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Red
Imaging
Detector

SDSU INTERFACE CONTROL DOCUMENT
VERSION 6.0

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Version Summary

This version builds upon the functionality of Version 5.0 and adds the interface required for the SDSU PCI card.

Introduction

This document describes the protocol used for communication between the Host computer system and the SDSU detector controller that forms part of the INGRID instrument. These sub systems are linked together using two fibre optic cables connected directly between the interface card in the Host Computer and the Timing Board of the SDSU controller. The uplink from Host to SDSU is a slow link operating at 4 MHz which is used for sending commands to the SDSU controller. The downlink operates at 50 MHz and is used for sending responses to the uplink commands and also image data to the Host System. There is also an electrical communication serial link operating between the Timing Board and Utility Board in the SDSU controller using the standard Motorola DSP SSI interface.

This document presents the protocol in a table format. The significance of each of the columns is as follows:-

Column 1 = Executable Command
Column 2 = Originator of Command
Column 3 = Destination of Command (specifies if available after BOOT or only when an application APPL has been uploaded)
Column 4 = Number of words in command
Column 5 = Response to the command

Column 6 = Specifies the action taken on receiving the command
Column 7 = Remarks and more information

The format of the messages sent between HOST and SDSU has been described many times elsewhere; suffice to say that each command or response consists of 2 – 7 words. Each word is made up of 33 bits. Of these, 24 bits are valid and the rest are used as header information. The programmer need not worry about this header information. The hardware strips away the header information to leave the expected 24 bit word, which is then processed by the SDSU controller.
The downlink is used for responses and image data. When transmitting image data, then it takes the form of 17 bit words, with one stop bit and 16 data bits. The host programmer should know when to expect the 33 bit packet or 17 bit packet and act accordingly. Again this is described in more detail in the SDSU documentation.

The intended audience for this document are those who are programming either the Host computer end or SDSU controller end of the fibre links.

This document also gives a table of MailBox addresses in the SDSU controller. These locations are used to communicate variables between host and sdsu and sdsu and host. For this purpose the X: memory area is deemed writable by the host and the Y: memory space readable from the host: The reverse is true for the sdsu controller.

Command	Source	Destin	Words	Response	Action	Remarks
TDL nnnnnn 0≤ nnnnnn ≤ ffffff (BOOT)	**HOST**	**TIMING, UTILITY**	**3**	**nnnnnn**	Test Data Link. Destination echoes nnnnnn back to Source.	
RDM maaaaa 0 ≤ aaaaa ≤ 0ffff (BOOT)	**HOST**	**TIMING, UTILITY**	**3**	**dddddd**	ReaD Memory. Read DSP address maaaaa. Returned data = dddddd. The most significant nibble of the address indicates the memory type. m = 1: P memory m = 2: X memory m = 4: Y memory m = 8: EEPROM	This command is used to read memory locations for low level fault finding or checking the simple variables, e.g. elapsed integration time.
WRM maaaaa dddddd 0 ≤ aaaaa ≤ 0ffff 0≤ dddddd ≤ ffffff (BOOT)	**HOST**	**TIMING, UTILITY**	**4**	**DON**	WRite Memory. Write to DSP address maaaaa with data = dddddd. The most significant nibble of the address indicates the memory type. m = 1: P memory m = 2: X memory m = 4: Y memory m = 8: EEPROM	This command is used to write to memory locations for low level fault finding and downloading the application code.
LDA n **n = 0 … 256** (BOOT)	**HOST**	**TIMING UTILITY**	**3**	**ERR**	Support for application program load from EEProm. Not implemented and will always return ERR	Redundant / future command. Applications are downloaded from host only.

Command	Source	Destin	Words	Response	Action	Remarks
RDC (APPL)	**HOST**	**TIMING**	**2**	**IMAGE DATA**	Performs one readout of array and sends data to host.	
GRB (APPL)	**HOST**	**TIMING**	**2**	**IMAGE DATA**	As per MRA but does not do the array flushing sequence so it is faster.	
MRA n 0≤n≤ 0xffffff (APPL)	**HOST**	**TIMING**	**3**	**IMAGE DATA**	Execute Multiple Non Destructive Read (MNDR) consisting of an array reset, n Reads – Integration and n reads.	The type of data sent depends on the flag set by the DAT command. A DON command is sent after the image data is sent.
RDT n 0≤n≤ 0xffffff (APPL)	**HOST**	**TIMING**	**3**	**IMAGE DATA**	Initiate Read Up Ramp readout with an array reset and a MNDR (n) readout.	This command sent once to initiate a read up ramp. The mode is reset by sending ABR. See discussion below for details.
ABR (APPL)	**HOST**	**TIMING**	**2**	**DON**	Abort Mode that Controller is in and return to Idle Mode – Resets READ/TIMER/VIDEO/IDLE mode flags.	ABR can be sent anytime after MRA command but will only be processed after post reset reads are completed. See v2.1 release notes for further info.

Command	Source	Destin	Words	Response	Action	Remarks
CLR (APPL)	**HOST**	**TIMING**	**2**	**DON**	Performs a complete reset (Clear) of the detector array.	Takes 1.3 ms + comms time to complete.
DAT n $0 \leq n \leq 3$ (APPL)	**HOST**	**TIMING**	**3**	**DON**	Determines type of data that MRA command transmits where n equals 0 => array data, 1 => 1111,2222,etc. 2=>0,1,2, 3..65535. 3 => array data 'read up ramp' mode (not implimented as yet)	Image data is transmitted faster than the test data because its algorithms runs from fast DSP memory whereas the test data runs from slow memory Mode set to 0 by reset & CON
IDL (APPL)	**HOST**	**TIMING**	**2**	**DON**	Enables periodic idle mode clearing of detector array	This mode is enabled as default when the PON/CON or ABR command are issued.
STP (APPL)	**HOST**	**TIMING**	**2**	**DON**	Disables periodic idle mode clearing of detector array	Used to establish 'INTEGRATE' mode
LSP (APPL)	**HOST**	**TIMING**	**2**	**DON**	Sets a series of parameters for performing lower speed readouts	Set low speed readout mode.
HSP (APPL)	**HOST**	**TIMING**	**2**	**DON**	Sets a series of parameters for performing higher speed readouts	Set High speed readout mode

Command	Source	Destin	Words	Response	Action	Remarks
SBS (APPL)	**HOST**	**TIMING**	**2**	**DON**	Re-establishes bias voltages from table to hardware.	Allows discrete bias voltage values to be changed without rebooting the controller. Be Careful !
CON (APPL)	**HOST, UTILITY**	**TIMING**	**2**	**DON**	Switch voltages ON to array Clears readout mode to 0 (real array data).	Automatically sent by the PON command
COF (APPL)	**HOST, UTILITY**	**TIMING**	**2**	**DON**	Switch voltages OFF to array	Automatically sent by the POF command.
PON (APPL)	**HOST**	**UTILITY**	**2**	**DON**	Enables +15V and –15V to analogue circuitry in controller + loads clock and video boards with voltage values.	This command now calls CON command in the Timing board i.e it powers up the complete system. Must be used before telemetry is read.
POF (APPL)	**HOST**	**UTILITY**	**2**	**DON**	Disable voltages to analogue circuitry and sets array to safe mode i.e biases and clocks clamped to gnd.	Calls COF in the timing board before powering down main supplies.
OSH (APPL)	**HOST**	**UTILITY**	**2**	**DON**	Open shutter	Remains OPEN until RESET or CSH sent
CSH (APPL)	**HOST**	**UTILITY**	**2**	**DON**	Close shutter	

Command	Source	Destin	Words	Response	Action	Remarks
PFL (APPL)	**HOST**	**UTILITY**	**2**	**DON**	Turns on preflash LED, starts preflash elapsed time timer and eturns immediately. Preflash LED will be switched off after the elapsed time >= demanded preflash time	Contary to spec DAS-18. Note that this command returns immediately. This to allow preflash periods greater than the host command timeout period.
LON (APPL)	**HOST**	**UTILITY**	**2**	**DON**	Switch internal LED ON	Remains ON until RESET or LOF sent
LOF (APPL)	**HOST**	**UTILITY**	**2**	**DON**	Switch internal LED OFF.	
BEX (APPL)	**HOST, TIMING**	**UTILITY**	**2**	**DON**	Begins exposure sequence by opening shutter and starting elapsed timer running. When elapsed time is >= to demanded time it will close shutter. Called by MRA, GRB, RUR	Sends DON flag after shutter opened but before integration time reached. Interacts with Timing board to effect complete exposure. Not normally needed to be sent from host.
PEX (APPL)	**HOST**	**UTILITY**	**2**	**DON**	Pause exposure. Closes shutter and stops elapsed timer running	Returns error if exposure not active
REX (APPL)	**HOST**	**UTILITY**	**2**	**DON**	Resumes exposure. Opens shutter and continues elapsed timer.	Returns error if exposure not active and/or paused by PEX command

Command/ Msg	Source	Destin	Words	Response	Action	Remarks
DEX (APPL)	**HOST**	**UTILITY**	**2**	**(Delayed) DON**	Detect end of exposure waits for maximum of 8 seconds for elapsed timer to be = to demanded time then returns status	Returns ERR if 8 seconds elapse before end of exposure.
CBK n (APPL)	**HOST, TIMING, UTILITY**	**TIMING, UTILITY**	**2**		Internal message used to synchronize the timing and utility commands to perform an integration and readout. Flag value (n) signifies whether to clear the integration timer (0) or not (1).	Can be simulated from the host but with zero purpose for operations. Remains available to host as a debug tool.
ERR (BOOT,APPL)	**TIMING, UTILITY**	**HOST**	**2**		Error message sent as result of command lookup error or incompatible command.	
SYR (BOOT)	**TIMING**	**HOST**	**2**		Informs HOST system that SDSU controller has performed a PWR RESET.	required for IRCAM compatibility
DON (BOOT,APPL)	**TIMING, UTILITY**	**HOST**	**2**		Acknowledge message sent as result of successful command execution	

Additional commands required only for the PCI card interface

Command/ Msg	Source	Destin	Words	Response	Action	Remarks
IIA (APPL)	**TIMING**	**PCI**	**2**		Initialise Image Address. This initialises the PCI card's image DMA address in readiness for pixel data.	No response is expected from the PCI card.
RDA x y (APPL)	**TIMING**	**PCI**	**4**		Activate the PCI pixel read mode, and inform the PCI card of the number of pixels to expect. X contains the number of columns, and y contains the number of rows.	The values for x and y are set by the host in notice board values X_EXT and Y_EXT. In practice, x is set to 1, and y is set to the number of pixels in the readout.

Notes to COMMAND Table :-

1. Not all commands are available at all times. Column #1 indicates whether each command is: (i) a BOOT command which is available aftyer power-up or reset or when the application is loaded, or (ii) an APPLication command which is available only for a unique application program which has been downloaded from the Host system.

Appendix A

This table shows a typical flow of commands and responses after the system has been reset.

Sequence	HOST command	SDSU Response	Description
1			System Reset
2		SYR	SDSU replies that it has RESET
3	000203 TDL 555555	020002 555555	Test the link to the TIMING board
4	000303 TDL AAAAAA	030002 AAAAAA	Test the link to the UTILITY board
5	000203 RDM 100006	020002 xxxxxx	Read version no. of Timing board boot code
6	000303 RDM 100006	030002 xxxxxx	Read version no. of Utility board boot code
7	*.lod file downloaded using WRM command		Download Timing Board Application Code
8	*.lod file downloaded using WRM command		Download Utility Board application code
9	000302 PON	030002 DON	Switch supplies ON to boards
10	000203 RDM 1001FE	020002 001FF0	Read NBAX Timing board Mailbox location
11	000203 RDM 1001FF	020002 003FF0	Read NBAY Timing board Mailbox location
12	000303 RDM 1001FE	030002 0000F0	Read NBAX Utility board Mailbox location
13	000303 RDM 1001FF	030002 0000F0	Read NBAY Utility board Mailbox location
14	000304 WRM 0200F0 0007D0	030002 DON	Set integration time to Utility Mailbox area.
15	000203 MRA 1	Image Data…. 020002 DON	Sends image data then DON back

Appendix B

Addresses which can be accessed using the RDM command.

Board	Address	Available	Format	Description
Timing / Utility	P:7	BOOT	Binary	Version No. of Application code
Timing / Utility	P:1FE	BOOT	Binary	Noticeboard offset into X:mem space for UltraDas (NBAX)
Timing / Utility	P:1FF	BOOT	Binary	Noticeboard offset into Y:mem space for UltraDas (NBAY)
Timing	X:0	BOOT	Boolean	Timing status word (note 1).
Timing	X:22	APPL	Integer	Readout mode
Timing	X:24	APPL	Integer	Number of columns in image data
Timing	X:25	APPL	Integer	Number of rows in image data
Timing	X:26	APPL	Integer	Number of reads in last MRA sequence
Timing	X:27	APPL	Integer	Number of detector reset cycles
Timing	X:28	APPL	Integer	Number of read precondition (flush) cycles
Timing	NBAX	APPL	Int table	Window skip/read table origin
Timing	NBAX+F9	APPL	Integer	Number of rows in readout (for PCI interface)
Timing	NBAX+FA	APPL	Integer	Number of columns in readout (for PCI interface)
Timing	NBAX+FB	APPL	N/a	Dummy (Not used)
Timing	NBAX+FC	APPL	Boolean	UltraDas Active Flag
Timing	NBAX+FD	APPL	Integer	Binning Factor in x (Not used !)
Timing	NBAX+FE	APPL	Integer	Binning Factor in y (Not used !)
Timing	NBAX+FF	APPL	Boolean	Window table enable flag
Timing	NBAY	APPL	Integer	Error number (not used !)
Timing	NBAY+1	APPL	Integer	Window table dimension
Timing	NBAY+2	APPL	Boolean	Readout speed
Timing	NBAY+3	APPL	Integer	Pixel rate
Timing	NBAY+4	APPL	Boolean	Clock sequencer status

Board	Address	Available	Format	Description
Utility	X:0	BOOT	Boolean	Utility status word (note 2).
Utility	Y:0	BOOT	Byte Int	Detector ID code (1Eh)
Utility	NBAX	BOOT	Integer	Demanded exposure time (ms)
Utility	NBAX+1	BOOT	Integer	Demanded detector temp (mk)
Utility	NBAX+1	BOOT	Integer	Demanded preflash time (ms)
Utility	NBAY	BOOT	Integer	Elapsed exposure time (ms)
Utility	NBAY+1	BOOT	Integer	Current detector temp (mk)
Utility	NBAY+2	BOOT	Integer	Elapsed preflash time (ms)
Utility	NBAY+3	BOOT	Boolean	Shutter status
Utility	NBAY+4	BOOT	Integer	Error number (not used !)
Utility	NBAY+5	BOOT	Integer	Current optical table temp (mk)
Utility	NBAY+6	BOOT	Integer	Current shield temp (mk)
Utility	NBAY+7	BOOT	Integer	Current cryostat pressure (nanobar)

Notes

1. Bit significance for Timing Code Status Word (Read only)

Bit	Significance	Comment
0	Command mode	Power is on, doing idle loop execs.
1	Idle reset mode	Set if continuous reset mode active.
2	Video mode	Reserved for future video streaming.
3	Readout mode	Set if readout is in progress.
4	Timer mode	Set if elapsed timer active
5	Command waiting	Set if command waiting for service
6	Host Flag	Set if command from host
7	Command error	Set if command format error occurred
8	Even/Odd row	Used in window readout. Not relevant

2. Bit Significance for Utility Code Status Word (Read only)

Bit	Significance	Comment
0	Service request	1ms Service req. pending
1	Exposure timer active	Set to request exposure timer service
2	Preflash active	Set to request preflash timer service.
3	Timeout active	Set to request command timeout service.
4	BEX in progress	Indicates exposure in progress
5	PWR in progress	Indicates PWR command in progress

Appendix B.

Discussion of Read Up Ramp readout mode.

The sequence of events that allow read up ramp sequences of readouts to be effected is somewhat complicated. This by, among other reasons, the requirement for each read to be independently timed.

The flow diagram below attempts to show the sequence of a typical read up ramp sequence.

The host initiates the mode by setting the demanded integration time to zero and issuing the RDT command. This establishes the read up ramp mode for the timing and utility board control software and results in the array being reset and the first read made.

Immediately following an array reset the first data is received from the controller. The controller then waits for the host to set the demand integration time for the first read.

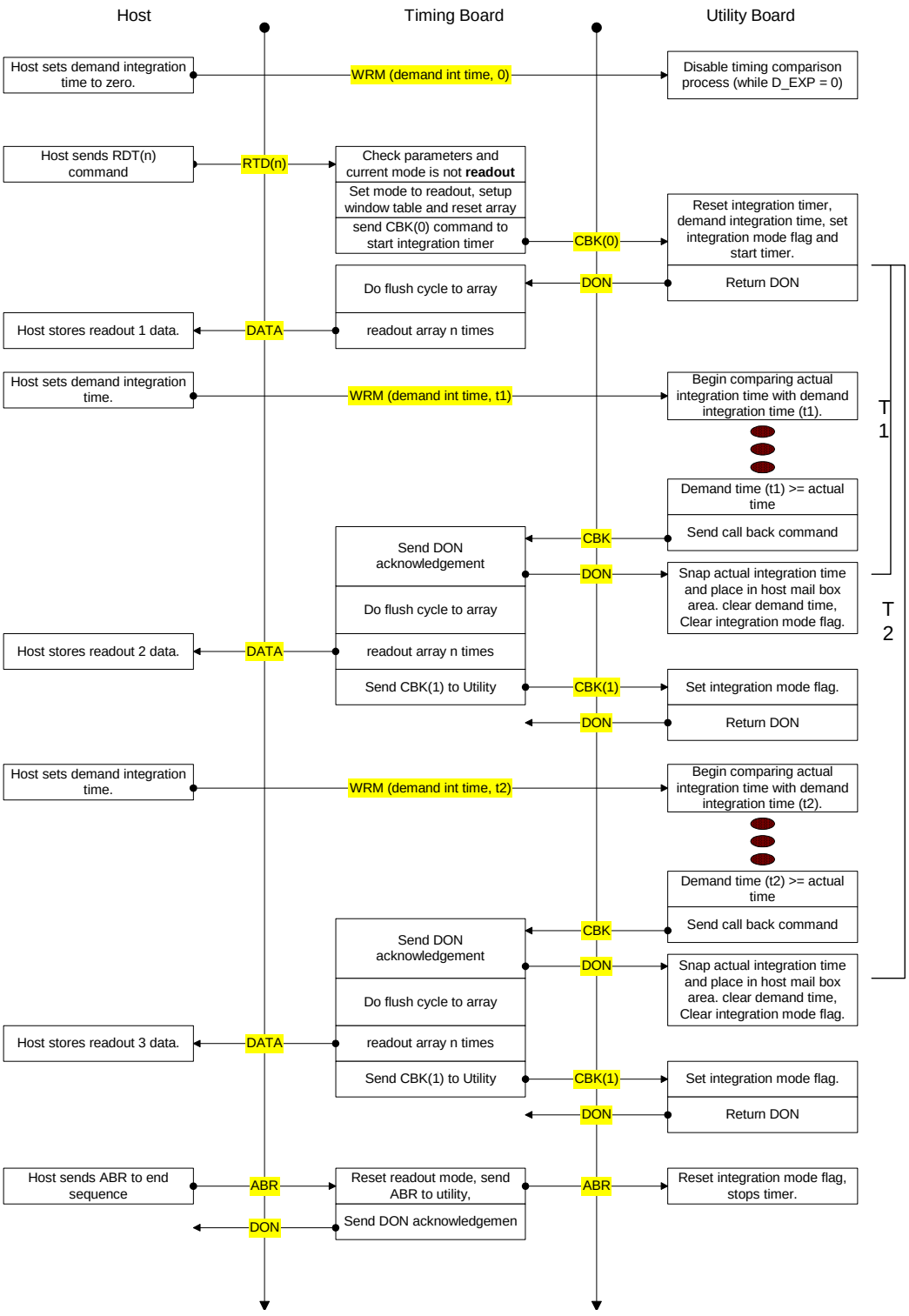
Once the demand time has been set the utility board will monitor the elapsed time and trigger a readout from the timing board when the demand time is met or exceeded. This readout produces the second readout data stream to the host.

The host can then retrieve the actual integration time and set a new demand integration time for the next read.

The demand time can then be set again to the next required interval and the utility board will monitor the elapsed time and trigger a readout from the timing board when the demand time is met or exceeded. This readout produces the third readout data stream to the host.

This process can continue ad infinitum until the desired total integration time has been met. Note that the integration times are accumulative.

To cancel this readout mode it is essential that the host send an abort (ABR) command to the timing board. This then clears the mode flags and returns the controller to its quiescent state. Failure to send an ABR command will result in a very short integration for the next commanded MRA or GRB command as the integration timer will still be running and immediately compared to the demand time set.


Host
Timing Board
Utility Board
Host sets demand integration time to zero.
WRM (demand int time, 0)
Disable timing comparison process (while D_EXP = 0)
Host sends RDT(n) command
RTD(n)
Check parameters and current mode is not readout
Set mode to readout, setup window table and reset array
send CBK(0) command to start integration timer
CBK(0)
Reset integration timer, demand integration time, set integration mode flag and start timer.
DON
Return DON
Do flush cycle to array
Host stores readout 1 data.
DATA
readout array n times
Host sets demand integration time.
WRM (demand int time, t1)
Begin comparing actual integration time with demand integration time (t1).
T 1
Demand time (t1) >= actual time
CBK
Send call back command
Send DON acknowledgement
DON
Snap actual integration time and place in host mail box area. clear demand time, Clear integration mode flag.
T 2
Do flush cycle to array
Host stores readout 2 data.
DATA
readout array n times
Send CBK(1) to Utility
CBK(1)
Set integration mode flag.
DON
Return DON
Host sets demand integration time.
WRM (demand int time, t2)
Begin comparing actual integration time with demand integration time (t2).
Demand time (t2) >= actual time
CBK
Send call back command
Send DON acknowledgement
DON
Snap actual integration time and place in host mail box area. clear demand time, Clear integration mode flag.
Do flush cycle to array
Host stores readout 3 data.
DATA
readout array n times
Send CBK(1) to Utility
CBK(1)
Set integration mode flag.
DON
Return DON
Host sends ABR to end sequence
ABR
Reset readout mode, send ABR to utility,
ABR
Reset integration mode flag, stops timer.
DON
Send DON acknowledgemen