Circadian Activity Monitor System (CAMS)

http://www.cams-behavior.com

448 Channel Data Acquisition System for Behavioral Analysis
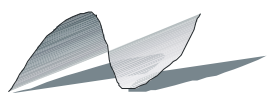
INSTRUCTION MANUAL

(version 1.2, November, 2007)

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CAMS USER / SYSTEM REFERENCES:

User References:

Name:	
Institution:	
Address	
Tel:Fax	
Email	
Website:	

Cams Program References

Licence Version	
Date	
Number of Input Channels	
Other:	

System Component Checklist:

CAMS code #	Description	Quantity	Serial Numbers

Shipping Date:

Other – Observations:
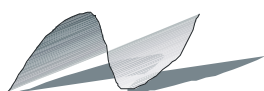
CAMS

CAMS SYSTEM DESCRIPTION

SYSTEM COMPONENTS:

The Circadian Activity Monitor System (CAMS) is a data acquisition system designed to record activity using a variety of behavioral and activity sensors (running wheels, infrared beams, TTL signals, switches, lick meters, passive infrared captors). The basic hardware and software features include:

- Industrial grade miniature PC data acquisition system (fanless, solid state disk)
- Dedicated data acquisition program
- High Speed data acquisition interface with power supply (interface module 1)
- 16 input data acquisition modules (Up to 448 input channels)
- Output Modules (controls up to 50 output channels light/electrical devices)
- Activity sensors (optional)
- Light and Temperature Sensors (optional)

SCHEMATIC DIAGRAM OF CAMS SYSTEM COMPONENTS
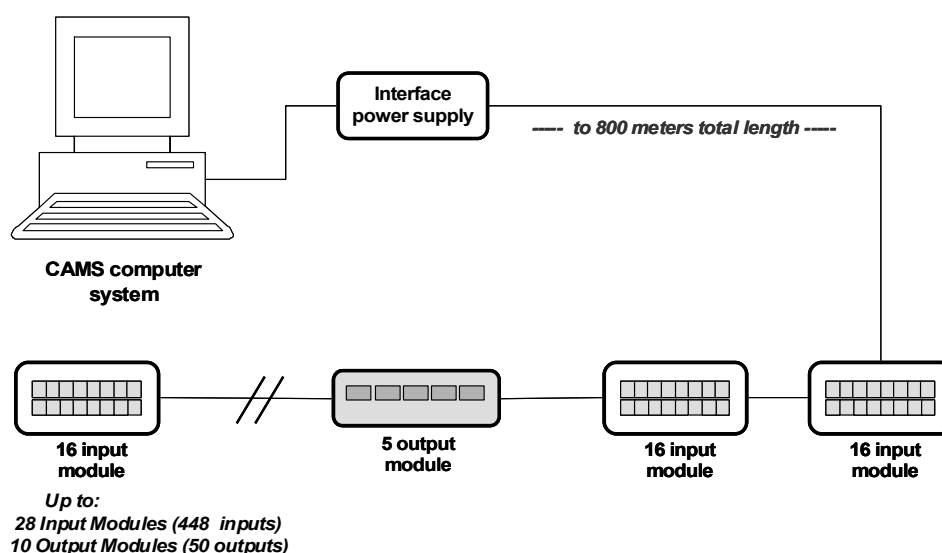
Starting data recording simply involves plugging in the computer, connecting the modules and captors, and turning the computer on. The system will immediately start recording data (see introductory section on "***GETTING STARTED")*** .

CAMS

KEY FEATURES OF CAMS

- Fully automatic, unattended data acquisition

- Easy installation and start-up

- Compact, robust industrial-grade components, minimal system parts

- Simple modular connections and instant plug and play operation

- Single thin network cable, up to 800 meters long

- Noiseless operation (fanless, no moving parts, solid state disk)

- Low power consumption (40 Watt)

- Up to 448 activity input channels, tests of individual inputs

  Uses various input devices (wheel, infrared, contacts, other)

  Ambient temperature and light captors

  Definition of captor type, experiment, user ID, groups

- Up to 50 output channels for control of light cycles, other equipment

  Definition of 24 hour, non-24 hour T-cycles and user defined variable on-off schedules

- High density display of on-going minute, hour and 24 hours of activity

- Display of raster and cumulative actograms of the current recording period

- Overlay of light cycle, light intensity and animal activity records

- Indication of no activity warning (captor malfunction, animal mortality)

- Automatically timed save file procedures (user defined)

- Tracking of total days of recording

- Protected against power failure (automatic restart, warning message time of power-off, power-restart)

- Wireless communication network (optional)

CAMS

BASIC PRINCIPLES OF CAMS SYSTEM FUNCTION

The Circadian Activity Monitoring System (**CAMS**) has been designed for simple and robust data acquisition for measures of locomotor activity and other behaviors in a variety of animals (rodents, birds, primates). **CAMS** is dedicated to continuous, unattended, uninterruptible data acquisition. Data can be periodically transferred to a Windows based computer for data analysis (we recommend ClockLab™, purchased separately from Actimetrics; http://www.actimetrics.com). Separating acquisition and analysis systems facilitates data management and avoids any possible interruptions during data recording.

The system is extremely simple to use and is based on robust industrial grade components: compact industrial grade PC, interface and data acquisition modules designed for use in harsh environments. The interface module (which also includes the power supply for the input modules) is connected to the computer via a simple high speed interface cable. Up to 28 external 16-input data acquisition modules and 10 output control modules can be connected. The total distance of the cable between the computer plus interface and the data acquisition modules can equal 800 meters so that the control computer can be located far from the animal housing facilities. Optional wireless communication is also available.

The program uses a simplified menu system to navigate through the program options, configure the system, save data and view activity plots. The system can be programmed to automatically save data files at predefined intervals without need for the experimenter to be present. Output controls can also be programmed to turn lights or other instruments on and off according to daily or arbitrary user-defined schedules. Once installed the system functions autonomously with a minimum of user intervention and can continue to run indefinitely.

What type of Data can be recorded by CAMS?

CAMS uses various captors to record long-term activity patterns in animals. The basic captors are either passive infra-red captors (for detecting movement using the animal's body heat), running wheels, or any type of switch/contact closure. Data events are recorded as total counts in one minute bins. An event consists of a switch closure, a signal from an electronic device, etc. Captors and other devices that can be used with **CAMS** are described in Appendix 4. File structure is described in Appendix 2.

CAMS

GETTING STARTED

> ***Important:*** Assemble all the system components, including all the modules and captors before powering on the computer.

5 SIMPLE STEPS TO ASSEMBLE THE SYSTEM COMPONENTS AND START RECORDING:

---- See figure on next page ----

Step 1.   Plug the keyboard, screen and Flash-Card reader *(Iomega)* into the computer

Step 2. Plug the Interface connector (DB9-pin plug) into the computer interface (**COM1**)

Step 3. Connect the ***16-channel input Modules*** to the Power-Interface module (in order of module numbers) using the interface cables).

Step 4. Connect the external sensors. Plug in the jacks (3.5 mm) of the wheels or infrared captors to the Channel inputs.

Step 5. Plug the power supply cables of the computer and the ***Power-Interface module*** into power outlet (220/110 Volt). Turn on the power switch on the rear side of the computer: Data acquisition will start immediately or if the first menu appears on the screen type "**A**" ("***Start Acquisition***").

(See system Menu (page 17) for further instructions).

The system will immediately start recording (system is pre-configured ready to go for your operation)
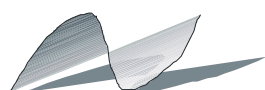
CAMS

SIMPLE 5-STEP SYSTEM SETUP
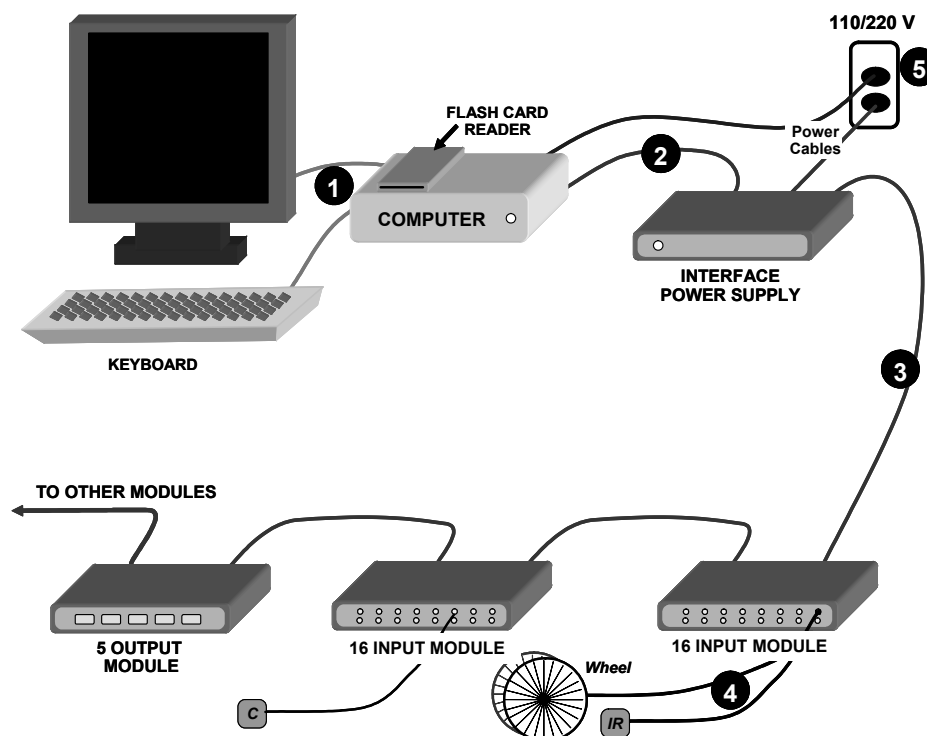
Description of Cable Connectors :

CABLE 2:   DB9- pin Serial Cable to computer (Com1)

CABLE 3:   XLR 4 Pin male-female Connector (4-wire cable)

CABLE 4:   3.5 mm stereo jack (3-wire cable) for IR captor, wheel or light-temperature captor

(See also Appendix 4: Computer System, Electrical Components)
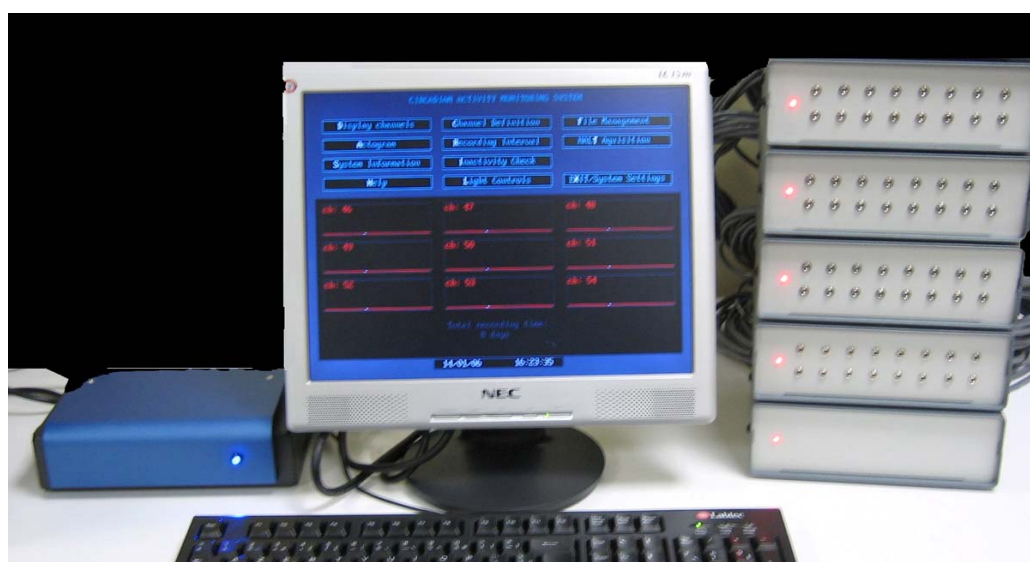
BASIC RECOMMENDATIONS FOR CORRECT USE OF THE SYSTEM

File Management and Battery Back-up

- Save activity files in separate folders in te CAMS computer at regular intervals. We recommend using an interval of 14-21 days (**see recording interval, file structure).**

- We recommend use of a **battery back-up** to protect against prolonged power failures. See also section on "*Protection Against Power Failure and Loss of Data"* for other built-in features of protection.

- Periodically check "**system information**" to all current options, etc. .

➔➔ ***See Also Appendix 1: Good File Management Practices ***

Connecting-Disconnecting Modules - Captors

- **NEVER** connect or disconnect any system components (modules, interface) during acquisition. The system requires the presence of all the modules for proper functioning. Plugging in or unplugging captors can also cause transient currents that can disturb the system. Use the Menu Option "***Halt Acquisition"*** (see page 18) to plug or to unplug modules or captors

➔➔ *See also page 21:*

Basic Trouble Shooting

In case of a problem with the system

- Verify that power LED's of computer, interface and modules are on.

- Reboot the system using the reset button of the computer. This should automatically restart the system. Otherwise consult **Appendix 3. Trouble Shooting / Problems**

CAMS

MENU ORGANISATION, NAVIGATING THROUGH THE PROGRAM

MENU SYSTEM

The menu system is very simple and uses single keystrokes to navigate through the options. **Menu Choices are made by typing the highlighted letter.** There are two main menu levels. The basic menu structure is shown below. Details of menu options are explained on the following pages.

MAIN MENU

This menu is displayed during the normal data acquisition mode of the system. Menu options lead to all other functions of the system: **Acrogram**, **Display Channels**, **File Management**, etc.

The **ESC** key always cancels a choice or returns to the main menu. After a **power failure** and automatic restart, the program enters the main menu.

The system will automatically return to this screen if no keys are activated during the previous 60 seconds.

SYSTEM MENU

This menu appears on the first system set-up, after choice of **Exit/System Settings** from the main menu or after an **Exit** from the program. Options include modification of the system parameters (i.e. adding/removing modules, setting correct time, etc..). During normal data acquisition this menu is not used.
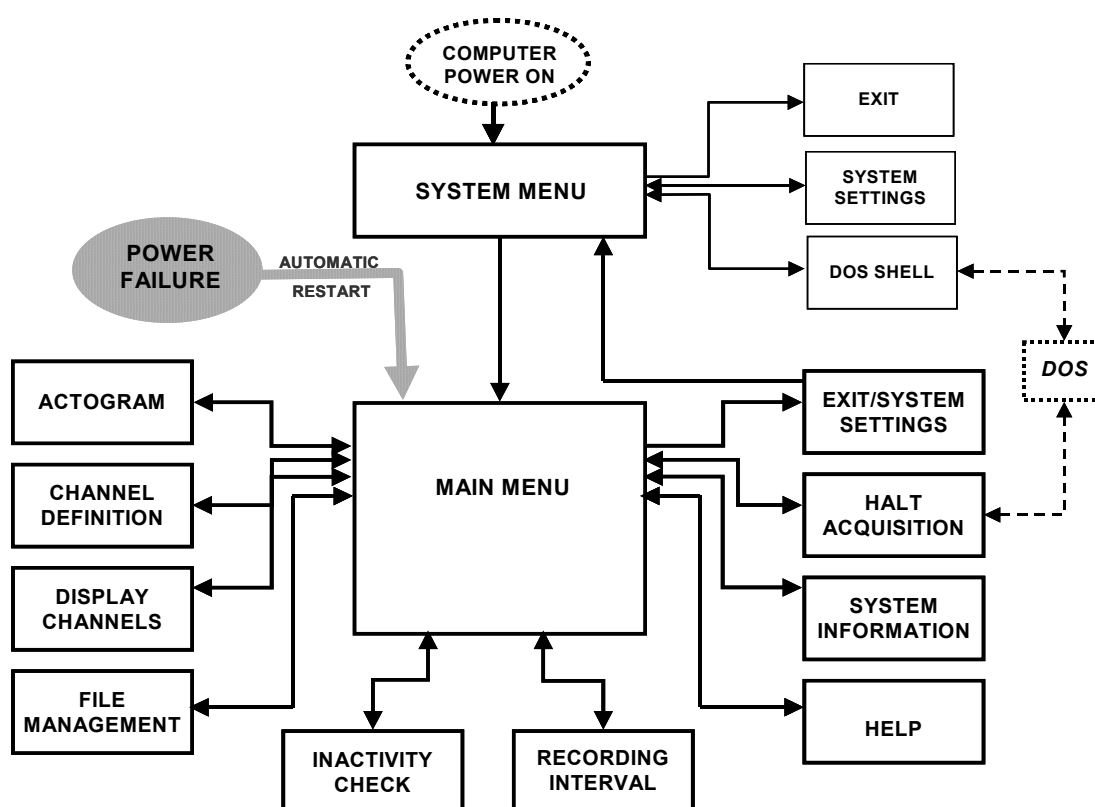
CAMS MENU STRUCTURE

MAIN MENU PAGE LAYOUT

SCREEN LAYOUT

The main menu layout is shown below. The upper part of the screen contains the various *menu options* that are chosen with the highlighted letter. When chosen, the option is highlighted and if appropriate other choices or messages are displayed in the main *display window*. Current date, time and total number of days recording are shown toward the bottom of the window.

In normal operation the display window shows multiple actograms of the activity for 9 of the channels during the current hour. The raster height is normalized to the maximum count and the white dot on the horizontal axis shows the approximate time marker for the current 60-minute period. The actograms displayed randomly alternate every 30 seconds.
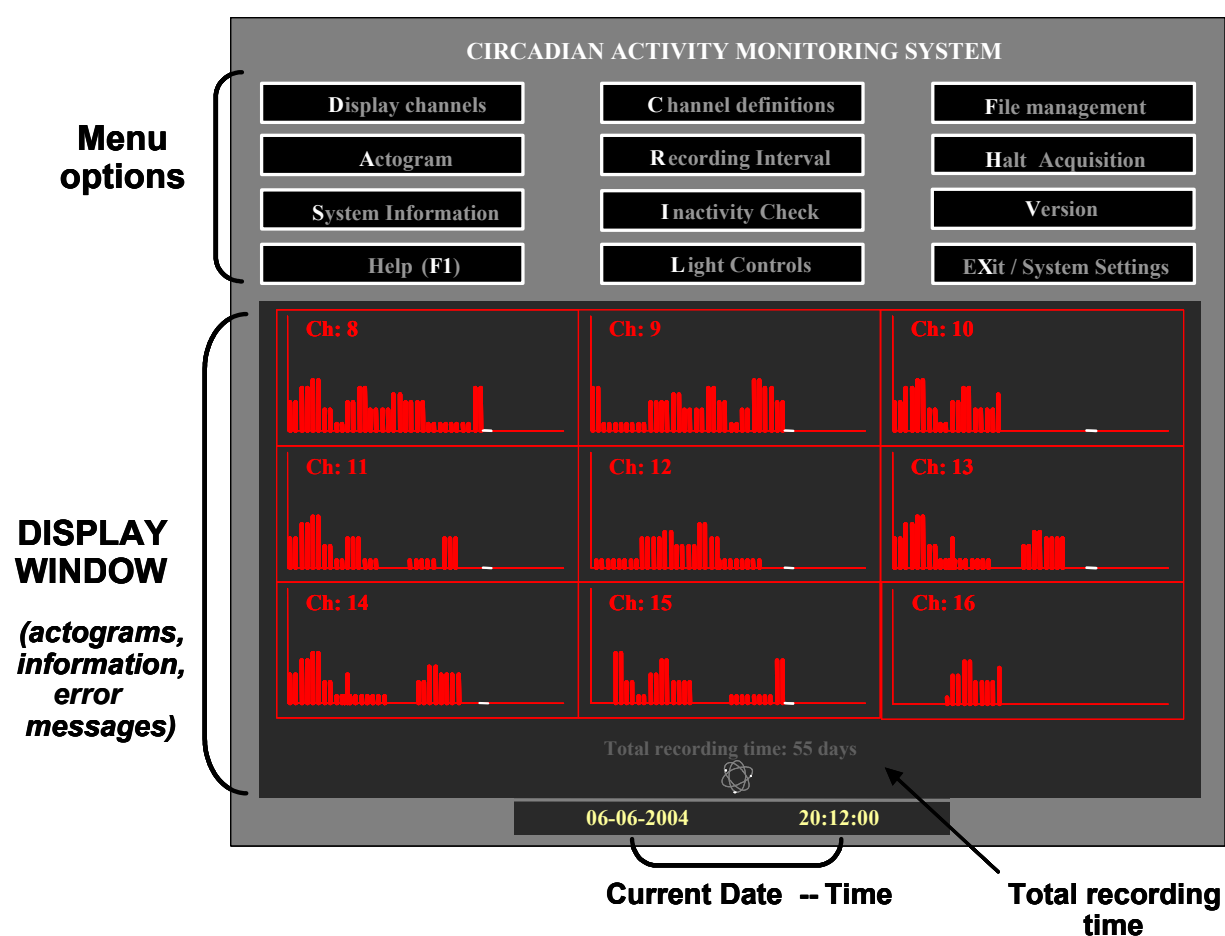
MAIN MENU OPTIONS

Display channels

Display Channels   ("D")

This option takes you to the *"channel display page"*. Channels are displayed in four columns, 28 channels per column and 112 channels per page. There are 4 pages for a total of 448 input channels. Displayed pages can be changed by using the up-down (↑↓) arrows. Channels are color coded according to type. Other information on the channel status is also indicated.

Screen layout

The top of the screen indicates scroll arrows (↑↓) to change pages, date time and **Exit ("E")** to return to main menu.:

SCROLL (↑↓)	14/01/2006	15:51:12	Exit

Channel Number, minute, hour, day counts

For each channel there are 4 columns of numbers.

Column 1 = Channel Number (from 1-448)
Column 2 = number of counts in previous minute
Column 3 = number of counts in previous hour
Column 4 = number of counts in previous 24 hours (reset at 00:00)

If channel input is a *light captor* then value is shown in LUX (previous minute average).

If channel input is a *temperature captor* then value is shown in °C (previous minute average).

EXAMPLE:

```
              ( Ch    Min    Hr    24 hrs )
                1      0     34     537
                2 ■   22    117    2239
                3     12     33    3115
                4      7    401    5634
                5 ■   11     76     597
                6     32    227     973
                7 ■    0     36     256
                8        Light    300  Lux
                9      Inactivity  27 hrs
               10 ■   15     99    1170
               11        Temp   24.2 °C
               12 •   (Red dot indicates ''channel off '')
               13    (Gray indicates channel not activated)
```

Highlighted square indicates active input →

■ Activity Input

The highlighted square indicates currently active input being received on the highlighted channel.

Inactivity *nn* hrs

Message indicating time since no activity has been detected. The alarm level (in hours) is defined in menu "***Inactivity Check***". Maximum display is 99 hrs.

Other:

Red dot next to channel Number = channel defined as off

Channel Number in Gray = "OFF" channel not activated

(note: activity files are generated (".dat") for every activated channel even if defined as "OFF".

Actogram

Actogram   ("**A**")

In the display window the user is first asked to enter the channel number in the dialog box. Hit enter to access the actogram display window.

The actogram (see next page) displays activity plots of the current recording period (data in current folder). The actogram shows both a ***Raster Actogram*** of daily activity (above- yellow-green) and a ***Cumulative Activity Profile*** (below- blue).

The records are plotted on a relative scale fit to maximum count (displayed on the right). This actogram display is only designed to provide a graphical view of recent activity for simple verification and is limited to display 22 days.

Menu Choices allow:

Zoom the scale using the "+" and "-" keys

Scroll up/down through the channels using the arrow keys (↑↓)

Choose ("**C**") to choose a specific channel to view

Choose ("**L**") to display light data to view superimposed with activity counts

Exit wil return to main menu

Note that the color of the horizontal scale line indicates the status of the system during acquisition:

Yellow Line: Period of normal data acquisition

Red Line: Absence of data acquisition (i.e. power off, exit from system). Data missing in file.

Gray Line: Outside of displayed recording period or absence of data (no data files generated)

EXAMPLE OF ACTOGRAM DISPLAY ON NEXT PAGE

CAMS
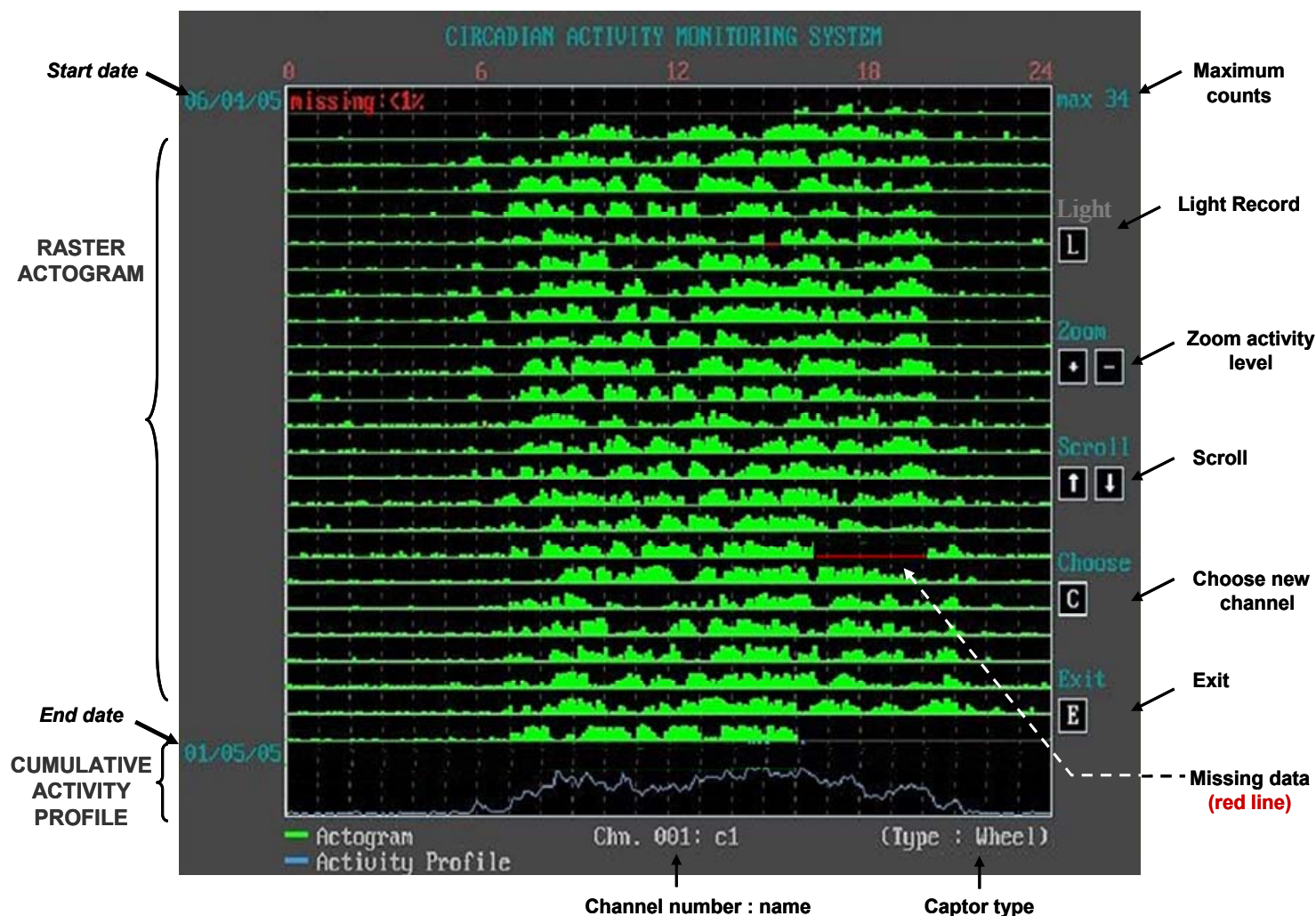
ACTOGRAM

Note the raster plot above (green) and the cumulative profile below (light blue). Other information displayed includes: begin and end date of display, maximum bin count, data missing, channel number and name, captor type.

Keystroke commands allow:

Light – superimpose associated light measures

Zoom of the activity level (height)

Scroll to next/previous channel

Choose a specific channel to display

Display associated light levels with activity count

Exit to main menu

Note the portion of the horizontal time line in red that indicates periods of missing data resulting from a power off, exit from system, halt in recording, etc.

System Information

System Information   ("S")

Displays essential information on the current status of the system including: file size, free memory, date of last save etc.. It is always good practice upon returning to the computer to check this information before making any menu choices. The screen layout is as follows:

INFORMATION
Recording Started: 10/04/05
Next Recording Starts: in 6 days
Recording Interval: every 7 days at 18:00   **Current Folder: 100405A**
161 Kb per Folder
Record Length: 3 days 17 hours   **1 Kb per File**
16 Kb total
807 Kb free on HDD
Inactivity Check: 18 hours
Clock Correction: 0 sec.
Number of Channels: 32   **[max: 448]**

SYSTEM INFORMATION WINDOW:

- *Recording Started* shows the date the current folder was created.
- *Next Record Starts* shows the date/time that the next folder will be created
- *Recording Interval* shows the user defined interval for opening a new folder (➔ See Menu Choice: *Recording Interval*).
- *Record Length* shows actual time length in days and hours of current recording (periods of power failure excluded
- Other file Information (right side of window) :
    Current Folder shows the name of the folder (➔ See Appendix 2: File Structure)
    Bar Graph shows a schematic representation of % file record completed. A red line indicates missing data (i.e., power off)
    Sizes (in Kb) are indicated for *File*, *Folder*, *Current Folder* and Free space on hard Disk (*HDD*)
- *Inactivity Check* shows the USER defined interval to check for absence of activity (➔ See Menu Choice: *Inactivity Check*)
- *Clock Correction* shows the user defined clock correction if necessary. (➔ See *System Settings*).

CAMS
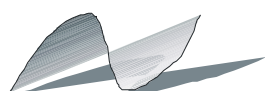
- **Number of Channels** shows the number of currently activated channels on the system.
- **Max:** indicates the maximum number of channels possible on your system.

> **Help (F1)**

Help ("F1")

Displays context-dependent help messages. Hitting "F1" will alternatively display the message and retruurn to the current page. The content of help message will depend on the particular site in the menu options. For example help in "File Management" will give information on options concerning saving and transferring files. Help in "Actogram" will give information on the various options available in actogram.

CAMS

<div style="text-align:center">

Channel definitions

</div>

Channel Definition   ("C")

Used to view and modify channel definitions. Initial display allows selection of Channel to modify (**S**elect Channel, "**S**") or **E**xit back to Main Menu:

Select Channel   **E**xit

Selecting a Channel will show the options to modify the channel definition. Channels are selected by scrolling using the arrow keys (↑↓).

Captor Type can be modified using **Tab**:

IR (Infrared captor, closed contact type)
Wheel (Running wheel, open contact type)
Light (Light captor, range 0-2500 Lux)
Temp (Temperature captor (10-50°C, Resolution 0.1°C)
CC (closed contact)
OC (open contact)
Off (channel not used)

Enter will skip to the next field (Name, Comment, Group). *Name* (8 characters) can be used to enter codes, names, cage # or animal ID). *Group* (2 characters) designates a group (user, experiment, room) and is used to associate light to activity channels for display in "**Actogram**". *Comments* can be up to 40 characters.

Enable sound Test "**T**" is used to test the function of individual inputs. A beeping sound is emitted when the selected channel entry is activated. Different channels can be tested by scrolling through the list. "**T**" will toggle the option on/off.

FIELD EDIT		
Tab: Modify	**T**: Enable Sound test	**Enter**: next field

No	Type	Name	Group	Comments
1	IR	C1		10/14 LD cycle
2	IR	C2		10/14 LD cycle
3	IR	C3		10/14 LD cycle
4	IR	C4		10/14 LD cycle
5	IR	C5		10/14 LD cycle
6	Wheel	C6		Phase shift
7	Wheel	C7		Phase Shift
8	Off	C8		Free Run

Recording Interval

Recording Interval   ("R")

Sets the interval for starting a new folder defined in **Number of Days** and **Time of Day**. This option is used to create new folders for defined recording periods to organise data records and define the size of individual activity files. It is recommended that the files for a given recording period do not become excessively large in size. We generally use intervals of 7-21 days.

Enter or Esc key will cancel.

► See also **Appendix 2:** File Structure and File Size

Inactivity Check

Inactivitity Check   ("I")

Sets the minimum duration for detection of no activity (lack of input to channel). No activity results from either a mechanical or an electrical failure of the sensor (wheel blocked, wire cut, plug removed, etc..) or a problem with the animal (escaped from cage, illness, mortality).

An alarm message can be read in the display channels screen (turn the channel "OFF" to avoid display of this message if the channel not used or temporarily not used.

Enter or Esc key will cancel.

CAMS

Light Controls

Light Controls ("L")

Allows control of output relays for example to turn on and off lights or other external electronic devices. The user defines the time "on" and the time "off" for each channel. Each page (page-down/page-up) will display up to 20 output channels.

Each output module contains 6 output channels Up to 10 modules can be added to the network for a total of 50 output channels. Output can switch on and off 220V lights or 12 V devices (inquire).

Display and modification of channel output is similar to that of "Channel Definition" (see above).

The display allows selection of the Output Channel to modify:

Select Channel, "S" or Exit back to Main Menu

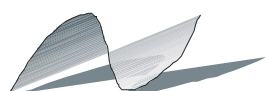Choosing a Channel is made by scrolling with the arrow keys (↑↓)

```
         CIRCADIAN ACTIVITY MONITORING SYSTEM

 ↑↓ Select channel                                          Exit


                    LIGHT OUTPUT OVERVIEW

  n°1   LC - 1        n°6   LC - 6        n°11  LC - 11       n°16  LC - 16
  ■ OFF Advanced            Disabled      ■ OFF 24 LD         ■ OFF 24 LD

  n°2   LC - 2   C2   n°7   LC - 7        n°12  LC - 12       n°17  LC - 17
  ■ ON  T-Cycle       ■ OFF Advanced      ■ OFF 24 LD               Disabled

  n°3   LC - 3   C2   n°8   LC - 8        n°13  LC - 13  22   n°18  LC - 18
  ■ ON  T-Cycle             Disabled      ■ OFF 24 LD               Disabled

  n°4   LC - 4   C2   n°9   LC - 9        n°14  LC - 14       n°19  LC - 19
  ■ ON  T-Cycle             Disabled      ■ OFF 24 LD               Disabled

  n°5   LC - 5        n°10  LC - 10       n°15  LC - 15       n°20  LC - 20
        Disabled            Disabled      ■ OFF 24 LD               Disabled


              17/01/07        13:35:38
```

CAMS

DEFINING DIFFERENT LIGHT CYCLES.

Once an output channel is selected use "TAB" to choose one of three types of output light cycle schedules:

- *24 hr LD cycle:* 24 hour light schedule
- *T cycle:* Non-24 hour light regime (T-cycles shorter or longer than 24 hours)
- *Advanced:* Used to define any arbitrary on-off cycle over any period of time.

After cjhossing the type of light cycle, you can indicate successively the *"Name"* of the output channel, the *"Group"* name, the period of *"Light Duration"*, and the *"Time of Lights On"*. For the "*T-Cycle*" the period length of the light-cycle can also be defined.

In the example below, a *T-cycle* of 24.10 hours is defined to start at 12:00 hrs on the first day. Note that in the T--cycle schedule, the duration of the *lights on* period is in circadian time, not real clock time.

EXAMPLE OF A T-CYCLE OF 24.10 hrs:

CAMS
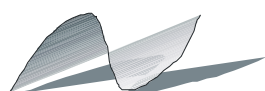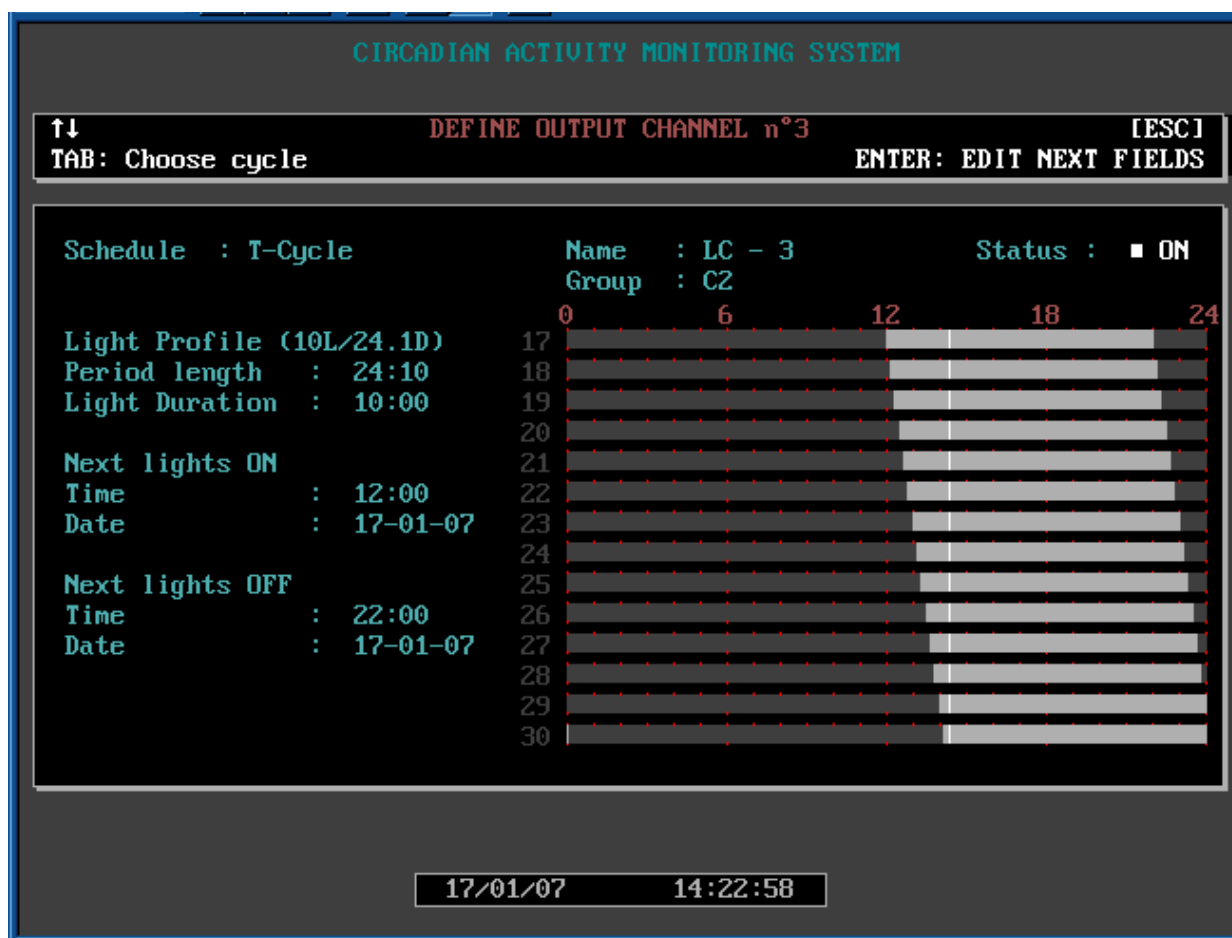
EXAMPLE OF ADVANCED LIGHT SCHEDULE:

In the example below an advanced timing schedule has been defined. An advanced schedule if programmed externally in Ascii (notepad) or in Excel format. This allows definition of any timing schedule of lights on-lights-off for weeks or months. Multiple light on and off can be defined each day. The timing resolution is in 1 minute intervals.

(inquire with CAMS for detailed information and examples)
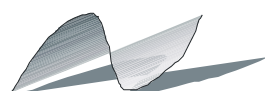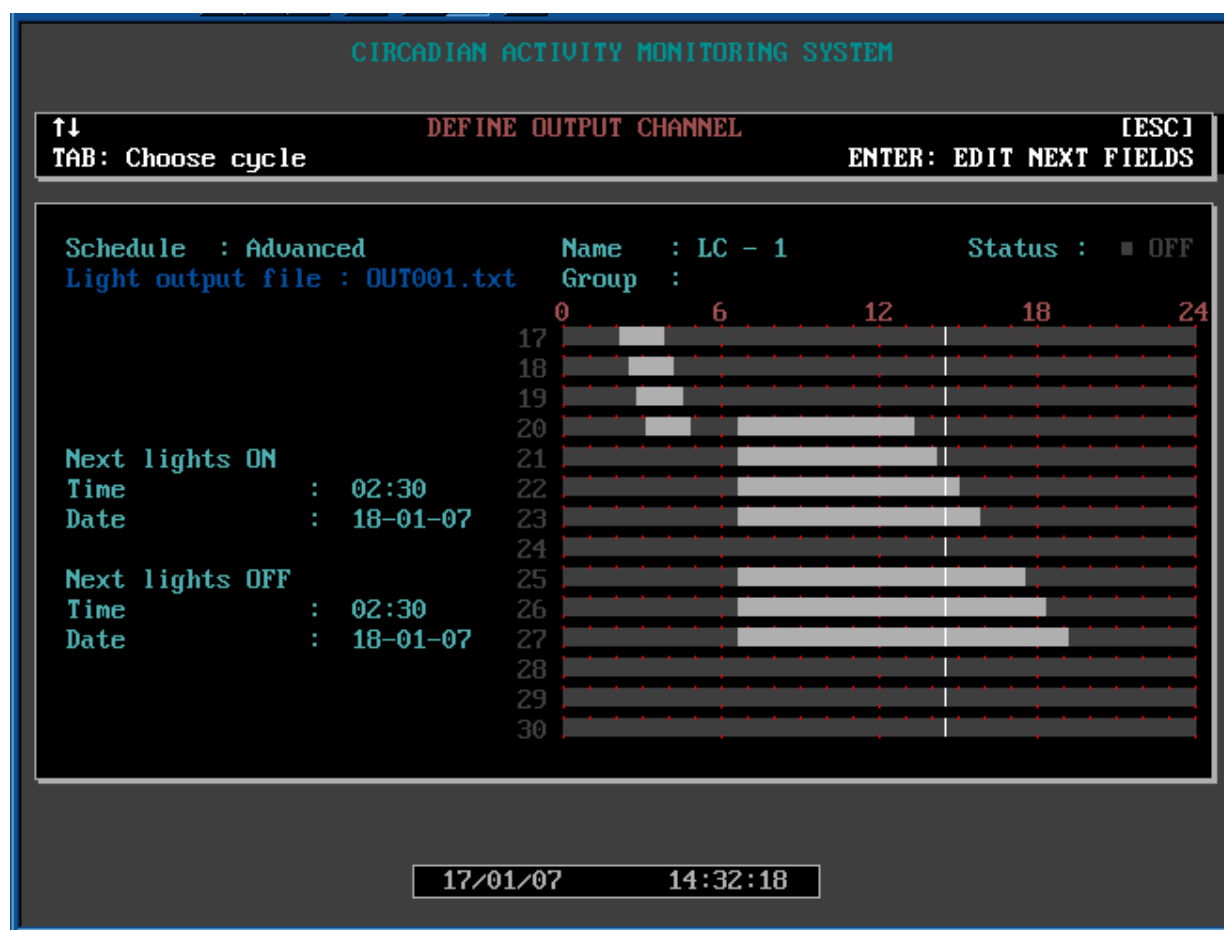
File Management

File Management   ("F")

This option allows copying files to disk (External Flashcard). The following options for file management are shown in the window as below.

► Options are chosen by typing the *number*

► *Esc* will cancel the operation.

```
         -- CHOOSE OPTION  --
      1.  Copy files from current folder
      2.  Copy files from another folder
      3.  Start New Recording (Create New Folder)
      4.  Delete Old Folders
```

Copy files from current folder will show the following message to copy all files to the disk. All the records of the folder are copied.

Insert Disk in drive D: and type "Y" to transfer file

Copy files from another folder will show a list of previously recorded folders to copy which can be scrolled and selected or unselected by **"S'. "U"** will unselect all. All the records of the folders are copied.

(see *file selection scroll menu* below)

Delete Old Folders will allow removing old folders if disk space becomes limited. A list of current folders to delete will be shown.

(see *file selection scroll menu* below)

FILE SELECTION SCROLL MENU:

```
   Scroll List using  (↑↓)
   Select / unselect Folders
   Unselect ALL            1)  010405A
                           2)  070405A
                           3)  140405A
                           4)  210405A
                           5)  280405A
                           6)  050505A

       Press Enter to (Copy or Delete) files
```

Start New Recording (Create New Folder) will end the current recording and start a new recording folder. Files of the new recording session will be saved in the newly created folder named according to the present date The following message appears:

> *New record will be started in Folder – name - . Type "Y" to proceed*

FOLDER NAMES. Folder names for records are automatically generated according to the date of creation are and coded as "day-month year-suffix" (*ddmmyyA*). The suffix is added if more than one folder is created in the same day (A...B...C...). The coding allows for quick identification of recording periods and chronological sorting of folders.

➜➜ *See also appendices 1 and 2 for information on file structure disk space.*

<div align="center">

Halt Acquisition

</div>

Halt Acquisition   **("H")**

This option is used to temporarily suspend data acquisition for example to connect and unconnect modules or captors or to suspend data acquisition during cleaning or changing of cages. A message first appears as:

Strike "**S**" to suspend acquisition
Strike "**D**" to perform DOS SHELL Operations
(Then return to Acquisiton by typing "EXIT"

On typing "**S**" a flashing message indicates in the window that data acquisition is suspended. **Esc** will return to Data acquisition mode.

IT IS IMPORTANT TO USE THE HALT MODE WHENEVER ANY OF THE MODULES AND/OR CAPTORS ARE PLUGGED OR UNPLUGGED, OR DURING ANY CHANGES IN ELECTRICAL CONNECTIONS.

For experienced users only: It is possible to exit to **DOS** using the shell command. The system password (*CAMS*) is required. Typing "*exit*" at the DOS prompt returns to the system in acquisition mode

<div align="center">

CAMS

</div>

Version

Version   ("V")

Indicates the program version, licence number and users address.

EXit / System Settings

EXit / System Settings   ("X")

This allows access to the System Settings Menu. Data acquisition will be interrupted and *the current record ends*. This should only be used for major modifications of the internal characteristics of the system such as physically adding new modules, removing modules, clock correction, or other advanced features.

Requires use of a password for access. Current password is "*CAMS*". Only needs to be used if the system is modified (adding or removing modules);


Caution: Using this option will automatically reset certain system variables and create a new folder for activity recording.

CAMS

SYSTEM MENU

The system menu will normally only be displayed:

1) At the first Power up, verify the correct system settings and then press
"**A**" to **Start Acquisition** (see **INSTRUCTIONS** below)

2) After main Menu Choice *EXit / System Settings*

3) After a formal system exit has been performed (shut down).

Start Acquisition	**SheIL Operations**
System Settings	**EXit**
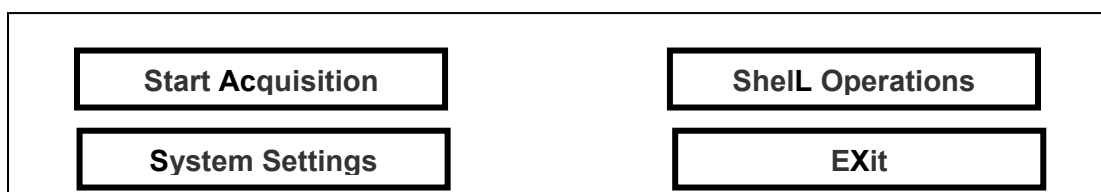
- **Start Acquisition** will go to the Main Menu and start data acquisition.
  (a new recording folder is automatically created)
- **SheIL Operations** exits to dos (type *Exit* in DOS to return to program).
- **System Settings** will allow access to change settings. Care should be used if any changes need to be made. Inappropriate changes can perturb the system.
- **EXit** will terminate the program.

System Settings	
- 1- Number of Modules	: 2
- 2 - Number of Channels	: 32
- 3 - < Channel Settings Menu >	
- 4 - Set Date:	: dd/mm/yy
- 5 - Set Time	: hh:mm:ss
- 6 - Clock Correction:	: .. sec
- 7- Data Save Interval	: 7 days

INSTRUCTIONS FOR FIRST POWER UP:

1) Verify that the correct *Date* and *Time* are appropriately set.

2) Define the *Channel Settings* (i.e. type of captors to be used). Can also be modified in main menu.

3) Modify the *Data Save Interval* if necessary (can also be modified in main menu).

Number of Modules / Number of Channels only needs to be changed if modules are added or removed to the network.

Clock Correction only needs to be set (+ or – seconds if the computer clock is inaccurate. The correction is the number (or fraction) of seconds error per day.

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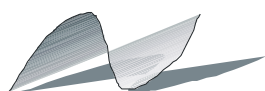
Protection Against Power Failure and Loss of Data

The system is protected against loss of data due to power failures or other events. It is advised to use a **battery back-up**, but in case of a prolonged power failure, the system automatically restarts,and continues recording. The system is protected against loss of data in several ways:

Automatic restart after Power failure.

The computer will automatically restart after a power failure, repair the files and continue recording. After a power failure, the following flashing message will be displayed at the bottom of the screen showing the time of power-off and the time that the system restarted. This is saved in a log file. The flashing message can be cancelled by pressing "**P**".

Power fail at dd/mm / hh:mm:ss
Power on at dd/mm / hh:mm:ss
< P > to reset

Watchdog Timer. *(not yet implemented)*

The computer also has a "Watchdog" utility which continually monitors that the program is functioning. If for any reason the program halts (other than power failure) an automatic restart will occur.

Verification of proper function communication of the modules.

On system start-up the proper functioning of the communication port is verified. The function presence and function of all modules are also systematically verified. A module mal-function is displayed in the information window on the main page and also on the channel definition page for each module.

Automatic data transfer.

The system can be programmed to periodically save files in sub-directories at defined intervals (number of days and time of day) to ensure more secure data recording.

Peripheral data conditioning.

In contrast with other data acquisition systems, part of the signal treatment and storage is done peripherally within the modules. This means that 99% of the time the computer is actually idle and only periodically needs to communicate with the external acquisition modules.

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Adding New Modules to the System

Adding a new 16 input module requires exiting the system and re-configuring the number of channels. Simply follow the instructions in the System Menu and modify the number of modules and channels accordingly. Note that if physically defined modules are not present the system will detect their absence and indicate this on the menu page and in the channel definition page.

All the cables for connecting modules are identical. Male / Female connectors prevent inappropriate connections.

IMPORTANT: Modules have preset "*addresses*" in their ROM memory and must be detected by the computer for proper functioning. If a module malfunctions, is disconnected or absent, the program detects this and indicates a module malfunction. It is advised to always run the system with all the modules defined in the system menu present.

Note that all modules are **numbered** and that modules and channel numbers are **predefined**. Modules however can be connected in any order but it advised to always connect modules in ascending order. The system is "daisy chained" and communicates sequentially with successive modules in the network: If the a module is disconnected the chain is "broken" and all the following modules will not be detected by the computer.

In case of a re-configuration of the system by the user the modules numbers can be easily modified (please contact us for instructions).

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Additional Utility Programs: Joining and Converting Files

The two main programs included in the utilities are for use on a windows based PC (not on the **CAMS** computer) to join activity files of successive recording periods together, to convert files to ASCII (EXCEL compatible format) or to a format used by other behavioral analysis programs (ACTIVIEW™ Minimitter).

To install and use the utility programs, follow the instructions in the **"UTILITIES_INSTALL.DOC"** file.

UnZIP the file "CAMS_UTILITIES.ZIP" to the folder (we recommend a folder called "CAMS") you would like to use on a windows XP computer. This will install all the required programs and folders (see below). The utilities programs are compiled from MATLAB and require certain routines to function properly. This is simple to do. Please read the instructions carefully.

USING THE UTILITIES PROGRAMS

Two main programs included in CAMS_UTILITIES are :

1) Join_dat_Files.exe will join successive dat files into a single file.

This utility will join any number of successive records into a single file. For example, if CAMS is programmed to create a new folder every 20 days, the user may wish to join the files together for analysis for periods spanning 40, 60 or more days. This can be easily and automatically done in Windows.

Conv_Dat_awd_v2.exe will convert dat files to both ASCII and to ACTIVIEW (*.awd).

This utility will convert the **CAMS** *.dat* file to an ASCII file format which can be imported into EXCEL for analysis by the user or for export to other data analysis programs. File structure is in three columns (separated by tabs): Date – Time – Activity Count.   Records will also be converted to ACTIVIEW™ format. This file format can be read by the Minimitter program ACTIVIEW for displaying and printing actograms, periodograms, etc... All the dat files in a folder will be automatically converted to both ASCII and .awd.

Using the back-up CD ROM to reinstall the program:

If required (loss of the flashcard disk) the **CAMS** program/system files can be re-installed from the files included on the CD (inquire for advice).

The files should be copied to a windows computer.

The files can easily be copied to the flashdisk which can then be reinserted in the **CAMS** computer.   Restart the system.

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Appendices

Appendix 1. Good File Management Practices

Appendix 2. System, File structure, File Management

Appendix 3. Trouble Shooting / Problems

Appendix 4. Electrical Components, Connections

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Appendix 1. Good File Management Practices

- ### *Defining Automatic Recording Intervals*

It is recommended to set the automatic recording period so that data records are of regular lengths. Long periods should be avoided since this creates large files which if lost or corrupted are a risk for the user. We recommend short recording periods from 7 to 31 days. These files can subsequently be joined to any length (joinfiles.exe) at any time in Windows.

- ### *Copy Files Regularly –*

Copy files from **CAMS** to transfer media at regular intervals. if several users are working with the system, copy all files from to a main directory (back-up) on a single windows based computer. Each user can then copy files from the main directory to his/her personal directory for analysis.

<div style="border:1px solid black; text-align:center">

<u>NEVER</u> copy files from one folder to another since records have identical names (*nnn*.dat)

</div>

- ### *Size of Available Space on Transfer Media*

Do not exceed the available space on the transfer media. With the FlashCard Drives this should never pose a problem. For example, 20 days recoding on the maximum 448 channels for 1 months records would be less than 28 Mo. (including records + channel definition table).
   To calculate the disk space required use the following formula:

Number of channels X 82 bytes   X 24 hours   X $\dfrac{\text{number of days}}{1024}$ = Kilobytes memory per folder

- ### *Available Disk Space*

Verify the remaining computer disk space after long periods of use. CAMS uses a solid state disk memory for security and performance (no mechanical parts). Total capacity is 512Mo or 1 Go. After prolonged periods of use old folders should be deleted to make space. The capacity according to disk size is the following:.

Number of *Years* Recording According to Number of Channels and System Flash Card Capacity

| # CHANNELS	512 Mo	1 Go
32	22,6	44,1
64	11,3	22,1
128	5,6	11,0
192	3,8	7,4
256	2,8	5,5
336	2,2	4,2
448	1,6	3,2
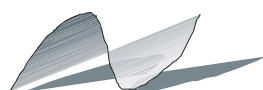
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Appendix 2. System, File Structure, File Management

System/Directory Structure, Files

The basic structure of directories and files is illustrated below. The main program files are contained in the directory "CAMS". All data records are in the directory "RECORDS". The user should never need to copy or delete any of these files, which can result in critical problems for system function. For advanced users, DOS commands can be used for copying or erasing files – only from the records subdirectories. Further information on directory structure and files can be obtained on request.
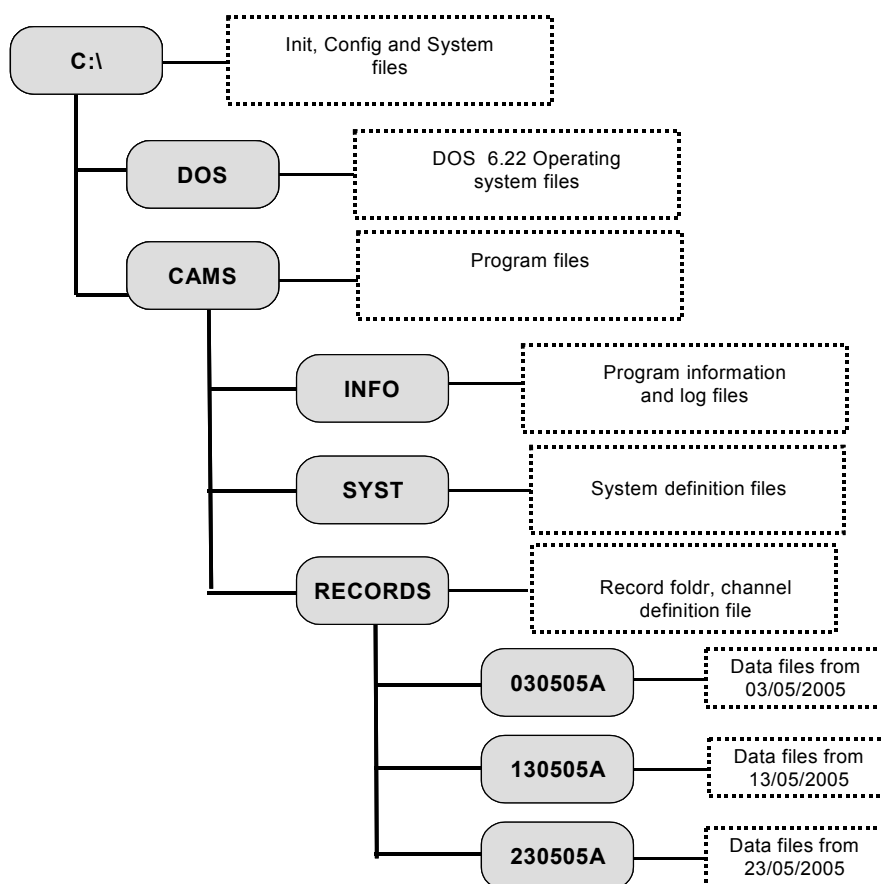
Data File Records   (*nnn.dat*)

Data for each channel is contained in a single data file. The filename is always the channel number followed by the suffix "dat" (i.e., files 001.dat to 448.dat). The file structure is shown below. Each hour record is contained in 82 bytes (binary code). This provides a very compact file structure. The header (22 bytes) contains information on animal, date, captor). The last 60 bytes contains 1 hour of data (1 byte per minute bin). Each data file contains *n* records (where *n i*s the number of hours).

A value of 0 indicates no counts. The value 255 is reserved for absence of data (power or system off). Presence of 255 appears in the actogram as a red line.

Number of Bytes	8	8	1	1	1	1	2	60
Use	Channel name	Date	Hour	Reserved	Channel Type	Reserved	Channel Number	60 min data bins

Appendix 3. Problems, Trouble Shooting.

PROBLEM	SOLUTION
Computer screen and all LED lights are off	Verify that the power supply is on and power cables are properly connected.
Computer screen is off but red LED'S of modules are on	Verify that the computer and screen are turned on, that the computer power supply is connected and that the Blue LED is on.
Computer (blue LED) and Screen are on but program does not initiate	Verify that the interface/power module LED is on and that the LED's of all modules are on. Verify that the power cable for the power supply is properly connected.
Computer (blue LED), and module red LED's are on but the program fails to initiate or is halted.	Verify that all the cables are properly connected between the modules. Reboot the system if necessary.
Module red LED is off but power is on	Verify that the jacks of the captor (wheel or infrared) are properly and fully inserted. If not fully inserted this can cause a short circuit (each modules is short circuit protected).
Cables appear properly connected but the problem persists	Verify that all the captors are properly inserted into the modules (use the captor test function in channel definition) Verify that the system is not in *HALT* mode.
The program is functioning but one of the modules is not detected.	Verify the status of the modules in Channel Definition. Verify each of the captors (no short-circuit?)
Cannot transfer files to the USB Flash Disk	Verify that the flash card is properly formatted and that the Flash Card Reader is properly connected. Try unplugging and reconnecting the reader. If this fails reboot the computer (reboot button rear side of computer).
One of the captors fails to detect activity	Verify that the captor is properly plugged in. Verify that there is no short-circuit in the captor cable (wire is not frayed or gnawed). .

If in doubt or if the problem persists turn the computer off for 15 seconds and then turn on again. This simulates a power failure after which the system should reinitiate itself.

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For further assistance email to cams@lyon.inserm.fr or cooper@lyon.inserm.fr.
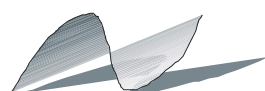
Be sure to mention:

Name and Institute

User Reference Number (see page 2)

CAMS program version (see page 2)

Number of Input Channels, Modules

(send a copy of the files in directories : INFO, SYST)

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# Appendix 4. Electrical Components, Connections

BASIC SYSTEM COMPONENTS

Computer:	Fanless VIA Eden Micro PC/ Onboard VIA Eden ESP6000 667 MHz / ESP10K 1 GHz CPU; VGA, LCD, Audio, Dual LAN, CF, 2 COM & 2 USB 1.1
Storage:	Solid State Flash Card 1 GB, SanDisk or equivalent
Screen:	NEC 153 LCD LC15M 1280X1024/75hz 16ms or equivalent
Data Transfer Device:	Iomega 7-1 Flash Card Reader
Interface	RS-232:RS-485 converter. Type 7520 or equivalent;
Input modules:	DAS-7053 – 16 input digital counter. Mechanical contact or TTL
Output Modules:	DAS-7065 – 5 output relay module. Form "A" relay SPST (N.O.). Rating AC: 250VAC@5A; DC: 30V @5A
Infrared Captors	Passive infrared, 9-28 volt operation.

HOW TO CONNECT CAPTORS TO THE SYSTEM

Different types of captors and devices can be connected to the 16-channel input modules to detect different activities or events. These are of 2 basic types, mechanical ("dry") contacts or switches and electronic TTL (logic) signals. The most frequent uses require running wheels or passive infrared captors, both of which use mechanical contacts. A simple mounting procedure is schematically illustrated below.

First it is necessary to identify the electrical contacts of the 3.5 mm male jacks. This type of jack is an industry standard for use in stereo equipment and is easily available. The contacts include:

1) Gnd - the electrical ground of the system
2) V+ - the voltage supplied by the system (**12 volts**)
3) Signal – connection to the input signal for counting.
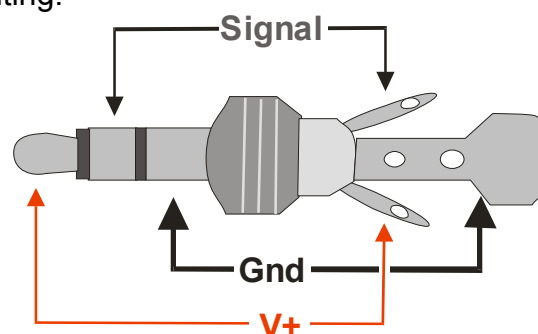
How to connect an activity wheel (or other contact devices)

A few examples of simple mechanical contacts using different type of switches are shown in the figure to the right. Contact is established when two metal pieces touch and broken when they are separated. An output is generated when signal is brought to ground.

The 2 contacts of the switch need to be attached via a 2-wire cable to the ground (**Gnd**) and **signal** contacts (soldered) of the input jack as shown. Three typical examples are illustrated:

Reed magnetic switch: this is often used in running wheel. The contact is established when the magnetic sensitive switch is in proximity with a magnetic field. The magnet can be attaced to the running wheel.
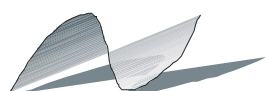
Micro-switch: contact is established when the switch is activated. This type of switch is also used in running wheels or for passage through doors, etc.

Simple wire contact: A contact can be made by bringing any 2 pices of wire or metal into contact.

Lick meter contact: The animal itself can be used to establish a contact to ground when a metal mesh on the bottom of the cage and the drinking spout are used as contacts.

reed magnetic switch

simple wire contact

lick contact
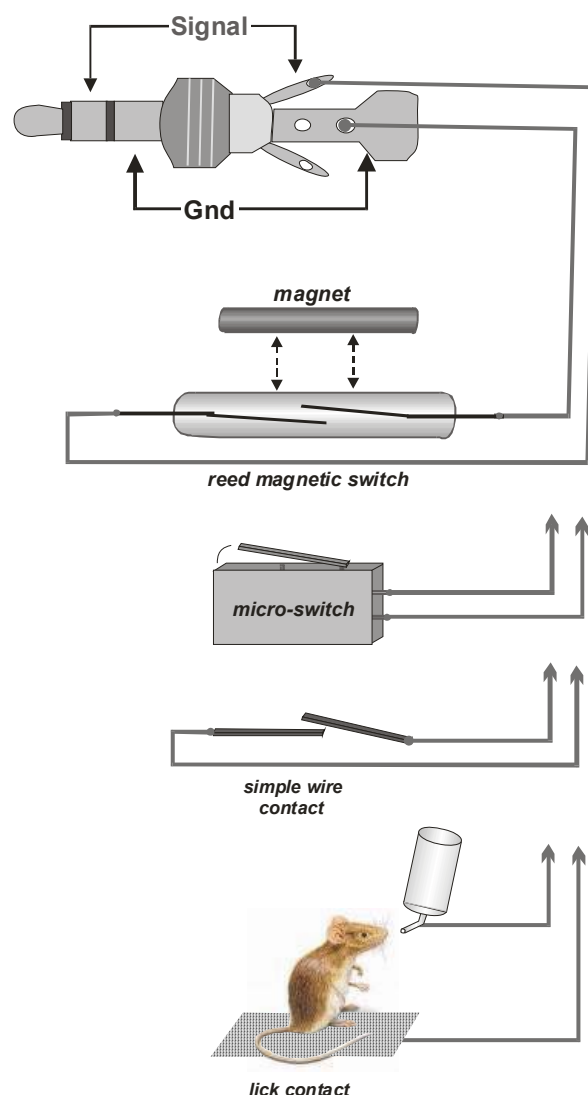
The wire cables between the jack and the jack and the captor can be of any length, since generation of an output merely requires a contact between signal and ground.

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How to connect a Passive Infrared Captor

Passive infrared (IR) captors are based on detection of infrared wavelengths (heat) emitted by the animal itself. The infrared light is projected into several zones of the captor's surface by a lens and movements are detected when the relative amounts of light change between the zones. IR captors can thus be used to detect activity in any warm-blooded animal (rodents, birds, monkeys humans) but are useless for fish, reptiles amphibians, etc. There are many types of IR captors available that have different response times, sensitivities and fields of view. The field of view is an important consideration in relation to the cage set-up.

Passive IR captors can be used to detect movements at both short (mouse cage) and long distances (entire room). For example, we use the same model detector to monitor mice in small cages (25 x 20 x 20 cm), monkeys in cages 100 x 150 cm x 120 cm and the presence of caretakers in the animal facility. The model we use is a **Quest**, passive infrared captor-**PIR** (with standard lens) made by Electronics Line (http://www.electronics-line.com/products.html) with distributors in many countries.
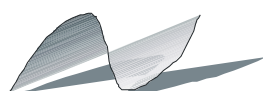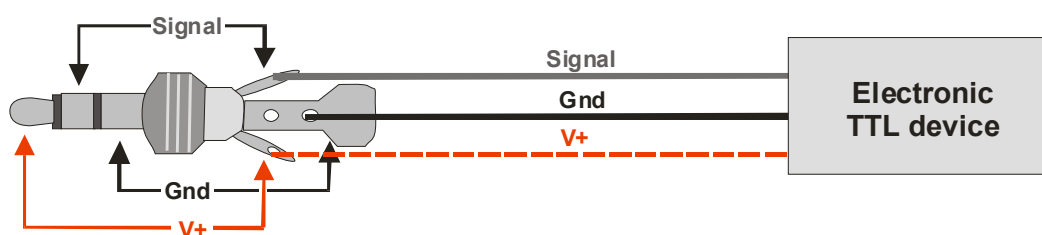
Infrared captors require a voltage supply (i.e.,between 9-18 volts), provided by **V+** and **Gnd**. In The output is a typically an electronic relay that simply establishes a contact, similar to the electrical contact devices shown on the previous page. The mounting schematic of CAMS captors is illustrated below.
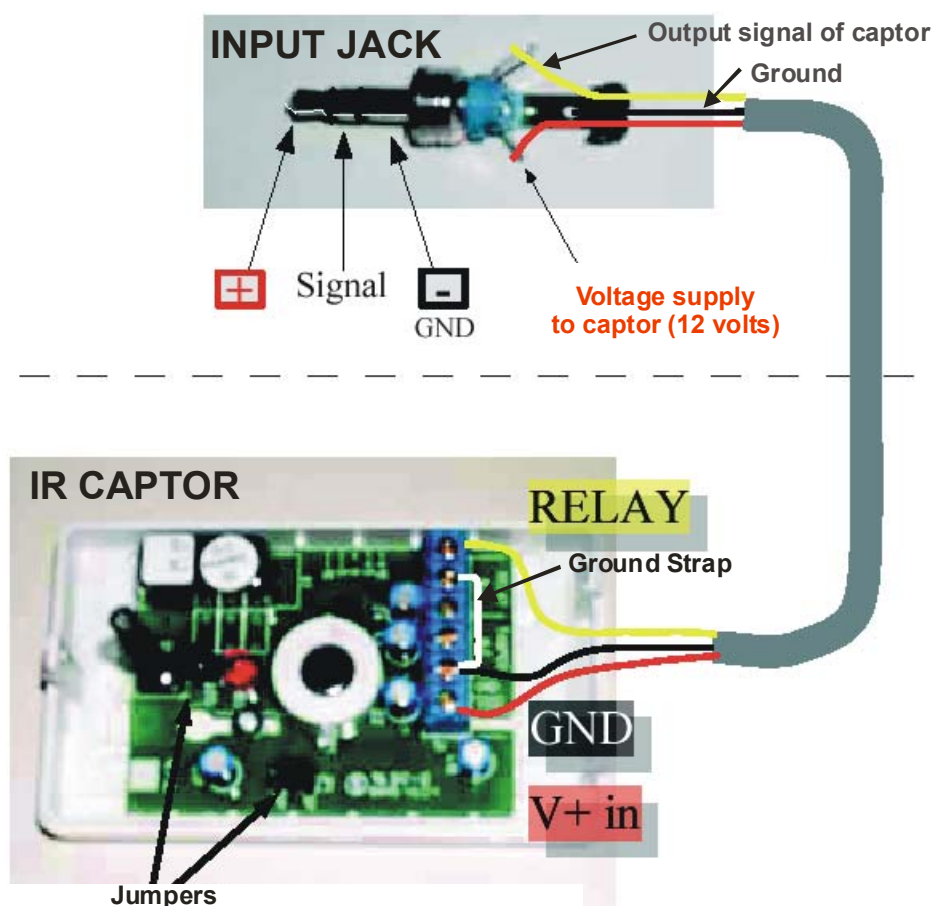
How to connect TTL devices

TTL devices use logic signals ("0" or "1") of specific voltage ranges. Many TTL devices exist that are used to detect a variety of events. The most common are active infrared captors that emit an IR beam. When the beam of light is interrupted the logic state will change from 1 to 0 and this can be detected by the CAMS input module.

Typically any electronic devoice can be used simply by connecting ground and signal (see simple diagram below). This assumes that the electronic device uses its own power supply. The 12 volts furnished by CAMS can also be used but in some cases a voltage converter may be required if the TTL components function off a 5 volt supply. Attaching electronic TTL devices requires some knowledge of electronic and CAMS should be consulted for specific advice.

END PAGE