# HAL MSIU Software User Manual

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## TITLE

HAL MSIU Software User Manual

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## DATE

27 June, 2003

## SUMMARY

This document describes the remote mass spec. controller commands. NOTE: this document is intended for INTERNAL USE.

## NOTE

This document is intended for internal use, if distributed to customers this document is provided "as is"; the information herein is not guaranteed accurate or complete and is subject to change by Hiden without notice.

## SOFTWARE REVISION

This document is applicable to release 3.2 of the firmware ( HA-061-702m ).

## DOCUMENT REVISION HISTORY

Revision 0 : Preliminary draft . 30 Mar 1993

Revision 1 : Current state of interface on 18 June 1993. Unimplemented command shown with grey background.

Revision 2 : More info on returned value formats and errors added. Scan **results** parameter documented. 22 July 1993.

Revision 3 : 8th Sept 1993 : SJOB STAT SVAL SOUT SERR RBUF & RERR commands implemented. **terminator** parameter implemented.

Error summary updated.

Revision 4 : 25 Oct 1993 : DATA command implemented. report field implemented. **cycles** and **points** parameters implemented.

Revision 5 : 2 Nov 1993 : Section 1 culled from specification document & re-written. current and mode fields documented. *SDEL all* command documented.

Revision 6: 19 Aug 1994: Scan option & return fields documented. Mass alignment procedure added. Trip priority field documented. Standby mode renamed Shutdown. *DATA on* and *DATA off* documented.

Revision 7: 28 March 1996: QUIT TEST & HELP commands documented. Scan cycles, interval & state fields documented. Group documentation updated. Logical device descriptions updated. Error summary updated. Operation sequence added

Revision 8: 23rd May 1996: Added documentation for test EPROM devices.

Revision 9: 8th July 1996: Added documentation of ESP EPROM devices. Documented range device operation. Data Event enhancements ( SM51 ) documented. Documented BOOT command.

Revision 10: 3rd January 1997: Changed name from HAL 68K Software User Manual to HAL MSIU Software User Manual. Issued as HA-085-006 Revision a.

Revision 11: 18th March 1997: HA-085-006 Revision b. Documented device state hierarchy.

# 1. System Description

## 1.1. Key Concepts

This software is built on two key concepts, the logical device and the scan. These two are inter-related in that a table of scans is represented by a scan logical device.....

### 1.1.1. The Logical Device

A logical device is a way of associating a name with a hardware or software function. By asking the controller what logical devices are available a remote computer may find out the capabilities of the system. Once the names of the available logical devices are known the remote computer may enquire the capabilities of each device by use of the commands LMIN, LMAX, LRES, LUNT, LUSE, LTYP and LVAL. These commands return values that have been configured into the logical device table in the EEPROMs. Their use is documented in section 2.

Each logical device has a corresponding logical device number . The command LID# may be used to obtain this, given the devices name. Logical device numbers may vary from system to system so should always be obtained by use of the LID# command. Once known their use is quicker than using the logical device name, but logical device names and numbers may be used interchangeably in most commands ( For future reference : this also applies to Parameter names and numbers and Field names and numbers ).

The command LSET may be used to set a logical device to a value and LGET to read a value. Thus LSET mass 28 sets the mass DAC to 28 and LGET SEM will read the SEM and display the result.

The command LINI is used to initialise a device.

Logical devices may be grouped together in a group logical device. Thus all devices that need initialising are in the "all" group. The names of these devices may be obtained by the command *LID$ all* which will display their names as a comma separated string. . To initialise all devices use *LINI all*. The LINI command is executed on each device in the all group in turn.

All the group logical devices are themselves in the "groups" group. This device should always be present in the configuration. By using *LID$ groups* the remote computer may enquire what groups the system supports. By then doing LID$, using each of the group names returned , the devices in each group may be obtained.

Groups may be used to suggest to the remote computer which devices to use for a particular purpose, e.g. devices in the "source" group for source tuning. For these groups using the LSET command will generate an error, though LINI source might be useful to reset the source DACs to their default values.

Groups may also be used to change the value of a number of DACs simultaneously. An example of this is the "mode" group. SIMS systems may operate in 3 modes :- RGA, SIMS +ve ion and SIMS -ve ion. Initial values for each mode are configured into the logical device table entry of every device in the mode group. Each mode represents a "state" of the logical devices comprising the group. The logical device table has room for 7 states for each device.

The state of a group may be changed using the LSET command. *LSET mode 2* will change all devices in the mode group to the value appropriate for SIMS +ve ion operation. Once a state has been selected you may use LSET to tune an individual device in the group. The value set will be stored in the state of the device according to the mode.

*LGET mode* will return the last value of mode set.

When a remote computer initially interrogates the controller it will need to know the settings of all states of a device. The command LVAL returns the device state followed by 7 values, one for each state. and by the calibration intercept and slope.

The reverse of this command is LPUT, which allows the 7 values corresponding to each state to be downloaded. LPUT does not change the state, but does set the device to the new value for its current state.

Devices may be calibrated using the LINT & LSLO commands to set the intercept and slope. The intercept is expressed in the units of the device to 6 decimal places using the default slope. Rounding errors may occur in its calculation so take care if you are reading it and setting it back again that the value does not creep up or down. The slope is expressed as a ratio to the default.

### 1.1.2. The Scan

As noted above the command LSET may be used to set a logical device to a value and LGET to read a value. Thus LSET mass 28 sets the mass DAC to 28 and LGET SEM will read the SEM and display the result. A scan can be programmed to do this automatically:

```
SSET scan Ascans
SSET row 1
SSET input mass
SSET start 28
SINI step
SSET input SEM
```

These commands set up a scan table for the scan logical device Ascans.:

| SCAN | ROW | START | STOP | STEP | INPUT | OUTPUT |
|---|---|---|---|---|---|---|
| Ascans | 1 | 28 | 28 | 0.02 | SEM | mass |

The above example just measures mass 28, to scan over a range of masses use:

*SSET start 28*
*SSET stop 40*
*SSET step 1*

Which sets up the table:

| SCAN | ROW | START | STOP | STEP | INPUT | OUTPUT |
|---|---|---|---|---|---|---|
| Ascans | 1 | 28 | 40 | 1 | SEM | mass |

scan, row, start, stop, step, input, output, are field names. Fields correspond to the columns in the scan logical device's table. The syntax of the commands the operate on fields is similar to those that operate on logical devices. Many logical device commands have their equivalent field command, but beginning with S instead of L: SGET SSET SMIN SMAX SID$ SID# and SINI. Like logical devices fields may be referred to by their name or field number, as returned by SID#. See section 2 for details of field commands and field names.

A sequence of scan steps may be set up by entering values for other rows:

| SCAN | ROW | START | STOP | STEP | INPUT | OUTPUT |
|---|---|---|---|---|---|---|
| Ascans | 1 | 18 | 18 | 1 | SEM | mass |
| Ascans | 2 | 28 | 28 | 1 | SEM | mass |
| Ascans | 3 | 32 | 32 | 1 | SEM | mass |
| Ascans | 4 | 40 | 40 | 1 | SEM | mass |

Ascans may be acquired by the following command sequence:

*LINI Ascans*
*LGET Ascans*

Note that you initialise and get the logical device. *LGET Ascans*

scans each row of Ascans for all indices from its start value to its stop value. LSET may be used to execute a scan logical device 1 step at a time, the value set specifying the index of the step. Thus with START 10 , STOP 20 and STEP 1 *LSET Ascans 1* would measures at mass 10, *LSET Ascans 2* would measure at mass 11 and so on. Where START = STOP the index value does not matter.

Thus scan may be envisaged as having 1 input device and 1 output device, in addition it has an index input and a data output to Report. The scan has 2 main parameters, the start value and the stop value:

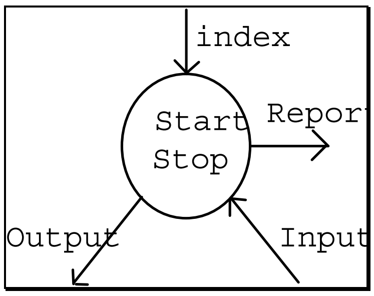


**Figure 1**

The output device will normally be the mass DAC and the input device the main input ( e.g. the SEM ADC or pulse counter ). The values between Start and Stop are output to the Output device and each time the input device is called to return a value.

The input and output devices may be any logical device ( though using some make more sense than others ) including a scan logical device.

Now let us replace the SEM input with a scan logical device, Bscans. Bscans outputs to the energy DAC:

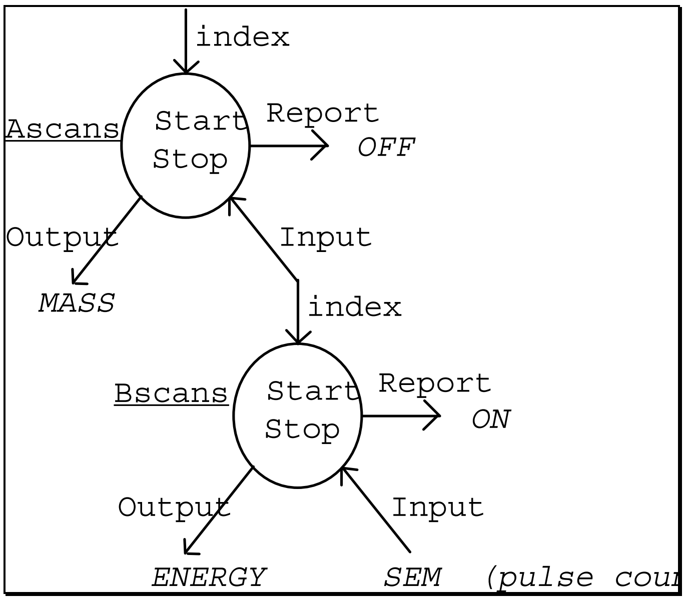


**Figure 2**

In this case Ascans will scan *mass* between Start and Stop, at each step it will output the mass then call Bscans to input a value; Bscans will then scan the *energy* between its start and stop, inputting readings from *SEM*.

The structure in figure 2 represents a 2 dimensional scan. By chaining scans to the input as many dimensions as desired may be built up.

Now let us place Bscans as an output to Ascans:

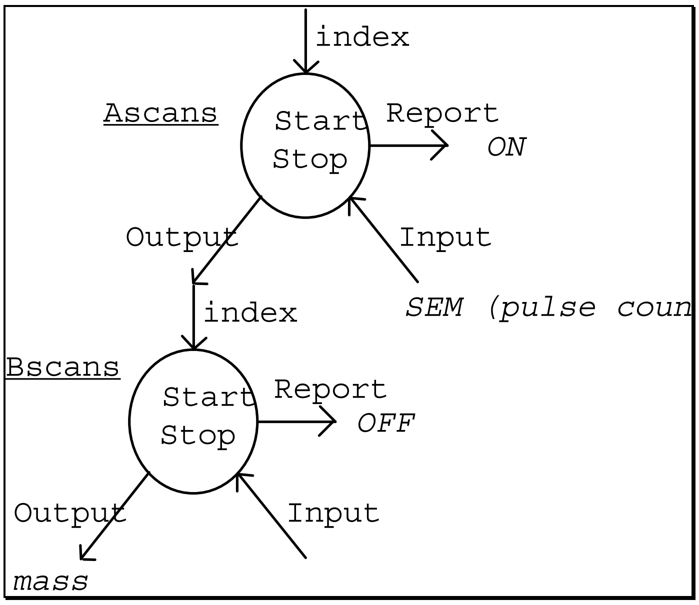


**Figure 3**

In figure 3 Ascans calls Bscans for each step between its Start and Stop. Each time Bscans is called it is clocked once and advances 1 step between its Start and Stop, outputting to *mass* each time it does so. There is no input to Bscans. Having called

Bscans to set the *mass* Ascans reads *SEM.*

This is functionally equivalent to figure 1. This structure only becomes useful if you have lists of scans:

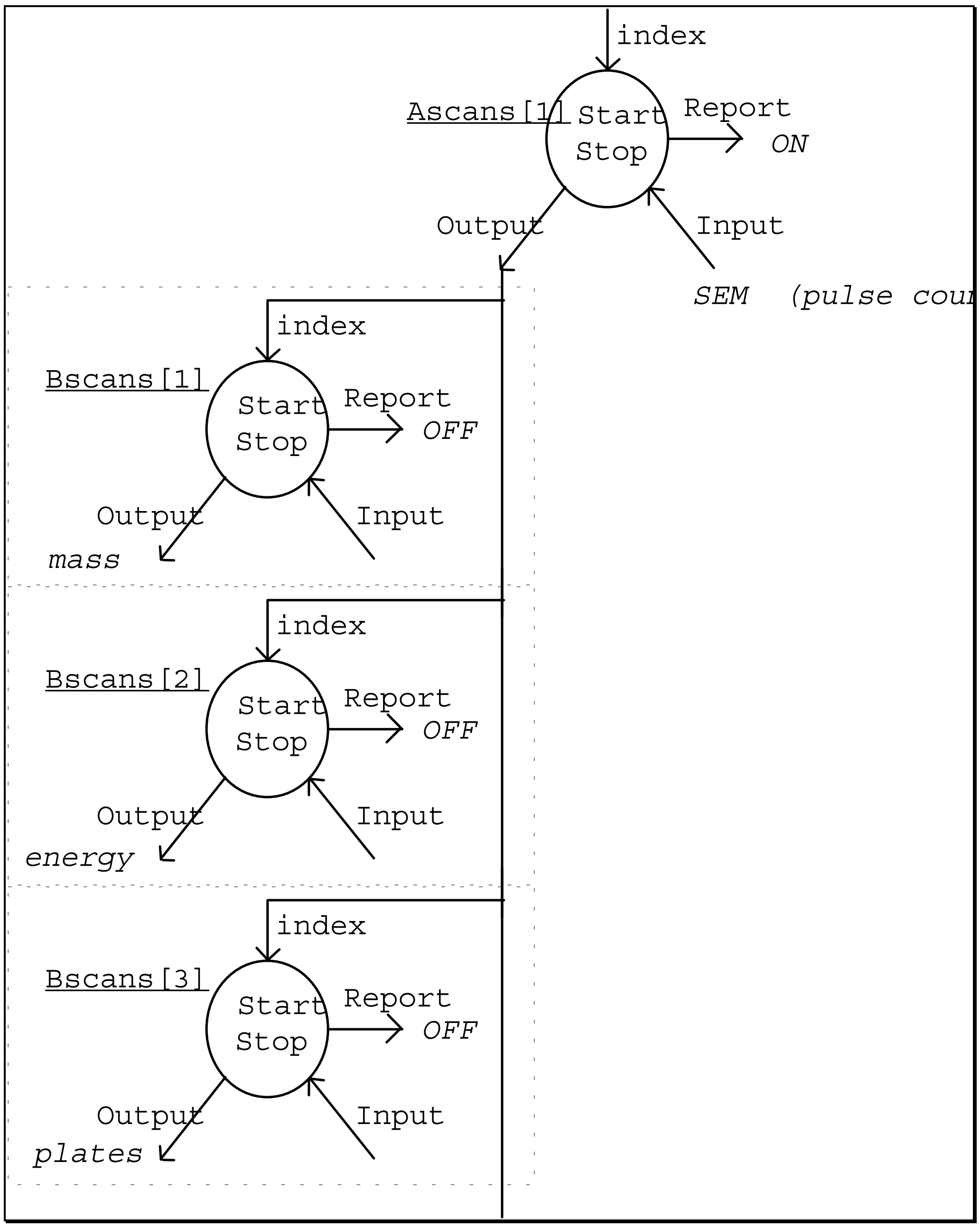


**Figure 4**

Now each time Ascans clocks Bscans the *mass* , *energy* and *plates* all increment by 1 step, then Ascans reads *SEM.* When Bscans is used as an output to Ascans the behaviour of Bscans does depend on Ascans's Stop and Start. Ascans' Stop and Start may be regarded as indices to Bscans' Stop and Start. Thus if Ascans scans from w to x and Bscans from y to z then when Ascans clocks Bscans it can scan from y+w-1 to min(y+x-1,z) - assuming unit step sizes. To ensure that all Bscans steps can be run a stop value of ∞ must be provided in Ascans' stop.

In figure 4 none of Bscans' scans have inputs. Although I see no reason to prohibit output scans having inputs, great care would have to be taken in their use because Bscans[1]'s input would be read before Bscans[2]'s output had been set. If two inputs are required Bscans[3]'s input and Ascans' input may be used, if more inputs are required then dummy output devices are needed at the end of the Bscans list.

If a list of scans, Bscans[1] to [3] as above, was used as an input device then Bscans[1] would scan from its Start to Stop then Bscans[2] would scan from its Start to Stop and finally Bscans[3] would scan from its Start to Stop. The value returned would be the value returned by Bscans[3].

Putting Xscans into a logical device in a scan will call that scan as a logical device; however calling it from within a scan will is exactly the same as the commands LGET Xscans or LSET Xscans because the commands must perform initialisation which it is undesirable to repeat from within a scan.

To prevent circular definitions the scans are hierarchical, only being able to call a lower level scan : so Ascans may call Bscans to Zscans, but Bscans may not call Ascans.

In tabular form the scans may be represented as follows:

An ordinary MID type table:

| SCAN | ROW | START | STOP | STEP | INPUT | OUTPUT |
|---|---|---|---|---|---|---|
| Ascans | 1 | 18 | 18 | 1 | SEM | mass |
| Ascans | 2 | 28 | 28 | 1 | SEM | mass |
| Ascans | 3 | 32 | 32 | 1 | SEM | mass |
| Ascans | 4 | 40 | 40 | 1 | SEM | mass |

A 2 dimensional scan, scanning Energy from -5 to 10 and mass from 1 to 55 avoiding mass 28.

| SCAN | START | STOP | STEP | INPUT | REPORT | OUTPUT | REPORT |
|---|---|---|---|---|---|---|---|
| Ascans | -5 | 10 | 1 | Bscans | no | energy | no |
| Bscans | 1 | 27 | 1 | SEM | yes | mass | no |
| Bscans | 29 | 55 | 1 | SEM | yes | mass | no |

To scan the plate voltage with the mass the following may be used:

| SCAN | START | STOP | STEP | INPUT | REPORT | OUTPUT | REPORT |
|---|---|---|---|---|---|---|---|
| Ascans | 1 | 150 | 1 | SEM | yes | Bscans | no |
| Bscans | 1 | 150 | 1 | NONE | no | mass | no |
| Bscans | 7.2 | 7.6 | 0.00268 | NONE | no | plate | no |

To use the above format easily will require the implementation of the STEP field in the form where the step value indicates the total number of steps, not the increment as 0.00268 is less than the resolution of the plate DAC.

All three of the above may be combined: A 2 dimensional scan of energy and mass of selected masses, with the plate voltage tracking the mass:

| SCAN | START | STOP | STEP | INPUT | REPORT | OUTPUT | REPORT |
|---|---|---|---|---|---|---|---|
| Ascans | -5 | 10 | 1 | Bscans | no | energy | no |
| Bscans | 18 | 18 | 1 | SEM | yes | Cscans | no |
| Bscans | 28 | 28 | 1 | SEM | yes | Cscans | no |
| Bscans | 32 | 32 | 1 | SEM | yes | Cscans | no |
| Bscans | 40 | 40 | 1 | SEM | yes | Cscans | no |
| Cscans | 1 | 300 | 1 | NONE | no | mass | no |
| Cscans | 7.2 | 8.0 | 0.00268 | NONE | no | plate | no |

## 1.2. Glossary

| | |
|---|---|
| Apex scan | The scan logical device at the top of the scan tree. When Ascans calls Bscans as an input or output device and Ascans is the scan acquired by the LGET command then Ascans is the apex scan. |
| Command | The first 4 non-space characters on each input line are interpreted as a command. Commands are available to manipulate logical devices, parameters and the scan tables associated with scan logical devices. |
| Environment | There are two environments. The system environment is the state of all logical devices. Each scan may have a local environment, a list of logical devices and values that apply only during that scan. |

| | |
|---|---|
| Event | A component of an event sequence. ( Formerly called a trip. The term trip is now reserved for intensity trips and X axis set points.) Events may be strung together to form "Event Sequences" that can execute commands, print messages or values and perform simple calculations. These Event Sequences may be used as the actions of normal trips or may be run independantly by means of the TRUN command.<br><br>See Trip, below. |
| Field | An entry in a row of a scan logical device table, e.g. start, stop or step.. It may be regarded as the name of a column in the table. In this manual field names are underlined. |
| Group | Groups are logical devices that operate more than 1 logical device. Sometimes a group is used merely to identify related devices, e.g. source identifies those DACs that control the source. |
| HAL IV | |
| HAL 4 | Working title for the HAL RC 2 and HAL RC 6 project during development. |
| Logical Device | At its simplest a logical device represents a hardware device. By means of the Logical Device Table the software "knows" about the capability of a device and how to operate it. By reference to this table a device may be set to a given value or the value read from the device. This idea is extended to "devices" that only exist as software, not as hardware, e.g. the elapsed time clock. This is taken still further in that a list of scans is a scan logical device and may be set or read.<br><br>The logical devices available depend on the hardware that the EEPROMs have been configured for. |
| Mode | SIMS systems may operate in 3 modes :- RGA, SIMS +ve ion and SIMS -ve ion. In addition a Shutdown mode ( always mode 0 ) is provided; this is used to put the system into a safe state. The mode of the system is implemented as a group logical device. This enables the settings for a number of logical devices to be changed simultaneously to the value appropriate for that mode. Because the mode interacts with the local scan environment a scan field, mode, is assigned for the mode of the scan. |
| MSIU | Mass Spectrometer Interface Unit. The 2U, 6U or 7U unit containing the electrode power supplies and microprocessor. |
| Parameter | Parameters represent values used by the software. Unlike logical devices the parameters available depend only on the release of the software - they are not configured to match |

| | |
|---|---|
| | the hardware. Like logical devices their values may be read, and most may be set. A few are read-only for information only. |
| Scan | A scan is 1 row of a scan logical device table. It controls the scanning of an input device from a start value to a stop value. At each step an input is read. |
| Scan Logical Device | An abstract logical device representing a table of scans. 26 scan logical devices are available named Ascans to Zscans. Complex nested scan structures may be built by allowing a scan to call a scan logical device as an input or output device. |
| Standby | |
| aka | |
| Shutdown | Mode 0. Used to put the system into a safe state, ie SEM and first dynode voltages removed and the beam parked. The protection trips set the system to Shutdown when a trip occurs. Mode 0 will be present on all instruments and may be assumed, it is not enumerated by the LUNT *mode* command. |
| Stream | A channel of communications e.g. COM1: ( the RS422 port ), COM2: ( the RS232 port ) DLC1:, DLC2:, DLC3: ( the network ). These streams may receive commands and can return results, data, errors or the output from event sequence messages. A stream may also be purely internal, e.g. NUL:, BUFFER: and ERROR:. These streams can not receive commands. The names of all streams may be obtained by using the command PGET stream. |
| Task | To enable more than 1 command to execute at once 6 background tasks are available. These may be started explicitly by use of the SJOB command or automatically, e.g. the DATA command. Thus, by use of the SJOB command, while a scan logical device is scanning tuning commands may also be sent. Use of SJOB allows a command to be STOPed before it completes. Two tasks are started automatically at power-up, one is the TRIP task and the other runs an event sequence that monitors the inhibit input. |
| Trip | Trips are structures that may be set to check the data as it is acquired and perform actions should limits be exceeded. This function is performed by the TRIP command. In addition trips may be strung together to form trip "programmes". In this context trips are now termed events and comprise part of event sequences.<br><br>See Event, above. |

# 2. Main Software Functions

The general intention of the command interface is to have a small set of commands acting on a large number of logical devices. Fast response to commands is aided by having a fixed 4 character command format. The first 4 non-space characters of the command line are interpreted as a command.

Commands may be divided into 4 groups:

1 Commands associated with the command interface itself.

2 Logical device commands - commands beginning in L.

3 Parameter commands - commands beginning in P.

4 Scan table commands. - commands beginning in S.

5 Trip & Event commands - commands beginning in T

The commands for type 2, 3 4 & 5 commands are, as far as possible isomorphic. Thus there are L, P S & T versions of the GET, SET, ID#, ID$, MIN & MAX commands.

*NOTE: Commands are not case dependant but logical device names are.*

All commands return a Carriage Return on completion. Errors are returned via the STDERR device. By default this is the same as STDOUT so errors will be returned prior to any returned value and the terminal CR. With the **terse** parameter set to 0 errors return a verbose error string e.g.:

```
lset mass 500 *Command error   9  Logical device value out of range*
```

The error message consists of 3 parts, the error type, the error number and the error ID$.

With terse set to 1 this error gives:

```
lset mass 500 *C09*
```

Here C indicates a command error and 09 the error number. The * * helps separate the error from any following result. The EID$ command may be used to get a verbose version of an error from its error number.

The errors associated with the commands in the following sections are not exhaustive, they are those produced by the standard & default device drivers; other logical devices may produce device-specific errors.

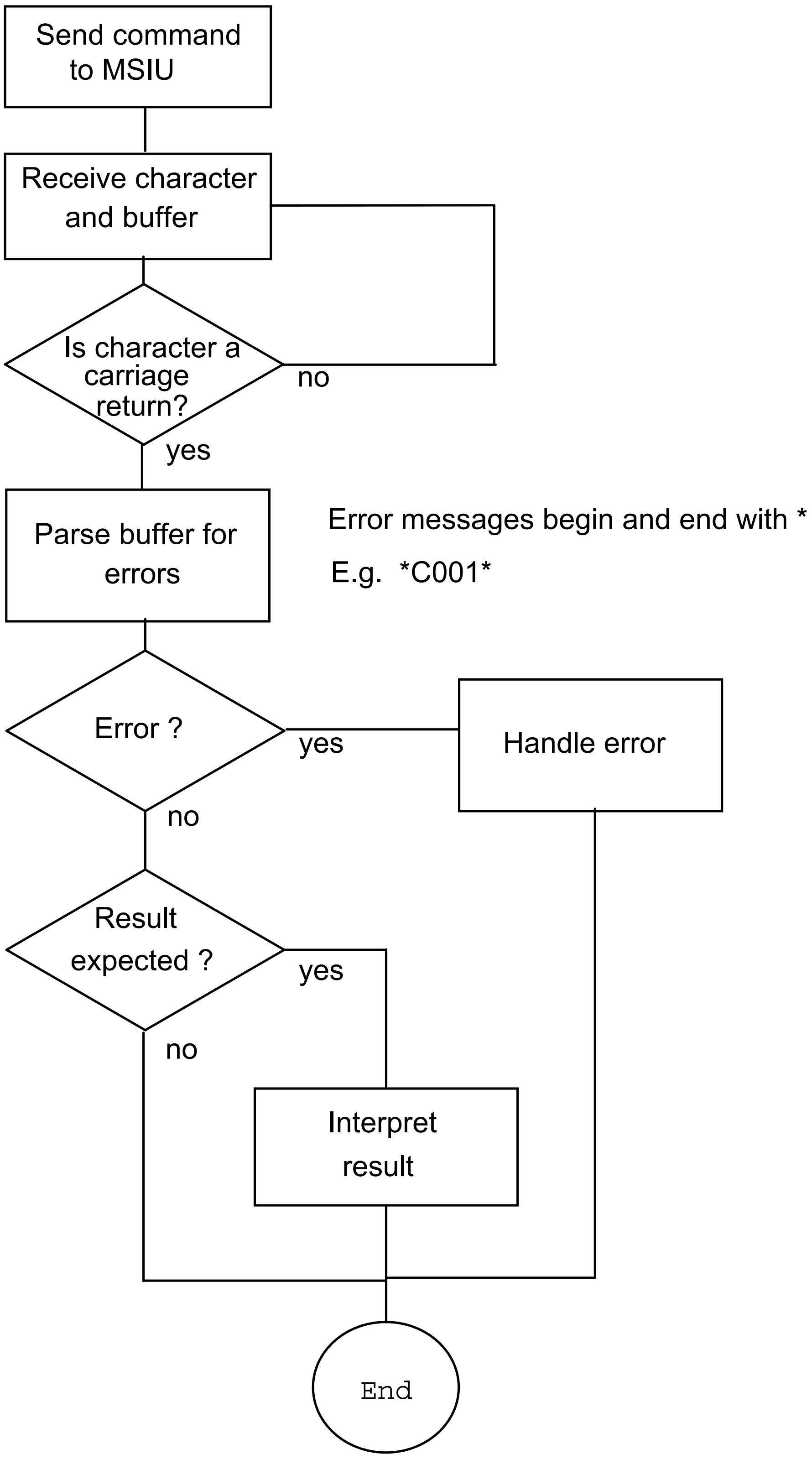
Any command of less than 4 characters, including blank lines, produces the error:

```
Command error   3  Command truncated
```

Unrecognised commands produce:

```
Command error   1  Unknown command
```

The following flow chart summarises command processing.



### 2.0.1. Command Streams

Commands may be sent on any input stream. The following input streams have been implemented: COM1:, COM2:, DLC1:, DLC2:, DLC3:.

Commands received from any input stream are ALWAYS executed by task 0. Task 0 executes the command until it completes. No other command can be processed until task 0 completes; Thus, for instance, if the command LGET SEM were issued then the command task would be tied to this operation for the duration of the settle and dwell times for the measurement. During this time no other commands can be executed, not even STOP. Running an event sequence that loops by using the command TRUN <event> will lock the command task forever. For this reason time consuming commands must be run in a background task by using the command SJOB.

NOTE: *This is unlike most operating systems. Usually each input stream executes in its own task.*

Unless redirected by the command COUT the output from a command is sent back to the stream that issued the command. Output is redirected by the commands COUT, CERR, SOUT and SERR. COUT redirects results from commands and CERR redirects error messages. Thus errors can be buffered by redirecting to BUFFER: then polled with the RERR command. Likewise SOUT and SERR redirect the output of commands started as backgound tasks by the SJOB command. Each input stream maintains its own settings for COUT CERR SOUT and SERR, thus each stream may redirect its output independant of any other stream.

When a command is received on an input stream the corresponding output stream is locked. This prevents the output from commands received on any other stream being redirected to it and prevents background tasks ( e.g. an event sequence ) sending messages to it. Any task attempting to write to a locked stream will block until a QUIT command is received on the locked stream. Its status, as shown by the STAT <task#> command will show as "blocking".

NOTE: *Although the MSIU is only intended to be sent commands by one stream it is capable of receiving commands on any input stream at any time. If the user wishes to do this they should be aware of the possibilty of deadlock due to a command, whose output has been redirected by COUT, blocking when trying to write to the other input stream's output. The command task will then be deadlocked, as it can not complete the current command and can not process a QUIT command from the other stream. A deadlock state of this nature is not detected by the 32s scheduler watchdog and will not cause the system to re-boot ( See the BOOT command). Use COUT with caution!*

### 2.0.1.1. The COM1: Stream

The COM1: stream corresponds to the RS422 input. The RS422 input operates at 19.2Kbaud, No parity, 8 data bits and 1 stop bit. This is not alterable by the user.

No protocol is used by the RS422, other than that of command and response or error.

A checksum is not used.

### 2.0.1.2. The COM2: Stream

The COM2: stream corresponds to the RS232 input. The RS232 input operates at 19.2Kbaud, No parity, 8 data bits and 1 stop bit. This is not alterable by the user.

No protocol is used by the RS232, other than that of command and response or error.

A checksum is not used.

### 2.0.1.3. The DLC1: Stream

DLC1: is an Ethernet LAN stream. The DLC1: stream corresponds to SAP C0 at the MSIU's Ethernet address. This may be obtained by issuing the command PGET net-address. The Ethernet address given to HAL IV MSIUs is a locally adminstered address. Unless otherwise comfigured it will be 02484100xxxx where xxxx is the unique 4 digit ID given to each MSIU. This number is shown beneath the serial number on the rear of the MSIU, it corresponds to the instruments Works Reference number.

The DLC1: stream is connected to the 10Base2 BNC connector. It operates at 10Mbits per second using ISO 8802-3.

DLC1: uses the ISO 8802-2 Logical Link Control protocol ( LLC II ), compatible with Microsoft's MSDLC.

The SAP is always open. The SAP supports only 1 link station so only 1 PC may connect to the SAP at any given time.

The parameter "DLC_p_timer" times the interval during which the LCC shall expect to receive a PDU with the "F" bit set to 1 in response to a sending a Type 2 command with the P bit set to 1. The default value is 15 ( 105ms ).

The parameter "DLC_ack_timer" times the interval during which the LCC shall expect to receive an acknowledgement to one or more outstanding I PDUs or expect a response PDU to a sent unnumbered command PDU.The default value is 30 ( 210ms ).

The parameter "DLC_rej_timer" times the interval during which the LLC shall expect to receive a reply to a REJ PDU.The default value is 15 ( 105ms ).

The parameter "DLC_busy_timer" times the interval that the LLC waits for a busy state at the other LLC to clear.The default value is 150 ( 1s ).

The parameter "DLC_retries" defines the number of times that a PDU is sent following the running out of the acknowledgement timer, the P-bit timer or the reject timer.The default value is 10

The parameter "DLC_tick_timer" scales all the other timers.The default value is 7. This gives a tick time of 7ms.

#### 2.0.1.4. The DLC2: Stream

DLC2: is an Ethernet LAN stream. The DLC2: stream corresponds to SAP C4 at the MSIU's Ethernet address. In all other respects it is identical to DLC1:.

The DLC2: stream is intended for returning data.

#### 2.0.1.5. The DLC3: Stream

DLC3: is an Ethernet LAN stream. The DLC3: stream corresponds to SAP C8 at the MSIU's Ethernet address. In all other respects it is identical to DLC1:.

The DLC3: stream is intended for redirecting error messages.

## 2.1. Command Interface Commands

I am not sure how many of these I will be able to implement. Unimplemented stuff is shown on a grey background.

| | |
|---|---|
| EID$ | EID$ &lt;n&gt; returns the error message string of error &lt;n&gt;. |
| ESET | ESET &lt;n&gt; generates error number &lt;n&gt; on the current error stream. |
| CMD$ | Saves a command string for parsing by CMD=. This will be a dummy - it will discard the rest of the command line. Use to specify the columns to edit the scan table.<br><br>`CMD$  SSET scan, SSET row, SSET output, SSET start, SSET stop, SSET step, SSET input, SSET rangedev, SSET low, SSET high, SSET current, SSET dwell, SSET settle, SSET mode,`<br><br>Field numbers can be substituted for field names. Field numbers can be obtained using the SID# command.<br><br>`CMD$  SSET 1, SSET 2, SSET 3, SSET 4, SSET 5, SSET 6, SSET 7, SSET 8, SSET 9, SSET 10, SSET 11, SSET 12, SSET 13, SSET 14,` |

**CMD=** Executes each command in the string saved by CMD$, each command taking its parameters from the current input. This will be implemented as a command to parse the command line into the scan table in a fixed format.

```
example: CMD= Ascans,1,masss,1,100,1,Faraday,range,-10,-7, -7, 50%,100%,1
```

Logical device numbers may be substituted for logical device names in the fields corresponding to scan ( 1 - 26 ), output, input and rangdev. Logical device numbers may be obtained by use of the LID# command.

**COUT** Sets the output device of the command task.

```
example COUT PRINTER
```

**CERR** Sets the error device of the command task

```
example CERR COM2
```

**SJOB** Starts a command in the background without waiting for the result. Thus to run a scan the command required is:

```
Example : SJOB  LGET Ascans

Returns : Task <task#>, job <job#>,↲

Errors:

If more than 3 background tasks already running:

        "Command error  30  No free task"
```

**STOP** Stops a background job. Syntax STOP <task#> [<job#>]. Stops job <job#> in task <task#>. If <job#> is omitted stops the current task. No error if task is idle.

```
Example : STOP 1 1234 or

        STOP 1

Returns : ↲

Errors:

Error number  31 "Command error  31  Task number out of range"

if <job#> does not match current job:

Error number  32 "Command error  32  Job not running"
```

**DATA** Reads the data buffer. This command starts a background task called "data" ( note lowercase ). When the background task terminates the data from it is followed by ! .

The number of data points returned by any given DATA command is specified by the **points** parameter. PSET points 0 makes the number of data points unlimited. After the specified number of points, or if the last point is still being acquired, DATA suspends. The command DATA without an argument, see below, resumes recall.

Data is returned in almost the same format as is returned by using the **results** parameter. See section 2.1.0.1, "Returned Data", page 19.

*The results parameter is now obsolete and no longer supported.*

The DATA command may be nested. If data is misread another DATA <scan-dev> <n> command ( see below ) may be issued to read the missed data. The data should be read until a ! is received or the current DATA command stopped by DATA stop.

When a scan is initialised ( LINI <scan> ) or started ( LGET <scan> or LSET <scan> ) all background data commands are stopped.

This command has the following syntax:

DATA <scan-dev-name>  or

DATA <scan-dev-number>

Reports the results of the last cycle of the scan given by <scan-dev-name> ( E.g. Ascan ) or <scan-dev-num>.

DATA <scan-dev-name>  <n> or

DATA <scan-dev-number> <n>

Reports the results of cycle <n> of the scan given by <scan-dev-name> ( E.g. Ascan ) or <scan-dev-num>. Each time a scan is called, either as an input or output ldev, the scan's cycle number is incremented. Note that the scans' cycle numbers are independent. If Ascans calls Bscans 4 times Ascans may be on cycle 1 while Bscans is on cycle 4..

DATA all

Reports all stored data from the head of the stored data list onward.

DATA

Reports the next available data points. Will automatically re-start the background task if it has terminated ( ! received ). If DATA commands have been nested DATA alone after ! un-nests the previous DATA <scan> command and resumes it.

### 2.1.0.1. Returned Data

Scan logical devices can be made to return the readings as they are taken by using the **results** parameter. Stored data can be recalled by the DATA command, the format of the recalled data is determined, scan by scan, by the report field. The **results** parameter and the report field can take a value between 0 & 31. Each of the 5 bits of this value control part of the output format: The **terse** parameter determines if the short form of the reading is returned, with **terse** = 1 the units are omitted.

The basic output string of a reading with all fields present ( **results** or report = 31 ) from a single row, MID type ( start = stop ) , scan:

| Row | Output | Start | Stop | Step | Input |
|---|---|---|---|---|---|
| 1 | mass | 1 | 1 | 0.04 | SEM |

is:

1234/"mass" 1.00 amu:"SEM"0 c/s,

<time><time_units>/"<o/p_dev>"<o/p_value><o/p_units><separator>"<i/p_dev>"<i/p_reading><i/p_units><comma>

| Field | bit set in **results** or report | |
|---|---|---|
| <time> | 4 | The elapsed time in milliseconds |
| <time_units> | 4 and **terse** = 0 | The units of the elapsed time ( "mSecs" ) . |
| / | 4 | Time separator. |
| "<o/p dev>" | 3 | The output logical device name in quotes |
| <o/p_value> | 2 | The value set to the output |
| <o/p_units> | 2 and **terse**=0 | The units of the output device |
| <separator> | 2 or 3 | The separator is a colon, it is present if the output device value is reported in the results or report. |
| "<i/p dev>" | 1 | The input logical device name in quotes |
| <i/p_reading> | 0 | The value read by the input logical device |
| <i/p_units> | 0 and **terse**=0 | The units of the input device. |
| <comma> | 0, 1, 2 or 3 | Always present if **results** or report is > 0 |

Hence if **results** or report =31 and **terse** = 1 ; 1234/"mass" 1.00:"SEM"0,

The device names may be omitted if **results** or report = 21 ; 1234/1.00:0, The elapsed time may be omitted if **results** or report = 5 ;   1.00:0,

To just return the reading use **results** or report = 1 ; 0,

To aid interpretation of data from complex scan trees data may be parenthesised by characters in the **brackets** string parameter. This contains [](){} by default.

[]  Parenthesise the start and end of a scan cycle. A single cycle, as started by LGET, will start with [ and end with ].

()  Parenthesise the output of a scan logical device when called as an input or output device from within a scan.

{}  Parenthesise an individual scan. They are omitted if start = stop.

Thus, with **results** or report = 15 & **terse** = 1 the scan

| Row | Output | Start | Stop | Step | Input |
|---|---|---|---|---|---|
| 1 | mass | 1 | 1 | 0.04 | SEM |

```
returns: ["mass"  1.00:"SEM"0,]
```

| Row | Output | Start | Stop | Step | Input |
|---|---|---|---|---|---|
| 1 | mass | 1 | 10 | 1 | SEM |

```
returns:
      [{"mass"  1.00:"SEM"0,"mass"  2.00:"SEM"0,"mass"
      3.00:"SEM"0,"mass"    4.00:"SEM"0,"mass"  5.00:"SEM"0,"mass"
      6.00:"SEM"0,"mass"  7.00:"SEM"0,"mass"  8.00:"SEM"0,"mass"
      9.00:"SEM"0,"mass" 10.00:"SEM"0,}]
```

Adding a second scan ( underlined ) gives:

| Row | Output | Start | Stop | Step | Input |
|---|---|---|---|---|---|
| 1 | mass | 1 | 5 | 1 | SEM |
| 2 | mass | 51 | 55 | 1 | SEM |

```
lget Hscans returns:
[{"mass"  1.00:"SEM"0,"mass"  2.00:"SEM"0,"mass"  3.00:"SEM"0,"mass"
.00:"SEM"0,"mass"  5.00:"SEM"0,}{"mass" 51.00:"SEM"0,"mass"
52.00:"SEM"0,"mass" 53.00:"SEM"0,"mass" 54.00:"SEM"0,"mass"
55.00:"SEM"0,}]
```

If a second scan ldev is used as input device to create a multivarient ( 3 dimensional scan ) of energy and mass:

Hscans:

| Row | Output | Start | Stop | Step | Input |
|---|---|---|---|---|---|

| | | | | | |
|---|---|---|---|---|---|
| 1 | energy | -10 | 10 | 5 | Iscans |

Iscans:

| Row | Output | Start | Stop | Step | Input |
|---|---|---|---|---|---|
| 1 | mass | 28 | 32 | 1 | SEM |

Then lget Hscans returns:

```
[{"energy"- 10:"Iscans"({"mass" 28.00:"SEM"0,"mass" 29.00:"SEM"0
,"mass" 30.00:"SEM"0,"mass" 31.00:"SEM"0,"mass"
32.00:"SEM"0,})0,"energy"-
5:"Iscans"({"mass" 28.00:"SEM"0,"mass" 29.00:"SEM"0,"mass"
30.00:"SEM"0,"mass" 3
1.00:"SEM"0,"mass" 32.00:"SEM"0,})0,"energy"+  0:"Iscans"({"mass"
28.00:"SEM
"0,"mass" 29.00:"SEM"0,"mass" 30.00:"SEM"0,"mass" 31.00:"SEM"0,"mass"
32.00:"SEM
"0,})0,"energy"+  5:"Iscans"({"mass" 28.00:"SEM"0,"mass"
29.00:"SEM"0,"mass"
 30.00:"SEM"0,"mass" 31.00:"SEM"0,"mass" 32.00:"SEM"0,})0,"energy"+
10:"Isca
ns"({"mass" 28.00:"SEM"0,"mass" 29.00:"SEM"0,"mass" 30.00:"SEM"0,"mass"
31.00:"S
EM"0,"mass" 32.00:"SEM"0,})0,}]
```

Note that now the results or report of Iscans between ( and ) occurs between the input device name "Iscans" and the value returned by Iscans: "energy"  5:"Iscans"( .... )0, . To make it clearer I have underlined the output of Iscans .

When a scan ldev is used as and output device a covarient scan is produced, in this example energy and mass scan together:

Hscans:

| Row | Output | Start | Stop | Step | Input |
|---|---|---|---|---|---|
| 1 | Iscans | 1 | 5 | 1 | SEM |

Iscans:

| Row | Output | Start | Stop | Step | Input |
|---|---|---|---|---|---|
| 1 | mass | 28 | 32 | 1 | nul-dev |
| 1 | energy | -10 | 10 | 5 | nul-dev |

Then lget Hscans with **results** = 5 returns :

```
[{"Iscans"1({"mass" 28.00:"nul-dev",}{"resolution"- 10:"nul-dev",}):
"SEM"0,"Iscans"2({"mass" 29.00:"nul-dev",}{"resolution"-  5:"nul-
dev",}):"SEM"0,
"Iscans"3({"mass" 30.00:"nul-dev",}{"resolution"+  0:"nul-
dev",}):"SEM"0,"Iscans
"4({"mass" 31.00:"nul-dev",}{"resolution"+  5:"nul-
dev",}):"SEM"0,"Iscans"5({"ma
ss" 32.00:"nul-dev",}{"resolution"+ 10:"nul-dev",}):"SEM"0,}]
```

Note that now the results of Iscans between ( and ) occurs after the index passed to the output device and the colon separator : "Iscans"3( .... ):"SEM"0, . To make it clearer I have again underlined the output of Iscans. Note also that every scan in Iscans is enclosed in { }, even though it only performs 1 step, because start does not equal stop. The DATA command avoids these unnecessary pair of {}:
Hscans with report = 5 returns :

```
[{"Iscans"1("mass" 28.00:"nul-dev","resolution"- 10:"nul-dev",):
"SEM"0,"Iscans"2("mass" 29.00:"nul-dev","resolution"-  5:"nul-
dev",):"SEM"0,
"Iscans"3("mass" 30.00:"nul-dev","resolution"+  0:"nul-
dev",):"SEM"0,"Iscans
"4("mass" 31.00:"nul-dev","resolution"+  5:"nul-
dev",):"SEM"0,"Iscans"5("ma
ss" 32.00:"nul-dev","resolution"+ 10:"nul-dev",):"SEM"0,}]
```

When the output device name and value are omitted ( **results** or report = 3 ) then the colon is also omitted, E.g. a simple scan would give:

```
[{"SEM"0,"SEM"0,"SEM"0,"SEM"0,"SEM"0,"SEM"0,"SEM"0,"SEM"0,"SEM"0,"SEM"
      0,}]
```

However on a covarient scan the parentheses from the output scan ldev are still produced:

```
lget Hscans [{({"nul-dev",}{"nul-dev",})"SEM"0,({"nul-dev",}{"nul-
dev",})"SEM"0,
({"nul-dev",}{"nul-dev",})"SEM"0,({"nul-dev",}{"nul-
dev",})"SEM"0,({"nul-dev",}{
"nul-dev",})"SEM"0,}]
```

or

```
DATA all [{("nul-dev","nul-dev",)"SEM"0,("nul-dev","nul-dev",)"SEM"0,
("nul-dev","nul-dev",)"SEM"0,("nul-dev","nul-dev",)"SEM"0,("nul-dev",
"nul-dev",)"SEM"0,}]
```

Even though nul-dev returns no value. That the braces come from an output scan can be deduced from their occurrence before "SEM". If **results** or report = 1 ( the normal case? ) this is no longer true:

```
lget Hscans [{({,}{,})0,({,}{,})0,({,}{,})0,({,}{,})0,({,}{,})0,}]
```

or

```
DATA all [{(,,)0,(,,)0,(,,)0,(,,)0,(,,)0,}]
```

DATA stop

Stops the recall of data. Kills the most recent data recall task. The command DATA without an argument will resume a stopped data recall at the next scan. This command is equivalent to STOP <task> <n> where <task> is the task number of the "data" ( note lowercase ) task and <n> its job number.

DATA on

Scan will not reuse data storage until the data has been recalled. Issue this command before starting to scan. Data acquisition will suspend if all available storage is used up.

DATA off

Scan will reuse data storage even if not yet recalled.

Example : Start the data acquisition by LGET <scan>

Start the data recall by DATA all

Read the returned data then issue another DATA command.

Continue until a C70 error is received ( Command Error 70 No data. )

Returns : See section 2.1.0.1, "Returned Data", page 19.

When the DATA command has terminated the returned data ends in !↵

Errors:

If DATA <scan> or DATA <scan> <n> is used and <scan> does not exist or has not been initialised:

"Command error 26 Scan not initialised"

If too many background tasks have been started, either by nesting DATA commands or by use of SJOB:

"Command error 30 No free task"

The following error is produced when no more data is available for reporting and acquisition has stopped or when no data has been acquired. It is also produced by a DATA <scan> <n> command if cycle <n> does not yet or no longer exists in the data buffer.

"Command error 70 No data"

STAT Check status of a background job ( running, idle or stopped ).

Example : STAT 1

Returns : Task n,<status>,[job <job#>, <command>,]↵

where <status> is "running", "idle" or "stopped" ( not quoted ) and if running or stopped <command> is the command in progress.

Errors:

Error number 31 "Command error 31 Task number out of range"

SVAL Returns value returned by job. This can easily be implemented if each task has to own the output device before using it. So if the background task has the same output device as the command processor it will suspend. All SVAL has to do is free the output device and then wait until it can get it again. If the background task reports to a different device this will be free and so the task will not suspend. SVAL n suspends the command task for n cycles of the scheduler.

Example : SVAL or

SVAL 100.

Returns : <output from background task>↵

If the output from the background task ends in ↵ then SVAL returns:

<output from background task>↵
↵

SOUT Sets the output device of subsequent background tasks started by SJOB

Example SOUT COM1:

Returns : ↵

Errors:

"Command error 28 Unknown I/O device"

SERR Sets the error device of subsequent background tasks started by SJOB

Example : SERR ERROR:

Returns : ↵

Errors:

"Command error 28 Unknown I/O device"

RBUF Reads the data queue BUFFER: of messages produced by background tasks started by SJOB. Syntax: RBUF [<n>], where n is the maximum number of characters to be read. When a new line is encountered it is replaced by the character specified by the **terminator** parameter, by default ! and RBUF ends.

Example : RBUF , reads BUFFER: until a new line is encountered or BUFFER: is empty.

RBUF 100 , reads up to 100 characters from BUFFER:

Returns : <output from BUFFER:>↵

If the contents of BUFFER contains ↵ then SVAL returns:

<output from BUFFER:>!↵

RERR Reads the error queue ERROR: of error messages produced by background tasks started by SJOB. Syntax: RERR [<n>], where n is the maximum number of characters to be read.

Example : RERR , reads ERROR: until empty.

RERR 100 , reads up to 100 characters from ERROR:

QUIT Causes the command task to relinquish the lock on the input stream. Lock is re-established with the next command sent. Allows another task to write to the stream on which this command was received. Use this command if you use the RS232 or RS422 ports for testing from a terminal when you have finished using the port; output from event sequences will then be allowed to the port that you were using.

BOOT Causes a complete re-boot of the MSIU. Intended for use from a watchdog event sequence. The system will also re-boot if 1: any task does not relinquish to the scheduler for more than 32s - this can occur if an sequence of events with their priority field set to 1 loops continuously. or 2: if a break signal is received on the RS232 or RS422 inputs - this occurs when a PC is switched on or off. This feature can be disabled by setting the reset_on_break parameter to 0.

TEST Performs various tests. These commands are intended for execution from a remote terminal. They do not obey the normal syntax of returning a single line reply.

TEST DRAM - tests the dynamic RAM

Example : TEST DRAM

Result :

```
Set to FFFF.FFFF ... Ok
Set to 55AA.55AA ... Ok
Set to AA55.AA55 ... Ok
Set to 0000.0001 ... Ok
Set to 0000.0002 ... Ok
Set to 0000.0004 ... Ok
Set to 0000.0008 ... Ok
Set to 0000.0010 ... Ok
Set to 0000.0020 ... Ok
Set to 0000.0040 ... Ok
Set to 0000.0080 ... Ok
Set to 0000.0100 ... Ok
Set to 0000.0200 ... Ok
Set to 0000.0400 ... Ok
Set to 0000.0800 ... Ok
Set to 0000.1000 ... Ok
Set to 0000.2000 ... Ok
Set to 0000.4000 ... Ok
Set to 0000.8000 ... Ok
Set to 0001.0000 ... Ok
Set to 0002.0000 ... Ok
Set to 0004.0000 ... Ok
Set to 0008.0000 ... Ok
Set to 0010.0000 ... Ok
Set to 0020.0000 ... Ok
Set to 0040.0000 ... Ok
Set to 0080.0000 ... Ok
Set to 0100.0000 ... Ok
Set to 0200.0000 ... Ok
Set to 0400.0000 ... Ok
Set to 0800.0000 ... Ok
Set to 1000.0000 ... Ok
Set to 2000.0000 ... Ok
Set to 4000.0000 ... Ok
Set to 8000.0000 ... Ok
Set to 0000.0000 ... Ok
```

### TEST SRAM - tests the static RAM

Example : TEST SRAM

Result :

```
Set to FFFF.FFFF ... Ok
Set to 55AA.55AA ... Ok
Set to AA55.AA55 ... Ok
Set to 0000.0001 ... Ok
Set to 0000.0002 ... Ok
Set to 0000.0004 ... Ok
Set to 0000.0008 ... Ok
Set to 0000.0010 ... Ok
Set to 0000.0020 ... Ok
Set to 0000.0040 ... Ok
Set to 0000.0080 ... Ok
Set to 0000.0100 ... Ok
Set to 0000.0200 ... Ok
Set to 0000.0400 ... Ok
Set to 0000.0800 ... Ok
Set to 0000.1000 ... Ok
Set to 0000.2000 ... Ok
Set to 0000.4000 ... Ok
Set to 0000.8000 ... Ok
Set to 0001.0000 ... Ok
Set to 0002.0000 ... Ok
Set to 0004.0000 ... Ok
Set to 0008.0000 ... Ok
Set to 0010.0000 ... Ok
Set to 0020.0000 ... Ok
Set to 0040.0000 ... Ok
Set to 0080.0000 ... Ok
Set to 0100.0000 ... Ok
Set to 0200.0000 ... Ok
Set to 0400.0000 ... Ok
Set to 0800.0000 ... Ok
Set to 1000.0000 ... Ok
Set to 2000.0000 ... Ok
Set to 4000.0000 ... Ok
Set to 8000.0000 ... Ok
Set to 0000.0000 ... Ok
```

### TEST timing - tests system clock and timers.

Example : TEST timing

Result :

```
Testing acquisition timer .... 1001 ms = 1 second
Testing real time clock
```

```
  Please wait 1 minute .... 60 seconds = 1 minute
```

### TEST ASCII -    returns an ASCII test string

Example :  TEST ASCII

Result :

```
TEST ASCII 1
ABCDEFGHIJKLMNOPQRSTUVWXYZabcdefghijklmnopqrstuvwxyz0123456789:;,.!$%&*-+=#@?<>
```

### TEST all   -    performs all of above tests

Example :  TEST  all

Result :

```
Testing SRAM
Set to FFFF.FFFF ... Ok
Set to 55AA.55AA ... Ok
Set to AA55.AA55 ... Ok
Set to 0000.0001 ... Ok
Set to 0000.0002 ... Ok
Set to 0000.0004 ... Ok
Set to 0000.0008 ... Ok
Set to 0000.0010 ... Ok
Set to 0000.0020 ... Ok
Set to 0000.0040 ... Ok
Set to 0000.0080 ... Ok
Set to 0000.0100 ... Ok
Set to 0000.0200 ... Ok
Set to 0000.0400 ... Ok
Set to 0000.0800 ... Ok
Set to 0000.1000 ... Ok
Set to 0000.2000 ... Ok
Set to 0000.4000 ... Ok
Set to 0000.8000 ... Ok
Set to 0001.0000 ... Ok
Set to 0002.0000 ... Ok
Set to 0004.0000 ... Ok
Set to 0008.0000 ... Ok
Set to 0010.0000 ... Ok
Set to 0020.0000 ... Ok
Set to 0040.0000 ... Ok
Set to 0080.0000 ... Ok
Set to 0100.0000 ... Ok
Set to 0200.0000 ... Ok
Set to 0400.0000 ... Ok
Set to 0800.0000 ... Ok
Set to 1000.0000 ... Ok
Set to 2000.0000 ... Ok
Set to 4000.0000 ... Ok
Set to 8000.0000 ... Ok
Set to 0000.0000 ... Ok
Testing DRAM
Set to FFFF.FFFF ... Ok
Set to 55AA.55AA ... Ok
Set to AA55.AA55 ... Ok
Set to 0000.0001 ... Ok
Set to 0000.0002 ... Ok
Set to 0000.0004 ... Ok
Set to 0000.0008 ... Ok
Set to 0000.0010 ... Ok
Set to 0000.0020 ... Ok
Set to 0000.0040 ... Ok
Set to 0000.0080 ... Ok
Set to 0000.0100 ... Ok
Set to 0000.0200 ... Ok
Set to 0000.0400 ... Ok
Set to 0000.0800 ... Ok
Set to 0000.1000 ... Ok
Set to 0000.2000 ... Ok
Set to 0000.4000 ... Ok
Set to 0000.8000 ... Ok
Set to 0001.0000 ... Ok
Set to 0002.0000 ... Ok
Set to 0004.0000 ... Ok
Set to 0008.0000 ... Ok
Set to 0010.0000 ... Ok
Set to 0020.0000 ... Ok
Set to 0040.0000 ... Ok
Set to 0080.0000 ... Ok
Set to 0100.0000 ... Ok
Set to 0200.0000 ... Ok
Set to 0400.0000 ... Ok
Set to 0800.0000 ... Ok
Set to 1000.0000 ... Ok
Set to 2000.0000 ... Ok
Set to 4000.0000 ... Ok
Set to 8000.0000 ... Ok
Set to 0000.0000 ... Ok
Testing timing
Testing acquisition timer .... 1001 ms = 1 second
Testing real time clock
  Please wait 1 minute .... 60 seconds = 1 minute
Testing ASCII
TEST ASCII 1 ABCDEFGHIJKLMNOPQRSTUVWXYZabcdefghijklmnopqrstuvwxyz0123456789:;,.!
$%&*-+=#@?<>
```

HELP Displays a summary of some common MSIU commands. This commands are intended for execution from a remote terminal. It does not obey the normal syntax of returning a single line reply.

Example : HELP

Result :

```
Logical Device Commands:
LID$ LID# LGET LSET LMIN LMAX LINI LUNT LUSE LTYP LNUL LINT LSLO LVAL LSTA
Parameter Commands:
PID$ PGET PSET PMIN PMAX PINI
Parameters:
terse name cycles results brackets terminator points
Scan Edit Commands:
SID$ SGET SSET SMIN SMAX SINI SDEL
Scan fields:
all scan row output start stop step input rangedev low high dwell settle mode env
Trip Edit Commands:
TID$ TGET TSET TMIN TMAX TINI TNEW TDEL TDIR
Use SJOB TRIP to start a trip task
Trip fields:
all input output from to <limit >limit action activate deactivate
Data commands:
DATA <scan> [<cycle>], DATA all , DATA , DATA stop
Commands:
SJOB STOP STAT SOUT SERR COUT CERR RBUF RERR
Other Commands:
HELP QUIT
```

*NOTE : COUT, CERR, SOUT and SERR apply to the current input device. Valid I/O devices are COM1: , COM2: , BUFFER: , ERROR: , DLC1: , DLC2: , DLC3: , NET1: , NET2: NET3: PRINTER: . BUFFER: is a 2000 character queue which may be read be RBUF. ERROR: is a 256 character queue that may be read by RERR*

### 2.1.1. Use of Background Tasks.

Tasks are not allocated to a specific function as they are on the HAL II, but are used to run a command in the background. Functions like trips, system monitoring & data reporting etc. will be implemented by running TRIP, REPT etc. commands as background tasks.

To run a scan ( say Ascan ) in the background you could use the following sequence ( responses are underlined);

```
PSET results 5↲
```

*The results parameter is now obsolete and no longer supported. The following section may be read as an example, but should not be used literally. Use the DATA command to retrieve data.*

```
↲
LINI Ascans↲
↲
SJOB LGET Ascans↲
Task 1, job 1,↲
```

LGET runs in the background as task1 but suspends as soon as it tries to output a value because the command task owns stdout. To get some data from LGET you could use SVAL, which causes the command task to relinquish stdout. The output from task 1 is double underlined:

```
SVAL↲
[{"energy"- 10:"Iscans"({"mass" 28.00: ↲
```

This has allowed task 1 to run for 1 cycle of the scheduler. To wait for 100 cycles use:

```
SVAL 100↲
[{"energy"- 10:"Iscans"({"mass" 28.00:"SEM"0,"mass" 29.00"SEM"0
,"mass" 30.00:"SEM"0,"mass" 31.00: ↲
```

The trouble with this that you do not know how many measurements the scan can make in 100 cycles. SJOB LGET <ldev> ↲ SVAL↲ is ok for reading a single logical device and getting its results back later but not satisfactory for use with scans.

To overcome this the output device of a background task may be reassigned. The BUFFER: output device is a 2000 character queue. If LGET Ascans outputs to buffer it may run in the background concurrently with the command task until it fills up BUFFER:, when it will suspend. The SOUT command is used to assign a background tasks stdout:

```
PSET results 5↵
↵
LINI Ascans↵
↵
SOUT BUFFER:↵
↵
SJOB LGET Ascans↵
Task 1, job 1,↵
```

Now the RBUF command may be used to read BUFFER: RBUF on its own reads BUFFER: until it is empty - in this case the amount of output is like the old maths problem of the bath with its plug out and the tap on - it depends on how fast the background task is filling BUFFER: and how quickly the command task is emptying it. Alternatively RBUF <n> may be used to read up to n characters from BUFFER:

```
RBUF 80↵
[{"energy"- 10:"Iscans"({"mass" 28.00:"SEM"0,"mass" 29.00"SEM"0
,"mass" 30.00:"S ↵
```

The output from several commands may be buffered in BUFFER:

```
SJOB LGET SEM↵
Task 1, job 2,↵
SJOB LGET mass↵
Task 2, job 1,↵
SJOB LGET energy↵
Task 1, job 3,↵
RBUF↵
40 amu!↵
RBUF↵
12345 c/s!↵
RBUF↵
100V!↵
```

Note that Task 2 job 1's output preceded Task 1 job 2's output because Task 2 job 1 finished first. The ! shows that the output is complete.

Error output may similarly be redirected to ERROR: Note that error messages are not terminated by a ↵ so the output of ERROR: obtained by RERR is, at the moment, one long string. In the near future ERROR: will append Task <task#> job <job#> <command> <device> <date & time>↵ to each string written to it.

## 2.2. Logical Device Commands

Logical device commands have the general format :

```
[ _ ]*Lxxx[ _ ]*<ldev-num>|<ldev-name> _ [ _ ]*<arg>[ _ ]*
```

where _ represents a space, [ _ ]* 0 or more spaces, <ldev-num> a logical device number or <ldev-name> a logical device name.

<arg> is required by LSET,LINT,LSLO. Currently <arg> should be a decimal number e.g. 1.23. The number of decimal places stored by LSET depends on the device - do you want an enquiry function to return it? Do not add lots of trailing 0s after the decimal point or you may exceed the number conversion range.

*NOTE: The current distributed version of FORTH used requires the use of a comma not a decimal point before the decimal fraction i.e. 1,23 not 1.23. This has been modified in KERNEL.F so that the decimal separator is stored in the 1 character string DPchar, which now contains . by default.*

In future the command interpreter should allow the use of commas and tabs as separators, but stick to spaces and tabs for the moment.

All logical device commands require a logical device name or number, and unknown name or an illegal number will produce the error:

```
Command error   8  Unknown logical device
```

LSET Set value of logical device.

LSET without an argument will reset a device to its default value.

Example : LSET mass 50

Returns : ↵

Errors :

```
Command error   9  Logical device value out of range
```

The value you have tried to set is below MIN or above MAX

```
Command error  10  Logical device value scaled out of range
```

When multiplied by SLO and offset by INT the value is outside the capability of the device - reset the slope and intercept.

LGET Return current value of logical device ( read value ), or return last set value for output devices.

Example : LGET SEM

Returns : (**terse** = 0 ) <READING><UNITS>↵

( **terse** = 1 ) <READING>↵

Errors : If the reading is less than MIN or greater than MAX returns:

( **terse** = 0 ) Warning! 12 Reading out of range<READING><UNITS>↵

( **terse** = 1 ) W12!<READING>↵

LMAX Return max value of logical device

Example : LMAX mass

Returns : (**terse** = 0 ) <Maximum Value><UNITS>↵

( **terse** = 1 ) <Maximum Value>↵

LMIN Return minimum legal value of logical device

Example : LMIN mass

Returns : (**terse** = 0 ) <Minimum Value><UNITS>↵

( **terse** = 1 ) <Minimum Value>↵

LRES Return resolution of logical device, this is the minimum step size when the device is scanned; rounding of mapping of device physical minimum and maximum to device logical minimum and maximum may make this value approximate.

Example : LRES mass

Returns : (**terse** = 0 ) <Resolution Value><UNITS>↵

( **terse** = 1 ) <Resolution Value>↵

LID$ Return ID string ( name ) of logical device

Example : LID$ multiplier

Returns : <DEVICE NAME>↵ Note : Not quoted and no comma, device name will not include spaces.

If the device is a *group* LID$ returns all the ID$ of all the members of the group in comma separated quoted string format:

"<DEVICE NAME>", ......"<DEVICE NAME>",↵

LID# Return ID number ( logical dev number ) of device.

Example : LID# multiplier

Returns : <DEVICE NUMBER>↵

Note LID# of a *group* does not return the ID#s of all the members of the group, it returns the ID# of the group logical device.

LUSE Return information about use of device, e.g. its location. Returns a quoted string, max length 80 characters, which may be used as help text.

Example : LUSE multiplier

Returns : "<Use Text>"↵ Note : Quoted but no comma, text may be up to 80 chars and may include spaces.

LINI Initialise logical device - resets device to defaults, including mode and slope & intercept. Beware of using LINI on a member of a group, it will may end up in a different mode to the rest of the group. Use LINI <group> instead to init all members of the group.

Example : LINI mass

Returns : ↲

Errors : Errors should not occur unless bad values have been compiled as defaults into the logical device table. As it calls LSET the following errors are theoretically possible:

Command error 9 Logical device value out of range

The default value is below MIN or above MAX

Command error 10 Logical device value scaled out of range

When multiplied by SLO and offset by INT the value is outside the capability of the device - reset the slope and intercept.

LNUL Invoke offset null routine for logical device, if supported.

LINT Set intercept ( 0 offset ) of logical device

Example : LINT multiplier 0.000009

Returns : ↲

LSLO Set slope ( gain/sensitivity cal factor ) of logical device

Example : LSLO multiplier 0.0855

Returns : ↲

LSTA Return status of logical device ( idle, ready, not-ready, locked )

Example : LSTA mass

Returns : idle↲

LTYP Return type of logical device. Types are DAC ADC counter timer digital output digital input relay trip dummy virtual nul-dev group

Example : LTYP mass

Returns : DAC↲

LUNT Return units of logical device.

Example : LUNT mass

Returns : amu↲

LVAL  Returns mode index followed by the 8 values stored in each mode followed by the slope & intercept .

Example : LVAL mass

Returns : (**terse** = 0 ) Index 1,5.50 amu,5.50 amu,5.50 amu,5.50 amu,5.50 amu,5.50 amu,5.50 amu,5.50 amu,Intercept 0.000000, Slope 1.000000,↵

( **terse** = 1 ) 1,5.50,5.50,5.50,5.50,5.50,5.50,5.50,5.50, 0.000000, 1.000000,↵

LPUT  Set mode values into logical devices. Upto 8 values may be entered The only value written to the device is the value whose index corresponds to the mode of the device.

Example : LPUT energy 10.00,-.20, 10.00, 10.00, ↵

Returns : ↵

Errors :

Command error 9 Logical device value out of range

The value you have tried to set is below MIN or above MAX

Command error 10 Logical device value scaled out of range

When multiplied by SLO and offset by INT the value is outside the capability of the device - reset the slope and intercept.

L999  Sets logical device safe in case of emergency, overriding lock.

Example : L999 mass 5.5

Returns : ↵

Errors :

Command error 9 Logical device value out of range

The value is below MIN or above MAX

Command error 10 Logical device value scaled out of range

When multiplied by SLO and offset by INT the value is outside the capability of the device - reset the slope and intercept.

## 2.3. Parameter Commands

The command interface will support parameters, like on the HAL II. They will be implemented like cut down logical devices and used to set "one-off" values in memory. These values will be grouped in a parameter structure. The parameter table in ROM will contain min & max values to allow validation, an initial value to allow init and reset to default, a name so that the parameter may be referred to by name or parameter number.

Parameters do not have units so terse has no affect on returned values. String parameters are quoted. Some parameters are read-only. The last read-only parameter is called readonly. pget readonly or pmax readonly or pid# readonly returns the pid# of the last readonly parameter.

Array parameters allow parameters to set or get more than 1 value of the same type.

Trying to access a non-existent parameter, by name or number, produces the error message:

```
Command error  13  Unknown parameter
```

The following commands support parameters:

PSET Set value of parameter.

PSET without a value resets parameter to its default value.

Example : PSET results 15

Example - to set an array:

```
PSET netaddress 02 48 41 00 00 07
```

The values in the array are separated by spaces.

Returns : ↵

Errors : Entering a value that is less than PMIN or greater than PMAX gives:

```
Command error  15  Parameter value out of range
```

Trying to set a read-only parameter gives:

```
Read-only parameter, can't use pset or pini
```

Trying to set **all** produces the error:

```
Command error  16  Can't set ALL parameters
```

PGET Return current value of parameter.

Example : PGET results

Returns : Numeric parameters return :<value>↵

String parameters return :"<string>"↵

Array parameters return : <value>,<value>,....,<value>↵

PMAX Return max value of parameter. PMAX ALL will be a special case and will return the highest parameter number.

Example : PMAX results

Returns : Numeric parameters return :<max value>↵

String parameters return a string , sometimes null "" , sometimes underscores e.g. "______"↵

Where a choice of 1 of a set of strings is possible PMAX returns the entire set separated by commas e.g "None,Align,AutoTune,Max,Sum,Top,XvalAtMaxY"↵

## PMIN Return minimum legal value of parameter

Example : PMIN results

Returns : Numeric parameters return :<minvalue>↵

String parameters return a string , usually null , ""↵

Where a choice from a set exists PMIN returns the minimum or default selection e.g "None"↵

## PID$ Return ID string ( name ) of parameter.

Example : PID$ 2

Returns : ID string ( i.e. name ) of parameter. Above example returns:

release↵ Note : ID string is not quoted and will not contain spaces.

PID$ ALL will be a special case and will returns all parameter names in comma separated quoted string format, e.g.:

"release","ID","readonly","terse","debug","results","brackets","echoing","flags", "name","anniversary","hesitation","terminator","cycles","points","stack","recall" ,"net-address","DLC_p_timer","DLC_ack_timer","DLC_rej_timer", "DLC_busy_timer","DLC_retries","DLC_tick_timer","poll","parse","AutoTuneWindow"," AutoTuneThreshold","AutoTuneMinimum","SearchSpan","SearchWindow","SearchThreshold ","SearchMinimum","masstable",

## PID# Return ID number ( parameter number ), converse of PID$.

Example : PID# release

Returns : <ID number of parameter>↵.

E.g. Above example returns: 2↵

## PINI Initialise parameter - set to its default- same as PSET without a value.

PINI **all** initialises all settable parameters.

Example : PINI results

Returns : ↵.

Errors : Trying to init a read-only parameter gives:

Read-only parameter, can't use pset or pini

## 2.4. Scan Table Editing Commands

The scan editing functions are analogous to the parameter functions. Each column in the scan table is given a logical name.

In all examples logical device numbers may be substituted for logical device names.

Note that changing a field may affect the values returned by the SGET, SMIN and SMAX commands of other fields.

SDEL Deletes a scan table

example: SDEL Ascans deletes all rows of scan A. The ldev number of Ascans may be used instead of the string Ascans

example SDEL Ascans 8 deletes row 8 of Ascans

example SDEL Cscans 1 10 deletes rows 1 to 10 inclusive of Cscans.

example SDEL all deletes all rows of all scans

SSET Set value of field in scan table. SSET without a value sets field to its default value.

SGET Return current value of field in scan table.

START, STOP and STEP fields return field's value in format of OUTPUT device, see LGET .

LOW and HIGH return field's value in format of RANGEDEV device, see LGET.

SMAX Return max value of field in scan table.

START, STOP and STEP fields return max value in format of OUTPUT device, see LMAX .

LOW and HIGH return max value in format of RANGEDEV device, see LMAX.

SMAX ALL will be a special case and will return the id# number of the last field in scan table.

SMIN Return minimum legal value of field in scan table

START, STOP and STEP fields return min value in format of OUTPUT device, see LMIN .

LOW and HIGH return min value in format of RANGEDEV device, see LMIN.

| | |
|---|---|
| SID$ | Return ID string ( name ) of field in scan table. SID$ ALL will be a special case and will returns the names of all the fields in the scan table, see LID$ |
| SID# | Return ID number ( field number ). |
| SINI | Initialise field in scan table - set to its default - same as SSET without a value. |

SID$ all Returns a string of all the scan fields.

```
example SID$ all      returns

"scan","row","cycles","interval","state","output","start","stop","step","input","
rangedev","low","high","current","zero","dwell,"settle","mode","report","options"
,"return","type","env",↵
```

SGET all Returns a string in the same format as required by CMD=. All fields are included except env, in the same order as SID$ all.

```
example SGET all

Ascans,1,0,.000,"",mass,1.00,50.00,1.00,SEM,PIC_SEM_range,+1,+7,+6,0,100%,100%,1,
17,"BeamOnBefore:,BeamOffAfter:",None,Bar,↵
```

### 2.4.1. Scan Table Column Logical Names

The SID# command may be used to get the field number of any field. The field number may be substituted for the field name in the examples below. Likewise logical device numbers may be substituted for logical device names.

scan Sets scan device field of scan table. Must be a scan device Ascans to Zscans. Must be specified before row.

*Default, initially Ascans. Subsequently the last SCAN edited.*

```
Example SSET scan Bscans

Error:

        "Command error  41  Scan field out of range "
```

row Sets current row of current sdev table.

*Default, last row +1. Will fill in gaps in scan table, so if you delete scans using SDEL then ROW will default to the first deleted line.*

```
Example SSET  row 1
```

Error:

"Command error  42  Row field out of range "

cycles

Sets the number of cycles to scan. If 0 scans until stopped or aborted.

This command applies to all rows in the scan logical device.

Example SSET cycles 100

interval

Sets the minimum time for a cycle in seconds to 3 decimal places.

This command applies to all rows in the scan logical device.

Example, to set the minimum cycle time to 1 minute:

SSET interval 60

state

States are not all mutually exclusive, 1 or more states may be selected by including them in the option string. Every option ends in : which is a required part of the option name. Options may be separated by [ ][,][ ] or concatenated. If spaces are included the entire option string must be quoted.

This command applies to all rows in the scan logical device.

The entire set of options is returned by SMAX state  e.g.

"Init:,Run:,Stop:,Wait:,Abort:"

The default option is returned by SMIN state e.g.

""

*When the scan logical device has been initialised the state becomes Init:*

*When the scan is started the state becomes Run:*

Example, to stop a scan at the end of the current cycle:

SSET state Stop:

Example, to abort a scan ( equivalent to L999 <scan> ).

SSET state Abort:

Example, to make a scan wait at the end of the current cycle:

SSET state Wait:

Example, to resume scanning when in Wait: state:

SSET state ""

| | |
|---|---|
| output | Scan Output Logical Device. Must be set before START,STOP or STEP. If a scan logical device it must have a ldev number > SCAN<br><br>*Default: mass*<br><br>Example SSET output energy<br><br>Error:<br><br>"Command error 43 Output device field out of range " |
| start | Start "mass" in units of OUTPUT, Scan Output Logical Device<br><br>N.B. Setting START also sets STOP. This ensures that STOP is not less than START. It enables rapid entry of MID type scans. To set up a scan from MIN to MAX default the START.<br><br>LMIN start will return MIN value of device in output. LMAX start will return MAX value of device in output.<br><br>*Default min value of device in OUTPUT. NB SINI START also sets STOP to max value of device in OUTPUT.*<br><br>Example SSET start 1<br><br>Error:<br><br>"Command error 44 Start field out of range " |
| stop | Stop "mass" in units of device in OUTPUT, Scan Output Logical Device<br><br>LMIN stop will return MIN value of device in output or value of start field, whichever is greater. LMAX stop will return MAX value of device in output.<br><br>*Default max value of device in OUTPUT.*<br><br>Example SSET stop 100<br><br>Error:<br><br>"Command error 45 Stop field out of range " |
| step | Step size in units of device in OUTPUT, Scan Output Logical Device. A negative step value scans from STOP to START<br><br>LMIN step will return RES value of device in output. LMAX step will return stop-start.<br><br>*Default 1 or LRES value of device in OUTPUT, whichever is greater.* |

Example SSET step 1

Error:

"Command error 46 Step field out of range "

input Scan Input Logical Device. Must be set before RANGEDEV, LOW, HIGH, DWELL and SETTLE. If a scan logical device it must have a ldev number > SCAN

*Default FARADAY.*

Example SSET input FARADAY

Error:

"Command error 47 Input device field out of range "

rangedev Scan Range Logical Device. MUST be *range*, the default.

Error:

"Command error 48 Range device field out of range "

low Scan Low Range. Low autorange limit. Represents lowest pressure range.

LMIN low will return MIN value of device in input. LMAX low will return MAX value of device in input.

*Default - lowest range available - LMIN value of device in RANGEDEV.*

Error:

"Command error 49 Low range field out of range "

high Scan High Range. High autorange limit. Represents highest pressure range.

LMIN high will return MIN value of device in input or the value of the low field, whichever is greater. LMAX high will return MAX value of device in input.

*Default highest range available - LMAX value of device in RANGEDEV.*

example

```
SSET low -7
SSET high -5  allows autoranging between 10-5 and 10-7, avoiding head amp
resistor change.
```

example

```
SSET low -8
SSET high -7   might be used to allow 1 decade autorange while using -8
"fixed" range  with an RS > 1
```

Error:

"Command error 50 High range field out of range "

current Scan current Range. Pressure range next reading to be measured on. Autoranging will alter this value between the limits of low and high.

LMIN current will return value of low field. LMAX high will return value of high field.

*Default high field value - 1..*

example
SSET low -7
SSET high -5 allows autoranging between 10-5 and 10-7, avoiding head amp resistor change.
SSET current -7 Start on range -7

Error:

"Command error 51 Current range field out of range "

zero If set to 1 the input device will be nulled ( zeroed ) at the start of the scan.

dwell Dwell. % of normal settling time or an absolute value.

*Default 100%*

example SSET dwell 500% sets the dwell to 5 x normal value for range.

example SSET dwell 1000 sets the dwell to 1000ms absolute, regardless of range

Error:

"Command error 52 Dwell time field out of range "

settle Settling time. % of normal settling time or an absolute value.

*Default 100%*

example SSET settle 50% sets the settling time to 1/2 normal value for range.

example SSET settle 100 sets the settling time to 100ms absolute, regardless of range

mode State of mode logical device for this scan. Mode 1 = RGA, mode 2 = +ve ion SIMS, mode 3 = -ve ion SIMS. If setting the mode involves changing the mode then the global environment is restored before the mode is changed. The mode is restored when a nested scan returns to the calling scan.

*Default 1*

example SSET mode 2 sets the mode to +ve ion SIMS.

report Report format for data command. Each bit in the report value corresponds to a part of the result format of the DATA command. Briefly: bit 0 input value, 1 input device name, 2 output value , 3 output device name, 4 elapsed time. See section 2.1.0.1, "Returned Data", page 19 for more information.

example SSET report 5 ; DATA command will report <o/p-val>:<i/p-val>, for this scan.

*NOTE: To speed up measurement where storage of the elapsed time is not required if bit 4 is not set the elapsed time is not read and stored.*

type — scan type - Affects default timings. Set automatically according to values in Stop Start and Step and the Align: return type. Automatic setting can be over-ridden using SSET type.

The entire set of options is returned by SMAX state e.g.

"Bar,Profile,MID,Total,Align"

The default option is returned by SMIN state e.g.

Bar

Bar , set if stop <> start and step = 1. Settle time occurs before every reading.

Profile, set if stop <> start and step <> 1. Settle time occurs before first reading, therafter the shorter hesitate time is used.

MID, set if stop = start . Settle time occurs before every reading.

Align, set if Align: return type is selected. Uses slower timings to improve accuracy.

Log, not set automatically. Users 5 x longer dwell to increase dynamic range.

options — Scan options. Options control the operation of some features of the scan. Options are not mutually exclusive, 1 or more options may be selected by including them in the option string. Every option ends in : which is a required part of the option name. Options may be separated by [ ][,][ ] or concatenated. If spaces are included the entire option string must be quoted.

The entire set of options is returned by SMAX options e.g.

"RestartAutoRange:,NoDeferAutoRange:,SaveScanDev:BeamOnBefore,BeamOffAfter"

The default option is returned by SMIN options e.g.

":BeamOnBefore,BeamOffAfter"

RestartAutoRange causes the current scan to be aborted and a new scan started on the next range as soon as an overrange peak is detected. Data is not made available for recall until the scan is complete.

NoDeferAutoRange forces remeasurement of a scan if the peaks are out of range. Data is not made available for recall until the scan is complete.

SaveScanDev effectively adds the scan output device invisibly to the scans environment. This causes the value of the scanned device to be preserved.

BeamOnBefore turns the beam on at the start of the scan. BeamOffAfter turns the beam off at the end of the scan. By default these are both set, this avoids damage to the SEM if the last mass measured is intense and avoids saturation of the input amplifier when you jump across an intense peak between scans.

return

Scan return value function. This function determines the value returned by the scan. Return functions are mutually exclusive, 1 and only 1 return function must be selected.

The entire set of return functions is returned by SMAX return e.g.

"None,Align,AutoTune,Max,Sum,Top,XvalAtMaxY"

The default option is returned by SMIN return e.g.

"None"

None does not return a value. The scan logical device will return the last value that it returned unchanged.

Align is used for mass scale alignment. It returns the DAC position that corresponds to the top of the peak and also enters this value and the centre mass of the scan into the mass table. If an entry already exists at that mass it is overwritten, otherwise an new entry is created. If no maximum is found the mass table is not changed.

AutoTune is used for tuning the global environment. It searches for the maximum in a scan and leaves the output device set to the corresponding value. If no maximum is found the previous value of the device is restored.

`Max returns the biggest value measured.

Sum returns the total of all values measured.

Top returns the average across the top of the peak. 2 times the value in the AutoTuneWindow parameter points are averaged - this number should be small in proportion to the peak width so that they all lie on the plateau otherwise Top will underestimate the peak height.

XvalAtMaxY returns the value of the output device at the point at which the highest reading was read - it also sets the output device to this value. The SaveScanDev option may be used with this return function to restore the output device to the value it had prior to the scan.

env

Scan environment. List of logical devices and values. Devices are read prior to the scan and then set to new value. Restored to old value after scan, unless set by next scan.

ENV has special syntax:

SGET env

returns the entire environment list

SGET env n,

returns just nth element as <ldev>,<val>, .

SMIN env

returns min ldev number name

SMIN env n,

returns min value of ldev in nth element as <ldev>,<val>, .

SMAX env

returns max ldev number name

SMAX env n,

returns max value of ldev in nth element as <ldev>,<val>, .

SSET env <scan-name>,n

where <scan-name> is Ascans ... Zscans

creates a link to scan <scan-name>, row n's environment list, if this in turn is a link it creates a link directly to the list.

SSET env n, <val>

where n is a number in range 1...26 set nth element to <val>.

SSET env <ldev>, <val>, [ldev, <val>,]*

creates a new environment list.

SSET env

Ignored.

SINI env

Deletes environment list..

*Default - no environment.*

#### 2.4.1.1. Notes on using the env field

The logical devices in the environment list are read prior to the start of a scan and their values stored. They are then set to required value. They are reset to their previous value at the start of the next scan, unless that scan too sets the device in its list. At the end of acquisition any remaining devices are reset to their original value.

The acquisition code creates a copy of the environment list before setting the devices so editing the list may occur at the same time as acquisition. Read values are stored in another copy of the list so at least 2 x the length of the longest environment list should be available as free environment space while scanning.

A consequence of reading the device values prior to each scan is that the environment may be used to preserve the value of a scanned device by setting the output device in the environment list to the start value. E.g.

```
sset output energy
sset start 1
sset stop 100
sset env energy 1
```

will scan energy from 1 to 100 and reset energy back to its original value at the end of a scan.

When nesting scans it is probably best to use sset env <ldevname> <row> to link environments to the topmost scan.

Setting an env with a list unlinks the scan. Editing by sset env <n> <val> does not.

Environment ldevs are not locked until they are used so locking conflicts are possible. As most output ldevs do not call the scheduler ( PAUSE ) this should not be a problem. In theory if a device is read when locked it may return 0 resulting in the wrong value being restored after a scan. A future version should handle this better.

## 2.5. Logical Devices

There are two main classes of logical devices: Physical devices and group devices. Device groups serve two functions: 1 to enable a number of devices to change state simultaneously. 2 to identify the capabilities of devices.

In case 1 the group device responds to all commands except LSLO, LINT & LVAL, which perform no useful function.

LSET sets is used to select the state of the group. Each device in the group may have up to 7 stored values. LSET sets the index into these values and sets the device to the value stored at that index.

LGET returns the current index of the group.

LMIN returns the minimum index. LMAX the maximum. Internally LINT may be used as an offset to the index - but the default value is referenced so changing LINT will have no effect.

LRES will always return 1.

LID$ returns the logical device names of all devices in the group in comma separated quoted string format.

LID# returns the logical device number of the group ( NOT of all its members! ).

LDEF sets all devices in the group to their default.

LINI initialises all devices in the group.

LNUL nulls all devices in the group.

LSTA is not useful.

In case 2 the only useful command is LID$, the group is used solely to identify its members.

### 2.5.1. Type 1 Groups

The command LID$ groups will return all group devices.

```
Example LID$ groups

Returns:
"rangedev","total/partial","switched","measurement","reference","extraction","sec
tor","quad","detector","source","degassing","mode","all","map","input","output","
environment","others","global","control",
```

all Used to access all logical devices except groups. Use LINI all to initialise all logical devices.

LSET ALL will ignore its argument - it will set all devices group indices to their default and set the last used value at that index. LMAX ALL will return the number of logical devices.

mode A group used to select RGA/SIMS operation. Index 1 selects RGA values, index 2 SIMs +ve ion and index 3 SIMS -ve ion.

switched A group used to turn the SEM HT on or off, i.e. multiplier & 1st-dynode. switched supports the following states 0 = SEM, 1 = Faraday , 2 = Total Pressure , 3 = shutdown.

enable A group used to emulate the enable control signal.

shutdown A sub-set of those devices in mode, but not in switched. Used internally by enable.

degas A group used turn degassing on or off.

beam A group used to turn the beam off in systems without a beam PIA device

total/partial A group that contains those devices that need to be switched when changing from Total pressure measurement to Partial Pressure measurement - used internally by the total input device.

measurement Devices used for measuring signal intensity.

```
The command LID$ measurement
```

returns: "SEM","Faraday","Total","auxiliary1","auxiliary2",

rangedev Used internally. When a device whose ID# precedes a device in the measurement group is in the rangedev group it may be used to set the range of the device in the measurement group.

The command LID$ rangedev

returns:
"SEM_range","Faraday_range","Total_range","auxiliary1_range","auxiliary2_range","nul_range",

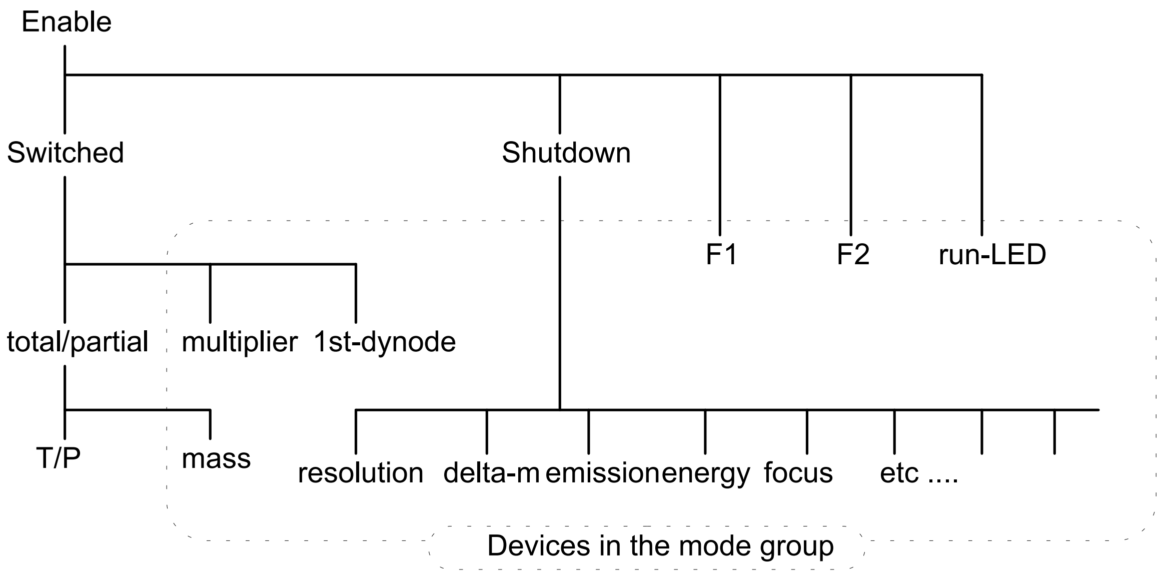
### 2.5.1.1. Device Hierarchy

Devices have 8 possible values. Which value is used is determined by the mode and the state of the device. When the state is 0 the mode is used as the index to the value, otherwise the state is used as the index; as shown below:

| VALUE 1 | VALUE 2 | VALUE 3 | VALUE 4 | VALUE 5 | VALUE 6 | VALUE 7 | VALUE 8 |
|---|---|---|---|---|---|---|---|
| Shutdown | RGA | +ve ion SIMS | -ve ion SIMS | -ve ion RGA | | | |
| MODE 0 | MODE 1 | MODE 2 | MODE 3 | MODE 4 | | | |
| STATE 8 | | | | | STATE 3 | STATE 2 | STATE 1 |

LGET and LSET operate on the value indexed by the mode of the device, regardless of the state of the device.

The device hierarchy is shown diagramatically below:



#### 2.5.1.1.1. enable

enable is a state device used to emulate the hardware enable signal of the HA-061-303 interface. When enable is 1 devices operate normally, when 0 they are forced into a safe state: the filaments are turned of the SEM HT supplies turned off and all other devices switched to their shutdown mode values.

When enable is set to 1 the state of its member devices is set to 0, the value of devices in the mode group then depend on their mode.

When enable is set to 0 the state of its member devices is set to 1. F1 F2 and run-LED are forced off ( they must have 0 in their Value 8 ). Devices in the shutdown state group are forced to their shutdown value ( Value 0 ). The switched state group is switched to shutdown, turning of the multiplier HT and 1st-dynode. Mass takes its shutdown value ( Value 0 ).

#### 2.5.1.1.2. shutdown

Originally enable forced the mode group into mode 0 but this conflicted with the operation of local environments:- if enable was changed during scanning ( e.g. by a trip ) then the saved environment value was restored to Mode 0. Therfore the shutdown group is now used to force devices to their shutdown value without changing their mode ( LGET and LSET get/set the value of the current mode, regardless of the current state ).

shutdown is a state device used to force its member devices into the shutdown state ( state 8 ), i.e. force them to use mode 0 values. It contains all the devices in the mode group except those that are decendants of switched. ( In fact shutdown sets all devices in the L613_MODE group and mode sets all devices that are either in the L613_MODE group or the L626_NONSHUTDOWN group; descendants of switched have been moved from L613_MODE to L626_NONSHUTDOWN ).

When shutdown is set to 0 the state of its member devices is set to 0, when shutdown is set to 1 the state of its member devices is set to 8.

#### 2.5.1.1.3. switched

switched is a state device used to set various devices according to the current input device selected. Switched can be set to the following values:

| | |
|---|---|
| 0 | SEM |
| 1 | Faraday |
| 2 | Total |
| 3 | Shutdown |

The value that switched is set to corresponds to the state that its member devices are set to.

These values are used to set the state of total/partial multiplier and 1st-dynode. When switched is 0 the value used by multiplier and 1st-dynode depends on the mode of the devices.

To ensure that the multiplier and 1st-dynode are off when switched is 1 2 or 3 multiplier and 1st-dynode must have 0 in Value 6, Value 7 and Value 8.

So that when enable is set 0 switched is set to Shutdown switched is configured to have these values:

| VALUE 1 | VALUE 2 | VALUE 3 | VALUE 4 | VALUE 5 | VALUE 6 | VALUE 7 | VALUE 8 |
|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |

**2.5.1.1.4. total/partial**

total/partial is a state device used to set the state of T/P and mass. Its state is in turn set by switched. When switched is set to 0 ( SEM ) total/partial is set to the value in its Value 1 ( 0 ). When switched is set to 1 ( Faraday ) uses the value in Value 8 ( 0 ). When switched is set to 2 ( Total ) uses the value in Value 7 ( 1 ). When switched is set to 3 ( Shutdown ) uses the value in Value 6 ( 8 ).

The value that total/partial is set to corresponds to the state that its member devices are set to.

total/partial is configured to have these values:

| VALUE 1 | VALUE 2 | VALUE 3 | VALUE 4 | VALUE 5 | VALUE 6 | VALUE 7 | VALUE 8 |
|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 8 | 1 | 0 |

so that the value that total/partial is set to depends on its state and its state corresponds to the value of switched:

| Switched = | total/partial = | use |
|---|---|---|
| 0 | 0 | SEM |
| 1 | 0 | Faraday |
| 2 | 1 | Total |
| 3 | 8 | Shutdown |

When set to 0 total/partial sets the state of T/P and mass to 0. In state 0 T/P uses Value 1; Value 1 is set to select Partial Pressure measurement. In state 0 the value used by mass spends on the mode.

When set to 1 total/partial sets the state of T/P and mass to 1. State 1 selects value 8. Value 8 of T/P contains the value required to select Total Pressure measurement. In state 1 mass uses Value 8. Value 8 of mass contains 20.00, the mass at which total pressure measurements are taken.

When set to 8 total/partial sets the state of T/P and mass to 8.

In state 8 T/P uses Value 1; Value 1 is set to select Partial Pressure measurement. In state 8 mass uses Value 1, the value used in mode 0 ( shutdown ), whatever mode mass is in.

total/partial should not be set to any other values than 0, 1 or 8.

total/partial should not be set directly, it should only be set by switched. Its Values should not be changed - do not set using LPUT.

### 2.5.2. Type 2 Groups

| | |
|---|---|
| groups | LID$ groups returns the names of all groups. |
| input | All input devices. |
| output | All output devices. |
| global | Devices in the global environment |
| environment | Devices in the local environment |
| others | Other devices that MasSoft needs to know about ( eg the filaments F1 and F2 ). |
| map | A group of devices used on SIMS instruments, corresponding to a devices available in the Map Gallery dialogue box as "Available to scan". |
| control | Reserved for future use by Hiden. |

#### 2.5.2.1. Type 2 Groups corresponding to HAL II SIMS menus

| | |
|---|---|
| reference | A group of devices used on High Energy SIMS instruments, corresponding to a Tune menu. |
| extraction | A group of devices used on SIMS instruments, corresponding to a Tune menu.<br><br>extractor, lens1. |
| sector | A group of devices used on SIMS instruments, corresponding to a Tune menu.<br><br>energy, D.C.quad , horiz, vert, plates, axis, lens2 |
| quad | A group of devices used to control the quadrapole analyser, corresponding to a Tune menu.<br><br>delta-m, resolution, focus2, suppressor. |
| source | A group of devices used to control the RGA ion source, |

|  |  |
|---|---|
|  | corresponding to a Tune menu.<br><br>emission, e-energy, cage. |
| detector | A group of devices used the detector operating parameters, corresponding to a Tune menu.<br><br>1st-dynode, multiplier, discriminator. |

### 2.5.3. Scan Logical Devices

|  |  |
|---|---|
| Ascans | ..... |
| Zscans | Names used to replace logical devices with scans when building scan lists.<br><br>You **MUST** use LINI Xscans to initialise a scan and all its dependants before using LGET Xscans or LSET Xscans.<br><br>LGET Xscans will cause the scan to run from its start to its stop .<br><br>LSET Xscans n will execute the nth step of a scan.<br><br>Use LSET cycles n to make the scan repeat n times. |

### 2.5.4. Range Devices

Certain input devices have an associated range device. The range device is not listed by the command *LID$ all* so is hidden from the user. Range devices may be listed by the comand *LID$ rangedev*. A range device always precedes its associated device in the logical device table ( ie its logical device number is one less than its associated input device ). A range devices name is usually ( BUT NOT ALWAYS ) the name of the input device suffixed with _range.

Range devices are not normally set by the user. Generally a scan will be used to take the reading. When a device with an associated range device is specified as the input device of a scan the scan's rangedev field is automatically set to the appropriate device. There is no need to make an entry in the rangedev field. The value in the scan's current field is set to the range device prior to taking a measurement.

If you do wish to take a reading other than from a scan then first set the range using the command *LSET <rangedev> <n>*, then take the reading using *LGET <inputdev>;* where <n> is the required range. The convention for naming ranges follows that for pressure ranges: thus range -5 means the $10^{-5}$ range, that is a range with a maximum ( full scale ) reading of $10x10^{-5}$ . On the auxiliary input therefore range 0 has 10V FSD ( $10x10^{+0}$ ) and with the x10 amplifier switched in the range is -1 ( 1V FSD = $10x10^{-1}$ ). Take particular care with the ESP current input. The 100mA range is range 1 ( 100mA = $10x10^{+1}$ ), the 10mA range is range 0 ( 10mA = $10x10^{+0}$ ), the 1mA range is range -1 ( 1mA = $10x10^{-1}$ ) and the 0.1mA range is range -2 ( 0.1mA = 10x10$^{-2}$ ).

If you take a reading on another range-switched input device use *LINI <inputdev>* to set the device to its current range before taking a reading using *LGET <inputdev>*.

Each range of a device has a Slope, Intercept and Offset DAC value associated with it. When you initialise an input device or set a range the appropriate values are copied into the input devices slope and intercept and the offset DAC is set.

The Slope, Intercept and Offset DAC value are usually calculated for the current range and stored by the *LNUL <inputdev>* command, or by setting the zero field to 1 in a scan.

If you need to set them manually ( eg for calibrating the ESP current input ) the following procedure must be followed:

1 Set the range by the command LSET <rangedev> <n>

2 Set the slope by the command LSLO <inputdev> <slope>

3 Set the intercept by the command LINT <inputdev> <int>

4 Set the offset DAC by the command LSET <offset-dac> <offset>

N.B. - the auxiliary inputs and the ESP voltage & current devices do not use an offset DAC so this steps may be omitted.

5 Copy these value to the range devices offset table by the command LNUL <rangedev>

These steps must be repeated for each range.

Note that the <int> intercept value is an integer not a floating point number. It is the offset on the current range of <inputdev>. E.g. if the offset is 4.23 x 10$^{-11}$ on range -9 then <int> is 0.0423 ( <int> = 4.23x10$^{-11}$ / 10$^{-9}$.) For the input device "current" on the 100mA range an offset of 1.24mA gives an <int> value of 0.124 ( 100mA range is 10x10$^{+1}$ range therefore <int> = 1.24 / 10$^{+1}$ )

The command *LINI <rangedev>* will reset all ranges to their default slope, intercept and offset.

## 2.5.5. Analogue RGA Physical Devices

*NOTE: The number and order of logical devices varies according to the configuration of the instrument. The user should interrogate the instrument by sending a LID$ all command to list the names of all devices. Then for each device name returned by LID$ all send a LID# <name> command to obtain the devices ldev number.*

On a standard RGA system LID$ all returns:

"multiplier","i/p_select","local_range","head_range","trip1","trip2","optrip","emission-LED","fault-LED","inhibit","RGA/SIMS","emission-range","F1","F2","beam","filok","emok","ptrip","IO1","IO2","IO3","IO4","IO5","rangedev","Faraday","Total","auxiliary1","auxiliary2","resolution","delta-m","mass","synch","rendezvous","mode","clock","mSecs","elapsed-time","delay","watchdog","enable","mode-change-delay",

| | |
|---|---|
| multiplier | The SEM HT DAC. This device is in the switched state-group. When switched is set to the HT off state then no multiplier voltage will be applied, regardless of the value written to this device. |
| i/p_select | For internal use only. Operates the input multiplexor. Set automatically when input device ( SEM Auxiliary1 etc ) is initialised. |
| local_range | For internal use only. Selects the local amplifier gain range ( x10 x1 ). |
| head_range | For internal use only. Selects the amplfier range in the RF head. |
| trip1 | Trip 1 relay output. 1 = on & increments use count , 0 = off, -1 decrements use count, turns trip off when it counts down to 0. |
| trip2 | Trip 2 relay output. 1 = on & increments use count , 0 = off, -1 decrements use count, turns trip off when it counts down to 0. |
| optrip | Overpressure relay output - clearing this is equivalent to STATUS RESET |
| emission-LED | Operates the emission LED on the front panel. 1 = on, 0 = off. Normally operated by a built in event sequence ( usually runs as task 3 ). |
| fault-LED | Operates the fault LED on the front panel. 1 = on, 0 = off. |
| inhibit | External trip input |
| RGA/SIMS | Changes mode of hardware. Do not operate directly. Set appropriately when the mode logical device is set. Redundant on an RGA instrument |
| emission-range | Changes emission range. The emission logical device sets this automatically. Changing this will change the value returned by LGET emission. Redundant on an RGA instrument |
| F1 | Filament 1 : 1 = on , 0 = off. |

| | |
|---|---|
| F2 | Filament 2: 1 = on , 0 = off. |
| beam | Beam on/off selection |
| ptrip | Overpressure trip input |
| filok | Current OK input |
| emok | Emission OK input |
| tripn | Trip n TTL output ( if configured in place of IO(n-2)). |
| IO1 | Input from Aux I/O T1 pin 10 . TTL output, set to 1 = 5V, 0 = 0V. Can also be configured as an input. |
| IO2 | Input from Aux I/O T2 pin 23 . set to 1 = 5V, 0 = 0V. Can also be configured as an input. |
| IO3 | Input from Aux I/O T3 pin 11 . set to 1 = 5V, 0 = 0V. Can also be configured as an input. |
| IO4 | Input from Aux I/O T4 pin 24 . set to 1 = 5V, 0 = 0V. Can also be configured as an input. |
| IO5 | Input from Aux I/O T5 pin 25 . set to 1 = 5V, 0 = 0V. Can also be configured as an input. |
| rangedev | A group logical device containing range devices associated with input devices. |
| Faraday | The main input ( V to F ). NB the LINI Faraday command makes Faraday the current input: turns off the SEM, sets T/P to partial. |
| Total | The main input ( V to F ). NB the LINI Total command makes Total the current input: turns off the SEM, sets T/P to total. |
| SEM | The main input ( ADC or pulse counting ). NB the LINI SEM command makes the SEM the current input. turns on the SEM HT, sets T/P to partial. |
| Auxiliary1 | Auxiliary input 1. NB the LINI Auxiliary1 command makes Aauxiliary1 the current input. |
| Auxiliary2 | Auxiliary input 2. NB the LINI Auxiliary2 command makes Auxiliary2 the current input. |
| none | A dummy input or output device. Min value 0.00, max 1000.00. May be used as a loop counter. |
| resolution | The resolution DAC |
| delta-m | The delta-m DAC |

| | |
|---|---|
| discriminator | The discriminator voltage DAC |
| mass-DAC | Hidden device. The raw mass DAC. Sets the mass DAC in DAC steps. |
| mass | The mass DAC. Sets the mass DAC in amu. DAC values corresponding to a mass are calculated from values in the **masstable** array parameter.<br><br>Use LINI mass to reset the **masstable** to its defaults.<br><br>Use LINT mass <n> to set the intercept of the **masstable** to mass <n>.<br><br>Use LSLO mass <n> to scale the slope of the **masstable**. Only affects the last entry in the **masstable**, which is ignored if there are 4 or more entries.<br><br>This device is in the Total/Partial state-group. When Total is selected it will be set to mass 20 regardless of the value written to the device. |
| energy | Electron energy DAC |
| emission | Emission current DAC |
| electron-energy | Electron energy DAC. |
| cage | Cage voltage DAC - set to -5V to turn off beam if no beam PIA. |
| [<name>] | Any other named DAC |
| mode | Sets the mode of the system. 0 = Shutdown, 1 = RGA, |
| mode-change-delay | Similar to the delay device. This device is in the mode group. When the mode is changed the appropriate delay is invoked. |
| enable | Prior to R2.7, operates the Run LED on the front panel.<br><br>R2.7 onward: A group device that emulates the enable hardware. Turns filaments off , turns the beam off, turns the SEM HT off and operates the front panel Run LED. Set when all DACs have been initialised. Always last logical device. |

### 2.5.6. SIMS Pulse Counting Devices

*NOTE: The number and order of logical devices varies according to the configuration of the instrument. The user should interrogate the instrument by sending a LID$ all command to list the names of all devices. Then for each device name returned by LID$ all send a LID# <name> command to obtain the devices ldev number.*

On a standard EQS High Energy system LID$ all returns:

```
"multiplier","1st-
dynode","i/p_select","local_range","head_range","trip1","trip2
","optrip","raster","LED2","LED3","inhibit","RGA/SIMS","emission-
range","F1","F2
","filok","emok","ptrip","IO1","IO2","IO3","IO4","IO5","resolution","de
lta-m","d
iscriminator","mass","rangedev","SEM","auxiliary1","auxiliary2","refere
nce","emi
ssion","electron-
energy","cage","suppressor","focus2","extractor","lens1","plate
s","lens2","vert","horiz","axis","energy","D.C.quad","X-Raster","Y-
Raster","mode
","clock","mSecs","elapsed-time","delay","watchdog","enable","mode-
     change-delay"
```

multiplier set the multiplier voltage. This device is in the switched state-group. When switched is set to the HT off state then no multiplier voltage will be applied, regardless of the value written to this device.

1st-dynode sets the 1st dynode volatge on the multiplier. This device is in the switched state-group. When switched is set to the HT off state then no 1st dynode voltage will be applied, regardless of the value written to this device.

i/p_select For internal use only. Operates the input multiplexor. Set automatically when input device ( SEM Auxiliary1 etc ) is initialised.

local_range For internal use only. Selects the local amplifier gain range ( x10 x1 ).

head_range For internal use only. Selects the amplfier range in the RF head.

trip1 Operates trip relay 1. 1 = on & increments use count , 0 = off, -1 decrements use count, turns trip off when it counts down to 0.

trip2 Operates trip relsay 2.1 = on & increments use count , 0 = off, -1 decrements use count, turns trip off when it counts down to 0.

optrip Operates over pressure trip relay output.

| | |
|---|---|
| raster | Set to 1 to enable rastering, 0 to disable. |
| LED2 | Operates the indicator LED2 on the rear of the pulse counting card. |
| LED3 | Operates the indicator LED3 on the rear of the pulse counting card. |
| inhibit | "Inhibit" external trip input. |
| RGA/SIMS | Changes mode of hardware. Do not operate directly. Set appropriately when the mode logical device is set. |
| emission-range | Changes emission range. The emission logical device sets this automatically. Changing this will change the value returned by LGET emission. |
| F1 | Selects filament 1: 1 = on , 0 = off. |
| F2 | Selects filament 2: 1 = on , 0 = off. |
| filok | Filament status input |
| emok | Emission status input |
| ptrip | Pressure trip input ( non functional on SIMS sysytems, even if present ). |
| IO1 | Input from Aux I/O T1 pin 10 . TTL output, set to 1 = 5V, 0 = 0V. Can also be configured as an input. |
| IO2 | Input from Aux I/O T2 pin 23 . set to 1 = 5V, 0 = 0V. Can also be configured as an input. |
| IO3 | Input from Aux I/O T3 pin 11 . set to 1 = 5V, 0 = 0V. Can also be configured as an input. |
| IO4 | Input from Aux I/O T4 pin 24 . set to 1 = 5V, 0 = 0V. Can also be configured as an input. |
| IO5 | Input from Aux I/O T5 pin 25 . set to 1 = 5V, 0 = 0V. Can also be configured as an input. |
| resolution | 8 bit DAC |
| delta-m | 8 bit DAC |
| discriminator | 8 or 12 bit DAC |
| mass-DAC | Hidden device. The raw mass DAC. Sets the mass DAC in DAC steps. |
| mass | The mass DAC. Sets the mass DAC in amu. DAC values corresponding to a mass are calculated from values in the **masstable** array parameter. |

| | |
|---|---|
| | Use LINI mass to reset the **masstable** to its defaults.<br><br>Use LINT mass <n> to set the intercept of the **masstable** to mass <n>.<br><br>Use LSLO mass <n> to scale the slope of the **masstable**. Only affects the last entry in the **masstable**, which is ignored if there are 4 or more entries. |
| rangedev | A group logical device containing range devices associated with input devices. |
| SEM | Pulse counting  input device. |
| Auxiliary1 | Auxiliary input 1. NB the LINI Auxiliary1 command makes Auxiliary1 the current input. Input range is +/- 10V by default. Can be configured for other input ranges ( e.g. temperature ). |
| Auxiliary2 | Auxiliary input 2. NB the LINI Auxiliary2 command makes Auxiliary2 the current input. Input range is +/- 10V by default. Can be configured for other input ranges ( e.g. temperature ). |
| none | A dummy input or output device. Min value 0.00, max 1000.00. May be used as a loop counter. |
| emission | Sets the demanded emission in micro Amps. |
| Tuning DACS: | electron-energy, cage, suppressor, focus2, extractor, lens1, plates, lens2, vert, horiz, axis, energy, D.C.quad |
| mode | Sets the mode of the system. 0 = Shutdown, 1 = RGA, 2 = +ve ion SIMS , 3 = -ve ion SIMS. |
| mode-change-delay | Similar to the delay device. This device is in the mode group. When the mode is changed the appropriate delay is invoked. |
| enable | Enables the system hardware. Set when all DACs have been initialised. Always last logical device. |

### 2.5.7. Other Devices

| | |
|---|---|
| clock | Real time clock. LGET clock returns:<br><br>dd/mm/yy hh:mm:ss<br><br>Set using:<br><br>LSET clock dd mm yy hh mm ss<br><br>Use spaces as sepeator. Enter mm as month number and hh in 24 hour clock. |
| elapsed-time | Elapsed time in dd hh:mm:ss format. dd starts at day |

1.

| | |
|---|---|
| mSecs | Elapsed time from start of scan in milliseconds. |
| elapsed-time | Elapsed time in day# hours/mins/secs.nnn . NB day# = 1 at time 0. |
| delay | Waits for a time in milliseconds. When invoked from task 0 does not wait.<br><br>Example, to wait for 6 seconds:<br><br>LSET delay 6000 |
| watchdog | Returns time in seconds to 3 dp since the last RERR or RBUF command was issued. Use this device to monitor if a PC is polling the BUFFER: and ERROR: streams. |

### 2.5.8. Devices in ESP EPROMS

On EPROMS for the HA-081-300 board LID$ all returns:

"i/p_select","beep","local_range","trip1","trip2","fault-LED","run-LED","head_range",
"calibrate","disconnect","motor_shutdown","motor_fault","IO1","IO2","IO3","IO4","IO5",
"potential","rangedev","auxiliary1","auxiliary2","current","voltage","mode","clock","mSecs",
"elapsed-time","delay","watchdog","none","enable","mode-change-delay",

| | |
|---|---|
| i/p_select | For internal use only. Operates the input multiplexor. Set automatically when input device ( SEM Auxiliary1 etc ) is initialised. 1=n/a (0V), 2=aux1, 3=aux2, 4=current, 5=zero, 6 = scanV, 7 = voltage |
| beep | Operates beeper. 1 = on, 0 = off. |
| local_range | For internal use only. Selects the local amplifier gain range ( 1 = x10 , 0 = x1 ). |
| trip1 | Trip 1 relay output. 1 = on & increments use count , 0 = off, -1 decrements use count, turns trip off when it counts down to 0. |
| trip2 | Trip 2 relay output. 1 = on & increments use count , 0 = off, -1 decrements use count, turns trip off when it counts down to 0. |
| fault-LED | Operates the fault LED on the front panel. 1 = on, 0 = off. |
| run-LED | Operates the run LED on the front panel. 1 = on, 0 = off. |
| head_range | For internal use only. Selects the Current input |

| | |
|---|---|
| | amplfier range. 0 sets .1mA range, 1 1mA range, 2 10mA range and 4 100mA range. 3 will set an illegal range, but as this device is for internal use this error is not trapped. |
| calibrate | Selects 100K calibration input resistor. With this resistor connected 100V set to the potential device will read 1mA on the current device. 1 = calibrate resistor connected, 0 = not connected. |
| disconnect | Disconnects input from probe. 1 = disconnected, 0 = connected. |
| motor_shutdown | Status input from stepper motor controller. 1 = motor shutdown, 0 = OK. |
| motor_fault | Status input from stepper motor controller. 1 = motor fault, 0 = OK. |
| IO1 | Input from Aux I/O T1 pin 10 . TTL input, set to 1 = 5V, 0 = 0V. |
| IO2 | Input from Aux I/O T2 pin 23 . set to 1 = 5V, 0 = 0V. |
| IO3 | Input from Aux I/O T3 pin 11 . set to 1 = 5V, 0 = 0V. |
| IO4 | Input from Aux I/O T4 pin 24 . set to 1 = 5V, 0 = 0V. |
| IO5 | Input from Aux I/O T5 pin 25 . set to 1 = 5V, 0 = 0V. |
| potential | Sets the potential applied to the probe. Range -100.000V to +100.000V. |
| rangedev | A group logical device containing range devices associated with input devices. |
| auxiliary1 | Auxiliary input 1. NB the LINI auxiliary1 command makes auxiliary1 the current input. As at R2.8 the slope of the auxiliary1 device is 910000 . For HA-072-302 from rev A and HA-061-303 from rev F should be 904977. With 910000 10V in reads 9.94V. This value is determined by the 44.2K input resistor to the AD652. On HA-061-303 revs A-E it was determined by 22K & 10K feedback resistors on input op amp. - calculated slope 909091. See NC 008/1.<br><br>This device can have its offset nulled by the command LNUL &lt;device&gt; |
| auxiliary2 | Auxiliary input 2. NB the LINI auxiliary2 command makes auxiliary2 the current input. See auxiliary1 for details.<br><br>This device can have its offset nulled by the command LNUL &lt;device&gt; |
| current | The main input. Reads the probe current. The associated range device is current_range. To select the 100mA range |

use LSET current_range 1 ( sets current range to $10x10^{+1}$ ). Likewise 0 sets 10mA range, -1 1mA range and -2 0.1mA range.

Although this device can have its offset nulled by the command *LNUL current* this only nulls the offset up to the input multiplexer. In normal operation the ESP software in the PC performs a calibration scan and calculates the regression of y on x ( I on V ) to get the slope of the line. ( More accurately the regression of $I_{measured}$ on $I_{applied}$ where $I_{applied}$ = V/100K. ) It then downloads these by first setting the range being calibrated by the command *LSET current_range <n>* then using the command *LSLO current <slope>* to set the slope and *LINT current <intercept>* to set the intercept. Finally the command *LNUL current_range* copies the slope and intercept to the offset table of the current_range device.

voltage Reads the voltage applied to the probe. The associated voltage range device has two ranges - range 0, +/- 100V and range -1, +/- 10V.

This device can have its offset nulled by the command LNUL <device>

none A dummy input or output device. Min value 0.00, max 1000.00. May be used as a loop counter.

mode Sets the mode of the system. 0 = Shutdown, 1 = RGA. This device is redundant in ESP systems.

mode-change-delay Similar to the delay device. This device is in the mode group. When the mode is changed the appropriate delay is invoked.

enable Enables the system hardware. Set when all DACs have been initialised. Always last logical device.

z-motion The z-motion device is not in the all group so is not listed by the *LID$ all* command, nor does the command *LINI all* initialise it; The z-motion must be initialised by the command *lini z-motion* before use. The command *LNUL z-motion* sends the z-motion to the home position. The command *LSET z-motion <n>* may be used to set the z-motion to an absolute displacement of <n>cm from the home position; the z-motion must be homed before the LSET command is used otherwise the error *P137* ( "Problem 137 z-motion has not been homed" ) is produced.

The z-motion device operates by sending commands to the OEM650 stepper motor controller. These commands are held as parameters so that they may be altered. The following parameters are related to the z-motion device:

| | |
|---|---|
| z-motion_baud | Sets the baud rate of the RS232 link to the OEM650: 96 0 8 1 sets 9600 baud, no parity, 8 data bits and 1 stop bit. |
| z-motion_init | The string sent to the OEM650 to initialise it |
| z-motion_home, | The string sent to the OEM650 to move to the home position |
| z-motion_set, | The string sent to the OEM650 to move to a displacement. Contains the string +@! which formats the displacement |
| z-motion_stat, | The string sent to the OEM650 to request its status. |
| z-motion_set_timeout, | The timeout in seconds ( to 3 dp ) for a LSET z-motion command. Default 60s. |
| z-motion_home_timeout | The timeout in seconds ( to 3 dp ) for a LNUL z-motion command. Default 300s. |

The z-motion device can return the following errors:

| | |
|---|---|
| *P130* | "Problem 130 z-motion busy" Status returned by the OEM650 R command indicates that the OEM650 is busy. |
| *P131* | "Problem 131 z-motion error" An unexpected response from the OEM650 has been received. ( A catch-all error ). |
| *F132* | "Fatal error 132 z-motion failure" Status returned by the OEM650 R command indicates that the OEM650 "needs attention". Usually caused by hitting a limit switch. This error is a fatal error. Any scan in progress will be halted. The z-motion must be re-homed by the command *LNUL z-motion* after this error. |
| *P133* | "Problem 133 z-motion comms error" ( Parity error ) |
| *P134* | "Problem 134 z-motion comms error" ( Framing error ) |
| *P135* | "Problem 135 z-motion comms error" ( Overrun ) |
| *P136* | "Problem 136 z-motion timeout". No response was received from the OEM650 within the timeout period for the command or the command failed to complete ( home and move command ) within the |

timeout period.

| | |
|---|---|
| *P137* | "Problem 137 z-motion has not been homed" The z-motion must be homed after initialisation or after a *F132* error before the command *LSET z-motion* may be used. |

### 2.5.9. Devices in the Test EPROMS

On the 072-302 test system LID$ all returns:

"multiplier","i/p_select","beep","local_range","head_range","trip1","trip2","optrip","raster",
"emission-LED","fault-LED","inhibit","run-LED","RGA/SIMS","emission-range",
"F1","F2","beam","degas-PIA","filok","emok","ptrip","IO1","IO2","IO3","IO4","IO5",
"rangedev","PIC-SEM","Faraday","SEM","Total","auxiliary1","auxiliary2","0V","10.24V",
"scanV","resolution","delta-m","discriminator","mass-DAC","mass",
"DAC1","DAC2","DAC3","DAC4","DAC5","DAC6","DAC7","DAC8","DAC9","DAC10",
"DAC11","DAC12","DAC13","DAC14","DAC15","DAC16","DAC17","DAC18","DAC19",
"DAC20","mode","clock","mSecs","elapsed-time","delay","watchdog","none","enable",
"mode-change-delay",

| | |
|---|---|
| multiplier | The 12bit SEM HT DAC on the HA-072-302 board. 0 to 3000V. |
| i/p_select | For internal use only. Operates the input multiplexor. Set automatically when input device ( SEM Auxiliary1 etc ) is initialised. 1=pic, 2=aux1, 3=aux2, 4=main, 5=zero, 6 = scanV, 7 = 10.24V. |
| beep | Operates beeper. 1 = on, 0 = off. ( Present on HA-072-302 from rev D and on HA-061-303 with 7U backplane from rev F ). |
| local_range | For internal use only. Selects the local amplifier gain range ( 1 = x10 , 0 = x1 ). |
| head_range | For internal use only. Selects the amplfier range in the RF head. |
| trip1 | Trip 1 relay output. 1 = on & increments use count , 0 = off, -1 decrements use count, turns trip off when it counts down to 0. |
| trip2 | Trip 2 relay output. 1 = on & increments use count , 0 = off, -1 decrements use count, turns trip off when it counts down to 0. |
| optrip | Overpressure relay output - clearing this is equivalent to |

| | |
|---|---|
| | STATUS RESET on HAL 2. |
| raster | Operates raster Blank signal **and enables rastering interrupt.** |
| emission-LED | Operates the emission LED on the front panel. 1 = on, 0 = off. Normally operated by a built in event sequence ( usually runs as task 3 ). |
| fault-LED | Operates the fault LED on the front panel. 1 = on, 0 = off. |
| inhibit | External trip input |
| run-LED | Operates the run LED on the front panel. 1 = on, 0 = off. |
| RGA/SIMS | Changes mode of hardware. Do not operate directly. Set appropriately when the mode logical device is set. Redundant on an RGA instrument |
| emission-range | Changes emission range. The emission logical device sets this automatically. Changing this will change the value returned by LGET emission. Redundant on an RGA instrument |
| F1 | Filament 1 : 1 = on, 0 = off. |
| F2 | Filament 2 : 1 = on, 0 = off. |
| beam | Beam on/off selection. 1 = on, 0 = off. |
| degas-PIA | Operates !DEGAS line on PIA. |
| filok | Current OK input. 1 = OK, 0 = fail |
| emok | Emission OK input. 1 = OK, 0 = fail |
| ptrip | Overpressure trip input. 1 = OK, 0 = fail. |
| IO1 | Input from Aux I/O T1 pin 10 . TTL input, set to 1 = 5V, 0 = 0V. |
| IO2 | Input from Aux I/O T2 pin 23 . set to 1 = 5V, 0 = 0V. |
| IO3 | Input from Aux I/O T3 pin 11 . set to 1 = 5V, 0 = 0V. . |
| IO4 | Input from Aux I/O T4 pin 24 . set to 1 = 5V, 0 = 0V. |
| IO5 | Input from Aux I/O T5 pin 25 . set to 1 = 5V, 0 = 0V. . |
| rangedev | A group logical device containing range devices associated with input devices. |
| Faraday | The main input ( V to F ). NB the LINI Faraday command makes Faraday the current input: turns off the SEM, sets T/P to partial. |

| | |
|---|---|
| | This device can have its offset nulled by the command LNUL <device> |
| Total | The main input ( V to F ). NB the LINI Total command makes Total the current input: turns off the SEM, sets T/P to total.<br><br>This device can have its offset nulled by the command LNUL <device> |
| SEM | The main input ( ADC ). NB the LINI SEM command makes the SEM the current input. turns on the SEM HT, sets T/P to partial.<br><br>This device can have its offset nulled by the command LNUL <device> |
| PIC-SEM | The pulse counting input. NB the LINI PIC-SEM command makes the PIC-SEM the current input. turns on the SEM HT, sets T/P to partial. |
| auxiliary1 | Auxiliary input 1. NB the LINI auxiliary1 command makes auxiliary1 the current input. As at R2.8 the slope of the auxiliary1 device is 910000 . For HA-072-302 from rev A and HA-061-303 from rev F should be 904977. With 910000 10V in reads 9.94V. This value is determined by the 44.2K input resistor to the AD652. On HA-061-303 revs A-E it was determined by 22K & 10K feedback resistors on input op amp. - calculated slope 909091. See NC 008/1.<br><br>This device can have its offset nulled by the command LNUL <device> |
| auxiliary2 | Auxiliary input 2. NB the LINI auxiliary2 command makes auxiliary2 the current input. See auxiliary1 for details.<br><br>This device can have its offset nulled by the command LNUL <device> |
| 0V | Internal input. Connects input to 0V. See auxiliary1 for details. |
| 10.24V | Internal input. Connects input to 10.24V. See auxiliary1 for details.<br><br>This device can have its offset nulled by the command LNUL <device> |
| scanV | Internal input. Connects input to the output from the mass DAC. See auxiliary1 for details.<br><br>This device can have its offset nulled by the command LNUL <device> |
| resolution | The 8 bit resolution DAC on the HA-072-302 board. +/- 100% |

| | |
|---|---|
| delta-m | The 8 bit delta-m DAC on the HA-072-302 board. +/- 100% |
| discriminator | The 12 bit discriminator voltage DAC on the HA-072-302 board. +/- 100%. **offset** is a hidden alias for this device. |
| mass-DAC | The raw mass DAC. Sets the mass DAC in DAC steps. 0 to 65535 DAC steps. |
| mass | The mass DAC. Sets the mass DAC in amu. DAC values corresponding to a mass are calculated from values in the **masstable** array parameter.<br><br>Use LINI mass to reset the **masstable** to its defaults.<br><br>Use LINT mass <n> to set the intercept of the **masstable** to mass <n>.<br><br>Use LSLO mass <n> to scale the slope of the **masstable**. Only affects the last entry in the **masstable**, which is ignored if there are 4 or more entries.<br><br>This device is in the Total/Partial state-group. When Total is selected it will be set to mass 20 regardless of the value written to the device. |
| DAC1-DAC4 | 12 bit D to As on HA-072-302 board or HA-061-303. +/- 10.00V |
| DAC5-DAC20 | 12 bit D to As on HA-072-304 board or HA-061-303. +/- 10.00V |
| mode | Sets the mode of the system. In the test EPROMS the mode is used to switch the device between its minimum, maximum & zero states. 0 = Shutdown, 1 = Zero, 2 = Maximum, 3 = Minimum |
| mode-change-delay | Similar to the delay device. This device is in the mode group. When the mode is changed the appropriate delay is invoked. |
| enable | Prior to R2.7, operates the Run LED on the front panel.<br><br>R2.7 onward: A group device that emulates the enable hardware. Turns filaments off , turns the beam off, turns the SEM HT off and operates the front panel Run LED. Set when all DACs have been initialised. Always last logical device. |

The following table list all the devices that are changed by the *LSET mode <n>* command. The table shows the value in each mode after the *LINI all* command has been issued. Note that if the device has been set using *LSET <device> <value>* then <value> replaces the the entry in the table for the device in the current mode until *LINI all* is issued.

| Device | Mode 0 | Mode 1 | Mode 2 | Mode 3 |
|---|---|---|---|---|
| "multiplier" | 0V | 0V | 3000V | 0V |
| "RGA/SIMS" | 0 = SIMS | 1 = RGA | 0 = SIMS | 0 = SIMS |
| "F1" | 0 | 0 | 0 | 0 |
| "F2" | 0 | 0 | 0 | 0 |
| "resolution" | 0 | 0 | +100% | -100% |
| "delta-m" | 0 | 0 | +100% | -100% |
| "discriminator" | 0 | 0 | +100% | -100% |
| "mass-DAC" | 0 | 0 | 64000 | 32000 |
| "DAC1" | 0V | 0V | +10.00V | -10.00V |
| "DAC2" | 0V | 0V | +10.00V | -10.00V |
| "DAC3" | 0V | 0V | +10.00V | -10.00V |
| "DAC4" | 0V | 0V | +10.00V | -10.00V |
| "DAC5" | 0V | 0V | +10.00V | -10.00V |
| "DAC6" | 0V | 0V | +10.00V | -10.00V |
| "DAC7" | 0V | 0V | +10.00V | -10.00V |
| "DAC8" | 0V | 0V | +10.00V | -10.00V |
| "DAC9" | 0V | 0V | +10.00V | -10.00V |
| "DAC10" | 0V | 0V | +10.00V | -10.00V |
| "DAC11" | 0V | 0V | +10.00V | -10.00V |
| "DAC12" | 0V | 0V | +10.00V | -10.00V |
| "DAC13" | 0V | 0V | +10.00V | -10.00V |
| "DAC14" | 0V | 0V | +10.00V | -10.00V |
| "DAC15" | 0V | 0V | +10.00V | -10.00V |
| "DAC16" | 0V | 0V | +10.00V | -10.00V |
| "DAC17" | 0V | 0V | +10.00V | -10.00V |
| "DAC18" | 0V | 0V | +10.00V | -10.00V |
| "DAC19" | 0V | 0V | +10.00V | -10.00V |
| "DAC20" | 0V | 0V | +10.00V | -10.00V |
| "mode-change-delay" | 0ms | 1000ms | 1000ms | 1000ms |

## 2.6. Parameters

**all** PID$ all returns:

```
"release","ID","stream","readonly","terse","debug","results","brackets"
,"echoing
","flags","name","anniversary","hesitation","delay-
matrix","terminator","cycles"
,"points","yieldpoints","stack","recall","net-
address","DLC_p_timer","DLC_ack_ti
mer","DLC_rej_timer","DLC_busy_timer","DLC_retries","DLC_tick_timer","p
oll","par
se","AutoTuneWindow","AutoTuneThreshold","AutoTuneMinimum","SearchSpan"
,"SearchW
indow","SearchThreshold","SearchMinimum","masstable","low_mass-
DAC","mass-DAC_se
ttle","raster-coords","raster-dwell","raster-step","SEM_V/mS",,"z-
motion_baud","z-motion_init","z-motion_home","z-motion_set","z-
motion_stat","z-motion_stat","z-motion_stat","z-motion_set_timeout","z-
motion_home_timeout""state","dwell","settle",
```

**anniversary** The clock 0 year.

Default 1980 - must be a leap year. Excel uses 1900, Excel on the Macintosh uses 1904, UNIX uses 1970 - not a leap year.

**AutoTuneWindow** width of window used to find top of peak by scan return functions.

**AutoTuneThreshold** minimum slope of peak, used by scan return functions.

**AutoTuneMinimum** minimum height of peak, used by scan return functions.

**brackets** 6 character string parameter. Parentheses for scan results, by default [](){}. A point ( . ) may be used as a placeholder if a bracket is not required, e.g. ..(){} omits the outermost brackets. Quote the string to include spaces.

**cycles** (0 - 2000M ) Used to cause the scan to repeat itself. If 0 repeats until stopped. This parameter is now obsolete. PSET cycles n is equivalent to SSET cycles n for Ascans.

**debug** (0-1) Flag for debug output.

**delay-matrix** The delay matrix for range changing.

**DLC_p_timer** DLC protocol poll response timer.

**DLC_ack_timer** DLC protocol acknowledge timer

**DLC_rej_timer** DLC protocol reject timer

**DLC_busy_timer** DLC protocol remote busy timer

**DLC_retries** DLC protocol, max number of retries

**DLC_tick_time**r DLC protocol tick timer for above timers.

**dwell** The dwell time used for the last measurement in .1 ms units.

**echoing** (0-1) 0 turns echoing of characters sent to HAL 4 off, 1 turns it on. Only operates in debugging mode.

**hesitation** % of default hesitation ( time between measurements ) delay used by the pulse counting SEM input logical device. Default 100%.

**ID** A readonly parameter, returns the ID string, e.g.

"HAL4 EQP Low Energy"

**low_mass-DAC** Invokes mass-DAC_settle when the mass DAC is set to a DAC value less than the value in this parameter.

| | |
|---|---|
| **name** | Initially the same as ID. May be set to any identifying string. Quote the string to include spaces. |
| **net-address** | Network Ethernet address of HAL4. Use PGET net-address to get network address of instrument. Returns: 2,48,41,0,84,62 |
| **mass-DAC_settle** | Invokes a delay equal to the value in mass-DAC_settle when the mass DAC is set to a DAC value less than the value in the Low_mass-DAC paramter. |
| **masstable** | Table of masses and corresponding DAC positions used by mass logical device. |
| **parse** | Flag to run network by polling rather than under interrupt. Set by PARZ command |
| **points** | Maximum number of data points to report during DATA command. 0 = no limit. |
| **poll** | Flag to run network by polling rather than under interrupt. Set by PARZ command. |
| **raster-coords** | Coordinates of raster area |
| **raster-dwell** | Dwell time for each raster step |
| **raster-step** | Raster step size |
| **readonly** | The last readonly parameter. |
| **recall** | Obsolete |
| **release** | A readonly parameter, returns the release string, e.g. "Release 2.5, 2/7/96" |
| **results** | (0-31) Scan results format - see scan logical device.# |
| **SearchSpan** | width of scan within which to search for a maximum |
| **SearchWindow** | width of window used to find top of peak by search routine. |
| **SearchThreshold** | minimum slope of peak, used by search routine |
| **SearchMinimum** | minimum height of peak, used by search routine. |
| **SEM_V/mS** | Slew rate of SEM HT supply as set by the multiplier device in Volts per ms. |
| **settle** | The settle time used for the last measurement in .1 ms units. |
| **stack** | Debuging aid, stack depth after command. |

**state** Debugging aid. State value of pulse counting state machine.

**stream** A readonly parameter that returns the names of all streams. PGET stream returns:

"COM1:","COM2:","DLC1:","DLC2:","DLC3:","NET1:","NET2:","NE
T3:","ERROR:","BUFFER:","NUL:"

**terminator** Termination character for input read by RERR & RBUF commands - substitutes for a Carriage Return ( ↵ ) character. Default ! .

**terse** (0-1) Flag for terse output. If 1 short format output is used - no text or units.

**yieldpoints** Used to optimise data recall using DATA command. Data task yields to multitasker after the number of data points set in yieldpoints have been processed.

**z-motion_baud** Sets the baud rate of the RS232 link to the OEM650: 96 0 8 1 sets 9600 baud, no parity, 8 data bits and 1 stop bit.

**z-motion_init** The string sent to the OEM650 to initialise it

**z-motion_home** The string sent to the OEM650 to move to the home position

**z-motion_set** The string sent to the OEM650 to move to a displacement. Contains the string +@! which formats the displacement

**z-motion_stat** The string sent to the OEM650 to request its status.z-motion_set_timeout, The timeout in seconds ( to 3 dp ) for a LSET z-motion command. Default 60s.

**z-motion_home_timeout** The timeout in seconds ( to 3 dp ) for a LNUL z-motion command. Default 300s.

**clock-format** The format string for the clock logical device. The default UK format is

" ##/##/## ##:##:##{DMYhms}".

The characters between { and } determine the order of the values. D formats the Day of the month, M formats the month, Y the year, h the hour and s the seconds. Each character between { and } must have a corresponding number format, either ## *# or @# 1/1/91 using ##/##/## displays as "01/01/91",using *#/*#/*# displays as " 1/ 1/91" and using @#/@#/@# displays as "1/1/91", i.e. # displays leading zeroes as 0. * as displays leading zeroes as a space and @ omits them.

The D format character may be followed by a $ to display the time as a TLA, i.e. Jan, Feb, Mar , in which case the corresponding number format must be replaced with a $ E.g. " ##/$/## {DM$Y}"

The following characters are special to the formatter and must be escaped by following with a \ if used as a separator: **#@*!$?^{ }~ . + -** . Use \\ to include \ itself.

To display the time & date as seconds since midnight PM on the 1st Jan of the anniversary year use:

"@#"

**time-format** The format string for the elapsed time logical device.

The default format is

"@#.###"

The elapsed time may be displayed in hours mins & secs using the format:

"##:##:##{hms.///}"

/// between { and } converts milliseconds to seconds by dividing by 10 for each /. # may be substituted for / to display a decimal place: The format "##:##:##.\{hms.#//}" may be used to display the time to 1/10th of a second. and "##:##:##.\{hms.##/} to 1/100th.

## 2.7. Mass Scale Alignment Procedure

Set up a scan structure with a sequence of "profile" scans, the centre mass of each scan being the mass that you wish to align. Use the minimum step size. Set the scans' return fields to Align. Use LINI <scan> to initialise the scan logical device.

Delete the existing mass table using *LINI mass*.

Align the mass table using *SJOB LGET <scan>*

When the scan has completed upload the mass table using *PGET masstable.*

This will return 20 comma separated numbers. These must be stored to be downloaded the next time the controller is used. When downloading replace the commas with spaces - sorry :

*PSET masstable <n> <n> .... <n>*

See Also:

scan "return" field.

masstable parameter.

mass logical device.

## 2.8. Trips & Events

### 2.8.1. Overview

There are two classes of trips.

1 Normal trips check the data as it is acquired and perform actions should limits be exceeded. Normal trips may be tied to a specified scan or may be global. If global you may specify to which input device the trip applies and, optionally, two output device values between which the trip applies.

Each normal trip has two limit values, an upper limit and a lower limit. These may be used in a variety of ways: between limits, outside limits , equal to either limit ( useful when testing on/off values ) above upper limit or less than lower limit; these last two may be used with hysteresis. When a trip exceeds its limits it becomes active and the input value read is stored.

When a trip changes state from inactive to active or active to inactive it can perform 1 of 3 types of action: 1/ Write a value to a logical device, 2/ Enable or disable another trip , or 3/ Run an event sequence.

Normal trips will usually have the trip type field set to *input*, meaning that the trip limits apply to the value read by the input device; however with the trip type set to output the limits apply to the value written to the output device. This may be used in combination with the enable action to apply trips with multiple conditions.

2 Programme trips or Events can execute commands, extract values from stored data, print messages or values and perform simple calculations. A varient of the normal trip may be used as an event where it may be used to check values read directly from a logical device against limits; in addition it can check values extracted or calculated by other Events or the last value that tripped a normal trip. A sequence of this class of trip create an Event sequence.

Event sequences may be used as the actions of normal trips or may be run independantly by means of the TRUN command.

Trips & events are referred to by their "label", this is a name given to the trip when it is created by the *TNEW <label>* command. When created the trip will be a Normal Trip with the type field set to *input*. Trip labels must not be numbers or the same as any logical device name and must be unique. Only the first 7 characters plus the length of the label is stored.

The labels of the existing trips may be displayed by means of the TDIR command. Labels longer than 7 characters will have dots for the extra characters.

The TDIR command will show 20 pre-created trips labelled P1 to P20 - these are the trips used for system protection. P1 is the SEM protection trip; if the upper limit is exceeded it runs the Event sequence in trips P3 to P5 which select mode 0, stop scanning and issue an error message. P2 is the external trip monitor; it checks the inhibit logical device. If this input becomes active ( 1 ) it runs the Event sequence in trips P6 to P10 which select mode 0, stop scanning and issue an error message. P10 waits for the input to return to 0. P11 to P20 are spare.

A trip may be deleted by the command *TDEL <label>*. *TDEL all* deletes all trips except P1 to P20.

### 2.8.2. Trip Commands

Trip commands have the general syntax of <command> <field> <trip-label> <value>. Trips must always be refered to by their label, there is no equivalent of a trip id#. Fields may be refered to by either their name or by the id# returned by the command TID# <field>.

You might think that the <trip-label> would be irrelevant for commands like TMAX where the value returned depends on the maximimum value allowed for a field. This is true for some fields ( e.g. enable ) but for other like >limit the value depends on the logical device entered in another field. Also whether a field is legal depends on the type of trip so <trip-label> is required. *TID$ all* is a special case.

Trying to access a non-existent trip produces the error message:

```
Command error  70  Unknown trip
```

Trying to access a non-existant field produces the error message:

```
Command error  17  Unknown field
```

Not all fields are valid for all types of trip. Trying to access an invalid field produces the message:

```
Command error  97  Trips: field illegal with this type of trip
```

The following commands support trips:

TNEW Create a trip

```
Example : TNEW t1
```

Returns : ↲

Errors :

Entering a number or the name of a logical device as the label :

Command error 73 Invalid trip name

Entering the name of an existing trip :

Command error 72 Trip name already exists

No more unused trips ( maximum number of non-protection trips is currently 100 ) :

Command error 71 Trip table full

## TDEL Delete a trip

Example : TDEL t1

Returns : ↲

Errors : If the trip does not exist :

Command error 70 Unknown trip

*NOTE: The system protection trips P1 to P20 are not deleted by TDEL P<n> or TDEL all , but no error message is produced.*

## TMEM Returns number of free trips left

Example : TMEM

Returns : 99↲

## TDIR Returns names of all defined trips

Example : TDIR

Returns : t1,P20,P19,P18,P17,P16,P15,P14,P13,P12,P11,P10,P9,P8,P7,P6,P5,P4,P3,P2,P1,↲

After using *TDEL all* the order of P1 to P20 returned by TDIR is reversed.

## TSET Set value of trip field.

Example : TSET input t1 mass

Returns : ↲

Errors :

Trying to set **all** produces the error:

Command error 40 Illegal command with ALL

## TGET Return current value of trip field.

Example : TGET >limit t1

Returns : 100000000 c/s↲

Example : TGET all t1

Returns : Returns values of all valid fields, depending on trip type e.g.:

```
       input,SEM,mass,0.40 amu,300.00 amu,<>,0 c/s,100000000 c/s,
              trip1,1 (1 = on, 0 = off ),0 ( 1 = on, 0 = off ),1 ,↲
```

TMAX Return maximum legal value of trip field.

Example : TMAX >limit t1

Returns : 100000000 c/s↲

Example : TMAX all t1

Returns : Returns max value of all valid fields, depending on trip type e.g.:

```
       command,enable,enable,300.00 amu,300.00 amu,=,100000000 c/s,100000000 c/s,
              enable,1 ( 1 = on, 0 = off ),1 ( 1 = on, 0 = off ),1 , ↲
```

TMIN Return minimum legal value of trip field.

Example : TMIN from t1

Returns : 0.40 amu↲

Example : TMIN all t1

Returns : Returns max value of all valid fields, depending on trip type e.g.:

```
       input,Ascans,range,0.40 amu,0.40 amu,<>,0 c/s,0 c/s,
              range,0 ( 1 = on, 0 = off ),0 ( 1 = on, 0 = off ),0 ,↲
```

TID$ Return ID string ( name ) of trip field.

Example : TID$ 2 t1

Returns : ID string ( i.e. name ) of field. Above example returns:

type↲ Note : ID string is not quoted and will not contain spaces.

Example TID$ all t1

Returns : names of all fields valid for the type of trip of t1. E.g for default type *input:*

"type","input","output","from","to","logic","<limit",">limit","action","activate","deactivate","enable",

TID$ all without a <trip-label> argument is a special case and returns all trip field names in comma separated quoted string format in the order of their id#. e.g.:

"type","input","output","from","to","logic","<limit",">limit","action","activate","deactivate","enable","row","next","text","source","expression","format-as","scan","index","cycle","on-error","stream","priority",

TID# Return ID number ( field number ), converse of TID$. Does not require a <trip-label> argument.

Example : TID# next

Returns : <ID number of trip field>↵.
E.g. Above example returns: 15↵

*NOTE: Field ID numbers may change between releases. Always use TID# to establish the ID# of a field.*

TINI Initialise trip field - set to its default. In some cases this nulls a field ( eg *TINI next* ).

*TINI all* initialises all fields except the type.

Example : TINI input

Returns : ↵. Sets the input to the default input, Faraday on analogue instruments, SEM on ion counting instruments.

## 2.8.3. Trip Types

Every trip has a type field. When the trip is created by the TNEW command it will have type "input". The command *TSET type <label> <type>* may be used to change the type of trip.

*NOTE: Changing the type initialises all the other fields.*

The trip types and their fields are shown in the table below. These are the fields that are returned if the command *TID$ all <label>* is used for a trip with the type set as shown in the type column.

*NOTE The command **TID$ all <label>** does not return the fields in order of their TID#.*

All the fields names may be listed in TID# order by omitting the label, eg:

example TID$ all returns

"type","input","output","from","to","logic","<limit",">limit","action","activate","deactivate","enable","row","next","text","source","expression","format-as","scan","index","cycle","on-error","stream","priority",

| TRIP TYPE | FIELD ID$ | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| input | typ | input | output | from | to | logic | <limi | >limit | actio | activ | deactiv | enab |
| output | typ | input | output | from | to | logic | <limi | >limit | actio | activ | deactiv | enab |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| limit | typ | source | logic | <limi | >lim | actio | activ | deactiv | enabl | prior | next | |
| data | typ | scan | row | index | cycl | on- | prior | next | | | | |
| eval | typ | express | format | prior | next | | | | | | | |
| print# | typ | source | format | strea | prior | next | | | | | | |
| print$ | typ | text | stream | prior | next | | | | | | | |
| command | typ | text | stream | prior | next | | | | | | | |

Trip types shown on a grey background are Events.

### 2.8.4. Input Trip Fields

This is the default type of normal trip

| | |
|---|---|
| type | Trip Type. Set to input |
| input | Trip Input Logical device. Scans must have same input device for this trip to apply. If a scan logical device is specified in the input field of the trip then the trip is "tied" to a scan in that scan logical device. The scan must specified by the row field, which replaces the output field.<br><br>The units of the <limit and >limit fields depend on the input device so changing the input fields initializes the <limit & >limit fields. |
| output | Trip Output Logical device. For this trip to apply to a scan the trip and the scan must have the same output device and the value output by the scan must be >= the value in the from field and <= the value in the to field; if the from & to fields are equal this can be determined prior to the start of a scan.<br><br>The logical device all is treated as a special case; in this case the trip will apply to any scan whose input device matches the trips input device, regardless of the scan's output device or the output value.<br><br>This field is replaced by the row field if the input field |

specifies a scan logical device.

row Scan row of a tied trip. This field is only present if the input field specifies a scan logical device. Together the input field and row field specify the scan to which the trip is tied. The trip then behaves as if the scan's input & output fields were its own input and output fields.

Tied trips have a lower processing overhead than global trips because the trip can be linked to a specific scan.

from From output value limit. For this trip to apply to a scan the trip and the scan must have the same output device as the trip and the value output by the scan must be >= the value in the from field and <= the value in the to field; if the from & to fields are equal this can be determined prior to the start of a scan.

**Warning! If the from or to fields are equal and are altered after scanning has started the links to scans may become incorrect.**

If the trip is tied to a scan ( the trips input field is a scan logical device ) then the from & to limits apply to the logical device specified in the scan's output field.

The from & to fields are not used if the output field is set to *all*.

to To output value limit. For this trip to apply to a scan the trip and the scan must have the same output device as the trip and the value output by the scan must be >= the value in the from field and <= the value in the to field; if the from & to fields are equal this can be determined prior to the start of a scan.

**Warning! If the from or to fields are equal and are altered after scanning has started the links to scans may become incorrect.**

If the trip is tied to a scan ( the trips input field is a scan logical device ) then the from & to limits apply to the logical device specified in the scan's output field.

The from & to fields are not used if the output field is set to *all*.

logic The logic field determines the operation of the <limit & >limit values. It may be set to 1 of 7 modes represented by the symbols : <> , >< , < , > , >> , << and = .

| Symbol | Logic | Description |
|---|---|---|
| **<>** | Out of band limit. | If the value being tested is less than <limit or greater than >limit then the trip is active. |

| | | |
|---|---|---|
| >< | In band limit | If the value being tested is greater than or equal to <limit and less than or equal to >limit the the trip is active. |
| < | Low limit | If the value being tested is less than <limit the trip is active. >limit is not used. |
| > | High limit | If the value being tested is greater than >limit the trip is active. <limit is not used. |
| << | Low limit with hysteresis | The trip becomes active when the value being tested is less than <limit. It remains active until the value is greater than >limit. |
| >> | High limit with hysteresis | The trip becomes active when the value being tested is greater than >limit. It remains active until the value is less than <limit. |
| = | Comparison | The trip is active if the value being tested is equal to either <limit or >limit. |

<limit Trip lower limit. The value read by the scan's input device is compared with this limit according to the rules specified by the logic field.

The units, and minimum and maximum value, of this field depend on the device specified in the input field. If the input field is a scan logical device they depend on the input device of the scan specified by the trip's input & row fields.

This field is initialised if the input field is changed.

>limit Trip upper limit. The value read by the scan's input device is compared with this limit according to the rules specified by the logic field.

The units, and minimum and maximum value, of this field depend on the device specified in the input field. If the input field is a scan logical device they depend on the input device of the scan specified by the trip's input & row fields.

This field is initialised if the input field is changed.

action Trip action logical device. This field specifies the device written to when a trip changes state. When a trip becomes active the value in the activate field is written to the device specified in this field. When the trip becomes inactive the value in the deactivate field is written.

A trip can be specified in place of a logical device in which case the trip is enabled when the trip becomes active and disabled when it becomes inactive.

If the action field is set to trun then an event sequence specified in activate is run when the trip becomes active and an event sequence specified in deactivate run when the trip becomes inactive.

Nothing is done if the trip does not change state from active to inactive or vice versa.

activate Trip activate action value. The value in the activate field is written to the action device when the trip changes state to active.

If the action field is set to trun the activate field may contain the name of a trip, which is run as an event sequence. If no action is desired TINI activate <trip-label> nulls this field.

If the action field specifies a trip trying to access the activate field produces the error: *Command error 94 Trips: activate field illegal with trip as action*.

deactivate Trip deactivate action value. The value in the dactivate field is written to the action device when the trip changes state to inactive.

If the action field is set to trun the deactivate field may contain the name of a trip, which is run as an event sequence. If no action is desired TINI deactivate <trip-label> nulls this field.

If the action field specifies a trip trying to access the deactivate field produces the error: *Command error 95 Trips: deactivate field illegal with trip as action*.

enable Trip enable. If this field is set to 1 the trip is enabled at start-up. A trip may be disabled by setting this field to 0. May be used in conjunction with the action field of another trip so that t1 is used to enable t2 when prior conditions have been met, perhaps as part of a multivarient scan.

### 2.8.5. Output Trip Fields

In this type of normal trip the <limit & >limit fields test the value written to the scan's output device. Its primary use is envisaged with multi-varient scans where the user is scanning 2 or more outputs. The output trip may be used to enable another trip when the ouput device that it is testing is in the correct range.

| | |
|---|---|
| type | Set to Output |
| input | Trip Input Logical device. In output trips the input field is used only for specifying which scans the trip applies to, scans must have same input device. Like input trips an output trip may be "tied" to a particular scan by specifying a scan logical device in the input field and the row of the scan in the row field of the trip, which replaces the output field. |
| output | Trip Output Logical device. Any scan that writes to this device has the value written tested against the values in the <limit & >limit fields provided that the scan's input device matches the trips input field and that the value output by the scan is >= the value in the from field and <= the value in the to field. In other words an output trip must fulfil the same criteria as an input trip to apply to a scan. Thus it is usually sensible to set from & to fields to their min and max values respectively, this will be done when these fields are initialized.<br><br>As in input scans if the from & to fields are equal the criteria can be tested prior to the start of a scan.<br><br>The units of the <limit and >limit fields depend on the output device so changing the output field initializes the <limit & >limit fields.<br><br>Do not specify the logical device all as an output device to input scans because the units of <limit & >limit will not be useful!<br><br>This field is replaced by the row field if the input field specifies a scan logical device. |
| row | Scan row of a tied trip. The function of this field is exactly the same as in input trips. This field is only present if the input field specifies a scan logical device. Together the input field and row field specify the scan to which the trip is tied. The trip then behaves as if the scan's input & output fields were its own input and output fields.<br><br>Tied trips have a lower processing overhead than global trips because the trip can be linked to a specific scan. |
| from | From output value limit. Like input trips, for this trip to apply to a scan the value output by the scan must be >= the value in the from field and <= the value in the to field; therefore the from field should be left at its minimum value, as initialized.<br><br>If the trip is tied to a scan ( the trips input field is a scan logical device ) then the from & to limits apply to the logical device specified in the scan's output field. |

| | |
|---|---|
| to | To output value limit. See from above. Should be left at its maximum value, as initialized. |
| logic | The logic field determines the operation of the <limit & >limit values. It may be set to 1 of 7 modes represented by the symbols : <> , >< , < , > , >> , << and = . See entry in input trips. |
| <limit | Trip lower limit. The value written to the scan's ioutput device is compared with this limit according to the rules specified by the logic field.<br><br>The units, and minimum and maximum value, of this field depend on the device specified in the output field. If the input field is a scan logical device they depend on the output device of the scan specified by the trip's input & row fields.<br><br>This field is initialised if the output field is changed. |
| >limit | Trip upper limit. The value written to the scan's output device is compared with this limit according to the rules specified by the logic field.<br><br>The units, and minimum and maximum value, of this field depend on the device specified in the output field. If the input field is a scan logical device they depend on the output device of the scan specified by the trip's input & row fields.<br><br>This field is initialised if the output field is changed. |
| action | Trip action logical device. This field has exactly the same function as in input trips. It specifies the device written to when a trip changes state or a trip to be enabled/disabled can be specified or the field may be set to *trun* to run an event sequence. |
| activate | Trip activate action value. This field has exactly the same function as in input trips. The value in the activate field is written to the action device when the trip changes state to active or if the action field is set to trun the activate field may contain the name of a trip, which is run as an event sequence. |
| deactivate | Trip deactivate action value. This field has exactly the same function as in input trips. The value in the deactivate field is written to the action device when the trip changes state to inactive or if the action field is set to trun the deactivate field may contain the name of a trip, which is run as an event sequence. |
| enable | Trip enable. This field has exactly the same function as in input trips. If this field is set to 1 the trip is enabled at start-up. A trip may be disabled by setting this field |

to 0.

### 2.8.6. Limit Trip Fields

Event. Used to apply limits to a value. May be used to create conditional branches in Event sequences by specifying *trun* in the action field.

type Set to limit.

source Source of value. Either a logical device may be specified here, in which case the device will be read, or a trip may be specified in which case the value is fetched from the value stored in the trip specified in the source field.

The value read or fetched is stored in the trip, along with its associated logical device number.

logic The logic field determines the operation of the <limit & >limit values. It may be set to 1 of 7 modes represented by the symbols : <> , >< , < , > , >> , << and = . See entry in input trips.

<limit Trip lower limit. The value obtained from the source is compared with this limit according to the rules specified by the logic field.

The units, and minimum and maximum value, of this field depend on the device specified in the source field. If the source field is a trip the value stored in the trip is associated with a logical device, either inherited from the original source of the value or imposed by the format-as field.

This field is initialised if the source field is changed.

>limit Trip Upper limit. The value obtained from the source is compared with this limit according to the rules specified by the logic field.

The units, and minimum and maximum value, of this field depend on the device specified in the source field. If the source field is a trip the value stored in the trip is associated with a logical device, either inherited from the original source of the value or imposed by the format-as field.

This field is initialised if the source field is changed.

action Trip action logical device. This field specifies the device written to when a trip changes state. When a trip becomes active the value in the activate field is written to the device specified in this field. When the trip becomes inactive the value in the deactivate field is written.

A trip can be specified in place of a logical device in which case the trip is enabled when the trip becomes active and disabled when it becomes inactive.

If the action field is set to trun then the Event sequence branches to the trip specified in activate when the trip is active and to the trip specified in deactivate when the trip is inactive. A null in either of these will terminate the Event sequence.

If the action is a logical device or a trip nothing is done if the trip does not change state from active to inactive or vice versa. If the action is trun the branch is always taken.

activate Trip activate action value. The value in the activate field is written to the action device when the trip changes state to active.

If the action field is set to trun the activate field may contain the name of a trip, which is the next step of the Event sequence. If the field is nulled by *TINI activate <trip-label>* the programme will terminate if the activate branch occurs.

If the action field specifies a trip trying to access the activate field produces the error: *Command error 94 Trips: activate field illegal with trip as action*.

deactivate Trip deactivate action value. The value in the deactivate field is written to the action device when the trip changes state from active to inactive.

If the action field is set to trun the deactivate field may contain the name of a trip, which is the next step of the Event sequence. If the field is nulled by *TINI deactivate <trip-label>* the programme will terminate if the deactivate branch occurs.

If the action field specifies a trip trying to access the deactivate field produces the error: *Command error 95 Trips: deactivate field illegal with trip as action*.

enable Trip enable. If this field is set to 1 the trip is enabled at start-up. A trip may be disabled by setting this field to 0. May be used in conjunction with the action field of another trip so that t1 is used to enable t2 when prior conditions have been met, perhaps as part of a multivarient scan. If the trip action is trun a disabled trip will continue by executing the trip specified in the <u>next</u> field

priority If this field is set to 1 the controller does not yield to other tasks. Used by protection trips to prevent scan executing while system being shut down. Injudicious use of this field can lock up the controller.

next Next trip in programme. After this trip has executed the

Event sequence continues with the trip specified in the next field. If you enter the name of a trip that does not exist a print$ trip is automatically created and the message *Warning! 98 Trips: next trip created automatically* is issued.

The next field may be nulled by the command *TINI next <label>*. Execution then stops after this trip has been executed.

*NOTE: If the <u>action</u> field is set to* trun *and the trip is enabled the trip will not continue with the trip in the <u>next</u> field but will branch to the trip specified in the <u>activate</u> or <u>deactivate</u> fields.*

### 2.8.7. Data Trip Fields

The Data trip is used to fetch data from the scan data storage buffer. The fetched value is stored in the trip, along with its associated input logical device.

| | |
|---|---|
| type | Set to data. |
| scan | The scan logical device from which the data is to be read must be specified here. Must be a scan device Ascans to Zscans. |
| row | The row of the scan device table. Defaults to the same value as the last scan device table row set by the *SSET row* command. |
| index | Index into scan. Only needed if the scan's <u>start</u> and <u>stop</u> fields differ. If <u>index</u> is set to n returns the n$^{th}$ reading from the scan; e.g. if the scan is from mass 20 to mass 30 in steps of 1 amu then an index of 1 will return the value of mass 20 and an index of 9 will return the value of mass 28. The minimum index is 1.<br><br>If the specified index has not been reached the data trip will wait until it is available. |
| cycle | cycle number. If 0 is the most recent data. If positive is an absolute cycle number, may be automatically incremented if the IncrementCycle#: option is set. If negative is relative to current cycle: -1 the previous cycle and so on; use this when you wish to compare 2 successive readings. The default cycle value is 0<br><br>Alternatively the name of another data event may be specified instead of a number. In this case the cycle number is taken from the specified event. Where this event specifies cycle 0 or a -ve cycle number the actual cycle number of the last data acquired by the event is used. This enables data events to ensure that they all take data from the same cycle, useful when normalising data relative to |

another scan.

| | |
|---|---|
| options | *TMAX options <event>* returns "IncrementCycle#:,NewData:,WaitForData:" .<br><br>If the IncrementCycle#: option is set the cycle number is automatically incremented after data has been acquired.<br><br>If the NewData: option is set a data event will not process the same data twice, the second time that it is called it will wait until new data has been acquired.<br><br>If the WaitForData: option is set the data event will not take an on-error branch if the scan has not yet acquired data. |
| on-error | If an error occurs when this event is run ( e.g scan not initialised ) then normally an error message is produced, the value of the data trip remains unchanged, and the Event sequence continues with the trip specified in the next field. If a trip is specified in the on-error field then when an error occurs the value of this trip is set to the error number and execution continues with the trip specified in the on-error field.<br><br>You may test for specific errors by using a limit trip, however this may be difficult to set up as the logical device associated with the value will be the scan's input device until an error occurs. Once an error occurs the associated input device becomes a scan logical device, which have an integer format and no units.<br><br>One solution is to use print$ & print# steps to print the error number first, using the format-as field of the print# to force the associsiated ldev to a scan, then for the limit trip to read the error from the value stored in the print# trip. Alternatively, if you do not wish to display the error, use an eval trip's format-as field to associate a scan as the ldev.<br><br>If, when setting on-error, you enter the name of a trip that does not exist a print$ trip is automatically created and the message *Warning! 107 Trips: on-error trip created automatically* is issued.<br><br>The on-error field may be nulled by the command *TINI on-error <label>*. The data trip then reverts to producing error messages. |
| priority | If this field is set to 1 the controller does not yield to other tasks. Used by protection trips to prevent scan executing while system being shut down. Injudicious use of this field can lock up the controller. |
| next | Next trip in programme. After this trip has executed the Event sequence continues with the trip specified in the |

next field. If you enter the name of a trip that does not exist a print$ trip is automatically created and the message *Warning! 98 Trips: next trip created automatically* is issued.

The next field may be nulled by the command *TINI next <label>*. Execution then stops after this trip has been executed.

next

### 2.8.8. Eval Trip Fields

The Eval trip performs simple calculations. The values may either be read from a logical device or fetched from the value stored in another trip or may be constants.

type Set to eval

expression Expression to evaluate. The expression consist of values and operators in the format:

[ = ] <val> [ <op> <val>] [ <op> <val>] [ <op> <val>] [ <op> <val>]

Operators, <op>, and values, <val>, must be separated by spaces. Upto 5 values ( hence 4 operators ) may be entered, further <op> <val> pairs are truncated without error.

The leading = is optional, but is always returned by *TGET expression*.

Valid operators are + - * /

<val> may either be a logical device name, in which case the device will be read, or a trip label, in which case the value is fetched from the value stored in the trip, or a number.

*NOTE: Logical devices must be refered to by name, not by their id#, in expressions in order to distinguish them from numbers.*

The value calculated is stored in the trip, along with its associated logical device number specified by the format-as field.

format-as If you enter a logical device in this field the number will be formatted as if it had been read by this device. The device in the format-as field is associated with the value stored in the trip.

The format-as field may be nulled by the command *TINI format-as <label>*. The value stored in the trip then be associated with ??? .

priority If this field is set to 1 the controller does not yield to other tasks. Used by protection trips to prevent scan executing while system being shut down. Injudicious use of this field can lock up the controller.

next Next trip in programme. After this trip has executed the Event sequence continues with the trip specified in the next field. If you enter the name of a trip that does not exist a print$ trip is automatically created and the message *Warning! 98 Trips: next trip created automatically* is issued.

The <u>next</u> field may be nulled by the command *TINI next <label>*. Execution then stops after this trip has been executed.

### 2.8.9. Print# Trip Fields

The print# trip prints a value. The value may either be read from a logical device or fetched from the value stored in another trip.

type Set to print#

source Source of value. Either a logical device may be specified here, in which case the device will be read, or a trip may be specified in which case the value is fetched from the value stored in the trip specified in the <u>source</u> field.

The value read or fetched is stored in the trip, along with its associated logical device number ( unless this is over-ridden by the <u>format-as</u> field).

format-as If you enter a logical device in this field the number will be formatted as if it had been read by this device. The device in the format-as field is associated with the value stored in the trip.

The <u>format-as</u> field may be nulled by the command *TINI format-as <label>*. The value stored in the trip then be associated with the the logical device obtained from the source.

stream The stream field specifies where the number is to be printed, it over-rides the SOUT for the task.Valid streams include COM1:, COM2:, BUFFER: and ERROR:. Others may be available.

*NOTE: If a stream is owned by another task or if the buffer becomes full the Event sequence will suspend; it will resume when the stream becomes available or if the buffer is read.*

priority If this field is set to 1 the controller does not yield to other tasks. Used by protection trips to prevent scan executing while system being shut down. Injudicious use of this field can lock up the controller.

next Next trip in programme. After this trip has executed the

Event sequence continues with the trip specified in the next field. If you enter the name of a trip that does not exist a print$ trip is automatically created and the message *Warning! 98 Trips: next trip created automatically* is issued.

The next field may be nulled by the command *TINI next <label>*. Execution then stops after this trip has been executed.

### 2.8.10. Print$ Trip Fields

The print$ trip prints the message in the text field to the output specified in the stream field.

| | |
|---|---|
| type | Set to print$ |
| text | This field contains the text of the message. If the message contains spaces enter it in quotes. |
| stream | The stream field specifies where the number is to be printed, it over-rides the SOUT for the task . Valid streams include COM1:, COM2:, BUFFER: and ERROR:. Others may be available. |

*NOTE: If a stream is owned by another task or if the buffer becomes full the Event sequence will suspend; it will resume when the stream becomes available or if the buffer is read.*

| | |
|---|---|
| priority | If this field is set to 1 the controller does not yield to other tasks. Used by protection trips to prevent scan executing while system being shut down. Injudicious use of this field can lock up the controller. |
| next | Next trip in programme. After this trip has executed the Event sequence continues with the trip specified in the next field. If you enter the name of a trip that does not exist a print$ trip is automatically created and the message *Warning! 98 Trips: next trip created automatically* is issued. |

The next field may be nulled by the command *TINI next <label>*. Execution then stops after this trip has been executed.

### 2.8.11. Command Trip Fields

The command trip may be used to run a command from within an event sequence.

| | |
|---|---|
| type | Set to command. |
| text | This field contains the text of the command. If the command contains spaces enter it in quotes. |

**WARNING! Do not use the SJOB command to start a task in a command trip.**

| | |
|---|---|
| stream | The stream field specifies where anything returned by the command is to be printed, it over-rides the SOUT for the task . Valid streams include COM1:, COM2:, BUFFER: and ERROR:. Others may be available. |

*NOTE: If a stream is owned by another task or if the buffer becomes full the Event sequence will suspend; it will resume when the stream becomes available or if the buffer is read.*

| | |
|---|---|
| priority | If this field is set to 1 the controller does not yield to other tasks. Used by protection trips to prevent scan executing while system being shut down. Injudicious use of this field can lock up the controller. |
| next | Next trip in programme. After this trip has executed the Event sequence continues with the trip specified in the next field. If you enter the name of a trip that does not exist a print$ trip is automatically created and the message *Warning! 98 Trips: next trip created automatically* is issued.<br><br>The next field may be nulled by the command *TINI next <label>*. Execution then stops after this trip has been executed. |

## 2.9. Error Summary

```
 Error number 0  "System error 0 "
 Error number 1  "Command error 1 Unknown command"
 Error number 2  "Command error 2 Syntax error"
 Error number 3  "Command error 3 Command truncated"
 Error number 6  "Fatal error 6 Bad configuration - Device missing"
 Error number 7  "Problem 7 Mass Table full"
 Error number 8  "Command error 8 Unknown logical device"
 Error number 9  "Command error 9 Logical device value out of range"
 Error number 10 "Problem 10 Logical device value scaled out of range"
 Error number 11 "Warning 11 Reading out of range"
 Error number 12 "Problem 12 Pressure too high for SEM"
 Error number 13 "Command error 13 Unknown parameter"
 Error number 14 "Command error 14 Read-only parameter, can't use pset
or pini"
 Error number 15 "Command error 15 Parameter value out of range"
 Error number 16 "Command error 16 Can't set ALL parameters"
 Error number 17 "Command error 17 Unknown field"
 Error number 18 "Command error 18 Unknown scan"
 Error number 19 "Command error 19 Scan table row out of range"
 Error number 20 "Problem 20 Current Fail"
 Error number 21 "Problem 21 Emission Fail"
```

Error number 22 "Problem 22 Scan in progress"
Error number 23 "Problem 23 Print in progress"
Error number 24 "Problem 24 Insufficient scan workspace memory"
Error number 25 "Problem 25 Insufficient data storage memory"
Error number 26 "Command error 26 Scan not initialised"
Error number 27 "Problem 27 Device in use"
Error number 28 "Command error 28 Unknown I/O device"
Error number 30 "Problem 30 No free task"
Error number 31 "Command error 31 Task number out of range"
Error number 32 "Command error 32 Job not running"
Error number 40 "Command error 40 Illegal command with ALL"
Error number 41 "Command error 41 Scan field out of range"
Error number 42 "Command error 42 Row field out of range"
Error number 43 "Command error 43 Output device field out of range"
Error number 44 "Command error 44 Start field out of range"
Error number 45 "Command error 45 Stop field out of range"
Error number 46 "Command error 46 Step field out of range"
Error number 47 "Command error 47 Input device field out of range"
Error number 48 "Command error 48 Range device field out of range"
Error number 49 "Command error 49 Low range field out of range"
Error number 50 "Command error 50 High range field out of range"
Error number 51 "Command error 51 Current range field out of range"
Error number 52 "Command error 52 Dwell time field out of range"
Error number 53 "Command error 53 Settle time field out of range"
Error number 54 "Command error 54 Mode field out of range"
Error number 55 "Command error 55 Report field out of range"
Error number 56 "Command error 56 Option not recognised"
Error number 57 "Command error 57 Return value type not recognised"
Error number 58 "Command error 58 Zero field out of range"
Error number 59 "Command error 59 Type field: scan type not recognised"
Error number 60 "Command error 60 Environment field: invalid logical device"
Error number 61 "Command error 61 Environment field: value out of range"
Error number 62 "Problem 62 Environment field: environment space full"
Error number 63 "Warning 63 Environment field: list not changed"
Error number 64 "Command error 64 Environment field: can't link; scan has no list"
Error number 65 "Command error 65 Environment field: can't link; no such
Error number 66 "Command error 66 Environment field: not in list"
Error number 67 "Command error 67 Cycles field out of range"

Error number 68 "Command error 68 Interval field out of range"

Error number 69 "Command error 69 State field: state not recognised"
Error number 70 "Command error 70 Unknown trip"
Error number 71 "Command error 71 Trip table full"
Error number 72 "Command error 72 Trip name already exists"
Error number 73 "Command error 73 Invalid trip name"
Error number 74 "Problem 74 Illegal trip type. Programme stopped."
Error number 75 "Problem 75 Can't get data from co/multi-varient scan
Error number 76 "System error 76 value in a field incompatible with thi

Error number 79 "Command error 79 Trips: invalid destination"

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Error number 80 "Command error 80 Trips: input field, invalid logical device"
Error number 81 "Command error 81 Trips: output field, invalid logical device"
Error number 82 "Command error 82 Trips: from field out of range"
Error number 83 "Command error 83 Trips: to field out of range"
Error number 84 "Command error 84 Trips: <limit field out of range"
Error number 85 "Command error 85 Trips: >limit field out of range"
Error number 86 "Command error 86 Trips: action field out of range"
Error number 87 "Command error 87 Trips: activate field out of range"
Error number 88 "Command error 88 Trips: deactivate field out of range"
Error number 89 "Command error 89 Trips: row field out of range"
Error number 90 "Command error 90 Trips: row field illegal, not scan input"
Error number 91 "Command error 91 Trips: output field illegal with scan as inpu
Error number 92 "Command error 92 Trips: type field unrecognized"
Error number 93 "Command error 93 Trips: logic field unrecognized"
Error number 94 "Command error 94 Trips: activate field illegal with trip as action"
Error number 95 "Command error 95 Trips: deactivate field illegal with
Error number 96 "Command error 96 Trips: enable field out of range"
Error number 97 "Command error 97 Trips: field illegal with this type of trip"
Error number 98 "Warning 98 Trips: next trip created automatically"
Error number 99 "Command error 99 Trips: text too short or too long"
Error number 100 "Command error 100 Trips: invalid operator in expression"
Error number 101 "Command error 101 Trips: invalid source"
Error number 102 "Command error 102 Trips: invalid expression"
Error number 103 "Command error 103 Trips: format-as field out of range"
Error number 104 "Command error 104 Trips: scan field out of range"
Error number 105 "Command error 105 Trips: index field out of range"
Error number 106 "Command error 106 Trips: cycle field out of range"
Error number 107 "Warning 107 Trips: on-error trip created automatically"
Error number 108 "Command error 108 Trips: stream field out of range"
Error number 109 "Command error 109 Trips: priority field out of range"
Error number 110 "Command error 110 No data"
Error number 111 "Problem 111 External trip"
Error number 112 "Problem 112 Over pressure trip"
Error number 113 "Problem 113 Filament failure"
Error number 114 "Problem 114 Emission failure"
Error number 115 "Problem 115 Advise checking amp. zero"
Error number 120 "Problem 120 Trips: Cycle field specifies wrong

```
type of event"
 Error number 121     "Command error 121 Trips: Option not recognised"
```

# 3. Operation Sequence

The typical operation sequence consists of the following steps:

- Explore the system for available mass spectrometers
- Interrogate the mass spectrometers to read their configuration
- Download the desired environment to the mass spectrometer
- Download the scan structure
- Download event sequences
- Start event sequences
- Start scanning
- Poll for data
- Stop scanning
- Place in standby state.

## 3.1. Sample Download Sequence

The following commands were captured from MasSoft:

*Comments have been added italic*

*Explore*
pget name
"HAL IV RC HALO 100 #8462"
*Interrogate*
smax options *Find out which options the instrument supports*
"RestartAutoRange:,NoDeferAutoRange:,SaveScanDev:,BeamOnBefore:,BeamOf
fAfter:"
smax return *Find out which scan return value types the instrument supports*
"None,Align,AutoTune,Max,Sum,Top,XvalAtMaxY"
sid$ zero *Test if instrument supports zero field in scan*
zero
pget stream *Get stream names*
"COM1:","COM2:","DLC1:","DLC2:","DLC3:","NET1:","NET2:","NET3:","ERROR
:","BUFFER:","NUL:"
lunt mode *Find out which modes the instrument supports*
( 1=RGA )
lid$ all *Get names of all logical devices*
"i/p_select","local_range","head_range","trip1","trip2","optrip","emis
sion-LED","fault-
LED","inhibit","RGA/SIMS","emission-
range","F1","F2","beam","filok","emok","ptrip","IO1","IO2","IO3","IO4"

```
,"IO5","rangedev","Faraday","Total","auxiliary1","auxiliary2","resolut
ion","delta-
m","mass","synch","rendezvous","mode","clock","mSecs","elapsed-
time","delay","watchdog","enable","mode-change-delay",
lid$ rangedev
"Faraday_range","Total_range","auxiliary1_range","auxiliary2_range","n
ul_range",
```

*Interrogate each logical device*

```
lid# i/p_select
27
luse 27
system control output
ltyp 27
digital output
lunt 27
( 1=pic, 2=aux1, 3=aux2, 4=main, 5=zero )
lmin 27
1
lmax 27
7
lres 27
1
lval 27
0,3,5,0,6,2,4,0,2,-0.000001, 2147.483647,
lid# local_range
28
luse 28
system control output
ltyp 28
digital output
lunt 28
range
lmin 28
0
lmax 28
1
lres 28
1
lval 28
30, 0, 0, 0, 0, 0, 0, 0, 0,-0.000001, 2147.483647,
lid# head_range
29
luse 29
system control output
ltyp 29
digital output
lunt 29
range
lmin 29
0
lmax 29
3
lres 29
1
lval 29
```

```
30, 0, 0, 0, 0, 0, 0, 0, 0,-0.000001, 2147.483647,
lid# trip1
31
luse 31
trip relay output
ltyp 31
trip
lunt 31
( 1 = on, 0 = off )
lmin 31
1
lmax 31
1
lres 31
1
lval 31
0,0,0,0,0,0,0,0,0,-0.000001, 2147.483647,
lid# trip2
32
luse 32
trip relay output
ltyp 32
trip
lunt 32
( 1 = on, 0 = off )
lmin 32
1
lmax 32
1
lres 32
1
lval 32
0,0,0,0,0,0,0,0,0,-0.000001, 2147.483647,
lid# optrip
33
luse 33
trip relay output
ltyp 33
trip
lunt 33
( 1 = on, 0 = off )
lmin 33
0
lmax 33
1
lres 33
1
lval 33
0,0,0,0,0,0,0,0,0,-0.000001, 2147.483647,
lid# emission-LED
34
luse 34
LED
ltyp 34
digital output
```

```
lunt 34
( 1 = on, 0 = off )
lmin 34
0
lmax 34
1
lres 34
1
lval 34
0,0,0,0,0,0,0,0,0,-0.000001, 2147.483647,
lid# fault-LED
35
luse 35
LED
ltyp 35
digital output
lunt 35
( 1 = on, 0 = off )
lmin 35
0
lmax 35
1
lres 35
1
lval 35
0,0,0,0,0,0,0,0,0,-0.000001, 2147.483647,
lid# inhibit
36
luse 36
system status input
ltyp 36
digital input
lunt 36
( 1 = on, 0 = off )
lmin 36
0
lmax 36
1
lres 36
1
lval 36
0,0,0,0,0,0,0,0,0,-0.000001, 2147.483647,
lid# RGA/SIMS
38
luse 38
system control output
ltyp 38
digital output
lunt 38
( 0=SIMS, 1=RGA )
lmin 38
0
lmax 38
1
lres 38
```

```
1
lval 38
0,0,1,0,0,0,0,0,0,-0.000001, 2147.483647,
lid# emission-range
39
luse 39
source control output
ltyp 39
range
lunt 39
uA
lmin 39
+0
lmax 39
+3
lres 39
+1
lval 39
30,+1,+1,+1,+1,+0,+0,+0,+0,-0.000001, 2147.483647,
lid# F1
40
luse 40
source control output
ltyp 40
digital output
lunt 40
( 1 = on, 0 = off )
lmin 40
0
lmax 40
1
lres 40
1
lval 40
0,0,0,0,0,0,0,0,0,-0.000001, 2147.483647,
lid# F2
41
luse 41
source control output
ltyp 41
digital output
lunt 41
( 1 = on, 0 = off )
lmin 41
0
lmax 41
1
lres 41
1
lval 41
0,0,0,0,0,0,0,0,0,-0.000001, 2147.483647,
lid# beam
42
luse 42
source control output
```

```
ltyp 42
digital output
lunt 42
( 1 = on, 0 = off )
lmin 42
0
lmax 42
1
lres 42
1
lval 42
1,0,0,0,0,0,0,0,0,-0.000001, 2147.483647,
lid# filok
43
luse 43
system status input
ltyp 43
digital input
lunt 43
( 1 = on, 0 = off )
lmin 43
0
lmax 43
1
lres 43
1
lval 43
0,1,0,0,0,0,0,0,0,-0.000001, 2147.483647,
lid# emok
44
luse 44
system status input
ltyp 44
digital input
lunt 44
( 1 = on, 0 = off )
lmin 44
0
lmax 44
1
lres 44
1
lval 44
0,0,0,0,0,0,0,0,0,-0.000001, 2147.483647,
lid# ptrip
45
luse 45
system status input
ltyp 45
digital input
lunt 45
( 1 = on, 0 = off )
lmin 45
0
lmax 45
```

```
1
lres 45
1
lval 45
0,0,0,0,0,0,0,0,0,-0.000001, 147.483647,
lid# IO1
46
luse 46
digital input
ltyp 46
digital input
lunt 46
( 1 = on, 0 = off )
lmin 46
0
lmax 46
1
lres 46
1
lval 46
0,0,0,0,0,0,0,0,0,-0.000001, 2147.483647,
lid# IO2
47
luse 47
digital input
ltyp 47
digital input
lunt 47
( 1 = on, 0 = off )
lmin 47
0
lmax 47
1
lres 47
1
lval 47
0,0,0,0,0,0,0,0,0,-0.000001, 2147.483647,
lid# IO3
48
luse 48
digital input
ltyp 48
digital input
lunt 48
( 1 = on, 0 = off )
lmin 48
0
lmax 48
1
lres 48
1
lval 48
+0,0,0,0,0,0,0,0,0,0,-0.000001, 2147.483647,
lid# IO4
49
```

```
luse 49
digital input
ltyp 49
digital input
lunt 49
( 1 = on, 0 = off )
lmin 49
0
lmax 49
1
lres 49
1
lval 49
0,0,0,0,0,0,0,0,0,-0.000001, 2147.483647,
lid# IO5
50
luse 50
digital input
ltyp 50
digital input
lunt 50
( 1 = on, 0 = off )
lmin 50
0
lmax 50
1
lres 50
1
lval 50
0,0,0,0,0,0,0,0,0,-0.000001, 2147.483647,
lid# rangedev
51
luse 51
group
ltyp 51
group
lunt 51
lmin 51
lmax 51
lres 51
lval 51
0,,,,,,,,, 0.000000, 1.000000,
lid# Faraday
53
luse 53
scan
ltyp 53
V to F input
lunt 53
torr
lmin 53
-1.00000E-4
lmax 53
1.00000E-4
lres 53
```

```
1.00000E-10
lval 53
0, 0.00000E+0, 0.00000E+0, 0.00000E+0, 0.00000E+0, 0.00000E+0,
0.00000E+0, 0.00000E+0, 0.00000E+0, 0.000000, 1.000000,
lid# Total
55
luse 55
scan
ltyp 55
V to F input
lunt 55
torr
lmin 55
-1.00000E-4
lmax 55
1.00000E-4
lres 55
1.00000E-11
lval 55
0, 0.00000E+0, 0.00000E+0, 0.00000E+0, 0.00000E+0, 0.00000E+0,
0.00000E+0, 0.00000E+0, 0.00000E+0, 0.000000, 1.000000,
lid# auxiliary1
57
luse 57
scan
ltyp 57
V to F input
lunt 57
V
lmin 57
-10.0000
lmax 57
10.0000
lres 57
0.0010
lval 57
0, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000,
0.000000, 1.000000,
lid# auxiliary2
59
luse 59
scan
ltyp 59
V to F input
lunt 59
V
lmin 59
-10.0000
lmax 59
10.0000
lres 59
0.0010
lval 59
0, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000,
0.000000, 1.000000,
lid# resolution
65
luse 65
Quad tuning DAC
ltyp 65
DAC
lunt 65
%
lmin 65
-100
lmax 65
+100
lres 65
+1
lval 65
00,+0,+0,+0,+0,+0,+0,+0,+0, 0.000000, 1.000000,
lid# delta-m
66
luse 66
Quad tuning DAC
ltyp 66
DAC
lunt 66
%
lmin 66
-100
lmax 66
+100
lres 66
+1
lval 66
00,+0,+0,+0,+0,+0,+0,+0,+0, 0.000000, 1.000000,
lid# mass
69
luse 69
scanable quad control DAC
ltyp 69
DAC
lunt 69
amu
lmin 69
0.40
100.00 lmax 69
lres 69
0.02
lval 69
0,5.50,5.50,5.50,5.50,5.50,5.50,5.50,20.00, 0.000000, 1.000000,
lid# synch
70
luse 70
Synchronise scans and trips
ltyp 70
pseudo-device
lunt 70
lmin 70
```

```
0
lmax 70
999
lres 70
1
lval 70
00, 0, 0, 0, 0, 0, 0, 0, 0, 0.000000, 1.000000,
lid# rendezvous
71
luse 71
Synchronise scans and trips
ltyp 71
pseudo-device
lunt 71
lmin 71
0
lmax 71
999
lres 71
1
lval 71
00, 0, 0, 0, 0, 0, 0, 0, 0, 0.000000, 1.000000,
lid# mode
74
luse 74
group
ltyp 74
group
lunt 74
( 1=RGA )
lmin 74
0
lmax 74
1
lres 74
1
lval 74
0,0,1,2,3,4,5,6,7, 0.000000, 1.000000,
lid# clock
75
luse 75
Battery-backed, hardware, Real Time Clock
ltyp 75
clock
lunt 75
lmin 75
01/01/80 00:00:00
lmax 75
19/01/48 03:14:07
lres 75
01/01/80 00:00:01
lval 75
0,01/01/80 00:00:00,01/01/80 00:00:00,01/01/80 00:00:00,01/01/80
00:00:00,01/01/80 00:00:00,01/01/80 00:00:00,01/01/80
00:00:00,01/01/80 00:00:00,-0.000001, 2147.483647,
lid# mSecs
76
luse 76
Elapsed time clock
ltyp 76
clock
lunt 76
ms
lmin 76
0
lmax 76
2147483647
lres 76
1
lval 76
0,1445,0,0,0,0,0,0,0,-0.000001, 2147.483647,
lid# elapsed-time
77
luse 77
§Elapsed time clock
ltyp 77
clock
lunt 77
ms
lmin 77
01,00:00:00.000
lmax 77
25,20:31:23.647
lres 77
01,00:00:00.001
lval 77
0,01,00:00:01.445,01,00:00:00.000,01,00:00:00.000,01,00:00:00.000,01,0
0:00:00.000,01,00:00:00.00,01,00:00:00.000,01,00:00:00.000,-0.000001,
2147.483647,
lid# delay
78
luse 78
General purpose delay timer
ltyp 78
timer
lunt 78
ms
lmin 78
0
lmax 78
2147483647
lres 78
1
lval 78
0,500,0,0,0,0,0,0,0,-0.000001, 2147.483647,
lid# watchdog
79
luse 79
§Elapsed time clock
ltyp 79
```

```
clock
lunt 79
s
lmin 79
.000
lmax 79
2147483.647
lres 79
.001
lval 79
0, .000, .000, .000, .000, .000, .000, .000, .000, 0.000000,
2147.483647,
lid# enable
90
luse 90
system control output
ltyp 90
digital output
lunt 90
( 1 = on, 0 = off )
lmin 90
0
lmax 90
1
lres 90
1
lval 90
0,1,1,1,1,1,1,1,1,-0.000001, 2147.483647,
lid# mode-change-delay
91
luse 91
Mode change delay timer
ltyp 91
timer
lunt 91
ms
lmin 91
0
lmax 91
2147483647
lres 91
1
lval 91
40,0,1000,1000,1000,0,0,0,0,-0.000001,2147.483647,
lid$ groups
"rangedev","total/partial","switched","measurement","quad","degassing"
,"mode","all","map","input","output","environment","others","global","
control",
ltyp rangedev
group
ltyp rangedev
group
ltyp total/partial
group
ltyp total/partial
```

```
group
ltyp switched
group
ltyp switched
group
ltyp measurement
group
ltyp measurement
group
ltyp quad
tune-group
ltyp quad
tune-group
ltyp degassing
group
ltyp degassing
group
ltyp mode
group
ltyp mode
group
ltyp all
group
ltyp all
group
ltyp map
group
ltyp map
group
ltyp input
group
ltyp input
group
ltyp output
group
ltyp output
group
ltyp environment
group
ltyp environment
group
ltyp others
group
ltyp others
group
ltyp global
group
ltyp global
group
ltyp control
group
ltyp control
group
```

*Read groups*

```
lid$ rangedev
```

```
"Faraday_range","Total_range","auxiliary1_range","auxiliary2_range","n
ul_range",
lid$ total/partial
¤"T/P","mass",
lid$ switched
"total/partial",
lid$ measurement
."Faraday","Total","auxiliary1","auxiliary2",
lid$ quad
"resolution","delta-m",
lid$ degassing
lid$ mode
"RGA/SIMS","F1","F2","resolution","delta-m","mass","mode-change-
delay",
lid$ all
"i/p_select","local_range","head_range","trip1","trip2","optrip","emis
sion-LED","fault-LED","inhibit","RGA/SIMS","emission-
range","F1","F2","beam","filok","emok","ptrip","IO1","IO2","IO3","IO4"
,"IO5","rangedev","Faraday","Total","auxiliary1","auxiliary2","resolut
ion","delta-
m","mass","synch","rendezvous","mode","clock","mSecs","elapsed-
time","delay","watchdog","enable","mode-change-delay",
lid$ map
"mass",
lid$ input
"inhibit","filok","emok","ptrip","IO1","IO2","IO3","IO4","IO5","Farada
y","Total","auxiliary1","auxiliary2","clock","mSecs","elapsed-
time","watchdog",
lid$ output
"i/p_select","local_range","head_range","trip1","trip2","optrip","emis
sion-LED","fault-LED","RGA/SIMS","emission-
range","F1","F2","beam","Faraday_range","Total_range","auxiliary1_rang
e","auxiliary2_range","nul_range","resolution","delta-m","mass",
lid$ environment
"resolution","delta-m","mass","mode-change-delay",
lid$ others
"F1","F2",
lid$ global
"F1","F2","resolution","delta-m","mass","mode-change-delay",
lid$ control
"F1","F2",
lid$ rangedev
"Faraday_range","Total_range","auxiliary1_range","auxiliary2_range","n
ul_range",
```

*Read devices*

```
lid# Faraday_range
52
luse 52
range
ltyp 52
range
lunt 52
torr
lmin 52
-10
```

```
lmax 52
-5
lres 52
+1
lval 52
60,-5,+27,+29,+28,+0,+67,+42,+63, 0.000000, 1.000000,
lid# Total_range
54
luse 54
range
ltyp 54
range
lunt 54
torr
lmin 54
-11
lmax 54
-5
lres 54
+1
lval 54
60,-5,+27,+29,+28,+0,+67,+42,+63, 0.000000, 1.000000,
lid# auxiliary1_range
56
luse 56
range
ltyp 56
range
lunt 56
V
lmin 56
-1
lmax 56
+0
lres 56
+1
lval 56
30,+0,+27,+0,+28,+0,+0,+27,+0, 0.000000, 1.000000,
lid# auxiliary2_range
58
luse 58
range
ltyp 58
range
lunt 58
V
lmin 58
-1
lmax 58
+0
lres 58
+1
lval 58
30,+0,+27,+0,+28,+0,+0,+27,+0, 0.000000, 1.000000,
lid# nul_range
```

```
60
luse 60
range
ltyp 60
range
lunt 60
lmin 60
+0
lmax 60
+0
lres 60
+1
lval 60
00,+0,+0,+0,+0,+0,+0,+0,+0, 0.000000, 1.000000,
```
*Upload the mass table*
```
pget masstable
10,0,10000,64000,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
```

*Download environment*
```
l999 scan  Stop all scans
lini all        initialise all devices
lset mode 0     set to Standby
sout NUL:  discard output of background tasks
data on         retain data until read
lput 40 0 1
lslo 40 2147.483647
lint 40 -0.000001
lput 41 0 0
lslo 41 2147.483647
lint 41 -0.000001
lput 65 +0 +0
lslo 651.000000
lint 650.000000
lput 66 +0 +0
lslo 66 1.000000
lint 66 0.000000
lput 69 5.50 5.50
lslo 69 1.000000
lint 69 0.000000
lput 91 0 1000
lslo 91 2147.483647
lint 91 -0.000001
```
*Down load the mass table*
```
pset masstable 10 0 10000 64000 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
```
*Set up scan structure*
```
sdel all
sset scan Ascans
sset row 1
sset output mass
sset start 1.00
sset stop 50.00
sset step1.00
sset input Faraday
sset low -10
sset high -5
sset current -5
sset dwell 100%
sset settle 100%
sset mode 1
sset report 17
sset options BeamOnBefore:,BeamOffAfter:,
sset zero 1
pset cycles 0
```
*Delete all trips & events*
```
tdel all
```
*Down load any trips and events here ...*
*Start scanning*
```
pset terse 1
pset points 70
serr ERROR:
sout NUL:
lini Ascans
sjob lget Ascans
4,1,
```
*Read data*
```
data on
data all        Start data task & read any data
rerr       Poll error queue
data       Poll for more data
data
data
data
data
data
rerr
data
[/1019/{
data
-1.83516E-8,-1.83516E-8, 0.00000E+0,-1.83516E-8, 0.00000E+0,-1.83516E-
8, 0.00000E+0,-
1.83516E-8, 0.00000E+0,-1.83516E-8,-1.83516E-8,-1.83516E-8,
0.00000E+0,-1.83516E-8,
0.00000E+0, 0.00000E+0,
data
0.00000E+0,0.00000E+0,-1.83516E-8, 0.00000E+0,-1.83516E-8,
0.00000E+0,-1.83516E-8,
0.00000E+0,-1.83516E-8, 0.00000E+0,-1.83516E-8,-1.83516E-8,
0.00000E+0,-1.83516E-8,
0.00000E+0, 0.00000E+0,-1.83516E-8, 0.00000E+0,-1.83516E-8,
0.00000E+0,-1.83516E-8,
0.00000E+0,-1.83516E-8, 0.00000E+0,-1.83516E-8, 0.00000E+0,-1.83516E-
8,-1.83516E-8, 0.0000
0E+0,-1.83516E-8, 0.00000E+0,-1.83516E-8, 0.00000E+0,-1.83516E-
8,}][/2693/{-1.83516E-9,-
1.83516E-9, 0.00000E+0, 0.00000E+0,-1.83516E-9,-1.83516E-9,-1.83516E-
9,-1.83516E-9,
data
0.00000E+0,0.00000E+0,-1.83516E-9, 0.00000E+0,-1.83516E-9, 0.00000E+0,
0.00000E+0,
0.00000E+0,-1.83516E-9, 0.00000E+0, 0.00000E+0, 0.00000E+0,-1.83516E-
```

```
9, 0.00000E+0,-
1.83516E-9,-1.83516E-9, 0.00000E+0,-1.83516E-9,-1.83516E-9,
0.00000E+0,-1.83516E-9,
0.00000E+0,-1.83516E-9, 0.00000E+0,-1.83516E-9, 0.00000E+0,-1.83516E-
9, 0.00000E+0,-1.83516
E-9,0.00000E+0,-1.83516E-9, 0.00000E+0,-1.83516E-9, 0.00000E+0,-
1.83516E-9, 0.00000E+0,-
1.83516E-9, 0.00000E+0,-1.83516E-9, 0.00000E+0,-1.83516E-9,
0.00000E+0,}][/4440/{
0.00000E+0, 0.00000E+0, 0.00000E+0, 0.00000E+0,
data
0.00000E+0,0.00000E+0, 0.00000E+0, 0.00000E+0, 2.74724E-11,
data
0.00000E+0,2.74724E-11, 2.74724E-11, 2.74724E-11, 0.00000E+0,
0.00000E+0, 2.74724E-11,
2.74724E-11, 0.00000E+0, 2.74724E-11, 0.00000E+0, 0.00000E+0,
rerr
data
0.00000E+0,0.00000E+0, 0.00000E+0,
data
```
*Stop data acquisition*
```
stop 4 1
```
*Continue polling for data*
```
data
E-9,0.00000E+0,-1.83516E-9, 0.00000E+0,-1.83516E-9, 0.00000E+0,-
1.83516E-9, 0.00000E+0,-
1.83516E-9, 0.00000E+0,-1.83516E-9, 0.00000E+0,-1.83516E-9,
0.00000E+0,}]
rerr
data
*C110*                Error 110, no data, indicates end of data
lset mode 0           Switch to shutdown mode
```