Pixirad-1 DAQ Network Interface

To communicate with Pixirad-1 box a TCP connection must be opened to the port “2222”. By default, if no DHCP Server is enabled on the box network, Pixirad-1 gets “192.168.0.1” as IP address. A command can then be sent and the connection closed again. Each command is LF (“\n”) terminated and has the same structure including the command name and parameters separated with blanks. Only capitals are admitted. Here's an example:

“DAQ:! INIT -20 1 300 1\n”

The example command sets the Detector temperature to -10°C activating the cooling system (1), sets the HV to 300V and applies it to the detector (1).
Commands at different levels are provided to manage the cooling system, detector configuration and acquisition status. A small set of High Level commands is listed below, other low levels commands are listed in table 1.
The command string always has the same following structure:

CmdName(Blank) Parameter1(Blank)....Parameter n'\n'

High Level Commands

R stays for decimal number string representation
N stays for Integer number string representation
S stays for String

DAQ:! INIT *CoolT CollStatus HVVal HVStatus*

Parameters

CoolT	(N) Detector Cooling temperature set (°C)
CollStatus	(N) Detector Coling System Status (“1”: On, “0”:Off)
HVVal	(N) Detector Bias Voltage (V)
HVStatus	(N) Detector Bias Status (“1”:On ,“0”:Off)

Description

Sets the detector Bias And cooling status;

DAQ:! SET_SYNC *Sync_in_pol Sync_out_pol Sync_out_function*

Parameters

Sync_in_pol	(S) polarity "POS" or "NEG"
Sync_out_pol	(S) polarity "POS" or "NEG"
Sync_out_function	(S) “SHUTTER”, “RODONE” or “READ”

Description

Sets configuration fo synchronization signals available on “SyncIn” and “SyncOut” Lemo connectors. When “SHUTTER” function is selected for SyncOut, it exactly

reproduce the “exposure” signal to the detector. “RODONE”, provide a fast pulse when detector readout phase is completed. “READ” is a signal that stays “High“ during detector read out phase.

DAQ:! SET_SENSOR_OPERATINGS ***HighTh1 LowTh1 HighTh0 LowTh0 VthMax Ref AuFS Dtf Nbi***

Parameters

HighTh1	(N) Threshold Set 1 Register 1 Threshold (4th Color)
LowTh1	(N) Threshold Set 1 Register 0 Threshold (3rd Color)
HighTh0	(N) Threshold Set 1 Register 1 Threshold (2nd Color)
LowTh0	(N) Threshold Set 1 Register 0 Threshold (1st Color)
VthMax	(N) Global Threshold Full Scale DAC value
Ref	(N) Set to “2”
AuFS	(N) Set to “7”
Dtf	(S) “DTF” to configure DeadTimeFree Mode for Detector “NODTF” otherwise
Nbi	(S) “NBI” to configure NBI Mode for Detector “NONBI” otherwise

Description

Sets the internal detector configuration and threshold levels. Values in 0-31 range are admitted and translate in number of electrons depending on VthMax value. For Example, if VthMax=1625 and LowTh1=1 discriminator threshold is set to 50e-, LowTh1=2 sets it to 100e-, and so on. Please note that the step increases for higher values.
Ref and AuFS are detectors internal biasing settings and should be set to “2” and “7” respectively. For a complete correspondence table between Thresholds counts and Threshold Energies please refer to table 3.

DAQ:! LOOP ***Frames Shutt_ms Pause_ms RunMode TrgMode TrsfMode HVMngmt***

Parameters

Frames	(N) Number of frames to acquire;
Shutt_ms	(R) Shutter width (ms);
Pause_ms	(R) Pause in ms;
RunMode	(S) Selects the detector run mode:

“2COL”	Two colors(Thlow, ThHigh threshold set 0);
“1COL0”	One color reg0 (ThLow threshold set 0);
“1COL1”	One color reg1 (ThHigh threshold set 0);
“DTF”	One Color in Dead Time Free(Thlow in threshold set 0);
“2COLDTF”	Two Colors in Dead Time Free(Thlow in threshold set 0 and 1);
“4COL”	Four colors(Thlow, ThHigh threshold set 0 and 1);

TrgMode	(S) Selects the trigger configuration:
“INT”	Internal trigger. Acquisition starts when the LOOP command is received by the box and Frames acquisition is internally triggered;
“EXT1”	External trigger fixed shutter width, a positive (or negative) edge at “SyncIn” triggers the frame acquisition.

Shutter duration is internally managed and set to ***Shutt_ms;***

"EXT2" External trigger variable shutter width. "SyncIn" is directly used to synchronize detector exposure and consequently its readout;

TrsfMode (S) Frame data Transfer Mode:

"MOD" a MODerated data trasfer "protocol" is implemented in data trasfer between Pixirad-1 box and PC (affects data throughput) ;

"UNMOD" a UNMODerated data trasfer (full speed);

HVMngmt (S) Detector High Voltage Bias Management mode:

"AUTOHV" HV is automatically applied and removed when acquisition is performed;

"STDHV" HV status must be explicitly managed sending the INIT command;

Description

Starts detector data acquisition. Depending on the selected run mode a number of "shots" are applied to the detector and related data sent out by the box. Frames come out the box one by one as they are acquired. The PC collecting them must expect to get (# of "Images"):

2 X ***Frames*** in "2COL" and "2COLDTF";

4 X ***Frames*** in "4COL";

1 X ***Frames*** in "1COL0", "1COL1", "DTF";

Number of triggers needed to complete an acquisition is still depending on the selected Run mode and number of frames with the following relation:

1 X ***Frames*** in "2COL", "DTF","1COL0", "1COL1";

2 X *Frames* in "4COL" and "2COLDTF";

DAQ:!!ACQUISITIONBREAK

Parameters

-

Description

Stops the running acquisition; be aware that the syntax for this command is slightly different from others;

DAQ:! AUTOCAL

Parameters

-

Description

Triggers the Detector Offsets Calibration;

DAQ:! SYSTEM_RESET [*Delay_ms]*

Parameters

Delay_ms (R) *Reset Delay in ms after command is received* (Optional)

Description

Triggers the Box Reset; if no delay is set, the detector system resets after 500ms.

Cmd Name	Parameter 1	Parameter 2
DAQ:! SET_VTHMAX	*Vthmax* *UINT32*	-
DAQ:! CONF_GLOB	*global_config[35..32]* *UINT32*	*global_config[31..0]* *UINT32*
DAQ:!AUTOCAL	-	-
DAQ:! SET_THSET	0	
	1	
SRV:! SET_T_MANAGEMENT_ON	-	
SRV:! SET_T_MANAGEMENT_OFF	-	
SRV:! SET_TCOLD	DetectorTemp [°C/100] INT16	
SRV:! SET_HV_ON	-	
SRV:! SET_HV_OFF	-	
SRV:! SET_HV	Detector Bias voltage [V] UINT16	
SRV:! SET_DETECTOR_ON	-	
SRV:! SET_DETECTOR_OFF	-	

Table 1: Pixirad-1 Low Level Command Set

Raw Image Data collection (UDP_Client.exe)

Raw Image data are sent out by the the detector over UDP packets. A console application named udp_client.exe is in charge of collecting datagrams and resemble them in raw image data. During measurement, the images are resembled and individually sent over a TCP socket on the port 4444. Each raw image consists of a (512X476 X 2 + 20) bytes stream. Data are represented as 16-bit unsigned integers in little endian order. The first 20 bytes (10 unsigned shorts) contain the header, then all the 512X476 pixel values follow. Header content is listed in table 2:

Offset (bytes)	Content
0	*0xffff*
2	*0x8000|this_frame_has_aligment_errors*
4	*0x8000|is_autocal_data*
6	*0x8000|-*
8	*0x8000|-*
10	*0x8000|slot_id*
12	*0x8000|Register*
14	*0x8000|-*
16	*0x8000|-*
18	*0x8000|-*

Table 2: Pixirad-1 Raw Image Header

In all the header words bit 15 is always set to '1'. The first header word is always 0xffff. Only some fields are used, others will be in next releases. In the following some meanings:

-)"*this_frame_has_aligment_errors":* informs the receiveing application that UDP packet drops affected the data transfer; if !=0 at least one packet has been lost;
-)"is_autocal_data": must be used to discriminate measurement data and detector offset calibration data; if !=0 the image contains compensation values;
-)"*slot_id*": not yet implemented will, in the next future contains an incremental number for images indexing;
-)"*Register":* indicates which of the two counters in the detector (0/1) generated the image;

For every Image *udp_client.exe* connects to a socket listening on port 4444 (127.0.0.1) send it the (512X467X2 +20) bytes then closes the connection.

Thresholds

As already mentioned, the effective threshold levels applied to the detector come as a combination of two parameters, ***Vthmax*** that affects all the discriminators together with an extremely fine granularity and a "local" setting (***HighTh1,LowTh1, HighTh0, LowTh0)*** which provides a coarse tuning**.** Table 3 shows the correspondence between values for the local threshold setting and thresholds energies (KeV) when ***VthMax*** is set to **2200**.

Threshold (*HighTh1,LowTh1.....)*	Energy [keV]
0	0.0
1	0.5
2	1.0
3	1.5
4	1.9
5	2.4
6	3.0
7	3.5
8	4.0
9	4.6
10	5.1
11	6.3
12	7.4
13	8.7
14	9.9
15	11.2
16	12.6
17	13.9
18	15.3
19	16.8

20	19.8
21	23.0
22	26.3
23	29.9
24	33.6
25	37.3
26	41.4
27	45.4
28	56.5
29	68.5
30	81.5
31	95.6

Table 3: Thresholds values

Table 3 applies to all counters in every exposure modality. Be aware that values 30-31 have been listed just for sake of completeness since they are not really meaningful.