CSM1
Card Storage Module

User Guide

Issued 1.6.00

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CSM1 Card Storage Module

The Card Storage Module system consists of a microprocessor-controlled read/write module (the CSM1) and removable credit card sized memory cards that hold data and/or datalogger programs in battery-backed memory. The memory cards are easily exchanged and transported to a computer for data retrieval.

The module is quickly prepared for use, and features built-in status indicators for module operation and data storage. The CSM1 can be left with the datalogger and the memory cards exchanged at regular intervals, or it can be moved from datalogger to datalogger to retrieve data from each one in turn. The low quiescent power consumption and wide operating temperature range allow the module to be used in remote battery-powered applications.

1. Introduction

Data stored in a card is separated into files. The files are stored sequentially in the card and are segregated by filemarks. A filemark can be written to the card in three ways:

- By plugging the card into a powered-up CSM1.
- Under control of the datalogger program when the CSM1 is connected to the datalogger.
- By using telecommunications commands when the CSM is connected to a computer.

This allows data from different dataloggers or different experimental runs to be separated.

Data in a card is read by connecting the CSM1 via an SC532 interface to the RS232 port of a PC. By using SMS, part of Campbell Scientific's PC208W Datalogger Support Software suite, you can easily communicate with the CSM1 from a PC. Using an intuitive graphical user interface, this program allows you to manipulate and extract data and load programs (generated with Campbell Scientific's Edlog program, also part of PC208W) into a memory card.

Alternatively you can develop your own programs to communicate with the CSM1. Simple ASCII telecommunications commands can be sent to the CSM1 to extract data and load programs.

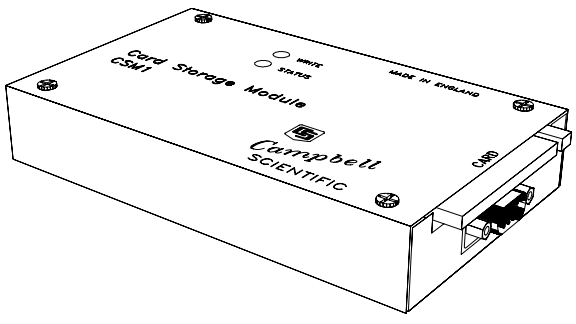

Figure 1 The CSM1

The CSM1 unit is housed in a compact aluminium case (see Figure 1). The card slot and connector are designed so that the card cannot be inserted the wrong way round. The card pushes in and locates with a positive click, and a push-button eject mechanism releases the card from the slot.

Below the card slot is a male 9-way D connector. This is a Campbell Scientific 9-way serial port. An SC12 cable (supplied) is used to connect this port to the datalogger (for data storage) or SC532 interface (for data retrieval). The card slot and 9-way connector are positioned together to allow the CSM1 to be mounted against the side wall of small enclosures, while still allowing the card to be removed or the unit to be unplugged. By first removing the electronic circuit boards inside the CSM1 the unit can be fixed to mounting plates using the two screw holes in the base of the case.

On top of the CSM1 are two light-emitting diodes (LEDs). The red 'Status' LED indicates the status of the module and card when the CSM1 is first powered up. The green 'Write' LED indicates when the CSM1 is writing to the card.

1.1 Mounting

The CSM1 storage module does not need to be permanently mounted for operation. However, if you do wish to mount the module either horizontally or vertically, two mounting holes are provided in the base for this purpose. Remove the top cover of the CSM1 by unscrewing and removing the four screws. After taking appropriate anti-static precautions, carefully withdraw both circuit boards together. The baseplate can then be mounted to any flat surface using two suitable screws or bolts. Take care not to overtighten the mounting screws as this may deform the baseplate and circuit boards. To avoid this, you may wish to remove the four rubber feet on the bottom of the case to provide a completely flat mounting surface.

CAUTION

To avoid the possibility of a short circuit, ensure the heads of any mounting bolts or screws are clear of the bottom surface of the circuit board.

Do not overtighten the mounting bolts, especially if the rubber feet are still in place, as deformation of the baseplate and circuit board could occur.

2. Specifications

2.1 Datalogger Compatibility

The CSM1 can be used with all current (and many older) dataloggers plus the DSP4. The CSM1 emulates Campbell Scientific Storage Modules for data storage (9600 baud, binary). Data can also be stored at 9600 baud in ASCII formats, but this uses more card memory. The CSM1 also supports data storage at 76800 baud with the CR10/10X and CR23X Burst Mode instruction.

Program storage and retrieval are supported for the CR10/10X, CR510, CR23X plus 21X, CR7 and DSP4. Note that the 21X and CR7 must be fitted with OSX- or OS7- software respectively.

Where the datalogger software supports it, a program stored in program area 8 in the memory card is automatically loaded into the datalogger on power-up.

COMPATIBILITY NOTE FOR CR23X USERS

If you have a CR23X with operating system version 1.7 or later, your CSM1 *must* be fitted with PROM version 7602-09 or later .

To check the PROM version, issue the 'A' (Status) telecommunications command as described in Section 7 of this User Guide. The first parameter in the returned status line will be of the form 'Vn,m', where 'n' is the PROM version. The value must be 10 or more for correct operation with a CR23X.

2.2 Card Types Supported

The CSM1 supports JEIDA 4, PCMCIA standard memory cards. Sizes of 128kb to 4Mb are supported (256 bytes reserved for system use). Low resolution data format requires two bytes per data value with high resolution data occupying four bytes. Datalogger programs require the space as stored on disk, plus an overhead of approximately five bytes.

Standard card sizes are 128, 256, 512kb and 1, 2 and 4Mb. These equate to low resolution data capacities of 65408, 130944, 262016, 524160, 1048448 and 2097024 locations respectively. (Please contact Campbell Scientific to check on the preferred card size and availability.)

NOTE CSM1 operation cannot be guaranteed with cards not tested and supplied by Campbell Scientific.

2.3 Operating Specifications

Guaranteed operating temperature range of module and cards: -25°C to +50°C (-40°C optional). Please contact Campbell Scientific if extended temperature ranges are required.

2.3.1 Battery Type

Lithium coin cell. Type and capacity varies with card manufacturer and card size. Capacity 120 to 170mAh.

2.3.2 Battery Back-up Life (Typical Figures for 1Mb Card)

These figures apply when the card is disconnected from an external power supply, i.e. the card is not plugged into the module and/or the module is not being powered by a datalogger.

@ -20°C 7 years

@ +20°C 8 years

@ +50°C 2 years

Low battery detection indicates approximately 3% battery life remaining. The CSM1 blocks attempted data storage when the battery is exhausted.

See Appendix C for further details.

2.3.3 Current Consumption of Module and Card (Typical Figures at 25°C)

Quiescent (when connected to datalogger and waiting for data): <200µA, plus standby current of card (typically 110µA for a 1Mb card).

NOTE The standby current of the card increases with card size, although not always in direct proportion.

Active (when storing data from the datalogger): 17mA

Active (in telecommunications mode): waiting for input 4mA, worst case (memory test) 18mA

2.3.4 Interface Type

9-pin Campbell Scientific. Connection to datalogger using SC12 cable (supplied).

2.3.5 Communication Speeds

Accepts data at 9600 baud. In telecommunications mode supports all standard rates in the range 300 to 38400 baud. Serial data format for telecommunications is one start bit, eight data bits, no parity and one stop bit.

Potential data read speed using SMS on a 25MHz 386 PC, at 38400 baud, (to hard disk in comma delineated format) is 1500 data values per second.

2.3.6 Memory Configuration

Fill and stop only. Data and programs delimited into files using filemarks.

2.3.7 Compatibility with SM192/SM716 and SM4M/SM16M Storage Modules

Unlike Campbell Scientific Storage Modules, the CSM1 does not support *9 Mode commands for the CR10/10X, CR500/510 or CR23X datalogger. Also it does not support remote communications via a datalogger.

The module address is fixed at 1. Therefore only one CSM1 can be connected to a datalogger. However, additional Storage Modules can be attached at the same time as a CSM1, providing their addresses are not 1.

2.4 Dimensions

Card size: 85 x 54 x 3mm

Card weight: 30g

CSM1 module size: 155 x 90 x 32mm

CSM1 weight: 350g

Construction: anodised aluminium case. Two LEDs in case top to indicate module status on power-up and data write operations to card.

3. Getting Started

1. When you first receive a Card Storage Module please check you have been supplied with an SC12 cable and the memory card that you ordered.

2. New memory cards are supplied without the battery installed to prevent premature discharge in transit or storage. Install the battery, following the small instruction leaflet supplied with the card. Be sure to insert the battery with the correct polarity. Also check that the write protect switch (if fitted), is not set in the 'protect' position.

3. Because the battery was not fitted, the card memory will be corrupted and the card will need to be 'erased' and reformatted before you can use it. This should be done, after connecting the CSM1 to your datalogger as described below, using the SMS function of PC208W, Campbell Scientific's Windows-based Datalogger Support Software and following the instructions in the on-line help or the PC208W manual. If you are using PC208 DOS-based software, please contact Campbell Scientific for advice.

4. Connect the CSM1 to your PC. To do this you need an SC532 interface. Connect the SC532 to a free serial (COM) port on your PC using either an SC25 or SC25AT cable, which plugs into the 25-way connector on the SC532. Make sure the SC532 is plugged into a power source and the PC is running. Plug the SC12 cable into the 9-way port of the SC532. (See Figure 2.)

5. Plug the memory card into the CSM1. The card should be inserted with the end with the small connector holes placed into the connector. It should not be possible to insert the card the wrong way round. Push the card in until you feel a positive click and the small button next to the card pops out. (See also Section 6.)

6. Plug the SC12 cable from the SC532 into the 9-pin connector on the end of the CSM1. Observe the status LED on the top of the case. After a short delay (up to 3.5 seconds) this should flash a number of times to indicate the status of the module and card. The LED flashes for 0.5s, with a wait period of 0.5s between flashes. Refer to Table 1 for a full description of the status indication. For a corrupt/unformatted card it will flash four times. If the LED does not flash, check all power and cable connections.

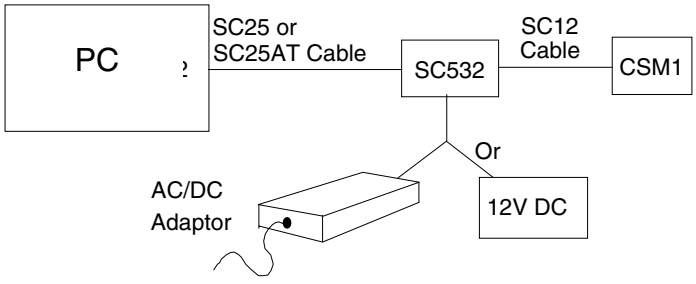

Figure 2 Connection of CSM1 to PC

Table 1 Status Indicator Flashing Sequence

No. of Flashes	Indication
1	Card Storage Module and card OK
2	EPROM failed; contact Campbell Scientific
3	Card not plugged into module
4	Card corrupted or unformatted
5	Card battery DEAD – CSM1 will not store data
6	Card write-protected
7	Card full warning (see section 6.2 for detailed explanation)

7. Run SMS and, after checking that your card is recognised, use SMS to Erase and Check the card. (See PC208W/SMS on-line help or the PC208W manual for further details.) Once the erase process is finished the card is ready to be used. Quit from the program and unplug the CSM1.

NOTES

1. While performing the power up tests, the 'Write' LED will normally flash for a short period, before the status indicator flashes. This is caused by the CSM1 checking that it is able to write to the card.
2. It is important that the SC12 cable is plugged into the CSM1 and also into the SC532 or datalogger, with the connector held perpendicular to the end of the case. If you force the connector in at any other angle, the CSM1 may not perform its power-up status display, although normally it will still be able to store data. However, if the CSM1 does not flash the status LED on power-up, it is advisable to unplug the connector, wait five seconds, and plug it back into the datalogger to ensure there is a good connection.

4. Storing Data

The CSM1 emulates Campbell Scientific's Storage Modules (SM192/716 and SM4M/16M) for most aspects of data storage. Therefore the same basic programs and procedures are used to store data in the CSM1. Details of how to store data for each datalogger type are given below:

4.1 CR10/10X, CR500/510 and CR23X

Write your program as normal, including instructions to store data to Final Storage. Include Instruction 96 to store data to a Storage Module after the output instructions. The CSM1 has a fixed address of 1 so the first and only parameter for Instruction 96 is 71 (see below for an example program).

Under the control of the program shown below, the datalogger makes a Module temperature measurement (in °C) and a thermocouple measurement (converted to °F) every 5 seconds. Every hour the output flag is set, and the day, hour and minute, as well as the hourly averages, for the two temperatures are sent to Final Storage. Following this, the same data is sent to the CSM1, if present.

If the CSM1 is not present, the data is backlogged for later transfer.

If you are using older versions of PC208/PC208W/Edlog to develop your program, entering the code 71 for Instruction 96 will only display SM192/SM716 as the output option. However, using parameter 71 will still work with the CSM1.

Sample Program Using Instruction 96 to Send Data to CSM1

```
;{CR10X}
;
*Table 1 Program
  01: 5          Execution Interval (seconds)

1:  Internal Temperature (P17)
 1: 1          Loc [ Modtemp    ]

2:  Thermocouple Temp (DIFF) (P14)
 1: 1          Reps
 2: 1          2.5 mV Slow Range
 3: 1          DIFF Channel
 4: 1          Type T (Copper-Constantan)
 5: 1          Ref Temp (Deg. C) Loc [ Modtemp    ]
 6: 2          Loc [ TCtemp     ]
 7: 1.8        Mult
 8: 32         Offset

3:  If time is (P92)
 1: 0          Minutes (Seconds --) into a
 2: 60         Interval (same units as above)
 3: 10         Set Output Flag High (Flag 0)

4:  Real Time (P77)
 1: 110        Day,Hour/Minute (midnight = 0000)

5:  Average (P71)
 1: 2          Reps
 2: 1          Loc [ Modtemp    ]

6:  Serial Out (P96)
 1: 71         Storage Module

*Table 2 Program
  02: 0.0000     Execution Interval (seconds)

*Table 3 Subroutines

End Program

-Input Locations-
1 Modtemp    1 2 1
2 TCtemp     1 1 1
3 Mostemp    1 0 0
4 __________ 1 0 0
5 __________ 0 0 0
6 __________ 0 0 0
7 __________ 0 0 0
8 __________ 0 0 0
9 __________ 0 0 0
```

If the datalogger executes Instruction 96 when a CSM1 is not plugged into the datalogger, the data is not lost. As long as the datalogger's memory is not overwritten, it remembers which data it last stored to the CSM1. Each time the datalogger executes Instruction 96 it checks for the presence of the CSM1 and outputs data if the CSM1 is connected and able to store data.

Using this feature you can use the CSM1 to collect data from a datalogger programmed with Instruction 96, without the need for a keyboard or any knowledge of the operation of the datalogger. To collect data, simply plug in the CSM1. The 'Write' LED flashes briefly and the 'Status' LED flashes once to indicate that the CSM1 is ready. You then wait until Instruction 96 is executed. When this happens the datalogger detects the CSM1 and sends data to it; the 'Write' LED illuminates as data is written to the card. The 'Write' LED only goes out when the datalogger has finished writing all the data destined for the Storage Module. When it does go out you can disconnect the module, having collected all available data.

You can also initiate data transfers to the CSM1 manually using the *8 Mode commands, again specifying the destination code as 71 (Storage Module with an address of 1). For Instruction 96 it is also possible to write a filemark into the memory card, to effectively close an open file, by pressing 'C' after the address (displayed as '71--').

The CSM1 also supports data storage at 76800 baud, when output from a CR10/10X and CR23X with the Burst Mode instruction. To do this, specify the output code for 'Serial port, 76800 baud to SM192/716 Storage Module' (see datalogger manual for further details).

NOTE The CSM1 does not support the *9 commands.

4.2 21X and CR7

If your 21X/CR7 is fitted with a version of OSX/OS7 software respectively you should store data by including Instruction 96 after the data storage instructions, with the device code 30 as the first and only parameter of Instruction 96.

With OSX/OS7 software the datalogger checks for the presence of the CSM1 before outputting data. If the CSM1 is not connected the datalogger does not output data but remembers which data was last written to the CSM1. Thus you can leave a datalogger without a CSM1 connected and collect the data at a later date, without touching the keyboard, as outlined above for the CR10.

Manual dumps of data to the CSM1 are done using the *9 Mode, entering 30 for the device code. Both *9 and Instruction 96 can also be used to write a filemark into the card by specifying a device code of 31.

The CSM1 also supports data storage at 76800 baud, when output from the 21X with the Burst Mode instruction. To do this, specify the output code for 'Serial port, 76800 baud to SM192/SM716 Storage Module' (see 21X manual for further details). This is only available on CSM1 PROMs 7602-02 and later.

4.3 DSP4

DSP4s that support storage of data to a Storage Module can be used by enabling output at 9600 baud in binary (9600B). The CSM1 is used in the same way as an SM192/716 Storage Module. See Section 5, below, for details of using the DSP4 to store and retrieve programs.

CAUTION The DSP4 does not check if a Storage Module is plugged in when it outputs data, so if the CSM1 is not plugged in data will be lost.

NOTE When using pre-OSX 21X dataloggers, pre-OS7 CR7 dataloggers and DSP4s you should allow the CSM1 to finish its power-up test routines, which take about five seconds, before allowing output of data to the CSM1, as data may be lost during the power-up test.

4.4 Data Retrieval

Once data is stored in the card, the card or whole module can be unplugged and the data read off the card in any card reader. However, this is normally done from the CSM1 using PC208W/SMS.

If data has been stored in the card in binary format, as is normal when using Instruction 96, you can specify whether to write the data to disk in comma delineated or printable ASCII format. If data was stored in the card in printable ASCII format (on old 21X/CR7 dataloggers) or in Burst Mode binary format, you should store the data to disk using the 'As stored (8-bit)' option.

5. Storing and Retrieving Datalogger Programs

Datalogger programs can be stored in a card for subsequent loading into a datalogger. The programs are stored in the card using the same memory available for data storage, i.e. there is no reserved area in which programs are stored. When loaded into the card the programs are put into special files in the next available memory in the card. Every two bytes of a .DLD file loaded into the card reduces the amount of space for data storage by one location.

We recommend Campbell Scientific's PC208W Windows-based datalogger support software program, which includes SMS for communicating with the CSM1 from your PC. Details are given below.

Programs can also be transferred to and from a datalogger using the *D mode, as explained below.

5.1 SMS Storage Module Support Software

Select the Program tab in SMS. Refer to the PC208W or PC200W manual for more information. A comprehensive on-line help facility is included with SMS.

NOTE SMS is included with both PC208W and later versions of PC200W. PC200W is available as a free download from our website (www. campbellsci.co.uk).

If you wish to use the older PC208 DOS-based software, or versions of PC208W which do not support SMS, please contact Campbell Scientific for advice.

5.2 Transferring Programs to / from Datalogger using *D Mode

CR10/10X, CR500/510 and CR23X dataloggers, plus 21X dataloggers with OSX software and CR7 dataloggers with OS7 software can be instructed to transfer a program between the datalogger's memory and one of the eight program areas of the CSM1 memory card. This is done using the *D Mode:

1. Connect the CSM1 to the datalogger and using the keyboard (CR10KD for the CR10/10X and CR500/510), enter ***D**. Enter **71A** in response to the '13:' prompt to address the CSM1.
2. To *store a program in the card* enter **1NA**, where N is the number of the card program area (1..8) in which you wish to store the datalogger program.
3. To *load a program from the card* into the datalogger, enter **2NA**, where N is the number of the card program area (1..8) in which the program is stored.
4. To *clear a program stored in a card*, enter **3NA**, where n is the card program area.

NOTE This does *not* immediately free the memory used by the program for use for data storage. The card must be erased to allow that memory to be used again.

Current dataloggers (and earlier models with appropriate operating systems) support automatic loading of a program from card program area 8 when the datalogger first powers up. The program is loaded into program memory and compiled so it runs automatically on power up.

CAUTION The datalogger clock is set to the default value on power-up and needs setting manually to the correct date and time if this is critical to the application.

5.3 Using the DSP4 Heads Up Display to Store and Retrieve Datalogger Programs

In addition to real-time monitoring of datalogger measurements, the DSP4 Heads Up Display can be used with the CR10/10X, CR23X, 21X (including pre-OSX versions with Extended Software) and the CR7 dataloggers to store and retrieve data and programs. The DSP4 Load and Save program commands allow loading and saving CR10/10X, CR23X, 21X, and CR7 datalogger programs in the CSM1 module.

The DSP4 Flag buttons 1...8 execute the Load or Save command using the CSM1 as the medium. Up to eight datalogger programs can be saved in the Storage Module. The program to be saved or loaded is selected by pressing the appropriate push button switch. Refer to the DSP4 Instruction Manual for more details.

6. Additional Operating Details

6.1 Inserting the Card into the CSM1

One of the features of the CSM1 is that you can either leave the card in the CSM1 and move the module from datalogger to datalogger (or from datalogger to office), or you can install the CSM1 with the datalogger and transport the memory

cards between sites. Whichever is your chosen method of use it is critical that the card is inserted into the CSM1 correctly.

When plugging the card in, please ensure that you push the card in firmly until it reaches the back of the card connector, i.e. it will go no further. The eject button on the card slot comes out as the card is pushed in. When the card is fully inserted, the end of the eject button should be level with the end of the card.

If the card is plugged into a CSM1 which is then connected to a datalogger the CSM1 validates the status of the card on power-up and reports any errors by flashing the status LED (see Table 1). If a card is plugged into a CSM1 which is already connected to a datalogger, similar tests are done on the card and the status LED flashes with the same meaning. If the LED flashes three times indicating the card is not plugged in it is possible that you have not inserted it correctly. To correct this you should remove the card completely and reinsert it.

6.2 Response of CSM1 on Detection of Full Card Memory

The card memory structure is predefined as 'fill and stop'. This means that data can be stored in the card until it is determined that it is full. The card is then marked by the CSM1 as being full and can no longer can be used to store new data. The card must be erased before it can store new data.

The CSM1 recognises that a card is full if it reaches the end of available memory while storing data. At this point the CSM1 changes the indicated number of available storage locations to zero and marks the card as full. Further attempts at data storage are not accepted; this is evident when a datalogger attempts to write data as the 'Write' LED will not come on.

This method of marking the card as full can lead to confusion when writing data to the card with a datalogger or when storing programs in the card using a PC. This is because both processes involve transferring blocks of data to the CSM1, with a validation procedure at the end of the transfer process.

In the case of the datalogger data, the CSM1 accepts data as a complete block and writes it to the card as it receives the block. However, it only updates its internal data pointers to indicate that it has new data at the end of a transmission. Also, the datalogger only updates its own Storage Module Pointer (SPTR) after a signal from the CSM1 that it has received the data correctly.

If the CSM1 detects that a card is full while accepting data from a datalogger, it marks the card as full and immediately aborts the receipt of the whole block. It does not move its internal pointers and consequently the CR10/10X does not get confirmation of successful data transfer at the end of the transmission; thus it does not move its SPTR. This means that no data is lost as the CR10/10X will send the whole block again. However, for a large block transmission from the datalogger, e.g. a manual dump of the whole memory, it can appear that the card suddenly becomes full without storing any data from the datalogger. Subsequent attempts at storing small blocks of data to the card are unsuccessful, as the card is marked as full and the module does not wake up. This method of operation has been implemented to minimise power consumption in remote applications.

A similar phenomenon will be apparent when writing large programs or text files to a card that is almost full.

Once a card has been marked as full it cannot store any more data until the 'full' flag is reset. There are two mechanisms you can use to do this:

1. By erasing and resetting the card after extracting your data.
2. By disconnecting and reconnecting the CSM1 to the datalogger. If the card is plugged in when the CSM1 powers up, the CSM1 warns you that the card has previously been marked as being 'full' by flashing the status LED seven times. The CSM1 then resets the card's internal 'full' flag to enable further attempts at data storage to be made. If there is any free space in the card, it can then be used to collect smaller blocks of data. However, if it is reconnected to the same CR10/10X, as in the example above, which still has too large a block of uncollected data, collection will not be successful. If too large a block is sent again, the card will be marked as full again.

6.3 Changing the Battery

CAUTION If the battery is removed from the card all data, programs and general card format will be lost, even if the battery is replaced after a short time. If this happens the card will have to be erased and reformatted after the battery has been replaced. (See section 3.)

The card battery can be replaced safely without losing data if the card is plugged into a powered-up CSM1 while the battery change takes place.

7. Telecommunications Commands

Once in the telecommunications mode the CSM1 responds to the commands listed below. To enter a command enter the characters followed by a carriage return character. The CSM1 does not support text correction using the backspace/ delete characters; if an unexpected character is read, command entry is aborted and the prompt is returned. With the exception of the F and 0H commands, all commands finish with a carriage return/linefeed/prompt sequence on completion. Some commands show the status line before the prompt.

A
Status

This command returns the status of the card on a single line with each parameter preceded by a character. The parameters are as follows:

Vn.m, where n is the CSM1 PROM version number and m is the card version number.

Mnn, where nn is the number of 16 kbyte pages of memory in the card.

Bn, where n is 0, 1, or 2 and indicates the battery status. 0 is dead, 1 is low (less than 3% capacity left) and 2 is OK. The CSM1 does not attempt to store data if the battery is indicated as being dead.

En, where n in the range of 0..254 indicates the number of bad characters received from a datalogger, e.g. framing errors. If n=255, this indicates that the CSM1 has detected some corruption of its reserved memory area in the card, which could indicate some of the other values on the status line are bad.

Pn, where n indicates the number of programs stored in the card.

Annnnnn, where nnnnnn is the number of free storage locations.

Rnnnnnn, where nnnnnn is the position of the storage reference pointer, i.e. where the next new data value will be stored.

Lnnnnnn, where nnnnnn is the position of the display pointer, which indicates where subsequent instructions that display or output data will start.

Dnnnnnn, where nnnnnn is the position of the dump pointer, which is used to mark where data was last dumped up to.

Cnnnnn, where nnnnn is a decimal representation of the checksum of all characters transmitted by the CSM1 since the last prompt character was transmitted. (This includes echoed commands.) The checksum is the standard Campbell Scientific checksum used by the dataloggers when transmitting binary data. Please refer to the datalogger manuals for further details.

An example of a status line is:

V1.1 M16 B2 E0 P3 A80313 R50632 L2 D23455 C23922

nnnnnnG
Move display pointer

Moves the display pointer to a specified location nnnnnn. The status line is displayed after the pointer is moved.

nnnnnnC
Output ASCII data

Outputs data in a comma delineated, ASCII format. nnnnnn arrays of data are dumped, or until the next filemark is reached. 0C means dump continuously until the next filemark. When the command is completed the display pointer is moved to after the end of the data dumped and the status line is sent.

nnnnnnF
Output binary data

Outputs nnnnnn storage locations of data, from the display pointer, in a binary format. The data is output in exactly the same format as was transmitted to the file for storage. Two bytes of data are sent per location. At the end of the block of data, the CSM1 waits. If the next character sent to the module is an 'S' it transmits a two-byte binary checksum that is the signature of the previous data. If any other character is sent the prompt is returned by the CSM1. The display pointer is moved to after the position of the data just dumped. The F command only dumps up to a filemark in the card and returns no further data until other instructions are used to move it past the filemark. It will jump over programs stored between blocks of data providing that the program is not delimited by filemarks. 0F causes a continuous dump until the next filemark is reached.

nnnnnnHF
Output binary and ASCII data

This command is similar to the F command except data is sent in both hex and ASCII formats, in a way similar to the DOS DEBUG command. At the start of each line the location of the first value output on that line is printed. This command is intended for diagnostic purposes only. When dumping data, the HF command does not stop at filemarks or programs, but shows the hex representation of the filemark and program data.

NFM
Next filemark

Changes the display pointer to point to the location after the next filemark in the card. This instruction can take several seconds to find a filemark if the files are large as the CSM1 has to scan through the data to find the next filemark. The NFM command ignores programs stored in the card, unless the program itself has a filemark at the beginning. The status line is transmitted when the filemark is found.

BFM
Back to filemark

Moves the display pointer backwards in memory to find the previous filemark. As with the NFM command the pointer is set to point to the location after the filemark. The positions of the previous two filemarks are recorded in the card to improve the response time of this instruction. Moving further back than two files can take several seconds if the files are large. The status line is displayed when the filemark is found.

9H
Force filemark

Forces a filemark to be stored in the card at the current SRP. The status line is then displayed.

0H
Receive data

Makes the CSM1 store any subsequent data sent to the CSM1 in the card. The CSM1 sends a carriage return, linefeed and '<' prompt when it is ready to receive the data. This mode can only be terminated by resetting the module, e.g. removing power or dropping the handshaking lines to the SC532.

4H
Move dump pointer

Moves the dump pointer to the current display pointer position, then displays the status line.

08G
Move display pointer

Moves the display pointer to the current position of the dump pointer, then displays the status line.

1243K
Reset error counter

This command resets the communications error counter (the number beginning with 'E') to zero, then displays the status line. Neither the programs nor data stored in the card are affected by this command.

1248K
Full reset and test

This resets all pointers and tests all the RAM in the card.

CAUTION

The 1248k command erases all data and programs stored in the card.

The memory test can take a while as it is extremely thorough. There are three phases to the test. The memory is tested in 16k byte pages. First, pseudo random data is written to the card and a series of '+' symbols is displayed as each page is written to. The data written is then verified, page by page. A '-' symbol is displayed for each page of good memory. At the same time further test data is written into the card. On a new line the result of a validation check is shown, again showing good pages as '-'. Another test pattern is loaded into the card at this stage. Finally this is validated on the third line and the memory erased at the same time. The status line is then returned. If at any stage an 'x' appears, this indicates a page of memory has failed the test. Please contact Campbell Scientific for further advice if a failure occurs.

1249K
Quick reset

This command is similar to the 1248K command — *it also erases all memory and programs.* However, it does not do a complete memory test, it simply resets the reserved memory and the pointers, which effectively erases the memory. This is much faster than the 1248K command and is designed for routine erasure of the card. Do not use this instruction if the memory card has been corrupted or battery power lost as without doing a full memory test the CSM1 is unable to accurately determine how much good memory the card has — you should use the 1248K command instead.

NOTE

If the1249K command is used by mistake, and no further data is stored in the card, it may be possible to recover old data from the card; please contact Campbell Scientific for further details.

N
Signature

Checks and reports the checksum signature of the CSM1 PROM. If the signature is incorrect a zero is returned otherwise the PROM signature is returned. The status line is returned after this command.

nDP
Send program

Dumps the program stored in program area n. The CSM1 sends the program followed by a 2-byte binary checksum. The checksum includes all characters transmitted since the last prompt character. If the program area is empty the CSM1 sends the byte sequence 30 05 05 Hex, followed by the checksum and then the prompt.

nSP
Store program

Store a program in program area n. The CSM1 responds with a '<' character and then stores any data sent to it in the program area specified. Programs must start with an ASCII character 7D (Hex) and end with two CTRL-E characters (05 05 Hex). At the end of the transmission, detected by the receipt of the 05 05 sequence, the CSM1 sends carriage return, linefeed and a decimal representation of the checksum of the received program file. The status line is then sent.

nCP
Clear program

Clears a program from program area n. However, the memory used by the program cannot be used for data storage until the card is erased. The status line is sent after this command.

Commands that send data from the CSM1 support software flow control. Sending an 'XOFF' character (ASCII 13 Hex, CTRL-S) to the CSM1 stops output. Sending any other character restarts output. If the flow is not restarted within 10 seconds the CSM1 continues transmission of the data.

Sending ESC (1B Hex) or CTRL-C (03 Hex) aborts the data output and returns to the CSM1 prompt.

Appendix A. 9-Pin Storage Module Interface

Pin 1 (input)	5V supply to CSM1. The minimum voltage for operation is 4.85V. Below approximately 4.85V the CSM1 will neither accept data nor communicate; it is effectively disabled.
Pin 2	Power and signal ground
Pin 3 (input)	Ring indicate (not used by CSM1)
Pin 4 (output)	CSM1 Transmit Data line (TxD). In telecommunications mode data is transmitted to the computer on this line. Data is transmitted asynchronously at levels of 0-5V DC. The idle state is 0V. This line is held high to indicate that the CSM1 can accept data, when receiving data from 21X and CR7 dataloggers.
Pin 5 (input)	Modem Enable line. The CSM1 uses this line to detect other communications activity on the datalogger serial port. When this line is high, the CSM1 does not attempt to communicate.
Pin 6 (input)	Printer Enable/Serial Device Enable line. In combination with line 7 this is used by the datalogger to wake up the CSM1 to receive data. The mode of operation depends on the datalogger type (see datalogger manual for further details). To force the CSM1 into telecommunications mode this line must be taken high with line 7.
Pin 7 (input/output)	Clock/Handshake line. For the CR10/10X, CR500/510 and CR23X this line is used in conjunction with line 6 to control transfer of data to the CSM1. For telecommunications mode this must be taken high before, or at exactly the same time as pin 6.
Pin 8 (input)	Not used
Pin 9 (input)	CSM1 Receive Data line (RxD). Data transmitted from a datalogger or computer is received on this line.

Appendix B. Internal Data Formats and Pointers in the Card Memory

Knowledge of the format in which data is stored in the card memory is not normally necessary to use the CSM1. However, if you intend to save text files in the card or need to try to extract corrupted data the following information may be useful.

B.1 Byte Pairs

All data stored in the card is stored in byte pairs. If you transmit a file to the module that has an uneven number of bytes, the remaining odd byte at the end of the file is filled with an ASCII null (0 Hex) character.

B.2 File Structure

Data files are delimited in the card using markers called filemarks. A filemark is written to the card when either a CSM1 with card fitted is powered up or if a card is plugged into a CSM1 that is powered up. Filemarks can also be written into a card under software control in telecommunications mode or with some dataloggers. Filemarks are also written into the card, with dataloggers that fully support the Storage Modules, when a program is recompiled in the datalogger. A filemark is not written into the card if a filemark already exists in the preceding data location.

A filemark is the byte pair 7C 01 Hex stored in the card. If you send this sequence to the CSM1 as data it is interpreted as a filemark.

To allow for future developments the CSM1 always places a filemark in the first location in a card during the process of erasing a card. It is necessary to jump over this filemark, by placing the display pointer at location 2, before you can read the first data file in the card.

B.3 Program Files

Datalogger programs are stored in the card in the next available area of memory (as would be new data). Datalogger programs always start with the byte sequence 011111101 XXXXXXXX 1XXXXXXX (X = don't care). A filemark may also be found before this sequence if no data has been stored in the card since the card was last powered down. To enable the CSM1 to find each program quickly without having to scan through the whole card, the card holds a record (in the reserved memory) of where each program starts.

B.4 Data Pointers

256 bytes of the card are reserved to hold working data relevant to the management of data in the card. Within this area are stored three pointers you can observe or control via the status line:

The *storage reference pointer* (R): this points to the location where the CSM1 will write the next data value in the card.

The *display location pointer* (L): this points to the location which holds the first value which will be sent in response to the C, F or HF commands. If this pointer points to a filemark or start of a program, no data is output by these commands. You must move the pointer past the filemark to get further data. The simplest way of doing this is to use the NFM command.

The *dump pointer* (D): this is used by the PC software to recall the point from where new data should be collected. The dump pointer points to the first location where new data should be collected. It is up to the PC software to move the Bdump pointer after successful data collection. The CSM1 does not move this pointer.

Appendix C. Card Batteries

The make and type of battery supplied with the memory card can vary with the size and manufacturer of the card. Campbell Scientific reserves the right to supply cards of different manufacture with different battery sizes and types.

The batteries fitted to the cards are readily obtainable from electrical suppliers. You must ensure that the replacement battery is compatible with those recommended by the manufacturer of the card. Please refer to the manufacturer's instructions for further details on removing and replacing the batteries.

C.1 General

There are two technologies used in the batteries, both of which are lithium based:

a) Lithium polycarbonmonofluoride (Lithium CFX), which is the newer technology. These batteries are rated to very low temperatures, e.g. -40°C, and usually have a slightly higher initial capacity than those below. Manufacturers' part numbers for these batteries normally start with a 'BR' suffix.

b) Lithium manganese batteries, which are currently more readily available. These batteries operate at temperatures down to -20°C. The suffix for these batteries is generally 'CR'.

For some battery sizes either type of technology is available. It is important to match the digits after the suffix, e.g. BR2032 is equivalent to CR2032.

Both battery types have reduced capacity at low temperatures, e.g. at -20°C the capacity may only be 50% of that at room temperature. However, this is not as critical as one might imagine, for the following reasons:

a) Power is only taken from the back-up battery when the card is not powered from the CSM1. Therefore if the card is plugged into a CSM1 that is plugged into a datalogger, the back-up battery is not in use.

b) Power consumption from the back-up battery is highly dependent on temperature. For example, typical figures for a 1Mb card are 0.7µA at -30°C, 2 µA at 25°C and 16µA at 60°C. Therefore the reduced capacity is offset by the lower power consumption.

c) Although the effective capacity of a battery is reduced at sub-zero temperatures, if the card warms up, the effective capacity increases again.

To optimise the life of the back-up battery:

a) Leave the card plugged into a powered-up CSM1 for as long as possible.

b) When using the cards at very high or low temperatures, try to return them to a temperature close to room temperature as soon as they are unplugged from the CSM1, e.g. in a very cold situation, unplug the card and transfer it to the inside pocket of your coat.

c) When the card will not be used for long periods, remove the battery from the card and store it separately.

C.2 Battery Status Detection

There are three levels of battery status detection. The exact detection is done within the card itself; the status line only reflects the output from the card. The exact battery voltage thresholds the card indicates vary with the card manufacturer. The terminal voltage of the battery also varies with battery type and with temperature. Therefore the exact capacity of battery available when the level detector indicates the intermediate capacity (1 on the status line, LOW with CSMCOM), is not fixed. In particular, at low temperatures where the battery voltage is reduced, the LOW indication may be rather pessimistic.

The CSM1 only prevents data storage in the card when the card indicates the battery is dead (0 on status line). If the card is being used at very low temperatures and is almost exhausted, the dead indication may be given when the card is still able to hold data. In an emergency, you may be able to continue to use the card for a short period by warming the card, which will cause the battery voltage to rise slightly, before placing it in the CSM1.

NOTE Some card types only measure the battery voltage when the card is first powered up. The level of indication is then held in a latch. Other cards monitor the battery voltage continuously.