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DIOS Device Handlers

Reference Manual
Part II

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Abstract

This manual is designed to be used by system programmers and other advanced programmers wishing to use standard DIOS device handlers. It contains a description of the functions of the currently supported standard DIOS devices.

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Preface

0.1 Manual Objectives

This manual is designed to be used by system programmers and other advanced programmers wishing to use standard DIOS device handlers. It contains a description of the functions of all of the currently supported standard DIOS devices.

It is assumed that the reader is familiar with the operation of standard RSX-11M device handlers and their related executive directives. These points are fully covered in the manuals RSX-11M Executive Reference Manual and RSX-11M I/O Drivers Reference Manual. The user should also be familiar with the information contained in the DIOS Operations Manual, in particular, the loading and unloading procedures and standard I/O functions. It is recommended that the reader also refer to the RSX-11M Guide to Writing an I/O Driver.

0.2 Structure of the Manual

This manual is organized into chapters. The first chapter gives a description of the format of the remaining chapters. The remainder of the manual consists of detail descriptions of each of the DIOS standard device handlers.

0.3 Introduction

Each of the following chapters gives a detailed description of a specific device handler supported by the DIOS system. The descriptions adhere to a standardized format which is outlined here.

1. Introduction to the Hardware and Software

   This section gives a brief description of the hardware operation and the features which are supported by the software. The reader should note the restrictions mentioned, as in many cases, not all hardware functions are supported. The reader

should also note that some hardware functions are changed somewhat (in the software) in order to simplify the user interface; these changes are also described here.

2. Loading the Module

The next section provides information on how the device handler can be loaded. The MCB format details deserve particular attention as its contents are critical for the proper functioning of the DIOS system. Note that only the device specific MCB parameters are described and that general information about MCB's is contained in the DIOS Operations Manual.

3. Unloading the Module

The third section gives a brief summary of the procedure used for unloading a module.

4. QIO Functions to the Loaded Module

This section provides information of high importance for the proper functioning of the module. The I/O functions specific to the device are described in detail, in particular, the device specific parameters associated with a device initialization request (IO.INI). The reader should note that, although only one form of the QIO directive macro is given, all forms ($, $C, $S) of the QIO as well as QIOW macro may be used. Care should be taken that the parameter lists associated with the macros have the proper form. These points are discussed in the DIOS Operations Manual and the RSX-11M I/O Drivers Reference Manual.

5. Status Returns and Error Handling

The fifth section gives a description of the error codes which may be returned in the I/O Status Block and their possible causes.

6. Programming Hints

The final section gives useful hints on using the device and warnings concerning common pitfalls.

CHAPTER 1

ALDRV -- LeCroy 2232A 32-Input Differential ADC

1.1 Introduction

The LeCroy Model 2232A is a 32-Input Differential ADC in a single width CAMAC module. It converts input voltages to proportional 12-bit digital data words. An on-board switch provides the option of a monopolar mode, 0 to +10 volts, differential, from minus to plus input, and a bipolar mode, -5 to +5 volts. Output is offset binary with all zeros corresponding to the most negative value and all ones to the most posive value.

The voltage level at the 32 inputs on the front-panel connectors are converted sequentially, requiring 550 microseconds per channel for conversion and storage in the internal memory. The total cycle time is 18 msec. The LeCroy 2232A operates in 2 different modes selectable by an on-board switch:

1. In the Continuous Scan Mode each channel of the 2232A continuously updates its memory every 18 msec.
2. In the Single Shot Mode the CAMAC function F25 initializes the Analog Switch Adress to Channel 1 and starts a single scan of all 32 channels. This may also be accomplished by applying a TTL logical one pulse to a front-panel Lemo-type connector (Scan Trigger).

The DIOS driver for the LeCroy 2232A, ALDRV, operates on the module as follows: at initialization time the user determines the mode of operation appropriate to the 2232A on-board switch. Because the driver das not support interupt mode, the maximum number of data available is limited to 32 words, one word for each channel. The ALDRV reads data in sequence starting always with channel 1 up to channel 32. It is recommendable to read always all available data (64 bytes), otherwise an error code will be returned and the remaining (not requested) data are lost.

1.2 Loading the Module

The module is loaded by either of the two macro calls

```
QIO$S   #IO.LOD,#$LDR,...,<mcb,lmcb,lun>
```

or

```
LOAD    lun,mcb,sts,flg
```

The use of these macros and meaning of the arguments are given in the manual "DIOS I/O Operations".

1.2.1 MCB Format

In the macro calls above, mcb denotes the address of the module control block for the LeCroy 2232A. The device specific portions of the MCB should be set as follows:

Offset	Contents
M.TYP	"AL" -- 2-character code identifying the LeCroy 2232A device type.
M.UNIT	Unit number identifying each LeCroy 2232A module.
M.ACP	2-character identifier of the ACP containing the AL driver.
M.CTL	Control bits
MC.SUB = 0	AL is not a submodule
MC.INT = 0	Indicates interrupt service is not required by the LeCroy 2232A.
MC.CAM = 1	Indicates the LeCroy 2232A is a CAMAC module.
M.ADR	CAMAC address in BCNA format (A=0) of the module.
M.DLN	2 => Length of one data item = 2 bytes.
M.DFM	2 => Data returned as integers

1.3 Unloading the Module

The module is unloaded by either of the two macro calls

```
QIO$S   #IO.ULM,lun
```

or

UNLOAD lun

The use of these macros and the meaning of the arguments are given in the manual "DIOS I/O Operations".

1.4 QIO Functions to the Loaded Module

This section summarizes the standard and device-specific QIO requests processable by the AL driver.

1.4.1 Standard Functions

Format		Function
QIO$S	#IO.VAT,...	;Attach Module
QIO$S	#IO.VDT,...	;Detach Module
QIO$S	#IO.KIL,...	;Cancel I/O on Module
QIO$S	#IO.ULM,...	;Unload the Module

1.4.2 Module-specific Functions

Format		Function
QIO$S	#IO.INI,...,<ddp,lpm>	;Initialize AL
QIO$S	#IO.TER,...,<#0,#4>	;Terminate AL
QIO$S	#IO.RVB,...,<buf,lbuf>	;Read data from AL

ddp is the address of a block of device-dependent parameters defining the mode in which the LeCroy 2232A is initialized.
lpm is the length of the block in bytes.
buf is the address of a buffer to receive data read from the module.
lbuf is the length of the data buffer in bytes.

1.4.2.1 IO.INI -- Initialize the LeCroy 2232A -

IO.INI passes a buffer specified in the parameter list of the QIO containing device-dependent parameters specifying the mode of initialization. Depending upon the contents of the buffer, the following actions are performed:

1. The mode of operation will be checked for legality. Valid characters for MODE are:

   MODE Function

   C Continuous Sampling Mode.
   Each channel of the 2232A continuously updates its memory location. The data received from IO.RVB depends on the time on which the QIO directive was issued. On IO.INI the continuous sampling will be initiated by a start trigger.

   I Internal Single Shot Mode.
   At initialization the AL driver performs one internal trigger (F25).

   E External Single Shot Mode.
   It will be assumed that an external source delivers the scan trigger. No further operation is performed.

The buffer consists of 2 bytes which are formatted as follows:

Offset	Name	Type	Meaning
0	MODE	[A]	Mode in which the LeCroy 2232 is operating: C Continuous Sampling Mode I Internal Single Shot Mode E External Single Shot Mode
1	RESEV		Reserve for future use.

The driver sets the status as defined by the device dependent parameter, where the parameter is checked for legality, and executes the internal trigger if specified. Errors are reported by setting the status block accordingly.

1.4.2.2 IO.TER -- Terminate AL Operations -

IO.TER only resets the MODE-key in the VCB. It prevents the module from being read until it is reinitialized with IO.INI.

1.4.2.3 IO.RVB -- Read Data from the LeCroy 2232A -

LeCroy 2232A channels are read in sequence, starting with channel number 1 after each single QIO directive up to channel number 32. All available data (64 bytes) should be read with a single QIO. If this condition is not observed, the error code IE.DAO will be returned and further reads are disabled.

In Continuous Sampling mode and External Single Shot mode the reading of the LeCroy 2232A internal memory can be repeated provided that allways exactly 64 bytes will be requested. In Internal Single Shot mode only one IO.RVB can be performed after initialization. Data are read and returned to the user buffer until the given buffer length is exhausted or until the physical end of the module internal memory is detected.

1.5 Status Returns and Error Handling

Status information from a completed QIO operation is returned in the I/O status block if one was specified in the QIO. The first word contains an error or success code; the second contains zero or the number of bytes read with an IO.RVB operation.

1.5.1 First Status Word (low byte)

Code	Meaning
IS.SUC	OPERATION SUCCESSFUL No error occurred in processing the given QIO function. Returned from IO.INI, IO.RVB or IO.TER.
IE.IFC	INVALID FUNCTION CODE Returned from all QIO functions other than the standard functions or IO.INI, IO.TER, or IO.RVB.
IE.IDS	OPERATION INCONSISTENT WITH DEVICE STATE Returned from IO.RVB if the AL has not been initialized since being loaded or terminated with IO.TER.
IE.OFL	DEVICE OFFLINE Returned from IO.INI and IO.RVB if the crate is offline, or the module is not at the specified address.
IE.EOV	END OF VOLUME DETECTED All data available at present (64 bytes) have been read. Returned from IO.RVB if Internal or External Single Shot mode was selected.
IE.DAO	DATA OVERRUN Not all data available in the 2232A have been read with a single QIO. Returned from IO.RVB in all modes.
IE.FHE	FATAL HARDWARE ERROR Reading of the LeCroy 2232A internal memory was not successfull.(Q-response is missing). Returned from IO.RVB.
IE.BAD	BAD PARAMETERS Returned from IO.INI, if any bad characters for the MODE-key were encountered.

1.5.2 First Status Word (high byte)

Contains the group number of the error code returned by the driver (see Appendix A of "DIOS I/O Operations"). All

errors returned by ALDRV belong to error group 0.

1.5.3 Second Status Word

After IO.INI, IO.TER, or the standard I/O functions, the second status word contains zero.

After IO.RVB, the second status word always contains the number of bytes actually transferred to the user buffer.

NOTE

The LAM-line of the LeCroy 2232 module must be disabled (disconnected from the dataway), because it is not possible to prevent LAM's by software.

CHAPTER 2

ATDRV -- IPP Attenuator Module

2.1 Introduction

The IPP Attenuator Module is packaged in a single width CAMAC module and consists of four identical amplifiers. Each of the 4 amplifiers can be separately programmed to one of the following gain factors:

0.01, 0.02, 0.05, 0.1, 0.2, 0.5, 1, 2, 5, 10

Furthermore the Attenuator Module offers a TTL signal on its front panel to switch any external instrumentation on or off, controlled by software. Hardware characteristics and specifications may be obtained from the reference documentation.

The Attenator Module usually operates as pre-amplifier in connection with other modules as LeCroy Model 2250Q or LeCroy transient recorders. In this case often more amplifier channels are required as available on one Attenuator Module.
Therefore multiple Attenuator modules may be arranged up to the maximum number of 32 amplifier channels, building one 'logical' Attenuator module. In the remaining chapter the term "logical Attenuator" will be used for the configuration of all daisy-chained Attenuator modules connected to a single ADC module. Multiple Attenuator modules forming a logical Attenuator must occupy consecutive CAMAC stations.

The DIOS driver for the IPP Attenuator Module, ATDRV, operates on the module as follows:

At initialization time the user determines the physical configuration of the logical Attenuator by specifying the number of amplifier channels available in his physical configuration. From this value the driver calculates the number of Attenuator modules and

transfers the appropriate number of gain factors to the modules. Furthermore the signal 'HV' will be switched on for each module.

At termination time merely the signal 'HV' will be switched off.

For the further desciption following definitions are used:

NOC = Maximum number of amplifier channels available on the logical Attenuator.
NOA = Number of physical Attenuator modules.
ATM = Attenuator Module

2.2 Loading the Module

The module is loaded by either of the two macro calls

```
QIO$S   #IO.LOD,#$LDR,...,<mcb,lmcb,lun>
```

or

```
LOAD    lun,mcb,sts,flg
```

The use of these macros and meaning of the arguments are given in the manual "DIOS I/O Operations".

2.2.1 MCB Format

In the macro calls above, mcb denotes the address of the module control block for the ATM. The device specific portions of the MCB should be set as follows:

Offset	Contents
M.TYP	"AT" -- 2-character code identifying the ATM device type.
M.UNIT	Unit number identifying each logical ATM.
M.ACP	2-character identifier of the ACP containing the AT driver.
M.CTL	Control bits
MC.SUB = 0	AT is not a submodule
MC.INT = 0	Indicates interrupt service is not required by the Attenuator module.
MC.CAM = 1	Indicates the ATM is a CAMAC module.
M.ADR	CAMAC address in BCNA format (A=0) of the first module in the chain.

2.3 Unloading the Module

The module is unloaded by either of the two macro calls

```
QIO$S   #IO.ULM,lun
```

or

```
UNLOAD  lun
```

The use of these macros and the meaning of the arguments are given in the manual "DIOS I/O Operations".

2.4 QIO Functions to the Loaded Module

This section summarizes the standard and device-specific QIO requests processable by the AT driver.

2.4.1 Standard Functions

Format		Function
QIO$S	#IO.VAT,...	;Attach Module
QIO$S	#IO.VDT,...	;Detach Module
QIO$S	#IO.KIL,...	;Cancel I/O on Module
QIO$S	#IO.ULM,...	;Unload the Module

2.4.2 Module-specific Functions

Format		Function
QIO$S	#IO.INI,...,<ddp,lpm>	;Initialize AT
QIO$S	#IO.TER,...,<#0,#4>	;Terminate AT

ddp is the address of a block of device-dependent parameters defining the mode in which the Attenuator module is initialized.

lpm is the length of the block in bytes.

2.4.2.1 IO.INI -- Initialize the logical ATM -

IO.INI passes a buffer specified in the parameter list of the QIO containing device-dependent parameters specifying the mode of initialization. Depending upon the contents of the buffer, the following actions are performed:

1. The number of available amplifier-channels (NOC) will be checked for legality. This parameter also determines the number of physical Attenuator modules constituting a logical ATM.
   The channels used are distributed among the component ATM's as follows:
   In every module but the last one, all four channels must be used. The last module may be set to use 1, 2, 3, or 4 channels.

2. The gain factors of all amplifier channels specified by parameter 'NOC' will be checked for legality.

The buffer has the following format:

Offset	Name	Type	Meaning
0	NOC	[I]	Number of amplifier channels, which are available on the logical ATM. Allowed values for NOC: 1 <= NOC <= NOA * 4
4	GAIN	[E]	Floating point value of the gain factor for the first amplifier channel. Only the following values are allowed: 0.01, 0.02, 0.05, 0.1, 0.2 0.5, 1, 2, 3, 10
			....
4(i+1)	GAIN	[E]	Floating point value of the gain factor for the (i+1)th amplifier channel. Legal values: see above
			.... (Up to a maximum of 32 gain factors).

The driver then converts these values to hardware-compatible gain specifiers and load them into the physical Attenuator modules. Note that only as much gain

factors as specified by parameter 'NOC' are checked for legality and transferred to the ATM. Remaining amplifier channels are set to gain factor 0.01. Furthermore the signal 'HV' is switched on by the ATDRV to control any external instrumentation. Errors are reported by setting the status block accordingly.

2.4.2.2 IO.TER -- Terminate AT Operations -

For IO.TER the AT driver resets the signal 'HV' and cleans up the VCB. This prevents the module from being read until it is reinitialized with IO.INI.

2.5 Status Returns and Error Handling

Status information from a completed QIO operation is returned in the I/O status block if one was specified in the QIO. The first word contains an error or success code; the second word contains zero.

2.5.1 First Status Word (low byte)

Code Meaning

IS.SUC OPERATION SUCCESSFUL

No error occurred in processing the given QIO function. Returned from IO.INI or IO.TER.

IE.IFC INVALID FUNCTION CODE

Returned from all QIO functions other than the standard functions or IO.INI or IO.TER.

IE.IDS OPERATION INCONSISTENT WITH DEVICE STATE

Returned from IO.TER if the AT has not been initialized since being loaded or terminated with IO.TER.

IE.OFL DEVICE OFFLINE

Returned from IO.INI and IO.TER if the crate is offline, the logical Attenuator Module is not at the specified address or the number of Attenuator modules specified at IO.INI was greater than really available in the configuration.

IE.FHE FATAL HARDWARE ERROR

Returned from IO.INI, if any gain factor, specified by parameter 'GAIN' and written to the ATM, does not correspond to the value read back from the Attenuator module.

IE.BAD BAD PARAMETERS

Returned from IO.INI, if any bad parameters were encountered.

These include:

- specifying an invalid number of amplifier channels (NOC=0 or NOC>32).

- specifying an invalid gain factor. (see section 2.4.2.1)

2.5.2 First Status Word (high byte)

Contains the group number of the error code returned by the driver (see Appendix A of "DIOS I/O Operations"). All errors returned by ATDRV belong to error group 0.

2.5.3 Second Status Word

After IO.INI, IO.TER, or the standard I/O functions, the second status word contains zero.

CHAPTER 3

DDDRV -- Borer Dataway Display Module

3.1 Introduction

The Borer Dataway Display Module is a single-width CAMAC module designed for test- and supervision-functions of the CAMAC dataway.
The Borer-DD module further allows a 24-bit word to write into an internal register. This register may also be read back to examine its contents. The DDDRV uses this feature to synchronize the data acquisition system with an intelligent subsystem (Auxiliary Crate Controller).

The DIOS driver for the Borer Dataway Display module, DDDRV, operates on the module as follows: at initialization time the user determines a Data-Parameter, which will then be written into the Borer-DD register. The DDDRV can also read this register by IO.RVB.

3.2 Loading the Module

The module is loaded by either of the two macro calls

```
QIO$S   #IO.LOD,#$LDR,...,<mcb,lmcb,lun>
```

or

```
LOAD    lun,mcb,sts,flg
```

The use of these macros and meaning of the arguments are given in the manual "DIOS I/O Operations".

3.2.1 MCB Format

In the macro calls above, mcb denotes the address of the module control block for the Borer-DD module. The device specific portions of the MCB should be set as follows:

Offset	Contents
M.TYP	"DD" -- 2-character code identifying the Borer-DD module device type.
M.UNIT	Unit number identifying each Borer-DD module module.
M.ACP	2-character identifier of the ACP containing the DD driver.
M.CTL	Control bits
MC.SUB = 0	DD is not a submodule
MC.INT = 0	Indicates interrupt service is not required by the Borer-DD module.
MC.CAM = 1	Indicates the Borer-DD module is a CAMAC module.
M.ADR	CAMAC address in BCNA format (A=0) of the module.
M.DLN	2 => Length of one data item = 2 bytes.
M.DFM	2 => Data returned as integers

3.3 Unloading the Module

The module is unloaded by either of the two macro calls

```
QIO$S   #IO.ULM,lun
```

or

UNLOAD lun

The use of these macros and the meaning of the arguments are given in the manual "DIOS I/O Operations".

3.4 QIO Functions to the Loaded Module

This section summarizes the standard and device-specific QIO requests processable by the DD driver.

3.4.1 Standard Functions

Format		Function
QIO$S	#IO.VAT,...	;Attach Module
QIO$S	#IO.VDT,...	;Detach Module
QIO$S	#IO.KIL,...	;Cancel I/O on Module
QIO$S	#IO.ULM,...	;Unload the Module

3.4.2 Module-specific Functions

Format		Function
QIO$S	#IO.INI,...,<ddp,lpm>	;Initialize DD
QIO$S	#IO.TER,...,<#0,#4>	;Terminate DD
QIO$S	#IO.RVB,...,<buf,lbuf>	;Read data from DD

ddp is the address of a block of device-dependent parameters defining the mode in which the Borer-DD module is initialized.
lpm is the length of the block in bytes.
buf is the address of a buffer to receive data read from the module.
lbuf is the length of the data buffer in bytes.

3.4.2.1 IO.INI -- Initialize the Borer-DD module -

IO.INI passes a buffer specified in the parameter list of the QIO containing device-dependent parameters. The following actions are performed:

1. The DDDRV disables the 'Monitor mode' of the Borer-DD module.

2. The parameter DATA specified on IO.INI will be written to the Borer-DD register.

The buffer consists of 2 bytes which are formatted as follows:

Offset	Name	Type	Meaning
0	DATA	[D]	The value of DATA will be transferred to Borer-DD register on IO.INI.

The driver disables the Borer-DD 'Monitor Mode' and writes the parameter DATA into the Borer-DD internal register. Errors are reported by setting the status block accordingly.

3.4.2.2 IO.TER -- Terminate DD Operations -

IO.TER resets the INI-Flag in the VCB. It prevents the module from being read until it is reinitialized with IO.INI. Furthermore the Borer-DD module is switched back into 'Monitor mode'.

3.4.2.3 IO.RVB -- Read Data from the Borer-DD module -

Data from the Borer-DD module register should be read with a single QIO (2 Bytes) after Initialization. If more than 2 bytes are requested by the user, the error code IE.EOV will be returned.

3.5 Status Returns and Error Handling

Status information from a completed QIO operation is returned in the I/O status block if one was specified in the QIO. The first word contains an error or success code; the second contains zero or the number of bytes read with an IO.RVB operation.

3.5.1 First Status Word (low byte)

Code	Meaning
IS.SUC	OPERATION SUCCESSFUL No error occurred in processing the given QIO function. Returned from IO.INI, IO.RVB or IO.TER.
IE.IFC	INVALID FUNCTION CODE Returned from all QIO functions other than the standard functions or IO.INI, IO.TER, or IO.RVB.
IE.IDS	OPERATION INCONSISTENT WITH DEVICE STATE Returned from IO.RVB if the DL has not been initialized since being loaded or terminated with IO.TER.
IE.OFL	DEVICE OFFLINE Returned from IO.INI and IO.RVB if the crate is offline, or the module is not at the specified address.
IE.EOV	END OF VOLUME DETECTED All data available at present (2 bytes) have been read. Returned from IO.RVB.

3.5.2 First Status Word (high byte)

Contains the group number of the error code returned by the driver (see Appendix A of "DIOS I/O Operations"). All errors returned by DDDRV belong to error group 0.

3.5.3 Second Status Word

After IO.INI, IO.TER, or the standard I/O functions, the second status word contains zero.

After IO.RVB, the second status word always contains the number of bytes actually transferred to the user buffer.

CHAPTER 4

FLDRV - LeCroy Transient Digitizer (Model 8210)

4.1 Introduction

The LeCroy Model 8210 is a quad 10-Bit Transient Digitizer packaged in a triple width CAMAC module. Up to 4 analog inputs to the 8210 are sampled simultaneously by track-and-hold circuits having analog bandwidths greater than 5 MHz and channel-to-channel sampling uncertainty of <5 nsec. The analog signal is digitized by a 10-bit, successive approximation ADC. The data is stored in the Model 8800/10 memory module under the control of the 8210. Each 8800/10 module has a capacity of 32K 10-bit words; up to 4 memory modules may be used in a serial fashion. The memory per channel is the total memory divided by the number of active channels.

The LeCroy 8210 is capable of sampling each input with a maximum rate of 1MHz. Sampling rate is determined either by an internal clock or by an external clock.

The analog input range is bipolar +5 Volt to -5 Volt. Output is offset binary with all zeros corresponding to the most negative value and all ones to the most positive value.

The DIOS driver for the LeCroy 8210, FLDRV, operates on the module as follows:

At initialization time, the user determines the following items:

- The frequency of the internal clock (zero corresponds to external clocking),
- the number of pretrigger samples,
- the number of posttrigger samples,
- the number of 8800/10 memory modules attached to 8210,
- a flag, which determines the increment of the posttrigger switch on the 8210 front panel, and

- the physical configuration of the logically connected (on-line) channels.

The FLDRV driver will read all available data (e.g. number of pretrigger and posttrigger samples). Data is returned separately for each channel number. The channels are read in ascending order, whereby those channels not marked as online are skipped. The maximum number of data available is given by the Number of Channels (NOC) multiplied by the sum of Pretrigger and Posttrigger samples. Any number of data up to the maximum available (32768) may be read with a single QIO.

The first IO.RVB after initialization can only be performed if the stop trigger was received and the posttrigger samples are finished.

In order to make sure the memory cycles through at least once, the following minimum time interval must elapse following initialization before the stop trigger is given:

$$T = 32768 * NOM/(NOC * CLK)$$

where

CLK = sample clock frequency
NOM = number of memory modules
NOC = number of channels

At least one sample clock pulse must occur before the Stop Trigger is received.

Further definitions used in this chapter are:

PTS = number of posttrigger samples
PRE = number of pretrigger samples

4.2 Loading the Module

The module is loaded by either of the two macro calls

```
QIO$S   #IO.LOD,#$LDR,...,<mcb,lmcb,lun>
```

or

```
LOAD    lun,mcb,sts,flg
```

The use of these macros and meaning of the arguments are given in the manual "DIOS I/O Operations".

4.2.1 MCB Format

In the macro calls above, mcb denotes the address of the module control block for the LeCroy 8210. The device specific portions of the MCB should be set as follows:

Offset	Contents
M.TYP	"FL" -- 2-character code identifying the LeCroy 8210 device type.
M.UNIT	Unit number identifying each LeCroy 8210 module.
M.ACP	2-character identifier of the ACP containing the FL driver.
M.CTL	Control bits
MC.SUB = 0	FL is not a submodule
MC.INT = 0	Indicates interrupt service is not required by the LeCroy 8210.
MC.CAM = 1	Indicates the LeCroy 8210 is a CAMAC module.
M.ADR	CAMAC address in BCNA format (A=0) of the module.
M.DLN	2 => Length of one data item = 2 bytes.
M.DFM	2 => Data returned as integers

4.3 Unloading the Module

The module is unloaded by either of the two macro calls

```
QIO$S   #IO.ULM,lun
```

or

```
UNLOAD  lun
```

The use of these macros and the meaning of the arguments are given in the manual "DIOS I/O Operations".

4.4 QIO Functions to the Loaded Module

This section summarizes the standard and device-specific QIO requests processable by the FL driver.

4.4.1 Standard Functions

Format		Function
QIO$S	#IO.VAT,...	;Attach Module
QIO$S	#IO.VDT,...	;Detach Module
QIO$S	#IO.KIL,...	;Cancel I/O on Module
QIO$S	#IO.ULM,...	;Unload the Module

4.4.2 Module-specific Functions

Format		Function
QIO$S	#IO.INI,...,<ddp,lpm>	;Initialize FL
QIO$S	#IO.TER,...,<#0,#4>	;Terminate FL
QIO$S	#IO.RVB,...,<buf,lbuf>	;Read data from FL

ddp is the address of a block of device-dependent parameters defining the mode in which the LeCroy 8210 is initialized.
lpm is the length of the block in bytes.
buf is the address of a buffer to receive data read from the module.
lbuf is the length of the data buffer in bytes.

4.4.2.1 IO.INI -- Initialize the LeCroy 8210 -

IO.INI passes a buffer specified in the parameter list of the QIO containing device-dependent parameters specifying the mode of initialization. Depending upon the contents of the buffer, the following actions are performed:

1. The frequency delivered in floating point format will be checked for legality.
   Legal values: 0, 1E4, 25E3, 5E4,
   1E5, 25E4, 5E5, 1E6.

   For frequency 0 the external clock will be enabled.

2. Each of the 4 analog input channels can be declared as logically online or offline corresponding to the physical situation. The coordination of the online bitmap to the number of selected channels (NOC) will be performed as follows:
   If the highest online channel number lies between
   - 3 and 4, NOC = 4.
   - if channel #2 online, NOC = 2, and if
   - only channel #1 online, NOC = 1.

3. The number of memory modules attached to the 8210 is established and determines the maximum data available from 8210.
   Legal values: 1,2,3,4 , corresponding to 32K, 64K,
   96K, 128K words of data, respectively.

4. The 8210 posttrigger samples counter may be programmed by a jumper so that the front panel posttrigger samples switch indicates either increments of 1024 or 2048 posttrigger samples. The FLDRV must know the state of this jumper for the evaluation of the correct number of posttrigger samples. This information is contained in the INCFLG parameter.
   Allowed posttrigger values:

   INCFLG=0: 1024, 2048, 3072, 4096,
   5120, 6144, 7168, and 0.
   INCFLG=1: 2048, 4096, 6144, 8192,
   10240, 12288, 14336, and 0.

5. The number of pretrigger samples (PRE), entered in floating point format, must satisfy the condition:

   PRE =< (NOM * 32768)/NOC - PTS

6. The number of posttrigger samples (PTS), entered in FP-format, will be checked for legality (see above). Furthermore the condition

PTS =< (NOM * 32768)/NOC - PRE must hold.

The buffer consists of 16 bytes which are formatted as follows:

Offset	Name	Type	Meaning
0	FREQU	[E]	Clock frequency for the 8210 in floating point format. Frequency 0 means external clock enabled.
4	PRE	[E]	Number of pretrigger samples in floating point format. Only positive integers are allowed.
10	PTS	[E]	Number of posttrigger samples in floating point format. Only positive integers are allowed.
14	NOM	[I]	Number of LeCroy Model 8800/10 memory modules attached to the 8210.
15	INCFLG	[B]	Flag (Bit 0) to indicate that the 8210 jumper for the increment of the PTS switch was set to 2048. INCFLG=0 means: Increment = 1024 INCFLG=1 means: Increment = 2048
16	BITMAP	[Y]	LeCroy 8210 online bitmap. This bit pattern describes which channels are physically connected to the module. Bit n set means that channel number n+1 is declared online.
17	RESEV		Reserve for future use.

The driver compares the IO.INI parameters with the 8210 front panel switch settings and, provided that they correspond, initiates continuous sampling cycle. The DAC display on scope will then be disabled. Furthermore the driver sets the status as defined by the device dependent parameters, where all parameters are checked for legality. Errors are reported by setting the status block accordingly.

4.4.2.2 IO.TER -- Terminate FL Operations -

IO.TER always re-initiates the LeCroy 8210 DAC display on scope and cleans up all parameters in the VCB. It prevents the module from being read until it is reinitialized with IO.INI.

4.4.2.3 IO.RVB -- Read Data from the LeCroy 8210 -

Readout is processed by the FL driver in the following manner:

The driver scans the online bitmap, starting with channel number 1 up to channel number 4. When it reaches an online channel, it reads all data available from this channel (e.g. number of PRE+PTS). Then the driver switches to the next channel which was defined as physically connected and reads the data from it. This process will be repeated until the last "online" channel was read. The total number of data available is:

(PTS+PRE)*ONCH

where ONCH is the number of on-line channels.

When the 8210 works in the single-channel mode and the stop trigger is not synchronised with the sample triggers, it is possible that one datum (the earliest pretrigger sample) is truncated. Therefore the maximum number of available data may be reduced by 1.

Data are read and returned to the user buffer until the given buffer length is exhausted or until the physical end of the module memory is detected. Subsequent read requests continue from the word following the last word read. If any error occurs, IO.RVB returns the appropriate error code in the user status block.

4.5 Status Returns and Error Handling

Status information from a completed QIO operation is returned in the I/O status block if one was specified in the QIO. The first word contains an error or success code, the second contains zero or the number of bytes read with an IO.RVB operation.

4.5.1 First Status Word (low byte)

Code	Meaning
IS.SUC	OPERATION SUCCESSFUL No error occurred in processing the given QIO function. Returned from IO.INI, IO.RVB or IO.TER.
IE.IFC	INVALID FUNCTION CODE Returned from all QIO functions other than the standard functions or IO.INI, IO.TER, or IO.RVB.
IE.IDS	OPERATION INCONSISTENT WITH DEVICE STATE Returned from IO.RVB if the FL has not been initialized since being loaded or terminated with IO.TER.
IE.OFL	DEVICE OFFLINE Returned from all functions if the crate is offline, or the module is not at the specified address.
IE.EOT	END OF TAPE DETECTED All valid (available) data have been read. That means the number of requested data was greater than the data really stored on the LeCroy 8210 memories. Returned from IO.RVB.
IE.EOV	END OF VOLUME DETECTED All data available according to the attached memory modules have been read since the last IO.INI. Returned from IO.RVB.
IE.DAO	DATA OVERRUN The LeCroy 8210 memories contain more data than specified on initialization. This means the number of 8800/10 memories physically attached to the LeCroy 8210 is greater than NOM as defined in IO.INI. Returned from IO.RVB.
IE.DNR	DEVICE NOT READY This error code will be returned, if - no Stop Trigger was received or - the posttrigger samples were not yet finished or - the memory was not ready to read out. Returned from IO.RVB
IE.FHE	FATAL HARDWARE ERROR

If this error code occured after IO.RVB, the FL driver cannot read valid data.
(Q-response is missing).

IE.BAD BAD PARAMETERS

Returned from IO.INI, if any bad parameters were encountered.

These include:

- specifying an invalid number of trigger pulses.
- Frequncy was out of range (see Section 4.4.2).
- The online bitmap was equal to 0 (no channels online), or does not correspond to the NOC switch on 8210 front panel.
- The number of memory modules was equal to 0 or greater than 4.
- The increment of the posttrigger sample switch, specified by INCFLG, does not correspond to the increment jumpered on the 8210 module.
- The number of pretrigger samples was greater than (32768 * NOM)/NOC - PTS , or not a positive integer.
- The number of posttrigger samples is not one of the allowed values (see Section 4.4.2) corresponding to the appropriate increment-jumper, or is larger than the memory available to each channel minus the pretrigger samples, or is not a positive integer.

4.5.2 First Status Word (high byte)

Contains the group number of the error code returned by the driver (see Appendix A of "DIOS I/O Operations"). All errors returned by FLDRV belong to error group 0.

4.5.3 Second Status Word

After IO.TER, IO.INI or the standard I/O functions, the second status word contains zero.

After IO.RVB, the second status word always contains the number of bytes actually transferred to the user buffer.

CHAPTER 5

LMDRV - LeCroy Dual Port Memory (Model 8801)

5.1 Introduction

The LeCroy Model 8801 dual port memory module is a single width CAMAC module with a capacity of 16384 16-bit words. The external port (via rear-panel connector) allows storage and readout of sequential data which can be randomly accessed from the CAMAC Dataway. The 8801 can also be used as a general-purpose random access storage unit via the CAMAC Dataway. Autoincrement of memory addresses allows for high speed direct memory access (DMA) operations. Use of tri-state logic permits memory expansion by cascading memory modules.
Addressing for access via the dataway is done by setting an address register and then transferring the data or in auto-increment mode. Loading memory from the external bus is always done with automatic address increment.

The DIOS driver for the LeCroy 8801, LMDRV, operates on the module as follows: at initialization time the user determines the startaddress of memory from which to read or write, and whether access is via the dataway or from the external bus. A read or write function always switches the access lines to the dataway, starting I/O at the address specified at initialization time. Any number of data (16-bit words) available may be read or written with a single QIO.

5.2 Loading the Module

The module is loaded by either of the two macro calls

```
QIO$S   #IO.LOD,#$LDR,....,<mcb,lmcb,lun>
```

or

```
LOAD    lun,mcb,sts,flg
```

The use of the macros and meaning of the arguments are given in the DIOS Operations Manual.

5.2.1 MCB Format

In the macro calls above, mcb is the address of the Module Control Block, described in the DIOS Operations Manual. The device specific portions of the MCB should be set as follows:

Offset	Contents
M.TYP	"LM" -- 2-letter type code for LeCroy 8801
M.UNIT	Unit number of LeCroy 8801.
M.ACP	2-Letter code of ACP containing the 8801 driver.
M.CTL	Control bits, set as follows:
	MC.CAM=1 Indicates the 8801 is a CAMAC module. MC.INT=0 Indicates interrupt service is not required by the 8801.
M.ADR	CAMAC address in BCNA format (A=0) of the module.

5.3 Unloading the Module

The module is unloaded by either of the two macro calls:

```
QIO$S   #IO.UNL,#lun,...
```

or

```
UNLOAD  lun,sts,flg
```

The use of these macros and the meaning of the arguments are given in the DIOS Operations Manual.

5.4 QIO Functions to the Loaded Module

This section summarizes the standard and device-specific QIO requests processable by the driver.

5.4.1 Standard Functions

```
        Format                          Function

QIO$S   #IO.VAT,...                     ;Attach Module
QIO$S   #IO.VDT,...                     ;Detach Module
QIO$S   #IO.KIL,...                     ;Cancel I/O on Module
QIO$S   #IO.UNL,...                     ;Unload Module
```

5.4.2 Module-specific Functions

```
        Format                          Function

QIO$S   #IO.INI,...,<ddp,lpm>   ;Initialize LeCroy 8801
QIO$S   #IO.TER,...,<0,2>       ;Terminate LeCroy 8801
QIO$S   #IO.RVB,...,<buf,lbuf>  ;Read data from LeCroy 8801
QIO$S   #IO.WVB,...,<buf,lbuf>  ;Write data to LeCroy 8801
```

where

ddp	is the address of a block of device-dependent parameters defining the mode in which the LeCroy 8801 is initialized.
lpm	is the length of the block in bytes.
buf	is the address of the buffer into which data are read or from which data are written.
lbuf	is the length of the data buffer in bytes.

5.4.2.1 IO.INI - Initialize the LeCroy 8801

IO.INI passes a buffer specified in the parameter list of the QIO containing device-dependent parameters specifying the mode of initialization. Depending upon the contents of the buffer, the following actions are performed:

1. The start address, from which data will be read or into which data will be written, is established.

2. The data bus, either the 8801 external bus or the CAMAC Dataway, is enabled.

The buffer consists of 6 bytes which are formatted as follows:

Offset	Name	Type	Meaning
0	UNUSED		These two bytes are unused by the LM driver version implemented at this time. Reserved for later versions.
2	RELADR	[D]	Memory start address from which will be read or into which will be written with autoincrement. Allowed range: 0 ... 16383 .
4	ACCESS	[A]	set to "E" if external access is desired, or set to "I" if I/O is done via the dataway.
5	RESRV		reserved for future use.

The driver sets the status as defined by the device dependent parameters, where all parameters are checked for legality. Errors are reported via setting the status block accordingly.

5.4.2.2 IO.TER - Terminate Operations on the LeCroy 8801

IO.TER always sets the LeCroy 8801 to be accessed via the dataway. The start address is reset to zero.

5.4.2.3 IO.RVB - Read Data from the LeCroy 8801

The LeCroy 8801 I/O lines are switched to the dataway. Reading is done in auto-increment mode and starts at the location set by an IO.INI function or one word behind the address of the last read/write cycle. External input does not alter the location counter for a read function. Data are read and returned to the user buffer until the given

buffer length is exhausted or until the physical end of the LeCroy 8801 memory is detected.

5.4.2.4 IO.WVB - Write Data to the LeCroy 8801

The same actions are taken as with IO.RVB, except that data are written from the user buffer to the LeCroy 8801. If more data are to be written than the capacity of the LeCroy 8801 allows, an error status is returned and all following attempts to write data are ignored until the next IO.INI.

5.5 Status Returns and Error Handling

When a QIO function is completed, status information about the functions is returned in the I/O status block if specified in the QIO macro call.

5.5.1 First Status Word (low byte)

The error codes listed below may be returned by the LeCroy 8801 Driver.

Code	Meaning
IS.SUC	A QIO for IO.INI, IO.TER, IO.RVB or IO.WVB was successfully completed.
IE.IFC	A function code other than IO.INI, IO.TER IO.RVB or IC.WVB or the standard functions was encountered.
IE.BAD	Returned from IO.INI, if any bad parameters were encountered.
IE.OFL	Returned from IO.INI, IO.RVB, IC.WVB or IO.TER if the module is not at the given CAMAC station or the crate is offline.
IE.IDS	Returned from IO.RVB or IO.WVB if an error occured during the last QIO or if it was not (or not correct) initialized.
IE.FHE	Returned from IO.RVB or IO.WVB if the 'MEMORY FULL' signal does not appear at the correct time calculated by the LM driver.
IE.EOV	Returned from IO.RVB or IO.WVB if the storage capacity becomes exhausted during a read or write operation.

5.5.2 First Status Word (high byte)

DIOS drivers use this byte to group error conditions. Bit n on selects error code group n+1. All error codes used by the LMDRV belong to error code group zero.

5.5.3 Second Status Word

This word shows in all cases the number of bytes actually transferred to or from the user buffer.

5.6 Programming Hints

In DIOS the LeCroy 8801 is provided to be filled from the external bus (e.g. with experimental data) and then to be read out via the data way. For this purpose the user initializes the LeCroy 8801 for external access as outlined obove (IO.INI). After information is stored in the LeCroy 8801 the user merely has to perform succeeding QIOs with function code IO.RVB to obtain the data stored in the 8801, where the amount of data to be read each time is given by the user's buffer length. Data are returned in the same order as they are transferred to the 8801, so the user is not concerned with any addressing. However, if the user wants to specify his own start address he might do so with another initialization, which does not alter the contents of the 8801.

CHAPTER 6

LSDRV -- LeCroy 8590 Octal 100MHz Latching Scaler

6.1 Introduction

The LeCroy Model 8590 Latching Scaler is packaged in a single width CAMAC module and permits scaling rates up to 100MHz. The module contains eight identical 16-bit binary scalers with parallel storage latches and was designed for use as an independent 8 channel scaler or in a system consisting of up to 9 LeCroy 8590 modules and an associated buffer memory module, the LeCroy Model 8801 Dual Port Memory.

Multiple 8590 modules may be arranged up to the maximum number of 72 scaler channels, physically connected to one LeCroy 8801 memory. In the remaining chapter the term "logical 8590" will be used for the configuration of all daisy-chained 8590 modules connected to a single 8801 memory. Multiple 8590 modules forming a logical 8590 must occupy consecutive CAMAC stations.

The DIOS driver for the LeCroy 8590, LSDRV, operates on the module as follows:

At initialization time the user determines the physical configuration of the logical 8590 by specifying the number of scaler channels available in his physical configuration. From this value the driver calculates the number of 8590 modules physically connected to one 8801 memory (see section 6.4.2.1) and sets the appropriate number of active channels on the 8590 module(s).
Furthermore the user can choose between two modes of operation: Normal operation or Test operation.
For Test-Mode an additional parameter must be specified to inform the LS driver how many test pulses to generate on the 8590 modules.

With an IO.RVB the user gets information about the logical 8590. This information will be delivered as a block of data in a fixed format and can be read as often as desired. The maximum number of data available depends on the number of 8590 modules physically connected to one 8801, and is given by the formula 15+NOS*8 words.
Any number of data up to the maximum available (87 words for NOS=9) can be read with a single QIO.

For the further desciption following definitions are used:

NOC = Maximum number of scaler channels available on the logical 8590.
NOS = Maximum number of 8590 modules available in the configuration.

6.2 Loading the Module

The module is loaded by either of the two macro calls

```
QIO$S   #IO.LOD,#$LDR,...,<mcb,lmcb,lun>
```

or

```
LOAD    lun,mcb,sts,flg
```

The use of these macros and meaning of the arguments are given in the manual "DIOS I/O Operations".

6.2.1 MCB Format

In the macro calls above, mcb denotes the address of the module control block for the LeCroy 8590. The device specific portions of the MCB should be set as follows:

Offset	Contents
M.TYP	"LS" -- 2-character code identifying the LeCroy 8590 device type.
M.UNIT	Unit number identifying each logical LeCroy 8590.
M.ACP	2-character identifier of the ACP containing the LS driver.
M.CTL	Control bits
MC.SUB = 0	LS is not a submodule
MC.INT = 0	Indicates interrupt service is not required by the LeCroy 8590.
MC.CAM = 1	Indicates the LeCroy 8590 is a CAMAC module.
M.ADR	CAMAC address in BCNA format (A=0) of the first module in the chain.
M.DLN	2 => Length of one data item.= 2 bytes.
M.DFM	2 => Data returned as integers

6.3 Unloading the Module

The module is unloaded by either of the two macro calls

```
QIO$S   #IO.ULM,lun
```

or

UNLOAD lun

The use of these macros and the meaning of the arguments are given in the manual "DIOS I/O Operations".

6.4 QIO Functions to the Loaded Module

This section summarizes the standard and device-specific QIO requests processable by the LS driver.

6.4.1 Standard Functions

Format		Function
QIO$S	#IO.VAT,...	;Attach Module
QIO$S	#IO.VDT,...	;Detach Module
QIO$S	#IO.KIL,...	;Cancel I/O on Module
QIO$S	#IO.ULM,...	;Unload the Module

6.4.2 Module-specific Functions

Format		Function
QIO$S	#IO.INI,...,<ddp,lpm>	;Initialize LS
QIO$S	#IO.TER,...,<#0,#4>	;Terminate LS
QIO$S	#IO.RVB,...,<buf,lbuf>	;Read data from LS

ddp is the address of a block of device-dependent parameters defining the mode in which the LeCroy 8590 is initialized.
lpm is the length of the block in bytes.
buf is the address of a buffer to receive data read from the module.
lbuf is the length of the data buffer in bytes.

6.4.2.1 IO.INI -- Initialize the logical LeCroy 8590 -

IO.INI passes a buffer specified in the parameter list of the QIO containing device-dependent parameters specifying the mode of initialization. Depending upon the contents of the buffer, the following actions are performed:

1. The mode of operation will be checked for legality. Valid characters for MODE are:

   MODE Function

   N Normal operation.
   All operations on the 8590 modules, such as INHIBIT, STOP and LATCH, are controlled by external signals; the scalers count pulses delivered from external sources. The data received from IO.RVB depends on the time at which the QIO directive was issued and shows the scaler status at the time of the last LATCH pulse.

   T Test operation.
   The user specifies a given number of internal test pulses to be issued by the driver. The driver than executes this number of F25 operations for each scaler in each 8590 module; each scaler should than contain this number of pulses. No external signals are required for the Test Mode.

2. The number of available channels (NOC) will be checked for legality. This parameter also determines the number of LeCroy 8590 modules physically connected to a single LeCroy 8801 memory and constituting a logical 8590 module.
   The channels used are distributed among the component 8590 modules as follows:
   In every module but the last one, all eight channels must be used. The last module may be set to use 1, 2, 4, or 8 channels. Thus the number of modules is given by:

   $$NOS = NOC/8 .$$

   The number of channels must satisfy the condition:

   $$NOC = (NOS-1)*8 + 2**v$$

   where v is 0, 1, 2, or 3.

The buffer consists of 4 bytes which are formatted as follows:

Offset	Name	Type	Meaning
0	MODE	[A]	Mode in which the LeCroy 8590 is operating: N Normal operation T Test operation
1	NOC	[I]	Number of scaler channels; which are available on the logical 8590 and are connected to one LeCroy 8801 memory. Allowed values for NOC: (NOS-1)*8 + 2**v. (see above).
2	COUNTS	[D]	Number of scaling counts; generated by the LS driver on all modules if Test-Mode was selected.

The driver sets the status as defined by the device dependent parameters.After checking the parameters for legality, it clears all scalers and overflow-bits, sets the number of active channels on all modules according to the specified parameter (NOC) and executes the number of internal generated count-pulses if Test function was enabled. Errors are reported by setting the status block accordingly.

6.4.2.2 IO.TER -- Terminate LS Operations -

For IO.TER the LS driver clears all scalers and overflow-bits on all 8590 modules, sets the number of active channels on all modules to 1 and cleans up the VCB. This prevents the module from being read until it is reinitialized with IO.INI.

6.4.2.3 IO.RVB -- Read Data from the LeCroy 8590 -

For IO.RVB the LS driver delivers information about the current state of the logical 8590. Data are returned in a block of NOS*16+30 bytes which are formatted as follows:

OFFSET	MEANING
0	Total number of data transferred to the LeCroy 8801 memory from all connected LeCroy 8590 modules which form one logical 8590.
2	LeCroy overflow bit map; This is a bit pattern which informs the user if any of the 8590 scaler channels overflowed. Bit n set means that an overflow occurred on channel number (n+1). The overflow bit map consists of 72 bits, one bit for each of the up to 72 channels which may be connected to a single 8801 memory within a logical 8590 module.
14	Number of data transferred to the LeCroy 8801 memory by each separate 8590 module. Because it is possible to connect up to 9 LeCroy 8590 modules on one 8801 memory, 9 words must be reserved to store the data transfer counts of all available modules.
36	At this offset the data of the scaler channels updated by the last LATCH pulse will be stored, beginning with 8590 module #1 (scaler values from channel #1 to 8), then module #2 (scaler values from channel #9 to 16) up to module #9 (scaler values from channel #65 to 72) provided that the modules are available in the configuration.

If Test Mode was selected at initialization, the LS driver will generate an internal LATCH pulse on all available 8590 modules with the first IO.RVB before it reads out data from the modules. Any number of data up to the maximum available (NOS*16+30) can be read with a single IO.RVB. For example, if the user only want to know the total number of data transferred to memory and the overflow bit map, he must only request 6 words. In this case and if fewer data were requested than are available, the error code IE.DAO will be returned. End of volume will be indicated if more data were requested than available on the 8590 modules (more than NOS*16+30 bytes). Reading of the "Diagnostic Block" may be done as often as desired to monitor the current status of the logical 8590.

6.5 Status Returns and Error Handling

Status information from a completed QIO operation is returned in the I/O status block if one was specified in the QIO. The first word contains an error or success code; the second contains zero or the number of bytes read with an IO.RVB operation.

6.5.1 First Status Word (low byte)

Code	Meaning
IS.SUC	OPERATION SUCCESSFUL No error occurred in processing the given QIO function. Returned from IO.INI, IO.RVB or IO.TER.
IE.IFC	INVALID FUNCTION CODE Returned from all QIO functions other than the standard functions or IO.INI, IO.TER, or IO.RVB.
IE.IDS	OPERATION INCONSISTENT WITH DEVICE STATE Returned from IO.RVB or IO.TER if the LS has not been initialized since being loaded or terminated with IO.TER.
IE.OFL	DEVICE OFFLINE Returned from IO.INI, IO.TER and IO.RVB if the crate is offline, the logical 8590 is not at the specified address or the number of 8590 modules specified at IO.INI was greater than really available in the configuration.
IE.EOV	END OF VOLUME DETECTED All data available (NOS*16+30 bytes) have been read. Returned from IO.RVB.
IE.DAO	DATA OVERRUN Not all data available in the logical 8590 have been read with a single QIO. Returned from IO.RVB.
IE.BAD	BAD PARAMETERS Returned from IO.INI, if the mode key was not one of the allowed options, or if an invalid number of channels was specified (see Section 6.4.2.1).

6.5.2 First Status Word (high byte)

Contains the group number of the error code returned by the driver (see Appendix A of "DIOS I/O Operations"). All errors returned by LSDRV belong to error group 0.

6.5.3 Second Status Word

After IO.INI, IO.TER, or the standard I/O functions, the second status word contains zero.

After IO.RVB, the second status word always contains the number of bytes actually transferred to the user buffer.

CHAPTER 7

MLDRV - LeCroy Datalogger (Model 8212)

7.1 Introduction

The LeCroy Model 8212 is a 32-input, 12-bit ADC intended for use with the LeCroy Model 8800 Series 32K Memory Modules in low frequency transient monitoring applications. This combination of units provides 4,8,16, or 32 channels of 12-bit fast data logging with memory capacity determined by the number of 8800/12's utilized. With the 8212 used in the 4-channel mode, for instance, one memory module provides 8k words of storage for each input. Similarly, one 8800/12 provides 1024 words of memory for each channel of an 8212 used in the full 32-input mode.

The LeCroy 8212 is capable of sampling each input from a maximum rate of 40 kHz in the 4-input mode to a maximum rate of 5 kHz in the full 32-input mode. An important feature of the 8212 is the simultaneous sampling of all channels. Sampling rate is determined either by an internal clock or by an external clock.

The analog signals at the inputs of the 8212 are converted sequentially, each input requiring 5.5 microseconds dwell time. A complete scan of all 32 inputs takes 176 microseconds.

The analog input range is bipolar +5 Volt to -5 Volt. Output is offset binary with all zeros corresponding to the most negative value and all ones to the most positive value.

The DIOS driver for the LeCroy 8212, MLDRV, operates on the module as follows:

At initialization time the user determines the frequency of the internal clock (zero corresponds to external clocking), the physical configuration of the logigally connected (online) channels, the number of 8800/12 memory modules

attached to the 8212, the jumper configuration for the selected posttrigger samples, the number of pretrigger samples, the number of posttrigger samples and the mode for readout.

There are 3 possibilities for reading data from LeCroy 8212:

1. Channel selected reading.
   The driver will read all available data (e.g. number of pretrigger and posttrigger samples). Data is returned separately for each channel number. The channels are read in ascending order, whereby those channels not marked as online are skipped.

2. Sequential reading of memory.
   In this mode all data from the external memory (8800/12) will be read sequentially as stored (e.g. successive memory words will be read). The maximum number of data available is given by the Number of Channels (NOC) multiplied by the sum of Pretrigger and Posttrigger samples.

3. Reading for test purposes.
   In this mode only the internal memory of the LeCroy 8212 will be read out. The number of data available is limited to 32 words, one word for each channel.

Any number of data up to the maximum available (32768) may be read with a single QIO.

The first IO.RVB after initialization can only be performed if the stop trigger was received and the posttrigger samples are finished (Mode 1+2). In mode 3 no external trigger is needed.

In order to make sure the memory cycles through at least once, the following minimum time interval must elapse following initialization before the stop trigger is given:

$$T = 32768 * NOM/(NOC * CLK)$$

where

CLK = sample clock frequency
NOM = number of memory modules
NOC = number of channels

At least one sample clock pulse be occur before the Stop Trigger is received.

Further definitions used in this chapter are:

PTS = number of posttrigger samples
PRE = number of pretrigger samples

7.2 Loading the Module

The module is loaded by either of the two macro calls

```
QIO$S   #IO.LOD,#$LDR,...,<mcb,lmcb,lun>
```

or

```
LOAD    lun,mcb,sts,flg
```

The use of these macros and meaning of the arguments are given in the manual "DIOS I/O Operations".

7.2.1 MCB Format

In the macro calls above, mcb denotes the address of the module control block for the LeCroy 8212. The device specific portions of the MCB should be set as follows:

Offset	Contents
M.TYP	"ML" -- 2-character code identifying the LeCroy 8212 device type.
M.UNIT	Unit number identifying each LeCroy 8212 module.
M.ACP	2-character identifier of the ACP containing the ML driver.
M.CTL	Control bits
MC.SUB = 0	ML is not a submodule
MC.INT = 0	Indicates interrupt service is not required by the LeCroy 8212.
MC.CAM = 1	Indicates the LeCroy 8212 is a CAMAC module.
M.ADR	CAMAC address in BCNA format (A=0) of the module.
M.DLN	2 => Length of one data item = 2 bytes.
M.DFM	2 => Data returned as integers

7.3 Unloading the Module

The module is unloaded by either of the two macro calls

```
QIO$S   #IO.ULM,lun
```

or

```
UNLOAD  lun
```

The use of these macros and the meaning of the arguments are given in the manual "DIOS I/O Operations".

7.4 QIO Functions to the Loaded Module

This section summarizes the standard and device-specific QIO requests processable by the ML driver.

7.4.1 Standard Functions

Format		Function
QIO$S	#IO.VAT,...	;Attach Module
QIO$S	#IO.VDT,...	;Detach Module
QIO$S	#IO.KIL,...	;Cancel I/O on Module
QIO$S	#IO.ULM,...	;Unload the Module

7.4.2 Module-specific Functions

Format		Function
QIO$S	#IO.INI,...,<ddp,lpm>	;Initialize ML
QIO$S	#IO.TER,...,<#0,#4>	;Terminate ML
QIO$S	#IO.RVB,...,<buf,lbuf>	;Read data from ML

ddp is the address of a block of device-dependent parameters defining the mode in which the LeCroy 8212 is initialized.
lpm is the length of the block in bytes.
buf is the address of a buffer to receive data read from the module.
lbuf is the length of the data buffer in bytes.

7.4.2.1 IO.INI -- Initialize the LeCroy 8212 -

IO.INI passes a buffer specified in the parameter list of the QIO containing device-dependent parameters specifying the mode of initialization. Depending upon the contents of the buffer, the following actions are performed:

1. The frequency delivered in floating point format will be checked for legality.
   Legal values: 0, 0.2E3, 1E3, 2E3,
   5E3, 1E4, 2E4, 4E4 Hz.
   The frequency must satisfy the condition:

   FREQU =< 160kHz/NOC.

   For frequency 0 the external clock will be enabled.

2. Each of the 32 analog input channels can be declared as logically online or offline corresponding to the physical situation. The coordination of the online bitmap to the number of selected channels (NOC) will be performed as follows:
   If the highest online channel number lies between
   - 17 and 32, NOC = 32;
   - 9 and 16, NOC = 16;
   - 5 and 8, NOC = 8;
   - 1 and 4, NOC = 4.

3. The number of memory modules attached to the 8212 is established and determines the maximum data available from 8212.
   Legal values: 1,2,3,4

4. The jumper configuration determines the number of posttrigger samples. The table below shows the allowed PTS values appropriate to a selected jumper configuration:

JUMPER=1	JUMPER=2	JUMPER=3	JUMPER=4
128	256	512	128
256	512	1024	1280
384	768	1536	2432
512	1024	2048	3584
640	1280	2560	4736
768	1536	3072	5888
896	1792	3584	7040
1024	2048	4096	8192

5. The number of pretrigger samples (PRE), entered as a positive FP integer, must satisfy the condition:

   PRE =< (NOM * 32768)/NOC - PTS

6. The number of posttrigger samples (PTS), entered as a positive FP integer, will be checked for legality (see table). Furthermore the condition

   PTS =< (NOM * 32768)/NOC - PRE must hold.

7. The mode in which data are to be read from the LeCroy 8212 by IO.RVB is determined by the MODE key:

Key	Function
C	Channel selected reading.
S	Sequential reading.
T	Reading for test purposes. The "single scan" mode will be enabled and an internal trigger by CAMAC command F27 generated.

The buffer consists of 20 bytes which are formatted as follows:

Offset	Name	Type	Meaning
0	FREQU	[E]	Clock frequency for the 8212 in floating point format. Frequency 0 means external clock enabled.
4	PRE	[E]	Number of pretrigger samples in floating point format. Only positive integers are allowed.
10	PTS	[E]	Number of posttrigger samples in floating point format. Only positive integers are allowed.
14	NOM	[I]	Number of LeCroy Model 8800/12 memory modules attached to 8212.
15	JUMPER	[I]	Number of jumper configuration wired on LeCroy 8212.
16	BTMPLO	[O]	LeCroy 8212 online bitmap for channels 1...16. This bit pattern describes which channels are physical connected to the module. Bit n set means that channel number n+1 is declared online.
20	BTMPHI	[O]	LeCroy 8212 online bitmap for channels 17...32.
22	MODE	[A]	Mode of readout: C Channel selected reading S Sequential reading

		T Reading for test purposes
23	RESEV	Reserve for future use.

The driver enables the "sweep and log" mode and writes the parameters (FREQU,NOC,PTS) binary coded into LeCroy 8212 Function-Latch. If MODE=T specified, "single scan" mode will be enabled and an internal trigger generated. Furthermore the driver sets the status as defined by the device dependent parameters, where all parameters are checked for legality. Errors are reported by setting the status block accordingly. The second status word contains the generated binary code of the 8212 Function-Latch . It may be used for test purposes.

7.4.2.2 IO.TER -- Terminate ML Operations -

IO.TER always resets the LeCroy 8212 into "sweep and log" mode and cleans up all parameters in the VCB. It prevents the module from being read until it is reinitialized with IO.INI.

7.4.2.3 IO.RVB -- Read Data from the LeCroy 8212 -

The ML driver reads data from LeCroy 8212 in 3 different ways:

1. Channel selected reading.
   The driver scans the online bitmap, starting with channel number 1 up to channel number 32. When it reaches an online channel, it reads all data available from this channel (e.g. number of PRE+PTS). Then the driver switches to the next channel which was defined as physically connected and reads the data from it. This process will be repeated until the last "online" channel was read.

2. Sequential reading.
   After initialization, the ML driver sets the LeCroy 8212 into the "data streaming" mode and reads the data from the external memory (8800/12) sequential, that means sucessive memory words. memory (8800/12) sequentially as stored in memory. Data from each pulse are stored in a block of NOC words beginning with channel 1 up to channel #NOC. The number of blocks is given by the number of pulses, (PRE + PTS), hence the total number of datawords available is: NOC * (PRE+PTS).

3. Reading for test purposes.
   In this mode the ML driver only reads the internal memory of the LeCroy 8212. This memory has a capacity of 32 words, one word for each channel, and contains data sampled and converted at initialization time. The number of data available depends on the selected channel number (NOC). The maximum is 32 words (NOC=32).

Data are read and returned to the user buffer until the given buffer length is exhausted or until the physical end of the module memory is detected. Subsequent read requests continue from the word following the last word read. If any error occurs, IO.RVB returns the appropriate error code in the user status block.

7.5 Status Returns and Error Handling

Status information from a completed QIO operation is returned in the I/O status block if one was specified in the QIO. The first word contains an error or success code. The contents of the second word depend on the I/O Function: on IO.INI, it contains the function code for the LeCroy 8212 Latch; on IO.RVB, it contains the actual number of bytes read; and on IO.TER, it is zero.

7.5.1 First Status Word (low byte)

Code	Meaning
IS.SUC	OPERATION SUCCESSFUL No error occurred in processing the given QIO function. Returned from IO.INI, IO.RVB or IO.TER.
IE.IFC	INVALID FUNCTION CODE Returned from all QIO functions other than the standard functions or IO.INI, IO.TER, or IO.RVB.
IE.IDS	OPERATION INCONSISTENT WITH DEVICE STATE Returned from IO.RVB if the ML has not been initialized since being loaded or terminated with IO.TER.
IE.OFL	DEVICE OFFLINE Returned from all functions if the crate is offline, or the module is not at the specified address.
IE.EOV	END OF VOLUME DETECTED All data available according to the selected mode have been read since the last IO.INI. Returned from IO.RVB
IE.EOT	END OF TAPE DETECTED All valid (available) data have been read. That means the number of requested data was greater than the data really stored on the LeCroy 8212 memories. Returned from IO.RVB.
IE.DAO	DATA OVERRUN The LeCroy 8212 memories contain more data than specified on initialization . This means the number of 8800/12 memories physically attached to the LeCroy 8212 is greater than NOM as defined in IO.INI. Returned from IO.RVB.
IE.DNR	DEVICE NOT READY This error code will be returned, if - no Stop Trigger was received or - the posttrigger samples were not yet finished or - the memory was not ready to read out. Returned from IO.RVB
IE.FHE	FATAL HARDWARE ERROR

After IO.INI this error code means that the generated Function-Code was not correctly written to the module Function-Latch.
If this error code occured after IO.RVB, the ML driver cannot read valid data.
(Q-response is missing).

IE.BAD BAD PARAMETERS

Returned from IO.INI, if any bad parameters were encountered.

These include:

- specifying an invalid number of gate pulses.
- Frequncy was out of range or
  FREQU > 160kHz/NOC or
  FREQU > 0, if MODE=T selected.
- The online bitmap was equal to 0.(no channels online)
- The number of memory modules was equal to 0 or greater than 4.
- The number of the jumper configuration was equal to 0 or greater than 4.
- The number of pretrigger samples was greater than (32768 * NOM)/NOC - PTS , or not a positive integer.
- The number of posttrigger samples is not one of the allowed values (see Section 7.4.2) corresponding to the appropriate jumper configuration, or is larger than the memory available to each channel minus the pretrigger samples , or is not a positive integer.
- A bad MODE was entered

7.5.2 First Status Word (high byte)

Contains the group number of the error code returned by the driver (see Appendix A of "DIOS I/O Operations"). All errors returned by MLDRV belong to error group 0.

7.5.3 Second Status Word

After IO.TER or the standard I/O functions, the second status word contains zero.

After IO.INI the second status word contains the Function-Code generated by IO.INI for the LeCroy 8212 Function-Latch.

After IO.RVB, the second status word always contains the number of bytes actually transferred to the user buffer.

CHAPTER 8

MBDRV - LeCroy Datalogger (Model 8212)

8.1 Introduction

The LeCroy Model 8212 is a 32-input, 12-bit ADC intended for use with the LeCroy Model 8800 Series 32K Memory Modules in low frequency transient monitoring applications. This combination of units provides 4,8,16, or 32 channels of 12-bit fast data logging with memory capacity determined by the number of 8800/12's utilized. With the 8212 used in the 4-channel mode, for instance, one memory module provides 8k words of storage for each input. Similarly, one 8800/12 provides 1024 words of memory for each channel of an 8212 used in the full 32-input mode.

The LeCroy 8212 is capable of sampling each input from a maximum rate of 40 kHz in the 4-input mode to a maximum rate of 5 kHz in the full 32-input mode. An important feature of the 8212 is the simultaneous sampling of all channels. Sampling rate is determined either by an internal clock or by an external clock.

The analog signals at the inputs of the 8212 are converted sequentially, each input requiring 5.5 microseconds dwell time. A complete scan of all 32 inputs takes 176 microseconds.

The analog input range is bipolar +5 Volt to -5 Volt. Output is offset binary with all zeros corresponding to the most negative value and all ones to the most positive value.

The DIOS driver for the LeCroy 8212, MBDRV, operates on the module as follows:

At initialization time the user determines the frequency of the internal clock (zero corresponds to external clocking), the physical configuration of the logigally connected (online) channels, the number of 8800/12 memory modules

attached to the 8212, the jumper configuration for the selected posttrigger samples, the number of pretrigger samples, the number of posttrigger samples and the mode for readout.

There are 3 possibilities for reading data from LeCroy 8212:

1. Channel selected reading.
   The driver will read all available data (e.g. number of pretrigger and posttrigger samples). Data is returned separately for each channel number. The channels are read in ascending order, whereby those channels not marked as online are skipped.

2. Sequential reading of memory.
   In this mode all data from the external memory (8800/12) will be read sequentially as stored (e.g. successive memory words will be read). The maximum number of data available is given by the Number of Channels (NOC) multiplied by the sum of Pretrigger and Posttrigger samples.

3. Reading for test purposes.
   In this mode only the internal memory of the LeCroy 8212 will be read out. The number of data available is limited to 32 words, one word for each channel.

Any number of data up to the maximum available (32768) may be read with a single QIO.

The first IO.RVB after initialization can only be performed if the stop trigger was received and the posttrigger samples are finished (Mode 1+2). In mode 3 no external trigger is needed.

In order to make sure the memory cycles through at least once, the following minimum time interval must elapse following initialization before the stop trigger is given:

$$T = 32768 * NOM/(NOC * CLK)$$

where

CLK = sample clock frequency
NOM = number of memory modules
NOC = number of channels

At least one sample clock pulse be occur before the Stop Trigger is received.

Further definitions used in this chapter are:

PTS = number of posttrigger samples
PRE = number of pretrigger samples

NOTE

The MBDRV is a special version of the MLDRV. It is fully compatible with the MLDRV, but very faster in the execution time through the implemented 'Block Read Mode'. The MBDRV does not support the KS 3992 serial CAMAC Controller !

8.2 Loading the Module

The module is loaded by either of the two macro calls

```
QIO$S   #IO.LOD,#$LDR,...,<mcb,lmcb,lun>
```

or

```
LOAD    lun,mcb,sts,flg
```

The use of these macros and meaning of the arguments are given in the manual "DIOS I/O Operations".

8.2.1 MCB Format

In the macro calls above, mcb denotes the address of the module control block for the LeCroy 8212. The device specific portions of the MCB should be set as follows:

Offset	Contents
M.TYP	"MB" -- 2-character code identifying the LeCroy 8212 device type.
M.UNIT	Unit number identifying each LeCroy 8212 module.
M.ACP	2-character identifier of the ACP containing the MB driver.
M.CTL	Control bits
MC.SUB = 0	MB is not a submodule
MC.INT = 0	Indicates interrupt service is not required by the LeCroy 8212.
MC.CAM = 1	Indicates the LeCroy 8212 is a CAMAC module.
M.ADR	CAMAC address in BCNA format (A=0) of the module.
M.DLN	2 => Length of one data item = 2 bytes.
M.DFM	2 => Data returned as integers

8.3 Unloading the Module

The module is unloaded by either of the two macro calls

```
QIO$S   #IO.ULM,lun
```

or

```
UNLOAD  lun
```

The use of these macros and the meaning of the arguments are given in the manual "DIOS I/O Operations".

8.4 QIO Functions to the Loaded Module

This section summarizes the standard and device-specific QIO requests processable by the MB driver.

8.4.1 Standard Functions

Format		Function
QIO$S	#IO.VAT,...	;Attach Module
QIO$S	#IO.VDT,...	;Detach Module
QIO$S	#IO.KIL,...	;Cancel I/O on Module
QIO$S	#IO.ULM,...	;Unload the Module

8.4.2 Module-specific Functions

Format		Function
QIO$S	#IO.INI,...,<ddp,lpm>	;Initialize MB
QIO$S	#IO.TER,...,<#0,#4>	;Terminate MB
QIO$S	#IO.RVB,...,<buf,lbuf>	;Read data from MB

ddp is the address of a block of device-dependent parameters defining the mode in which the LeCroy 8212 is initialized.
lpm is the length of the block in bytes.
buf is the address of a buffer to receive data read from the module.
lbuf is the length of the data buffer in bytes.

8.4.2.1 IO.INI -- Initialize the LeCroy 8212 -

IO.INI passes a buffer specified in the parameter list of the QIO containing device-dependent parameters specifying the mode of initialization. Depending upon the contents of the buffer, the following actions are performed:

1. The frequency delivered in floating point format will be checked for legality.
   Legal values: 0, 0.2E3, 1E3, 2E3,
   5E3, 1E4, 2E4, 4E4 Hz.
   The frequency must satisfy the condition:

   FREQU =< 160kHz/NOC.

   For frequency 0 the external clock will be enabled.

2. Each of the 32 analog input channels can be declared as logically online or offline corresponding to the physical situation. The coordination of the online bitmap to the number of selected channels (NOC) will be performed as follows:
   If the highest online channel number lies between
   - 17 and 32, NOC = 32;
   - 9 and 16, NOC = 16;
   - 5 and 8, NOC = 8;
   - 1 and 4, NOC = 4.

3. The number of memory modules attached to the 8212 is established and determines the maximum data available from 8212.
   Legal values: 1,2,3,4

4. The jumper configuration determines the number of posttrigger samples. The table below shows the allowed PTS values appropriate to a selected jumper configuration:

JUMPER=1	JUMPER=2	JUMPER=3	JUMPER=4
128	256	512	128
256	512	1024	1280
384	768	1536	2432
512	1024	2048	3584
640	1280	2560	4736
768	1536	3072	5888
896	1792	3584	7040
1024	2048	4096	8192

5. The number of pretrigger samples (PRE), entered as a positive FP integer, must satisfy the condition:

   PRE =< (NOM * 32768)/NOC - PTS

6. The number of posttrigger samples (PTS), entered as a positive FP integer, will be checked for legality (see table). Furthermore the condition

   PTS =< (NOM * 32768)/NOC - PRE must hold.

7. The mode in which data are to be read from the LeCroy 8212 by IO.RVB is determined by the MODE key:

Key	Function
C	Channel selected reading.
S	Sequential reading.
T	Reading for test purposes. The "single scan" mode will be enabled and an internal trigger by CAMAC command F27 generated.

The buffer consists of 20 bytes which are formatted as follows:

Offset	Name	Type	Meaning
0	FREQU	[E]	Clock frequency for the 8212 in floating point format. Frequency 0 means external clock enabled.
4	PRE	[E]	Number of pretrigger samples in floating point format. Only positive integers are allowed.
10	PTS	[E]	Number of posttrigger samples in floating point format. Only positive integers are allowed.
14	NOM	[I]	Number of LeCroy Model 8800/12 memory modules attached to 8212.
15	JUMPER	[I]	Number of jumper configuration wired on LeCroy 8212.
16	BTMPLO	[O]	LeCroy 8212 online bitmap for channels 1...16. This bit pattern describes which channels are physical connected to the module. Bit n set means that channel number n+1 is declared online.
20	BTMPHI	[O]	LeCroy 8212 online bitmap for channels 17...32.
22	MODE	[A]	Mode of readout: C Channel selected reading S Sequential reading

		T Reading for test purposes
23	RESEV	Reserve for future use.

The driver enables the "sweep and log" mode and writes the parameters (FREQU,NOC,PTS) binary coded into LeCroy 8212 Function-Latch. If MODE=T specified, "single scan" mode will be enabled and an internal trigger generated. Furthermore the driver sets the status as defined by the device dependent parameters, where all parameters are checked for legality. Errors are reported by setting the status block accordingly. The second status word contains the generated binary code of the 8212 Function-Latch . It may be used for test purposes.

8.4.2.2 IO.TER -- Terminate MB Operations -

IO.TER always resets the LeCroy 8212 into "sweep and log" mode and cleans up all parameters in the VCB. It prevents the module from being read until it is reinitialized with IO.INI.

8.4.2.3 IO.RVB -- Read Data from the LeCroy 8212 -

The MB driver reads data from LeCroy 8212 in 3 different ways:

1. Channel selected reading.
   The driver scans the online bitmap, starting with channel number 1 up to channel number 32. When it reaches an online channel, it reads all data available from this channel (e.g. number of PRE+PTS). Then the driver switches to the next channel which was defined as physically connected and reads the data from it. This process will be repeated until the last "online" channel was read.

2. Sequential reading.
   After initialization, the MB driver sets the LeCroy 8212 into the "data streaming" mode and reads the data from the external memory (8800/12) sequential, that means sucessive memory words. memory (8800/12) sequentially as stored in memory. Data from each pulse are stored in a block of NOC words beginning with channel 1 up to channel #NOC. The number of blocks is given by the number of pulses, (PRE + PTS), hence the total number of datawords available is: NOC * (PRE+PTS).

3. Reading for test purposes.
   In this mode the MB driver only reads the internal memory of the LeCroy 8212. This memory has a capacity of 32 words, one word for each channel, and contains data sampled and converted at initialization time. The number of data available depends on the selected channel number (NOC). The maximum is 32 words (NOC=32).

Data are read and returned to the user buffer until the given buffer length is exhausted or until the physical end of the module memory is detected. Subsequent read requests continue from the word following the last word read. If any error occurs, IO.RVB returns the appropriate error code in the user status block.

8.5 Status Returns and Error Handling

Status information from a completed QIO operation is returned in the I/O status block if one was specified in the QIO. The first word contains an error or success code. The contents of the second word depend on the I/O Function: on IO.INI, it contains the function code for the LeCroy 8212 Latch; on IO.RVB, it contains the actual number of bytes read; and on IO.TER, it is zero.

8.5.1 First Status Word (low byte)

Code Meaning

IS.SUC OPERATION SUCCESSFUL
No error occurred in processing the given QIO function. Returned from IO.INI, IO.RVB or IO.TER.

IE.IFC INVALID FUNCTION CODE
Returned from all QIO functions other than the standard functions or IO.INI, IO.TER, or IO.RVB.

IE.IDS OPERATION INCONSISTENT WITH DEVICE STATE
Returned from IO.RVB if the MB has not been initialized since being loaded or terminated with IO.TER.

IE.OFL DEVICE OFFLINE
Returned from all functions if the crate is offline, or the module is not at the specified address.

IE.EOV END OF VOLUME DETECTED

All data available according to the selected mode have been read since the last IO.INI.
Returned from IO.RVB

IE.EOT END OF TAPE DETECTED

All valid (available) data have been read. That means the number of requested data was greater than the data really stored on the LeCroy 8212 memories.
Returned from IO.RVB.

IE.DAO DATA OVERRUN

The LeCroy 8212 memories contain more data than specified on initialization . This means the number of 8800/12 memories physically attached to the LeCroy 8212 is greater than NOM as defined in IO.INI.
Returned from IO.RVB.

IE.DNR DEVICE NOT READY

This error code will be returned, if
- no Stop Trigger was received or
- the posttrigger samples were not yet finished or
- the memory was not ready to read out.

Returned from IO.RVB

IE.FHE FATAL HARDWARE ERROR

After IO.INI this error code means that the generated Function-Code was not correctly written to the module Function-Latch.
If this error code occured after IO.RVB, the MB driver cannot read valid data.
(Q-response is missing).

IE.BAD BAD PARAMETERS

Returned from IO.INI, if any bad parameters were encountered.

These include:

- specifying an invalid number of gate pulses.
- Frequncy was out of range or
  FREQU > 160kHz/NOC or
  FREQU > 0, if MODE=T selected.
- The online bitmap was equal to 0.(no channels online)
- The number of memory modules was equal to 0 or greater than 4.
- The number of the jumper configuration was equal to 0 or greater than 4.
- The number of pretrigger samples was greater than (32768 * NOM)/NOC - PTS , or not a positive integer.
- The number of posttrigger samples is not one of the allowed values (see Section 8.4.2) corresponding to the appropriate jumper configuration, or is larger than the memory available to each channel minus the pretrigger samples , or is not a positive integer.
- A bad MODE was entered

8.5.2 First Status Word (high byte)

Contains the group number of the error code returned by the driver (see Appendix A of "DIOS I/O Operations"). All errors returned by MBDRV belong to error group 0.

8.5.3 Second Status Word

After IO.TER or the standard I/O functions, the second status word contains zero.

After IO.INI the second status word contains the Function-Code generated by IO.INI for the LeCroy 8212 Function-Latch.

After IO.RVB, the second status word always contains the number of bytes actually transferred to the user buffer.

CHAPTER 9

PADRV - LeCroy Differential Amplifier (Model 8100)

9.1 Introduction

The LeCroy Dual Differential Amplifier 8100 is packaged in a single-width CAMAC module and contains 2 full independent amplifier channels. The gain of the amplifiers is programmable by computer over the CAMAC interface. All settings can also be made by hand to facilitate setup or to operate without a computer. Hardware characteristics and specifications may be obtained from the reference documentation.

The DIOS driver for the LeCroy 8100, PADRV, operates on the module as follows:

At initialization time the user determines for each of the 2 amplifier channels the gain division factor, the gain factor and the voltage offset factor. Furthermore the user may select, if the butterworth filter is switched on and if the input lines are grounded.
All these parameters will be checked for legality by the PADRV and transferred to the LeCroy 8100 module, if the module is in the 'Remote' state. On IO.RVB the PADRV reads the actual switch settings from the LeCroy 8100 module and transfers them to the user in the same format as the parameters specified on IO.INI. The maximum number of data available from LeCroy 8100 is limited to 40 Bytes.

9.2 Loading the Module

The module is loaded by either of the two macro calls

```
QIO$S   #IO.LOD,#$LDR,....,<mcb,lmcb,lun>
```

or

```
LOAD    lun,mcb,sts,flg
```

The use of the macros and meaning of the arguments are given in the DIOS Operations Manual.

9.2.1 MCB Format

In the macro calls above, mcb is the address of the Module Control Block, described in the DIOS Operations Manual. The device specific portions of the MCB should be set as follows:

Offset	Contents
M.TYP	"PA" -- 2-letter type code for LeCroy 8100
M.UNIT	Unit number of LeCroy 8100.
M.ACP	2-Letter code of ACP containing the 8100 driver.
M.CTL	Control bits, set as follows:
	MC.CAM=1 Indicates the 8100 is a CAMAC module.
	MC.INT=0 Indicates interrupt service is not required by the 8100.
M.ADR	CAMAC address in BCNA format (A=0) of the module.

9.3 Unloading the Module

The module is unloaded by either of the two macro calls:

```
QIO$S   #IO.UNL,#lun,...
```

or

UNLOAD lun,sts,flg

The use of these macros and the meaning of the arguments are given in the DIOS Operations Manual.

9.4 QIO Functions to the Loaded Module

This section summarizes the standard and device-specific QIO requests processable by the driver.

9.4.1 Standard Functions

	Format	Function
QIO$S	#IO.VAT,...	;Attach Module
QIO$S	#IO.VDT,...	;Detach Module
QIO$S	#IO.KIL,...	;Cancel I/O on Module
QIO$S	#IO.UNL,...	;Unload Module

9.4.2 Module-specific Functions

	Format	Function
QIO$S	#IO.INI,...,<ddp,lpm>	;Initialize LeCroy 8100
QIO$S	#IO.TER,...,<0,2>	;Terminate LeCroy 8100
QIO$S	#IO.RVB,...,<buf,lbuf>	;Read data from LeCroy 8100

where

ddp	is the address of a block of device-dependent parameters defining the mode in which the LeCroy 8100 is initialized.
lpm	is the length of the block in bytes.
buf	is the address of the buffer into which data are read or from which data are written.
lbuf	is the length of the data buffer in bytes.

9.4.2.1 IO.INI - Initialize the LeCroy 8100

IO.INI passes a buffer specified in the parameter list of the QIO containing device-dependent parameters specifying the mode of initialization. Depending upon the contents of the buffer, the following actions are performed:

1. The gain division factor (1 or 2) is established and checked for legality. Gain should be divided by 2 when outputs driving 50 Ohm. In this case the voltage offset also must be divided by 2. The parameter 'FACT' is only of interest for the user, not for the PADRV.

2. The gain factor will be checked for legality.
   Legal values: 0, 0.2, 0.5 , 1, 2
   5, 10, 100, 200, 500
   Gain factor 0 must be set, if the input lines should be grounded.

3. The parameter 'FILT' must be set to 1, if the Butterworth filter should be switched on.
   FILT = 0 Filter is switched off
   FILT = 1 Filter is switched on

4. The parameter 'GRND' must be set to 1, if the input lines should be grounded (GAIN=0).
   GRND = 0 Input lines not grounded
   GRND = 1 Input lines grounded

5. The parameter 'OFFS' determines the analogue voltage offset of the amplifiers.
   Allowed range: 0 ... 4095
   The offset voltage corresponds to the 'OFFS' values as follows:

Voltage	OFFS
+5.5 V	0
0.0 V	2047
-5.5 V	4095

All parameters can be set separatly for each of the 2 channels and must be specified in floating point representation.

The buffer consists of 40 bytes which are formatted as follows:

Offset	Name	Type	Meaning
0	FACT1	[E]	Gain division factor. The user must divide the gain and the offset value by this factor to

get the correct amplifier settings.
FACT1 = 1 if driving high impedance
FACT1 = 2 if driving 50 Ohm

4 GAIN1 [E] Gain value of the first amplifier channel (upper).
Allowed values: 0, 0.2, 0.5, 1, 2
5, 10, 20, 50, 100
GAIN1 = 0 must be set, if the input lines should be grounded.

10 FILT1 [E] This parameter specifies, if the butterworth filter is to switch on or off.
FILT1 = 0 Filter off
FILT1 = 1 Filter on

14 GRND1 [E] This parameter specifies, if the input lines should be grounded.
GRND1 = 0 Input lines not grounded
GRND1 = 1 Input lines grounded

20 OFFS1 [E] The analogue offset voltage of the LeCroy 8100 amplifier. The connection between the offset voltage, the offset value (OFFS1) and the division factor (FACT1) shows following table:

Voltage	OFFS1	FACT1	mV/bit
+5.5 V	0	1	2.7
0.0 V	2047	1	2.7
-5.5 V	4095	1	2.7
+2.75V	0	2	1.35
0.0 V	2047	2	1.35
-2.75V	4095	2	1.35

24 FACT2 [E] Gain division factor.
The user must divide the gain and the offset value by this factor to get the correct amplifier settings.
FACT2 = 1 if driving high impedance
FACT2 = 2 if driving 50 Ohm

30 GAIN2 [E] Gain value of the second amplifier channel (lower).
Allowed values: 0, 0.2, 0.5, 1, 2
5, 10, 20, 50, 100
GAIN2 = 0 must be set, if the input lines should be grounded.

34 FILT1 [E] This parameter specifies, if the butterworth filter is to switch on or off.

FILT2 = 0 Filter off
FILT2 = 1 Filter on

40 GRND2 [E] This parameter specifies, if the input lines should be grounded.
GRND2 = 0 Input lines not grounded
GRND2 = 1 Input lines grounded

44 OFFS2 [E] The analogue offset voltage of the LeCroy 8100 amplifier. The connection between the offset voltage, the offset value (OFFS2) and the division factor (FACT2) shows following table:

Voltage	OFFS2	FACT2	mV/bit
+5.5 V	0	1	2.7
0.0 V	2047	1	2.7
-5.5 V	4095	1	2.7
+2.75V	0	2	1.35
0.0 V	2047	2	1.35
-2.75V	4095	2	1.35

The driver sets the status as defined by the device dependent parameters, where all parameters are checked for legality. The PADRV examines, if the LeCroy 8100 module is in the 'Remote' state. In this case the module will be setup appropriate to the parameters specified on IO.INI. If the module was switched into 'Local' mode, the IO.INI parameters will be only checked for legality and not transferred to the 8100 module. Errors are reported via setting the status block accordingly.

9.4.2.2 IO.TER - Terminate Operations on the LeCroy 8100

IO.TER performs no operation on the LeCroy 8100 module, it only cleans up the flag-bits on the VCB. This prevents the module from being read until it is reinitialized with IO.INI.

9.4.2.3 IO.RVB - Read Data from the LeCroy 8100

On IO.RVB the PADRV reads the actual switch settings from the LeCroy 8100 differential amplifiers. Data are returned in a block of up to 40 bytes, which are formatted in the same manner as the IO.INI parameter block:

Offset	Name	Type
0	FACT1	[E]
4	GAIN1	[E]
10	FILT1	[E]
14	GRND1	[E]
20	OFFS1	[E]
24	FACT2	[E]
30	GAIN2	[E]
34	FILT2	[E]
40	GRND2	[E]
44	OFFS2	[E]

All data are delivered by the PADRV in floating point representation. The meaning of the data items is described more detailed in chapter 9.4.2.1. If the LeCroy 8100 module was set into 'Local' mode, the data returned on IO.RVB must not correspond to the parameters specified on IO.INI. Any number of real values up to the maximum available (10*4 bytes) can be read with a single QIO. It is recommended to read all desired data with one QIO. For example, if the user only want to know the switch settings of channel 1, he must only request 5 real values. If the user have not requested a complete floating point number, the error code IE.DAO will be returned. End of volume will be indicated if more data were requested than available on the LeCroy 8100 module (40 bytes).

9.5 Status Returns and Error Handling

When a QIO function is completed, status information about the functions is returned in the I/O status block if specified in the QIO macro call.

9.5.1 First Status Word (low byte)

The error codes listed below may be returned by the LeCroy 8100 Driver.

Code	Meaning
IS.SUC	A QIO for IO.INI, IO.TER or IO.RVB was successfully completed.
IE.IFC	A function code other than IO.INI, IO.TER IO.RVB or the standard functions was encountered.
IE.BAD	Returned from IO.INI, if any bad parameters were encountered.
IE.OFL	Returned from IO.INI or IO.RVB if the module is not at the given CAMAC station or the crate is offline.
IE.FHE	Returned from IO.RVB if the gain factor read from the LeCroy 8100 module does not correspond to any factor, prescribed by the 8100 specifications.
IE.IDS	Returned from IO.RVB if an error occured during the last QIO or if it was not (or not correct) initialized.
IE.DAO	Returned from IO.RVB if a number of data was requested by the user, which is not a multiple of 4 bytes (only floating point values may be read).
IE.EOV	Returned from IO.RVB if the number of data requested exceeds the maximum number of data available by the PA module (40 bytes).

9.5.2 First Status Word (high byte)

DIOS drivers use this byte to group error conditions. Bit n on selects error code group n+1. All error codes used by the PADRV belong to error code group zero.

9.5.3 Second Status Word

This word shows in all cases the number of bytes actually transferred to or from the user buffer.

CHAPTER 10

QLDRV -- LeCroy Charge Digitizer (Model 2250Q)

10.1 Introduction

The LeCroy Model 2250Q 12-Channel Analog-to-Digital Converter offers twelve complete integrating ADC's in a single-width CAMAC module. Each ADC channel digitizes to 9 bits the amount of charge received at the analog inputs over the duration of an externally applied common gate pulse. The LeCroy 2250Q has a digitizing time of 9 microseconds for full scale and allows a maximum repetition cycle of 10 microseconds for the gate pulses. Another important feature of the 2250Q is a 32-deep first-in-fist-out (FIFO) memory for each of the 12 ADC channels, permitting many events to be accumulated before readout. Hardware characteristics and specifications may be obtained from the reference documentation.

The LeCroy 2250Q uses an inverse quadratic response mode to achieve a wide dynamic range. The amount of charge, q, at the analog input during the gate is related to the number of counts, n, by the relation:

$$q = An^{**2} + Bn + C$$

The values of the constants, A,B, and C, particular to each ADC channel are supplied with each unit in the form of a computer printout and must be included in the MCB as device dependent parameters. A full scale output of the 2250Q corresponds to an input charge of approximatly 248 picocoulombs.

The DIOS driver for the LeCroy 2250Q, QLDRV, operates on the module as follows: at initialization time the user determines the configuration of the physically connected channels and how many gate pulses are to be expected. Because the driver das not support interupt mode, the maximum number of gate pulses is limited to 32 (maximum depth of FIFO memory). Further gate pulses are ignored. At initialization time two additional features are available:

a hareware test facility and a test for data overrun performed after each readout. To enable these features the appropriate flags must be set. The QLDRV reads data in sequence starting with channel zero up to channel 11. Data are returned in MUX-format, in which the low 9 bits represent the converted value, bit 9 on indicates that the channel is offline, and the high 4 bits give the LeCroy 2250Q channel number from which the datum is taken. Any number of data up to the maximum available (12*32 16-bit words) may be read with a single QIO.

10.2 Loading the Module

The module is loaded by either of the two macro calls

```
QIO$S   #IO.LOD,#$LDR,...,<mcb,lmcb,lun>
```

or

```
LOAD    lun,mcb,sts,flg
```

The use of these macros and meaning of the arguments are given in the manual "DIOS I/O Operations".

10.2.1 MCB Format

In the macro calls above, mcb denotes the address of the module control block for the LeCroy 2250Q. The device specific portions of the MCB should be set as follows:

Offset	Contents
M.TYP	"QL" -- 2-character code identifying the LeCroy 2250Q device type.
M.UNIT	Unit number identifying each LeCroy 2250Q module.
M.ACP	2-character identifier of the ACP containing the QL driver.
M.CTL	Control bits
MC.SUB = 0	QL is not a submodule
MC.INT = 0	Indicates interrupt service is not required by the LeCroy 2250Q.
MC.CAM = 1	Indicates the LeCroy 2250Q is a CAMAC module.
M.ADR	CAMAC address in BCNA format (A=0) of the module.
M.DLN	2 => Length of one data item = 2 bytes.
M.DFM	4 => Data in MX format
M.DFM	2 => Data returned as integers

10.3 Unloading the Module

The module is unloaded by either of the two macro calls

```
QIO$S   #IO.ULM,lun
```

or

UNLOAD lun

The use of these macros and the meaning of the arguments are given in the manual "DIOS I/O Operations".

10.4 QIO Functions to the Loaded Module

This section summarizes the standard and device-specific QIO requests processable by the QL driver.

10.4.1 Standard Functions

Format		Function
QIO$S	#IO.VAT,...	;Attach Module
QIO$S	#IO.VDT,...	;Detach Module
QIO$S	#IO.KIL,...	;Cancel I/O on Module
QIO$S	#IO.ULM,...	;Unload the Module

10.4.2 Module-specific Functions

Format		Function
QIO$S	#IO.INI,...,<ddp,lpm>	;Initialize QL
QIO$S	#IO.TER,...,<#0,#4>	;Terminate QL
QIO$S	#IO.RVB,...,<buf,lbuf>	;Read data from QL

ddp is the address of a block of device-dependent parameters defining the mode in which the LeCroy 2250Q is initialized.
lpm is the length of the block in bytes.
buf is the address of a buffer to receive data read from the module.
lbuf is the length of the data buffer in bytes.

10.4.2.1 IO.INI -- Initialize the LeCroy 2250Q -

IO.INI passes a buffer specified in the parameter list of the QIO containing device-dependent parameters specifying the mode of initialization. Depending upon the contents of the buffer, the following actions are performed:

1. Each of the 12 analog input channels can be declared as logically online or offline corresponding to the physical situation.

2. The expected number of gate pulses, which must be known prior to readout, is established.

3. The built-in hardware test function (F25A0) will be performed when the appropriate flag (TSTFLG) is set. In this case the gate count must be equal to one, because only one gate pulse will be generated by F25A0. A subsequent readout from 2250Q delivers the residual pedestal values of the module.

4. An additional flag (DAOFLG) enables the driver to check the module for data overrun, which occurs whenever more gate pulses were received by the module than specified with IO.INI.

The buffer consists of 6 bytes which are formatted as follows:

Offset	Name	Type	Meaning
0	BITMAP	[0]	LeCroy 2250Q online bitmap. This bit pattern describes which channels are physical connected to the module. Bit n set means that channel number n is declared online.
2	GATE	[D]	The expected number of gate pulses. The valid range is: 1<= GATE <=32.
4	TSTFLG	[B]	Test flag (bit 0): If set, enables the built-in hardware test function to be executed on initialization. (GATE) must be set to 1.
	DAOFLG	[B]	Test flag (bit 1): If set, enables the driver to check for data overrun after each IO.RVB.
5	RESEV		Reserve for future use.

The driver clears the LeCroy 2250Q FIFO's and scalers

and performs the hardware test if specified. Furthermore it sets the status as defined by the device dependent parameters, where all parameters are checked for legality. Errors are reported by setting the status block accordingly.

10.4.2.2 IO.TER -- Terminate QL Operations -

IO.TER always resets the LeCroy 2250Q FIFO's and scalers and clears the current gate count and bitmap. It prevents the module from being read until it is reinitialized with IO.INI.

10.4.2.3 IO.RVB -- Read Data from the LeCroy 2250Q -

LeCroy 2250Q channels are read in sequence, starting with channel number zero after initialization, or with the channel number following the last channel read. Data are read and returned to the user buffer until the given buffer length is exhausted or until the physical end of the module FIFO is detected. Each datum consists of 9 bits of data and a 4-bit channel number within on a 16-bit word. Bit 9 is set, if this channel was declared offline. If more data are requested than the initial gate pulse number multiplied by 12 or if the initial gate pulse number is greater than the actually received gate pulses, IO.RVB returns the appropriate error code in the user status block.

10.5 Status Returns and Error Handling

Status information from a completed QIO operation is returned in the I/O status block if one was specified in the QIO. The first word contains an error or success code; the second contains zero or the number of bytes read with an IO.RVB operation.

10.5.1 First Status Word (low byte)

Code	Meaning
IS.SUC	OPERATION SUCCESSFUL No error occurred in processing the given QIO function. Returned from IO.INI, IO.RVB or IO.TER.
IE.IFC	INVALID FUNCTION CODE Returned from all QIO functions other than the standard functions or IO.INI, IO.TER, or IO.RVB.
IE.IDS	OPERATION INCONSISTENT WITH DEVICE STATE Returned from IO.RVB if the QL has not been initialized since being loaded or terminated with IO.TER.
IE.OFL	DEVICE OFFLINE Returned from all functions if the crate is offline, or the module is not at the specified address.
IE.EOV	END OF VOLUME DETECTED All data (number of gate pulses multiplied by 12) have been read since the last IO.INI. Returned from IO.RVB
IE.EOT	END OF TAPE DETECTED All valid (available) data have been read. That means the number of requested data was greater than the data really stored on the module FIFO. Returned from IO.RVB.
IE.DAO	DATA OVERRUN The LeCroy 2250Q FIFO memory received more data than was specified on initialization. This test for data overrun will only performed when the flag DAOFLG is set. Returned from IO.RVB.

IE.BAD BAD PARAMETERS

Returned from IO.INI, if any bad parameters were encountered.

These include:

- specifying an invalid number of gate pulses. The number of gate pulses must lie between 1 and 32.
- specifying channels other than 0 to 11 as being online.
- specifying no channels as being online.
- specifying a number of gate pulses other than 1, if the hardware test function is enabled.

10.5.2 First Status Word (high byte)

Contains the group number of the error code returned by the driver (see Appendix A of "DIOS I/O Operations"). All errors returned by QLDRV belong to error group 0.

10.5.3 Second Status Word

After IO.INI, IO.TER, or the standard I/O functions, the second status word contains zero.

After IO.RVB, the second status word always contains the number of bytes actually transferred to the user buffer.

CHAPTER 11

SMDRV - LeCroy Dual Port Memory (Model 8801)

11.1 Introduction

The LeCroy Model 8801 dual port memory module is a single width CAMAC module with a capacity of 16384 16-bit words.
The external port (via rear-panel connector) allows storage and readout of sequential data which can be randomly accessed from the CAMAC Dataway. The 8801 can also be used as a general-purpose random access storage unit via the CAMAC Dataway. Autoincrement of memory addresses allows for high speed direct memory access (DMA) operations. Use of tri-state logic permits memory expansion by cascading memory modules.
Addressing for access via the dataway is done by setting an address register and then transferring the data or in auto-increment mode. Loading memory from the external bus is always done with automatic address increment.
If the LeCroy 8801 memory is connected to several LeCroy 8590 Latching Scalers a special operation mode, called 'scaler-mode', is available to allow the user channel-selected reading of LeCroy 8590 scaler data.

The DIOS driver for the LeCroy 8801, SMDRV, operates on the module as follows:
at initialization time the user determines the startaddress of memory from which to read or write, and whether access is via the dataway or from the external bus. A further access-mode is available if the LeCroy 8801 memory is connected to LeCroy 8590 modules. In this case two additional parameters must be specified: the number of LeCroy 8590 scaler channels connected to the 8801 memory and the number of data delivered by each scaler channel.
A read or write function always switches the access lines to the dataway, starting I/O at the address specified at initialization time. Any number of data (16-bit words) available may be read or written with a single QIO.

Note: The SMDRV is an extended version of the LMDRV .

11.2 Loading the Module

The module is loaded by either of the two macro calls

```
QIO$S   #IO.LOD,#$LDR,....,<mcb,lmcb,lun>
```

or

```
LOAD    lun,mcb,sts,flg
```

The use of the macros and meaning of the arguments are given in the DIOS Operations Manual.

11.2.1 MCB Format

In the macro calls above, mcb is the address of the Module Control Block, described in the DIOS Operations Manual. The device specific portions of the MCB should be set as follows:

Offset	Contents
M.TYP	"SM" -- 2-letter type code for LeCroy 8801
M.UNIT	Unit number of LeCroy 8801.
M.ACP	2-Letter code of ACP containing the 8801 driver.
M.CTL	Control bits, set as follows:
	MC.CAM=1 Indicates the 8801 is a CAMAC module.
	MC.INT=0 Indicates interrupt service is not required by the 8801.
M.ADR	CAMAC address in BCNA format (A=0) of the module.

11.3 Unloading the Module

The module is unloaded by either of the two macro calls:

```
QIO$S   #IO.UNL,#lun,...
```

or

UNLOAD lun,sts,flg

The use of these macros and the meaning of the arguments are given in the DIOS Operations Manual.

11.4 QIO Functions to the Loaded Module

This section summarizes the standard and device-specific QIO requests processable by the driver.

11.4.1 Standard Functions

	Format	Function
QIO$S	#IO.VAT,...	;Attach Module
QIO$S	#IO.VDT,...	;Detach Module
QIO$S	#IO.KIL,...	;Cancel I/O on Module
QIO$S	#IO.UNL,...	;Unload Module

11.4.2 Module-specific Functions

	Format	Function
QIO$S	#IO.INI,...,<ddp,lpm>	;Initialize LeCroy 8801
QIO$S	#IO.TER,...,<0,2>	;Terminate LeCroy 8801
QIO$S	#IO.RVB,...,<buf,lbuf>	;Read data from LeCroy 8801
QIO$S	#IO.WVB,...,<buf,lbuf>	;Write data to LeCroy 8801

where

ddp	is the address of a block of device-dependent parameters defining the mode in which the LeCroy 8801 is initialized.
lpm	is the length of the block in bytes.
buf	is the address of the buffer into which data are read or from which data are written.
lbuf	is the length of the data buffer in bytes.

11.4.2.1 IO.INI - Initialize the LeCroy 8801

IO.INI passes a buffer specified in the parameter list of the QIO containing device-dependent parameters specifying the mode of initialization. Depending upon the contents of the buffer, the following actions are performed:

1. The start address, from which data will be read or into which data will be written, is established.
2. The data bus, either the 8801 external bus or the CAMAC Dataway, is enabled.

The buffer consists of 10 bytes which are formatted as follows:

Offset	Name	Type	Meaning
0	UNUSED		These two bytes are unused by the SM driver version implemented at this time. Reserved for later versions.
2	RELADR	[D]	Memory start address from which will be read or into which will be written with autoincrement. Allowed range: 0 ... 16383 .
4	ACCESS	[A]	Mode of access: E external port will be enabled I I/O is done via the dataway. S Scaler-Mode. Data are returned separately for each scaler channel number.
6	SCACHA	[D]	Number of LeCroy 8590 scaler channels connected to the LeCroy 8801 memory. (only for ACCESS=S).
10	NDATA	[D]	Number of data delivered from each LeCroy 8590 scaler channel. (only for ACCESS=S).

The driver sets the status as defined by the device dependent parameters, where all parameters are checked for legality. Errors are reported via setting the status block accordingly.

11.4.2.2 IO.TER - Terminate Operations on the LeCroy 8801

IO.TER always sets the LeCroy 8801 to be accessed via the dataway. The start address is reset to zero.

11.4.2.3 IO.RVB - Read Data from the LeCroy 8801

The LeCroy 8801 I/O lines are switched to the dataway. Reading is done in auto-increment mode and starts at the location set by an IO.INI function or one word behind the address of the last read/write cycle. External input does not alter the location counter for a read function. Data are read and returned to the user buffer until the given buffer length is exhausted or until the physical end of the LeCroy 8801 memory is detected.

If the access-mode "S" was selected, data are be read in the following manner:
The SMDRV reads data from the 8590 scaler channels in ascending order, starting with channel number 1 up to the highest channel number specified at initialization parameter "SCACHA". The number of data available from one channel is determined by the parameter "NDATA". After reading of one channel the driver searches the data of the next channel and returns it to the user. This process will be repeated until the last channel was read.

11.4.2.4 IO.WVB - Write Data to the LeCroy 8801 The same actions are taken as with IO.RVB, except that data are written from the user buffer to the LeCroy 8801. If more data are to be written than the capacity of the LeCroy 8801 allows, an error status is returned and all following attempts to write data are ignored until the next IO.INI.

11.5 Status Returns and Error Handling

When a QIO function is completed, status information about the functions is returned in the I/O status block if specified in the QIO macro call.

11.5.1 First Status Word (low byte)

The error codes listed below may be returned by the LeCroy 8801 Driver.

Code	Meaning
IS.SUC	A QIO for IO.INI, IO.TER, IO.RVB or IO.WVB was successfully completed.
IE.IFC	A function code other than IO.INI, IO.TER IO.RVB or IO.WVB or the standard functions was encountered.
IE.BAD	Returned from IO.INI, if any bad parameters were encountered.
IE.OFL	Returned from IC.INI, IO.RVB, IO.WVB or IO.TER if the module is not at the given CAMAC station or the crate is offline.
IE.IDS	Returned from IO.RVB or IO.WVB if an error occured during the last QIO or if it was not (or not correct) initialized.
IE.FHE	Returned from IO.RVB or IO.WVB if the 'MEMORY FULL' signal does not appear at the correct time calculated by the SM driver.
IE.EOV	Returned from IO.RVB or IO.WVB if the storage capacity becomes exhausted during a read or write operation.
IE.EOT	Returned from IO.RVB in "scaler-mode" if the number of requested data was greater than the data really available from the LeCroy 8590 scalers.

11.5.2 First Status Word (high byte)

DIOS drivers use this byte to group error conditions. Bit n on selects error code group n+1. All error codes used by the SMDRV belong to error code group zero.

11.5.3 Second Status Word

This word shows in all cases the number of bytes actually transferred to or from the user buffer.

11.6 Programming Hints

In DIOS the LeCroy 8801 is provided to be filled from the external bus (e.g. with experimental data) and then to be read out via the data way. For this purpose the user initializes the LeCroy 8801 for external access as outlined obove (IO.INI). After information is stored in the LeCroy 8801 the user merely has to perform succeeding QIOs with function code IO.RVB to obtain the data stored in the 8801, where the amount of data to be read each time is given by the user's buffer length. Data are returned in the same order as they are transferred to the 8801, so the user is not concerned with any addressing. However, if the user wants to specify his own start address he might do so with another initialization, which does not alter the contents of the 8801.

CHAPTER 12

SNDRV - LeCroy Dual Port Memory (Model 8801)

12.1 Introduction

The LeCroy Model 8801 dual port memory module is a single width CAMAC module with a capacity of 16384 16-bit words.
The external port (via rear-panel connector) allows storage and readout of sequential data which can be randomly accessed from the CAMAC Dataway. The 8801 can also be used as a general-purpose random access storage unit via the CAMAC Dataway. Autoincrement of memory addresses allows for high speed direct memory access (DMA) operations. Use of tri-state logic permits memory expansion by cascading memory modules.
Addressing for access via the dataway is done by setting an address register and then transferring the data or in auto-increment mode. Loading memory from the external bus is always done with automatic address increment.
If the LeCroy 8801 memory is connected to several LeCroy 8590 Latching Scalers a special operation mode, called 'scaler-mode', is available to allow the user channel-selected reading of LeCroy 8590 scaler data.

The DIOS driver for the LeCroy 8801, SNDRV, operates on the module as follows:
at initialization time the user determines the startaddress of memory from which to read or write, and whether access is via the dataway or from the external bus. A further access-mode is available if the LeCroy 8801 memory is connected to LeCroy 8590 modules. In this case two additional parameters must be specified: the number of LeCroy 8590 scaler channels connected to the 8801 memory and the number of data delivered by each scaler channel. Furthermore the user can determine a number of parameters, which will be transferred to LeCroy 8801 memory on an address, specified at IO.INI. The data will then be written into memory in ascending order. A read or write function always switches the access lines to the dataway, starting I/O at the address specified at initialization time. Any

number of data (16-bit words) available may be read or written with a single QIO.

Note: The SNDRV is an extended version of the SMDRV .

12.2 Loading the Module

The module is loaded by either of the two macro calls

```
QIO$S   #IO.LOD,#$LDR,....,<mcb,lmcb,lun>
```

or

```
LOAD    lun,mcb,sts,flg
```

The use of the macros and meaning of the arguments are given in the DIOS Operations Manual.

12.2.1 MCB Format

In the macro calls above, mcb is the address of the Module Control Block, described in the DIOS Operations Manual. The device specific portions of the MCB should be set as follows:

Offset	Contents
M.TYP	"SN" -- 2-letter type code for LeCroy 8801
M.UNIT	Unit number of LeCroy 8801.
M.ACP	2-Letter code of ACP containing the 8801 driver.
M.CTL	Control bits, set as follows: MC.CAM=1 Indicates the 8801 is a CAMAC module. MC.INT=0 Indicates interrupt service is not required by the 8801.
M.ADR	CAMAC address in BCNA format (A=0) of the module.

12.3 Unloading the Module

The module is unloaded by either of the two macro calls:

```
QIO$S   #IO.UNL,#lun,...
```

or

```
UNLOAD  lun,sts,flg
```

The use of these macros and the meaning of the arguments are given in the DIOS Operations Manual.

12.4 QIO Functions to the Loaded Module

This section summarizes the standard and device-specific QIO requests processable by the driver.

12.4.1 Standard Functions

	Format	Function
QIO$S	#IO.VAT,...	;Attach Module
QIO$S	#IO.VDT,...	;Detach Module
QIO$S	#IO.KIL,...	;Cancel I/O on Module
QIO$S	#IO.UNL,...	;Unload Module

12.4.2 Module-specific Functions

	Format	Function
QIO$S	#IO.INI,...,<ddp,lpm>	;Initialize LeCroy 8801
QIO$S	#IO.TER,...,<0,2>	;Terminate LeCroy 8801
QIO$S	#IO.RVB,...,<buf,lbuf>	;Read data from LeCroy 8801
QIO$S	#IO.WVB,...,<buf,lbuf>	;Write data to LeCroy 8801

where

ddp	is the address of a block of device-dependent parameters defining the mode in which the LeCroy 8801 is initialized.
lpm	is the length of the block in bytes.
buf	is the address of the buffer into which data are read or from which data are written.
lbuf	is the length of the data buffer in bytes.

12.4.2.1 IO.INI - Initialize the LeCroy 8801

IO.INI passes a buffer specified in the parameter list of the QIO containing device-dependent parameters specifying the mode of initialization. Depending upon the contents of the buffer, the following actions are performed:

1. The start address, from which data will be read or into which data will be written, is established.
2. The data bus, either the 8801 external bus or the CAMAC Dataway, is enabled.
3. If parameters should be transferred to the memory on IO.INI (if LBLK <> 0), the specified number of parameters are written in LeCroy 8801 memory at the startaddress determined by parameter STBLK.

The buffer consists of minimal 42 bytes which are formatted as follows:

Offset	Name	Type	Meaning
10	NDATA	[E]	Number of data delivered from each LeCroy 8590 scaler channel. (only for ACCESS=S).
14	SCACHA	[D]	Number of LeCroy 8590 scaler channels connected to the LeCroy 8801 memory. (only for ACCESS=S).
22	ACCESS	[A]	Mode of access: E external port will be enabled I I/O is done via the dataway. S Scaler-Mode. Data are returned separately for each scaler channel number.
44	RELADR	[D]	Memory start address from which will be read or into which will be written with autoincrement. Allowed range: 0 ... 16383 .
50	LBLK	[D]	Number of parameters ,which should be written into 8801 memory on startaddress STBLK. If LBLK=0 no data will be transferred to memory. All parameters are transferred at IO.INI time.
54	STBLK	[D]	Startaddress of LeCroy 8801 memory, into which the specified parameters (LBLK) are written with autoincrement. Allowed range: 0 ... 16383-LBLK .
60	PAR1	[D]	First parameter, which will be

written into memory at address STBLK on IO.INI.

62 PAR2 [D] Second parameter, which will be written into memory at address STBLK+1 on IO.INI.

...

PAR(LBLK) Last parameter, which will be written into memory at address STBLK+(LBLK-1).

The driver sets the status as defined by the device dependent parameters, where all parameters are checked for legality. Errors are reported via setting the status block accordingly.

12.4.2.2 IO.TER - Terminate Operations on the LeCroy 8801
IO.TER always sets the LeCroy 8801 to be accessed via the dataway. The start address is reset to zero.

12.4.2.3 IO.RVB -- Read Data from the LeCroy 8801

The LeCroy 8801 I/O lines are switched to the dataway. Reading is done in auto-increment mode and starts at the location set by an IO.INI function or one word behind the address of the last read/write cycle. External input does not alter the location counter for a read function. Data are read and returned to the user buffer until the given buffer length is exhausted or until the physical end of the LeCroy 8801 memory is detected.

If the access-mode "S" was selected, data are be read in the following manner:
The SNDRV reads data from the 8590 scaler channels in ascending order, starting with channel number 1 up to the highest channel number specified at initialization parameter "SCACHA". The number of data available from one channel is determined by the parameter "NDATA". After reading of one channel the driver searchcs the data of the next channel and returns it to the user. This process will be repeated until the last channel was read.

12.4.2.4 IO.WVB - Write Data to the LeCroy 8801 The same actions are taken as with IO.RVB, except that data are written from the user buffer to the LeCroy 8801. If more data are to be written than the capacity of the LeCroy 8801 allows, an error status is returned and all following attempts to write data are ignored until the next IO.INI.

12.5 Status Returns and Error Handling

When a QIO function is completed, status information about the functions is returned in the I/O status block if specified in the QIO macro call.

12.5.1 First Status Word (low byte)

The error codes listed below may be returned by the LeCroy 8801 Driver.

Code	Meaning
IS.SUC	A QIO for IO.INI, IO.TER, IO.RVB or IO.WVB was successfully completed.
IE.IFC	A function code other than IO.INI, IO.TER IO.RVB or IO.WVB or the standard functions was encountered.
IE.BAD	Returned from IO.INI, if any bad parameters were encountered.
IE.OFL	Returned from IO.INI, IO.RVB, IO.WVB or IO.TER if the module is not at the given CAMAC station or the crate is offline.
IE.IDS	Returned from IO.RVB or IO.WVB if an error occured during the last QIO or if it was not (or not correct) initialized.
IE.FHE	Returned from IO.RVB or IO.WVB if the 'MEMORY FULL' signal does not appear at the correct time calculated by the SN driver.
IE.EOV	Returned from IO.RVB or IO.WVB if the storage capacity becomes exhausted during a read or write operation.
IE.EOT	Returned from IO.RVB in "scaler-mode" if the number of requested data was greater than the data really available from the LeCroy 8590 scalers.

12.5.2 First Status Word (high byte)

DIOS drivers use this byte to group error conditions. Bit n on selects error code group n+1. All error codes used by the SNDRV belong to error code group zero.

12.5.3 Second Status Word

This word shows in all cases the number of bytes actually transferred to or from the user buffer.

12.6 Programming Hints

In DIOS the LeCroy 8801 is provided to be filled from the external bus (e.g. with experimental data) and then to be read out via the data way. For this purpose the user initializes the LeCroy 8801 for external access as outlined obove (IO.INI). After information is stored in the LeCroy 8801 the user merely has to perform succeeding QIOs with function code IO.RVB to obtain the data stored in the 8801, where the amount of data to be read each time is given by the user's buffer length. Data are returned in the same order as they are transferred to the 8801, so the user is not concerned with any addressing. However, if the user wants to specify his own start address he might do so with another initialization, which does not alter the contents of the 8801.

CHAPTER 13

TLDRV - LeCroy Transient Digitizer (Model 2264)

13.1 Introduction

Packaged in a triple width CAMAC module, the LeCroy Model 2264 is a 8-input, 8-bit ADC intended for use with the LeCroy Model 8800 Series 32K Memory Modules in high frequency transient monitoring applications. This combination of units provides 1,2,4, or 8 channels of 8-bit fast data logging with memory capacity determined by the number of 8800/8's utilized. With the 2264 used in the 4-channel mode, for instance, one memory module provides 8k words of storage for each input. Similarly, one 8800/8 provides 4096 words of memory for each channel of an 2264 used in the full 8-input mode.

The LeCroy 2264 is capable of sampling each input from a maximum rate of 4 MHz in the single-input mode to a maximum rate of 500 kHz in the full 8-input mode. Sampling rate is determined either by an internal clock or by an external clock.

The analog signals at the inputs of the 2264 are converted sequentially, each input requiring 200 nsec dwell time. A complete scan of all 8 inputs takes approximatly 2 microseconds.

The analog input range is selectable by the front panel switches:

OFFSET	Model 2264	Model 2264 H
Negative	-0.511 - 0 V	-10.23 - 0 V
Positive	0 - +0.511 V	0 - +10.23 V
Bipolar	-0.255 - +0.256 V	-5.11 - +5.12 V

Data is output in a complementary binary code, i.e., the most positive voltage in the input voltage range is

represented by all "zeros", and the most negative voltage in the input voltage range by all "ones".

The DIOS driver for the LeCroy 2264, TLDRV, operates on the module as follows:

At initialization time, the user determines the following items:

- The frequency of the internal clock (zero corresponds to external clocking),
- the number of pretrigger samples,
- the number of posttrigger samples,
- the number of 8800/8 memory modules attached to 2264,
- a flag, which determines the increment of the posttrigger switch on the 2264 front panel,
- the physical configuration of the logically connected (on-line) channels and
- the analog input range settings for each channel.

The TLDRV driver will read all available data (e.g. number of pretrigger and posttrigger samples). Data is returned separately for each channel number. The channels are read in ascending order, whereby those channels not marked as online are skipped. The maximum number of data available is given by the Number of Channels (NOC) multiplied by the sum of Pretrigger and Posttrigger samples. Any number of data up to the maximum available (32768) may be read with a single QIO.

The first IO.RVB after initialization can only be performed if the stop trigger was received and the posttrigger samples are finished.

In order to make sure the memory cycles through at least once, the following minimum time interval must elapse following initialization before the stop trigger is given:

$$T = 32768 * NOM/(NOC * CLK)$$

where

CLK = sample clock frequency
NOM = number of memory modules
NOC = number of channels

At least one sample clock pulse be occur before the Stop Trigger is received.

Further definitions used in this chapter are:

PTS = number of posttrigger samples
PRE = number of pretrigger samples

13.2 Loading the Module

The module is loaded by either of the two macro calls

```
QIO$S   #IO.LOD,#$LDR,...,<mcb,lmcb,lun>
```

or

```
LOAD    lun,mcb,sts,flg
```

The use of these macros and meaning of the arguments are given in the manual "DIOS I/O Operations".

13.2.1 MCB Format

In the macro calls above, mcb denotes the address of the module control block for the LeCroy 2264. The device specific portions of the MCB should be set as follows:

Offset	Contents
M.TYP	"TL" -- 2-character code identifying the LeCroy 2264 device type.
M.UNIT	Unit number identifying each LeCroy 2264 module.
M.ACP	2-character identifier of the ACP containing the TL driver.
M.CTL	Control bits
MC.SUB = 0	TL is not a submodule
MC.INT = 0	Indicates interrupt service is not required by the LeCroy 2264.
MC.CAM = 1	Indicates the LeCroy 2264 is a CAMAC module.
M.ADR	CAMAC address in BCNA format (A=0) of the module.
M.DLN	1 => Length of one data item = 1 byte.
M.DFM	2 => Data returned as integers

13.3 Unloading the Module

The module is unloaded by either of the two macro calls

```
QIO$S   #IO.ULM,lun
```

or

```
UNLOAD  lun
```

The use of these macros and the meaning of the arguments are given in the manual "DIOS I/O Operations".

13.4 QIO Functions to the Loaded Module

This section summarizes the standard and device-specific QIO requests processable by the TL driver.

13.4.1 Standard Functions

Format		Function
QIO$S	#IO.VAT,...	;Attach Module
QIO$S	#IO.VDT,...	;Detach Module
QIO$S	#IO.KIL,...	;Cancel I/O on Module
QIO$S	#IO.ULM,...	;Unload the Module

13.4.2 Module-specific Functions

Format		Function
QIO$S	#IO.INI,...,<ddp,lpm>	;Initialize TL
QIO$S	#IO.TER,...,<#0,#4>	;Terminate TL
QIO$S	#IO.RVB,...,<buf,lbuf>	;Read data from TL

ddp is the address of a block of device-dependent parameters defining the mode in which the LeCroy 2264 is initialized.
lpm is the length of the block in bytes.
buf is the address of a buffer to receive data read from the module.
lbuf is the length of the data buffer in bytes.

13.4.2.1 IO.INI -- Initialize the LeCroy 2264 -

IO.INI passes a buffer specified in the parameter list of the QIO containing device-dependent parameters specifying the mode of initialization. Depending upon the contents of the buffer, the following actions are performed:

1. The frequency delivered in floating point format will be checked for legality.
   Legal values: 0, 4E4, 2E5, 4E5, 2E6, 4E6
   The frequency must satisfy the condition:

   FREQU =< 4MHz/NOC.

   For frequency 0 the external clock will be enabled.

2. Each of the 8 analog input channels can be declared as logically online or offline corresponding to the physical situation. The coordination of the online bitmap to the number of selected channels (NOC) will be performed as follows:
   If the highest online channel number lies between
   - 5 and 8, NOC = 8;
   - 3 and 4, NOC = 4.
   - if channel #2 online, NOC = 2, and if
   - only channel #1 online, NOC = 1.

3. The number of memory modules attached to the 2264 is established and determines the maximum data available from 2264.
   Legal values: 1,2,3,4 , corresponding to 32K, 64K, 96K, 128K words of data, respectively.

4. The 2264 posttrigger samples counter may be programmed by a jumper so that the front panel posttrigger samples switch indicates either increments of 1024 or 2048 posttrigger samples. The TLDRV must know the state of this jumper for the evaluation of the correct number of posttrigger samples. This information is contained in the INCFLG parameter.
   Allowed posttrigger values:

   INCFLG=0: 1024, 2048, 3072, 4096,
   5120, 6144, 7168, 8192.
   INCFLG=1: 2048, 4096, 6144, 8192,
   10240, 12288, 14336, 16384.

5. The offset switch settings on the 2264 front panel will be read out and compared with the specifications made by parameter OFFSET. Only online-declared channels will be checked.
   The parameter OFFSET consists 8 entries (one for

each channel) of two bits each which correspond to the offsets as follows:

OFFSET	Bit(n)	Bit(n+1)
Positive Offset	1	0
Zero Offset	1	1
Negative Offset	0	1

6. The number of pretrigger samples (PRE), entered in floating point format, must satisfy the condition:

   PRE =< (NOM * 32768)/NOC - PTS

7. The number of posttrigger samples (PTS), entered in FP-format, will be checked for legality (see above). Furthermore the condition

   PTS =< (NOM * 32768)/NOC - PRE must hold.

The buffer consists of 22 bytes which are formatted as follows:

Offset	Name	Type	Meaning
0	FREQU	[E]	Clock frequency for the 2264 in floating point format. Frequency 0 means external clock enabled.
4	PRE	[E]	Number of pretrigger samples in floating point format. Only positive integers are allowed.
10	PTS	[E]	Number of posttrigger samples in floating point format. Only positive integers are allowed.
14	NOM	[I]	Number of LeCroy Model 8800/8 memory modules attached to the 2264.
15	INCFLG	[B]	Flag (Bit 0) to indicate that the 2264 jumper for the increment of the PTS switch was set to 2048. INCFLG=0 means: Increment = 1024 INCFLG=1 means: Increment = 2048
16	BITMAP	[Y]	LeCroy 2264 online bitmap. This bit pattern describes which channels are physically connected to the module. Bit n set means that channel number n+1 is declared online.
24	OFFSET	[0]	LeCroy 2264 offset map; this is a

bit pattern which describes the analog offset of each 2264 input channel. This parameter must correspond to the switch settings on the 2264 front panel for all on-line declared channels.

The driver compares the IO.INI parameters with the 2264 front panel switch settings and, provided that they correspond, initiates continuous sampling cycle. The DAC display on scope will then be disabled. Furthermore the driver sets the status as defined by the device dependent parameters, where all parameters are checked for legality. Errors are reported by setting the status block accordingly.

13.4.2.2 IO.TER -- Terminate TL Operations -

IO.TER always re-initiates the LeCroy 2264 DAC display on scope and cleans up all parameters in the VCB. It prevents the module from being read until it is reinitialized with IO.INI.

13.4.2.3 IO.RVB -- Read Data from the LeCroy 2264 -

Readout is processed by the TL driver in the following manner:

The driver scans the online bitmap, starting with channel number 1 up to channel number 8. When it reaches an online channel, it reads all data available from this channel (e.g. number of PRE+PTS). Then the driver switches to the next channel which was defined as physically connected and reads the data from it. This process will be repeated until the last "online" channel was read. The total number of data available is:

(PTS+PRE)*ONCH

where ONCH is the number of on-line channels.

When the 2264 works in the single-channel mode and the stop trigger is not synchronised with the sample triggers, it is possible that one datum (the earliest pretrigger sample) is truncated. Therefore the maximum number of available data may be reduced by 1.

Data are read and returned to the user buffer until the given buffer length is exhausted or until the physical end of the module memory is detected. Subsequent read requests

continue from the word following the last word read. If any error occurs, IO.RVB returns the appropriate error code in the user status block.

13.5 Status Returns and Error Handling

Status information from a completed QIO operation is returned in the I/O status block if one was specified in the QIO. The first word contains an error or success code, the second contains zero or the number of bytes read with an IO.RVB operation.

13.5.1 First Status Word (low byte)

Code	Meaning
IS.SUC	OPERATION SUCCESSFUL No error occurred in processing the given QIO function. Returned from IO.INI, IO.RVB or IO.TER.
IE.IFC	INVALID FUNCTION CODE Returned from all QIO functions other than the standard functions or IO.INI, IO.TER, or IO.RVB.
IE.IDS	OPERATION INCONSISTENT WITH DEVICE STATE Returned from IO.RVB if the TL has not been initialized since being loaded or terminated with IO.TER.
IE.OFL	DEVICE OFFLINE Returned from all functions if the crate is offline, or the module is not at the specified address.
IE.EOT	END OF TAPE DETECTED All valid (available) data have been read. That means the number of requested data was greater than the data really stored on the LeCroy 2264 memories. Returned from IO.RVB.
IE.EOV	END OF VOLUME DETECTED All data available according to the attached memory modules have been read since the last IO.INI. Returned from IO.RVB.
IE.DAO	DATA OVERRUN The LeCroy 2264 memories contain more data than specified on initialization . This means the number of 8800/8 memories physically attached to the LeCroy 2264 is greater than NOM as defined in IO.INI. Returned from IO.RVB.
IE.DNR	DEVICE NOT READY This error code will be returned, if - no Stop Trigger was received or - the posttrigger samples were not yet finished or - the memory was not ready to read out. Returned from IO.RVB
IE.FHE	FATAL HARDWARE ERROR

If this error code occured after IO.RVB, the TL driver cannot read valid data.
(Q-response is missing).

IE.BAD BAD PARAMETERS

Returned from IO.INI, if any bad parameters were encountered.

These include:

- specifying an invalid number of trigger pulses.
- Frequncy was out of range (see Section 13.4.2) or
  FREQU > 4 MHz/NOC .
- The online bitmap was equal to 0 (no channels online), or does not correspond to the NOC switch on the 2264 front panel.
- The number of memory modules was equal to 0 or greater than 4.
- The increment of the posttrigger sample switch, specified by INCFLG, does not correspond to the increment jumpered on the 2264 module.
- The analog input switch settings do not correspond to the specifications made by parameter OFFSET.
- The number of pretrigger samples was greater than (32768 * NOM)/NOC - PTS , or not a positive integer.
- The number of posttrigger samples is not one of the allowed values (see Section 13.4.2) corresponding to the appropriate increment-jumper, or is larger than the memory available to each channel minus the pretrigger samples, or is not a positive integer.

13.5.2 First Status Word (high byte)

Contains the group number of the error code returned by the driver (see Appendix A of "DIOS I/O Operations"). All

errors returned by TLDRV belong to error group 0.

13.5.3 Second Status Word

After IO.TER, IO.INI or the standard I/O functions, the second status word contains zero.

After IO.RVB, the second status word always contains the number of bytes actually transferred to the user buffer.

NOTE

The LAM-line of the LeCroy 2264 module must be disabled (disconnected from the dataway), because it is not possible to prevent LAM's by software.

CHAPTER 14

TBDRV - LeCroy Transient Digitizer (Model 2264)

14.1 Introduction

Packaged in a triple width CAMAC module, the LeCroy Model 2264 is a 8-input, 8-bit ADC intended for use with the LeCroy Model 8800 Series 32K Memory Modules in high frequency transient monitoring applications. This combination of units provides 1,2,4, or 8 channels of 8-bit fast data logging with memory capacity determined by the number of 8800/8's utilized. With the 2264 used in the 4-channel mode, for instance, one memory module provides 8k words of storage for each input. Similarly, one 8800/8 provides 4096 words of memory for each channel of an 2264 used in the full 8-input mode.

The LeCroy 2264 is capable of sampling each input from a maximum rate of 4 MHz in the single-input mode to a maximum rate of 500 kHz in the full 8-input mode. Sampling rate is determined either by an internal clock or by an external clock.

The analog signals at the inputs of the 2264 are converted sequentially, each input requiring 200 nsec dwell time. A complete scan of all 8 inputs takes approximatly 2 microseconds.

The analog input range is selectable by the front panel switches:

OFFSET	Model 2264	Model 2264 H
Negative	-0.511 - 0 V	-10.23 - 0 V
Positive	0 - +0.511 V	0 - +10.23 V
Bipolar	-0.255 - +0.256 V	-5.11 - +5.12 V

Data is output in a complementary binary code, i.e., the most positive voltage in the input voltage range is

represented by all "zeros", and the most negative voltage in the input voltage range by all "ones".

The DIOS driver for the LeCroy 2264, TBDRV, operates on the module as follows:

At initialization time, the user determines the following items:

- The frequency of the internal clock (zero corresponds to external clocking),
- the number of pretrigger samples,
- the number of posttrigger samples,
- the number of 8800/8 memory modules attached to 2264,
- a flag, which determines the increment of the posttrigger switch on the 2264 front panel,
- the physical configuration of the logically connected (on-line) channels and
- the analog input range settings for each channel.

The TBDRV driver will read all available data (e.g. number of pretrigger and posttrigger samples). Data is returned separately for each channel number. The channels are read in ascending order, whereby those channels not marked as online are skipped. The maximum number of data available is given by the Number of Channels (NOC) multiplied by the sum of Pretrigger and Posttrigger samples. Any number of data up to the maximum available (32768) may be read with a single QIO.

The first IO.RVB after initialization can only be performed if the stop trigger was received and the posttrigger samples are finished.

In order to make sure the memory cycles through at least once, the following minimum time interval must elapse following initialization before the stop trigger is given:

$$T = 32768 * NOM/(NOC * CLK)$$

where

CLK = sample clock frequency
NOM = number of memory modules
NOC = number of channels

At least one sample clock pulse be occur before the Stop Trigger is received.

Further definitions used in this chapter are:

PTS = number of posttrigger samples
PRE = number of pretrigger samples

NOTE

The TBDRV is a special version of the TLDRV. It is fully compatible with the TLDRV, but very faster in the execution time through the implemented 'Block Read Mode'. The TBDRV does not support the KS 3992 serial CAMAC Controller !

14.2 Loading the Module

The module is loaded by either of the two macro calls

```
QIO$S   #IO.LOD,#$LDR,...,<mcb,lmcb,lun>
```

or

```
LOAD    lun,mcb,sts,flg
```

The use of these macros and meaning of the arguments are given in the manual "DIOS I/O Operations".

14.2.1 MCB Format

In the macro calls above, mcb denotes the address of the module control block for the LeCroy 2264. The device specific portions of the MCB should be set as follows:

Offset	Contents
M.TYP	"TB" -- 2-character code identifying the LeCroy 2264 device type.
M.UNIT	Unit number identifying each LeCroy 2264 module.
M.ACP	2-character identifier of the ACP containing the TB driver.
M.CTL	Control bits
MC.SUB = 0	TB is not a submodule
MC.INT = 0	Indicates interrupt service is not required by the LeCroy 2264.
MC.CAM = 1	Indicates the LeCroy 2264 is a CAMAC module.
M.ADR	CAMAC address in BCNA format (A=0) of the module.
M.DLN	1 => Length of one data item = 1 byte.
M.DFM	2 => Data returned as integers

14.3 Unloading the Module

The module is unloaded by either of the two macro calls

```
QIO$S   #IO.ULM,lun
```

or

```
UNLOAD  lun
```

The use of these macros and the meaning of the arguments are given in the manual "DIOS I/O Operations".

14.4 QIO Functions to the Loaded Module

This section summarizes the standard and device-specific QIO requests processable by the TB driver.

14.4.1 Standard Functions

Format		Function
QIO$S	#IO.VAT,...	;Attach Module
QIO$S	#IO.VDT,...	;Detach Module
QIO$S	#IO.KIL,...	;Cancel I/O on Module
QIO$S	#IO.ULM,...	;Unload the Module

14.4.2 Module-specific Functions

Format		Function
QIO$S	#IO.INI,...,<ddp,lpm>	;Initialize TB
QIO$S	#IO.TER,...,<#0,#4>	;Terminate TB
QIO$S	#IO.RVB,...,<buf,lbuf>	;Read data from TB

ddp is the address of a block of device-dependent parameters defining the mode in which the LeCroy 2264 is initialized.
lpm is the length of the block in bytes.
buf is the address of a buffer to receive data read from the module.
lbuf is the length of the data buffer in bytes.

14.4.2.1 IO.INI -- Initialize the LeCroy 2264 -

IO.INI passes a buffer specified in the parameter list of the QIO containing device-dependent parameters specifying the mode of initialization. Depending upon the contents of the buffer, the following actions are performed:

1. The frequency delivered in floating point format will be checked for legality.
   Legal values: 0, 4E4, 2E5, 4E5, 2E6, 4E6
   The frequency must satisfy the condition:

   FREQU =< 4MHz/NOC.

   For frequency 0 the external clock will be enabled.

2. Each of the 8 analog input channels can be declared as logically online or offline corresponding to the physical situation. The coordination of the online bitmap to the number of selected channels (NOC) will be performed as follows:
   If the highest online channel number lies between
   - 5 and 8, NOC = 8;
   - 3 and 4, NOC = 4.
   - if channel #2 online, NOC = 2, and if
   - only channel #1 online, NOC = 1.

3. The number of memory modules attached to the 2264 is established and determines the maximum data available from 2264.
   Legal values: 1,2,3,4 , corresponding to 32K, 64K, 96K, 128K words of data, respectively.

4. The 2264 posttrigger samples counter may be programmed by a jumper so that the front panel posttrigger samples switch indicates either increments of 1024 or 2048 posttrigger samples. The TBDRV must know the state of this jumper for the evaluation of the correct number of posttrigger samples. This information is contained in the INCFLG parameter.
   Allowed posttrigger values:

   INCFLG=0: 1024, 2048, 3072, 4096, 5120, 6144, 7168, 8192.
   INCFLG=1: 2048, 4096, 6144, 8192, 10240, 12288, 14336, 16384.

5. The offset switch settings on the 2264 front panel will be read out and compared with the specifications made by parameter OFFSET. Only online-declared channels will be checked.
   The parameter OFFSET consists 8 entries (one for

each channel) of two bits each which correspond to the offsets as follows:

OFFSET	Bit(n)	Bit(n+1)
Positive Offset	1	0
Zero Offset	1	1
Negative Offset	0	1

6. The number of pretrigger samples (PRE), entered in floating point format, must satisfy the condition:

   PRE =< (NOM * 32768)/NOC - PTS

7. The number of posttrigger samples (PTS), entered in FP-format, will be checked for legality (see above). Furthermore the condition

   PTS =< (NOM * 32768)/NOC - PRE must hold.

The buffer consists of 22 bytes which are formatted as follows:

Offset	Name	Type	Meaning
0	FREQU	[E]	Clock frequency for the 2264 in floating point format. Frequency 0 means external clock enabled.
4	PRE	[E]	Number of pretrigger samples in floating point format. Only positive integers are allowed.
10	PTS	[E]	Number of posttrigger samples in floating point format. Only positive integers are allowed.
14	NOM	[I]	Number of LeCroy Model 8800/8 memory modules attached to the 2264.
15	INCFLG	[B]	Flag (Bit 0) to indicate that the 2264 jumper for the increment of the PTS switch was set to 2048. INCFLG=0 means: Increment = 1024 INCFLG=1 means: Increment = 2048
16	BITMAP	[Y]	LeCroy 2264 online bitmap. This bit pattern describes which channels are physically connected to the module. Bit n set means that channel number n+1 is declared online.
24	OFFSET	[0]	LeCroy 2264 offset map; this is a

bit pattern which describes the analog offset of each 2264 input channel. This parameter must correspond to the switch settings on the 2264 front panel for all on-line declared channels.

The driver compares the IO.INI parameters with the 2264 front panel switch settings and, provided that they correspond, initiates continuous sampling cycle. The DAC display on scope will then be disabled. Furthermore the driver sets the status as defined by the device dependent parameters, where all parameters are checked for legality. Errors are reported by setting the status block accordingly.

14.4.2.2 IO.TER -- Terminate TB Operations -

IO.TER always re-initiates the LeCroy 2264 DAC display on scope and cleans up all parameters in the VCB. It prevents the module from being read until it is reinitialized with IO.INI.

14.4.2.3 IO.RVB -- Read Data from the LeCroy 2264 -

Readout is processed by the TB driver in the following manner:

The driver scans the online bitmap, starting with channel number 1 up to channel number 8. When it reaches an online channel, it reads all data available from this channel (e.g. number of PRE+PTS). Then the driver switches to the next channel which was defined as physically connected and reads the data from it. This process will be repeated until the last "online" channel was read. The total number of data available is:

(PTS+PRE)*ONCH

where ONCH is the number of on-line channels.

When the 2264 works in the single-channel mode and the stop trigger is not synchronised with the sample triggers, it is possible that one datum (the earliest pretrigger sample) is truncated. Therefore the maximum number of available data may be reduced by 1.

Data are read and returned to the user buffer until the given buffer length is exhausted or until the physical end of the module memory is detected. Subsequent read requests

continue from the word following the last word read. If any error occurs, IO.RVB returns the appropriate error code in the user status block.

14.5 Status Returns and Error Handling

Status information from a completed QIO operation is returned in the I/O status block if one was specified in the QIO. The first word contains an error or success code, the second contains zero or the number of bytes read with an IO.RVB operation.

14.5.1 First Status Word (low byte)

Code Meaning

IS.SUC OPERATION SUCCESSFUL
No error occurred in processing the given QIO function. Returned from IO.INI, IO.RVB or IO.TER.

IE.IFC INVALID FUNCTION CODE
Returned from all QIO functions other than the standard functions or IO.INI, IO.TER, or IO.RVB.

IE.IDS OPERATION INCONSISTENT WITH DEVICE STATE
Returned from IO.RVB if the TB has not been initialized since being loaded or terminated with IO.TER.

IE.OFL DEVICE OFFLINE
Returned from all functions if the crate is offline, or the module is not at the specified address.

IE.EOT END OF TAPE DETECTED

All valid (available) data have been read. That means the number of requested data was greater than the data really stored on the LeCroy 2264 memories. Returned from IO.RVB.

IE.EOV END OF VOLUME DETECTED

All data available according to the attached memory modules have been read since the last IO.INI. Returned from IO.RVB.

IE.DAO DATA OVERRUN

The LeCroy 2264 memories contain more data than specified on initialization . This means the number of 8800/8 memories physically attached to the LeCroy 2264 is greater than NOM as defined in IO.INI. Returned from IO.RVB.

IE.DNR DEVICE NOT READY

This error code will be returned, if
- no Stop Trigger was received or
- the posttrigger samples were not yet finished or
- the memory was not ready to read out.

Returned from IO.RVB

IE.FHE FATAL HARDWARE ERROR

If this error code occured after IO.RVB, the TB driver cannot read valid data.
(Q-response is missing).

IE.BAD BAD PARAMETERS

Returned from IO.INI, if any bad parameters were encountered.

These include:

- specifying an invalid number of trigger pulses.
- Frequncy was out of range (see Section 14.4.2) or
  FREQU > 4 MHz/NOC .
- The online bitmap was equal to 0 (no channels online), or does not correspond to the NOC switch on the 2264 front panel.
- The number of memory modules was equal to 0 or greater than 4.
- The increment of the posttrigger sample switch, specified by INCFLG, does not correspond to the increment jumpered on the 2264 module.
- The analog input switch settings do not correspond to the specifications made by parameter OFFSET.
- The number of pretrigger samples was greater than (32768 * NOM)/NOC - PTS , or not a positive integer.
- The number of posttrigger samples is not one of the allowed values (see Section 14.4.2) corresponding to the appropriate increment-jumper, or is larger than the memory available to each channel minus the pretrigger samples, or is not a positive integer.

14.5.2 First Status Word (high byte)

Contains the group number of the error code returned by the driver (see Appendix A of "DIOS I/O Operations"). All

errors returned by TBDRV belong to error group 0.

14.5.3 Second Status Word

After IO.TER, IO.INI or the standard I/O functions, the second status word contains zero.

After IO.RVB, the second status word always contains the number of bytes actually transferred to the user buffer.

NOTE

The LAM-line of the LeCroy 2264 module must be disabled (disconnected from the dataway), because it is not possible to prevent LAM's by software.

CHAPTER 15

TXDRV: Experiment Trigger Input -DR11/K Interface

15.1 Introduction

The TRIGGER (TX) module merely consists of a interface to a PDP11, so the TXDRV is designed to operate with standard PDP11 interface DR11K. Its purpose is to inform the user about external events, which are signalled via the interrupt logic of the interface, and the type of event (request A or B). Furthermore additional information about the requests (shotnumber, time,date) may be delivered from the TX driver by performing an appropriate DR11K I/O operation. Hardware characteristics, specifications and operation may be obtained from the reference documentation.

The DIOS driver for the TX, TXDRV, operates on the module as follows: Initialization and termination functions cause the interrupt logic to be disabled and output and input buffer to be cleared. A read function enables the interrupt logic. On occurance of an interrupt further interrupts are disabled, the type of request (A or B) will be determined and up to 16 words of data may be read if desired. In this case the TX driver outputs an address over the DR11K output port and increments this address after reading of each word, beginning with address zero up to address 15. This procedure allows an external multiplexer, which is connected to the DR11K interface, to select its next channel.

15.2 Loading the Module

The module is loaded by either of the two macro calls:

```
QIO$S #IO.LOD,#$LDR,....,<mcb,lmcb,lun>
```

or

```
LOAD lun,mcb,sts,flg
```

The use of the macros and meaning of the arguments are given in the DIOS Operations Manual.

15.2.1 MCB Format

In the macro calls above, mcb is the address of the Module Control Block, described in the DIOS Operations Manual. The device specific portions of the MCB should be set as follows:

Offset	Contents
M.TYP	"TX" -- 2-letter module type code for TX.
M.UNIT	Unit number of TX.
M.ACP	2-Letter code of ACP containing the TX driver.
M.CTL	Control bits, set as follows:
	MC.CAM=0 Indicates the TX is not a CAMAC module.
	MC.INT=1 Indicates interrupt service is required by the TX.
M.ADR	CSR address of the module.

15.3 Unloading the Module

The module is unloaded by either of the two macro calls:

```
QIO$S #IO.UNL,#lun,...
```

or

UNLOAD lun,sts,flg

The use of the macros and the meaning of the arguments is given in the DIOS Operations Manual.

15.4 QIO Functions to the Loaded Module

This section summarizes the standard and device-specific QIO requests processable by the driver.

15.4.1 Standard Functions

Format	Function
QIO$S #IO.VAT,...	;Attach Module
QIO$S #IO.VDT,...	;Detach Module
QIO$S #IO.KIL,...	;Cancel I/O on Module
QIO$S #IO.UNL,...	;Unload Module

15.4.2 Module-specific Functions

Format	Function
QIO$S #IO.INI,...,<ddp,lpm>	;Initialize TX
QIO$S #IO.TER,...,<0,2>	;Terminate TX
QIO$S #IO.RVB,...,<buf,lbuf>	;Await external event

where

ddp is the address of a block of device-dependent parameters defining the mode in which the Trigger is initialized.
lpm is the length of the block in bytes.
buf is the address of the buffer into which data are read.
lbuf is the length of the data buffer in bytes.

15.4.2.1 IO.INI - Initialize the Trigger

IO.INI passes a buffer specified in the parameter list of the QIO containing device-dependent parameters specifying the mode of initialization. The buffer consists of four bytes which are at present not significant, but are reserved for future use. The driver disables the interrupt logic of the interface and clears its input and output buffer registers.

15.4.2.2 IO.TER - Terminate Operations on the Trigger

The same action is taken as with I/O operation code IO.INI.

15.4.2.3 IO.RVB - Read Data from the Trigger

The interrupt logic of the module is enabled. On occurance of an interrupt, further interrupts are locked out. Input and output buffer registers of the interface are cleared to generate Reset pulses on the DR11K interface. Depending on the buffer length, specified by IO.RVB, a block of data (up to 17 words) may be read from the input port of the DR11K interface. The first word will contain an ASCII character which shows the type of request. Character 'A' means that an interrupt A was occurred and character 'B' informs about an interrupt B. The remaining 16 words will be returned as integers.

Before reading the DR11K input port the TX driver outputs an address for the multiplexer which is connected to the DR11K output port. This address will be incremented after each reading, starting with address zero up to address 15.

15.5 Status Returns and Error Handling

When a QIO function is completed, status information about the functions is returned in the I/O status block if specified in the QIO macro call.

15.5.1 First Status Word (low byte)

The error codes listed below may be returned by the TX Driver.

Code	Meaning
IS.SUC	A QIO for IO.INI, IO.RVB or IO.TER was successfully completed.
IE.IFC	A function code other than IO.INI, IO.RVB, IO.TER or the standard functions was encountered.
IE.ABO	Returned from IO.KIL if a read operation was in progress.
IE.EOV	Returned from IO.RVB if the number of data requested was greater as available (17 words).
IE.FHE	Returned from IO.RVB if the DR11K status register shows an ilegal status or if both requests have arrived at the same time (interrupt service time).

15.5.2 First Status Word (high byte)

DIOS drivers use this byte to group error conditions. Bit n on selects error group n+1. All error codes returned by the TXDRV belong to error code group zero.

15.5.3 Second Status Word

This word shows in all cases the number of bytes actually transferred to the user buffer.

CHAPTER 16

TADRV: Experiment Trigger Input -DR11/K Interface

16.1 Introduction

The TRIGGER (TA) module consists of an interface to a PDP11, so the TADRV is designed to operate with standard PDP11 interface DR11K. Its purpose is to inform the user about external events, which are signalled via the interrupt logic of the interface, and the type of event (request A or B). Furthermore additional information about the requests (shotnumber, time,date) may be delivered from the TA driver by performing an appropriate DR11K I/O operation. Hardware characteristics, specifications and operation may be obtained from the reference documentation.

The DIOS driver for the TA, TADRV, operates on the module as follows: Initialization and termination functions cause the interrupt logic to be disabled and output and input buffer to be cleared. A read function enables the interrupt logic. On occurance of an interrupt further interrupts are disabled, the type of request (A or B) will be determined and information about the current shot will be obtained by the multiplexer connected to the DR11K I/O-lines. These data consist of the request-type, time, date and the number of the shot actually processed.

The TA driver also generates a set of additional signals for the communication between the experiment and the data acquisition. These signals are described in detail by a timing diagram (Appendix A).

16.2 Loading the Module

The module is loaded by either of the two macro calls:

```
QIO$S #IO.LOD,#$LDR,....,<mcb,lmcb,lun>
```

or

```
LOAD lun,mcb,sts,flg
```

The use of the macros and meaning of the arguments are given in the DIOS Operations Manual.

16.2.1 MCB Format

In the macro calls above, mcb is the address of the Module Control Block, described in the DIOS Operations Manual. The device specific portions of the MCB should be set as follows:

Offset	Contents
M.TYP	"TA" -- 2-letter module type code for TA.
M.UNIT	Unit number of TA.
M.ACP	2-Letter code of ACP containing the TA driver.
M.CTL	Control bits, set as follows:
	MC.CAM=0 Indicates the TA is not a CAMAC module.
	MC.INT=1 Indicates interrupt service is required by the TA.
M.ADR	CSR address of the module.
M.VCT	Interrupt vector A of the DR11K divided by 4.
M.PRI	Interrupt priority of the DR11K.
M.DFM	Integer data returned.
M.DLN	2-Byte data item.

16.3 Unloading the Module

The module is unloaded by either of the two macro calls:

```
QIO$S #IO.UNL,#lun,...
```

or

```
UNLOAD lun,sts,flg
```

The use of the macros and the meaning of the arguments is given in the DIOS Operations Manual.

16.4 QIO Functions to the Loaded Module

This section summarizes the standard and device-specific QIO requests processable by the driver.

16.4.1 Standard Functions

Format	Function
QIO$S #IO.VAT,...	;Attach Module
QIO$S #IO.VDT,...	;Detach Module
QIO$S #IO.KIL,...	;Cancel I/O on Module
QIO$S #IO.UNL,...	;Unload Module

16.4.2 Module-specific Functions

Format	Function
QIO$S #IO.INI,...,<ddp,lpm>	;Initialize TA
QIO$S #IO.TER,...,<0,4>	;Terminate TA
QIO$S #IO.RVB,...,<buf,lbuf>	;Await external event

where

ddp is the address of a block of device-dependent parameters defining the mode in which the Trigger is initialized.
lpm is the length of the block in bytes.
buf is the address of the buffer into which data are read.
lbuf is the length of the data buffer in bytes.

16.4.2.1 IO.INI - Initialize the Trigger Device

IO.INI passes a buffer specified in the parameter list of the QIO containing device-dependent parameters specifying the mode of initialization. Depending upon the contents of the buffer, the corresponding shot-mode (Cleaning- or Tokomak-Shot) will be initiated.

The buffer consists of 2 bytes which are formatted as follows:

Offset	Name	Type	Meaning
0	MODE	[B]	Mode in which the trigger device is operating: 0 Normal Tokomak-Shot Operation 1 Cleaning-Shot Operation
1	RESEV		Reserve for future use.

The driver sets the status as defined by the device dependent parameter, disables the interrupt logic of the interface , clears its input and output buffer registers and generates the signal MDEEIN to inform the experiment that the data acquisition is ready to run. Errors are reported by setting the status block accordingly.

16.4.2.2 IO.TER - Terminate Operations on the Trigger

IO.TER disables the interrupt logic of the interface, clears its input and output register and resets the signal MDEEIN. The VCB will be cleaned up to prevent the DR11K interface from being read until it is reinitialized with IO.INI.

16.4.2.3 IO.RVB - Read Data from the Trigger Device

The interrupt logic of the interface is enabled and the handshake-signals MDEPBE and MDESBE are generated depending on the expected request-type (A or B). On occurance of an interrupt, further interrupts are locked out. Input and output buffer registers of the interface are cleared to generate Reset pulses on the DR11K interface and handshake-signals MDEPBE and MDESBE are switched off corresponding to the received request.
After receiving the Trigger the TA driver delivers information about the actual experiment shot. Data are returned in a block of up to 20 bytes which are formatted as follows:

Offset	Type	Meaning
0	[A]	Type of the received request. A Request A: Start of shot B Request B: End of shot
2	[D]	Milliseconds
4	[D]	Seconds
6	[D]	Minutes
10	[D]	Hours
12	[D]	Days
14	[D]	Months
16	[D]	Years
20	[O]	Low order part of shotnumber
22	[O]	High order part of shotnumber

The requests (A or B) must obey the following rules:
1. Both requests may never arrive at the same time (error code IE.FHE will be returned).
2. After Initialization the TADRV always expects an interrupt A, then an interrupt B, after it an interrupt A again and so on. If this sequence is not observed the driver returns error code IE.ISQ.
3. On a request A the TA driver will advance the shotnumber by 1 to get the correct (next) shotnumber. This number will be stored on VCB and must correspond to the shotnumber read on request B. If this condition is not satisfied error code IE.BVR will be returned.

Before reading the DR11K input port the TA driver outputs an

address for the external multiplexer which is connected to the DR11K I/O lines. The data items returned from each multiplexer address may be obtained from a diagram (Appendix B). All data are delivered by the multiplexer in form of BCD numbers, which are converted by the TA driver into integers or douple precision integers (e.g. shotnumbers).

The last two words returned from the TADRV contain the low-order and high-order parts of a douple precision integer which represents the experiment shotnumber depending of the shot-mode specified on initialization (Cleaning-Shot or Tokomak-Shot).

16.5 Status Returns and Error Handling

When a QIO function is completed, status information about the functions is returned in the I/O status block if specified in the QIO macro call.

16.5.1 First Status Word (low byte)

The error codes listed below may be returned by the TA Driver.

Code	Meaning
IS.SUC	OPERATION SUCCESSFUL A QIO for IO.INI, IO.RVB or IO.TER was successfully completed.
IE.IFC	INVALID FUNCTION CODE A function code other than IO.INI, IO.RVB, IO.TER or the standard functions was encountered.
IE.ABO	REQUEST TERMINATED Returned from IO.KIL if a read operation was in progress.
IE.EOV	END OF VOLUME DETECTED Returned from IO.RVB if the number of data requested was greater than available (10 words).
IE.FHE	FATAL HARDWARE ERROR Returned from IO.RVB if the DR11K status register contained an illegal status, or if both interrupts arrived at the same time (interrupt service time).

IE.VER PARITY ERROR ON DEVICE
Returned from IO.RVB if data read by the TA driver have not the correct format (illegal BCD numbers).

IE.IDS OPERATION INCONSISTENT WITH DEVICE STATE
Returned from IO.RVB if the TA has not been intialized since being loaded or terminated with IO.TER, or if any errors occured during the last IO.RVB.

IE.ISQ ILLEGAL SEQUENTIAL OPERATION
Returned from IO.RVB if the requests A and B appeared in an illegal sequence (see Section 16.4.2.4).

IE.BVR BAD VERSION NUMBER
Returned from IO.RVB if the shot number read from request B is not equal to one plus the shot number read from the preceding request A.

16.5.2 First Status Word (high byte)

DIOS drivers use this byte to group error conditions. Bit n on selects error group n+1. All error codes returned by TADRV belong to error code group zero.

16.5.3 Second Status Word

This word shows in all cases the number of bytes actually transferred to the user buffer.

CHAPTER 17

VDDRV - LeCroy 20MHz Video Digitizer (Model 8258)

17.1 Introduction

Packaged in a triple width CAMAC module, the LeCroy Model 8258 is an one-channel, 8-bit ADC intended for use with the LeCroy Model 8800 Series 32K Memory Modules in high frequency applications as digitizing the output of a vidicon or solid state (CCD) television camera. The unit can sample and digitize a waveform at any rate between 512KHz and 20MHz.
A minimum of four LeCroy 8800/9 32K-word 9-bit memory modules are necessary to store data from the digitizer at 20MHz. At 10MHz and 5MHz maximum rates, the minimum required memory sizes are 2-8800/9 and 1-8800/9 respectively (jumper option). Further expansion of the memory is possible in 2, 3 or 4 module steps to a total of 64 memory modules. Model 8800/8 memory can also be used when synchronization information is not needed.

The analog input range is adjustable by a front panel screw:

Input Amplitude	DC offset	Digitized DC Offset	Digitized Signal
-512mV	+256mV	0	0
-256mV	+256mV	0	128
0mV	+256mV	0	256
-256mV	0mV	128	0
0mV	0mV	128	128
+256mV	0mV	128	256
0mV	-256mV	256	0
+256mV	-256mV	256	128
+512mV	-256mV	256	256

The voltage v at the analog input is related to the digitized signal s and the digitized offset p by the relation:

$$v[volts] = ((p-256)+s)/500$$

The DIOS driver for the LeCroy 8258, VDDRV, operates on the module as follows:

At initialization time, the user determines the following items:

- The frequency of the external sampling clock. Frequency 0 means that sampling pulses will be delivered by a programable pulse generator.
- the number of 'pseudo' pretrigger samples,
- the number of posttrigger samples,
- the number of 8800/9 memory modules attached to 8258,
- the physical configuration of the logically connected (on-line) channels (always one) and
- the mode in which the LeCroy 8258 should operate.

Any number of data up to the maximum available (32768) may be read with a single QIO until the end of the memory is detected or all posttrigger samples are read.

The first IO.RVB after initialization can only be performed if the stop trigger was received and the whole memory is filled with data.

In this chapter following definitions are used:

PTS	=	number of posttrigger samples
PRE	=	number of 'pseudo' pretrigger samples
NOM	=	number of memory modules

17.2 Loading the Module

The module is loaded by either of the two macro calls

```
QIO$S   #IO.LOD,#$LDR,...,<mcb,lmcb,lun>
```

or

```
LOAD    lun,mcb,sts,flg
```

The use of these macros and meaning of the arguments are given in the manual "DIOS I/O Operations".

17.2.1 MCB Format

In the macro calls above, mcb denotes the address of the module control block for the LeCroy 8258. The device specific portions of the MCB should be set as follows:

Offset	Contents
M.TYP	"VD" -- 2-character code identifying the LeCroy 8258 device type.
M.UNIT	Unit number identifying each LeCroy 8258 module.
M.ACP	2-character identifier of the ACP containing the VD driver.
M.CTL	Control bits
MC.SUB = 0	VD is not a submodule
MC.INT = 0	Indicates interrupt service is not required by the LeCroy 8258.
MC.CAM = 1	Indicates the LeCroy 8258 is a CAMAC module.
M.ADR	CAMAC address in BCNA format (A=0) of the module.
M.DLN	1 => Length of one data item = 1 byte.
M.DFM	2 => Data returned as integers

17.3 Unloading the Module

The module is unloaded by either of the two macro calls

```
QIO$S   #IO.ULM,lun
```

or

```
UNLOAD  lun
```

The use of these macros and the meaning of the arguments are given in the manual "DIOS I/O Operations".

17.4 QIO Functions to the Loaded Module

This section summarizes the standard and device-specific QIO requests processable by the VD driver.

17.4.1 Standard Functions

Format		Function
QIO$S	#IO.VAT,...	;Attach Module
QIO$S	#IO.VDT,...	;Detach Module
QIO$S	#IO.KIL,...	;Cancel I/O on Module
QIO$S	#IO.ULM,...	;Unload the Module

17.4.2 Module-specific Functions

Format		Function
QIO$S	#IO.INI,...,<ddp,lpm>	;Initialize VD
QIO$S	#IO.TER,...,<#0,#4>	;Terminate VD
QIO$S	#IO.RVB,...,<buf,lbuf>	;Read data from VD

ddp is the address of a block of device-dependent parameters defining the mode in which the LeCroy 8258 is initialized.
lpm is the length of the block in bytes.
buf is the address of a buffer to receive data read from the module.
lbuf is the length of the data buffer in bytes.

17.4.2.1 IO.INI -- Initialize the LeCroy 8258 -

IO.INI passes a buffer specified in the parameter list of the QIO containing device-dependent parameters specifying the mode of initialization. Depending upon the contents of the buffer, the following actions are performed:

1. The number of channels must be 1.

2. The number of memory modules attached to the 8258 is established and determines the maximum data available from 8258.
   Legal values: 1,2,..,64 , corresponding to 32K, 64K,
   up to 2048K words of data,respectively.

3. The number of posttrigger samples may be in the range:

   $$0 <= PTS <= (32768 * NOM) + PRE$$

4. The number of 'pseudo' pretrigger samples (PRE), entered in floating point format, must satisfy the condition:

   $$0 >= PRE >= PTS - (32768 * NOM)$$

   Because the LeCroy 8258 module can only generate posttrigger samples, the parameter 'PRE' has not the same meaning as defined for other LeCroy ADC's. The parameter 'PRE' was only introduced for compatibility with other LeCroy transient recorders and is therefore combined with the term 'pseudo'. Physically the number of pseudo pretrigger samples represents the start address of the memory from which the posttrigger samples start and data will be read. Unlike the real pretrigger samples, the 'pseudo' pretrigger sample values must be 0 or negative integers.

5. The mode in which data are to be read from the LeCroy 8258 by IO.RVB is determined by the MODE key:

Key	Function
N	Normal read operation. Digitized data are read without synchronisation information.
E	External fast data output port enabled. Data are transferred over the external port. In this mode data are not available to read by the VD driver.
P	Pattern select data mode. If this mode is selected, the 9-bit data

word from the 8800/9 memories will be transformed into an 8-bit data byte according to the following algorithm:

Bits(0-7)	Bit(8)	Results
XXXXXXXX	0	XXXXXXXX
XXXXXXXX	1	00000000
00000000	0	00000001
00000000	1	00000000

The buffer consists of 20 bytes which are formatted as follows:

Offset	Name	Type	Meaning
0	FREQU	[E]	Clock frequency for the 8258 in floating point format. Allowed range: 512KHz ... 20MHz Using a programable pulse generator, frequency 0 must be selected.
4	PRE	[E]	Number of pseudo pretrigger samples in floating point format. Only negative integers or 0 are allowed.
10	PTS	[E]	Number of posttrigger samples in floating point format. Only positive integers are allowed.
14	NOM	[I]	Number of LeCroy Model 8800/9 memory modules attached to the 8258. Allowed numbers: 1..64
16	BITMAP	[Y]	LeCroy 8258 online bitmap. This bit pattern describes which channels are physically connected to the module. On LeCroy 8258 only one channel (the first) is available.
22	MODE	[A]	Mode of readout: N Normal read operation E Readout over fast external data port P Pattern select data mode
23	RESEV		Reserve for future use.

The driver sets the status as defined by the device dependent parameters, where all parameters are checked for legality. Furthermore the VD driver sets the 8258 into the READY mode which enables the module to digitize the analogue input signal. Errors are reported by setting the status block accordingly.

17.4.2.2 IO.TER -- Terminate VD Operations -

IO.TER always cleans up all parameters in the VCB. It prevents the module from being read until it is reinitialized with IO.INI.

17.4.2.3 IO.RVB -- Read Data from the LeCroy 8258 -

Readout is processed by the VD driver in the following manner:

On the first IO.RVB after initialization the VD driver always reads the analogue offset of the LeCroy 8258 ADC and transfers it to the user buffer as the first data byte. Afterthere the VDDRV reads data from the 8800/9 memories starting at the memory address specified by the initialization parameter PRE.

Data are read and returned to the user buffer until the physical end of the module memory is detected, the specified number of posttrigger samples is completely transferred or until the given buffer length is exhausted. Subsequent read requests continue from the word following the last word read. If any error occurs, IO.RVB returns the appropriate error code in the user status block.

Depending upon the mode specified on IO.INI, the VD driver delivers data in different formats:

1. Normal readout (MODE=N).
   Data will be returned in normal fashion without information about the synchronism signal.

2. Pattern select data mode (MODE=P).
   Depending on the synchronism signal data are transformed according to the algorithm described in section 17.4.2.1.

3. Readout over external port (MODE=E).
   Digitized data can be read over the external fast data port. If this mode has been selected, the VDDRV returns the error code IE.EOV on an IO.RVB request.

17.5 Status Returns and Error Handling

Status information from a completed QIO operation is returned in the I/O status block if one was specified in the QIO. The first word contains an error or success code, the

second contains zero or the number of bytes read with an IO.RVB operation.

17.5.1 First Status Word (low byte)

Code Meaning

IS.SUC OPERATION SUCCESSFUL

No error occurred in processing the given QIO function. Returned from IO.INI, IO.RVB or IO.TER.

IE.IFC INVALID FUNCTION CODE

Returned from all QIO functions other than the standard functions or IO.INI, IO.TER, or IO.RVB.

IE.IDS OPERATION INCONSISTENT WITH DEVICE STATE

Returned from IO.RVB if the VD has not been initialized since being loaded or terminated with IO.TER.

IE.OFL DEVICE OFFLINE

Returned from all functions if the crate is offline, or the module is not at the specified address.

IE.EOV END OF VOLUME DETECTED

All data available according to the attached memory modules or the specified number of posttrigger samples have been read since the last IO.INI. Furthermore this error code will always be returned if the external mode was selected on IO.INI.
Returned from IO.RVB.

IE.DNR DEVICE NOT READY

This error code will be returned, if
- no Stop Trigger was received or
- the posttrigger samples were not yet finished or
- the memory was not ready to read out.
Returned from IO.RVB

IE.FHE FATAL HARDWARE ERROR

If this error code occured after IO.RVB, the VD driver cannot read valid data.
(Q-response is missing).

IE.BAD BAD PARAMETERS

Returned from IO.INI, if any bad parameters were encountered.

These include:

- the online bitmap was not equal to 1.
- the number of memory modules was equal to 0 or greater than 64.
- the number of postrigger samples and 'pseudo' pretrigger samples does not satisfy the condition:
  PTS - PRE <= NOM * 32768
- the number of posttrigger samples was not a postive integer.
- the number of 'pseudo' pretrigger samples was greater than 0 or not an integer.
- a bad MODE key was entered.

17.5.2 First Status Word (high byte)

Contains the group number of the error code returned by the driver (see Appendix A of "DIOS I/O Operations"). All errors returned by VDDRV belong to error group 0.

17.5.3 Second Status Word

After IO.TER, IO.INI or the standard I/O functions, the second status word contains zero.

After IO.RVB, the second status word always contains the number of bytes actually transferred to the user buffer.

NOTE

The LAM-line of the LeCroy 8258 module must be disabled (disconnected from the dataway), because it is not possible to prevent LAM's by software.

CHAPTER 18

CXDRV: IPP CAMAC Memory Module

18.1 Introduction

The CAMMEM is a random access memory in CAMAC norm (CAMAC single width module) with 2048, 4096, 8192 or 16384 16-bit words. The CAMMEM may be accessed via the Dataway or from an external data bus. Addressing for access via the dataway is done by setting an address register and then transferring the data or in auto-increment mode. Loading memory from the external bus is always done with automatic address increment. Mutiple CAMMEMs may be arranged up to 32K words capacity, where 2K, 4K, 8K or 16K modules may be intermixed. Multiple CAMMEMs connected to form one logical CAMMEM must occupy consecutive CAMAC stations.

The DIOS driver for the CAMMEM, CXDRV, operates on the module as follows: at initialization time the user determines the physical configuration of the logical CAMMEM to be used, and whether access is via the dataway or from the external bus. A read or write function always switches the access lines to the dataway, starting I/O at the address specified at initialization time. Any number of data (16-bit words) available may be read or written with a single QIO.

18.2 Loading the Module

The module is loaded by either of the two macro calls

```
QIO$S   #IO.LOD,#$LDR,....,<mcb,lmcb,lun>
```

or

```
LOAD    lun,mcb,sts,flg
```

The use of the macros and meaning of the arguments are given in the DIOS Operations Manual.

18.2.1 MCB Format

In the macro calls above, mcb is the address of the Module Control Block, described in the DIOS Operations Manual. The device specific portions of the MCB should be set as follows:

Offset	Contents
M.TYP	"CX" -- 2-letter type code for CAMMEM
M.UNIT	Unit number of CAMMEM.
M.ACP	2-Letter code of ACP containing the CAMMEM driver.
M.CTL	Control bits, set as follows:
	MC.CAM=1 Indicates the CAMMEM is a CAMAC module.
	MC.INT=0 Indicates interrupt service is not required by the CAMMEM.
M.ADR	CAMAC address in BCNA format (A=0) of the module.

18.3 Unloading the Module

The module is unloaded by either of the two macro calls:

```
QIO$S   #IO.UNL,#lun,...
```

or

UNLOAD lun,sts,flg

The use of these macros and the meaning of the arguments are given in the DIOS Operations Manual.

18.4 QIO Functions to the Loaded Module

This section summarizes the standard and device-specific QIO requests processable by the driver.

18.4.1 Standard Functions

	Format	Function
QIO$S	#IO.VAT,...	;Attach Module
QIO$S	#IO.VDT,...	;Detach Module
QIO$S	#IO.KIL,...	;Cancel I/O on Module
QIO$S	#IO.UNL,...	;Unload Module

18.4.2 Module-specific Functions

	Format	Function
QIO$S	#IO.INI,...,<ddp,lpm>	;Initialize CAMMEM
QIO$S	#IO.TER,...,<0,2>	;Terminate CAMMEM
QIO$S	#IO.RVB,...,<buf,lbuf>	;Read data from CAMMEM
QIO$S	#IO.WVB,...,<buf,lbuf>	;Write data to CAMMEM

where

ddp	is the address of a block of device-dependent parameters defining the mode in which the CAMMEM is initialized.
lpm	is the length of the block in bytes.
buf	is the address of the buffer into which data are read or from which data are written.
lbuf	is the length of the data buffer in bytes.

18.4.2.1 IO.INI - Initialize the CAMMEM

IO.INI passes a buffer specified in the parameter list of the QIO containing device-dependent parameters specifying the mode of initialization. Depending upon the contents of the buffer, the following actions are performed:

1. One or more physical CAMMEMs are logically connected to create a single, large external storage module.

2. The start address, from which data will be read or into which data will be written, is established.

3. The data bus, either the CAMMEM bus or the CAMAC Dataway, is enabled.

The buffer consists of 8 bytes which are formatted as follows:

Offset	Name	Type	Meaning
0	CORMAP	[D]	CAMMEM core map; this is a bit pattern which describes the physical modules of one logical CAMMEM. The word consists 4 entries of four bits each, where the low one is the logical online bit (bit set means module online) and the high three bits show the storage capacity of the module (0 means 2K, 1 means 4K, 2 means 8K, 3 means 16K module)
2	RELADR	[D]	Memory start address relative to the first module.
4	ACCESS	[A]	set to "E" if external access is desired, or set to "I" if I/O is done via the dataway.
5	RESRV		reserved for future use.

The driver sets the status as defined by the device dependent parameters, where all parameters are checked for legality. Errors are reported via setting the status block accordingly.

18.4.2.2 IO.TER - Terminate Operations on the CAMMEM

IO.TER always sets the logical CAMMEM, defined by a prior IO.INI function, to be accessed via the dataway. The start address is reset to zero.

18.4.2.3 IO.RVB - Read Data from the CAMMEM

The CAMMEM I/O lines are switched to the dataway. Reading is done in auto-increment mode and starts at the location set by an IO.INI or IO.TER function or one word behind the address of the last read/write cycle. External input does not alter the location counter for a read function. Data are read and returned to the user buffer until the given buffer length is exhausted or until the physical end of the logically connected CAMMEMs is detected.

18.4.2.4 IO.WVB - Write Data to the CAMMEM

The same actions are taken as with IO.RVB, except that data are written from the user buffer to the CAMMEM. If more data are to be written than the capacity of the CAMMEM allows, an error status is returned and all following attempts to write data are ignored until the next IO.INI.

18.5 Status Returns and Error Handling

When a QIO function is completed, status information about the functions is returned in the I/O status block if specified in the QIO macro call.

18.5.1 First Status Word (low byte)

The error codes listed below may be returned by the CAMMEM Driver.

Code	Meaning
IS.SUC	A QIO for IO.INI, IO.TER, IO.RVB or IO.WVB was successfully completed.
IE.IFC	A function code other than IO.INI, IO.TER IO.RVB or IO.WVB or the standard functions was encountered.
IE.BAD	Returned from IO.INI, IO.TER, IO.RVB or IO.WVB if any bad parameters were encountered.
IE.OFL	Returned from IO.INI or IO.TER if the module is not at the given CAMAC station or the crate is offline.
IE.EOV	Returned from IO.RVB or IO.WVB if the storage capacity becomes exhausted during a read or write operation.

18.5.2 First Status Word (high byte)

DIOS drivers use this byte to group error conditions. Bit n on selects error code group n+1. All error codes used by the CXDRV belong to error code group zero.

18.5.3 Second Status Word

This word shows in all cases the number of bytes actually transferred to or from the user buffer.

18.6 Programming Hints

In DIOS the CAMMEM is provided to be filled from the external bus (e.g. with experimental data) and then to be read out via the data way. For this purpose the user initializes a logical CAMMEM for external access as outlined obove (IO.INI). After information is stored in the CAMMEM the user merely has to perform succeeding QIOs with function code IO.RVB to obtain the data stored in the CAMMEM, where the amount of data to be read each time is given by the user's buffer length. Data are returned in the same order as they are transferred to the CAMMEM, so the user is not concerned with any addressing. However, if the user wants to specify his own start address he might do so with another initialization, which does not alter the ccntents of the CAMMEM.

DIOS Device Handlers
Reference Manual

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