SCSICrate™
INTEGRATED CAMAC CRATE AND CONTROLLER

Physical Measurement Redefined ™

Now with the power of SCSI

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1 SCSICrate GENERAL DESCRIPTION

The Data Design SCSICrate is a CAMAC (IEEE 583) compatible mainframe with eleven individual module stations. An integral power supply furnishes up to 360 watts of power at six normal CAMAC operating voltages. The controller which usually occupies two of the module stations within a CAMAC system is designed into the SCSICrate enclosure. Thus, all eleven stations are available for modules.

The module enclosure compartment of the SCSICrate contains two cooling fans. Up to 130 CFM of cooling is supplied to the CAMAC module area. These fans and the fan cooling the power supply compartment are brushless DC type which eliminates any 50/60Hz voltages within the CAMAC module area and reduces the possibility of pickup of 50/60 Hz coupling to susceptible modules. The fans operate from the two 6V supplies through a special power line filter. The cooling is enhanced by the use of steel guide rail assemblies designed with a substantial open aperture to permit a high degree of airflow.

The SCSICrate has two stage RFI protection to minimize RF coupling from the external AC line as well as to prevent line coupled interference from within the SCSICrate. These filters consist of common mode line filters, one on the power supply board and the other within the power entry IEC connector module. In addition, the all metal enclosure and shielded power supply compartment provide a high degree of isolation from radiated RFI. Further details about the power supply can be found in section 2 of this manual.

The SCSI interface feature allows the SCSICrate to operate as a standard SCSI-2 compatible peripheral device. Common commands are implemented as required to allow SCSI connected systems to identify the SCSICrate and verify its health. The remainder of the commands are specific to the SCSICrate and allow easy processing of FAN commands, block transfers, global control (C, Z, and I), and status and health inquires. For PC SCSI hosts a complete library of software drivers is included for both DOS and Windows. Programming examples and completed interfaces are supplied for several software development systems including LabVIEW, Visual Basic, and C. For users interested in interfacing other platforms a detailed description of the implemented SCSI command set is provided in this manual. For complex installation requirements, multiple SCSICrates can be connected on the same SCSI bus. Further details about SCSI operation can be found in section 3 of this manual.

1.1 General SCSICrate Specifications Summary

Number of Stations
Eleven stations all usable for modules

Dataway Interface
IEEE 583-1975

Backplane
Six layer with integral ground plane

Mounting
Desktop or rack mount
Integral tilt bail

Power Supply
360W total over 6 standard voltages

Module Cooling Provision
Two Brushless DC fans 75 CFM each

Ambient Temperature Range
0 to 50 degrees C

Double Pole AC Power Switch
With pilot lamp

Dimensions

Height	12.75 "
Width	12.0 "
Depth	15.5 "
Weight	25 LB

SCSI OPERATION

Required Support
SCSI-2 Compatible Host Computer

Standard SCSI-2 Bus Commands

Block Transfer
Full data width selectivity
Q-Stop or Q-Ignore

CAMAC Specific Commands
FAN Operation
Global Control Lines
Status Reporting

Transfer Rate
Up to 2.5 MB/S

1.2 General Setup and Installation

The SCSICrate is a self contained instrumentation system which is ready to operate right out of the box. It can be plugged in and turned on with no other connection. The fans will operate indicating a working power supply and power will be available on the backplane. Operation of the SCSICrate through the SCSI port requires only minimal hardware to establish a high speed data and control path to a host computer. Installation of the SCSI interface is covered in section 3.

The SCSICrate in intended to be installed like a common instrument right on the bench top. An integral tilt bail is connected to the bottom for use if a backward tilt is desirable. It is recommended that the SCSICrate be tilted to improve air flow if installed modules are drawing a significant amount of power.

A rack mount kit is available to install the SCSICrate within a standard EIA rack enclosure. The kit consists of two angle sections which mount to the case of the SCSICrate via three screws on each side. The rack mount kit may be ordered from Data Design by specifying kit M10. It is normally furnished in blue to match the color of the front panel. In some instances, it may be necessary to remove the tilt bail assembly when the rack mount kit is installed.

2 SCSICrate POWER SUPPLY CIRCUIT DESCRIPTION

The SCSICrate is designed to operate on either 120V or 240V AC 47-65 Hz. The selection of operating power is made at the power entry module. A transparent window on the rear panel power entry module shows which voltage selection is in place. Be sure that the correct voltage selection is made before plugging the SCSICrate into the AC power source. It may also be necessary to change the fuse in the rear line connector for maximum protection. A 7A fuse is required for 120V operation while a 4A fuse is installed for 240V operation. Normally, the voltage selector is installed for the line voltage of the country to which the SCSICrate is shipped. However, the selection should be checked. See Appendix A for additional information.

The SCSICrate contains a highly efficient switching power supply capable of supplying over 360 watts. The power supply has completely separate positive and negative sections, so that the current ratings are based upon individual use and not shared load conditions. Separate windings exist on the power supply output transformers for each supply voltage, including the 12V and 24V supplies. The 24V outputs are regulated by magamp regulators while the 12V supplies are linearly regulated. The total efficiency of the power supply exceeds 80%. In addition, secondary filters on each output reduce the ripple and noise to a comparatively low value for a switching supply. A separate cooling fan within the SCSICrate power supply compartment provides cooling as well as decoupling any of the power supply heat from the module enclosure.

The SCSICrate power supply contains circuitry to shut it down if an over voltage condition exists which might damage a module. This circuitry consists of fast limiting transient absorbing diodes together with slower voltage comparators. Upon detecting an over voltage condition, the voltage sensing comparator will shut off the entire power supply of the SCSICrate. The shutoff condition will be latched until it is reset by switching off the front panel power switch. Over current sensors will also shut off the power supply if load currents in excess of 120% of the specified maximums are drawn by the installed modules. In addition, a temperature sensor installed on the main heat sink of the power supply is connected to the shutdown circuit. This device will trip when the heat sink temperature approaches 70 degrees C.

Each of the protection circuits when activated generates a latched shutdown condition, which effectively turns off the drive to the power supply inverter for both the positive and negative sections. The latched shutdown can only be reset by turning off the SCSICrate. An indication that the latched shutdown condition exists is that the front panel power indicating light will be on but no output will be produced and the cooling fans will not be operating. Once the fault condition is removed, the SCSICrate will operate normally as soon as it is turned on again. Note that if the fault condition is still present, the power supply will turn on for a fraction of a second when switched on and then return to the latched shutdown condition.

The excessive temperature sensor may be activated even if the SCSICrate is operated within power limits if some obstruction exists in the airflow to the power supply. It is important to keep the top of the SCSICrate clear, especially the area directly over the power cooling fan. If it is desired to operate the SCSICrate at power levels near the maximum, some increase in cooling may be produced by tilting the unit using the integral tilt bail.

2.1 SCSICrate Power Supply Specifications Summary

Output Voltages
+6V 0-17A
-6V 0-17A
+24V 0-2.5A
-24V 0-2.5A
+12V 0-1.5A
-12V 0-1.5A

Input Voltage
Voltage range switch selectable
120V Setting: 100V to 130V
240V Setting: 200V to 260V
Frequency: 47 to 65 Hz

Input power
450 watts maximum

Output Ripple
6V less than 10 mV
24V less than 50 mV
12V less than 50 mV

Power Line To Output Isolation
3750 VDC

Power Supply Protection
Over voltage shutdown on all outputs
Over current shutdown on 6V and 24V outputs
Current limiting on 12V outputs
Over temperature shutdown

Output Voltage Regulation
0.2% on all outputs

Line Regulation
0.2% change when input within specifications

Power Supply Cooling
15 CFM fan in power supply compartment

RFI Filtering
Two stage RFI filter incorporating common mode and differential filtering

2.2 SCSICrate Power Supply Safety Considerations

The SCSICrate switching power supply is an off line type. This style of supply does not have an isolation transformer between the input power line and the primary inverter. For this reason, the entire primary circuit of the power supply operates at high voltage. In addition, contact between any point of the primary circuit and a grounded lead or personnel may result in damage to the power supply or severe electric shock. For these reasons, it is important not to operate the SCSICrate without the outer cover installed where contact with the power supply is possible.

The power supply has an outstanding reliability history. However, in case of power supply failure it is strongly recommended that the unit be returned to Data Design for service. Power supplies of this type are not easy to repair. In addition, without special equipment, working on the power supply will subject personnel to the possibility of electrical injury either through direct contact with the high voltage circuits or through contact with a line potential component.

The SCSICrate has been designed with operator safety features including a power switch which disconnects both sides of the power line, internationally approved components on AC line circuitry including power line filtering, 3750V insulation on power transformers, and power line grounded chassis. **Under no circumstances should the SCSICrate be operated with the grounding terminal of the power line plug removed or disconnected.** In addition to compromising protection against electric shock, the RFI protection of the unit would be reduced due to the lack of a ground path for RFI currents.

3 OPERATION OF THE SCSICrate IN A SCSI SYSTEM

The SCSI interface feature is the primary strength of the SCSICrate. This standard SCSI-2 bus connection provides high speed operation of the CAMAC dataway from any host platform supporting the SCSI-2 bus. On the PC environment the included driver software provides seamless operation of the SCSICrate and any installed modules with very limited programming requirements. This section describes the hardware and software operation of the SCSICrate through the SCSI interface. The general setup process is discussed first followed by details about the PC driver software. Also included are several complete interface applications and programming examples. Simple control panel user interface applications for DOS and Windows are provided to help get the test and development process started quickly. They are mentioned in this section but are described in more detail in section 4.

3.1 SCSI Setup and Installation

To use the SCSICrate in SCSI mode, the user must have a host computer platform with a SCSI host adapter port supporting SCSI-2 operation. To use the Data Design software drivers and application programs, the user must have a PC compatible host computer with Adaptec SCSI adapter hardware and drivers installed. Any 286 or better PC may be used for DOS applications, but Windows applications will require a 486 or better processor with at least 16MB of memory.

All SCSI devices including the adapter card in the host computer must have an address from zero to seven. Each device on the SCSI bus must have a unique address. In general, the adapter card will have an address of seven. Be sure to identify the address of other devices connected to the SCSI bus to determine a free address. Multiple SCSICrates can be connected on the same SCSI bus at different addresses. Set the address of the SCSICrate(s) connected to the bus to free address(es) with the thumbwheel switch at the back of the SCSICrate. Connect the SCSICrate to the host adapter external connection using a cable meeting SCSI-2 specifications. The SCSI bus must be properly terminated at both ends. Refer to the Adaptec SCSI adapter installation manual for further instructions on SCSI bus installation and termination. Use both low density SCSI connectors on the SCSICrate in any configuration. One connector must be connected to a cable from the host adapter or previous SCSI device and the second must be connected to a terminator or additional SCSI device.

The SCSICrate software is distributed on a compact disc (CD) with directories containing software drivers and programming examples. The directory DRVLIB contains the SCSICrate drivers and libraries discussed in this section. These are the primitive DOS and Windows libraries for use in software development. The files needed and where they are to be installed will depend on the environment in which the SCSICrate will be programmed. For this reason, there is no automatic installation tool for these files. This section describes in detail how to install and use the primitive SCSICrate programming libraries. The SCSICrate control panel interfaces discussed in section 4 are also an important part of the SCSICrate software. It may be convenient to install the appropriate control panel first for a quick start to the SCSI connection process.

The Data Design programming libraries access the SCSICrate from a PC through the ASPI (Advanced SCSI Programming Interface) drivers which are installed with the SCSI adapter software. These routines work well with Adaptec adapter cards and ASPI drivers. Other vendor SCSI systems may also work depending on their conformance to existing ASPI standards. The Adaptec cards are highly recommended. Several models are available from Data Design, one of which is generally included with the SCSICrate.

Two library formats are provided. The first is for the DOS platform and may be accessed by programming environments which can link to DOS libraries. The other library is implemented as a Windows DLL for 32-bit Windows (NT and 95) environments and can be accessed by any Windows programming environment which can access DLL's. This includes most popular programming environments such as Windows C compilers, LabVIEW, and Visual Basic. Note that the obsolete 16-bit Windows environments are no longer supported in the SCSICrate distribution. Contact Data Design for information on support for these environments.

The following description of the library routines assumes that the user is familiar with the C language header syntax. For advanced users familiar with SCSI programming and wishing to interface the SCSICrate to other computer platforms, a detailed description of the SCSICrate SCSI interface implementation details is provided along with the structure of the associated SCSI commands.

3.2 SCSICrate Libraries For DOS

The DOS libraries are included on the CD in the DOSCRATE.LIB and DOSCRATE.H files. The DOSCRATE.LIB file is the object code library ready to link to application programs. The header file contains prototypes for the library routines in a C syntax. Include the header file in C code applications and link the final object file with the library file as appropriate for the compiler. The following functions are defined in the header file.

```
int fan(BYTE f, BYTE a, BYTE n, DWORD w, BYTE *status);
int crate_clr_init(BYTE c, BYTE z);
int crate_inhibit(BYTE inhibit);
int camac_read_word(BYTE word_size,  DWORD *data, BYTE *status);
int camac_read_block(BYTE word_size, WORD words, BYTE flow_control, DWORD *data, BYTE *status);
DWORD camac_read_to_file(BYTE word_size, DWORD words, BYTE flow_control,  char *filename, BYTE *status);
int camac_status(BYTE *status, DWORD *LAM);
int find_crate(BYTE crate_address);
int aspi_driver(BYTE action);
```

The data types shown are defined within the header files of some compilers. The DOSCRATE.H header file defines them as follows if required. Note that *int* is a signed 16-bit number and *char* is a signed 8-bit number or ASCII character.

```
typedef BYTE unsigned char;          /* unsigned 8-bit number */
typedef WORD unsigned int;           /* unsigned 16-bit number */
typedef DWORD unsigned long;         /* unsigned 32-bit number */
```

The library functions are described in the following paragraphs. Unless otherwise noted, the return value is one if the function completed successfully and zero if problems were encountered. Data collected may not be valid if the return value is zero. Before any library function may be called, FIND_CRATE must be called successfully to initialize the library with the address of an active SCSICrate. Before an active SCSICrate is addressed all other function calls will fail. If the active SCSICrate is removed from the SCSI bus after the library is initialized, function calls will fail but will work again if the SCSICrate is returned to the SCSI bus. In the DOS implementation, ASPI_DRIVER must be called to open a path to the ASPI driver before FIND_CRATE can be called successfully.

1) FAN accepts three byte arguments *F*, *A*, *N*, and one four byte argument *W* corresponding to function, subaddress, station number, and data to be sent to the CAMAC dataway. A CAMAC cycle will be performed with these parameters. A *status* byte is returned by reference and has the format specified in conjunction with the CAMAC_STATUS function.

2) CRATE_CLR_INIT performs an initialization cycle by activating the Z line for one CAMAC cycle if the *Z* argument is true and performs a clear cycle by activating the C line for one CAMAC cycle if the *C* argument is true. False is defined as zero. Any other number is true.

3) CRATE_INHIBIT activates the I signal if the *inhibit* argument is true and clears the I signal if the *inhibit* argument is false. False is defined as zero. Any other number is true.

4) CAMAC_READ_WORD reads one 24-bit word from the CAMAC dataway and returns it by reference in the 32-bit *data* argument along with a status byte in *status*. The data should be available at the dataway output registers as the result of a previously issued FAN command. The *word_size* argument causes undesired bytes to be masked/cleared. If this number is not 1 or 2 then all 3 bytes (24-bits) are returned.

5) CAMAC_READ_BLOCK reads a block of up to 16384 words of data from the dataway to the buffer of 32-bit words pointed to by the *data* argument. The size of the word to be read on each CAMAC cycle is determined by the *word_size* argument. If the *word_size* is not 1, 2, or 3, then the routine fails and no data are returned. This feature allows maximum speed to be obtained by not transferring unused bytes. The *data* buffer should be an array of 32-bit words with enough space for all words to be returned. Unused bytes in each word are zero. The number of words to be transferred is specified by the *words* argument. If this value is greater than 16384, then the routine fails and no data are returned. The dataway should be set to read from a module and the first word of data should be at the dataway output registers as the result of a previously issued FAN command. Note that the 16384 word limit is available only with drivers of version 2 and greater. This number is the theoretical limit in DOS for a near pointer but is more useful in the Windows library which uses the same call format.

This function repeats the CAMAC cycle with the installed FAN command under hardware control. The *flow_control* argument contains two qualification bits affecting the data transfer. If the LSB is a one, *NQ_STOP* operation is specified. If the next LSB is a one, *BIG_ENDIAN* operation is specified. These modes may be specified in any combination. The bit values are defined in the header file and may be ORed as required. If *NQ_STOP* is specified, the data transfer will be stopped before the requested number of words are transferred if the Q signal becomes false. If *BIG_ENDIAN* is specified, the byte order is swapped in the incoming data so that words are constructed with the higher eight data lines requested as the LSB. For 8-bit transfers this is immaterial. For 16-bit transfers W9-W16 form the LSB. For 24-bit transfers W17-W24 form the LSB.

The return value is the number of words actually transferred. If *NQ_STOP* is requested and Q is false when the routine is called, no CAMAC cycles will be issued and the returned word count will be zero. A status byte is returned by reference which represents the CAMAC status at the time the routine completes.

6) CAMAC_READ_TO_FILE attempts to collect the number of *words* of *word_size* bytes each to a file specified in *filename* from the dataway of the currently addressed SCSICrate. The dataway should be set to read from a module and the first word of data should be at the dataway output registers as the result of a previously issued FAN command.

This function repeats the CAMAC cycle with the installed FAN command under hardware control. The *flow_control* argument works exactly as it does for the CAMAC_READ_BLOCK routine. In effect, this function issues a series of read block commands until the required number of words are read. This function may also terminate early if a file error occurs. The return value is the number of words actually transferred. No more than 4 giga*bytes* can be returned. A status byte is returned by reference and represents the CAMAC status at the time the routine completes.

Note that transfer of 16-bit data to a file should be performed in little endian format (LSB first) if the data are to be read from the file as 16-bit integers on a PC. The order of data on the dataway may be module dependent. Specify *big_endian* transfers if required. With 24-bit data, only three bytes are stored per word, requiring analysis software to reconstruct the data one byte at time anyway.

7) CAMAC_STATUS returns by reference a *status* byte containing the CAMAC status points as follows.

status = | 4-bit encoded LAM | I | L | Q | X |

The I, Q, and X bits are the status of the I (inhibit), Q, and X lines and are one if true. The L bit is one if any LAM lines are active and zero if no LAM lines are active. The encoded LAM is a 4-bit integer representing the highest number station issuing a LAM and is zero if no LAM lines are active.

An unsigned 32-bit integer returned by reference in *LAM* contains the status of the LAM lines starting with the least significant bit as station one. An active LAM line will contain a one and an inactive LAM line will contain a zero.

10) FIND_CRATE determines if a SCSICrate is present on the SCSI bus and records its SCSI address within a data member private to the library. This data member must contain the address of a SCSICrate before any other command can complete successfully. The routine will attempt to find a SCSICrate at the address specified in *crate_address*. If no SCSICrate is found at that address, the routine searches for a SCSICrate by step incrementing the address. An address out of range will be coerced to zero. Upon reaching address seven with no crate found, the search starts again at address zero and continues until a SCSICrate is found or address seven is reached again. The first SCSICrate found by this search pattern will be identified as the active SCSICrate. In this way if more than one SCSICrate is connected to the bus, a host program can set any SCSICrate as the active SCSICrate. The SCSI address of the first SCSICrate found is returned. If no SCSICrate is found, then -1 is returned. The returned address identifies the new active SCSICrate.

11) APSI_DRIVER is used to open and close access to the DOS ASPI driver. An argument greater than zero opens a path to the driver. An argument of zero closes the path. This routine only exists in the DOS library and must be executed before FIND_CRATE can be executed successfully under DOS. It should also be executed to close the driver before closing the application program.

3.3 SCSICrate Libraries For Windows

The Windows library is provided in the form of a Windows Dynamic Link Library (DLL). This library may be accessed from any Windows programming environment that supports dynamic linking. The function definitions and operations are generally the same as those in the DOS library except as follows. The ASPI_DRIVER function does not exist in the Windows implementation because the Windows ASPI DLL takes care of these low level details. It is only necessary to call the FIND_CRATE function to open a channel to the SCSICrate. Another difference is that the Windows library routines will display message boxes when errors occur to give the user a little more information about what might have caused a routine to fail.

In the Windows DLL version 2.00 and higher, an additional function is added which automatically loops on the CAMAC_READ_BLOCK function to transfer larger data blocks to memory. Use of this function is best suited for advanced C programming environments. Prototype information on all available DLL functions is contained in the DDCAM32.H header file. Finally, in the Windows DLL version 2.10 and higher, the FIND_CRATE function will search across multiple SCSI adapters for a SCSICrate. The search begins at the specified address at the host adapter currently in use and proceeds to address zero of the next host adapter until each of the first four host adapters are searched. Upon first entry, host adapter zero is in use.

The DLL is identified as DDCAM32.DLL and should be installed in the \WINNT\SYSTEM32 or equivalent directory. The DLL has calling conventions standard for 32-bit Windows platforms such as Windows NT and Windows 95. The supporting DLL CW3220MT.DLL is also present on the CD and should be copied to the same directory. If these files already exist, they may be overwritten without disrupting other software. The DLL also uses the WNASPI32.DLL library which is installed with the SCSI adapter card.

3.4 SCSICrate SCSI Command Definitions

This section describes in detail the operation of the SCSICrate on the SCSI bus including supported commands and command structure. This summary is intended to be useful to advanced programmers who wish to interface the SCSICrate to other host environments. To take advantage of this information, the user must be fully versed in SCSI bus operation and programming.

The SCSICrate supports the standard SCSI formats for the INQUIRY, REQUEST_SENSE, and TEST_READY opcodes. INQUIRY will return information to inform the initiator that among other things: SCSI-2 is in use, synchronous communication is not supported, the device is a processor device, and the device model is SCSICrate. The SCSICrate is not strictly a processor device as defined in SCSI-2, but it is a computer. More importantly this device type is easily identified by most SCSI bus scanning software and will generally not cause interference with drivers for other device types. REQUEST_SENSE will return data in the SCSI sense record format but will include only the sense code, the additional sense code, and the additional sense code qualifier to assist in determining the cause of any SCSI errors. The implementation of the sense function is not elaborate and only includes codes showing normal operation, bad field, and unsupported opcode. TEST_READY always returns ready if the SCSICrate is connected and operating. The SCSICrate does not support SCSI messages beyond IDENTIFY, COMMAND COMPLETE, and MESSAGE REJECT. Command linking and tagged queuing are not supported.

There are seven vendor specific commands which operate the functions of the SCSICrate. The first is a 10-byte group seven command which provides a means to issue individual FAN CAMAC cycles on the CAMAC dataway. The rest are 6-byte group six commands which perform data transfer and various other utility functions. These commands are described below.

1) The FAN command is formatted as shown below where F contains the function code, A contains the subaddress, N contains the station number, and W contains the data to applied to the CAMAC dataway. Because the dataway is only 24-bits, the MSB of the data is ignored. Data is always applied to the dataway. If the data is not important to the command, these bytes can be filled with zeros or random data.

Opcode = E0H
Reserved = 00H
F
A
N
W MSB
W Next MSB
W Next LSB
W LSB
Control Code = 00H

2) The CLR_INIT command performs clear (C) and/or initialize (Z) CAMAC cycles on the CAMAC dataway if the C and/or Z bytes are non-zero respectively. One or both types of cycles may be performed in sequence. If both cycles are performed, clear occurs before initialize.

Opcode = D0H
Reserved = 00H
C
Z
Reserved = 00H
Control Code = 00H

3) The INHIBIT command activates the inhibit line on the CAMAC dataway if the I byte is non-zero and deactivates the inhibit line if the I byte is zero.

Opcode = D1H
Reserved = 00H
I
Reserved = 00H
Reserved = 00H
Control Code = 00H

4) The CAMAC_STATUS command contains no arguments but returns a six byte record containing the status of the I, Q, X, and LAM lines. The command has the following format.

Opcode = D2H
Reserved = 00H
Reserved = 00H
Reserved = 00H
Reserved = 00H
Control Code = 00H

This command will cause the SCSICrate to put the SCSI bus in the data in phase and return the six byte data record shown below. The first byte contains status bits. The R bits are reserved, I is the status of the inhibit line, L indicates the presence of at least one active LAM line, Q is the status of the Q line, and X is the status of the X line. All status bits are one when the signal is active. The encoded LAM is an integer identifying the highest station number with an active LAM line. It is zero if there are no active LAM lines. Each bit of the LAM bytes contains the status of the LAM line for a particular station starting with station one in bit zero. The SCSICrate only has eleven stations, so only the low order eleven bits contain relevant data.

R R R R I L Q X
Encoded LAM
LAM MSB
LAM Next MSB
LAM Next LSB
LAM LSB

5) The READ_WORD command reads one 24-bit word from the CAMAC dataway output buffers. The data must have been deposited there by a previously executed FAN command cycle. The command has the following format.

Opcode = D3H
Reserved = 00H
Reserved = 00H
Reserved = 00H
Reserved = 00H
Control Code = 00H

This command will cause the SCSICrate to put the SCSI bus in the data in phase and return the following four byte record. Because there are only 24 bits of data, the MSB will always be zero.

Data LSB
Data Next LSB
Data Next MSB
Data MSB

6) The READ_BLOCK command attempts to transfer the number of bytes specified by the *byte count* field from the CAMAC dataway by collecting the number of bytes specified by the *word size* parameter on each CAMAC cycle. Note that the byte count specifies bytes, not words. One, two, or three bytes may be collected on each CAMAC cycle. If any other word size is specified, then the command fails and sets a sense code indicating a bad field. Likewise, the byte count must also be an integer multiple of the number of bytes to be transferred on each CAMAC cycle. This point is not checked by the SCSICrate but an incorrect number may result in lost data. If the field *Stop On Q False* is non-zero, then the command completes when Q false is detected even if the byte count has not been reached. If this mode is set and Q is false when the command is issued, no CAMAC cycles will be generated before the command completes normally with no data returned. The command always completes normally if the byte count is reached. The command has the following format.

Opcode = D4H
Stop On Q False
Word Size
Byte Count MSB
Byte Count LSB
Control Code = 00H

Note that it is the responsibility of the host application program to set the target module to a state where it is ready to read out data. The first word to be read must be in the dataway output buffers as the result of a previously issued FAN command cycle. This cycle will be repeated by DMA hardware until the transfer completes as described previously. It is the responsibility of the driver to determine how much data is actually returned. Data are transferred in little endian format (LSB first) for each word transferred until all required bytes are transferred.

7) The REPORT_RESIDUAL command contains no arguments but returns a two byte record containing a count of the number of bytes requested but not returned during the last executed READ_BLOCK command. The command has the following format.

Opcode = D5H
Reserved = 00H
Reserved = 00H
Reserved = 00H
Reserved = 00H
Control Code = 00H

This command will cause the SCSICrate to put the SCSI bus in the data in phase and return a two byte data record as follows.

Residual Count LSB
Residual Count MSB

The READ_BLOCK command byte count argument loads a DMA counter in the SCSICrate which controls the number of bytes to be transferred during the execution of the READ_BLOCK command if the process is not interrupted by a stop on Q false or an error condition. The record returned by the REPORT_RESIDUAL command contains a single 16-bit number representing the count of bytes remaining to be transferred when the last executed READ_BLOCK command was terminated. If all requested bytes were transferred, this number will be zero. This number will also be zero if no READ_BLOCK has been performed since reset. While some host system SCSI driver software is designed to provide this information, this is the only way that the actual number of bytes transferred can be determined using only the SCSICrate and the host application software. The use of this command is insulated from the user in the Data Design interface libraries.

4 SCSICrate SOFTWARE AND PROGRAMMING EXAMPLES

This section describes the operation of the SCSICrate control panel software included on the distribution CD. These simple programs provide a means to get started quickly with the SCSICrate and to perform primitive operations on the dataway as might be desired when installing and learning about a new module. The control panels are also provided as programming examples. Complete source code is included which exercises all of the functions of the SCSICrate programming libraries.

The *SCSICrate Control Panel for DOS* is a programming example for the DOS environment. The executable and source code are included on the CD in the directory DOSCP. This application was created with Borland C using the DOSCRATE.LIB library. The source code can be useful as a starting point for using the SCSICrate in the DOS environment. The *DOS Console Library* is included in the KEYS.LIB and KEYS.H files. These files will be required to compile the source code but are not required for interface to the SCSICrate. Refer to the full documentation below for more information.

The Visual Basic Windows programming environment has become popular for the rapid development of Windows user interfaces. The SCSICrate can be easily interfaced from this environment through the use of the DDCAM32.DLL dynamic link library. The *SCSICrate Control Panel for Windows* was designed with the Visual Basic 4 programming environment and is included as source code and as a compiled utility application. The control panel has a standard Windows setup procedure for easy installation. The installation will also install the associated DLL support files. The source code for the control panel application is included as a Visual Basic project in the VB directory on the distribution CD along with the associated forms and source files. Of particular importance in the source code is the declaration of the DLL routines in the MODULE1.BAS public module. These prototypes allow direct access to library routines with the DLL properly installed. Refer to the full documentation to follow for more information.

The LabVIEW programming environment has become popular for use in the operation of instrumentation connected to a host computer. A Windows DLL is an easy way to connect LabVIEW to specialized hardware. Several VI's are included in the LabVIEW directory on the distribution CD in the VI library LVCAM32.LLB. These VI's show how to access the functions in the DDCAM32.DLL dynamic link library. These VI's include a set of primitive LabVIEW definitions for the DLL functions and some application structures which operate the features of the SCSICrate. The DLL definitions assume a particular location for the DLL and may need to be modified if these files are located in another directory.

4.1 SCSICrate Control Panel For DOS

SCSICrate Control Panel for DOS is a simple dialog window control panel application which allows the user to operate a SCSICrate through SCSI hardware and driver software installed on a PC. The control panel can also be used to access any modules installed in the SCSICrate but is not designed for the support of any particular system configuration.

There are two intentions behind the design of the control panel. The first is to provide the SCSICrate user with a jump start in test and configuration of a CAMAC instrumentation system. The second intention is to provide a demonstration of the command and control features provided through the SCSICrate's SCSI interface and how they are accessed from a DOS programming environment. For this reason, the source code for the control panel application is provided and may be used as a reference and a starting point in the development of system specific applications.

4.1.1 Setup and Installation

SCSICrate Control Panel for DOS is a simple DOS executable which requires no support files except installed SCSI drivers. The system requirements include a PC with 286 or better processor, MS-DOS 5.0 or higher operating system, and an Adaptec SCSI adapter card with EZ-SCSI DOS drivers installed.

Before installing the control panel, install the SCSI adapter hardware and driver software and connect the SCSICrate as an external peripheral device as described in the documentation which came with the SCSI adapter. The control panel will access the SCSI drivers to establish communications with the SCSICrate. The installation of the control panel itself is straight forward. Simply copy the executable DOSCRATE.EXE to a hard drive in the desired directory from the DOSCP directory on the distribution CD. It may be desirable to also copy the source files from the DOSCP directory at this time.

4.1.2 Control Panel Features

When *SCSICrate Control Panel for DOS* is started, it searches for a SCSICrate on the SCSI bus. If a SCSICrate is found, its SCSI address will be displayed next to the *Crate Address* menu item in the upper left corner of the main window. The control panel will immediately begin polling the SCSICrate for status which will be displayed in the status and LAM status display areas. If no SCSICrate is connected and operating, the control panel will be displayed but all menu items will be disabled and the crate address will show as *NONE*. Other indicators will show as '-' to indicate an indeterminate state. This state will also be entered if ever the control panel is unable to communicate with the SCSICrate.

When a SCSICrate is active on the SCSI bus, it can be found by selecting the *Crate Address* menu item. Select this and any other menu item by pressing the key indicated in ( ) next to the menu item. The menu is not case sensitive. If a SCSICrate is found, its SCSI address will be displayed next to the *Crate Address* menu item and it will be polled for status. Multiple SCSICrates can be connected to the same SCSI bus if they have different addresses. Find the SCSICrate with the next higher address by selecting *Crate Address* again.

Several menu items and indicators on the control panel address system level functions. Of primary importance are the status indicators. The status box in the upper right corner of the control panel shows the status of the Q and X lines on the last executed CAMAC cycle and the current status of the inhibit (I) line. These indications may also be seen on the front panel of the SCSICrate. Note that if inhibit is set, most of the menu items on the control panel are disabled.

The second indicator box is the LAM status box in the lower right corner of the control panel. This box will not display anything if the control panel is not polling for status. If the control panel is polling, the LAM status box will display the current status of the LAM lines for each module station in the SCSICrate. An active LAM line is indicated with a bright X. Polling is toggled with the (P) menu item. The Yes/No status indicator near (P) will indicate current status and a 'τ' will appear near the LAM status each time the SCSICrate is actually polled. If the SCSICrate is not being polled, the LAM status boxes show a '-' and the status box shows only the status of the SCSICrate at the last operation.

The menu items above the LAM status box provide a means to issue clear (C) and initialize (Z) cycles and to toggle the status of the inhibit (I) line. The change in status can be observed in the status box and on the front panel of the SCSICrate.

To target a specific module from the control panel, select the module station number (N) by selecting the *N* menu item and entering the station number. In the same way, a specific function code (F) and subaddress (A) can be selected. If data is to be sent with the command, select the *W* menu item and enter the data to be placed on the W1-W24 lines when the command is issued. Data may be entered in decimal, hexadecimal, octal, or binary by prefacing the data with D, H, O, or B. Decimal is the default and a D will appear if no other preface is given. The *D*, *H*, *O*, and *B* menu items select the form in which the data are displayed on the control panel. When the FAN command has been assembled, select the *Send Command* menu item to issue a cycle with this command on the SCSICrate CAMAC dataway. If data is expected on the R1-R24 lines, it can be read after the command is issued by selecting the *Read Data* menu item. The data from R1-R24 as presented to the dataway from the module on the last CAMAC cycle is displayed with the *W* menu item. This is a manual operation to remind the developer that reading the dataway in the SCSICrate is a separate operation from issuing an FAN command.

Block data transfers are performed through dialog boxes launched from the menu items in the right center of the control panel. To transfer any amount of data to a file by a variety of methods, select the *Retrieve Data to File* menu item. To examine data as it is transferred, such as for setup and test purposes, select either of the *Block Transfer* menu items as required. Both of these block transfer methods will perform a transfer from the CAMAC dataway to the SCSI bus under hardware control. The user must install the appropriate FAN command in the CAMAC dataway control registers before the transfer begins by setting the FAN command on the control panel and selecting the *Send Command* menu item. This command should install the first element of data from the target module in the dataway R1-R24 output registers. At that point the user can successfully execute a block transfer from the targeted module. The first item of data collected by the block transfer will be the word already in the dataway output registers followed by data from additional CAMAC cycles using the installed FAN command until the requested number of words have been transferred.

Upon selecting the *Retrieve Data to File* menu item, a dialog box will be displayed by which a block data transfer to a file can be initiated with the required parameters. A destination file name must be specified before a transfer can be executed. This name must contain only the filename with no path information. The file will be written to the current directory. Navigate around the dialog box with the Up and Down arrows and the Tab key. The *Words To Transfer* box should be used to specify the total number of words to collect from the module. The *Word Size* box accepts the numbers 8, 16, or 24 which configures the transfer to collect one, two, or three bytes of data from a module on each CAMAC cycle. The two check boxes at the bottom of the dialog box further configure the data transfer as may be required by some modules. A box may be checked or unchecked with the *ENTER* key. The *Stop on Q* check box can be checked to complete the transfer when the Q line becomes false even if not all requested words have been received. If this feature is used, Q must be true before the transfer can begin. The *Big Endian* check box reverses the byte order of the data transferred. The data are ordinarily stored in little endian form with the LSB, R1-R8, being stored first. Some modules may require the opposite pattern for the convenience of post processing analysis software. After all parameters are established, the transfer can be started by pressing the *END* key. A message will be displayed which confirms that the transfer succeeded or failed and how many words were actually transferred during the process. The transfer can be cancelled from this dialog box by pressing the *ESC* key.

Select either of the *Block Transfer* menu items to transfer data to a display box as it is being read from the target module. Both menu items display the same dialog box which transfers and displays 128 words at a time starting with word 0000 as the word which was in the dataway read registers when the transfer began as a result of the initializing FAN command. Press ESC to quit the dialog box and any other key to collect the next 128 words. The current status of Q is displayed at the end of each transfer in the upper right corner of the dialog box. If the transfer began from the *Repetitive Block Transfer* menu item, this status is ignored. If the transfer began from the *Block Transfer Until Q False* menu item, the transfer will stop on the word where Q becomes false.
All data are displayed as 24-bit hexadecimal numbers in sets of six with the starting word number on the far left displayed as a 16-bit hexadecimal number. If transfers are continued beyond word number FFFF, the word counter will start over but the dialog box will continue to display new data. This data transfer feature is used primarily for setup and test purposes to examine data which are transferred from the target module in a convenient form. The dialog also demonstrates the use of the primitive block transfer function in source code.

4.1.3 Source Code Description

For users interested in programming the SCSICrate in the DOS environment, the source code for the control panel is a very useful starting point. There is only one source file for the control panel which is called DOSCRATE.C and is included in the DOSCP directory on the distribution CD.   There are several supporting libraries and header files also included on the CD. Copy the entire DOSCP directory to the desired code development directory on a hard disk before beginning.

The DOS library DOSCRATE.LIB is the only item required to access the SCSICrate through installed SCSI drivers from any DOS programming environment able to link to DOS object libraries. The header file DOSCRATE.H contains the prototypes for the library functions and may be used directly in C programming environments. The DOS Console Library is included in the files KEYS.LIB and KEYS.H and will be required to recompile the source code. The control panel encompasses the functionality of all the routines in the DOSCRATE.LIB library. The C dialect used in the control panel source code is Borland C. The source code procedures can be used as a convenient starting point when developing code in the C environment.

4.2 SCSICrate Control Panel for Windows

SCSICrate Control Panel for Windows is a simple dialog window control panel application which allows the user to operate a SCSICrate through SCSI hardware and driver software installed in a PC. The control panel can also be used to access any modules installed in the SCSICrate but is not designed for the support of any particular system configuration.

There are two intentions behind the design of the control panel. The first is to provide the SCSICrate user with a jump start in test and configuration of a CAMAC instrumentation system. The second intention is to provide a demonstration of the command and control features provided through the SCSICrate's SCSI interface and how they are accessed from a Windows programming environment. For this reason, the source code for the control panel application is provided and may be used as a reference and a starting point in the development of system specific applications.

4.2.1 Setup and Installation

SCSICrate Control Panel for Windows is a standard Windows software package with familiar installation procedures. The system requirements include a PC with 486 or better processor, 16MB or more memory, a 32-bit Windows operating system, and an Adaptec SCSI adapter card with EZ-SCSI software installed.

Before installing the control panel, install the SCSI adapter hardware and driver software and connect the SCSICrate as an external peripheral device as described in the documentation which came with the SCSI adapter. The control panel will access the SCSI software drivers to establish communications with the SCSICrate.

The installation of the control panel itself is straight forward. Use the *Start:Run* menu to execute SETUP.EXE from the WINCP directory of the distribution CD. Follow the instructions given by the setup program to guide the installation process. This installation process will also install the Windows dynamic link library DDCAM32.DLL which is the principal SCSICrate software library for use by programs written in any Windows programming environment. This DLL, along with an array of other files, will be installed in the \WINNT\SYSTEM32 or equivalent subdirectory.

4.2.2 Control Panel Features

When *SCSICrate Control Panel for Windows* is started, it searches for a SCSICrate on the SCSI bus. If a SCSICrate is found, its SCSI address will be displayed in the *Crate Address* box in the upper left corner of the main window. The control panel will immediately begin polling the SCSICrate for status which will be displayed in the status and LAM status display areas. If no SCSICrate is connected and operating, the control panel will be displayed but all operational controls will be disabled and the *Crate Address* box and other indicators will contain a '-' character to indicate an indeterminate state. This state will also be entered if ever the control panel is unable to communicate with the SCSICrate.

When a SCSICrate is active on the SCSI bus, it can be found by clicking one of the arrow buttons near the *Crate Address* box. If a SCSICrate is found, its SCSI address will be displayed in the *Crate Address* box and it will be polled for status. These buttons may be used to switch between multiple SCSICrates connected to the same SCSI bus. Multiple SCSICrates on the same SCSI bus must have different addresses.

Several controls and indicators on the control panel address system level functions. Of primary importance are the status indicators. The *Status* box in the upper right corner of the control panel shows the status of the Q and X lines on the last executed CAMAC cycle and the current status of the inhibit (I) line. Note that if inhibit is set, most of the controls on the control panel are disabled. These indications may also be seen on the front panel of the SCSICrate.

The second indicator box is the *LAM Status* box in the lower left corner of the control panel. This box will not display anything if the control panel is not polling for status. If the control panel is polling, the *LAM Status* box will display the current status of the LAM lines for each module station in the SCSICrate. An active LAM line is indicated with a red marker. Polling is activated with a check in the *Poll Status* check box in the lower right corner of the control panel. If this box is checked, the control panel will poll the SCSICrate for status once every second. If this box is not checked, no polling occurs, the *LAM Status* boxes show a '-' character, and the *Status* box shows only the status of the SCSICrate at the time of the last operation.

The three buttons at the upper center of the control panel provide a means to issue clear (C) and initialize (Z) cycles and to toggle the status of the inhibit (I) line. The change in status can be observed in the status box and on the front panel of the SCSICrate.

To target a specific module from the control panel, select the module station number (N) using the arrow buttons next to the station number box. In the same way, a specific function code (F) and subaddress (A) can be selected. If a data word is to be sent with the command, simply type it in the *Data* text box. This box accepts and displays decimal or hexidecimal numbers depending on the setting of the adjacent radio buttons. This data word will be placed on the W1-W24 lines when the command is issued. When the FAN command has been assembled, click the *Send Command* button to issue a cycle with this command on the SCSICrate CAMAC dataway. If data is expected on the R1-R24 lines, it can be read after the command is issued by clicking the *Read Data* button. The data from R1-R24 as presented to the dataway from the module on the last CAMAC cycle are displayed in the *Data* box. This is a manual operation to remind the developer that reading the dataway in the SCSICrate is a separate operation from issuing an FAN command.

Block data transfers are performed through one of two dialog boxes available from options under the *Data Transfer* menu item. To transfer any amount of data to a file by a variety of methods, select the *To File* ... option. To examine data as they are transferred, such as for setup and test purposes, use the *To Array* ... option to collect up to 16384 words at a time through a variety of methods and examine the data after they are received.

Both of these block transfer methods will perform a transfer from the CAMAC dataway to the SCSI bus under hardware control. The user must install the appropriate FAN command in the CAMAC dataway control registers before the transfer begins by setting the FAN command on the control panel and clicking the *Send Command* button. This command should install the first element of data from the target module in the dataway R1-R24 output registers. At that point the user can successfully execute a block transfer from the targeted module. The first item of data collected by the block transfer will be the word already in the dataway output registers followed by data from additional CAMAC cycles using the installed FAN command until the requested number of words have been transferred. To transfer data to a file, select the *To File* ... option from the *Data Transfer* menu. A dialog box will be displayed by which a block data transfer to a file can be initiated with the required parameters. The dialog box uses the familiar Windows file selection controls to allow selection of a target disk drive, directory, and file name. A file name must be specified before a transfer can be executed. The *Word Size* selection box configures the transfer to collect one, two, or three bytes of data from a module on each CAMAC cycle. The *Words To Transfer* box is used to specify the total number of words to collect from the module. The two check boxes in the lower left corner of the dialog box further configure the data transfer as may be required by some modules. The *Stop on Q* check box can be checked to complete the transfer after the Q line becomes false even if the requested number of words has not yet been transferred. If this feature is used, Q must be true before the transfer can begin. The *Big Endian* check box reverses the byte order of the data transferred. The data are ordinarily stored in little endian form with the LSB, R1-R8, being stored first. Some modules may require the opposite pattern for the convenience of post processing analysis software. After these parameters are established, the transfer can be started by clicking on the *Begin Transfer* button. A message will be displayed which confirms that the transfer succeeded or failed and how many words were actually transferred during the process. The transfer can be cancelled by clicking the *Cancel* button or by closing the dialog box.

To transfer data to an array for on screen examination select the *To Array ...* option from the *Data Transfer* menu. A dialog box will be displayed in which a block data transfer of limited length may be initiated. This feature is primarily for setup and test purposes to examine data which are transferred from the target module in a convenient form. This dialog also demonstrates the use of the primitive block transfer function in source code.

The transfer configuration process is identical to that described for the *To File ...* dialog above except that the number of words which can be transferred is limited to 16384. Unlike the transfer to file process, this process always transfers all 24 bits from the dataway but masks the bytes which are not desired before they are displayed. Click the *Read To Array* button to begin the transfer. A message box will appear proclaiming success or failure of the transfer and how many words were actually transferred.

After a transfer is performed the *Words To Transfer* box will show how many words were actually transferred. The data may be examined by clicking the *Step Up* and *Step Dn* buttons. The index box indicates the cycle on which the data appeared. Index zero contains the data which was in the dataway read registers when the transfer began as a result of the initializing FAN command. The data are displayed in decimal or hexidecimal format depending on the setting of the radio buttons next to the *Data* box on the main control panel.

4.2.3 Source Code Description

For users interested in programming the SCSICrate in the Visual Basic environment, the source code for the control panel is a very useful starting point. The Visual Basic project, source code, and forms for the control panel are included on the distribution CD in the VB directory. Copy the source code to the desired project development directory. The project file may have to be updated to locate all of the forms and modules in the desired directory.

Of particular importance in the source code is the declarations section of the public module MODULE1.BAS which contains the prototypes for the DLL functions of the DDCAM32.DLL Windows dynamic link library. Once these prototypes are declared, they can be used throughout the code just like any other subroutine. The control panel is designed to demonstrate the functionality of all the routines in the DLL along with useful structures for working with the SCSICrate such as form load procedures and a routine to find a SCSICrate on the SCSI bus which is identified in the source code as Camac32.Crate_Address_Sel_Click.

Appendix A
SETTING OPERATING VOLTAGE

Selection of operating voltage (line voltage) is accomplished by removing the jumper card in the power input module on the back of the SCSICrate, orienting it to the proper configuration and then reinserting the card into the module. This *must* be accompanied by the replacement of the fuse with one of the proper rating for the line voltage selected. Only ceramic slow blow or time delay type fuses are to be used in the power input module.

Procedure for changing operating voltage:

1) Turn the SCSICrate off and remove power cord from the power input module.

2) Slide plastic window on the power input module upward to expose fuse.

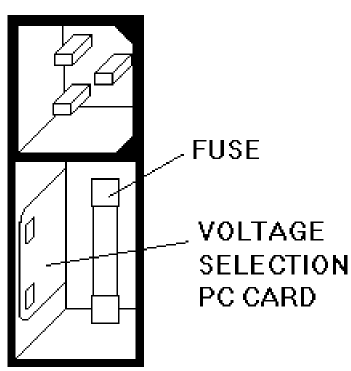
3) Remove the fuse by pulling the plastic “Fuse Pull” lever out and up.

4) Return the “Fuse Pull” lever to the down position and look inside the power input module for a large white number on the jumper card (i.e. 100, 120, 220 or 240). This indicates the voltage selected.

5) To change the voltage selection, return the “Fuse Pull” lever to the up position and with a pair of small pliers and pull the jumper card straight out.

6) There are two selections on each side of the card, 120/240 on one side, and 100/220 on the other. Reinsert the PC card with the required voltage number visible after the card is inserted.

7) Replace the fuse with one of the proper rating. For 100/120V use 7A slow blow fuse. For 220/240V use a 4A slow blow fuse. **Failure use the correct fuse may result in damage to the power supply circuitry and may cause injury.**



Manufacturers product information for power input module fuses:

Cooper/Bussman - MDA Time Delay 1/4 inch x 1 1/4 inch fuse, CERAMIC
--- Both 4A and 7A fuses

Littelfuse - 3AB SLO-BLO fuse
--- 4A, CERAMIC, Littelfuse # 326004
--- 7A, CERAMIC, Littelfuse # 326007

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