AT.39.3/

THE AT MONITORING SYSTEM

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THE AT MONITORING SYSTEM

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The monitoring system described here is the organisation of software and hardware that supervises the operation of the compact array, and provides diagnostic assistance when components are malfunctioning.

Monitoring hardware has been built into all the units of the array; the monitoring system has the task of collating the information from that hardware, bringing it back to the central site, packaging it into a digestible format and checking for symptoms of malfunction. There are seven major components:

a. **Datasets**. These units make the connection between hardware and computers. On command they can read voltages, collect digital information, and control hardware. The monitor data is dispatched to the associated computer (the ACC).

b. **Database.** There are about 400 monitor points on each antenna. The description of each one - the dataset address and type; what type of data (real, integer or logical); the limits; and the units, for example - these descriptions are stored in a number of files which collectively form a relational database.

c. **MP2.** The monitor data is placed in common memory in the vax (NOEL). MP2 is the task that organises the data: it provides the ACCs with a list of the monitor points which must be sampled; this list also contains the destination of each datum - where it must be placed in the common area. This list is available to tasks running in the Vax, so that they can access the data.

d. **CAMON.** This task lets a user display and examine the data. Any number of copies of this task can be run, from any site that has access to NOEL.

e. **CHECKER.** Every datum returned to the central site is checked against previously defined limits. If an error condition exists, it will be signalled to the control desk. CHECKER also archives the monitor data as it arrives. The consequent large mass of data is subsequently compressed, each day, from the 5 second cycles to 30 minute averages. The compression operation is done by:

f. **COMPRESS.** (not yet in place). The intention is to place the compressed data in a 7-day rolling buffer, as well as to archive the data to tape.

g. **XARCHIVE.** This is a utility that provides access to the archived monitor data.

This note provides a user guide to each of the main tasks.

Acknowledgements

The AT monitoring system owes much to J.Argyros. He developed the communications package (the "ghosts"), and wrote initial versions of many of the tasks described here.

2. MP2

2.1 Functional description.

MP2 takes as input a number of lists defining the different categories of monitor points. It allocates space in core to each monitor point and communicates the lists and the core mapping to the ACC; a local file describing the mapping is prepared, and becomes available to all the tasks which need to access the data.

MP2 should rarely be run: the monitor system should be reasonably stable once operations start; furthermore, the archiving formats mirror the core mapping, so changing one will require a change in the other. The ACCs will retain a copy of the core mapping on local disk, so that there is no need to run MP2 each time an ACC is rebooted.

2.2 Monitor point categories.

There a four categories of monitor points:

A. Antenna, FAST. These are the time critical antenna-based points which must be returned to the Vax each integration cycle. The system temperature is an example. There about 20 such points in each antenna.

B. Antenna, SLOW. The rest of the antenna-based points, (about 400 in number) are returned as fast as possible, but with reduced priority. This means that the entire list is returned approximately once a minute.

C. Screened Room, FAST.

D. Screened Room, SLOW. An ACC will be installed in the screened room to carry out the monitoring tasks required: to monitor the Correlator peripherals, the Fibre Optic transmission system, the Line stabilisation of the Local Oscillator system, and the spectral line system. Both Fast and Slow monitoring will be available.

E. CAOBS. The observing task may produce data which falls into the "monitor" category - the derived system temperatures, for example. Meteorological data is also deposited in his area.

2.3 To run the task.

At any NOEL terminal (and from a computer group UIC), type :

N$ *MP2*

This just one question at present: do you want to send the lists to the ACCs, or simply rebuild the Vax copy? This latter option is useful if the monitor point scale factors or limits need to be changed - the mapping is the same, only the information passed to the vax-based tasks may change.

The task should indicate its progress - listing the monitor points accessed. Errors will be indicated on the fly, and will be recapitulated after the task completes. The operation is fairly slow (yet another good reason why the task should rarely be run).

2.4 Input files.

There is a master file whose name is coded into MP2: **at$monitor:mp2.file**. This is an ascii file, and may be edited with a standard editor. It contains the names of the files which list the monitor points. These files are also resident in at$monitor. The present files are:

classA.file	for the fast monitor points
classB.file	for the slow monitor points.

The format is the same for these two (ASCII) files:

Class	(A or B), followed by a list of monitor points:
name	short name (as known to the database).

A line with a leading "!" is treated as a comment.

Two simplifications are currently in place:

a. All antennas use the same monitor points.
b. All the records following the class also have the processing information. This will (may) be entered in the database. Thus the present (possibly temporary) format is:

name type scale offset low_limit high_limit units

(Tabs separate each element)

TYPE defines the algorithm to be used, with the following types now defined:

ANG	Angle, displayed as dd:mm
ANT	ACC status (the very specific Antenna function 6-byte code)
I*2	integer (2 bytes)
I*4	integer (4 bytes)
R*4	real
PDB	detector levels, expressed in dB. (G.Graves special)
PSR	pseudo real r = (datum/2048 - 1)
T12	R.Gough's polynomial/logarithmic expression for temperature
VAC	impements R.Gs conversion Volts to Vacuum (mBars)
LOB	Logical, obs/maintenance mode
LLK	Logical, lock/unlock
LOK	Logical, ok/error
LTF	Logical, true/false

The low and high limits refer to the scaled data.

Logic levels are treated somewhat differently: the "Low limit" (0 or 1) defines the normal state. If the level is not equal to the "low limit" an error condition will be signalled. A variety of text strings are available, defined by the algorithm type chosen. For example, a monitor point specified as type LOB will be shown in the display as either OBS (the normal condition) or MAINT (in reverse video, as an error).

By way of example, figure 2.1 lists the contents of classA.file

2.4.1 To check the format of these files.

A utility task has been provided: **at$monitor:check_mpfile.**

This will examine the file and check that all items are present, with the correct spacers. A listing file can be requested.

2.5 Output files

The generic core mapping is stored in **at$monitor:mpoints.file.**

mpoints.file is an ascii file, with the following format:

name area_start pointer num_bytes class processing info.

name, class and the processing information are copied from the classA/B.files

area_start, pointer and num_bytes are the core mapping data, and define the location of the datum in the common area. Note that since all antennas have the same lists of monitor points they can share the same mapping parameters.

2.5.1 Error summary

An error summary is presented on completion of the task; this summary is also stored in **at$monitor:mpoints.log**

```
ANT:FAST
!
!  The list of FAST monitor point to be returned from the antennas.
!
ANTFN          ANT    0.      0.      0.      0.
!
! Sampler statistics
!
SAMP_A1N       R*4    1.      0.      0.      256.
SAMP_A1P       R*4    1.      0.      0.      256.
SAMP_A1O       R*4    1.      0.      0.      4096.
A1GTP          PSR    1.      0.      -999.   999.    v
B1GTP          PSR    1.      0.      -999.   999.    v
A1SDO          PSR    1.      0.      -999.   999.    v
B1SDO          psr    1.      0.      -999.   999.    v
!
!
```

Figure 2.1

The ClassA file - the list of FAST monitor points

3. CAMON

3.1 This is an interactive task allowing the user access to all the monitor points defined by MP2. A number of display formats have been defined; the user can freely define arbitrary displays of his own choosing. Error conditions will be signalled (in reverse video) if they apply to the monitor points being displayed. Serious problems (severe weather conditions or cryogenics failures) will break through no matter which display is chosen.

Care has been taken to ensure that the displays only refer to valid monitor points; should a system be taken off-line for any period of time, then its monitor points will be disabled, and the displays will ignore them. Two further options have been provided in this regard: an entire antenna can be disabled (eg, antenna #6); also, one can partially disable a monitor point: it will be read, and displayed, but not checked for error. These options are entered when the task is started (a file, CONFIG.file is consulted); in addition, at any time the options can be invoked with the commands: enable/disable/mask/unmask - see below, 3.3)

3.2 To run the task, type at any terminal logged into NOEL (directly or via set host) :

N$ *camon*

The file **at$monitor:mpoints.file** will be loaded, and then the user is asked to specify the update interval - 15 seconds is the current (default) setting. The basic communications status display is brought up, and the task is open to user interaction. Figure 3.1 shows the COMMS1 display.

3.3 Commands

ANTENNA n	define the antenna for the antenna-specific displays. An abbreviation is offered: n alone will suffice.
ARRAY	display the status of CAOBS, the ACCs and the correlator
COMMS1	display the status of the Vax-ACC communications
COMMS2	display the status of the Vax-Correlator communications
DISABLE BELL	disable the error bell
DISABLE CA0n	disable all checking of antenna "n"
DISABLE TIME	disable the datestamping check (this enables you to access the data, even if the acc cycling has failed).

DISABLE PROCESS — disable the "Ghost" check - you can read the last messages sent, after the communications task to the acc has failed.

DUMP — copy the current screen to a dump file in **at$monitor**.

ENABLE BELL — enable the error bell
ENABLE CA0n — enable all checking of antenna "n"
ENABLE TIME — enable the datestamp check (default)
ENABLE PROCESS

EXIT

HELP

MAKE — define a new display page. The user lists the monitor points by their short names; the page will be displayed after the last point is entered.

MASK — add to the list of items to be "masked" - defective modules (eg, the missing L/S receivers in antennas 2 and 3 for example can be so signalled: they should not be examined; one can also mark monitor points to be read and displayed, but not checked for errors. The user is invited to define these items by a key which will be matched against the long names. UNMASK deletes items from the list; LIST allows the user to check that the items identified are the ones required.

PRINT — prints the current screen.

SAVE — save the current display page definitions. (Eg, having defined a new display page, you can save it as a .page file for future reference).

SET CYCLE n — change the cycle interval to "n" seconds
SET ANTENNA n — Define the antenna for the antenna-specific displays.

WEATHER — displays the latest weather data

/filename[/n] — This will produce the display defined in the file named. The files are expected to reside in the at$monitor directory, with .page extension. (ie. */pcc* will find the file at$monitor:pcc.page). The optional "/n" defines the antenna for the antenna-specific displays.

DIRECTORY — list all .page files.

A more complete list of the display pages, along with a brief synopsis is available in **at$monitor:page_def.txt.** Appendix A has a preliminary version (as of 18/3/90) of this file.

3.4 Displays.

ARRAY This display is intended to provided a global view of the array status: it shows the current CAOBS status (observing/waiting/not running); the antenna status (slewing/on source/stowing/stopped/ error), the Local Oscillator status (OK/not ok), the receiving system temperatures.

COMMS1 This is a particularly sensitive monitor of the array's health: it shows the state of the communications between the ACC and the Vax. The top 3 rows show the datestamps for the first areas - these should be fairly close to current; the first refers to the FAST monitor points, and should increment in 5 second steps. The rest of the display provides statistics of the acc-vax communications traffic.

In addition we have 3 flexible, user-definable display types:

a. Global - This displays data from all 6 antennas.

b. Antenna - This is intended to cover the LO and receiver requirements: it shows a large number of points from a single antenna.

c. Universal - This allows the user to specify each entry in each of 6 columns, in up to 17 lines.

Each display is defined in a file with the following format:

line 1: /G , /A or /U the display type

There follows up to 16 lines, each line defining a line in the display, with a different format for each display type.

type G the short name of the monitor (as known to the database), one point per line in the file. See figs. 3.2a and 3.2b

type A the short name, with the frequency/polarisation variable signalled:

1/L4TUNI	will produce 1L4TUNI and 2L4TUNI
A/1/L2OBS	will produce A1L2OBS, B1L2OBS,A2L1OBS and B2L2OBS.
1L4TUNI	gives 1L4TUNI only.

see figs. 3.3 a and b.

type U — Seven fields per line; the first is the text for the left hand column; the remaining 6 fields are each a short name. An "*" signals a blank. See figs 3.4a and b for an example.

Any line prefixed with a ">" will be treated as a line of text; thus the title could be indicated as:

> A possible Title

In addition, additional lines of text (or blank lines) can be inserted at any point in the display.

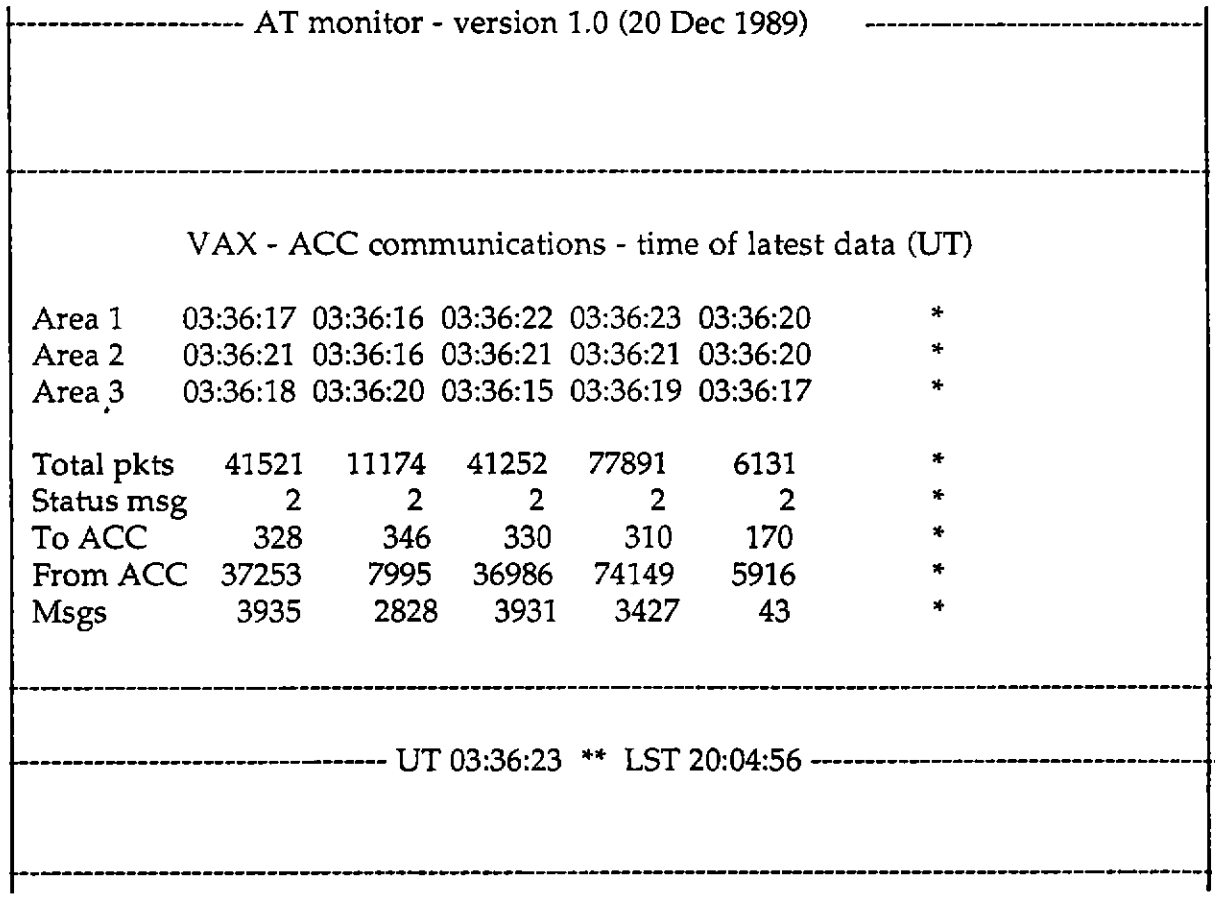

Figure 3.1

CAMON - comms display

Area 1 contains the "fast" monitor data; the other two have slow data.

Note that the "*" in column 7 refers to antenna 6 to which there is no communication.

```
/G
>              1L4 status                    -- the title
>
1l4da                                        -- the monitor points
1l4int
1l4tuni
1l4ang
1l4heat
1l4ref
1l4if
1l4fmi
1l4srdd
1l4srdv
1l4obs
1l4lok
```

Figure 3.2a

An example of a GLOBAL display page file. (1L4.page)

AT monitor - version 1.1 (29 Dec 1989)

1L4 status

1L4DA	-20.00	-20.00	-20.00	-20.00	-20.00	*	GHz
1L4INT	-5.000	-5.000	-5.000	-5.000	-5.000	*	v
1L4TUNI	-568.6	-568.6	-568.6	-568.6	-568.6	*	amp
1L4ANG	-5.000	-5.000	-5.000	-5.000	-5.000	*	v
1L4HEAT	-5.000	-5.000	-5.000	-5.000	-5.000	*	v
1L4REF	-5.000	-5.000	-5.000	-5.000	-5.000	*	v
1L4IF	-5.000	-5.000	-5.000	-5.000	-5.000	*	v
1L4FMI	-5.000	-5.000	-5.000	-5.000	-5.000	*	v
1L4SRDD	-5.000	-5.000	-5.000	-5.000	-5.000	*	v
1L4SRDV	-5.000	-5.000	-5.000	-5.000	-5.000	*	v
1L4OBS	maint	maint	maint	maint	maint	*	
1L4LOK	unlock	unlock	unlock	unlock	u nlock	*	

UT 22:24:51 ** LST 15:08:19

```
mon> dir
mon> /114
```

Figure 3.2 b

The display corresponding to file 1L4.page

```
/a
>              LO (1)
>
1/L4LOK
1/L4OBS
1/L3LOK
1/L3OBS
1/L3SRDLK
>
A/1/L2OBS
A/1/L2LLOK
A/1/L2ULOK
A/1/L22LOK
```

Figure 3.3 a

An example of an ANTENNA display file (lo_1,page)

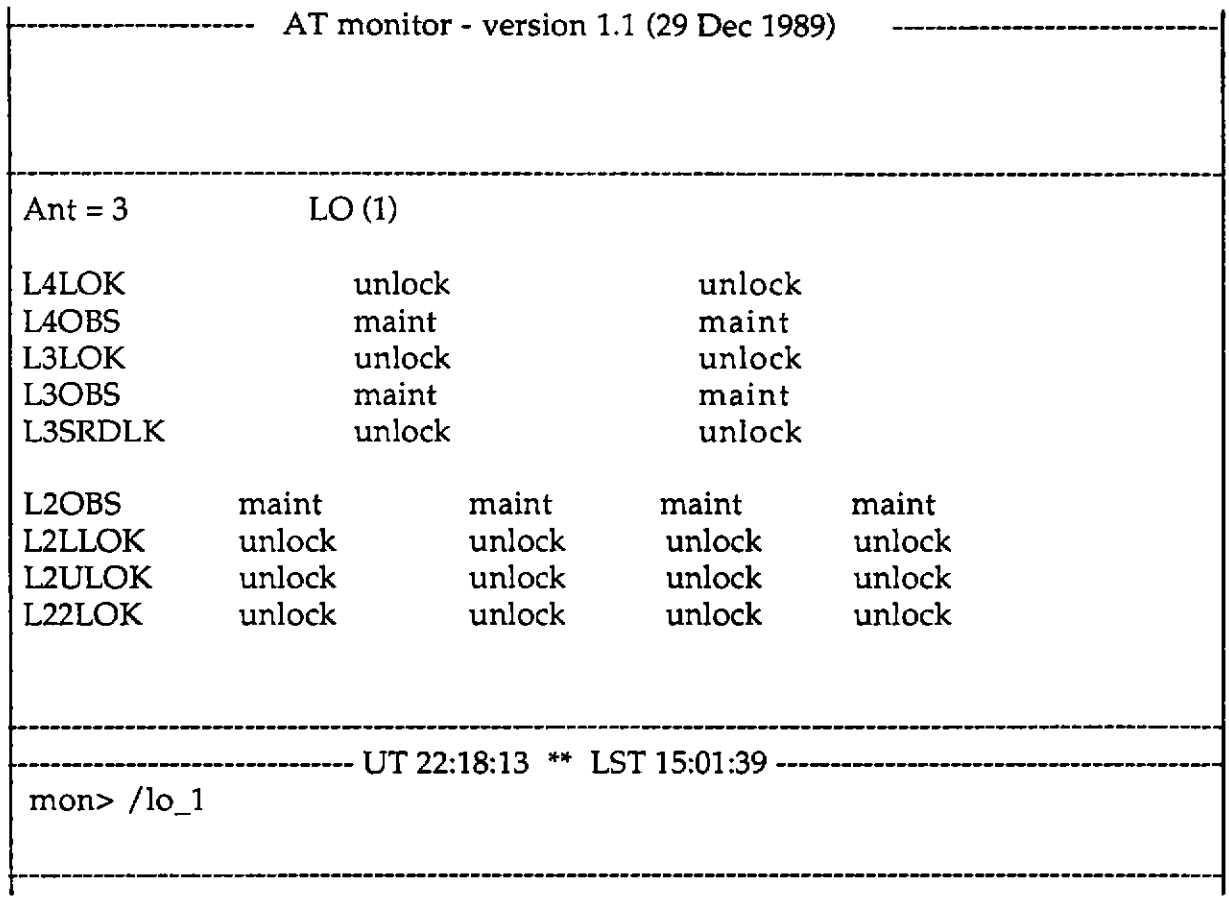

Figure 3.3 b

The display corresponding to file LO_1

```
/u
>                    C/X FET BIAS
>
>               A-POLARIZATION       B-POLARIZATION
>
>             Vds  Ids(mA)  Vgs    Vds  Ids(mA)  Vgs
>
C-Band_Stage_1   cxcavds1 cxcaids1 cxcavgs1 cxcbvds1 cxcbids1 cxcbvgs1
C-Band_Stage_2   cxcavds2 cxcaids2 cxcavgs2 cxcbvds2 cxcbids2 cxcbvgs2
C-Band_Stage_3   cxcavds3 cxcaids3 cxcavgs3 cxcbvds3 cxcbids3 cxcbvgs3
C-Band_Stage_4   cxcavds4 cxcaids4 cxcavgs4 cxcbvds4 cxcbids4 cxcbvgs4
>
X-Band_Stage_1   cxxavds1 cxxaids1 cxxavgs1 cxxbvds1 cxxbids1 cxxbvgs1
X-Band_Stage_2   cxxavds2 cxxaids2 cxxavgs2 cxxbvds2 cxxbids2 cxxbvgs2
X-Band_Stage_3   cxxavds3 cxxaids3 cxxavgs3 cxxbvds3 cxxbids3 cxxbvgs3
X-Band_Stage_4   cxxavds4 cxxaids4 cxxavgs4 cxxbvds4 cxxbids4 cxxbvgs4
```

Figure 3.4 a

An example of a UNIVERSAL display file (CX_BIAS.page)

---------- AT monitor - version 1.2 (4 Jan 1990) ----------

mon> /cx_bias/2

Antenna 2

C/X FET BIAS

	A-POLARIZATION			B-POLARIZATION		
	Vds	Ids(mA)	Vgs	Vds	Ids(mA)	Vgs
C-Band Stage 1	3.010	8.105	-0.266	3.005	8.105	-0.342
C-Band Stage 2	-1.228	8.032	-0.894	3.008	8.008	-0.942
C-Band Stage 3	1.997	8.032	-1.221	2.007	8.032	-0.986
C-Band Stage 4	3.125	0.049	0.718	2.026	0.146	0.718
X-Band Stage 1	3.206	8.057	-1.045	3.196	7.983	-0.984
X-Band Stage 2	3.206	7.886	-0.840	3.203	7.935	-0.496
X-Band Stage 3	3.213	8.008	-0.771	3.208	7.959	-0.642
X-Band Stage 4	3.208	2.002	-0.906	2.400	2.026	2.036

---------- UT 22:26:15 ** LST 15:37:18 ----------

Figure 3.4 b

The display corresponding to file CX_BIAS.page

4. CHECKER

This task carries out the global checking and archiving of all monitor points. It will be fired up whenever **NOEL** is rebooted; CAOBS will also check that it is running, and complain if it isn't.

The setup file **at$monitor:config.file** is referenced when the task starts, so CHECKER knows which antennas are expected to be operational.

4.1 Checking.

Every 5 seconds CHECKER performs the following checks, for each operational antenna:

a. Communications

- Is there an open communications channel? ie., is the ghost alive?
- Has the ACC returned data for each monitor point within the past two minutes?

b. Monitor point data

Every monitor point is checked against its limits.

The task presents its findings on a terminal adjacent to the control desk; in addition, a log file and printer output are produced. These contain the UT of the onset of the error conditions, and the UT at which the errors are cleared up. Fig, 4.1 shows an example of the monitor display, and fig. 4.2 has an example of the printer output. The log file is **at$monitor:checker_log.file**.

4.2 Archiving.

CHECKER also performs the archiving function, logging data whenever a fresh buffer is deposited in the common area. The archive file is **at$monitor:archive.log**.

4.3 Commands

The operator has a few commands, to alleviate the noise and confusion when there is a large number of error conditions - the BELL can be suppressed, and the error checking can be disabled on a specified antenna:

DISABLE BELL/ENABLE BELL
DISABLE CA0n/ENABLE CA0n (for antenna "n")

EXIT

```
---------- AT Checker - version 1.0 (27 Dec 1989) ----------
04:09:23 UT     Antenna 4  A1L21DIG    error
04:09:23 UT     Antenna 5  A1L21DIG    error
04:09:23 UT     Antenna 1  A1L21OBS     MAINT
04:09:23 UT     Antenna 2  A1L21OBS     MAINT
04:09:23 UT     Antenna 3  A1L21OBS     MAINT
04:09:23 UT     Antenna 4  A1L21OBS     MAINT
04:09:23 UT     Antenna 5  A1L21OBS     MAINT
04:09:23 UT     Antenna 1  CXPSUP      -500.0
04:09:27 UT     Antenna 2  CXPSUP      -500.0
04:09:28 UT     Antenna 3  CXPSUP      -500.0
04:09:28 UT     Antenna 4  CXPSUP      -500.0
04:09:28 UT     Antenna 5  CXPSUP      -500.0
04:09:28 UT     Antenna 1  CXPRET      -500.0
04:09:28 UT     Antenna 2  CXPRET      -500.0
04:09:28 UT     Antenna 3  CXPRET      -500.0
04:09:28 UT     Antenna 4  CXPRET      -500.0
04:09:28 UT     Antenna 5  CXPRET      -500.0
-------------------------------------------------------------------------------

---------- UT 04:09:34 ** LST 20:38:12 ----------
Errors :    23     23     23     23     22     0
Total number of points checked :  500
-------------------------------------------------------------------------------
```

Figure 4.1

CHECKER display

The summary is evaluated every cycle (normally set to 5 seconds).

5. XARCHIVE.

This task is still in an early phase. It will examine an archive file, and extract data according to the user's specifications. The options:

SUMMARY - get start/stop times; antennas available; basicaly check the data.

AVERAGE - This scans the archive file over a user-specified time range and extracts averages (and rms) of specified monitor points.
Two options: Single antenna, up to 6 points; or All antennas, 1 point. The output is directed both to the terminal and to a file (at$monitor:xarchive.log).

PLOT - produce plots of the data.

6. Programming Notes

6.1 The Global Common.

The monitor data returned to NOEL is placed in global common and available to tasks running on NOEL. The format of this common is roughly as defined by J.Argyros:

Each source of monitor data (the antennas, the screened room, the ghosts) has its own block. Within each block the space is subdivided into 100 data byte chunks (plus a small header); the idea here is to allow the source to fill each chunk separately, and to datestamp each chunk as it is loaded. This allows us to monitor the updating of the monitor data. The first chunk in the antenna blocks is used for the FAST monitor data, and should be refreshed each cycle; the next 28 chunks are filled by the SLOW monitor data. The last chunk is used by the checker task to hold a summary of the antenna's status. The datestamp is the UT of the cycle in which the data was collected. (UT at the start of the cycle).

6.2 The MPOINTS file

The mapping of the monitor data into the global common is defined by the task MP2, and stored in the file **AT$MONITOR:MPOINTS.FILE.** There is one record for each monitor point, oontaining :

short name;
area address, in bytes. (This is : address = 1 + (area number-1)*100)
point address within the area.
number of bytes
class (A - FAST, antenna; B - SLOW, antenna; C - FAST, screened room; D - SLOW, screened room)
Then follows the processing information, as described in section 2.4.

Each MPOINTS.FILE carries an identification(MP_ID); this is updated each time the mapping changes. This ID is returned by the reporting sources as a monitor point, so that the various tasks using monitor data can check that their version of the data mapping is consistent with the source of monitor data. The ID is the creation date in the vax internal 8-byte format. It appears as the first point in the SLOW list.

Appendix A

CAMON PAGE SUMMARY

(**AT$MONITOR:page_def.txt,** as at 18/3//90)

The CAMON pages have the following general form:

AA-n

where AA is the abreviated system name and n is the page number. For example, L2-2 is the second page of L2 monitor points.

There are also some general monitor pages which include monitor points from more than one system. The general form of the page name is just the page number n. For example, 1 is a general page howing the receiver system status.

Help monitor pages are available. The general form here is HELP-n, where n=1 to 10.

SYSTEM: GENERAL

1 : receiver system status
- 20/13cm (L/S) and 6/3cm (C/X) 20K cryogenic temperatures
- Local Oscillator lock status (BIN-wired OR)
- total power and switched noise levels, for both polarisations.

2 : Local Oscillator and Switched mode power supply status

3 : Detailed local oscillator lock status for frequency 1
4 : Ditto, frequency 2

5 : Front-end and conversion rack switched mode power supply status

6 : LO and sampler rack ditto.

10 : Antenna specific dispay of receiver status:

- LO status for frequency 1
- Total power and switched noise levels.

SYSTEM: CRYOGENICS

CRYO-1 : L/S and C/X cryogenics monitor page.

SYSTEM: L/S FRONT-END

LS-1 Antenna summary of LA, LB, SA and SB FET bias voltages adn currents
LS-2 Array, L/S pre-regulator and post-regulator power supply voltages
LS-3 Array, LA FET bias voltages and currents
LS-4 Array, LB FET bias voltages and currents
LS-5 Array, SA FET bias voltages and currents
LS-6 Array, SB FET bias voltages and currents

SYSTEM: C/X FRONT-END

CX-1 : Antenna summary page of CA, CB, XA and XB FET bias voltages and currents.
CX-2 Array, C/X pre-regulator and post-regulator power supply voltages
CX-3 Array, CA FET bias voltages and currents
CX-4 Array, CB FET bias voltages and currents
CX-5 Array, XA FET bias voltages and currents
CX-6 Array, XB FET bias voltages and currents

SYSTEM: CONVERSION

C40-1 Array conversion system status, for frequency 1

SYSTEM: LOCAL OSCILLATOR

LO-1 : Antenna, LO status (L1-L4) for frequency 1
LO-2 : Antenna, LO phase rotator status (L21-L22) for frequency 1
LO-3 : Antenna, monitor points related to BIN 3 -wired-OR
LO-4 : Antenna, monitor points related to BIN 4 -wired-OR
LO-5 : Antenna, monitor points related to BIN 5 -wired-OR

L4-1 : 7 GHz local oscillator module L4, frequency 1, first page.
L4-2 : 7 GHz local oscillator module L4, frequency 1, second page.

L3-1 : 2 GHz local oscillator module L3, frequency 1, first page.
L3-2 : 2 GHz local oscillator module L3, frequency 1, second page.

L2-1 : UHF local oscillator module L2, polarisation A, frequency 1, first page.

L2-2 : UHF local oscillator module L2, polarisation A, frequency 1, second page.
L2-3 : UHF local oscillator module L2, polarisation B, frequency 1, first page.
L2-4 : UHF local oscillator module L2, polarisation B, frequency 1, second page.

L1-1 : sampler clock module L1, polarisation A, frequency 1.
L1-2 : sampler clock module L1, polarisation B, frequency 1.

L22-1 : UHF phase rotator module L22, polarisation A, frequency 1.
L22-2 : UHF phase rotator module L22, polarisation B, frequency 1.

L21-1 : sampler phase rotator module L22, polarisation A, frequency 1.
L21-2 : sampler phase rotator module L22, polarisation B, frequency 1.

L31-1 : local oscillator reference module L31.

L32-1 : local oscillator reference module L32.

L33-1 : local oscillator reference module L33.

SYSTEM: SWITCH-MODE POWER SUPPLIES

PS-1 : switch-mode power supply voltages and currents for the front-end, conversion and local oscillator racks.
PS-2 : switch-mode power supply status and monitor voltages for the front-end, conversion and local oscillator racks.

PSF-1 : front-end switch-mode power supply voltages and currents, first page.
PSF-2 : front-end switch-mode power supply voltages and currents,

PSC-1 : conversion rack switch-mode power supply voltages and currents, first page.
PSC-2 : conversion rack switch-mode power supply voltages and currents, second page.

PSL-1 : local oscillator rack switch-mode power supply voltages and currents, first page.
PSL-2 : local oscillator rack switch-mode power supply voltages and currents, second page.

PCC : Array, PCC/ACC status.