SICS–MAD–Reference Manual

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Chapter 1

Introduction

Welcome to SICS-MAD! SICS-MAD is the SINQ solution for running triple axis spectrometers. The name consists of two parts: SICS is the SINQ Instrument Control System. MAD is mad. It is a compatability layer on top of SICS which emulates the command set and behaviour of the venerable MAD software from the ILL.

SICS is a client server system. This means there is a magic server program running on the instrument computer which does all the work. The user interacts with SICS only with client applications which communicate with the server through the network. Most instrument hardware (motor controllers, counter boxes etc.) is connected to the system through RS-232 serial connections. These RS-232 ports are connected to a terminal server which is accessed through another server program, the SerPortServer program, which is also running on the instrument computer. The SICS server communicates with the terminal server and other devices through the network.

The MAD compatibility layer is implemented in the SICS server. Most MAD commands were mapped to their SICS equivalents through procedures written in SICS internal scripting language. Some crucial operations, such as driving and scanning, were implemented in C, sometimes even using F77 routines from the ILL MAD sources for performing the triple axis calculations.

SICS clients are small programs which implement the user interface to the SICS server. Clients connect to the SICS server through the TCP/IP network and display the instrument status or allow to control the instrument. Of interest to the triple axis spectrometer user are the dedicated TAS client, named tas, the general SICS comand line client, sics, and the variable watcher, varwatch, which allows to plot any SICS variable as a function of time. All clients are java applications and can be run from any computer for which a JDK1.1 compatible Java runtime system is available.

Chapter 2

Running SICS

2.1 SICS Invocation

SICS means SINQ Instrument Control System. SICS is a client server system. This means there are at least two programs necessary to run the experiment. The first is the SICServer which does the actual instrument control work. A user rarely needs to bother about this server program as it is meant to run all the time. See instructions below if things go wrong.

Then there are client programs which interact with the instrument control server. These client programs implement the status displays and a command line application which forwards commands to the SICS server and displays its response. Graphical User Interfaces may be added at a later time. The user has only to deal with these SICS client programs. SICS Clients and the SICServer communicate with each other through the TCP/IP network.

Currently the following SICS clients are available:

- A command line control client for sending commands to the SICS server and displaying its repsonses.
- A status display for the powder diffractometers DMC and HRPT.
- A status display for MORPHEUS and general scans.
- A status display for SANS and SANS2.
- A status display for FOCUS.
- A AMOR control and status program.
- A triple axis control and status program.
- A SICS variable watcher. This application graphically logs the change of a SICS variable over time. Useful for monitoring for instance temperature controllers.
- A graphical client for TRICS.

2.1.1 Steps necessary for logging in to SICS

The following actions have to be taken in order to interact with the SICS server through a client:

- Start the client application.
- Connect the client to a SICS server.
- In case of command line clients: authorize yourself as privileged SICS user.

2.1.2 Starting SICS client applications

These programs can be started on a Linux system by issuing the following commands at the command prompt:

sics & for the control client.

powderstatus & for the DMC status display client.

topsistatus & for the MORPHEUS status display.

sansstatus & for the SANS status display.

focustatus for the FOCUS status display.

amor & for the AMOR status display and control application.

tas & for the triple axis status display and control application.

varwatch & for the variable watcher.

trics & for the starting the TRICS graphical client.

Another option to start SICS clients is the Java Webstart mechanism which is available for most platforms. Java webstart requires both Java and Java webstart to be installed on the computer running the client. Then clients can be started directly from a WWW-page. The advantage is that clients are automatically updated in this system as soon as new version have been copied to the WWW-site. Installation instructions for Java webstart and links to start all SICS clients though this mechanism can be found at: the SICS webstart[1] page. This service is only accessible within the PSI network.

2.1.3 Connecting

After startup any SICS client is not connected to a SICS server and thus not active. A connection is established through the connect menu of the client.

[1]See URL http://lns00.psi.ch/sics/wstart

2.1.4 Authorization

SICS is a multi user instrument control system. In order to prevent malicious manipulations of the instrument SICS supports a hierarchy of user rights. In order to run an experiment you need at least user level privilege. In order to achieve this privilege you have to invoke the Authorize dialog. There you have to enter the apropriate username and password kindly provided by your instrument scientist.

2.1.5 Restarting the Server

The SICS server should be running all the time. It is only down if something went wrong. You can check for the presence of the SICS server by loging in to the instrument computer and typing **monit status** at the command prompt. The output will tell you what is happening. If you need to restart the SICS server log in as the instrument user at the instrument computer and invoke the appropriate command to start the server. These are:

DMC Computer = dmc, User = dmc

TOPSI Computer = morpheus, User = morpheus

SANS Computer = sans, User = sans

SANSLI Computer = sans2, User = sans2

TRICS Computer = trics, User = trics

HRPT Computer = hrpt, User = hrpt

FOCUS Computer = focus, User = focus

AMOR Computer = amor, User = amor

TASP Computer = tasp, User = tasp

POLDI Computer = poldi, User = poldi

The SICS server process are controlled through the monit program. Usually the monit daemon is running. If not, for instance after a reboot, it can be started by typing **monit** at the unix prompt logged in as the instrument user. Further monit commands:

monit start target start the monit surveyed process target. For the choice of targets see below.

monit stop target stops the monit surveyed process target. For the choice of targets see below.

monit restart target restart the monit surveyed process target. Possible targets are:

> **sicsserver** The SICServer
>
> **SerPortServer** The serial port control program

sync The file synchronisation program. This is responsible for coyping data files to the common AFS area.

simserver Only on TASP: a simulation SICS server

all Stop all processes

monit status prints a status listing of everything watched by monit

monit quit Stops monit itself

Stopping everything thus involves two commands:

- monit stop all
- monit quit

Restarting after this involves:

- monit

The older command startsics and killsics are still working and operate on the monit daemon as of now.

If all this does not help look under trouble shooting SICS (cf. Section 6.5).

2.2 The TAS Client

The TAS client is the dedicated SICS client for the triple axis spectrometers. It allows both to control the instrument and to view its current status.

2.2.1 Step 1: Starting the TAS Client

On the LNS unix systems the TAS client can be started by typing:

```
tas &
```

at the unix command prompt. For PC's and proper Macintosh computers (proper is MacOS ¿ 10) the recommended way to start the TAS program is to install Java Web Start and run it from the SICS Java Web Start page. Further instructions and the applications can be found at: http://lns00.psi.ch/sics/wstart .

2.2.2 Step 2: Connect to an Instrument

Due to the client server architecture, the client program alone is only of very limited use. In order to become usefule, a connection to a SICS server has to be established. The obvious way to do this is through the menu selections in the Connect menu of the TAS client. There are various entries for various triple axis spectrometers and their simulation programs. With the Custom Connect option the connection parameters, the computer running the SICS server and the server port where the SICS server listens, can be entered manually. This is only necessary when SICS had to be relocated due to a hardware outage.

2.2.3 Step 3: Use The TAS Client

The TAS client consists of a menubar, a row of buttons beneath and a central activity area. The central activity area can display three different sub panels. These sub panels are selected through the buttons underneath the menubar. The following sub panels are available:

- A Command Panel for entering commands.
- A Status panel displaying the current values of interesting instrument parameters, most notably the positions of the 6 magic triple axis motors.
- A Plot panel showing the data collected in the currently running scan and some auxiliary information about the scan.

At the very bottom of the screen is a yellow line displaying the current status of a pending counting operation. Below that is a text line displaying the current status of the instrument.

The Command Panel

The command panel consists mainly of a text area in which the communication between the TAS client and the SICS server is logged. A text entry field at the bottom serves to enter commands to the SICS server. The little red button, labelled Interrupt, besides the text entry field can be used to interrupt the currently running measurement.

The Command Panel has a menu associated with it. Through this menu logging to a file can be enabled. This log file is written locally on the machine running the TAS client. Submenu entries are available for opening and closing such log files. SICS has various levels of user rights. When connecting to the SICS server you are logged in with lowest possible privilege. In order to change your privilege, enter a username and a password through the Command/User Rights dialog.

The Plot Panel

The Plot Panel displays the data collected in the current scan. This display is automatically updated as soon as new data becomes available through the progress of the scan. You may *zoom in* on details in th plot by dragging a rectangle enclosing the interesting region from top to bottom. You may *zoom out* by dragging a rectangle from the bottom to the top.

2.2.4 Step 4: Closing the TAS Client

You can exit the TAS client through the File/Exit menu entry. You can also disconnect from the current SICS server through the Connect/Disconnect option and connect to another SICS server through the menu choices provided.

Chapter 3

SICS User Commands

3.1 Logging your activity

SICS offers not less then three different ways of logging your commands and the SICS server's responses:

- You may create a similar per client log file on the computer running the SICS server through the logbook (cf. Section 3.1.1) command.
- Then there is a way to log all activity registered from users with either user or manager privilege into a file. This means: all commands which affect the experiment regardless from which client they have been issued. This is accomplished with the commandlog (cf. Section 3.1.2) command.

3.1.1 LogBook command

Some users like to have all the input typed to SICS and responses collected in a file for further review. This is implemented via the LogBook command. LogBook is actually a wrapper around the config file command. LogBook understands the following syntax:

LogBook alone prints the name of the current logfile and the status of event logging.

LogBook file *filename* sets the filename to which output will be printed. Please note that this new filename will only be in effect after restarting logging.

LogBook on This command turns logging on. All commands and all answers will be written to the file defined with the command described above. Please note, that this command will overwrite an existing file with the same name.

LogBook off This command closes the logfile and ends logging.

3.1.2 The Commandlog

The commandlog is a file where all communication with clients having user or manager privilege is logged. This log allows to retrace each step of an experiment. This log is normally configured in the startup file or can be configured by the instrument manager. There exists a special command, commandlog, which allows to control this log file.

commandlog new *filename* starts a new commandlog writing to filename. Any prior files will be closed. The log file can be found in the directory specified by the ServerOption LogFileDir. Usually this is the log directory.

commandlog displays the status of the commandlog.

commandlog close closes the commandlog file.

commandlog auto Switches automatic log file creation on. This is normally switched on. Log files are written to the log directory of the instrument account. There are time stamps any hour in that file and there is a new file any 24 hours.

commandlog tail [*n*] prints the last n entries made into the command log. n is optional and defaults to 20. Up to 1000 lines are held in an internal buffer for this command.

commandlog intervall Queries and configures the intervall in minutes at which time stamps are written to the commandlog.

It is now possible to have a script executed whenever a new log file is started. In order to make this work a ServerOption with the name logstartfile must exist in the instrument configuration file. The value of this option must be the full path name of the file to execute.

3.2 Batch Processing in SICS

Users rarely wish to stay close to the instrument all the time but appreciate if the control computer runs the experiment for them while they sleep. SICS supports two different ways of doing this:

- SICS has a built in macro programming (cf. Section 3.2) facility based on the popular scripting language Tcl. The most primitive usage of this facility is processing batch files.
- Second there is the LNS Rünbuffer (cf. Section 3.2) system.
- Third there is the new Batch File execution system.

Macro Commands

SICS has a built in macro facility. This macro facility is aimed at instrument managers and users alike. Instrument managers may provide customised measurement procedures in this language, users may write batch files in this language. The macro language is John Ousterhout's Tool Command Language (TCL). Tcl has control constructs, variables of its own, loop constructs, associative arrays and procedures. Tcl is well documented by several books and online tutorials, therefore no details on Tcl will be given here. All SICS commands are available in the macro language. Some potentially harmful Tcl commands have been deleted from the standard Tcl interpreter. These are: exec, source, puts, vwait, exit,gets and socket. A macro or batch file can be executed with the command:

fileeval *name* tries to open the file name and executes the script in this file.

batchrun *name* prepends to name a directory name configured in the variable batchroot and then executes that batchfile. The usage scenerio is that you have a directory where you keep batch files. Then the variable batcroot is set to contain the path to that directory. Batchrun then allows to start scripts in that directory without specifying the full path. Please note that fileeval and batchrun are obsolete and to be replaced by the new batch manager command, exe, as described below.

Then there are some special commands which can be used within macro-sripts:

ClientPut sometext1 ... Usally SICS suppresses any messages from SICS during the processing of batch files. This is in order not to confuse users with the output of intermediate results during the processing of batch files. Error messages and warnings, however, come through always. Clientput now allows to send messages to the user on purpose from within scripts.

SICSType object allows to query the type of the object specified by object. Possible return values are

- **DRIV** if the object is a SICS drivable object such as a motor
- **COUNT** if the object is some form of a counter.
- **COM** if the object is a SICS command.
- **NUM** if the object is a number.
- **TEXT** if object is something meaningless to SICS.

SICSbounds *var newval* checks if the new value newval lies within the limits for variable var(example: SICSbounds D1HL 10). Returns an error or OK depending on the result of the test.

SICSStatus *var* SICS devices such as counters or motor may be started and left running while the program is free to do something else. This command inquires the status of such a running device. Return values are internal SICS integer codes. This command is only of use for SICS programmers.

SetStatus *newval* sets the SICS status to one of: Eager, UserWait, Count, NoBeam, Driving, Running, Scanning, Batch Hatl or Dead. This command is only available in macros.

SetInt *newval, GetInt* sets SICS interrupts from macro scripts. Not recommended! Possible return values or new values are: continue, abortop, abortscan, abortbatch, halt, free, end. This command is only permitted in macros. Should only be used by SICS programmers.

Rünbuffer Commands

LNS scientists have got used to using Rünbuffers for instrument control. A Rünbuffer is an array of SICS commands which typically represent a measurement. This Rünbuffer can be edited at run time. This is very similar to a macro. In contrast to a macro only SICS commands are allowed in Rünbuffers. When done with editing the Rünbuffer it can be entered in a Rünlist. This is a stack of Rünbuffers which get executed one by one. While this is happening it is possible (from another client) to modify the Rünlist and edit and add additional Rünbuffers on top of the stack. This allows for almost infinite measurement and gives more control than a static batch file. In order to cater for this scheme three commands have been defined:

The **Buf** object is responsible for creating and deleting Rünbuffers. The syntax is:

- **Buf new *name*** creates a new empty Rünbuffer with the name name. name will be installed as a SICS object afterwards.
- **Buf copy *name1 name2*** copies Rünbuffer name1 to buffer name2.
- **Buf del *name*** deletes the Rünbuffer name.

After creation, the Rünbuffer is accessible by his name. It then understands the commands:

- ***NAME* append *what shall we do with a drunken sailor*** will add all text after append as a new line at the end of the Rünbuffer.
- ***NAME* print** will list the contents of the Rünbuffer.
- ***NAME* del *iLine*** will delete line number iLine from the Rünbuffer.
- ***NAME* ins *iLine BimBamBim*** inserts a new line **after** line iLine into the Rünbuffer. The line will consist of everything given after the iLine.
- ***NAME* subst pattern *newval*** replaces all occurences of pattern in the Rünbuffer by the text specified as newval. Currently this feature allows only exact match but may be expanded to Unix style regexp or shell like globbing.
- ***NAME* save *filename*** saves the contents of the Rünbuffer into file filename.
- ***NAME* load *filename*** loads the Rünbuffer with the data in file filename.
- ***NAME* run** executes the Rünbuffer.

The Rünlist is accessible as object **stack** . Only one Rünlist per server is permitted. The syntax:

- **stack add *NAME*** adds Rünbuffer name to the top of the stack.
- **stack list** lists the current Rünlist.
- **stack del *iLine*** deletes the Rünbuffer iLine from the Rünlist.
- **stack ins *iLine NAME*** inserts Rünbuffer name after Rünbuffer number iLine into the Rünlist.
- **stack run** executes the Rünlist and returns when all Rünbuffers are done.
- **stack batch** executes the Rünlist but does not return when done but waits for further Rünbuffers to be added to the list. This feature allows a sort of background process in the server.

3.2.1 The Token Command

In SICS any client can issue commands to the SICS server. This is a potential source of trouble with users possibly issuing conflicting commands without knowing. In order to deal with this problem a "token" mechanism has been developed. In this context the token is a symbol for the control of an instrument. A connection can grab the token and then has full control over the SICS server. Any other connection will not be privileged to do anything useful, except looking at things. A token can be released manully with a special command or is automatically released when the connection dies. Another command exists which allows a SICS manager to force his way into the SICS server. The commands in more detail:

token grab Reserves control over the instrument to the client isssuing this command. Any other client cannot control the instrument now. However, other clients are still able to inspect variables.

token release Releases the control token. Now any other client can control the instrument again. Or grab the control token.

token force password This command forces an existing grab on a token to be released. This command requires manager privilege. Furthermore a special password must be specified as third parameter in order to do this. This command does not grab control though.

3.3 TAS Data Storage

Triple axis spectrometer data is stored in ASCII files. These ASCII files are formatted in a format compatible to the ILL's triple axis data file format. Data files can be found in directories:

```
/home/INST/data/YYYY
```

on the instrument computer or in

```
/data/lnslib/data/INST/data/YYYY
```

on any other LNS unix system. INST is a placeholder for the instrument name in capitals, YYYY for the year of data collection. Data files are named according to the SINQ naming convention:

```
instRRRRRYYYY.dat
```

with inst being the placeholder for the instrument name in lowercase, RRRRR the run number as a five digit number and YYYY again the year of data collection. Example: tasp003302002.dat is data collected in run number 330 in 2002.

The last measured data file can be discarded by typing the command:

```
killfile
```

in SICS. SICS managers privilege is required for this command.

Automatically generated log files can be found in the /home/INST/log directory for each day. They are named according to the scheme:

```
autoYYYY-MM-DD@HH-MM-SS.log
```

YYYY is again the year, MM the month, DD the day, HH the hour, MM the minute and SS the second of file creation.

Chapter 4

MAD Commands in SICS

The TASMAD program (hereafter referred to as MAD) is used to control all spectrometer activity on triple-axis instruments. It includes motor movement, scans in Q-E space and, where appropriate, control of power supplies, flippers, temperature, etc.

4.1 Terminology and Conventions

In this chapter of the documentation, the following terms are used:

<xxxx> This has two functions. One is to indicate the key with the label *xxxx*, e.g. <Return> indicates the key labelled *Return*. The other is to indicate a parameter field which should be substituted, e.g. <> could represent *lnsw02.psi.ch* or whatever.

Enter ... The word *enter*, when used in connection with something which must be typed on the keyboard such as command, indicates that the action must be terminated by hitting the <Return> or <Enter> key.

Hit ... The word *hit* indicates that the single key (or key combination) indicated should be pressed once. The action should **not** be terminated by hitting the <Return> or <Enter> key.

Examples Whenever examples are shown, anything which is actually typed by the user is shown *like this*. It will generally be shown in lower case. E.g.

```
scan a1=0 da1=1 np=6
```

indicates that everything between the *s* and *6*, inclusive, is to be typed by the user.

Optional Arguments Square brackets, [ ], indicate optional arguments .

4.2 Syntax

```
There are a few rules :

     - An input line must always begin with a command.
```

- A command MUST always be abbreviated to its first TWO relevant letters, e.g. CO is equivalent to COU or COUNT
  but for SetZero type SZ or SZERO and so on.
- A command must be separated from information which follows on the same line by at least one space.
- Only one command may be given per line of input.
  However this does not exclude using, for example, the DRIVE command to drive several or even all motors.
- All command lines are terminated by a carriage return <CR>. So do not forget to put one <CR> (or more) at the end of your jobfile.

Most commands are followed either by:

Syntax type (A)

(A) a sequence of variable names
e.g. DM,DA,SS (carry out command given on variables DM, DA, SS)
e.g. ALF1-ALF4 (carry out command given on variables between ALF1 and ALF4 in storage order; see section V)
e.g. DM,ALF1-ALF4,SS,DA (a combination of the above) Variables separated by commas need not be typed in their order of storage in the program.

Note : that for this type of syntax (type A) the only acceptable variable separators are ' ' (i.e. a space), ',' and '-' (' ' and ',' are equivalent).

Syntax type (B)

(B) a sequence of variable names and values
e.g. AS=3.24,CC=90 (AS is set to value 3.24 and CC to 90)
e.g. QH=1,0,2.0 (variable QH takes the value 1 and the following variables in storage [QK, QL] take the values 0 and 2)
e.g. QH=1,0,2.0,AS=3.24,CC=90 (a combination of the above)

In commands involving this construction type (B) the program echoes the variable names and values it has understood.
Possible separators are ',' and ' ' ('space')

There is a third type of commands which requires no parameters. These commands are:-
AUTO, EXIT, HELP, LIST, LL, LE, LL, LM, LS, LT, LZ, LD, PAL, SAVE and SWITCH.

4.3 Commands

```
CL  CLear          : Unfixes one or more motors or power supplies.
CO  COunt          : Counts for given preset TIme or MoNitor.
DO  DO             : Runs a jobfile without testing the syntax first.
DR  DRive          : Changes a variable and drives spectrometer to
its new position.
FI  FIx            : Fixes a given motor or power supply, FIx without
argument will give a list of fixed motors and
power supplies.
FM  FindMax        : As FindZero but SetZero is not performed, the
spectrometer is only driven to the maximum.
FZ  FindZero       : Scans a simple variable, finds maximum, drives to
maximum and performs a SetZero with the given
value.
LI  LIst           : Listing of variables and parameters.
LE ListEnergies     Energies, k and Q values.
LL ListLimits       Limits and zeros.
LZ ListZero         Limits and zeros.
LM ListMach         Machine parameters.
LS ListSample       Sample parameters.
LT ListTargets      Targets and positions.
LD ListDiaphragms   Diaphragms.
LP ListPower        Power supply values.
LO  LOg            : Controls terminal logging.
OF  OFf            : Turns flipper off.
ON  ON             : Turns flipper on.
OU  OUtput         : Defines output variables.
PA  Pol.An.        : Defines a polarization analysis file (default
file ext'n is .PAL).
PR  PRint          : Prints one ore more variables or parameters.
RU  RUn            : Runs a jobfile.
SC  SCan           : Scans a variable with given or previously
defined increment, number of points and
time interval or monitor count.
SE  SEt            : Sets a parameter value.
SF  ScanFast       : Scans a variable quickly.
SW  SWitch         : Sets some switches.
SZ  SetZero        : Set zero in such a way that value as given
is defined as actual position of variable
(works only for simple variables, i.e.
variables that have a zero).
```

4.3.1 CLEAR

CL(EAR) : The CLEAR command un-fixes a previously fixed motor or power supplies. Issued alone it un-fixes all previously fixed motors and power supplies. CLEAR is a command with type A syntax. In all cases the motors or supplies which have been cleared are listed by THE Program.

```
e.g.   CL A1-A3<CR>
 CL I3,RA,I4<CR>
 CL<CR>
```

4.3.2 COUNT

CO(UNT) : Counts for a given preset TIme or MoNitor.
This is a command of type B syntax. If the command is issued alone, the preset used will be that most recently set. However, the preset may also be specified on the same line as the COUNT command.
  (For use of COnt in a P.A. file, see SCan and PA).

```
e.g.  CO TI=10<CR>(count for 10 seconds)
 CO MN=100<CR>(count for 100 M1 counts)
 CO<CR>
```

4.3.3 DO

DO : Runs a jobfile without testing the syntax.
The jobfile system enables a series of commands to be executed in sequence without the operator being present.
 The DO command is identical to the RUN command except that the 'dry run', i.e. the syntax and limit violation check, is not performed.
Those who like forests prefer the DO command to RUN

```
 e.g.  DO MYJOB<CR>
```

The DO command is also used to change monochromators automatically , respectively to change zeroes and d-spacing after a (manual!) change of the analyzer. For each type of monochromator or analyzer available there is a .JOB file.
After changing the monochromator (analyzer), do not forget to drive the incident (final) wavevector to the required value as this is not done in the .JOB file.
For analysers, do not forget to SEt SA (sense of diffusion on the analyser) to the required value as it may have been changed by the job file in order to set the proper zero of A5.

```
 e.g.  DO PG002M<CR> for graphite 002 monochromator
 DO HEUSLA<CR> for heusler analyzer
```

A list of available analyzers and monochromators can be found in the userguide, or be obtained by typing on any terminal connected to the instrument computer "DIR/PROT .JOB".

4.3.4 DRIVE

DR(IVE) : Changes variables which describe the spectrometer configuration in some way. These variables have always a current position (actual value) and a target value. Under normal circumstances, targets and positions are equal within a small error.

Definition of wavevectors : Ki, Q, and Kf are defined by the current values of the Two-Theta angles , A2, A4, A6 respectively. Therefore, it is possible (after an abort or an explicit motor drive) that the spectrometer is not really at the given position in Q-energy space, but every unperturbed drive of Q-energy will restore the correct position in Q-energy space: that means that all the four variables Qh, Qk, Ql and EN will be driven (explicitly or implicitly) to their target values if (at least) one of them is explicitly driven or scanned.

Motor angles, wavevectors, energies, temperature, power-supply and Helmholtz-field values must all be driven.
DRIVE is a command of type B syntax. The spectrometer is driven to its new position and the appropriate variable is altered in the memory.

A DRIVE command will fail (non destructively) if:
- a motor or power supply is protected or fixed
- a software or hard limit is exceeded; the soft limits may be changed if necessary using the SET command provided the value desired is within the allowed range.
- there is ambiguity among the driven variables.
  e.g. DR KI=2.662,A2=40<CR>
 sets two different targets for A2 and fails.

Examples of valid DRive commands:
```
 DR A1=10,A2=20<CR>
```
move A1 to 10 and A2 to 20 degs

```
 DR EI=14<CR>
```
moves A1 and A2 to give an incident energy of 14 whichever

unit was chosen at start-up.

```
 DR QH=1,0,0,0<CR>
```
moves the spectrometer at fixed KI or KF depending on the
value of FX - so that QH=1,QK=0, QL=0 and EN=0

If one of QH, QK, QL and EN is driven, ALL the others are taken into
consideration.
e.g.   DR EN=5<CR>
uses the value of EN specified and the existing target values
of QH, QK and QL and makes the appropriate
spectrometer movements taking account of the value of FX.
It is thus a good habit to specify all four variables (QH, QK, QL
& EN) each time one or several of them is to be changed.

4.3.5 FIX

FI(X) : Fixes a simple variable
(i.e. a variable that is directly connected with the position of a
spectrometer motor , or the value of a current)
The variable is fixed at its current value so that subsequent attempts
to change the value will fail unless a CLEAR command is issued first.
FIX is a command of type A syntax. The FIX command issued with no
variable name gives a list of motors and supplies which are fixed.

e.g. FI A3<CR>

4.3.6 FindMaximum

  FM : Find Maximum

This is the same as FindZero except that the zero of the
variable is not changed at the end of the scan.

  The syntax is the same as for SCAN.

4.3.7 FindZero

FZ : Find Zero

Scans a simple variable, finds the maximum (or minimum)
intensity within the scanned region, drives to the
maximum and then sets the zero of the scanned variable so

that the zero-corrected current position of the variable
is zero.

More precisely, the command drives to the centre of gravity
of the intensity distribution. The routine for finding the
extremum is not that good and MAD frequently finds
no extremum even when there is obviously one. In that case
the variable is left at the last point of the scan.

Example:

```
  MAD > fz a4 0 da4 0.2 np 7 ti 5
```

The syntax is as for SCAN.

4.3.8 LIST

LI(ST) : LIST gives a listing of all spectrometer variables and
 parameters. There are "subsidiary" commands
 LE, LL, LM, LS, LT and LZ as described below.

LE : List Energies: Ei,ki,Ef,kf,QH,QK,QL,EN,QM,TT,TRT

LL : List Limits. Gives a listing of all motor limits and zeros.
For clarity, only non-zero zero-offsetss are displayed.
The current motor position is also shown.

LM : List Machine. Gives a listing of all machine parameters.

LS : List Sample. Gives a listing of all sample parameters.

LT : Lists Targets. Gives a listing of all target values (i.e.
where the motors ought to be) and actual positions of
the motors. If a motor has a zero-offset, this is also
listed. The positions of disabled motors are indicated
by "-".

LD : List Diaphragms: Gives a listing of all diaphragm
positions.

LZ : Lists Zeros. Equivalent to LL (ListLimits).

Note: The target values usually describe the actual
spectrometer configuration and should be equal
(within a certain tolerance) to the positions.
Clear exceptions are for a power supply which has
been turned disabled, the abort of a DRive via

```
Interrupt and, for instance, the incident wavevector
after a drive of A1 or A2.
```

4.3.9 LOG

It is possible for the user's terminal dialogue with MAD to be logged to disk file. Disk logging goes via the auxilliary process, NSWITCH. This process must therefore be active for logging to be possible. The commands which control disk logging are:

```
LOg start : Starts the logging of the MAD terminal
dialogue to file.
LOg stop  : Stops  the logging of the MAD terminal
dialogue to file.
LOg new   : Closes the current log file (if open)
and opens a new log file.
```

4.3.10 ON/OFF

```
ON and OF(F) : Both flippers may be turned ON or OFF. In all  cases,
the OFF command simply turns off the relevant power supplies. Thus

 OFF F1<CR>
turns off flipper 1

If a flipper is already on, the ON command will have no effect.If it is
off, the ON command will cause the most recent target values to be
achieved.

-For flippers F1 and F2, the OFF command sets the currents in both
the vertical and horizontal-field coils of the flipper to zero.

The ON command yields the following currents:
  F1:vertical-field current = IF1V
     horizontal-field current = KI*IF1H
  F2:vertical-field current = IF2V
     horizontal-field current = KF*IF2H

The quantities IF1V etc can be changed by the SET command when
appropriate values have been determined from calibration scans.
Note that MAD Program automatically divides the horizontal current for
you by the incident or final wavevector respectively.

If the current in one of the supplies connected to a flipper is changed
by an explicit DRIVE command of the power supply, the flipper may have
the logical value OFF even though the currents in its coils are
non-zero.(This is because it no longer behaves as a flipper.)
```

Note that the ON and OFF commands are the only ones which can be used to change F1 and F2. Both ON and OFF are of type A syntax.

4.3.11 OUT

OU(TPUT) :Defines extra variables to be output.
The teletype and disk-file output produced by a SCAN command usually consists of values of variables which are
scanned in addition to values of M1, M2, time and detector counts.
The OUTPUT command may be used to force the output of additional variables. The total number of variables which can be output (including those which are scanned and those which are referred to in a .PAL file but excluding monitor, time and detector counts) is ten (10) . Thus setting a variable to be output means that its value will be printed for every point in every scan until disabled.
Typing OU with NO following variables will stop the output of ALL variables apart from scanned ones.
Type A syntax. A variable that has to be output because it is scanned
        and has also been selected with the OUT command will only be output
        once.

```
e.g.   OU A3,A4<CR>
```

A3 & A4 will be printed in addition to the scan variables.

```
 OU<CR> Stops all extra output
```

4.3.12 PA

PA (Polarization Analysis): This command allows a polarization analysis loop to be carried out for each point in a scan. The commands for the polarization analysis loop are contained in a file whose default extension is .PAL .Thus the command:

```
 PA POLL<CR>
```

causes the commands in file POLL.PAL to be executed for each subsequent scan. If no file name is given after the PA command, MAD Program asks for one.

If several scans are to be run from the console with the same polarization analysis loop the 'PA loop retention' switch should be set to ON (see SWITCHES). In a jobfile every SCAN command should always be preceded by its own PA command.

A .PAL file may contain ONLY the commands SE, CO, DR, ON and OFF i.e. those commands which refer to flippers, Helmholtz coils and counting.

-For example, if POLL.PAL contains:

```
 OFF F1,F2 <CR>
 DR HX=5,0,5 <CR>
 CO MN=200 <CR>
 ON F1 <CR>
 CO MN=20 <CR>
 DR HX=0 10 0 <CR>
 OFF F1 <CR>
 CO MN=500 <CR>
 ON F1 <CR>
 CO MN=50 <CR>
```

four counts will be carried out for each scan point:

```
# cnt F1 F2 HX HY HZ MN
(i) off off 5 0 5 200
(ii) on off 5 0 5 20
(iii) off off 0 10 0 500
(iv) on off 0 10 0 50
```

A preset monitor or time given in a .PAL file overrides that given in a SCAN command for which the .PAL file is executed.
When the command PA is issued, the contents of the relevant .PAL file is listed at the terminal and its syntax is checked.

A .PAL file is cancelled after a scan, except for scans from the terminal if the PA retention switch is set.
Therefore, if scans are performed within a job file, the .PAL file required must be specified for each scan.

When a .PAL file is executed, the position variables used in the file are included in the scan output at the terminal and in the .SCN file if space permits. Preference is given to variables defined in the SCAN command but .PAL file variables take precedence over variables requested by the OUTPUT command (see OUTPUT).

A concatenated version of the .PAL file is written on lines 10 and 11 of the .SCN file. Up to 240 characters can be written in this way (see section VI).

When a .PAL file is used, scan point output to the terminal or the .SCN file are labelled 1.1,1.2,1.3....1.n where n is the number of count instructions in the .PAL file.
A .PAL file may not contain more than 6 COUNT commands.

4.3.13 PRINT

PR(INT) : Prints the current value of one or more variables or parameters. PRINT is a command of type A syntax:

```
e.g.   PR A1,A5<CR>
 PR QH-EN,GM<CR>
```

4.3.14 RUN

RU(N) : Runs a jobfile. All commands which may be issued at the terminal may also be included in a job-file which essentially replaces the user at the terminal.
The commands in the job file are executed by running the job file. Before running the job file a syntax check is done. The file is listed on the terminal and all scans are checked for limit violations. When checking is complete, execution is started even if errors have been reported during the check. To interrupt the sequence type CTRL-C twice (see interruption section II above). If the RUN command is issued alone, MAD Program asks for a job file name. The default file extension for a job file is .JOB. The job-file name may also be given on the same line as the RUN command. Job files can be created as normal OpenVMS files using one edtir (EDT/TPU/NEDIT).
Nesting : Job files may be nested. That is, a job file may contain any number of RUN commands. The nesting depth should not exceed 3 however.
 See also DO.

```
e.g.   RU MYJOB.HET<CR>commands from file MYJOB.HET
   RU MYJOB<CR>commands from file MYJOB.JOB
 RUN<CR>  gives prompt for job file name
JOB-FILE NAME:
```

4.3.15 SCAN

SC(AN) : Scans a variable. All variables which may be driven may also be scanned.

There are three major items to be known about the use of the scan command
1) syntax :
2) data files
3) scan output

1) Syntax :

The SCan command is of type B syntax . The scan-increment, preset monitor (MN) (or time, TI) and the number of scan points (NP) may be specified by a SET command (done before the scan), by default (the most recently used values) or on the same line as the SCAN command. Any number (less than 10) of variables may be scanned in a single command. The value of the scanned variable given in the SCAN command is the CENTRAL point of the scan.
The maximum number of points per scan is 100.
For odd NP this means that the centre is at the middle of the scan; for even NP the centre is the first point after the middle

```
example:  SC A1=0,DA1=1,NP=3  --> A1= -1, 0, +1
SC A1=0,DA1=1,NP=6 --> A1=-3, -2, -1, 0, 1, +2
```

2) data files :

All tas####.dat files are copied to the mainframe computer automatically.

3) Scan output :

The SCAN command has type B syntax. The values of M1, M2, counting time and detector counts are printed on the teletype for each point as are the scanned variables (i.e. the variables given in the SCan command line).
Any additional variables requested (see OUTPUT) are also printed.

When a scan terminates, MAD Program examines the data and tries to find the centre of a peak or dip which may have ocurred in the detector. The method involves moments of the measured count distribution and may not be reliable if the peak/dip is ill-defined or if there is a sloping

background. Specially the width is calculated from the first and second moment and is not necessary identical to the FWHM.
For information on scans involving polarization analysis loops see the PA command.
4) examples :

```
e.g.  SC A2=-40,DA2=0.1,NP=11,TI=10<CR>
```

scans A2, in steps of 0.1 , about A2=-40 degrees for 10 seconds per point.

```
 SC A3=20.2,A4=40.4,DA3=-0.1,DA4=-0.2<CR>
```

gives a theta-two-theta scan.
If NP and TI have not been changed since the example above, there will be 11 points each counted for 10 seconds.

```
 SC QH=1,0,0,0,DQH=0,0,0,0.1,NP=31,MN=100<CR>
```

causes a constant-Q scan, with an energy step of 0.1 (meV or THz) depending on the start-up conditions) to be carried out at Q=(1,0,0). There are 31 points each counted for 100 monitor counts. If the user now types

```
 SC EN=1.1<CR>
```

The constant-Q scan will be repeated, centered at an energy transfer of 1.1 (meV or THz).

As with the DRIVE command, scans in Q-E space are carried out at fixed KI (FX=1) or fixed KF (FX=2). During a scan with Kf fixed (i.e.FX=2) the program will automatically check and adjust A5 and A6; for Ki fixed (FX=1) however, MAD Program will not adjust at check and adjust at every point A1 and A2 because these variables are not likely to move in a Ki-fix scan.

```
 SC EI=14,DEI=0.1,NP=9,TI=1<CR>
```

causes a scan of the incident energy to be performed.Such a scan may be carried out independently of the value of FX.

4.3.16 SET

SE(T) : This command is used to change the values of parameters which do not directly alter the spectrometer configuration (variables which do alter the spectrometer configuration must be changed with the DRIVE command).
The parameters which may be changed using SET are given in section V; in general these are instrument parameterssuch as monochromator and analyzer d-spacings, sample parameters, motor limits and zeroes, and

```
steps for scans

MAD Program echoes the values which it has understood. SET is a
command of type B syntax.

e.g.   SE DM=3.355,DA=3.355<CR>
sets dM and dA to 3.355
```

4.3.17 SF

ScanFast Scans a simple variable quickly. The variable is driven from start to end without stopping and measurements are made on the fly. Only one simple parameter may be scanned and it moves at the speed as set up in the parameters in the motor controller. The parameters are similar to those for SCAN. The TI parameter sets the period between reads of the neutron counter. Reading stops when the motor stops moving. The values of NP and the motor increment are used merely to calculate the start and end points of the scan. At a later date, the syntax may be improved to allow these values to be specified directly. Example:

```
    SF A1=6,DA1=1,NP=13,TI=2   --> A1 = 0 to +12 with
    readings every 2 secs.
```

All of the data is output to a disk file as with the SCAN command. Any additionally requested variables (see OUTPUT) are also output.

4.3.18 SETZERO

```
SZ : (SetZero.) This command sets the zero for a variable such that
its current value is change into a specified value.
Obviously this command works only for variables that have a zero.
e.g.  PR A3
A3  -45.42
 SZ A3= 45
Old values for A5 Lower=-182.11 Upper= 125.00 Zero=  25.00
          Posn= - 45.42 Target= - 45.40
New values for A5 Lower=-162.11 Upper= 145.00 Zero=  45.00
          Posn= - 20.42 Target= - 20.40
```

4.3.19 SWITCHES

```
SW(ITCHES) : This command allows the user to set the switches
described below. In response to the command SW, MAD
generates output of the following form:

1 Powder Mode                        OFF
```

```
2 Polarization mode                OFF
Give Switch Number to change or RETURN to finish >
```

To change a value of one switch, enter the appropriate number (from 1 to 2) and hit <Return>. To make no change, type only <Return>. Please note, that due to a bug in the Macintosh JDK at least two characters have to be entered which can be spaces.

To change the value of switches without being prompted, issue a command of the form:

```
    sw <sn> <val> <sn> <val> ...
```

where <sn> is a switch number in the range 1 to 2 and <val> is its new value. <val> may be either On, Off or Flip.

4.3.20 Examples

Example of phonon scan:

```
 SC QH=2.1 3.2 0 12 DQH=0 0 0 .1 NP=11 MN=1000
```

this means that the scan will be centered at hkl=2.1,3.2,0 and omega=12, with steps of .1 in omega and 11 points with monitor 1000

```
 SC QH=2.1 3.2 0 12 DQH=.02 0 0 0 NP=11 MN=1000
```

scan centered at same position but scanned in the QH-direction with steps of 0.02

N.B.!!!

1. Always define increments for scanned variables (as DQH,DQK,DQL and DEN in example above) unless you know what you are doing (i.e MAD Program stores the old value of the steps, and will use these by default in a new scan, unless you define new steps).

2. The incoming neutron wavevector is defined in MAD Program by A2 and the monochromator d-spacing, under normal circumstances A1 should have the correct (i.e.half the value of A2) position, if not MAD Program will issue a warning message; the same holds for the definition of the final neutron wavevector by A6 and the position of A5.

4.4 Special commands

MAD recognises the following special commands:

set title ... Sets the title string (up to 72 characters) to be written to the data file header.

set user ... Sets the experiment user's name (6 characters).

set local ... Sets the local contact's name (6 characters).

4.5 Standard hints

```
Check of a graphite filter :
Before aligning a PG-filter it is essential to set up the
spectrometer in a configuration where most of the detected neutrons
are 2*ki neutrons. This provides for the best count-rate sensitivity
to filter misalignments. In practice one may proceed as follows:

1/  DR KI=2.662
SE DA=6.71
   DR KF=2.662

This will result in 2*ki neutrons being reflected by PG(002) at the analyser
position, while first-order neutrons are not reflected since PG(001) is extinct.

 2/  DR QH=0.5,0.5,1.5,0

This will result in 2*Ki neutrons being reflected by a strong Bragg reflection
at the sample position. Here it is assumed that the sample is a single crystal
with a strong (113) Bragg peak, and no coherent elastic scattering at
(0.5 0.5 1.5).

One may then proceed with the alignment itself. In general it is
sufficient to verify the orientation of the filter in the horizontal
plane. Once this is done:

   3/  SE DA=3.355
    DR KF=2.662

N.B. If one attempts to align a PG-filter using a beam which contains a
significant proportion of Ki neutrons, experience shows that one finds a
transmission minimum for a filter orientation which is misset by a few degrees
from the nominal orientation (c-axis parallel to neutron beam). This position,
however, corresponds to a transmission minimum for Ki neutrons.
```

4.6 Measurements Modes

l : Two-axis mode : If you want to work in TWO-AXIS mode, just SEt SA to 0 ! This will change the zero of A5 by 90 and any following drive of Ki or Kf will drive the detector to zero and the analyser perpendicular to the beam (just check that there is no absorbing cache [Cd, B4C,...] behind the analyser !). Due to the change of A5 zero the value of A5 will be ZERO (0!) with a analyser orthogonal to the scatterred beam.

l : Constant QM Mode: If you have a powder sample and want to work in -1 at a given QM (modulus of Q that you cannot drive), just SEt the sample lattice parameters (AS, BS, CS) to 2.p and lattice angles (AA, BB, CC) to 90 . Any subsequent drive of QH will drive the machine to the correct QM value. Use the powder switch to inhibit the A3 (q) movement.

```
E.G.    SE AS=6.2832 6.2832 6.2832
SE AA = 90 90 90
SE AX=1 0 0 0 1 0
FI A3
DR QH=.1 0 0 0
PR QM
QM=.1
```

l : Constant DEN Mode : . An other tricky mode of operation is the constant DEN mode, not constant Ki or Kf mode but a mixture with either aconstant DEN mode or (more tricky) a mode which keeps the difference between energy transfer and the final energy constant This gives a varying wavelength scan for scanning through a bragg peak or checking a filter transmission or a (fast) varying energy resolution useful on IN1 to have a good energy resolution at small EN [pfor phonons] and broad energy resolution at higher energy transfer [magnons]).

For example :

```
E.G.   se FX=1
sc QH= 1 0 0  100  DQH=0 0 0 10 DEI=10
```

l : AUto command: If you have strange or obscure warnings or messages on the teletype, try first the AU(to) command. It will reinitialize all motor modules. This may cure the problem.

4.7 Variables

Variables are divided into five groups:

(i) parameters which define some aspect of the instrument configuration but are not directly related to a motor angle or power supply value. These variables are changed by the SET command.

(ii) parameters which relate to the sample.These are also changed by SET.

(iii) limits and zeroes for motors and power supplies, also changed by SET.

(iv) Variables which are explicitly or implicitly related to a motor position or power supply value. These variables are changed by the DRive command.

(v) Increments (steps) for the variables of type (iv); these are changed by SET.

The following list gives the variable identifiers and definitions, where the order is as the variables are stored in the program.

P.A Variables : Variables marked with an asterisk are not recognized unless THE Program is run in polarization analysis mode(see SWitch).

4.7.1 Instrument variables

```
DM  Monochromator d-spacing  [ ].
DA  Analyzer d-spacing  [ ].
SM Scattering sense at Mono  (+ve to the left)
SS Scattering sense at Sample  (+ve to the left)
SA  Scattering sense at Analyzer  (+ve to the left)
ALF1 Horizontal collimation before mono  [minutes FwHm]
ALF2 Horizontal collimation mono to sample [minutes FwHm]
ALF3 Horizontal collimation sample to anal.  [minutes FwHm]
ALF4 Horizontal collimation before detector  [minutes FwHm]
BET1 Vertical collimation before mono    [minutes FwHm]
```

```
BET2 Vertical collimation mono to sample  [minutes FwHm]
BET3 Vertical collimation sample to analyzer [minutes FwHm]
BET4 Vertical collimation before detector  [minutes FwHm]
ETAM Monochromator mosaic  [minutes FwHm]
ETAA Analyzer mosaic  [minutes FwHm]
FX  =1 for constant Ki; =2 for constant Kf
NP  Number of points in a scan
TI  Preset time [seconds] for a COunt or SCan
MN  Preset monitor for a COunt or SCan
TO  Time-out in for WAit command  [minutes]
DTL lower temperature error allowed   [Kelvin]
DTU upper temperature error allowed  [Kelvin]

*IF1V IF1V and IF2V are currents [Amps] in the vertical-field
*IF2V coils for Flipper 1 and Flipper 2.
*IF1H Horizontal-field currents are KI*IF1H for Flipper1 and
*IF2H KF*IF2H for F2.
*HELM  Angle between axis of Helmholtz pair one and KI.

remark:  ALF1 to ETAA are not used by MAD Program but stored for your own
convenience.
Please DO NOT FORGET to update ALF1-ALF4 variable after collimator
change to avoid confusion when you analyse your data after one or
two years!
```

4.7.2 Sample variables

```
AS  -\
BS    +--  Sample unit-cell edges [ ]
CS  -/

AA  -\
BB    +--  Sample unit-cell angles  [degrees]
CC  -/

ETAS Sample mosaic [minutes FwHm]

AX  -\
AY    +--  Components of a recip. lattice vector in scattering plane
AZ  -/       of the sample. A3 is the angle between KI and (AX,AY,AZ).

BX  -\
BY    +--  Components of a second distinct recip. lattice vector in
BZ  -/       the sample's scattering plane.
```

4.7.3 Limits and Zeros

Lower and upper limits and zeros for all variables given in (iv)
below. L, U and Z are appended as a prefix to the variable names to
indicate Lower limit, Upper limit and Zero.
Storage order is the same as for the corresponding variables, i.e. :
LA1, UA1, ZA1, LA2, UA2, ZA2, LA3 ...
(see (iv) below).

4.7.4 Targets and Positions

```
A1 Monochromator angle  (Bragg angle in degrees)
A2  Scattering angle at mono. (twice Bragg angle in degrees)
A3 Sample angle (degs)  (A3=0 when (AX,AY,AZ) is along KI)
A4 Scattering angle at sample  [degrees]
A5 Analyzer angle  (Bragg angle in deg, TOPSI: not used)
A6 Scattering angle at analyzer (twice A5 in deg.,   TOPSI: not used)

SINQ Instruments:
MCV Mono curvature vertical
SRS Sample table second ring
ACH Anal curvature horizontal
MTL Mono   lower translation
MTU Mono   upper translation
STL Sample lower translation
STU Sample upper translation
ATL Anal   lower translation
ATU Anal   upper translation
MGL Mono   lower goniometer (Reserved)
MGU Mono   upper goniometer
SGL Sample lower goniometer
SGU Sample upper goniometer
AGL Anal   lower goniometer (Reserved)
AGU Anal   upper goniometer
MSC Mono   "sample" changer (TASP only)
ASC Anal   "sample" changer (TASP only)
CSC Collimator "sample" changer (TASP only)

D1T D1B D1R D1L Diaphragm 1 (top/bottom/right/left)
D2T D2B D2R D2L Diaphragm 2 (top/bottom/right/left)
D3T D3B D3R D3L Diaphragm 3 (top/bottom/right/left)

ILL Instruments:
CH  Monochromator changer position  [degrees or mm]
```

```
TM (LM) Monochromator translation  [(IN20 : 5mm)]
GM Monochromator goniometer angle  [1 unit = 4 ]
RM Monochromator curvature
GL Sample goniometer angle; lower arc  [1 unit = 4 ]
GU  Sample goniometer angle; upper arc  [1 unit = 4 ]
TA  Analyzer translation  [ ? mm]
GA  Analyzer goniometer angle  [ .4degrees]
RA Analyzer curvature

EI  Incident neutron energy  [THz or meV]
KI  Incident neutron wavevector  [  -1]
EF  Final neutron energy  [THz or meV]
KF  Final neutron wavevector  [  -1]

QH  -\
QK    +--  Components of Q in Reciprocal Lattice Units [R.L.U.]
QL  -/

EN Energy transfer; +ve neutron energy loss  [THz or meV]
QM Length of Q  [  -1]
TT (T) Temperature of sample thermometer  [K]
TRT(RT) Temperature of regulation thermometer  [K]
   (can only be printed out)
*I1   -\
*I2     \
*I3     +--  power supply current values [A]
 .      /
*I11  -/

*HX   -\     Components of Helmholtz fields at sample in Oersteds.
*HY    +--  HX is parallel to Q and HY is perpendicular to Q in
*HZ   -/     the scattering plane.

*F1   -\     Status of flippers one and two; these variables take the
*F2   -/     values ON or OFF.
```

4.7.5 Increments Variables

For all variables A1 through T in the list of type (iv) variables above, the identifier for the step used with a SCan command is obtained by prefixing the variable name with the letter D.
Storage order is DA1, DA2, DA3....etc as for type (iv) variables above.

Chapter 5

Simulation Mode

For testing batch files or in order to check the movement of the instrument it may be helpful to run SICS in simulation mode. You must theb connect to a special simulation SICS server which may have been setup for you. In the simulation server, everything is like in the actual SICS server, except that no hardware is moved, co counts collected and no data file written. There is one speciality, however. The command:

```
sync
```

synchronizes the parameters and limits in the simulation server with those in the instrument server.

Chapter 6

Advanced Topics

6.1 Sample Environment Devices

6.1.1 SICS Concepts for Sample Environment Devices

SICS can support any type of sample environment control device if there is a driver for it. This includes temperature controllers, magnetic field controllers etc. The SICS server is meant to be left running continously. Therefore there exists a facility for dynamically configuring and deconfiguring environment devices into the system. This is done via the **EVFactory** command. It is expected that instrument scientists will provide command procedures or specialised Rünbuffers for configuring environment devices and setting reasonable default parameters.

In the SICS model a sample environment device has in principle two modes of operation. The first is the drive mode. The device is monitored in this mode when a new value for it has been requested. The second mode is the monitor mode. This mode is entered when the device has reached its target value. After that, the device must be continously monitored throughout any measurement. This is done through the environment monitor or **emon**. The emon understands a few commands of its own.

Within SICS all sample environement devices share some common behaviour concerning parameters and abilities. Thus any given environment device accepts all of a set of general commands plus some additional commands special to the device.

In the next section the EVFactory, emon and the general commands understood by any sample environment device will be discussed. This reading is mandatory for understanding SICS environment device handling. Then there will be another section discussing the special devices known to the system.

6.1.2 Sample Environment Error Handling

A sample environment device may fail to stay at its preset value during a measurement. This condition will usually be detected by the emon. The question is how to deal with this problem. The requirements for this kind of error handling are quite different. The SICS model therefore implements several strategies for handling sample environment device failure handling. The strategy to use is selected via a variable which can be set by the user for any sample environment device separately. Additional error handling strategies can be added with a modest amount of programming. The error handling strategies currently implemented are:

Lazy Just print a warning and continue.

Pause Pauses the measurement until the problem has been resolved.

Interrupt Issues a SICS interrupt to the system.

Safe Tries to run the environment device to a value considered safe by the user.

Script Run a user defined script to do any magic things you may want.

6.1.3 General Sample Environment Commands

EVFactory

EVFactory is responsible for configuring and deconfiguring sample environment devices into SICS. The syntax is simple:

EVFactory new name type par par ... Creates a new sample environment device. It will be known to SICS by the name specified as second parameter. The type parameter decides which driver to use for this device. The type will be followed by additional parameters which will be evaluated by the driver requested.

EVFactory del name Deletes the environment device name from the system.

emon

The environment monitor emon takes for the monitoring of an environment device during measurements. It also initiates error handling when appropriate. The emon understands a couple of commands.

emon list This command lists all environment devices currently registered in the system.

emon register name This is a specialist command which registers the environment device name with the environment monitor. Usually this will automatically be taken care of by EVFactory.

emon unregister name This is a specialist command which unregisters the environment device name with the environment monitor. Usually this will automatically be taken care of by EVFactory Following this call the device will no longer be monitored and out of tolerance errors on that device no longer be handled.

General Commands UnderStood by All Sample Environment Devices

Once the evfactory has been run successfully the controller is installed as an object in SICS. It is accessible as an object then under the name specified in the evfactory command. All environemnt object understand the common commands given below. Please note that each command discussed below MUST be prepended with the name of the environment device as configured in EVFactory!

The general commands understood by any environment controller can be subdivided further into parameter commands and real commands. The parameter commands just print the name of the parameter if given without an extra parameter or set if a parameter is specified. For example:

Temperature Tolerance

prints the value of the variable Tolerance for the environment controller Temperature. This is in the same units as the controller operates, i. e. for a temperature controller Kelvin.

Temperature Tolerance 2.0

sets the parameter Tolerance for Temperature to 2.0. Parameters known to ANY envrironment controller are:

Tolerance Is the deviation from the preset value which can be tolerated before an error is issued.

Access Determines who may change parameters for this controller. Possible values are:

- 0 only internal
- 1 only Managers
- 2 Managers and Users.
- 3 Everybody, including Spy.

LowerLimit The lower limit for the controller.

UpperLimit The upper limit for the controller.

ErrHandler. The error handler to use for this controller. Possible values:

- 0 is Lazy.
- 1 for Pause.
- 2 for Interrupt
- 3 for Safe.
- 4 for Script.

For an explanantion of these values see the section about error (cf. Section 6.1.2) handling above.

errorscript The user specified script to execute when the controlled value goes out of tolerance. Will be used whne the ErrHandler 4, script, is used.

Interrupt The interrupt to issue when an error is detected and Interrupt error handling is set. Valid values are:

- 0 for Continue.
- 1 for abort operation.
- 2 for abort scan.
- 3 for abort batch processing.

- 4 halt system.
- 5 exit server.

SafeValue The value to drive the controller to when an error has been detected and Safe error handling is set.

MaxWait Maximal time in minutes to wait in a drive temperature command. If maxwait is set to 0: If the temperature is not reached within tolerance, it waits indefinitely.

Settle Wait time [minutes] after reaching temperature. Indicates how long to wait after reaching temperature. If the temperatures goes again out of tolerance during the settling time, the time outside tolerance is not taken into account.

Additionally the following commands are understood:

send par par ... Sends everything after send directly to the controller and return its response. This is a general purpose command for manipulating controllers and controller parameters directly. The protocoll for these commands is documented in the documentation for each controller. Ordinary users should not tamper with this. This facility is meant for setting up the device with calibration tables etc.

list lists all the parameters for this controller.

no command, only name. When only the name of the device is typed it will return its current value.

name val will drive the device to the new value val. Please note that the same can be achieved by using the drive command. and **log frequency** (both below)

Logging

The values of any sample environement device can be logged. There are three features:

- Logging to a file wih a configurable time intervall between log file entries.
- Sums are kept internally which allow the calculation of the mean value and the standard deviation at all times.
- A circular buffer holding 1000 timestamps plus values is automatically updated.

The last two systems are automatically switched on after the first drive or run command on the environment device completed. This system is run through the following commands.

name log clear Resets all sums for the calculation of the mean value and the standard deviation.

name log getmean Calculates the mean value and the standard deviation for all logged values and prints them.

name log frequency val With a parameter sets, without a parameter requests the logging intervall for the log file and the circular buffer. This parameter specifies the time intervall in seconds between log records. The default is 300 seconds.

name log file filename Starts logging of value data to the file filename. Logging will happen any 5 minutes initially. The logging frequency can be changed with the name log frequency command. Each entry in the file is of the form date time value. The name of the file must be specified relative to the SICS server.

name log flush Unix buffers output heavily. With this command an update of the file can be enforced.

name log status Queries if logging to file is currently happening or not.

name log close Stops logging data to the file.

name log tosicsdata dataname copies the content of the circular buffer to a sicsdata buffer. This is used by graphical clients to display the content of the circular buffer.

name log dump Prints the content of the circular log buffer to screen.

name log dumptofile filename Prints the content of the circular log buffer into the file specified as filename. Note, this file is on the computer where the SICS server resides.

6.1.4 Special Environment Control Devices

This section lists the parameters needed for configuring a special environment device into the system and special parameters and commands only understood by that special device. All of the general commands listed above work as well!

LakeShore Model 340 Temperature Controller

This is *the* temperature controller for cryogenic applications and should replace at least the Oxford & Neocera controllers at SINQ.

The control is handled by a seperate server process TECS (TEmperature Control Server) and is initialized by default on most instruments. If there is already an other device selected, it must be deleted with:

```
EVFactory del temperature
```

and TECS must be reinstalled with:

```
tecs on
```

(This is just an abbreavation for EVFactory new temperature tecs)

More details can be found on the Sample Environment Home Page[1]

ITC-4 and ITC-503 Temperature Controllers

These temperature controller were fairly popular at SINQ. They are manufactured by Oxford Instruments. At the back of this controller is a RS-232 socket which must be connected to a terminal server via a serial cable.

[1]See URL http://sinq.web.psi.ch/sinq/sample.env/tecs.html

ITC-4 Initialisation An ITC-4 can be configured into the system by:

EVFactory new Temp ITC4 computer port channel

This creates an ITC-4 controller object named Temp within the system. The ITC-4 is expected to be connected to the serial port channel of the serial port server porgramm at localhost listening at the specified port. For example:

EVFactory new Temp ITC4 localhost 4000 7

connects Temp to the serial port 7, listening at port 4000.

ITC-4 Additional Parameters The ITC-4 has a few more parameter commands:

timeout Is the timeout for the SerPortServer waiting for responses from the ITC-4. Increase this parameter if error messages contaning ?TMO appear.

sensor Sets the sensor number to be used for reading temperature.

control Sets the control sensor for the ITC-4. This sensor will be used internally for regulating the ITC-4.

divisor The ITC4 does not understand floating point numbers, the ITC-503 does. In order to make ITC4's read and write temperatures correctly floating point values must be multiplied or divided with a magnitude of 10. This parameter determines the appropriate value for the sensor. It is usually 10 for a sensor with one value behind the comma or 100 for a sensor with two values after the comma.

multiplicator The same meaning as the divisor above, but for the control sensor.

Installing an ITC4 step by step

1. Connect the ITC temperature controller to port 7 on the terminal server box. Port 7 is specially configured for dealing with the ideosyncracies of that device. No null modem is needed.
2. Install the ITC4 into SICS with the command:
   evfactory new temperature localhost 4000 7
   You may choose an other name than "temperature", but then it is in general not stored in the data file. Please note, that SICS won't let you use that name if it already exists. For instance if you already had a controller in there. Then the command:
   evfactory del name
   will help.
3. Configure the upper and lowerlimits for your controller appropriatetly.
4. Figure out which sensor you are going to use for reading temperatures. Configure the sensor and the divisor parameter accordingly.
5. Figure out, which sensor will be used for controlling the ITC4. Set the parameters control and multiplicator accordingly. Can be the same as the sensor.

6. Think up an agreeable temperature tolerance for your measurement. This tolerance value will be used 1) to figure out when the ITC4 has reached its target position. 2) when the ITC4 will throw an error if the ITC4 fails to keep within that tolerance. Set the tolerance parameter according to the results of your thinking.

7. Select one of the numerous error handling strategies the control software is able to perform. Configure the device accordingly.

8. Test your setting by trying to read the current temperature.

9. If this goes well try to drive to a temperature not to far from the current one.

ITC-4 Trouble Shooting If the ITC-4 **does not respond at all**, make sure the serial connection to is working. Use standard RS-232 debugging procedures for doing this. The not responding message may also come up as a failure to connect to the ITC-4 during startup.

If error messages containing the string **?TMO** keep appearing up followed by signs that the command has not been understood, then increase the timeout. The standard timeout of 10 microseconds can be to short sometimes.

You keep on reading **wrong values** from the ITC4. Mostly off by a factor 10. Then set the divisor correctly. Or you may need to choose a decent sensor for that readout.

Error messages when **trying to drive the ITC4**. These are usually the result of a badly set multiplicator parameter for the control sensor.

The ITC4 **never stops driving**. There are at least four possible causes for this problem:

1. The multiplicator for the control sensor was wrong and the ITC4 has now a set value which is different from your wishes. You should have got error messages then as you tried to start the ITC4.

2. The software is reading back incorrect temperature values because the sensor and divisor parameters are badly configured. Try to read the temperature and if it does have nothing to do with reality, set the parameters accordingly.

3. The tolerance parameter is configured so low, that the ITC4 never manages to stay in that range. Can also be caused by inappropriate PID parameters in the ITC4.

4. You are reading on one sensor (may be 3) and controlling on another one (may be 2). Then it may happen that the ITC 4 happily thinks that he has reached the temperature because its control sensor shows the value you entered as set value. But read sensor 3 still thinks he is far off. The solution is to drive to a set value which is low enough to make the read sensor think it is within the tolerance. That is the temperature value you wanted after all.

Haake Waterbath Thermostat

This is sort of a bucket full of water equipped with a temperature control system. The RS-232 interface of this device can only be operated at 4800 baud max. This is why it has to be connected to a specially configured port. The driver for this device has been realised in the Tcl extension language of the SICS server. A prerequisite for the usage of this device is that the file hakle.tcl is sourced in the SICS initialisation file and the command inihaakearray has been published. Installing the Haake into SICS requires two steps: first create an array with initialisation parameters, second install the device with evfactory. A command procedure is supplied for the first step. Thus the initialisation sequence becomes:

```
    inihaakearray name-of-array localhost name port channel
evfactory new temperature tcl name-of-array
```

An example for the SANS:

```
    inihaakearray eimer localhost 4000 1
evfactory new temperature tcl eimer
```

Following this, the thermostat can be controlled with the other environment control commands.

The Haake Thermostat understands a single special subcommand: **sensor**. The thermostat may be equipped with an external sensor for controlling and reading. The subcommand sensor allows to switch between the two. The exact syntax is:

```
temperature sensor val
```

val can be either intern or extern.

Bruker Magnet Controller B-EC-1

This is the Controller for the large magnet at SANS. The controller is a box the size of a chest of drawers. This controller can be operated in one out of two modes: in **field** mode the current for the magnet is controlled via an external hall sensor at the magnet. In **current** mode, the output current of the device is controlled. This magnet can be configured into SICS with a command syntax like this:

```
evfactory new name bruker localhost port channel
```

name is a placeholder for the name of the device within SICS. A good suggestion (which will be used throughout the rest of the text) is magnet. bruker is the keyword for selecting the bruker driver. port is the port number at which the serial port server listens. channel is the RS-232 channel to which the controller has been connected. For example (at SANS):

```
evfactory new magnet bruker localhost 4000 9
```

creates a new command magnet for a Bruker magnet Controller connected to serial port 9. In addition to the standard environment controller commands this magnet controller understands the following special commands:

magnet polarity Prints the current polarity setting of the controller. Possible answers are plus, minus and busy. The latter indicates that the controller is in the process of switching polarity after a command had been given to switch it.

magnet polarity val sets a new polarity for the controller. Possible values for val are **minus** or **plus**. The meaning is self explaining.

magnet mode Prints the current control mode of the controller. Possible answers are **field** for control via hall sensor or **current** for current control.

magnet mode val sets a new control mode for the controller. Possible values for val are **field** or **current**. The meaning is explained above.

magnet field reads the magnets hall sensor independent of the control mode.

magnet current reads the magnets output current independent of the control mode.

Warning: There is a gotcha with this. If you type only magnet a value will be returned. The meaning of this value is dependent on the selected control mode. In current mode it is a current, in field mode it is a magnetic field. This is so in order to support SICS control logic. You can read values at all times explicitly using magnet current or magnet field.

The Eurotherm Temperature Controller

At SANS there is a Eurotherm temperature controller for the sample heater. This and probably other Eurotherm controllers can be configured into SICS with the following command. The eurotherm needs to be connected with a nullmodem adapter.

evfactory new name euro computer port channel

name is a placeholder for the name of the device within SICS. A good suggestion is temperature. euro is the keyword for selecting the Eurotherm driver. port is the port number at which the serial port server listens. channel is the RS-232 channel to which the controller has been connected. **WARNING:** The eurotherm needs a RS-232 port with an unusual configuration: 7bits, even parity, 1 stop bit. Currently only the SANS port 13 is configured like this! Thus, an example for SANS and the name temperature looks like:

```
evfactory new temperature euro localhost 4000 13
```

There are two further gotchas with this thing:

- The eurotherm needs to operate in the EI-bisynch protocoll mode. This has to be configured manually. For details see the manual coming with the machine.
- The weird protocoll spoken by the Eurotherm requires very special control characters. Therefore the send functionality usually supported by a SICS environment controller could not be implemented.

The Risoe A1931 Temperature Controller

This is a temperature controller of unknown origin (probably built at Risoe) which is coming with the Risoe instruments. This temperature controller is connected to the computer systems through a GPIB bus and controller. A A1931 temperature controller is configured into SICS through the command:

evfactory new temperature-name a1931 gpib-controller-name gpibaddress

This creates a new command temperature-name. gpib-controller-name is the name of a GPIB controller within SICS. A GPIB controller is configured into SICS with the command MakeGPIB as described in the SICS managers documentation. gpibaddress is the address of the A1931 on the GPIB bus.

A A1931 temperature device understands a couple of additional commands on top of the standard set:

temperature sensor val The A1931 can switch control to various sensors. This command allows to query the control sensor (command without parameter) or set the control sensoe (command with parameter).

temperature file filename The A1931 can be configured through files containing calibration commands. Sich file can be loaded into the A1931 through the file subcommand. The full path of filename must be given.

The PSI-EL755 Magnet Controller

This is magnet controller developed by the electronics group at PSI. It consists of a controller which interfaces to a couple of power supplies. The magnets are then connected to the power supplies. The magnetic field is not controlled directly but just the power output of the power supply. Also the actual output of the power supply is NOT read back but just the set value after ramping. This is a serious limitation because the computer cannot recognize a faulty power supply or magnet. The EL755 is connected to SICS with the command:

evfactory new name el755 localhost port channel index

with port and channel being the usual data items for describing the location of the EL755-controller at the serial port server. index is special and is the number of the power supply to which the magnet is connected. An example:

```
evfactory new maggi el755 localhost 4000 5 3
```

connects to power supply 3 at the EL755-controller connected to lnsa09 at channel 5. The magnet is then available in the system as maggi. No special commands are supported for the EL755.

PSI-DSP Magnet Controller

The PSI-DSP magnet controller has been developed by the PSI electronics group, most notably by Lukas Tanner, for the SLS. However, these controllers are now being used at SINQ as well. This controller has a binary command protocoll and thus the send command does not work for it. In order to handle this protocoll SICS has to bypass the usual SerPortServer mechanism for communicating with serial devices and to connect to the terminal server directly. This also implies one gotcha: **The PSI-DSP works only at specially configured terminal server ports**.The terminal server port to which the PSI-DSP is connected **MUST** be configured to: 115200 baud, 8 data bits, 1 stop bit, odd parity. In general a system manager is required to do this. The PSI-DSP also requires a null-modem connector between the box and the terminal server. Once these hurdles have been mastered, the PSI-DSP can be configured into SICS with the command:

```
evfactory new name psi-dsp terminalservername port
```

with name being the name of the magnet in SICS, terminalservername the name of the terminal server, for example psts224 and port being the address of the binary port on the terminal server. This is usually the serial port number at the terminal server plus 3000. An example:

```
evfactory new maggi psi-dsp psts224 3016
```

configures a magnet named maggi which is connectd to port 16 at the terminal server psts224. maggi can now be read and driven like any other environment device.

Old Dilution Cryostat (Obsolete)

This is a large ancient device for reaching very low temperatures. This cryostat can be configured into SICS with the command:

```
EVFactory new Temp dillu computer port channel table.file
```

Temp is the name of the dilution controller command in SICS, dillu is the keyword which selects the dilution driver, computer, port and channel are the parameters of the Macintosh-PC running the serial port server program. table.file is the fully qualified name of a file containing a translation table for this cryostat. The readout from the dilution controller is a resistance. This table allows to interpolate the temperature from the resistance measurements and back. Example:

```
evfactory new temperature dillu lnsp19.psi.ch 4000 1 dilu.tem
```

installs a new dilution controller into SICS. This controller is connected to port 1 at the Macintos-PC with the newtwork adress lnsp19.psi.ch. On this macintosh-PC runs a serial port server program listening at TCP/IP port 4000. The name of the translation table file is dilu.tem.

The dilution controller has no special commands, but two caveats: As of current (October 1998) setting temperatures does not work due to problems with the electronics. Second the dilution controller MUST be connected to port 1 as only this port supports the 4800 maximum baud rate this device digests.

Old CryoFurnace Controller (Obsolete)

The CryoFurnace at PSI is equipped with a Neocera LTC-11 temperature controller. This controller can control either an heater or an analag output channel. Futhermore a choice of sensors can be selected for controlling the device. The LTC-11 behaves like a normal SICS environment control device plus a few additional commands. An LTC-11 can be configured into SICS with the following command:

```
evfactory new name ltc11 computer port channel
```

name is a placeholder for the name of the device within SICS. A good suggestion is temperature. ltc11 is the keyword for selecting the LTC-11 driver. Computer is the name of the computer running David Maden's SerPortServer program, port is the port number at which the SerPortServer program listens. Channel is the RS-232 channel to which the controller has been connected. For example (at DMC):

```
evfactory new temperature ltc11 localhost 4000 6
```

creates a new command magnet for a LTC-11 temperature Controller connected to serial port 6 at lnsp18.

The additional commands understood by the LTC-11 controller are:

temperature sensor queries the current sensor used for temperature readout.

temperature sensor val selects the sensor val for temperature readout.

temperature controlanalog queries the sensor used for controlling the analog channel.

temperature controlanalog val selects the sensor val for controlling the analog channel.

temperature controlheat queries the sensor used for controlling the heater channel.

temperature controlheat val selects the sensor val for controlling the heater channel.

temperature mode queries if the LTC-11 is in analog or heater control mode.

Further notes: As the CryoFurnace is very slow and the display at the controller becomes unusable when the temperature is read out to often, the LTC-11 driver buffers the last temperature read for 5 seconds. Setting the mode of the LTC-11 is possible by computer, but not yet fully understood and therefore unusable.

6.2 SICS motor handling

In SICS each motor is an object with a name. Motors may take commands which basically come in the form

motorname command ; example: D2HR list.

Most of these commands deal with the plethora of parameters which are associated with each motor. The syntax for manipulating variables is, again, simple.

Motorname parametername

will print the current value of the variable.

Motorname parametername newval

will set the parameter to the new value specified. A list of all parameters and their meanings is given below. The general principle behind this is that the actual (hardware) motor is kept as stupid as possible and all the intracacies of motor control are dealt with in software. Besides the parameter commands any motor understands these basic commands:

- ***Motorname list*** gives a listing of all motor parameters.
- ***Motorname* reset** resets the motor parameters to default values. This is software zero to 0.0 and software limits are reset to hardware limits.
- ***Motorname* position** prints the current position of the motor. All zero point and sign corrections are applied.

- ***Motorname*** **hardposition** prints the current position of the motor. No corrections are applied. Should read the same as the controller box.
- ***Motorname*** **interest** initiates automatic printing of any position change of the motor. This command is mainly interesting for implementors of status display clients.

Please note that the actual driving of the motor is done via the drive command.

6.2.1 The motor parameters

- **HardLowerLim** is the hardware lower limit. This is read from the motor controller and is identical to the limit switch welded to the instrument. Can usually not be changed.
- **HardUpperLim** is the hardware upper limit. This is read from the motor controller and is identical to the limit switch welded to the instrument. Can usually not be changed.
- **SoftLowerLim** is the software lower limit. This can be defined by the user in order to restrict instrument movement in special cases.
- **SoftUpperLim** is the software upper limit. This can be defined by the user in order to restrict instrument movement in special cases.
- **SoftZero** defines a software zero point for the motor. All further movements will be in respect to this zeropoint.
- **Fixed** can be greater then 0 for the motor being fixed and less then or equal to zero for the motor being movable.
- **InterruptMode** defines the interrupt to issue when the motor fails. Some motors are so critical for the operation of the instrument that all operations are to be stopped when there is a problem. Other are less critical. This criticallity is expressed in terms of interrupts, denoted by integers in the range 0 - 4 translating into the interrupts: continue, AbortOperation, AbortScan, AbortBatch and Halt. This parameter can usually only be set by managers.
- **Precision** denotes the precision to expect from the motor in positioning. Can usually only be set by managers.
- **AccessCode** specifies the level of user privilege necessary to operate the motor. Some motors are for adjustment only and can be harmful to move once the adjustment has been done. Others must be moved for the experiment. Values are 0 - 3 for internal, manager, user and spy. This parameter can only be changed by managers.
- **Sign** reverses the operating sense of the motor. For cases where electricians and not physicists have defined the operating sense of the motor. Usually a parameter not to be changed by ordinary users.

- **failafter** This is the number of consecutive failures of positioning operations this motor allows before it thinks that something is really broken and aborts the experiment.
- **maxretry** When a motor finishes driving, SICS checks if the desired position was reached. If the position read back from the motor is not within precision to the desired value, the motor is restarted. This is done at max maxretry times. After maxretry retries, the motor throws an error.
- **ignorefault** If this is bigger then 0, positioning faults from the motor will be ignored.

This list of parameters may be enhanced buy driver specific parameters. motor list will show all parameters.

6.2.2 Motor Error Handling Concepts

As mechanical components motors are prone to errors. SICS knows about two different classes of motor errors:

HWFault This is when there is a problem communicating with the motor, a limit is violated etc. SICS assumes that such errors are so grave that no fix is possible. If such a HWFault is detected a configurable interrupt (see parameter InterruptMode) is set which can be used by upper level code to act upon the problem.

HWPosFault This is a positioning failure, i.e. The motor did not reach the desired position. Such a positioning problem can come from two sources:

- The positioning problem is reported by the motor driver. SICS then assumes that the driver has done something to solve the problem and promotes this problem to a HWFault.
- The motor driver reported no error and SICS figures out by itself, that the desired position has not been reached. SICS thinks that this is the case if the difference between the desired position and the position read from the motor controller is greater then the parameter precision. If SICS detects such a problem it tries to reposition the motor. This is done for the number of times specified through the parameter maxretries. If the position has not been reached after maxretries repositionings, a HWFault is assumed.

In any case lots of warnings and infos are printed.

If SICS tries to drive an axis which is broken hardware damage may occur (and HAS occurred!). Now, SICS has no means to detect if the mispositioning of a motor is due to a concrete block in the path of the instrument or any other reason. What SICS can do though is to count how often a motor mispositions in sequence. This means SICS increments a mispositioning counter if it cannot drive a motor, if the motor is driven succesfully, the mispositioning counter is cleared. If the count of mispositionings becomes higher then the parameter failafter, SICS thinks that there is something really, really wrong and aborts the measurement and prints an error message containing the string: MOTOR ALARM.

There are some common pitfalls with this scheme:

You want upper level code to be signalled when your critical motorfails. Solution: set the parameter interruptmode to something useful and check for the interrupt in upper level code.

SICS falsly reports mispositionings. Solution: increase the precision parameter.

You know that a motor is broken, you cannot fix it, but you want to measure anyway. Solution: increase the precision parameter, if SICS finds the positioning problem, increase maxretries, increase the failafter parameter. In the worst case set the ignorefault parameter to greater 0, this will prevent all motor alarms.

6.3 SICS counter handling

A counter in SICS is a controller which operates single neutron counting tubes and monitors. A counter can operate in one out of two modes: counting until a timer has passed, for example: count for 20 seconds. Counting in this context means that the noutrons coming in during these 20 seconds are summed together. This mode is called timer mode. In the other mode, counting is continued until a specified neutron monitor has reached a certain preset value. This mode is called Monitor mode. The preset values in Monitor mode are usually very large. Therefore the counter has an exponent data variable. Values given as preset are effectively 10 to the power of this exponent. For instance if the preset is 25 and the exponent is 6, then counting will be continued until the monitor has reached 25 million. Note, that this scheme with the exponent is only in operation in Monitor mode. Again, in SICS the counter is an object which understands a set of commands:

- **countername setpreset *val*** sets the counting preset to val.
- **countername getpreset** prints the current preset value.
- **countername preset *val*** With a parameter sets the preset, without inquires the preset value. This is a duplicate of getpreset and setpreset which has been provided for consistency with other commands.
- **countername setexponent *val*** sets the exponent for the counting preset in monitor mode to val.
- **countername getexponent** prints the current exponent used in monitor mode.
- **countername setmode *val*** sets the counting mode to val. Possible values are Timer for timer mode operation and Monitor for waiting for a monitor to reach a certain value.
- **countername getmode** prints the current mode.
- **countername *mode val*** With a parameter sets the mode, without inquires the mode value. This is a duplicate of getmode and setmode which has been provided for consistency with other commands. Possible values for val are either monitor or timer.

- **countername setexponent *val*** sets the exponent for the counting preset in monitor mode to val.
- **countername getcounts** prints the counts gathered in the last run.
- **countername getmonitor *n*** prints the counts gathered in the monitor number n in the last run.
- **countername count *preset*** starts counting in the current mode and the given preset.
- **countername status** prints a message containing the preset and the current monitor or time value. Can be used to monitor the progress of the counting operation.
- **countername gettime** Retrieves the actual time the counter counted for. This excludes time where there was no beam or counting was paused.
- **countername getthreshold *m*** retrieves the value of the threshold set for the monitor number m.
- **countername setthreshold *m val*** sets the threshold for monitor m to val. WARNING: this also makes monitor m the active monitor for evaluating the threshold. Though the EL7373 counterbox does not allow to select the monitor to use as control monitor in monitor mode, it allows to choose the monitor used for pausing the count when the count rate is below the threshold (Who on earth designed this?)
- **countername send *arg1 arg2 arg3 ...*** sends everything behind send to the counter controller and returns the reply of the counter box. The command set to use after send is the command set documented for the counter box elsewhere. Through this feature it is possible to diretclly configure certain variables of the counter controller from within SICS.

6.4 Serial Port Direct Access

At SINQ serial devices are connected to a UNIX/LINUX computer. On this machine runs a serial port server which allows to read and write data through TCP/IP sockets to a serial port connected to the machine. This document describes a simple interface for communicating with such serial devices.

6.4.1 Invocation

The interface to a serial device connected to a UNIX/LINUX computer is initialised with the following command given at the Tcl prompt:
Controller name computer port channel
This command opens a connection to the serial port on the UNIX/LINUX machine and installs a new command in order to interact with it. The parameters:

- **name** is the name of the new command to generate for the connection in Tcl.
- **computer** is the computer name of the UNIX/LINUX machine.

- port: is the TCP/IP port number at which the UNIX/LINUX machine serial port server is is listening. Usually this is 4000.
- channel: is the number of the RS-232 port to connect to.

6.4.2 Usage

Once the connection has been initialised name is available as a new command in Tcl. Let us assume, MC as the name for the purpose of this description. MC then can be used as follows:
MC -tmo value
Configures the timeout for the connection to value. Value is in microseconds.
MC arg1 arg2 ..... argn
Everything after MC is written to the serial port. The reply received from the port is returned.

All these commands can return errors. Mostly these refer to the wrong device being specified on initialisation. The others are network problems.

6.4.3 System Commands

sics_exitus . A single word commands which shuts the server down. Only managers may use this command.

wait *time* waits time seconds before the next command is executed. This does not stop other clients from issuing commands.

resetserver resets the server after an interrupt.

dir a command which lists objects available in the SICS system. Dir without any options prints a list of all objects. The list can be restricted with:

dir var prints all SICS primitive variables

dir mot prints a list of all motors

dir inter driv prints a list of all drivable objects. This is more then motors and includes virtual motors such as environment devices and wavelength as well.

dir inter count Shows everything which can be counted upon.

dir inter env Shows all currently configured environment devices.

dir match wildcard lists all objects which match the wildcard string given in wildcard.

status A single word command which makes SICS print its current status. Possible return values can be: Eager to execute commands, Scanning, Counting, Running, Halted. Note that if a command is executing which takes some time to complete the server will return an ERROR: Busy message when further commands are issued.

status interest initiates automatic printing of any status change in the server. This command is primarily of interest for status display client implementors.

backup [*file*] saves the current values of SICS variables and selected motor and device parameters to the disk file specified as parameter. If no file parameter is given the data is written to the system default status backup file. The format of the file is a list of SICS commands to set all these parameters again. The file is written on the instrument computer relative to the path of the SICS server. This is usually /home/INSTRUMENT/bin.

backup motsave toggles a flag which controls saving of motor positions. If this flag is set, commands for driving motors to the current positions are included in the backup file. This is useful for instruments with slipping motors.

restore [***file***] reads a file produced by the backup command described above and restores SICS to the state it was in when the status was saved with backup. If no file argument is given the system default file gets read.

killfile decrements the data number used for SICS file writing and thus consequently overwrites the last datafile. This is useful when useless data files have been created during tests. As this is critical command in normal user operations, this command requires managers privilege.

sicsidle prints the number of seconds since the last invocation of a counting or driving operation. Used in scripts.

6.4.4 Configuration Commands

SICS has a command for changing the user rights of the current client server connection, control the amount of output a client receives and to specify additional logfiles where output will be placed. All this is accessed through the following commands:

The SICS server logs all its activities to a logfile, regardless of what the user requested. This logfile is mainly intended to help in server debugging. However, clients may register an interest in certain server events and can have them displayed. This facility is accessed via the **GetLog** command. It needs to be stressed that this log receives messages from **all** active clients. GetLog understands the following messages:

- **GetLog All** achieves that all output to the server logfile is also written to the client which issued this command.
- **GetLog Kill** stops all logging output to the client.
- **GetLog OutCode** request that only certain events will be logged to the client issuing this command. Enables only the level specified. Multiple calls are possible.

Possible values for OutCode in the last option are:

- **Internal** internal errors such as memory errors etc.
- **Command** all commands issued from any client to the server.
- **HWError** all errors generated by instrument hardware. The SICS server tries hard to fix HW errors in order to achieve stable operations and may not generate an error message if it was able to fix the problem. This option may be very helpful when tracking dodgy devices.
- **InError** All input errors found on any clients input.
- **Error** All error messages generated by all clients.
- **Status** some commands send status messages to the client invoking the command in order to monitor the state of a scan.

- **Value** Some commands return requested values to a user. These messages have an output code of Value.

The **config** command configures various aspects of the current client server connection. Basically three things can be manipulated: The connections output class, the user rights associated with it, and output files.

- The command **config OutCode val** sets the output code for the connection. By default all output is sent to the client. But a graphical user interface client might want to restrict message to only those delivering requested values and error messages and suppressing anything else. In order to achieve this, this command is provided. Possible values Values for val are Internal,Command, HWError,InError,Status, Error, Value. This list is hierarchical. For example specifying InError for val lets the client receive all messages tagged InError, Status, Error and Value, but not HWError, Command and Internal messages.
- Each connection between a client and the SICS server has user rights assocociated with it. These user rights can be configured at runtime with the command **config Rights Username Password** . If a matching entry can be found in the servers password database new rights will be set.
- Scientists are not content with having output on the screen. In order to check results a log of all output may be required. The command **config File name** makes all output to the client to be written to the file specified by name as well. The file must be a file accessible to the server, i.e. reside on the same machine as the server. Up to 10 logfiles can be specified. Note, that a directly connected line printer is only a special filename in unix.
- **config close num** closes the log file denoted by num again.
- **config list** lists the currently active values for outcode and user rights.
- **config myname** retruns the name of the connection.
- **config myrights** prints the rights associated with your connection.
- **config listen 0 or 1**switches listening to the commandlog on or off for this conenction. If this on, all output to the commandlog, i.e. all interesting things happening in SICS, is printed to your connection as well.

6.5 SICS Trouble Shooting

There is no such thing as bug free software. There are always bugs, nasty behaviour etc. This document shall help to solve these problems. The usual symptom will be that a client cannot connect to the server or the server is not responding. Or error messages show up. This section helps to solve such problems.

6.5.1 Looking at Log Files

The first thing to do, especially when confronted with confusing statements from either users or instrument scientists, is to look at the SICS servers log files. The last 1000 lines of the instrument log are accessible from any SICS client or through the WWW interface. The SICS commands:

commandlog tail shows the last 20 lines of the log.

commandlog tail n shows the last n lines of the log.

will show you the information available. In order to see more, log in to the instrument account. There the following unix commands might help:

- **sicstail** shows the last 20 lines of the current log file and its name
- **sicstail n** shows the last n lines of the current log file.

In order to see some more, cd into the log directory of the instrument account. In there are files with names like:

```
auto2001-08-08@00-01-01.log
```

This means the log file has been started at August, 8, 2001 at 00:01:01. There is a new log file daily. Load appropriate files into the editor and look what really happened.

Another good ideas is to use the unix command grep on assorted log files. A grep for the strings ERROR or WARNING will more ofteh then not give an indication for the nature of the problem.

The log files show you all commands given and all the responses of the system. Additionally there are hourly time stamps in the file which allow to narrow in when the problem started. Things to watch out for are:

MOTOR ALARM This message means that the motor failed to reach his position for a couple of times. This is caused by either a concrete shielding element blocking the movement of the instrument, badly adjusted motor parameters, mechanical failures or the air cushions not operating properly.

EL734__BAD_EMERG_STOP Somebody has pushed the emergency stop button. This must be released before the instrument can move again. Moreover the motor controller will not respond to further commands in this mode. Thus restarting SICS on this error message will make SICS fail to initialize the motors affected!

EL*__BAD_PIPE, BAD_RECV, BAD_ILLG, BAD_TMO, BAD_SEND** Network communication problems. Can generaly be solved by restarting SICS.

EL737__BAD_BSY A counting operation was aborted while the beam was off. Unfortunately, the counter box does not respond to commands in this state and ignores the stop command sent to it during the abort operation. This can be safely ignored, SICS fixes this condition.

6.5.2 Restarting SICS

All of SICS can be restarted through the command:

```
monit restart all
```

6.5.3 Starting SICS

An essential prerequisite of SICS is that the server is up and running. The system is configured to restart the SICServer whenever it fails. Only after a reboot or when the keepalive processes were killed (see below) the SICServer must be restarted. This is done for all instruments by typing:

```
monit
```

at the command prompt. startsics actually starts two programs: one is the replicator application which is responsible for the automatic copying of data files to the laboratory server. The other is the SICS server. Both programs are started by means of a shell script called **keepalive**. keepalive is basically an endless loop which calls the program again and again and thus ensures that the program will never stop running.

When the SICS server hangs, or you want to enforce an reinitialization of everything the server process must be killed. This can be accomplished either manually or through a shell script.

6.5.4 Stopping SICS

All SICS processes can be stopped through the commands:

```
monit stop all
monit quit
```

given at the unix command line. You must be the instrument user (for example DMC) on the instrument computer for this to work properly.

6.5.5 Restart Everything

If nothing seems to work any more, no connections can be obtained etc, then the next guess is to restart everything. This is especially necessary if mechanics or electronics people were closer to the instrument then 400 meters.

1. Reboot the histogram memory. It has a tiny button labelled RST. That' s the one. Can be operated with a hairpin, a ball point pen or the like.

2. Wait 5 minutes.

3. Restart the SICServer. Watch for any messages about things not being connected or configured.

4. Restart and reconnect the client programs.

If this fails (even after a second) time there may be a network problem which can not be resolved by simple means.

6.5.6 Checking SICS Startup

Sometimes it happens that the SICServer hangs while starting up or hardware components are not properly initialized. In such cases it is useful to look at the SICS servers startup messages. On the instrument account issue the commands:

```
monit stop sicsserver
cd inst_sics
./SICServer inst.tcl | more
```

Replace inst with the name of the appropriate instrument in lower case. For example, from the home directory of the hrpt account on the computer hrpt:

```
cd
monit stop sicsserver
cd hrpt_sics
./SICServer hrpt.tcl | more
```

This allows to page through SICS startup messages and will help to identify the troublesome component. The proceed to check the component and the connections to it.

6.5.7 HELP debugging!!!!

The SICS server hanging or crashing should not happen. In order to sort such problems out it is very helpful if any available debugging information is saved and presented to the programmers. Information available are the log files as written continously by the SICS server and posssible core files lying around. They have just this name: core.pid, where pid is the process identification number. In order to save them create a new directory (for example dump2077) and copy the stuff in there. This looks like:

```
/home/DMC> mkdir dump2077
/home/DMC> cp log/*.log dump2077
/home/DMC> cp core.2077 dump2077
```

The `/home/DMC>` is just the command prompt. Please note, that core files are only available after crashes of the server. These few commands will help to analyse the cause of the problem and to eventually resolve it.