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ACQUISITION SYSTEM FOR TRANSIENT SIGNALS USING CAMAC DIGITIZERS

User's Manual

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CONTENTS

1. Introduction

This system is designed as a digital 10-trace storage oscilloscope. The fast acquisition of transients is done by Camac modules which are controlled, via GPIB, by a mini-computer PRO 380 (DEC, PDP-11 family). The maximum sampling frequency is 1 MHz for the first eight channels (2 modules Lecroy 8210 with four traces) and 32 MHz for the last two channels (2 modules Lecroy TR8837F with one trace each).

The software (program ACQUI) running on the PRO 380 is easy to use and no prior knowledge of the computer is necessary. It allows the User to setup the instrument to meet his needs, and to modify the display interactively. The options are selected from three menus: 'main menu', 'modify setup menu' and 'modify display menu'.

A hard copy of the screen can be produced on the printer. The transient signals are stored in disc files with all relevant information for further analysis: date, time, setup, scaling and User's comments.

The program ACQUI is intended to monitor the first gyrotron experiments. Typically the gyrotron will be operated during short pulses of 100 µs to 1 ms and one is interested in recording signals during that period. Since the maximum sampling frequency of the first eight traces is 1 MHz, the number of samples per trace has been deliberately limited to 1024 (1 K) to save disc space.

1.1 History of updates

Version 2 (02-JUN-86)

During the tests of the system, the Camac modules have exhibited some temporary failures. One module (8210) had to be sent twice to the factory for repair.

The above problem has been fixed by putting a delay of 50 ms between the reading of each trace.

Possibility of external clock for the modules 8210. Allowed external sampling frequencies in Hz: 5000, 2500, 1000 500,250,100. Slow phenomena can be thus monitored.

The restart of the Camac modules after readout is now optional.

Version 3 (23-JAN-87)

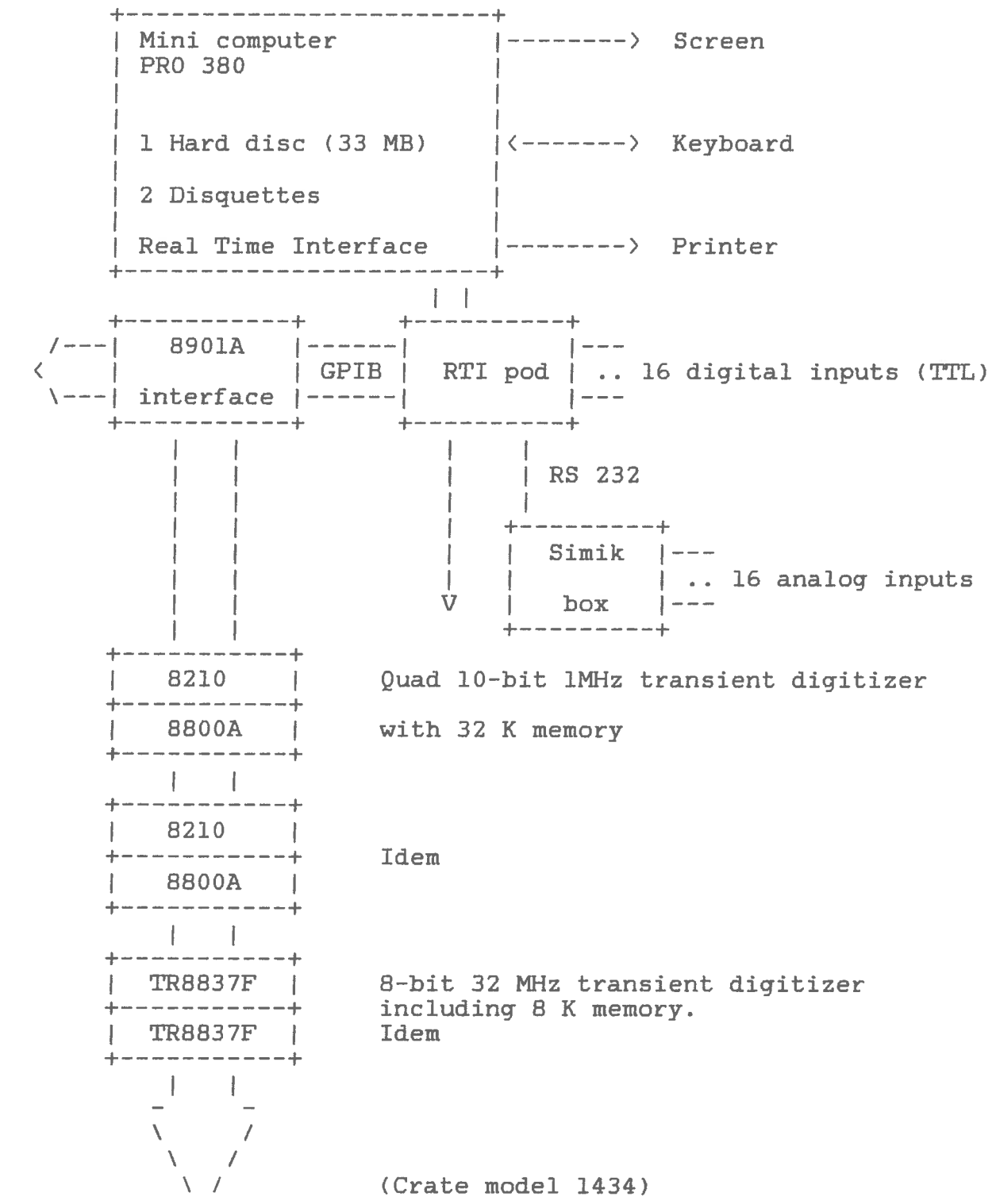
The display setup is saved on disc.
Possibility of making a stream of hard-copies.
Display of minima and maxima of each trace.

Version 4 (24-APR-87)

Possibility of reading 16 analog inputs and 16 digital inputs (TTL) with each shot.

2. Hardware configuration

2.1 Schema



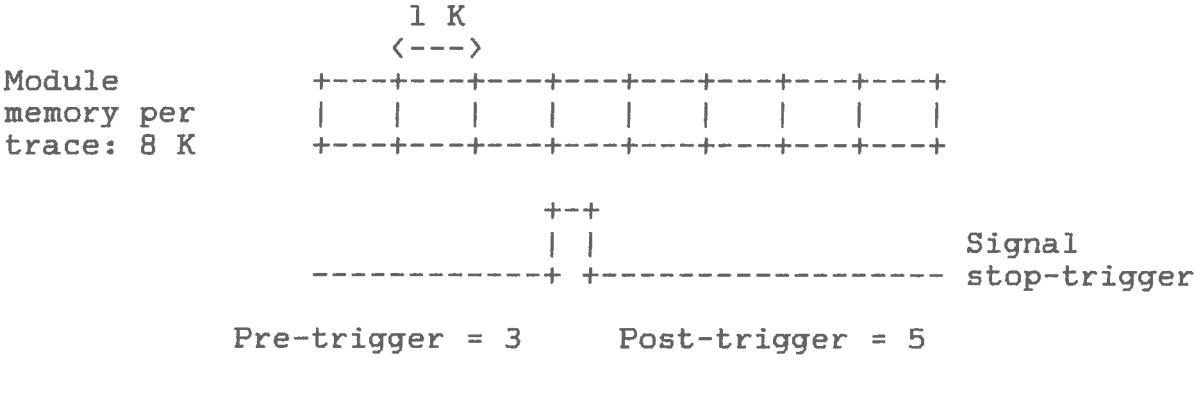
GPIB : General Purpose Interface Bus

Address of 8901A: 3

2.2 Timing of transient signals

The system operates in the following way: the Camac modules continuously digitize the input signals and store the values in circular buffers. When a 'stop-trigger' signal is sent to a module the pre-selected number of post-trigger samples (PTS) is taken and the digitizing stops. The module is then ready for computer readout.

Example: the number of PTS is 5 K



Following values of PTS can be pre-set:

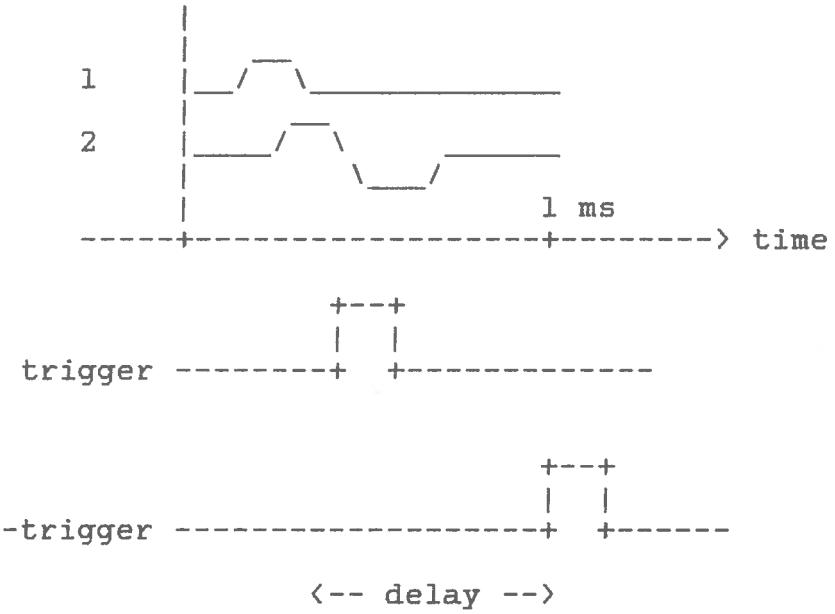
Module 8210 : 0 through 7
" 8837 : 1 through 8

Warning: on the 8837 front-panel the number of pre-trigger samples is displayed.
on the 8210 front-panel the switch is for post-trigger setting !

In the version described here the program ACQUI handles only 1 K of data per trace, so the the timing of stop-trigger signals and the module setup must be such that the transients to be studied fall in the first 1/8 of the 8 K memory.

Example: One wants to study the following transients at a frequency of 1 MHz during 1 ms before the stop-trigger.

The PTS must be set to 7 (for all modules).



The stop-trigger must be delayed by the appropriate time.
If a 'Simik timer box' is used, one must note that it considers the descending edge of TTL pulse, while the Camac modules react to the rising edge of positive going TTL pulse.

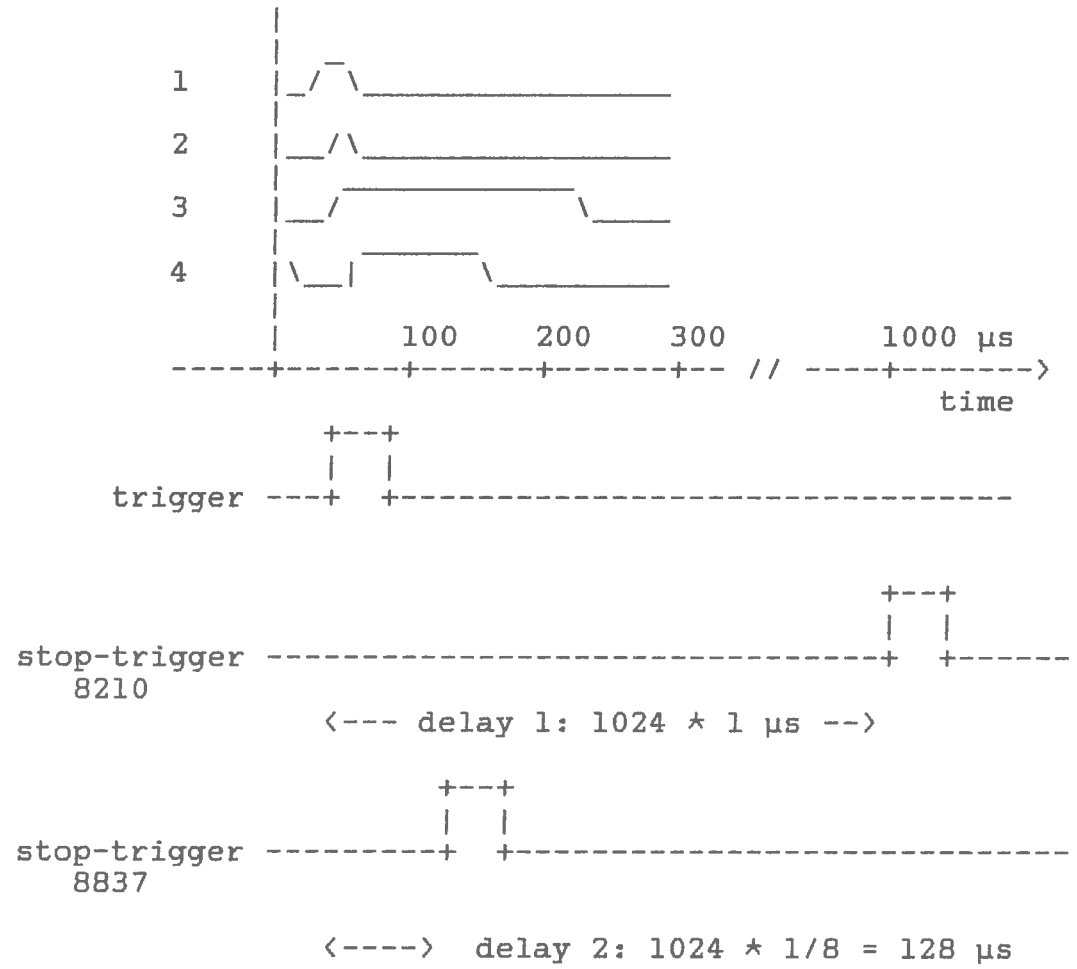
For the 8210 the pulse duration must be greater than 10 ns
" " 8837 " " " " " " " 50 ns.

When the digitizers work at different sampling frequencies, the stop-trigger signals are no longer synchronous if one wants a consistent display. The situation is best seen on an example:

Suppose one wants to study 4 traces over 100 µs;

traces 1 and 2 : to module 8210 @ 1 MHz (100 points)
traces 3 and 4 : to module 8837 @ 8 MHz (800 points)

The PTS must again be set to 7.



2.3 16-channel ADC

A "Simik box" is used for that purpose. The software can handle both fast and slow boxes. The settings must be:

Number of channels: 16

Number of samples: 1

Fast box sampling time: 64 µs (0064)

Slow box sampling time: 1200 µs (16 06)

The box records data whenever a trigger (positive TTL) is sent to it. The precision is 12 bits. Currently the range is set from -5 to +5 Volts.

2.4 16-channel ADC

TTL signals must be wired to the RTI pod inputs A0 - B7.

0 = TTL low if < 0.5 V
1 = TTL high if > 2.0 V

An ungrounded input is 1.

3. The program ACQUI

3.0 System deadstart

* Turn the power ON (PRO 380 and Camac crate)

  After 30 s the 'DIGITAL logo' appears on the screen, then the P/OS menu.

* Select P/OS Tool kit (press the 'down arrow' once, and press DO.

  When the initialization is complete, the PRO 380 can be used like a PDP 11 under RSX11M.

* Type RUN ACQUI

  The main menu is displayed and the system is ready.

```
        Main menu

0  Display this menu
1  Display the CURRENT setup
2  Modify the setup
3  Acquire new data
4  Modify plot/print displays
5  Plot data
6  Read an existing data file
7  Hard-copies "en masse"
8  Print minima and maxima
9  Print ADC values
10 Print digital input values
11 Exits from this program

  Your choice ?
```

Some of the options are documented in the next sections.

3.1 Display of the current setup (option 1)

3.1.1 CAMAC setup

The screen looks like this:

```
Setup of 16-OCT-85 17:25:56

... Camac  test ...
    -----------
        Gyrotron Group & Co
```

Trace	Select	Slot	Module	Freq	Memory	Trig	A (Min.)	B (Max.)	Name	Unit
1	1	2	8210	1000k	8	7	-5.0000E+00	5.0000E+00	Trace 1	Volt
2	1	2	8210	1000k	8	7	-5.0000E+00	5.0000E+00	Trace 2	Volt
3	1	2	8210	1000k	8	7	-5.0000E+00	5.0000E+00	Trace 3	Volt
4	1	2	8210	1000k	8	7	-5.0000E+00	5.0000E+00	Trace 4	Volt
5	1	6	8210	1000k	8	7	-5.0000E+00	5.0000E+00	Trace 5	Volt
6	1	6	8210	1000k	8	7	-5.0000E+00	5.0000E+00	Trace 6	Volt
7	1	6	8210	1000k	8	7	-5.0000E+00	5.0000E+00	Trace 7	Volt
8	1	6	8210	1000k	8	7	-5.0000E+00	5.0000E+00	Trace 8	Volt
9	1	12	8837	1000k	8	7	-5.1200E+02	5.1200E+02	Trace 9	mV
10	1	14	8837	1000k	8	7	-5.1200E+02	5.1200E+02	Trace 10	mV

```
Hit <RETURN> to see ADC setup
```

Select: Trace selector 1: trace is present
= will be read from Camac

0: trace is absent

Slot: Position of module in Camac crate

Memory: Camac memory size in K (always 8)

Freq: Sampling frequency (k stands for kHz)

Trig: Number of post-trigger samples in K (1K = 1024)

A, B: Physical range
The default values are the module maximum input voltage:
8210 : [-5.0 V to 5.0 V] (0 to 1024)
8837 : [-512. mV to 512. mV] (0 to 256)
If pre-amplifiers are in use, A & B should be changed to reflect the calibration.

Name: Trace name (up to 8 characters)

Unit: Physical unit (up to 4 characters)

At the top of the table: 3 lines (up to 32 characters) of comments to describe the experiment.

Remarks:

1) The front-panel settings of the Camac modules are read in each time this display is called. If you modify the settings while this display is active, you must reselect it in order to see the change.

2) The information which cannot be entered via the front-panel switches can be modified by using option 2 (section 3.2).
Ex.: The A & B constants, or all the settings of the TR8837F which has no front-panel switches.
The external sampling frequency can also be entered by using option 2.

3.1.2 ADC setup

```
Setup of 16-OCT-85 17:25:56

... ADC  test ...
    ---------
        Gyrotron Group & Co

Input Select  A (Min.)    B (Max.)       Name          Unit

  1     1   -5.0000E+00  5.0000E+00 Analog input    1 Volt
  2     1   -5.0000E+00  5.0000E+00 Analog input    2 Volt
  3     1   -5.0000E+00  5.0000E+00 Analog input    3 Volt

.....................................................

 16     1   -5.0000E+00  5.0000E+00 Analog input   16 Volt

Hit <RETURN> to see digital inputs setup
```

3.1.3 Digital inputs setup

```
Setup of 16-OCT-85 17:25:56

... Dig. Inp. test ...
    --------------
        Gyrotron Group & Co

Input Select            Name

  1     1   Digital input number    1
  2     1   Digital input number    2
  3     1   Digital input number    3

.....................................................

 16     1   Digital input number    16

Hit <RETURN> to return to the main menu
```

3.2 Modify the setup (option 2)

The following sub-menu is displayed:

```
Modify setup menu

0 Display this menu
1 Define trace parameters
2 Enter comments
3 Display CAMAC setup
4 Define  ADC setup
5 Display ADC setup
6 Define  setup of digital inputs
7 Display setup of digital inputs
8 Save setup on disc
9 Return to main menu

  Your choice ?
```

Typing 1: allows you to change all the parameters listed in section 3.1, except the parameters which have to be set manually on the modules 8210. All User's inputs are checked for plausibility.

- You can choose if you want automatic restart of the camac modules after readout or not.

- If you want to use an external clock for the sampling frequency, select "ext" on the front panel of the 8210 before to select the modify setup option. The program will thus know that the module is on "external" and will ask you to enter the frequency.

Typing 2: allows you to change only the comments (3 lines of 32 characters).

Typing 3: produces the same display as the one shown in 3.1.1

Typing 8: saves the current setup in a disc file (ASCII) named SETUP.ACQ. The file can be displayed or printed using the standard DCL commands TYPE or COPY (one must first exit from ACQUI).
Saving the setup saves the User from having to redefine all the trace parameters the next time he runs ACQUI. This file is read in automatically during the initialisation of the program.

Typing 9: Returns to the main menu.

3.3 Acquire new data (option 3)

All selected traces are read in sequentially and stored in a disc file named Gnnnnn.SHT, where nnnnn is the shot number. The shot number is automatically incremented and saved into an auxiliary file, so the User does'nt have to remember it. Writing twice the same file is also not possible.

After readout, the digitizing can be optionally restarted.

In this version, each trace has 1024 points. To conserve disc space, the data is stored in binary form. The length is thus (4*nt+1) blocks of 512 bytes, nt being the number of traces. The hard disc size is 65000 blocks.The directory is [GYRO]; the files can be listed, copied, deleted by using the DCL commands. (First, you have to exit from the program ACQUI. Type HELP to get information about system commands.)

If the disc becomes full, you can transfer files to another PRO or PDP 11 by using KERMIT. The procedure is described in appendix E.

If no stop-trigger has been sent before the readout, the modules will be stopped by software, but in this case, the synchronization between the modules will be lost! The message 'LAM test' may appear on the screen while the module is busy taking the required number of post-trigger samples.

3.4 Modify plot/print displays (option 4)

A table similar to this one is displayed on the screen:

Trace	Selec	Displ	First sample #	Time/div [µs]	Physical Y-values Min.	Max.
1	1	1	1	1.00E+02	-5.00	5.00
2	1	1	1	1.00E+02	-5.00	5.00
3	1	0	1	1.00E+02	-5.00	5.00
4	1	0	1	1.00E+02	-5.00	5.00
5	0	0	1	1.00E+02	-5.00	5.00
6	0	0	1	1.00E+02	-5.00	5.00
7	0	0	1	1.00E+02	-5.00	5.00
8	0	0	1	1.00E+02	-5.00	5.00
9	1	1	1	1.00E+02	-512.00	512.00
10	1	1	1	1.00E+02	-512.00	512.00

Display mode: Raw data

Modify display menu
---

1 Modify values in the above table
2 Modify Time/div for all traces in one go
3 Plot data
4 Return to the main menu

Your choice ?

Typing 1 allows you to change the following parameters.

Select: Trace selector 1: trace is present (see 3.1)
                        0: trace is absent

Displ: Display selector 1: trace will be displayed
                          0: trace will not be displayed

First sample # : Number of the first sample shown on the screen (Y-t display).

Time/div. : The time axis has 10 divisions, so the time axis length is 10 times the value printed in this column.

Physical Y-values : Lower and upper bounds for the display. The default values are the physical range of the trace (constants A & B section 3.1).

Two displays can be selected:

- Raw data: Values are shown from 0 to 1023 for the 8210
  " " " " 0 to 255 for the 8837

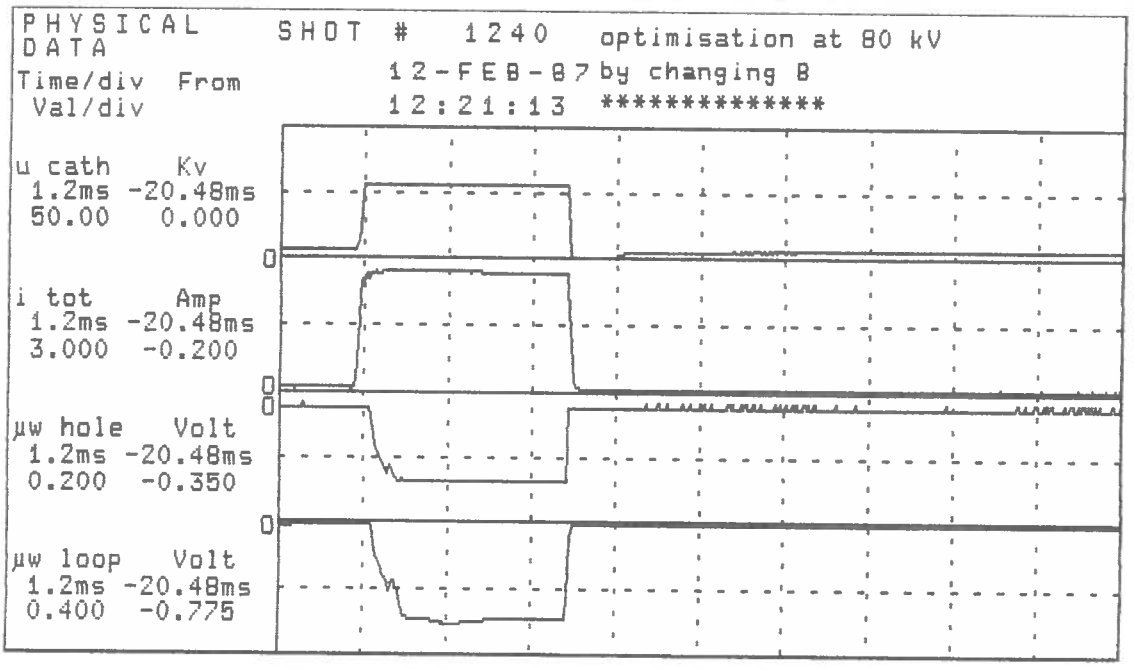
- Physical data: Values are scaled to the physical range.

Typing 2 allows you to change the time scale of all the traces by entering only one input.
Typing 3 plots the data (and return to the main menu)

At the end of the session, all the display setup information is saved onto the disc. (File DSETUP.ACQ).

3.5 Plot data (option 5)

Produces nice displays on the screen. Use the key 'Print screen' to get a hard copy.



3.6 Read an existing data file (option 6)

The User is prompted to enter the shot number. Since the traces have been stored with the corresponding setup information, the data can immediately be displayed.

3.7 Hard-copies "en masse" (option 7)

Since the LA210 printer in rather slow in graphic mode (2 minutes/full screen), it is recommended to use this option. The user is asked for the first and last shot number. Non existing shots will be skipped. The display setup is the same for all shots.

3.8 Print minima and maxima (option 8)

Displays in physical units the minimum, maximum and plateau of each trace.

```
Shot #   720          output power
21-JAN-87                  67 kv
17:44:59                   b=-1%

#   Name      Unit    Minimum     Maximum          Plateau              Integral
                                                                       [Units*s]
1   u cath    kv       -7.42       79.3        75.74       -4.728       0.751
2   i tot     amp     -0.176       2.85        2.600     -0.978E-01     0.219E-01
3   µw hole   volt    -0.908     0.977E-02  0.4717E-02  -0.8714       -0.744E-02
```

3.9 Print Analog values (option 9)

```
Shot #   720          Test Analogs
23-APR-87
17:44:59

 Analog input        Value     unit

Ophelia 1 cur.     4.0000E+02 Amps
Ophelia 2 cur.     3.7500E+02 Amps
.....................................

Level He C.B       3.6600E+01  %
```

3.10 Print Analog values (option 10)

```
Shot #   720          Test Dig. Inputs
23-APR-87
17:44:59

       Digital input name        Value

 1 Valve CV112                     0
 2 Valve CV111                     1
.....................................
16 Current lead band heater        1
```

Appendix A List of source files - directory [CAMAC]

ACQUI Version 4

File	Routines
ACQUI.FTN	Main program, blockdata, hardco
RSETUP.FTN	Rsetup
MSETUP.FTN	Msetup
RCAMAC.FTN	Rcamac, wrlrec
READSHOT.FTN	Rshot, relrec
CAMAC.FTN	Camini, camswi, ca8210, ca8837
CAMFUN.FTN	Camfun
READTRACE.FTN	Re8210, re8837, camrd
MODPLO.FTN	Modplo, disset
PLTDAT.FTN	Pltdat, grid
TITLE.FTN	Title, scales
DSPTRA.FTN	Dsptra, trigpt, zeropt
PRIDAT.FTN	Pridat
IEEE488.FTN	Include file for camini and camfun
ADCACQ.FTN	Adcacq, adcdis
DIGADC.FTN	Digacq, digdis
ACQUI.CMD	Command file containing everything to task-build the program
UTIL.FTN	Conversation subroutines (UTIL.OLB) in directory [Lib]

To compile: FOR file/SOURCE/NOMAP

To task-build: @ACQUI

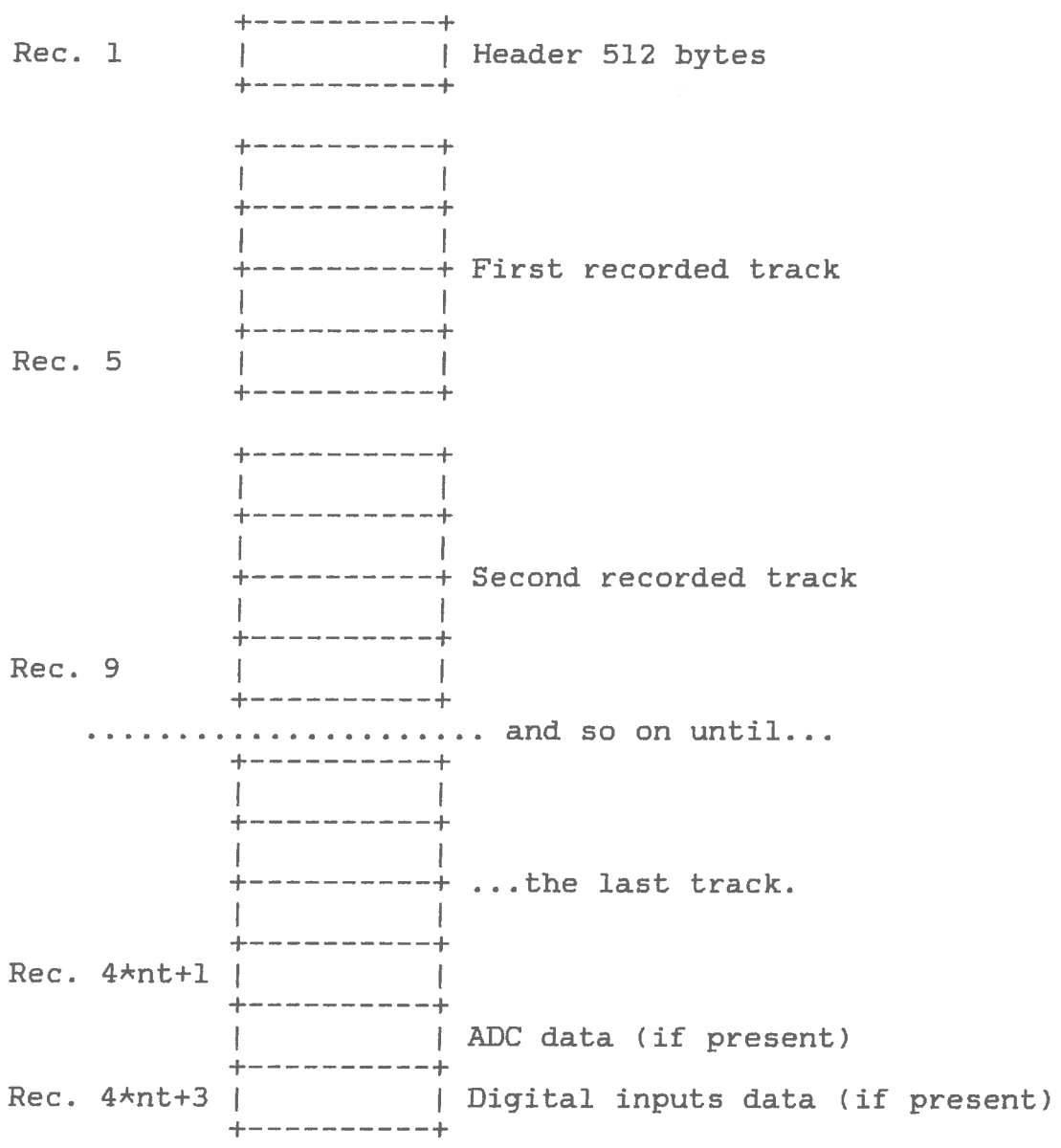
(Upper limit = 140000, APR 7 is used for I/O, APR 6 for resident libraries.)

Auxiliary files in directory [Gyro]: SETUP.ACQ present setup
DSETUP.ACQ display setup
NSHOT.ACQ last shot number

The user-ready task ACQUI.TSK resides in [Gyro].
Further versions of ACQUI should be developed in directory [Camac] and transferred to [Gyro] only when they are tested and documented.

Appendix B Structure of the shot file [GYRO]Gnnnnn.SHT

Records of 512 bytes = 1 block



To access the file, the parameters of Call OPEN are:

```
ACCESS='direct', FORM='unformatted',
RECL=128, BLOCKSIZE=512
```

Structure of the header block

Integer array IHEAD(16,16)

IHEAD(i,j) i-->

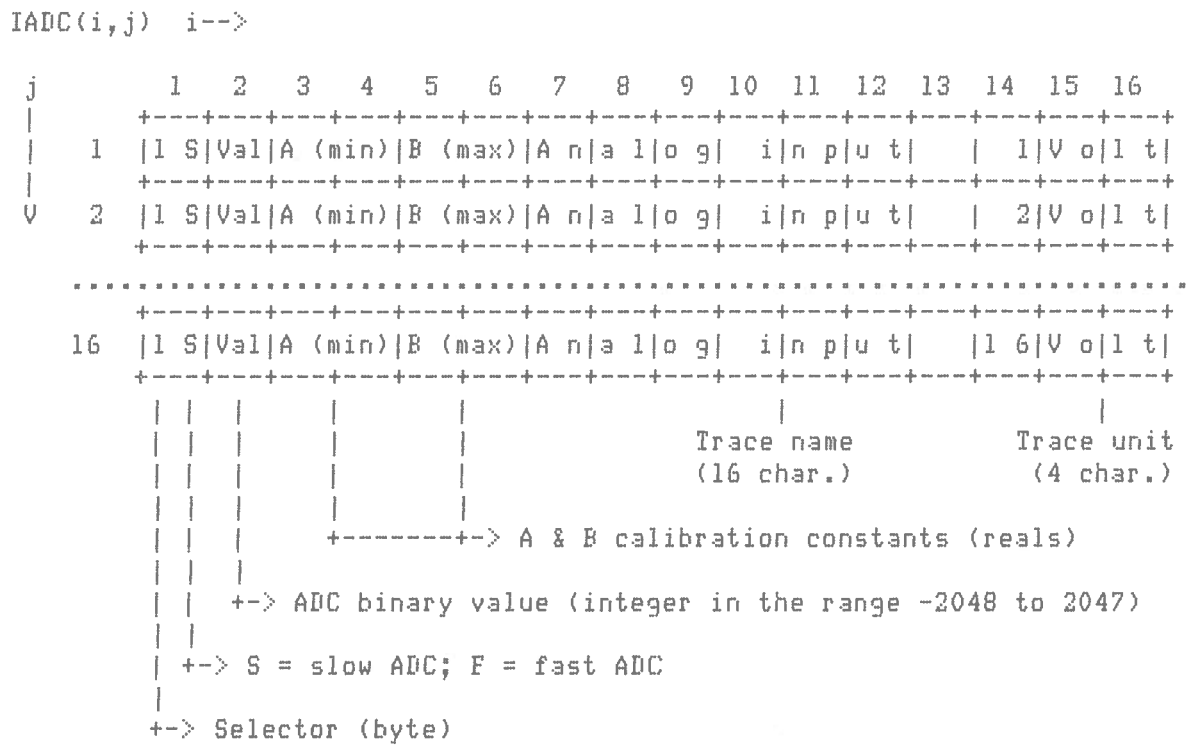
j \ i	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	Shot#	1	2	-	0	C	T	-	8	5	1	4	:	0	0	:	0	0	x	y				s
2	1	s	t		L		i	n	e		o	f	c	o	m	m	e	n	t	s	.	.	.	.	.	.	.	.
3	2	n	d		L		i	n	e		o	f	c	o	m	m	e	n	t	s	.	.	.	.	.	.	.	.
4	3	r	d		L		i	n	e		o	f	c	o	m	m	e	n	t	s	.	.	.	.	.	.	.	.
5	1	10	8210	1000	8	1			0		A (min)		B (max)		P	o	w	e	r		P	g	W	a	t	t		
6	1	10	8210	1000	8	1			0		A (min)		B (max)		U	c	o	l	1	e	c	t		k	V			
7	1	10	8210	1000	8	1			0		A (min)		B (max)		N	a	m	e		Unit								
8	1	10	8210	1000	8	1			0		A (min)		B (max)		N	a	m	e		Unit								
9	1	12	8210	1000	8	1			0		A (min)		B (max)		N	a	m	e		Unit								
10	1	12	8210	1000	8	1			0		A (min)		B (max)		N	a	m	e		Unit								
11	0	12	8210	1000	8	1			0		A (min)		B (max)		N	a	m	e		Unit								
12	0	12	8210	1000	8	1			0		A (min)		B (max)		N	a	m	e		Unit								
13	1	18	8837	32000	8	1			0		A (min)		B (max)		N	a	m	e		Unit								
14	1	20	8837	16000	8	1			0		A (min)		B (max)		N	a	m	e		Unit								
15																												
16	- F r e e -																											

```
                                                    Trace name  and  unit
                                                    ( 8 char.)   (4 char.)
                                                    |
                                                    +--> Calibration constants
                                                  +----------> A & B  (real)
                                                +--> External frequency in Hz
                                              +--> Post-trigger samples in K  (byte)
                                            +--> Memory size in K  (byte)
                                          +--> Frequency in kHz  (integer) (if=0 module on 'ext')
                                        +--> Module number  (integer)
                                      +--> Slot # in Camac crate  (byte)
                                    +--> Selector  (byte)
```

(x) IHEAD(11,1) = 1 if ADC Simik box is present
(y) IHEAD(12,1) = 1 if Digital inputs present
(s) IHEAD(16,1) = size of the file in blocks

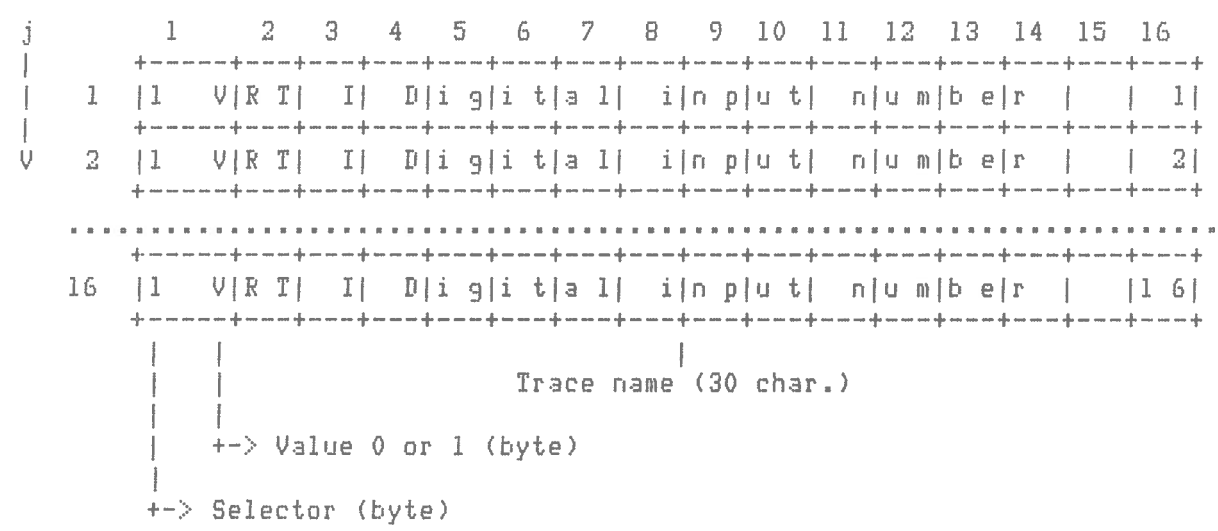
Data block for ADC's

Integer array IADC(16,16)



Digital input data block

Integer array IDIG(16,16)



Appendix C Settings to get the best resolution on the screen

(i.e. the maximum number of points on the horizontal axis.)

Full screen range	Time/div	8210 setting [us]	8837 freq [MHz]	# points 8210	# points 8837	8837 range in div.
100 ms	10 ms	100	0.5	1000	1000	0.1
40 ms	4 ms	40	0.5	1000	1000	0.25
20 ms	2 ms	20	0.5	1000	1000	0.5
10 ms	1 ms	10	0.5	1000	1000	1.
4 ms	400 µs	4	0.5	1000	1000	2.5
2 ms	200 µs	2	0.5	1000	1000	5.
1 ms	100 µs	1	1.	1000	1000	10.
500 µs	50 µs	1	2.	500	1000	10.
250 µs	25 µs	1	4.	250	1000	10.
100 µs	10 µs	1	8.	100	800	10.
50 µs	5 µs	1	16.	50	800	10.
30 µs	3 µs	1	32.	30	960	10.
On "external" :						
200 ms	20 ms	ext 5000 Hz	0.5	1000	1000	0.05
400 ms	40 ms	ext 2500 Hz	0.5	1000	1000	0.025
1 s	100 ms	ext 1000 Hz	0.5	1000	1000	0.01
2 s	200 ms	ext 500 Hz	0.5	1000	1000	0.005
4 s	400 ms	ext 250 Hz	0.5	1000	1000	0.0025
10 s	1 s	ext 250 Hz	0.5	1000	1000	0.001

Appendix D Error messages and trouble-shooting

Error	Possible action
Camac fails to answer	Power up Camac. Check GPIB cable connection.
Cannot read the front-panel switches of 8210 module	Correct the slot number of this module in the setup (3.1).
Please set the number of input channels of 8210 module in slot ... to 4	Pre-set manually the 8210.
Cannot send the settings to the TR8837F module in slot ...	Correct the slot number in the setup. Possible problem with the GBIP connection. If persistent, run the test program [IEEE488]RD8837 to localize the fault. Start and stop manually.
ADC - Simik - ERROR OR TIME-OUT ON DATA INPUT	Power up the Simik box. Check the RS232 cable (SLU 1). Use test program [ANALOG]ADCSIM to localize the fault.

Useful phone numbers for further help:

021 47 34 90	A.Perrenoud	Responsible of this system CRPP
022 82 33 55	M.Lamable	Maintenance of digitizers
	Vincelli	Maintenance
	R.Chevalley	Managing director
	C.Marchiando	Ingénieur software
	C.Durand	Ingénieur de vente Lecroy Research Systems S.A. Route du Nant-d'Avril 101 P.O. BOX 341 1217 Meyrin 1
021 47 45 87	J.Virchaux	Responsable SIG pour les mini-ordinateurs. A contacter avant d'appeler DEC. No. du système: WF51418494
021 47 41 47	Pittori	Contrats de maintenance DEC
021 27 45 61	P.Howald	Ingénieur de vente chez UNICS Av. de Cour 26 1007 Lausanne
01 829 92 22		DEC Zürich
022 43 59 40	Pralong	Ing. field service PC
	Agassiz	Ing. field service PC DEC Genève

Appendix E File transfer using KERMIT

14-APR-87

KERMIT is a communication software, which is becoming increasingly popular at the EPFL. It runs on mainframes as well as on mini computers or PC, and allows file transfer between them. KERMIT is usually well documented and has built-in "help features".

Here is the procedure to transfer files via EPNET from the PRO 380 at Ecublens to the PDP 11/44 of the CRPP à l'Avenue des Bains.

0. (Exit from program ACQUI)

1. Return to P/OS menu (hit the key Exit)

2. Select Additional applications
   Select PRO/Kermit version 1.0

3. Select Connect to host computer

4. Type C CRPP.44
   Hit the key <RETURN> to get the prompt >
   Enter your Userame and password: HEL GYRO/GYRO
   Terminal type: VT100

5. Type @KERMIT
   After initialization KERMIT prompts you for commands. Enter:
   Kermit-11>SET FIL BIN
   Kermit-11>SERVER then type <CTRL>\ C

6. You are now back in Kermit menu.
   Select Send a file to host
   The content of the directory [GYRO] is listed on the screen.
   Select the files to transfer by hitting the key 'Select' and press 'Do' when you are through.

7. When the transfer is completed, type 'Resume' to get back to the Kermit menu.
   Select Bye - Logout server Kermit and exit to P/OS.

8. You may login again on CRPP.44 to check that your files are there.

The program ACQUI is also available on the PDP 11/44, so you can analyze your data there, and produce hard-copies on the Versatec.

Notes: At point 5, if you get the message 'Line TT5: busy', try another line: SET DEF TT6:

Transmission is rather slow (2'20" for 8 traces of 1024) due to the communication protocol (encoding of binary data, checksum). On the PRO, the serial port speed is set to 9600 baud.

The storage of more than 600 blocks is not allowed on the disc DL1: of CRPP.44. Move it onto a private disc a.s.a.p.