TCS data are a part of the user (instrument) database. In this case, the items are updated using the calculation engine, instead of the scan system.

The tifTCS_PUBLIC DB class

tifTCS_PUBLIC	
tcsState	Global TCS state information
tcsState	TCS global state, as in Mode Switching
tcsSubstate	TCS substate, as in Mode Switching
track	TCS tracking flag (0/1)
focus	Current focus ID
domeStatus	Current dome Status
times	Time items
lst	Local Sideral Time
utc	Universal Time Coordinated
coord	Target coordinates
ha	Target actual Hour Angle
ra	Target actual RA
dec	Target actual declination
ra2000	RA at mean place of J2000 in HHMMSS
dec2000	dec at mean place of J2000 in DDMMSS
ra 2000deg	RA at mean place of J2000 in deg
dec2000deg	dec at mean place of J2000 in deg
alt	Telescope altitude
az	Telescope azimuth
prltic	Actual parallactic angle
track	Tracking parameters
airmass	Actual airmass
dvelra	Differential velocity RA
dveldec	Differential velocity dec
rotAngle	Actual rotator angle
adaAngle	Adapter angle (DEG)
adaPosAngle	Adapter pos angle (rot on sky) (DEG)
remtime	Remaining tracking time
remlimit	Remaining tracking time limit
trackingLost	Event flag for lost tracking
remTimeLow	Event flag for low remaining trk. time
guide	Auto Guide parameters
status	Auto Guide status
ra	RA of current guide star
dec	dec of current Guide Star
probeX	Guide probe position in X
probeY	Guide probe position in Y
ccdOnSky	angle on sky probe tccd
m2	M2 parameters

	focuValue	
ao		Active optics configuration
	m1corrected	
	m2corrected	
	commandState	
	targetSettings	
	currentIndexAvg	
info		General information
	telescop	Telescope name
	version	TCS software version in use
	installed	TCS software installation date
	oper	Telescope Operator name
	foculenNA	Focus length nasmyth
	foculenCA	Focus length cassegrain
	foculenCO	Focus length coude
	focuscaleNA	Focus scale nasmyth
	focuscaleCA	Focus scale cassegrain
	focuscaleCO	Focus scale coude
site		Site information
	longi	Longitude
	lati	Latitude
	level	Height above see level
chop		Chopping configuration
	status	chopping status (active or not)
	startTime	starting time (ISO string)
	stopTime	stop time (ISO string)
	freq	frequency
	throw	amplitude
	posOptImage	optimal position for image
	peakValleyRatio	peak to valley ratio
	telPointingAxis	telescope pointing axes
	posAng	chopping angle
	offsetChop	chopping offset with respect to center position
adc		Atmospheric dispersion corrector
	actDist	
hb		Hydrostatic bearings
	tempSer1	
	tempSer2	
	tempSer3	
	tempSer4	
	tempCnt1	
	tempCnt2	
	tempFlx1	
	tempFlx2	
	tempFlx3	

tempFlx4
asm Astronomical site monitor
seeing
windspeed
winddir

Using the tifTCS_PUBLIC class

1. Configure the TCS database to allow scanning from the remote user environment.
   To this purpose it is necessary to add a scan device for the environment in the TCS database.
   For example, add the following lines in the USER.db file of the TCS environment:
   POINT “<VLT scan dev>” ccs_config:scan\ config:LAN:wsIns
   BEGIN
   ALIASwsIns
   END
2. Configure the user database to perform scanning from the TCS environment.
   To this purpose it is necessary to add a scan device for the TCS environment in the user database.
   For example, add the following lines in the USER.db file of the user (instrument) environment:
   POINT “<VLT scan dev>” ccs_config:scan\ config:LAN:wsTcs
   BEGIN
   ALIAS wsTcs
   END
3. Add an instance of the tifTCS_PUBLIC class anywhere in the user database. The Makefile must contain proper definitions for the TARGET_TCS to be built (see section 4.7.2)
4. Configure the scan system by running the tifTcsScanSetup command.