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MONSOON
Generic Detector Head Electronics

Command and Data Stream Interface Description

NOAO Document ICD 6.0

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Revision History

Version	Date Approved	Sections Affected	Remarks
0.1.1	3/8/2002	All	Second release draft
0.1.2	4/29/2002	All	Restructured and changed nomenclature - ncb
1.0	8/9/2006	All	Reformatted and edited - aro

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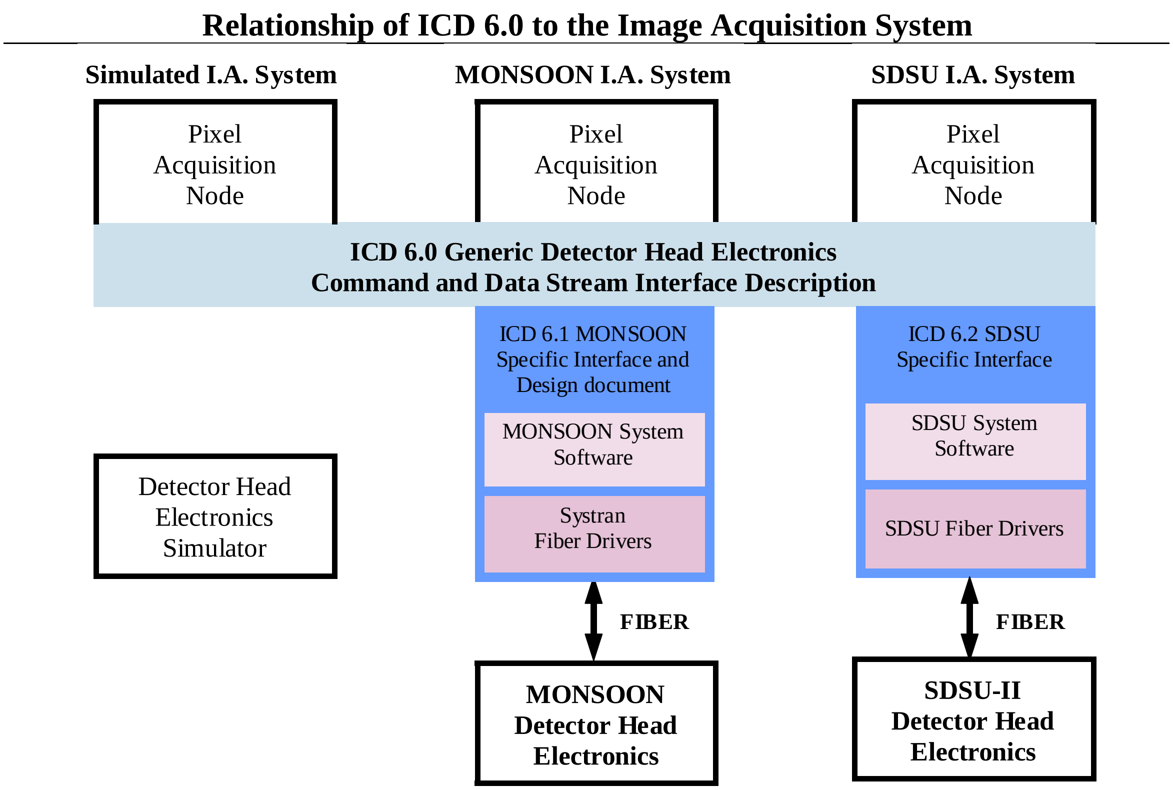
1.0 Introduction

1.1 Scope

This document is a description of the internal interface command and data stream interface between a *Detector Head Electronics* unit and the controlling *Pixel Acquisition Node*. This interface is described so future Detector Head Electronics / Detector Controllers will allow the reuse of all upper level camera, instrument and observation control code.

A companion document, ICD 6.1, describing exactly how the MONSOON Pixel Acquisition Node-Detector Head Electronics interface will be implemented, is available.



Relationship of ICD 6.0 to the Image Acquisition System
Figure 1

1.2 Purpose

This Interface Control Document (ICD) serves four purposes:

- To describe the nature of the communications interface between the Generic Pixel Acquisition Node and its attached Detector Head Electronics
- To describe the parameters that will pass between the Generic Pixel Acquisition Node and its attached Detector Head Electronics.
- To describe the behavior of the command/response interface between the Generic Pixel Acquisition Node and its attached Detector Head Electronics.
- To describe the commands accepted by the Generic Detector Head Electronics.

The document is divided into the following sections:

- Section 1.0 - Introduction
- Section 2.0 - Software Assumptions
- Section 3.0 - Hardware Assumptions
- Section 4.0 - Generic Command Set Description
- Section 5.0 - Data Stream Description
- Section 6.0 – Configuration and Attributes in the Detector Head Electronics

The intended audience for this document is:

- The MONSOON Image Acquisition System Development Group
- The ASTEROID Group
- Anyone else with an interest in the low level details of the Generic Detector Head Electronics Interface

1.3 Acronyms and Glossary

1.3.1 Abbreviations and Acronyms

ADC	Analog to Digital Converter
DAC	Digital to Analog Converter
DHS	Data Handling System
EIDN	Electronic Identification Number
ES	Embedded System
FITS	Flexible Image Transport System
FPA	Focal Plane Array
FPDP	Front Panel Data Port
IAS	Image Analysis System
IDPS	Image Data Preprocessor System
ID	Identifier
IR	Infrared
LAN	Local Area Network
MONSOON	Not an acronym
NICD	NOAO Interface Control Document
N/A	Not Applicable
OCS	Observation Control System
PDT	Parameter Description Table
ROI	Region of Interest
SUS	Status Update System
TBD	To Be Decided

1.3.2 Glossary

Attribute	An entity that describes some aspect of the configuration of a Detector Head Electronics, Image Acquisition System or science instrument. Examples are: the name of a filter, a DAC voltage value, or the tilt angle of a grating. Some attributes will be used by the Instrument Control System as command parameters. The OCS communicates with a science instrument by sending it sets of attributes and values.
Byte	8 bits.
Command	An instruction requiring a system to start some action. The action may result in a voltage change or some internal parameters being set to particular values. A command may have command parameters (arguments) that contain the details of the instruction to be obeyed.
Data Array	The data, while it is stored in data processing memory, which resulted from one or more readouts of an IR array or CCD detector.
Data Set	A self-contained collection of data generated as a result of a Pixel Server obeying a **gpxStartExp** command. Each **gpxStartExp** command results in one and only one data set.
Detector Head Electronics	The lowest level hardware system, normally closely connected to the detector and the dewar in which the detector resides. Sometimes referred to as the Detector Controller.
Exposure	The process and the data resulting from the process of resetting or clearing a detector, exposing it to photons and then reading one or more frames to determine the photon levels. These frames are processed into a data array, called an exposure, which may be further processed. For example, an exposure would be the data array that results when a single Reset-Readout-Integrate-Readout cycle is performed on an IR detector or a single CCD Clear-Integrate Readout cycle.
Frame	The result of a single readout of an array. Each frame represents the signal values obtained from reading the entire ROI being read out of the detector. Multiple frames may be processed into a single exposure.
Generic Pixel Server (GPX)	A set of software routines that implement a pixel server. A Generic Pixel Server does not require any particular set of proprietary hardware or software.

1.3.2 Glossary (Cont.)

Image	The array of detector pixel and description data representing a science or diagnostic exposure or combined set of exposures. An image is capable of being displayed or processed as a discrete entity. The values in the array may be stored in memory or on disk and are related to the data taken by the detector by some processing algorithm. For example, an image may consist of all the co-added and averaged exposures in one beam of a chop mode **gpxStartExp** command.
Image Acquisition System	A system of software and hardware capable of producing images from a detector on command.
Image Server	A system of software and hardware capable of producing images from a detector on command.
Instrument Control System	A set of software routines designed to control and configure a science instrument to take science observations.
Observation	The process of exposing the detector to photons through the telescope in one or more exposures. The result of an observation is a image.
Pixel Acquisition Node	The computer that handles the interface to the Detector Head Electronics and the image pre-processing of the data stream from the Detector Head Electronics.
Pixel Server	A set of software and hardware that accepts commands and produces a set of pixels (an image) related to those commands.
Read	When used as a noun to describe instrument data, a single read of a pixel on the detector. A read may consist of several A/D conversions of the pixel data that are averaged or processed in some other way to produce a single integer output value for the pixel. A readout is made up of one read of each pixel in the detector ROI being read.
Readout	When used as a noun to describe instrument data, a single read of every pixel on the detector. A frame is made up of one or more readouts averaged pixel by pixel.
Region of Interest (ROI)	A sub-array of the available detector area. There are two types of sub-arrays that can be defined. The Sequence ROI is on the active surface of the array used to increase the frequency of the array readout. The Data Reduction ROI is an arbitrary rectangle of any size that fits on the array. Data Reduction ROIs are defined to reduce the volume of data sent to the disk or DHS even when the entire array is being read out.

1.3.2 Glossary (Cont.)

Value	The value associated with an attribute.
Word	Four bytes or 32 bits.
MONSOON Image Acquisition System	A Generic Pixel Server. An extensible, modular Image Acquisition System. The design of the system is, to the extent possible, independent of the hardware being used in a particular implementation. Each component of the system should be capable of replacement by a similar component without having to redesign the rest of the system. Each component of the software is, as far as possible, independent of the underlying hardware and as modular as possible.

1.3.3 Reference Documents

SPE-C-G0037, "Software Design Description", Gemini 8m Telescopes Project.

"ICD/16 - The Parameter Definition Format", Steve Wampler, Gemini 8m Telescopes Project.

WHT-PDF-1, "FITS headers for WHT FITS tapes", Steve Unger, Guy Rixon & Frank Gribbin, RGO.

IEEE Std 610.12-1990 - "IEEE standard glossary of software engineering terminology" - Standards Coordinating Committee of the IEEE Computer Society, USA, 19901210

NOST 100-1.0, "Definition of the Flexible Image Transport System (FITS)",
NASA Office of Standards and Technology.

GEN-SPE-ESO-00000-794, "ESO Data Interface Control Document", Miguel Albrecht, ESO.

NOAO Document MNSN-AD-01-0002 - ICD 4.0 Version 1.0 - "Generic Pixel Server Communications, Command/Response and Data Stream Interface Description", Nick C. Buchholz (NOAO), Barry M. Starr (NOAO), 8/8/2006

1.4 Standard Terminology

To avoid confusion and to make very clear what the requirements for compliance are, many of the paragraphs in this standard are labelled with keywords that indicate the type of information they contain. The keywords are:

- RULE
- RECOMMENDATION
- SUGGESTION
- PERMISSION
- OBSERVATION

These keywords are used as follows:

RULE

<Paragraph Number> Subject Describing Text **RULE**

Rules form the basic framework of this draft standard. They are sometimes expressed in text form and sometimes in the form of figures, tables or drawings. All rules shall be followed to ensure compatibility between components. All rules use the “shall” or “shall not” words to emphasize the importance of the rule.

Example:

3.5 Status and Data Stream Interface **RULE**

RECOMMENDATION

<Paragraph Number> Subject Describing Text **RECOMMENDATION**

Wherever a recommendation appears, designers would be wise to take the advice given. Doing otherwise might result in some awkward problems or poor performance. It is possible to design a system that complies with all the rules but has poor performance. Recommendations found in this standard are based on this kind of experience and are provided to designers to speed their traversal of the learning curve. All recommendations use the “should” or “should not” words to emphasize the importance of the recommendation.

Example:

2.5.1 GPX Names **RECOMMENDATION**

SUGGESTION

<Paragraph Number> Subject Describing Text **SUGGESTION**

A suggestion contains advice that is helpful but not vital. The reader is encouraged to consider the advice before discarding it. Some design decisions that should be made are difficult until experience has been gained. Suggestions are included to help a designer who has not yet gained this experience.

Example:

2.5.2 Long Variables Names **SUGGESTION**

PERMISSION

<Paragraph Number> Subject Describing Text **PERMISSION**

In some cases, a rule does not specifically prohibit a certain design approach, but the reader might be left wondering whether that approach might violate the spirit of the rule or whether it might lead to some subtle problem. Permissions reassure the reader that a certain approach is acceptable and will cause no problems. All permissions use the “may” word to emphasize the importance of the permission.

Example:

2.6 Long Variables Names **PERMISSION**

OBSERVATION

<Paragraph Number>Subject Describing Text **OBSERVATION**

Observations do not offer any specific advice. They usually follow naturally from what has just been discussed. They spell out the implications of certain rules and bring attention to things that might otherwise be overlooked. They also give the rationale behind certain rules so that the reader understands why the rules shall be followed.

Example:

2.7 Long Variables Names **OBSERVATION**

2.0 Software Assumptions

The command set defined in this document is the one used to communicate between the Pixel Acquisition Node computer and the Detector Head Electronics hardware. The command set depends only on passing streams of bytes between the two systems. The systems will interpret this stream as necessary to complete the commands sent.

2.1 Software Systems RECOMMENDATION

While this ICD does not require any particular operating system or hardware, designers should consider the use of some flavor of LINUX as the operating system. It is also important that the Detector Controller and Pixel Acquisition Node be designed and implemented to work together. It highly recommended that the interface software between these two systems run on the same machine.

2.1.1 Software Systems OBSERVATION

As far as possible all software mechanisms and techniques recommended or required in this document are independent of hardware and operating systems. The goal of designs based on this document is reusable systems that will only require changes to a very restricted subset of the entire software system if the hardware or software requirements of the system change.

2.2 Command Completeness OBSERVATION

This command set has been tested against the SDSU, Arcon and WildFire controller command sets. To the extent that many of the same command concepts are used, it is compatible with all of them. However, many commands in each set are not carried forth into this generic command set. These missing commands are redundant in that they can be implemented using one of the generic commands.

3.0 Hardware Assumptions

No assumption is made concerning the exact hardware used to implement the Detector Head Electronics or the Pixel Acquisition Node. However, it is recommended that the interface software between these two systems reside on the same machine.

3.1 Connections RULE

The Pixel Acquisition Node and Detector Head Electronics shall be connected in a way that allows a serial stream of 8-bit bytes to pass between the two units.

3.2 Detector Head Electronics RULE

The Detector Head Electronics shall be capable of acting as a Master or a Slave in triggering the start of an Exposure. That is, it shall be able to generate a trigger when it begins an exposure or it shall be able to start an exposure when it receives an exposure trigger.

3.3 Pixel Acquisition Node

3.3.1 Memory Size **RULE**

The memory space of the Pixel Acquisition Node shall be sufficient to store a minimum of two complete raw data frames and two complete pre-processed data frames.

3.3.1.1 Memory Size **OBSERVATION**

Assuming an IR detector with 16-bit ADCs and 4 million pixels, this assumes 8 million bytes for a raw frame and 16 million bytes for a pre-processed data frame.

3.3.2 Hardware Platform **RECOMMENDATION**

The minimum hardware platform should be a 64-bit PCI backplane with a sufficiently powerful CPU or CPUs to handle the required data pre-processing tasks.

4.0 Generic Command Set Description

4.1 Command Structure **RULE**

Commands shall be structured as a stream of bytes that contain a representation of the command to be executed, followed by any parameters required to execute the command.

4.1.1 Error Checking **RECOMMENDATION**

The communications system that transfers commands between the Pixel Acquisition Node and Detector Head Electronics should include error checking to ensure that each command is correctly transferred.

4.2 Command Processing **RULE**

The Detector Head Electronics shall respond to each command sent from the Pixel Acquisition Node with a single message returned at the time the command is either rejected for an error or accepted as valid.

4.2.1 Response Time **RULE**

Each command response shall come no more than 150 milliseconds after the command is received.

4.2.2 Short Duration Processing Commands **RECOMMENDATION**

Short duration commands, with completion in less than 150 milliseconds, should be determined to be valid after the command processing is complete. These commands include such examples as setting a variable or programming a DAC.

4.2.3 Long Duration Processing Commands **RECOMMENDATION**

For long duration commands (more than a 150 milliseconds), the response should occur after the command has been determined to be valid and before the execution of the command is started. Examples of long duration commands are Start an exposure and read out the Array.

4.2.4 When to Respond **PERMISSION**

The system designer may decide when to respond to a particular command. A system may decide to respond to all commands as soon as the command is determined to be valid and respond with an asynchronous status message when the command actually completes. This should be clearly stated in the ICD for the particular Detector Head Electronics system involved.

4.3 Minimum Response **RULE**

The minimum response to a command shall be the strings “OK” or “ERROR”.

4.3.1 Response Format **PERMISSION**

The response from a Detector Head Electronics system may be in a binary format. However, it should be converted in the Pixel Acquisition Node to a meaningful string format at as low a level as possible.

4.3.2 Additional Response Information **PERMISSION**

The response to a command in any system may include additional information in the form of strings added to the basic “OK” or “ERROR”. The response:

“ERROR - your command failed because the cat died.”

is perfectly acceptable, if somewhat confusing.

4.3.3 Additional Response Messages **PERMISSION**

A system may cause additional responses to be generated from a single command. These additional responses would be in the form of asynchronous status messages (See paragraph 4.5.1, Asynchronous Status Message.)

4.4 Command Descriptions - Pixel Acquisition Node to Detector Head Electronics

The following command descriptions give the generic name for the commands. The representation of the command sent to the Detector Head Electronics in the command byte stream may be different from this generic name. In particular, an equivalent SDSU-II three-letter command or a byte code that will be used in a MONSOON message header may be used to represent the command. See Appendix I, Table 2 for equivalent commands.

Commands either configure the Detector Head Electronics, Set or Request attribute values in the Controller system or initiate actions. The result of action commands like “Read Detector” is determined by the configuration previously setup by the Pixel Acquisition Node configuration.

4.4.0.1 Minimum Command Set **RULE**

The commands in this section are the minimum set which shall be accepted by a Detector Head Electronics unit.

4.4.0.2 Rejecting Commands **RULE**

The commands in the minimum set which a particular Detector Head Electronics system does not implement or which result in no action shall result in a response of “OK” with some explanatory text. Thus if a system does not do a Pause, Exposure command shall respond with “OK Pause ignored”.

4.4.0.3 Invalid Commands — RECOMMENDATION

The “ERROR” response should be reserved for commands that are invalid and/or contain invalid or out of range parameters. A command which is not part of the interface or which could result in damage to the detector is an example of such a command. The command “destroyPlanet” might result in an “ERROR” response.

4.4.1 Read Value — RULE

This command shall read an attribute value from the Detector Head Electronics data store and return the value to the Pixel Acquisition Node in the reply message. A single parameter steers the Detector Head Electronics routine to the correct Attribute.

4.4.2 Write Value — RULE

This command shall write an attribute value to the Detector Head Electronics Data store. The first parameter word steers the Detector Head Electronics to the correct attribute value. The second parameter gives the value to be set.

4.4.3 Read Detector — RULE

This command shall be used to initiate a Detector Readout cycle. The result of this may or may not transmit the data read to the Pixel Acquisition Node computer. The Pixel Acquisition Node makes the decision as to whether data is transferred and it informs the Detector Head Electronics software by setting up a configuration variable.

4.4.4 Reset Detector Head Electronics — RULE

This command shall reset the Detector Head Electronics. The parameter may qualify the level or type of reset. At a minimum, with a ZERO parameter this would reset all of the Detector Head Electronics systems.

4.4.4.1 Partial Resets — PERMISSION

The parameter in the Reset Detector Head Electronics command may be used to give the ID of the subsystem to reset and the level of the reset, assuming more than one level is provided. The decision concerning multiple reset level is left to the system designer.

4.4.5 Abort Read Out — RULE

This command shall cause a previously initiated detector read out to abort. This will halt any data transfer taking place. The command may require additional cleanup actions to clear data transmitters, reset waveform generators and timers.

4.4.5.1 Clean Terminations — RECOMMENDATION

The abort should cleanly terminate any data transfer taking place and the disposition of the partial data transmitted will be cleanly dealt with.

4.4.5.2 Abort Clean-up — RECOMMENDATION

After the reply to the Abort Read Out command is sent by the Detector Head Electronics, the Detector Head Electronics should be ready to execute any valid command.

4.4.6 Detector Head Electronics Power Control — RULE

This command shall control the hardware power systems. This takes two parameters. The first specifies the subsystem to be controlled. The second tells whether the subsystem should be turned on or off. The system designer may elect not to provide such power control.

4.4.6.1 No Power Control Available in Detector Head Electronics — RULE

This command shall be a no-op if the Detector Head Electronics system has no power sub-systems to control. The correct response in this case is "OK - No Power systems to control"

4.4.7 Shutter Control — RULE

This command shall control the state of any shutter-like devices that may be controlled by the Detector Head Electronics directly. It is meant for the control of simple devices like shutters or perhaps polarizers that have only a few states, namely, OPEN-CLOSED, RIGHT-LEFT, and so forth. The parameter shall determine the action to be taken. The details shall be determined by the needs of the device and shall be finalized for each system when that system is designed.

4.4.7.1 Multiple Shutter-like Devices — PERMISSION

A Detector Head Electronics system may have multiple devices that look like shutters. In this case, this command would be expanded to have two parameters. The first will be the state of the device and the second the identifier of the device.

4.4.7.2 Switched Parameters — OBSERVATION

Note that this command reverses the normal pattern of parameters. Because it is expected that most systems will have only a single shutter like device, the device state is placed first. Since those systems that have multiple devices are the exception, giving the identifier second seems reasonable.

4.4.8 Bias Power Control — RULE

This command shall control the method used to power up and down the detector bias voltages. It is not intended for voltage level control. That is handled in a Write Value message. This command shall provide for controlled turn-on or turn-off of the bias voltages. The parameters shall determine the exact turn-on/off method and which biases are to be controlled. The details of this command shall be determined by the needs of the Detector.

4.4.8.1 Minimum Response — RULE

In the absence of bias voltage control within the Detector Head Electronics, the Detector Head Electronics shall respond to this command with "OK - No bias voltage control provided" or some similar indication of the situation.

4.4.8.2 Bias Voltage Control — PERMISSION

A system may either leave bias voltages powered-up all the time or have only a simple on-off state. The system designers will make the determination of what is required based on the Detector involved.

4.4.9 Asynchronous Response **RULE**

This command shall be sent to the Detector Head Electronics in response to an *Asynchronous Status Message*, (See paragraph 4.5.1, Asynchronous Status Message, for a more detailed explanation of these commands), sent to the Pixel Acquisition Node by the Detector Head Electronics. The parameter is the status message ID value passed to the Pixel Acquisition Node in the original Asynchronous Status Message. It determines the nature of the asynchronous message being responded to and will steer the Detector Head Electronics to the correct behavior for this particular response.

4.4.9.1 Ignoring the Asynchronous Response **PERMISSION**

A Detector head electronics system may do nothing except respond when this command is received. A response of "OK" for this command is acceptable.

4.4.9.2 Pixel Acquisition Node Behavior **OBSERVATION**

A Pixel Acquisition Node may initiate a send of this command without the Detector Head Electronics first sending an Asynchronous Status Message to the Pixel Acquisition Node. In this case, the Detector Head Electronics should simply echo the Asynchronous Response Message to the Pixel Acquisition Node.

4.4.10 Read Value Array **RECOMMENDATION**

The Pixel Acquisition Node should request the contents of a specific array of data in the Detector Head Electronics. This could be used for obtaining a block of housekeeping data, to read a section of the Embedded Controller's memory, or to read back the waveforms stored in the waveform table. The maximum length of the returned array is 255 four-byte integers.

4.4.10.1 Detector Head Electronics Behavior **OBSERVATION**

This command can be provided for convenience. It can be duplicated by a string of Read Value commands for successive locations in the Detector Head Electronics.

4.4.11 Write Value Array **RECOMMENDATION**

The Pixel Acquisition Node should modify the contents of a specific array of data in the Detector Head Electronics. The command could be used for configuring the Detector Head Electronics at start-up time or reconfiguring the system during operations. This should also be used to overwrite specific portions of the Embedded System memory. The maximum length of the array to be loaded is 255 four-byte integers

4.4.11.1 Detector Head Electronics Behavior **OBSERVATION**

This command can be provided for convenience. It can be duplicated at the cost of time and complication by a string of Write Value commands for successive locations in the Detector Head Electronics.

4.4.12 Load Wave Form **RECOMMENDATION**

This command should be used so the Detector Head Electronics can load the included waveform into the sequencer output clocking register. The embedded system controller writes the words into the clocking register from the message store. The speed and timing of the writes is determined by the speed of the Embedded System write cycle.

4.4.12.1 Debugging Information **OBSERVATION**

Since the output to the sequencer clocking register will be determined by the speed of the Embedded System write cycle, this command can only be usable as a debugging tool and is not appropriate for controlling most detectors.

4.4.12.2 Mode Setting **PERMISSION**

Detector Head Electronics systems may be built in which the array-clocking wave forms are downloaded over some fast data link to the clocking register while readout is taking place. This command may be used to put the hardware into the mode that results in the link data being written directly to the sequencer output clocking register. Some means will have to be provided which takes the system out of this mode.

4.4.13 Start Exposure **RULE**

This command shall handle arming and possibly starting the exposure sequencer in the Detector Head Electronics. It shall perform the actions necessary for the production of exposures which all have the same Detector Head Electronics configuration. The parameter gives the identifier of the trigger which the will begin the exposure. An identifier of ZERO should result in an immediate start of the exposure. A configuration parameter will determine the timeout value applied to the trigger.

4.4.13.1 Multiple Exposures **PERMISSION**

A Detector Head Electronics system may provide an internal sequencer capable of producing a string of images in a burst. The Pixel Acquisition Node will process these exposures in accordance with its directives.

4.4.13.2 Sequencing **OBSERVATION**

This command might wait for an external trigger, open or close shutters, reset or clear the array and read out the array one or more times, and wait an appropriate integration time between steps. The exact nature of the internal sequencing will be determined by the requirements of the detector being controlled. The upper level system of the Detector Head Electronics will produce a data stream of one or more frames that the Pixel Acquisition Node will deal with according to its data pre-processing configuration.

4.4.14 Pause Exposure **RULE**

This command shall pause an exposure sequence that has been previously started by a Start Exposure command in the Detector Controller. It shall perform the actions necessary to pause the exposure in such a way that a subsequent Resume Exposure can restart the system and the resulting data will be the same as if the Pause had not occurred.

4.4.14.1 No Shutter **PERMISSION**

Systems lacking an internal shutter or for which a Pause will result in the destruction or corruption of data may handle this command by rejecting it with an “OK Pause ignored” message.

4.4.15 Abort Exposure **RULE**

This command shall handle aborting an exposure sequence that has been previously started by a Start Exposure command in the Detector Controller. It performs the actions necessary to abort the exposure as quickly as possible.

4.4.15.1 Data Handling **RECOMMENDATION**

Any data that result from an aborted exposure should be discarded.

4.4.15.2 Data Handling **PERMISSION**

A particular Pixel Acquisition Node system may save the data from an aborted exposure. However, the resulting data should be marked as coming from an aborted exposure.

4.4.16 Resume Exposure **RULE**

This command shall handle resuming an exposure sequence that has been previously paused by a Pause Exposure command in the Detector Controller. It shall perform the actions necessary to resume the exposure in such a way that the resulting data will be the same as if the Pause/Resume had not occurred.

4.4.16.1 No Shutter **PERMISSION**

Systems lacking an internal shutter or which reject the Pause command or which are not currently “Paused” may handle this command by rejecting it with an “OK Resume ignored” message.

4.4.17 Stop Exposure **RULE**

This command shall handle stopping an exposure sequence that has been previously started by a Start Exposure command in the Detector Controller. It performs the actions necessary to stop the exposure as quickly as possible in keeping with the goal that the resulting data be valid.

4.4.17.1 Data Handling **RECOMMENDATION**

Any data that result from a stopped exposure should be saved as if the sequence went to normal completion.

4.4.17.2 Data Integrity **PERMISSION**

A stopped exposure may result in data that is, as far as possible, still valid data. For instance, this means that for systems that do Fowler Sampling the second readout of the array may include as many Fowler Samples as the first readout of the array.

4.4.18 TestDatalink **RECOMMENDATION**

4.4.19 TestClockDrivers **RECOMMENDATION**

4.4.20 TestDCBiasSup **RECOMMENDATION**

4.4.21 TestA/DConv **RECOMMENDATION**

4.4.22 TestD/AConv **RECOMMENDATION**

4.4.23 TestDIOCircuit **RECOMMENDATION**

These commands may allow the testing of various portions of the Detector Control system. The details of these commands are to be determined by the system designers and by what test facilities they provided in the hardware. At a minimum, tests of the communications link, DAC's and Bias control system should be provided.

4.5 Command Descriptions Detector Head Electronics to Pixel Acquisition Node

4.5.1 Asynchronous Status Message **RECOMMENDATION**

This command should be sent by the Detector Head Electronics in response to some change in status in the Detector Head Electronics. This could be a power glitch, a spontaneous reset of some part of the Detector Head Electronics or simply telling the Pixel Acquisition Node that the integration has 15 seconds to go. Parameter 1 is used as a message ID that identifies the reason for the message. Parameter two tells the Pixel Acquisition Node whether the Pixel Acquisition Node needs to respond to the message. Parameters 3 - MsgLen may be a string message that may be passed to the user as to inform them of the status change.

4.5.1.1 Status Response **PERMISSION**

A Detector Head Electronics System may decide not to implement this command. This would require the status of the Detector Head Electronics to be discovered by a series of Read Value or Read Value Array commands.

4.5.2 Available For Expansion

5.0 Data Stream Description

5.0.1 Data Transfer Protocols OBSERVATION

Note that one of the basic design tenets of new systems that will meet this ICD is that the data transfer rates will be large. Every effort should be made to reduce the data transfer overhead to a minimum.

5.1 Data Format RULE

The data produced by the Detector Head Electronics shall be in a standard format. No assumption shall be made as to the order in which the data is produced by the Detector Head Electronics. However, it is assumed that the data will be stored in contiguous memory locations in the Pixel Acquisition Node memory.

5.1.1 Acceptable Standard Formats RULE

Acceptable standard formats shall be as follows: Single byte unsigned integers - numbers 0 to 255; Single byte signed integers - numbers -128 to +127; Two byte unsigned Integers - numbers 0 to 65536; Two byte signed integers - numbers -32768 to 32767; Four byte unsigned integers - numbers 0 - 4294967296; Four byte signed Integers - numbers -2147483648 to 2147483647, Four byte IEEE floating point numbers.

5.1.2 Data Location RECOMMENDATION

The Pixel Acquisition Node Software should specify the address location of the incoming data. The data produced by the Detector Head Electronics should be placed in the designated memory location of the Pixel Acquisition Node without further handling by the Pixel Acquisition Node Software.

5.1.3 Data Alignment RULE

The data loaded into the memory of the Pixel Acquisition Node shall be aligned by the Detector Head Electronics software drivers to comply with the alignment standards of the Pixel Acquisition Node. Thus, if two-byte Integers are being transferred, the integers shall be placed on even address boundaries.

5.1.4 Data Block Size PERMISSION

The size of the data block transfer between the Detector Head Electronics and Pixel Acquisition Node when data is being transfer may be left to the discretion of the system Designers.

6.0 Configuration and Attributes in the Detector Head Electronics

6.0.1 Configuration and Control Philosophy — OBSERVATION

As a basic philosophy, the Pixel Acquisition Node and Detector Head Electronics treat all configuration attributes and parameters as if they were simple 'C' variables or locations in memory (memory mapped variables). This allows the Pixel Acquisition Node system to ignore the details of what is being set and how it is set. Only the actual set or read routine in the Detector Head Electronics will know that a value is actually set or read by manipulating some hardware.

Settable voltages, gain setting hardware and waveform memory are all treated as if they were just locations in memory to be set. This will allow isolation of the Pixel Acquisition Node software from the exact Detector Head Electronics hardware. It should be possible to substitute a different set of Detector Head Electronics hardware without changing any of the basic code in the Pixel Acquisition Node. The expectation is that removing the intelligence from the Detector Head Electronics hardware would only require writing to a hardware driver that appropriately manipulates the new hardware.

6.1 Detector Head Electronics Capabilities — RULE

Certain capabilities shall be assumed for the Detector Head Electronics.

6.1.1 Configuration Publication — RECOMMENDATION

The Detector Head Electronics should be able to respond to requests for the serial ID numbers of every identifiable unit in the system. It is planned that every electronics board in the Detector Head Electronics will be given a unique electronic ID. The Detector Head Electronics must be able to publish a list of those EIDN's on request of the Pixel Acquisition Node. This will use one of the standard commands, either readValue or readValArray.

6.1.2 Error Recovery — RECOMMENDATION

6.1.3 Synchronization to an External Trigger — RULE

6.1.4

6.1.5

6.1.6

6.1.7

6.2 Pixel Acquisition Node Capabilities

Certain capabilities are assumed for the Detector Head Electronics.

6.2.1 Capability Determination from Configuration RECOMMENDATION

6.2.2 Error Recovery RECOMMENDATION

6.2.3 Re-synchronization with a Detector Head Electronics in Error Recovery RECOMMENDATION

6.2.4

Appendix I Generic Name vs. SDSU & MONSOON Command Summary Table

Table 1 - Generic Name vs. SDSU & MONSOON Command Summary

Generic Command Name	Equivalent SDSU Command	Equivalent MONSOON Byte Code	No. of Parameters	Notes
Read Value	RDM	0x01	1	Read a parameter value
Write Value	WRM	0x03	2	Write a parameter value
Read Detector	RDC	0x07	0	Start the Detector Readout
Reset D.C.	RST	0x09	1	Perform a reset of the requested system
Abort Readout	ABR	0x0B	0	Halt detector readout in progress
Detector Head Electronics Power Control	PON	0x0D	1	Turns on analog hardware power
	POF			Turns off analog hardware power
Shutter Control	OSH	0x11	1	Open shutter
	CSH			Close shutter
BiasPowerCon	SBV	0x13	1	Activates the voltages in a controlled way
Asynchronous Response	---	0x15	1	Response from the upper level system in response to an Async Status message
Start Exposure	SEX	0x17	1	Start exposure
Pause Exposure	PEX	0x27	1	Pause exposure
Abort Exposure	AEX	0x37	1	Abort exposure
Resume Exposure	REX	0x47	1	Resume exposure
Stop Exposure	---	0x57	1	Stop exposure
Read Value Array	---	0x19	2	Read an array of values to the Embedded system
Write Value Array	---	0x21	2-255	Write an array of values to the Embedded system (Configuration, Waveform table load, etc.)
Load Waveform	---	0x05	2-255	Loads the message body into the Sequencer ClkOut register
TestDatalink	TDL	0x1F	1-255?	Test Data Link
TestClockDrivers	TCK	0x2F	1-255?	Tets Clock Drivers
TestDCBiasSup	TDC	0x3F	1-255?	Test DHE Bias supplies
TestA/DConv	TAD	0x4F	1-255?	Test A/D converter
TestD/AConv	TDA	0x5F	1-255?	Test D/A converter
TestDIOCircuit	TDG	0x6F	1-255?	Test digital I/O circuit
asyncStatusMsg	---	0x23	2-255?	Send a message to the PAN announcing a status change

Table 1 - Generic Name vs. SDSU & MONSOON Command Summary (Cont.)

Generic Command Name	Equivalent		No. of Parameters	Notes
	SDSU Command	**SDSU Command**		
---	LDA	0xF1		Not used
---	IRQ	0xF2		Not used
---	IDL	0xF3		Not used
---	STP	0xF4		Not used
---	CLR	0xF5		Not used
---	HGN	0xF6		Not used
---	LGN	0xF7		Not used
---	SYR	oxF8		Not used

Appendix II Parameter Lists

- Rows - number of rows in the controlled detector.
- Columns -number of columns in the controlled detector.
- Fowler Samples
- Co Add Frames -
- binning
- intTimeSecs
- intTimeMSecs
- dac Value *N* -
- gain Value *N* -
- num of exposures -
- Settling Delay -
- digital Averages
- Dig Avg Method

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