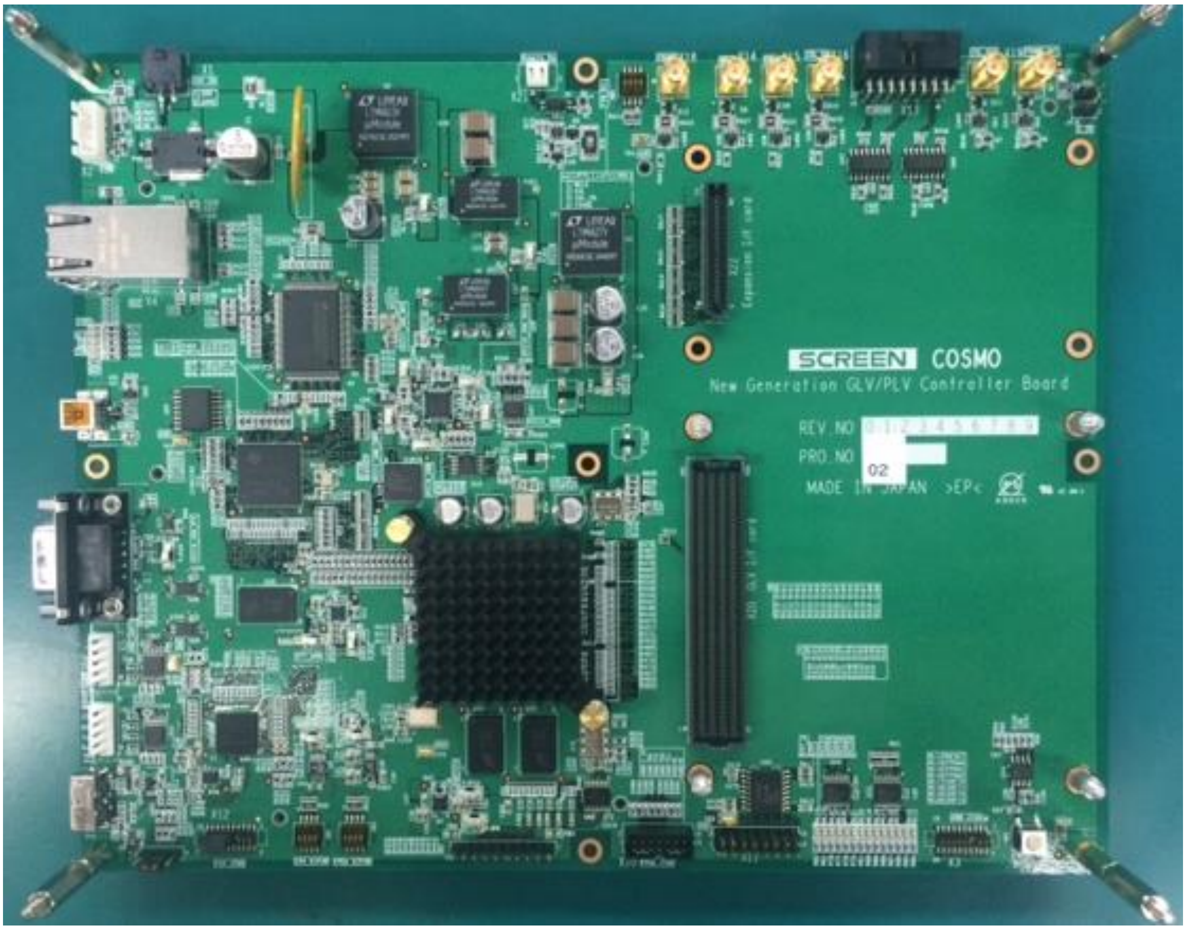
Cosmo Board Operating Manual

for High-Speed Buddy



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1 Introduction

The Cosmo Board is a custom designed single board computer that uses an ARM AM335x microprocessor, a Field Programmable Gate Array and features multiple interfaces for several GLV devices with different daughter cards.

The Cosmo board has three user interfaces: [1] RS-232c port (connector X7) for interfacing to a terminal using ASCII characters; [2] USB3.0 port (connector X9) for downloading image data; [3] 10/100/1000 base Ethernet port (connector X4) for upgrading microprocessor and FPGA program.

This manual describes how to operate the Cosmo Board from the terminal using ASCII characters. The architecture of the Cosmo Board is illustrated in Figure 1-1. Microprocessor and FPGA have been specifically designed to test the High-Speed Buddy GLV Module. The Cosmo Board generates test patterns that are written to the High-Speed Buddy (HSB) Module.

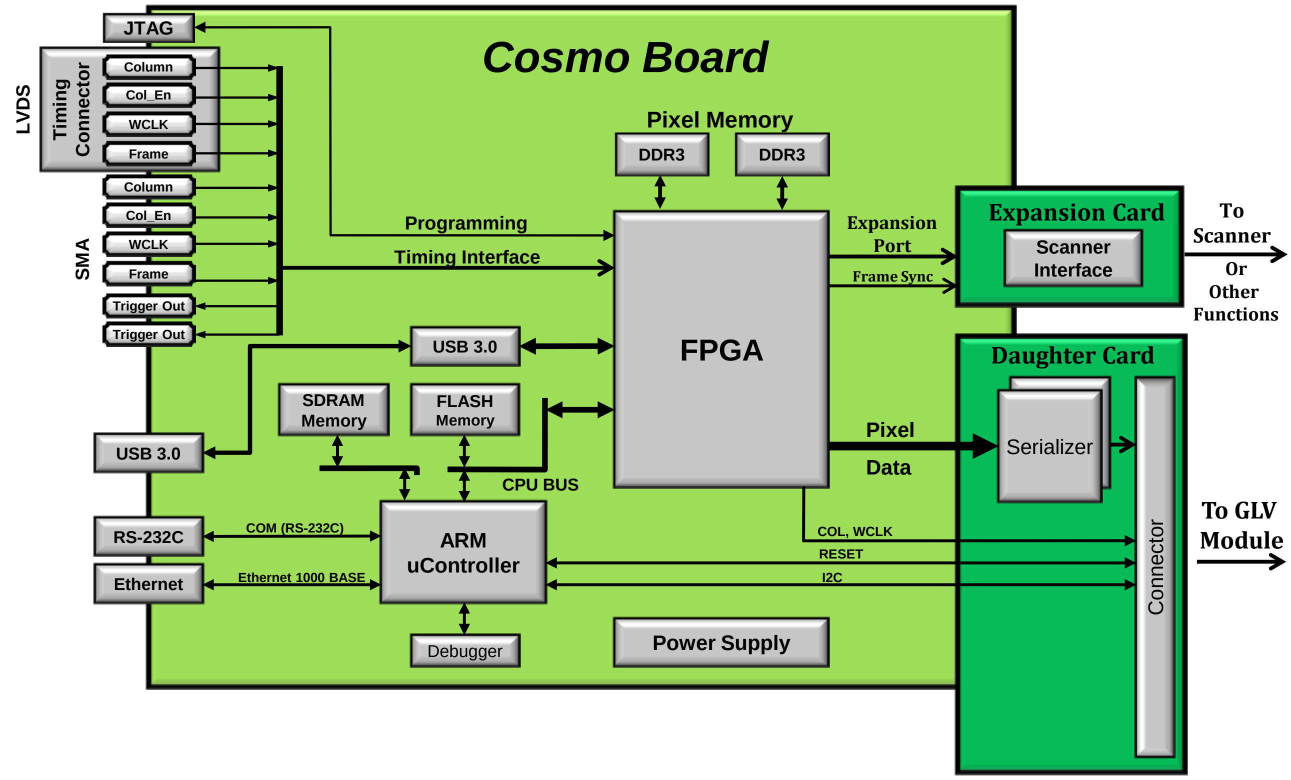


Figure 1-1 : Block Diagram of the Cosmo Board

The Cosmo Board has many advanced features. However, to get quickly started with setting up and operating the system, follow these basic steps:

- Set up the boards as described in paragraphs 3.1 and 3.2.
- Enter the commands listed in paragraph 8.1

2 System Overview

The components required to test a High-Speed Buddy GLV Module are:

- Computer with terminal emulator and USB3 port and Ethernet port
- Cosmo Board
- Cricket Board
- High-Speed Buddy Module
- Dual power supply (or two single power supplies)
- Cables required to interconnect all these components

The test system is illustrated in Figure 2-1>

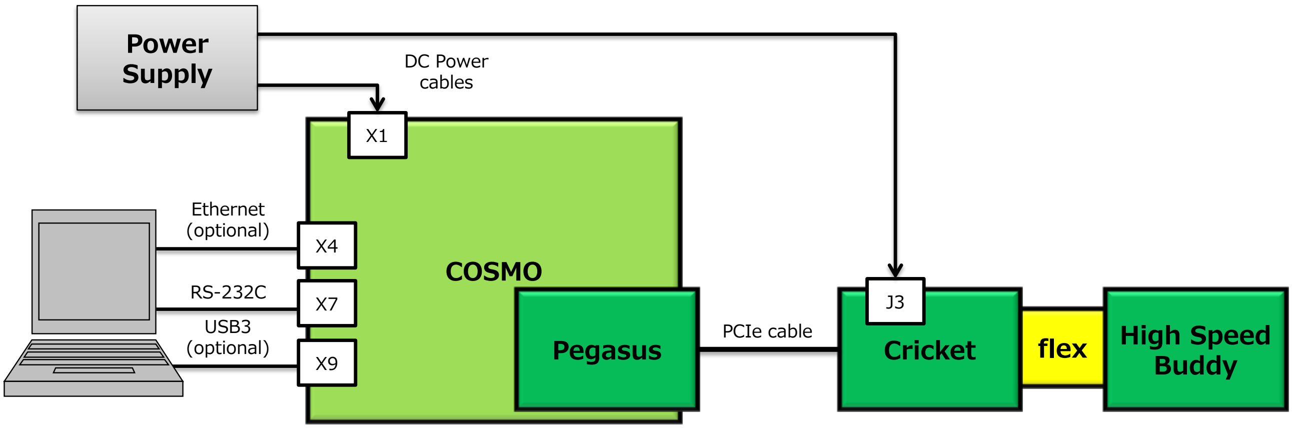


Figure 2-1 : Block Diagram of Test System

3 System Setup

The Cosmo board has several interfaces for user interface and timing interface.

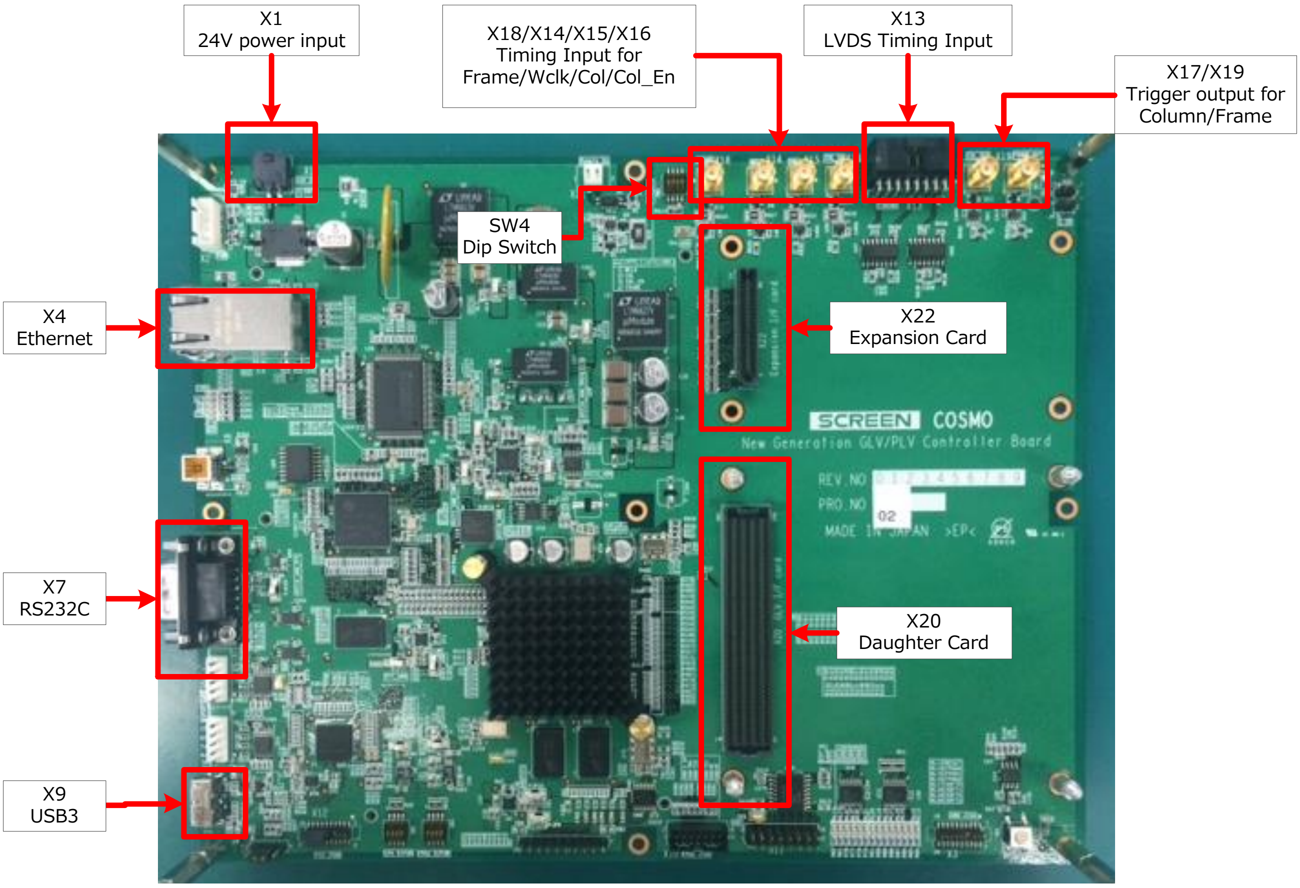


Figure 3-1 Cosmo Board Interfaces

3.1 Cable Connections

For basic operation of the High-Speed Buddy with the Cosmo Board, attach the cables listed below:

- Attach the Pegasus daughter card to connector X20 of the Cosmo (if the daughter card is not installed). Typically, the daughter card is pre-installed when it is delivered.
- Install an RS-232 serial cable between the X7 connector on the Cosmo Board and an RS-232 serial port on the PC. The RS-232c cable should be a straight through version where pin-2 connects to pin-2 and pin-3 connects to pin-3.
- Connect DC power cables from the power supplies to both the Cosmo Board and the Cricket Board as defined in Table 1.
  - Cosmo Board X1 connector to 24 Volts
  - Cricket Board J3 connector to 5 Volts
  - Note: Part number of power input connector of the Cosmo (X1) and the Cricket Board (J3) is 43650-0210 of Molex.

X1 (Cosmo)	Voltage(V)	Notes
Pin-1	+24	Power for Cosmo Board (*1)
Pin-2	Ground (24V return)	
J3 (Cricket)	Voltage (V)	Notes
Pin-1	+5	Power for Cricket Board and High-Speed Buddy (*2)
Pin-2	Ground (5V return)	

Table 3-1 Pinouts for power supply connectors

*Note 1: Use a 1 Amp (min) power supply with current limit at 1 Amps, typical current is < 0.4 Amps.

*Note 2: Use a 3 Amp (min) power supply with current limit at 3 Amps, typical current is < 2.1 Amps.

WARNING: The Cosmo board and the Cricket Interface Board have similar two-pin power connectors. Do not plug the Cosmo's 24V power cable into the Cricket Board or else permanent damage may occur.

- Connect the flex cable from the Cricket Board to the High-Speed Buddy Module. The flex cable is marked to indicate which side of the flex cable is connected to High-Speed Buddy or Cricket Board.
- Connect the PCIe cable between the M1 connector of the Pegasus daughter card and the M1 connector of the Cricket interface board.

HOT PLUG WARNING: Flex cable and the data cable were not designed to be hot plugged. Turn off all power to the boards when connecting these cables, otherwise damage may occur to the boards.

3.2 COM (RS-232c) Port Setup

To ensure proper communication between the PC and the Cosmo Board, the user needs to set up a terminal emulation program such as "HyperTerminal". Table 3-2 lists the terminal parameters and values.

Table 3-2 : HyperTerminal Parameters

Parameters	**Values**
Baud rate	115,200
Data bits	8
Parity	None
Stope bits	1
Flow control	Off
Emulation	TTY

3.3 USB3 setup (optional)

USB is used to download pixel data from PC. "Pixel Download Program" will be provided in order to download pixel data from PC. For further information about downloading pixel data via USB3, please refer to the Operating Manual of Pixel Download Program.

3.4 LAN (Ethernet) Setup (optional)

Ethernet is used to download EEPROM data to the Cricket board or to program new versions of the FPGA or ARM firmware to the Cosmo board. The "EEPROM Download Program" is used to download EEPROM data to the Cricket board. The EEPROM data is programmed at the factory prior to shipment and is typically not modified by the user. The "Cosmo Download Program" can be used to update the Cosmo FPGA or firmware in the field. The "Cosmo Download Program" will be provided to the customer in the event a revised FPGA or firmware version is released.

3.5 Timing Signal Setup (optional)

The Cosmo board sends expose data packets when it detects the column strobe signal and frame signal. With default setup, the Cosmo board uses internally generated column and frame signal. Instead of using internal timing signals, user can provide their own timing signal in order to synchronize with their equipment. In order to change the timing settings, use ASCII commands described in section 5.3. The user can provide either LVDS or single-ended timing signals (WCLK, COL, COL_EN, FRAME) as external timing inputs. For High-Speed Buddy, WCLK AND COL_EN signals are reserved feature for future growth. The Cosmo board has 4 SMA connectors for single-ended timing inputs as listed in Table 3-1.

Connector	Signal	Standard
X14	WCLK (reserved)	LVTTL
X15	COL	LVTTL
X16	COL_EN (reserved)	LVTTL
X18	FRAME	LVTTL

Table 3-3 Single-ended Timing Input Interface

X13 is timing input connector for LVDS signals. Part number if X13 is 90130-3216 of Molex. Pinout of LVDS timing input connector is listed in Table 3-4. "p" indicates positive signal of LVDS and "n" indicates negative signal of LVDS.

Pin number	Signal Name	Signal
1	FRAMEp	FRAME
3	FRAMEn	
6	WCLKp	WCLK
8	WCLKn	
9	COL_ENp	COL_EN
11	COL_ENn	
14	COLp	COL
16	COLn	
2,4,5,7, 10,12,13,15	GND	Ground of the Cosmo Board

Table 3-4 LVDS Timing Input Interface

Dip Switch (SW4) should be set appropriately in order to use external timing inputs. The user can select single-ended or LVDS by each channel of SW4. Settings for SW4 are listed in Table 3-5.

Channel	Signal	ON	OFF
1	WCLK	Single-ended LVTTL	LVDS
2	COL		
3	COL_EN		
4	FRAME		

Table 3-5 SW4 settings

4 Command Set

An ASCII command set is used to communicate from the PC computer to the Cosmo Board over RS232 port. The following tables define the legal set of commands and the associated parameters that can be sent to the High-Speed Buddy GLV Module. Note that the commands are not case-sensitive. The command set is organized into four major types.

1. General Purpose
2. User Defined Test Pattern (PLUT's)
3. Variable Timing Setting
4. Test Patterns

The General Purpose commands allow the user to control the GLV Module, initialize the GLV Module, get status from the GLV Module and perform advanced operations on the module. Most users will not need to use the "Advanced Operator Commands". The following tables that list the General Purpose command have an "I/O" column to indicate what hardware interface is used to execute the command. Key: I2C=I2C interface, D=Downlink Interface, D2=Downlink & I2C; USB=USB Interface, I/O=dedicated signal on Cricket I/O connector.

There is long command sequence to initialize the GLV Module. This command sequence can be executed with a single command (i.e. "BOOTUP"). When the Cosmo Board is powered up (or reset), the Cosmo issues the "BOOTUP" command automatically to the GLV Module. Therefore, the module can be operated by only using a few commands.

The "Example Sessions" section at the end of this document is a good guide to getting started with the Cosmo Test Board. Example Session #1 and #2 shows how easy it is to initialize and start running a test pattern.

The tables in this section provide list of all commands with their associated parameters and a brief description of their function. For convenience, the User Defined Test Pattern commands have been listed in both the PLUT Command Table and the Test Pattern Command Table. For a detailed description of the command's parameters and functions, see section 5 and section 6.

On-line Help and Documentation: The command set can be viewed by typing in "?" or "HELP" and followed by a return. Most commands have programmable parameters. Commands that have parameters also have on line documentation to define the parameters and to report the current status of the parameters. This documentation can be viewed on the Hyper-Terminal by typing the command without the parameter. For example, to get a list and description of the parameters of the LOOPLUT command, type in "LOOPLUT".

Control Commands			
Command	**Parameters**	**Description**	**I/O**
RESET		Resets the Cosmo & GLV Module	I/O
BOOTUP		Power up & initialize GLV Module	D2
VDDAH	<vddah_DAC (0-510)>	Set the VDDAH voltage on GLV module	I2C
USB	<dir> <start> <count>	Prepare sending pixel data from PC via USB	USB
POWERDOWN		Powers down the GLV Module	I2C

Table 4-1 General Commands
Control Commands

GLV Module BOOTUP Commands			
Command	**Parameters**	**Description**	**I/O**
RSTMODULE		Resets the GLV module	I/O
WAIT	<time(msec)>	Waits for specified time	-
I2CRDY		Displays the status of I2CRDY signal	I/O
POWERUP	LOW	Powers up the GLV Module	I2C
DESKEW		Executes SerDes deskew function	I2C
RSTFPGA		Resets the Cricket FPGA	I2C
INITDRIVER		Initializes all SLM212 drivers	D
ALLPIX	<data (0-1023)>	Writes one amplitude value to all pixels	D
HVEN		Enables the GLV module's high voltage	I/O
POWERUP		Powers up the GLV Module	I2C
BIAS	<bias_DAC (0-510)>	Set the BIAS voltage on GLV module	I2C
COMMON	<common_DAC (0-510)>	Set the COMMON voltage on GLV module	I2C

Table 4-2 General Commands
GLV Module BOOTUP Commands

Status & Info Commands			
Command	**Parameters**	**Description**	**I2C**
HELP or ?		Displays a list of all commands	-
STAT		Displays status of Cosmo & GLV Module	I2C
ADC	<channel (0-16)>	Displays measurement of an A/D channel	I2C
READADC		Displays measurement of all A/D channels	I2C
PSOC		Displays the status of the PSoC	I2C

Table 4-3 General Commands
Status & Information Commands

Advanced User Commands			
Command	**Parameters**	**Description**	**I2C**
READNV	<bank> <offset> <bytes>	Displays data in PSoC non-volatile memory	I2C
WRITENV	<bank> <offset> <bytes> <data1> <data2> … <data N>	Write data to PSoC non-volatile memory	I2C
SLOPES	<driver index> <slope0> <slope1> … <slope15>	Sets the 16 slopes on the selected SLM212 drivers	D
ECREF	<ECRef(U1)> <ECRef(U2)> <ECRef(U3)> <ECRef(U4)>	Sets the ECRef on SLM212 drivers	D
DRIVER	<en> <zipCode> <data>	Sets the specified SLM212 driver register	D

Table 4-4 General Commands
Advanced User Commands

PLUT Commands		
Command	**Parameters**	**Description**
POKELUT	<LUT#> <start pixel> <amp1> (amp2) (amp3) …	Writes multiple amplitude values to a PLUT array starting at a user defined pixel
PEEKLUT	<LUT#> <start pixel> <count>	Reads multiple amplitude values from a PLUT array starting at user defined pixel
COPYLUT	<dst> <src>	Copies source PLUT to destination PLUT
COPYLUTBLOCK	<dst> <src> <dst start> <src start> <count> <repeat>	Copies a block of pixels from a source PLUT to one or more blocks in a destination PLUT
FILLLUT	<LUT#> <amp>	Fills all pixels in PLUT to same amplitude
FILLLUTBLOCK	<LUT#> <start> <count> <amp>	Fills a block of pixels in a PLUT to the same amplitude value
FILLLUTLOHI	<LUT#> <amp_l> <amp_h> <width_l> <width_h> <offset>	Fills alternating blocks in a PLUT with two different amplitude levels
RESETLUT	<amp>	Resets all PLUT array values to specified amplitude value
User Defined Test Pattern Commands		
Command	**Parameters**	**Description**
GOLUT	<start LUT> <end LUT>	Sends a sequence of PLUT arrays to the GLV Module and stops
LOOPLUT	<start LUT> <end LUT> <count>	Sends a sequence of PLUT arrays to the GLV Module and repeats the sequence
LOOPFRAME	<start LUT> <col/frame> <frames> <count>	Sends a sequence of PLUT frames to the GLV Module and repeats the sequence

Table 4-5 PLUT Commands

Timing Control Commands		
Command	**Parameters**	**Description**
COLSOURCE	<C4_src> <C3_src> <C2_src>	Selects source of column strobe by selecting sources of the C4, C3 & C2 multiplexers
COLTIME	<time(ns)>	Sets the column period time
COLTRIGDELAY	<time(ns)>	Sets the delay of the output column trigger
TRIGCPWTIME	<time(ns)>	Sets pulse width of column trigger output
TRIGCSOURCE	<C6_src> <C5_src>	Selects source of the column trigger output by selecting sources of C6 & C5 muxes
FRAMECONTROL	<control (ON | OFF)>	Enables operation of the frame strobe or allows free-run operation
FRAMESOURCE	<src>	Selects the source of the frame strobe by selecting sources of the F2 mux
FRAMETIME	<time(us)>	Sets the frame time
FRAMEDELAYTIME	<time(us)>	Sets the frame delay time
TRIGFPWTIME	<time(us)>	Sets pulse width of frame trigger output
TRIGFSOURCE	<F4_src> <F3_src>	Selects source of frame trigger output by selecting sources of F4 and F3 muxes
COLSTATUS		Displays column strobe settings
FRAMESTATUS		Displays frame settings
SOFTTRIGGER	<trigger>	Generates a software trigger
SAVETIME		Saves the current time control settings to non-volatile memory
RECALLTIME		Recalls the time control settings from non-volatile memory.

Table 4-6 Timing Control Commands

Parameterized Test Pattern Commands		
Command	**Parameters**	**Description**
TEST1	<amp>	Set all pixels to a fixed amplitude level
TEST2	<start> <move> <no_id> <amp_off> <amp_on> <ramp>	Single pixel ramps from an amplitude level of 0 to 1023
TEST4	<amp0> <amp1>	Modulates all pixels between two amplitude levels
TEST5	<amp_on> <amp_off> <start pixel> <step pixel> <end pixel>	Modulates a single pixel between two amplitude levels
TEST9		All pixels ramp from amplitude level 0 to 1023 over 1024 columns
TEST12	<start LUT> <pixel#> <amp_off> <amp0> (amp1) (amp2) ⋯(amp31)	Single pixel steps to multiple user defined amplitude levels
TEST15	<amp_on> <amp_off> <start pixel> <step pixel> <end pixel> <on pixel>	Set a block of pixels to a programmed ON amplitude & the adjacent block to a programmed OFF amplitude

User Defined Test Pattern Commands		
Command	**Parameters**	**Description**
GOLUT	<start LUT> <end LUT>	Sends a sequence of PLUT arrays to the GLV Module and stops
LOOPLUT	<start LUT> <end LUT> <count>	Sends a sequence of PLUT arrays to the GLV Module and repeats the sequence
LOOPFRAME	<start LUT> <col/frame> <frames> <count>	Sends a sequence of PLUT frames to the GLV Module and repeats the sequence

Table 4-7 Test Pattern Commands

5 Description of Commands

The ASCII command set is described in the following paragraphs. The command set is organized into four sections. The general purpose commands are also defined in four types of commands.

5. General Purpose
   a. Control, b. GLV Module BOOTUP , c. Status & Info , d. Advanced User
6. PLUT Operation
7. Variable Timing setting
8. Test Patterns

ASCII commands are executed when they are sent to the Cosmo board via RS-232 terminal followed by a “return”. The Cosmo board will be ready to accept ASCII commands after it sends “[MNGR/IDLE]” message after powered up or initialized.

5.1 Description of General Purpose Commands

CONTROL COMMANDS

5.1.1 RESET

RESET command restarts and initializes the Cosmo board and GLV module.

5.1.2 BOOTUP

BOOTUP command executes all the ASCII commands to initialize High-Speed Buddy module. Following is the list of ASCII commands which are executed:

RSTMODULE
WAIT 2000
I2CRDY
POWERUP LOW
DESKEW
RSTFPGA
INITDRIVER
ALLPIX 0
HVEN
POWERUP
BIAS 0
COMMON 0

5.1.3 VDDAH

VDDAH command will set the high voltage (VDDAH) to the GLV module. Argument of this command is the DAC value for VDDAH (0-510).

VDDAH <vddah DAC>

The VDDAH command sets high-voltage power supply for the GLV active ribbons via the I2C interface as defined in the HSB Operating Manual (Section 3.2.3: Control Interface; D/A Conversion Protocol).

Each GLV Module has a unique recommended VDDAH level. The recommended VDDAH level is determined by the wavelength of the illumination laser and the fundamental characteristics of the GLV device. There is also a unique maximum VDDAH level for each GLV Module. Both the recommended and maximum VDDAH levels are stored in the Cricket PSoC's EEPROM memory. The PSoC on the Cricket Board will ignore any VDDAH setting commands that exceed the maximum VDDAH settings. Refer to the shipment documents that were received with the evaluation kit hardware for the recommended and maximum VDDAH setting.

5.1.4 USB

USB command will prepare receiving/sending data from/to PC. User should specify whether it is receiving or sending, start column index, and number of columns to be transferred. In order to send pixel data through USB3 port, Pixel Download Program is required.

USB <dir> <start> <count>

<dir> = 0 for sending data to the Cosmo, 1 for receiving data from the Cosmo

<start> = 0 ~ 65535

<count> = 1 ~ 65536

5.1.5 POWERDOWN

POWERDOWN command causes the PSoC to turn off all voltages on the GLV module (except the supply voltage to the PSoC). The POWERDOWN command is sent to the GLV Module via the I2C interface as defined in the HSB Operating Manual (Section 3.2.3: Control Interface; Module Device Control Protocol).

GLV MODULE BOOTUP COMMANDS

5.1.6 RSTMODULE

RSTMODULE command resets the GLV module by pulsing reset to the PSoC on the GLV module.

5.1.7 WAIT

WAIT command waits for specified number of milliseconds.

WAIT <time (msec)>

5.1.8 I2CRDY

I2CRDY command displays the status of I2CRDY signal.

5.1.9 POWERUP

POWERUP command will power up the power supplies on the GLV module. The POWERUP command is sent to the GLV Module via the I2C interface as defined in the HSB Operating Manual (Section 3.2.3: Control Interface; Module Device Control Protocol). The ASCII command can be used with the following options:

LOW – Power up the low voltages
ALL – Power up the all voltages
None – Power up the all voltages.

5.1.10 DESKEW

DESKEW command initiates the Serializer/Deserializer deskew function. To guarantee proper data integrity across the downlink, the deskew command is required during the power up sequence. Typically, most modules will run correctly without the DESKEW command. If data errors are encountered over the downlink, then try using the DESKEW command after POWERUP LOW and then execute the RSTFPGA command.

The ASCII DESKEW command turns on and off the LVDS De-skew function via the I2C interface as defined in the HSB Operating Manual (Section 3.2.3: Control Interface; Module Device Control Protocol) in coordination with the LVDS serializer deskew operation on the Cosmo Board.

5.1.11 RSTFPGA

RSTFPGA command resets the FPGA on the GLV module via the I2C interface as defined in the HSB Operating Manual (Section 3.2.3: Control Interface; Module Device Control Protocol).

5.1.12 INITDRIVER

INITDRIVER command initializes all SLM212 drivers. No parameter is required for this command.

5.1.13 ALLPIX

ALLPIX command writes amplitude value to all SLM212 amplitude 0 registers.

ALLPIX <data>

<data> = 0 ~ 1023

5.1.14 HVEN

HVEN command enables the GLV module's high voltage.

5.1.15 BIAS

BIAS command will set the BIAS voltage to the GLV module. Argument of this command is the DAC value for BIAS (0-510). The High-Speed Buddy Module is typically operated with the BIAS set to "0".

BIAS <bias DAC>

The BIAS command sets BAIS voltage to the GLV bias ribbons via the I2C interface as defined in the HSB Operating Manual (Section 3.2.3: Control Interface; D/A Conversion Protocol).

5.1.16 COMMON

COMMON command will set the COMMON voltage to the GLV module. Argument of this command is the DAC value for COMMON (0-510). The High-Speed Buddy Module is typically operated with the COMMON set to "0".

COMMON <common DAC>

The COMMON command sets COMMON voltage to the GLV Module via the I2C interface as defined in the HSB Operating Manual (Section 3.2.3: Control Interface; D/A Conversion Protocol).

STATUS & INFORMATION COMMANDS

5.1.17 HELP

? or HELP command displays a list of all the commands.

5.1.18 STAT

STAT command displays the status of the Cosmo and GLV Module.

5.1.19 ADC

ADC command reads and displays measurement data from the specified channel of the HSB health monitoring system via the I2C interface as defined in the HSB Operating Manual (Section 3.2.3: Control Interface; A/D Conversion Protocol).

ADC <channel (0-16)>

5.1.20 READADC

READADC command reads and displays measurement data from the all channels of the HSB health monitoring system via the I2C interface as defined in the HSB Operating Manual (Section 3.2.3: Control Interface; A/D Conversion Protocol).

5.1.21 PSOC

PSOC command reads and displays PSOC status information via the I2C interface as defined in the HSB Operating Manual (Section 3.2.3: Control Interface; Read PSoC Status Protocol). The PSOC command displays the status of the PSoC including:

- PSoC Status
- Power State
- Last error
- Source of last error
- PSoC firmware version information with revision control identification

ADVANCED USER COMMANDS

5.1.22 READNV

READNV command displays the data in the PSoC non-volatile EEPROM memory. The PSoC EEPROM is read via the I2C interface as defined in the HSB Operating Manual (Section 3.2.3: Control Interface; EEPROM Read Protocol). The user should specify which bank to read, data offset address and number of bytes to be read.

READNV <bank> <offset> <bytes>
<bank> = 0 ~ 15
<offset> = 0, 64, 128, 192
<bytes> = 0 ~ 255. <offset> + <bytes> should not exceed 256.

5.1.23 WRITENV

WRITENV command writes data to the PSoC non-volatile EEPROM memory. The PSoC EEPROM is written via the I2C interface as defined in the HSB Operating Manual (Section 3.2.3: Control Interface; EEPROM Write Protocol). This command should only be used by advanced users. Writing to Bank 8, 9, 10, 11 or 15 could destroy important information in the EEPROM.

User should specify which bank to be written, offset address for the data and number of byte. User should provide appropriate number of data which is defined by <bytes> parameter.

WRITENV <bank> <offset> <bytes> <data1> <data2> ··· <data N>
<bank> : Bank to be written. 0 ~ 15
<offset> : Offset bytes. 0, 64, 128, 192
<bytes> : Number of data bytes to be written. 0 ~ 256. <offset> + <bytes> should not exceed 256.
<data*> = 0 ~ 255.

5.1.24 SLOPES

SLOPES command programs the set of 16 slopes on SLM212 driver. The user should specify which driver to be set by <driver index> option. The driver index parameter is followed by the 16 slope values.

SLOPES <driver index> <slope0> <slope1> ··· <slope15>
<driver index> : 0~4, (0=U1, 1=U2, 2=U3, 3=U4, 4=All)
<slope*> : Slope value. 0 ~ 1023

The High-Speed Buddy Module is typically operated with all SLOPES set to “64”. Advance users can globally adjust slope segments of the high-voltage driver’s voltage vs. amplitude DAC response. For more information refer to the HSB Operating Manual (Section 6.3 Reference generation for slope segments).

5.1.25 ECREF

ECREF command sets the ECRef on SLM212 drivers. User should specify ECRef values for each driver.

ECREF <ECRef(U1)> <ECRef(U2)> <ECRef(U3)> <ECRef(U4)>
<ECREF*> : ECReF value. 0 ~ 1023

The High-Speed Buddy Module is typically operated with the ECREF set to "512". Advance users can globally adjust the slope of the high-voltage driver's voltage vs. amplitude DAC response. For more information refer to the HSB Operating Manual (Section 6.2 Global Reference - ECREF).

5.1.26 DRIVER

DRIVER command sets a SLM212 driver register. The DRIVER command is used for debug purposes and is not needed for normal operation of the GLV Module.

User should specify which driver to be set, zipCode of the register and data to be written. <en> is the 4bit data and each bit indicates write enables for the drivers. Bit0 is for U1, bit1 is for U2, bit2 is for U3 and bit3 is for U4. <en> parameter should be provided in hexadecimal format (0 ~ F). For example, in case only U1 is written, <en> should be 1. In case both U2 and U3 are written, <en> should be 6. In case all the drivers are written, <en> should be F. <zipCode> parameter should be written in hexadecimal.

DRIVER <en> <zipCode> <data>
<en> = 0 ~ F (in hexadecimal) (1=U1, 2=U2, 4=U3, 8=U4)
<zipCode> = 200 ~ 204, 207, 305, 306
<data> = 0 ~ 1023

For more information refer to the HSB Operating Manual (Section 5 SLM212 Driver: Data Interface Description).

5.2 PLUT Operation Commands

Pixel Look Up Table (PLUT) is an array of pixel amplitude DAC values. The array contains one 10-bit amplitude value for each GLV pixel. There are up to 65536 PLUTs in the Cosmo board. PLUT operating commands can be used to generate user defined test patterns.

5.2.1 POKELUT

POKELUT command writes multiple amplitude values to a PLUT array starting at user defined pixel. Up to 64 pixels can be updated with a single POKELUT command

POKELUT <LUT#> <start pixel> <amp1> (amp2) (amp3) ⋯

<LUT#> = 0 to 65535

<start pixel> = 0 to 1087

<amp> = 0 to 1023

5.2.2 PEEKLUT

PEEKLUT command reads multiple amplitude values from a PLUT array starting at user defined pixel.

PEEKLUT <LUT#> <start pixel> <count>

<LUT#> = 0 ~ 65535

<start pixel> = 0 ~ 1087

<count> = 1 ~ (1088 – start pixel)

5.2.3 COPYLUT

COPYLUT command copies source PLUT array to destination PLUT array.

COPYLUT <dst> <src>

<dst>,<src> = 0 ~ 65535

5.2.4 COPYLUTBLOCK

COPYLUTBLOCK command copies a block of pixels from a source PLUT to one or more blocks in a destination PLUT. When copying to multiple blocks, the destination blocks will be adjoining. The destination PLUT # can be the same as the source providing no overlap between the source and destination blocks.

COPYLUTBLOCK <dst> <src> <dst start> <src start> <count> <repeat>

<dst>,<src> = 0 ~ 65535. Destination and source PLUT #

<dst start> starting pixel where data are copied to. 0 ~ 1087

<src start> starting pixel where data are copied from. 0 ~ 1087.

<count> number of pixels which are copied. 1 ~ 1087

<repeat> number of repeated blocks of copied pixels

5.2.5 FILLLUT

FILLLUT command sets all 1088 pixels in a PLUT array to the same amplitude value.

FILLLUT <LUT#> <amp>

<LUT#> = 0 ~ 65535

<amp> = 0 ~ 1023

5.2.6 FILLLUTBLOCK

FILLLUTBLOCK command fills a block of pixels in a PLUT array to the same amplitude value.

FILLLUTBLOCK <LUT#> <start> <count> <amp>

<LUT#> : PLUT number. 0 ~ 65535

<start> : starting pixel from which the data are filled. 0 ~ 1087

<count> : number of pixels to be filled. 1 ~ (1087-<start>)

<amp> : Filled amplitude value. 0 ~ 1023

5.2.7 FILLLUTLOHI

FILLLUTLOHI command fills alternating blocks in a PLUT with two amplitude levels.

FILLLUTLOHI <LUT#> <amp_l> <amp_h> <width_l> <width_h> <offset>

<LUT#> : PLUT number. 0 ~ 65535

<amp> : Amplitude value for low and high level. 0 ~ 1023

<width> : Number of pixels in a block. 1 ~ 1088

<offset> : Start pixel number where data are filled. 0 ~ 1087

5.2.8 RESETLUT

RESETLUT command resets all PLUT array values to specified amplitude value.

RESETLUT <amp>

<amp> : 0 ~ 1023

5.3 Description of Timing Control Commands

The timing control commands control the frame and column timing. The timing control commands described in this paragraph are executed immediately when the ASCII command is entered. In addition, these commands will store timing control parameters in non-volatile memory on the Cosmo board. The stored parameters are loaded automatically at the next initialization of the Cosmo board (i.e. RESET or power cycle). The timing control function is described in section 7. Refer to the block diagram in section 7 for an illustration timing control circuitry.

5.3.1 COLSOURCE

COLSOURCE selects the source of the column strobe by selecting sources of the C4, C3 and C2 multiplexers. C4 selects between the internal or an external column strobe. C3 selects the source of the internal column strobe between "column counter" and the "software trigger". C2 selects the source of the external column strobe input, where the user can select either the positive-edge or negative-edge column strobe as the input. The COL_EN signal is reserved for future growth. (Potential growth feature: COL_EN uses the C4 mux to dynamically switches the column source between the external column strobe when COL_EN is high and the internal column strobe when COL_EN is low).

COLSOURCE <C4_src> <C3_src> <C2_src>

<C4_src> : Mux for column strobe. INT, EXT or ENA.

INT : internal column strobe

EXT : external column strobe

ENA : Reserved for future growth (where COL_EN will dynamically select internal OR external column strobe)

<C3_src> : Mux for internal column. CNT or SWS

CNT : column counter output

SWS : software column strobe trigger

<C2_src> : Mux for external column input. EXT or INV

EXT : positive-edge column strobe input

INV : negative-edge column strobe input

5.3.2 COLTIME

COLTIME command sets the column period counter from a user defined time. The <time> parameter is in units of nanoseconds, so to enter a column period of 1.0 us, the user should enter a value of 1000.

COLTIME <time(ns)>

5.3.3 COLTRIGDELAY

COLTRIGDELAY command sets the delay time of the column output trigger relative to the GLV column strobe. The <time> parameter is in units of nanoseconds and has a resolution of 10 nsec, so to enter a column period of 1.0 us, the user should enter a value of 1000.

COLTRIGDELAY <time(ns)>

5.3.4 TRIGCPWTIME

TRIGCPWTIME command sets the column pulse width counter from a user defined time. The <time> parameter is in units of nanoseconds, so to enter a column period of 1.0 us, the user should enter a value of 1000.

TRIGCPWTIME <time(ns)>

5.3.5 TRIGCSOURCE

TRIGCSOURCE command selects the source of the column output trigger by selecting sources of C6 and C5 muxes. The C5 mux allows the user to select a gated version of the column strobe. The gated column trigger is only pulsed when the GLV has received a new packet of pixel data and the gated column trigger indicates that the GLV has been updated with the new packet data. This is most useful when frame control is on and the number of pixel data packets may exceed the number of columns per frame. The GLV uses the non-gated version of the column strobe, however, GLV data changes only after a new packet of data has been received. The C6 mux allows the user to invert the column strobe (negative-edge). In addition, the C6 mux allows the user to select a software trigger as the trigger output.

TRIGCSOURCE <C6_src> <C5_src>

<C6_src> = POS, INV, SWS

POS : positive-edge

INV : negative-edge

SWS : software trigger

<C5_src> = GAT or NOG

GAT : Gated column trigger output

NOG : non-gated column trigger output

5.3.6 FRAMECONTROL

FRAMECONTROL command enables the operation of the frame strobe or allows free-run operation (i.e. next frame starts automatically after the previous frame).

FRAMECONTROL <control>

<control> = ON (Controlled by frame signal) or OFF (Free-run)

5.3.7 FRAMESOURCE

FRAMESOURCE command selects the source of the frame strobe by selecting sources of the F2 mux. Frame signal can be selected from external FRAME input (EXT), inverted external FRAME input (INV), internal frame counter (CNT) or software trigger (SWS).

FRAMESOURCE <src>

<src> = EXT, INV, CNT or SWS

5.3.8 FRAMETIME

FRAMETIME command programs the frame period counter from a user defined time. Parameter is in units of microseconds, so to enter a frame period of 1.0 ms, the user should enter a value of 1000.

FRAMETIME <time(us)>

<time(us)> = 0 ~ 20,000,000 (20 sec)

5.3.9 FRAMEDELAYTIME

FRAMEDELAYTIME command programs the frame delay counter from a user defined time. Parameter is in units of us, so to enter a delay of 2 us, the user should enter a value of 2.

FRAMEDELAYTIME <time(us)>

<time(us)> = 0 ~ 320

5.3.10 TRIGFPWTIME

TRIGFPWTIME command programs the frame pulse width counter from a user defined count. Parameter is in unit of us, so to enter a time of 1.0 us, the user should enter a value of 1.

TRIGFPWTIME <time(us)>

<time(us)> = 0 ~ 320

5.3.11 TRIGFSOURCE

TRIGFSOURCE command selects the source of the frame output trigger by selecting sources of F4 and F3 muxes. The F3 mux allows the user to select a delayed version of the frame strobe. The F4 mux allows the user to select an inverted version of the frame strobe. (negative-edge). In addition, the F4 mux allows the user to select a software trigger as a trigger output.

TRIGFSOURCE <F4_src> <F3_src>
<F4_src> = POS, INV, SWS
POS : positive-edge
INV : negative-edge
SWS : software trigger
<F3_src> = DEL or NOD
DEL : delayed column strobe.
NOD : non-delayed column strobe.

5.3.12 COLSTATUS

COLSTATUS command displays column strobe settings including:

- Internal column strobe period
- Column delay count (fixed value)
- Column strobe source
- Trigger output source
- Trigger output pulse width
- Trigger output delay value

5.3.13 FRAMESTATUS

FRAMESTATUS command displays frame settings including:

- Internal frame counter period
- Frame delay count
- Frame source
- Trigger output pulse width
- Trigger output source

5.3.14 SOFTTRIGGER

SOFTTRIGGER command generates a software trigger.

SOFTTRIGGER <trigger>
<trigger> = C1, C2, F1 or F2

C1 is the trigger for column strobe

C2 is the trigger for column trigger output

F1 is the trigger for frame signal

F2 is the trigger for frame trigger output

5.3.15 SAVETIME

SAVETIME command saves the user's current time control settings to non-volatile memory.

5.3.16 RECALLTIME

When the Cosmo Board is reset or powered up, the default timing settings are used. RECALLTIME command recalls the user's time control settings that are stored in non-volatile memory.

6 Test Patterns

The Cosmo board generates the test patterns listed below for the purpose of testing and characterizing the High-Speed Buddy GLV Module.

TEST1	Set all pixels to a fixed amplitude level.
TEST2	Single pixel ramps from an amplitude level of 0 to 1023.
TEST4	Modulates all pixels between two amplitude levels.
TEST5	Modulates a single pixel between two amplitude levels.
TEST9	All pixels ramp from amplitude level 0 to 1023 over 1024 columns.
TEST12	Single pixel steps to multiple user defined amplitude levels.
TEST15	Set a block of pixels to a programmed ON amplitude level and the adjacent block of pixels to a programmed OFF amplitude level.

When a test pattern is executed, the Cosmo board first initializes the High-Speed Buddy if not yet initialized, and then expose data packets are sent over the downlink. Expose timing is defined by the timing control ASCII commands. The test pattern repetitively sends out the expose data packets until the stop command "/" is sent to the Cosmo board.

6.1 TEST1

TEST1 pattern sets all the pixels at a fixed amplitude level. Following is the syntax for the TEST1 command:

TEST1 <amp>
<amp> : amplitude level for TEST1 pattern. 0 ~ 1023

TEST1 pattern is illustrated in Figure 6-1.

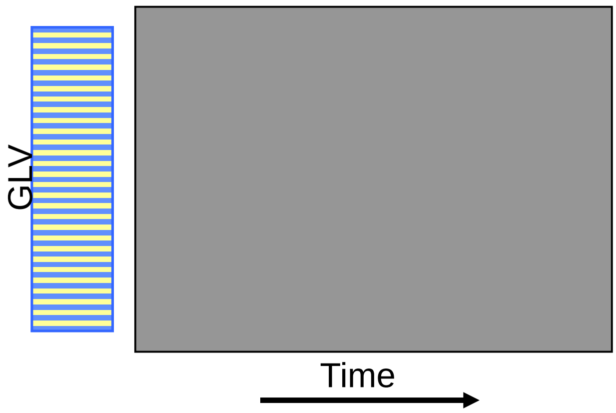


Figure 6-1 TEST1 pattern

6.2 TEST2

TEST2 pattern ramps a single pixel incrementing from 0 to 1023 or decrementing from 1023 to 0. User can define which pixel ramps by the <start> parameter. After a single pixel finishes ramping, then then adjacent pixel will start to ramp when the <move> option is set by the user, otherwise the same pixel keeps ramping. After the ramp is finished, the amplitude level of the pixel indicates the pixel ID in a 16-bit binary code (fiducial). The user can choose whether this ID is enabled or not. While a single pixel ramps, other pixels are fixed to user defined amplitude level. Following is the syntax for the TEST2 command:

TEST2 <start> <move> <no_id> <amp_off> <amp_on> <ramp>
<start> : Starting pixels for single pixel ramp. 0 ~ 1087
<move> : ramping pixel moves adjacent pixel after finishing ramp. 0 or 1
  0 : do not move to adjacent pixel
  1 : move to adjacent pixel
<no_id> : 0 (enable) or 1 (disable) the fiducial ID. 0 or 1
<amp> : amplitude level for background and fiducial IDs. 0 ~ 1023
<ramp> : 0 (ramp-up) or 1 (ramp-down)

TEST2 pattern is illustrated in Figure 6-2.

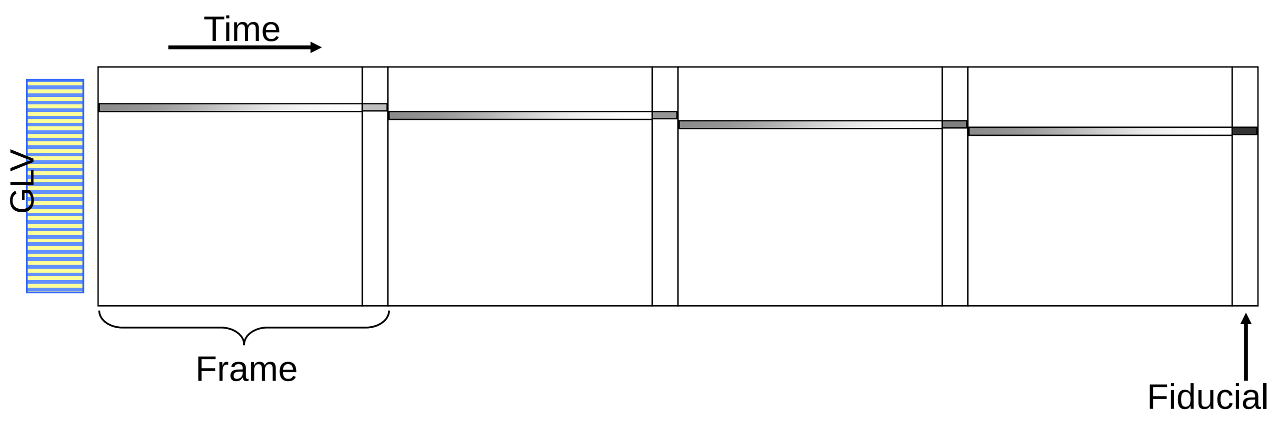


Figure 6-2 TEST2 pattern

6.3 TEST4

TEST4 pattern toggles all the pixels between two amplitude levels. The GLV switches between the two amplitude levels at every column strobe. Following is the syntax for the TEST4 command:

TEST4 <amp0> <amp1>
<amp*> : amplitude level. 0 ~ 1023

TEST4 is illustrated in Figure 6-3.

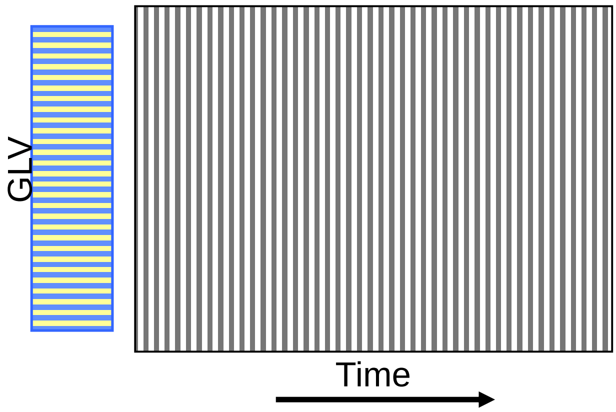


Figure 6-3 TEST4 pattern

6.4 TEST5

TEST5 modulates a single pixel between two amplitude levels. The single modulating pixel can be repeated along the array by defining a block (N) of non-modulating pixels. The non-modulating pixels are set to a fixed amplitude value defined by the <amp_off> parameter. The <step pixel> parameter is the number of non-modulating pixels + 1. Following is the syntax for the TEST5 command:

TEST5 <amp_on> <amp_off> <start pixel> <step pixel> <end pixel>
<amp*> : amplitude level for on and off pixels. 0 ~ 1023
<start pixel> : 0 ~ 1087
<end pixel> : <start pixel> ~ 1087
<step pixel> : 2 ~ 1088

TEST5 is illustrated in Figure 6-4.

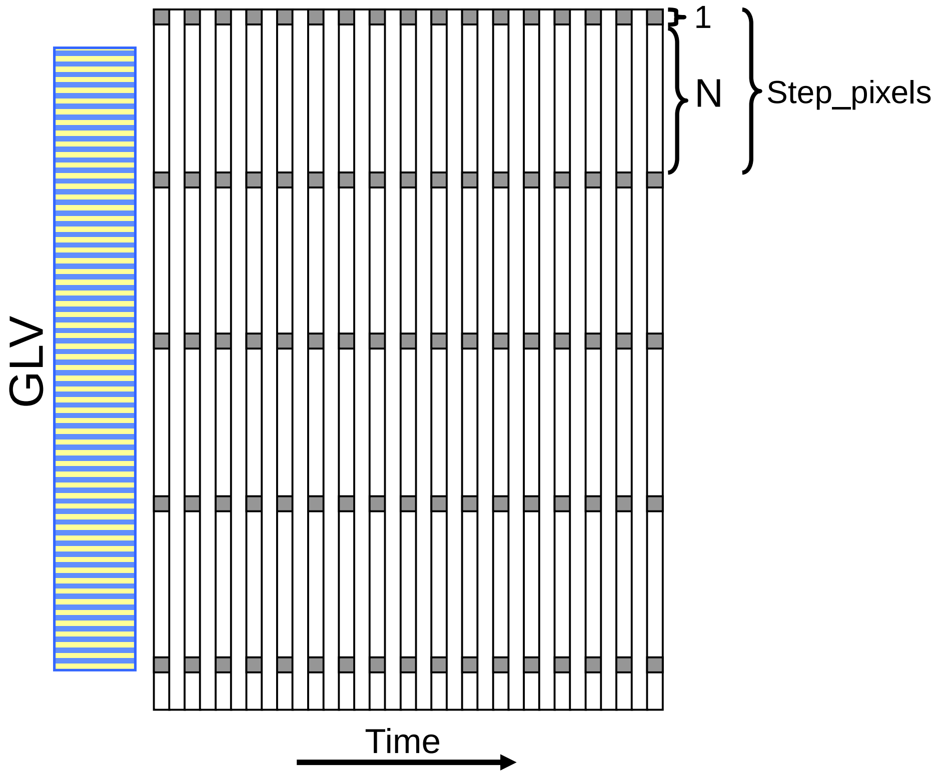


Figure 6-4 TEST5 pattern

6.5 TEST9

TEST9 pattern ramps all pixels incrementing from 0 to 1023. Following is the syntax for the TEST9 command: TEST9

No parameter is required for TEST9 command. TEST9 is illustrated in Figure 6-5.

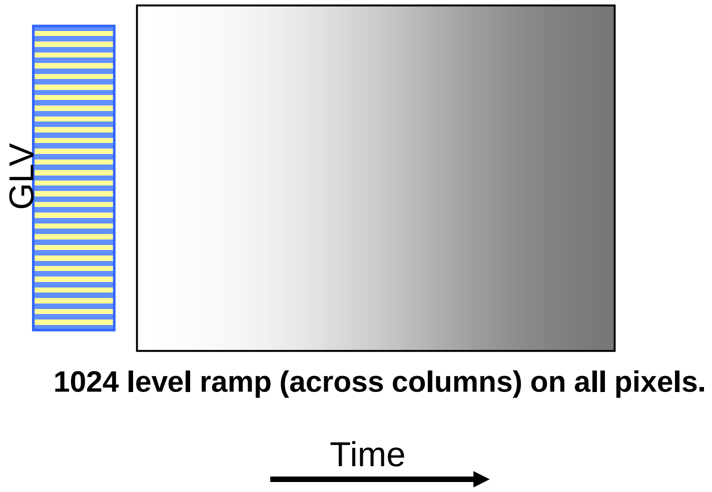


Figure 6-5 TEST9 pattern

6.6 TEST12

TEST12 pattern modulates a single pixel between user specified amplitude levels. The user can define up to 32 amplitude levels as a parameter for TEST12 command. Other pixels are fixed to a user specified amplitude level <amp_off> while the single pixel is modulated. Following is the syntax for the TEST12 command:

TEST12 <start LUT> <pixel#> <amp_off> <amp0> (amp1) (amp2) ··· (amp31)
<start LUT> : Start PLUT number where step amplitude data will be stored.
<pixel#> : pixel number of the modulating pixel 0 ~ 1087
<amp*> : amplitude level. 0 ~ 1023

TEST12 is illustrated in Figure 6-6.

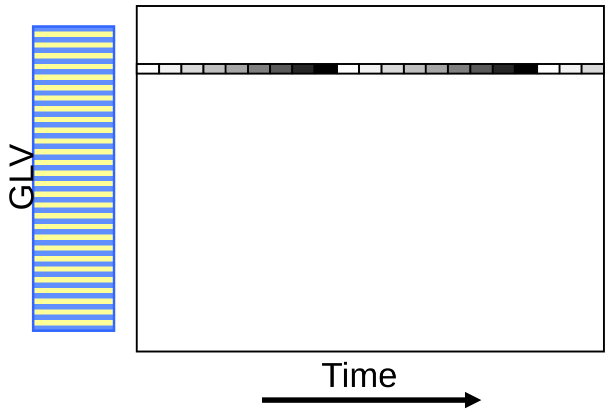


Figure 6-6 TEST12 pattern

6.7 TEST15

TEST15 sets a block of pixels to a programmed ON amplitude level and the adjacent block of pixels to a programmed OFF amplitude level. The pattern of M pixels ON and N pixels OFF can be repeated along the array of pixels. Amplitude levels for the ON and the OFF pixels are defined by the user from parameters. The first ON pixel is defined by user by the <start pixel> parameter. Number of ON pixels in a block (M) is also defined by user as the <on pixel> parameter. Number of off pixels in a block (N) is defined by the user as <step pixel> where <step pixel> = M+N. The M-on & N-off block will be repeated until the pixel number reaches <end pixel> parameter. Following is the syntax for the TEST15 command:

TEST15 <amp_on> <amp_off> <start pixel> <step pixel> <end pixel> <on pixel>
<amp> : amplitude level. 0 ~ 1023
<start pixel> : 0 ~ 1087
<step pixel> : 2 ~ 1088
<end pixel> : <start pixel> ~ 1087
<on pixel> : less than <step pixel>

TEST15 is illustrated in Figure 6-7.

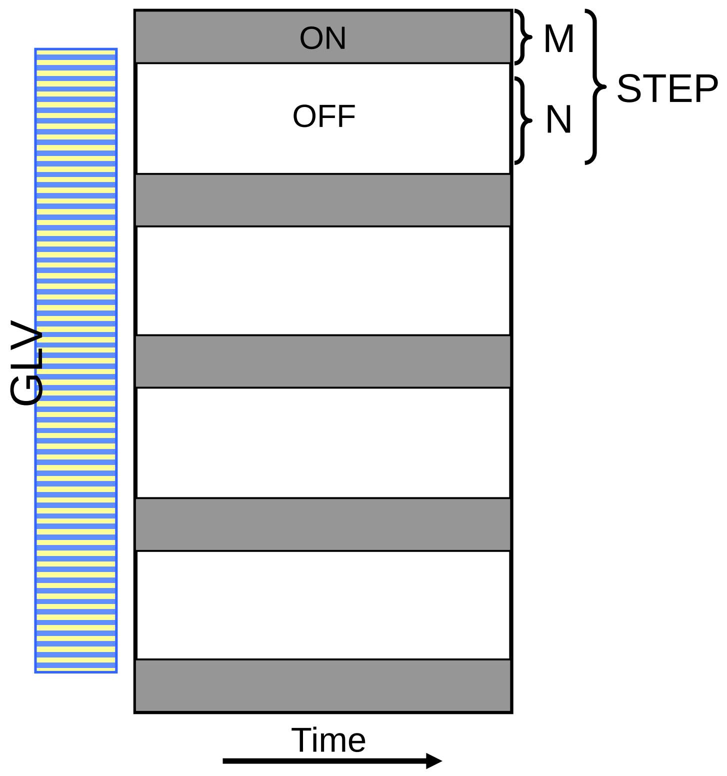


Figure 6-7 TEST15 pattern

6.8 User Defined Test Pattern

Programmable Look Up Table (PLUT) commands can be used to generate custom test patterns for the GLV. The PLUT feature allows the user to write user defined 10-bit amplitude DAC values to each individual pixel. Each PLUT array has 1088 entries (0 to 1087; that is one for each GLV pixel) and is used to produce a GLV line pattern. The PLUT arrays are stored in the Cosmo test board pixel memory. There are 65536 PLUT arrays. Each PLUT array has 1088 entries of 10-bit amplitude values. The PLUT commands that allow the user to write to the Cosmo pixel memory are described in section 5.2.

The following commands allow the user to send the pixel values from the Cosmo memory to the GLV: GOLUT, LOOPLUT, LOOPFRAME. These three command are described in the following paragraphs.

The user can also write pixel data to PLUTs through the USB3 interface by using the "Pixel Download Program". For further information about downloading pixel data through USB3, please refer to the Operating Manual of Pixel Download Program.

6.8.1 GOLUT

GOLUT command sends a single sequence of PLUT arrays to the GLV Module through the downlink interface. The sequence will stop after the last PLUT in the sequence is active on the GLV. The sequence can be triggered from the Frame trigger or can free-run. The figure shows that the data packet is written to the SLM212 drivers and the following column strobe outputs the new amplitude values to drive the GLV (intensity).

The user defines the PLUT range by the GOLUT command parameter. Following is the syntax for GOLUT command:

GOLUT <start LUT> <end LUT>
<start LUT> : LUT number of the first LUT in the sequence. 0 ~ 65535
<end LUT> : LUT number of the last LUT in the sequence. <start LUT> ~ 65535

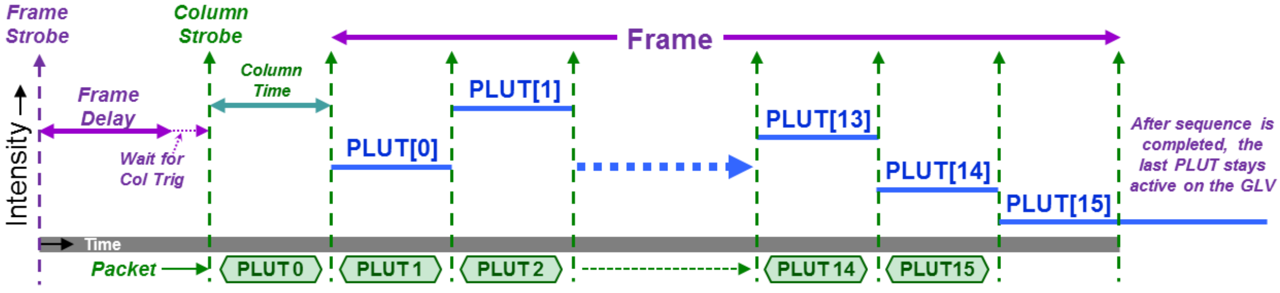


Figure 6-8 GOLUT sequence diagram

6.8.2 LOOPLUT

LOOPLUT command sends a sequence of PLUT arrays to the GLV Module and repeats the sequence. The <count> parameter defines the number of times that the sequence of PLUT's is repeated. If <count>is 0 then sequence will loop until the user stops the sequence by the "/" command. The sequence can be triggered from the Frame trigger or can free-run. Following is syntax for LOOPLUT command:

LOOPLUT <start LUT> <end LUT> <count>
<start LUT> : LUT number of the first LUT in the sequence. 0 ~ 65535
<end LUT> : LUT number of the last LUT in the sequence. <start LUT> ~ 65535
<count> : Number of loops to repeat the sequence. 0 ~ 65535. If count is 0, sequence is repeated until user stops the sequence.

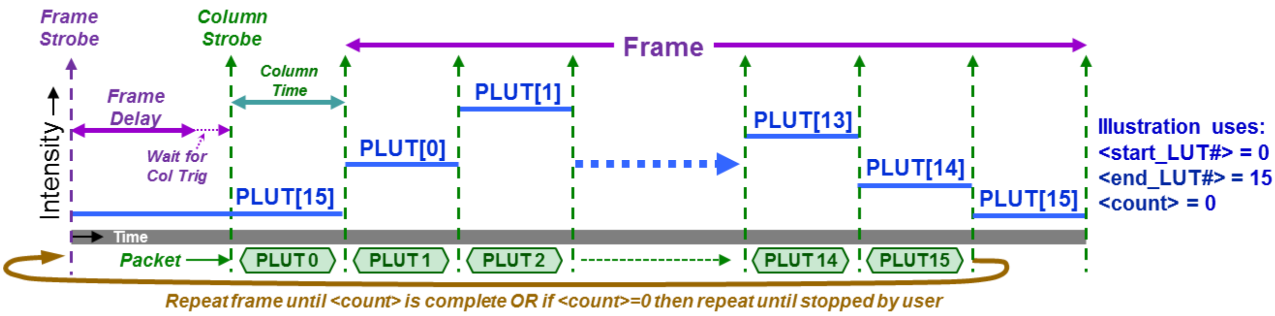


Figure 6-9 LOOPLUT sequence diagram (LOOPLUT 0 15 <count>)

6.8.3 LOOPFRAME

LOOPFRAME command sends a sequence of PLUT frames to the GLV Module and repeats the sequence. The PLUT sequence is composed of one or more frames. Each frame is a sequence of PLUT arrays where all frames contain the same number of PLUT arrays. The first PLUT# in a frame is equal to the last PLUT# of the preceding frame plus 1. Therefore, the PLUT sequence can be defined by the number of frames in a sequence and the number of columns (i.e. PLUT's) in a frame.

The <count> parameter defines the number of times that the sequence of PLUT's are repeated. If <count> is 0 then the sequence will loop until the user stops the sequence by the "/" command. Each frame can be triggered by the frame trigger or free-run. Following is syntax for LOOPFRAME command:

LOOPFRAME <start LUT> <col/frame> <frames> <count>
<start LUT> : LUT number of the first LUT in the sequence. 0 ~ 65535
<col/frame> : Number of columns per frame. 1 ~ 65536
<frames> : Number of frames in the sequence. 1 ~ 65536.
<count> : Number of loops to repeat the sequence. 0 ~ 65535. If count is 0, sequence is repeated until user stops the sequence.

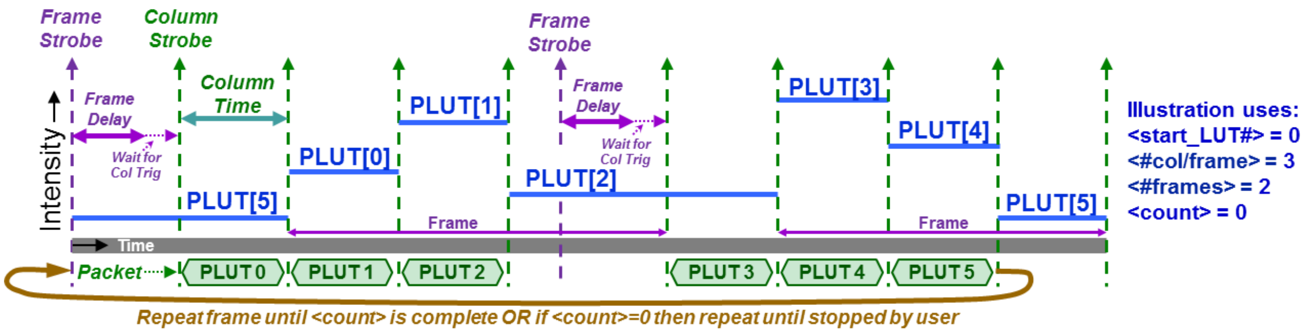


Figure 6-10 LOOPFRAME sequence diagram (LOOPFRAME 0 3 2 <count>)

In the figure, the sequence is generated with the following parameter values:

<start LUT> : 0
<col/frame> : 3
<frames> : 2
<count> : 0

7 Timing Control

Timing parameters can be entered by the user to control the timing of the Cosmo Board and the High-Speed Buddy Module. The timing parameters allow the user to control the column period and frame period of the test patterns generated by the Cosmo Board. However, not all Cosmo test patterns are organized in frames. The minimum column period is 2.86 usec (i.e. 350 kHz maximum frame rate). The software will currently allow the user to set a lower column period, but correct operation is not guaranteed below 2.86 usec (i.e. column to packet timing will be violated at column periods below 2.86 usec).

The Cosmo Board can be a master or a slave regarding the column or frame timing. The timing parameters allow the user to select the source of the column and frame strobes. When operating as a slave device, external column and frame strobes can be selected. And when operating as a timing master, the period of the internal column counter or frame counter can be programmed to set the column and frame periods.

In addition, two trigger outputs are provided to synchronize the GLV's output to external equipment. Timing parameters are provided that a allow the user to control the operation of these trigger outputs. Although the source of the trigger outputs are typically the column and frame strobes, other trigger sources can be switched to these two trigger output connectors. The timing control features are illustrated in the following figure and are summarized below:

- Column Strobe
  - Source of column strobe
  - Column period (2.86 usec is minimum)
- Frame Strobe
  - Source of frame strobe
  - Frame period
  - Frame delay
- Trigger Outputs
  - Source & sense of trigger outputs
  - Pulse width of trigger outputs
  - Column trigger output delay

In addition to the user controlled timing functions, there are additional features of the timing control circuits that are controlled by the Cosmo embedded software. These features are:

- DCLK Programmable Oscillator
- WCLK Programmable Oscillator: (WCLK is not used for the High-Speed Buddy)
- Column Delay Counter

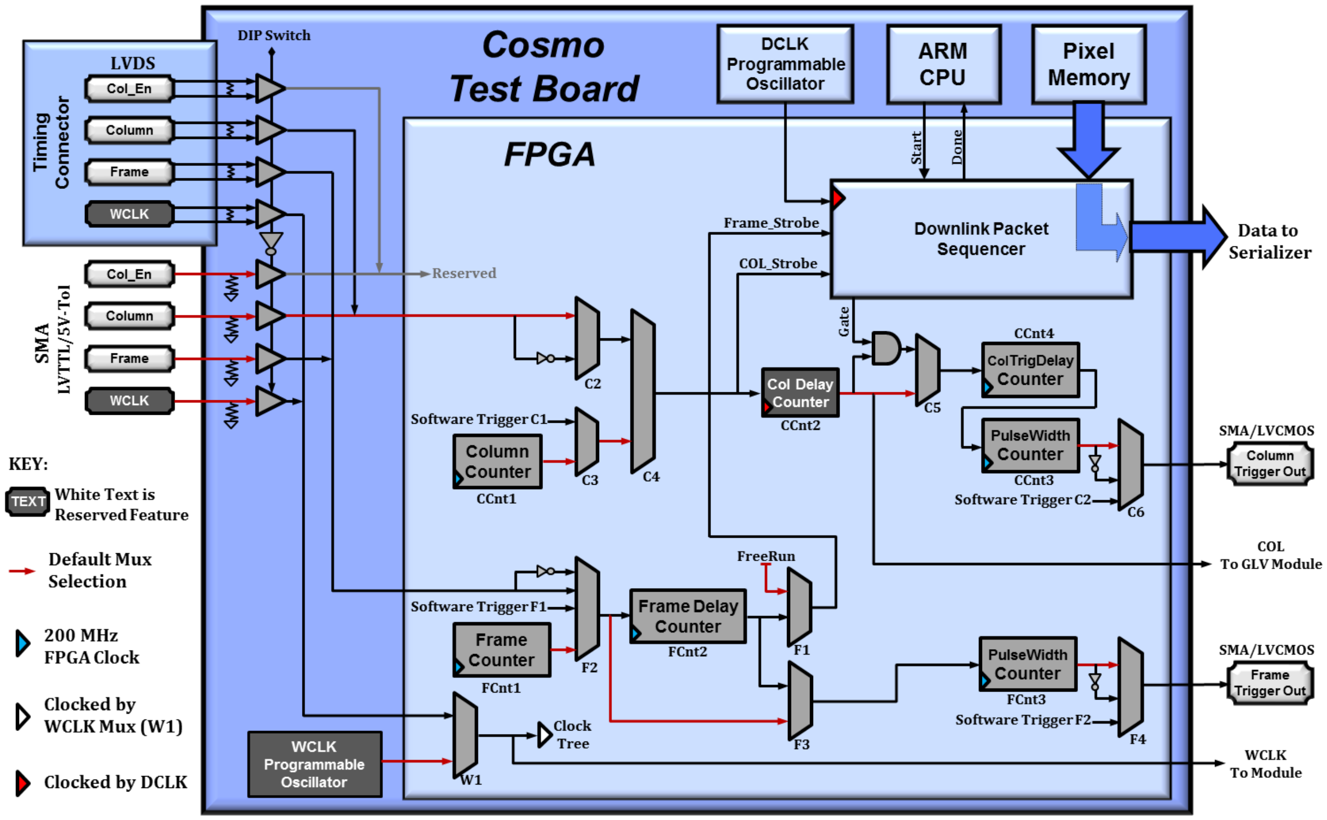


Figure 7-1 Timing Control Block Diagram

The Cosmo has two programmable oscillators on-board. One is the DCLK which generates the clock for the downlink deserializer, which in turn, is used to generate the DCLK to the SLM212 Drivers at one-half the Cosmo's DCLK frequency. The frequency of the DCLK programmable oscillator is managed by the Cosmo embedded software and is set to 104 MHz, which produces a 52 MHz data clock to the SLM212 Drivers. This DCLK frequency supports column rates up to 350 kHz on the High-Speed Buddy Module. When the column period is adjusted by the user, the DCLK frequency continues to operate at 104 MHz (52 MHz to SLM212).

The Cosmo embedded software also manages the Column Delay Counter setting to insure that the column strobe to data packet timing requirements are met for the SLM212 driver. There is also a WCLK programmable oscillator that is reserved for future growth and is not currently used for the High-Speed Buddy application.

The source of the column and frame input strobes can be generated internally by the Cosmo or can come from an external source. Two connector options are provide on the Cosmo for external column and frame triggers: (1) individual SMA connectors with 3.3 volt signal ended signals (5-volt tolerant) (Reference designators X15 & X16), or (2) a shared connector with LVDS signals (Reference Designator X13). On the High-Speed Buddy Modules, all 1088 GLV pixels are updated synchronous to the column strobe.

The Downlink Packet Sequencer can operate with or without an frame trigger input. To enable the frame control feature, send the "FRAMECONTROL ON" ASCII command to the Cosmo Board. The frame trigger can be internally generated with a counter or an external frame trigger can be input via an SMA connector. Figure 7-2 illustrates the operation of the Downlink Packet Sequencer. When frame control is ON, then the sequencer will wait until the frame trigger input is received prior to outputting a frame of pixel data packets. Each individual packet is output after a column strobe is received. Once the frame has completed, then the sequencer will wait for the next frame trigger input prior to sending out the next frame.

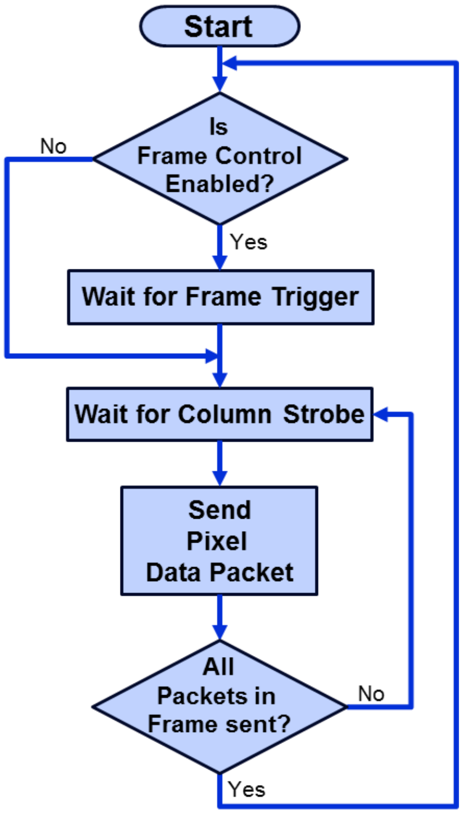


Figure 7-2 State Machine for Downlink Packet Sequencer

Simplified Timing Control & Default Timing Parameters

The timing control features allow a flexible timing interface to other components in a user's system. The many features may make the timing control function appear complex and difficult to use at first glance. However, the Cosmo Board is delivered with the timing control parameters set to the default setting. In the default timing configuration, the timing control is greatly simplified. Timing parameters are set to the default values when the Cosmo Board is shipped. In the default configuration, the timing control circuits can be controlled with the following two commands: COLTIME & TRIGCPWTIME.

At a conceptual level, the default parameters are set so that the frame control is disabled (free-run operation) and the column strobe is generated by the internal Column Counter (CCnt1). The pulse width of the column trigger output is set to 1 usec by the Column Pulse Width Counter (CCnt3). The details of the default setting are listed below and are illustrated in figure 7.2.

Column settings

Column source	: Internal column counter
Internal column count	: 2.86 us (350 kHz column rate)
Column trigger source	: Positive-edge, delayed column
Column trigger delay	: 0
Column trigger width	: 1.0 us

Frame settings

Frame control	: Free-run (Frame Control is OFF)
Frame source	: Internal frame counter
Internal frame count	: 100 us
Frame trigger source	: positive-edge non-delayed frame
Frame trigger width	: 10 us

When the Cosmo Board is reset or powered up, the default timing settings are used. At any time during a session, the user's current timing parameters settings can stored in non-volatile memory by using the SAVETIME command. The RECALLTIME command can be used to recall the stored timing parameter settings from non-volatile memory. Status of the timing parameters can be checked with the following commands: COLSTATUS and FRAMESTATUS.

COLRESET and FRAMERESET commands respectively. These commands put the timing circuits in the same functionality as the following set of commands:

- COLRESET
  - COLSOURCE INT CNT EXT
  - COLTIME 2860
  - TRIGCSOURCE POS NOG
  - TRIGCPWTIME 1000
  - COLTRIGDELAY 0
- FRAMERESET
  - FRAMECONTROL OFF

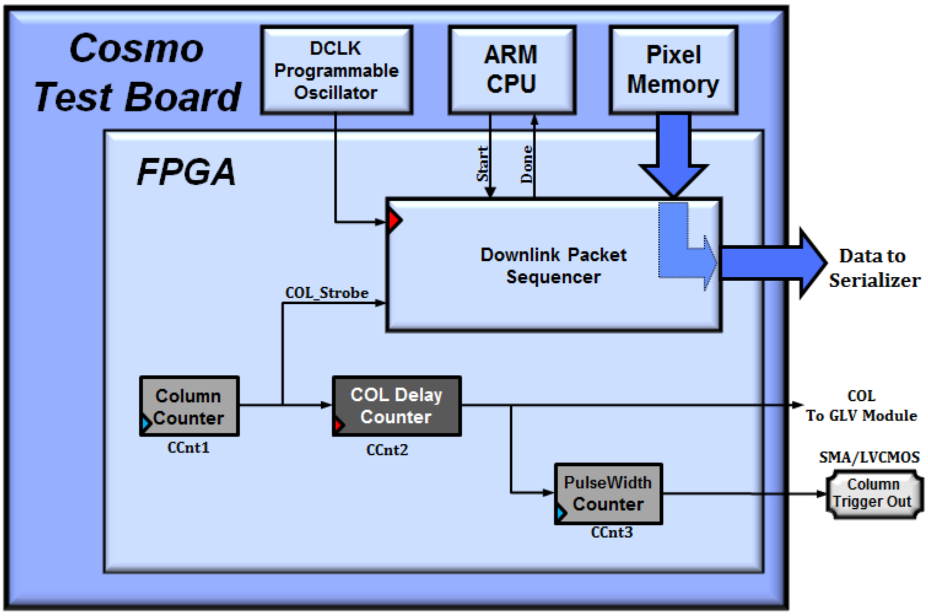


Figure 7-2 Simplified Timing Control Block Diagram

(Default Configuration)

8 Sample Sessions using ASCII Commands

This section shows sample sessions to operate the GLV Module using ASCII commands.

8.1 Example 1

Power up the boards and run a test pattern and stop the test pattern.

* Turn on 5 volt power supply for the Cricket Interface Board
* Turn on 24 volt power supply for the Cosmo Board (see note 1)
> VDDAH 200 (see note 2)
> TEST4 0 1023
> /

Notes:
(1): Cosmo automatically executes the "BOOTUP" command on power up (or Cosmo reset) for the purpose of initializing the Cricket & GLV Module.
(2): The recommended VDDAH level is custom setting for each individual GLV Module. The recommended VDDAH level is determined by the wavelength of the illumination laser and the fundamental characteristics of the GLV device. Refer to the shipment documents that were received the evaluation kit hardware for the recommended VDDAH setting. "200" value is used as an example.

8.2 Example 2

Power down the module then initialize module and run a test pattern.
> POWERDOWN
> BOOTUP
> VDDAH 200
> TEST4 0 1023
> /

8.3 Example 3

Fill 6 PLUTs in pixel memory and run a user defined test pattern using LOOPLUT command. The illustrated pattern makes all pixels do a stair-step test pattern with 6 amplitude steps. Assumes the GLV Module has been powered up and initialized.

> FILLLUT 100 1
> FILLLUT 101 200
> FILLLUT 102 400
> FILLLUT 103 600

```
> FILLLUT 104 800
> FILLLUT 105 1000
> LOOPLUT 100 105 0
> /
```

8.4 Example 4

Change the column period to 10 usec. Select the Column Trigger Output to be delayed and to be non-inverting. Set the pulse width of the Column Trigger Output to 2 usec. The COL trigger will be output at the same time that the GLV receives the COL strobe. Run test pattern 9.

```
> BOOTUP
> VDDAH 200
> COLTIME 10000
> TRIGCSOURCE POS DEL
> TRIGCPWTIME 2000
> TEST9
> /
```

8.5 Example 5

Run test pattern 12 using an externally generated column strobe.

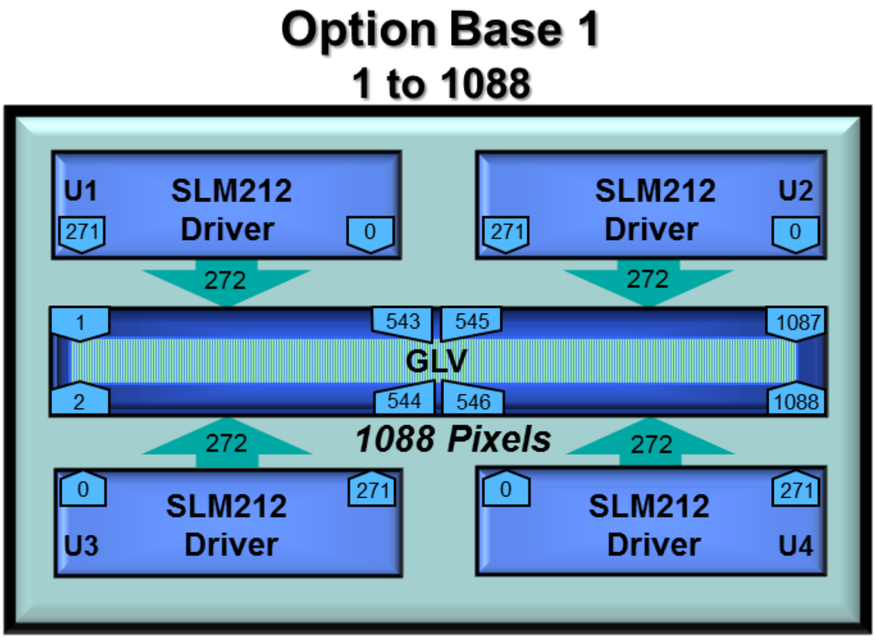
```
> BOOTUP
> VDDAH 200
> COLSOURCE EXT CNT EXT
> TEST12 50 0 1 100 300 500 700 900 1023
> /
```

Notes:

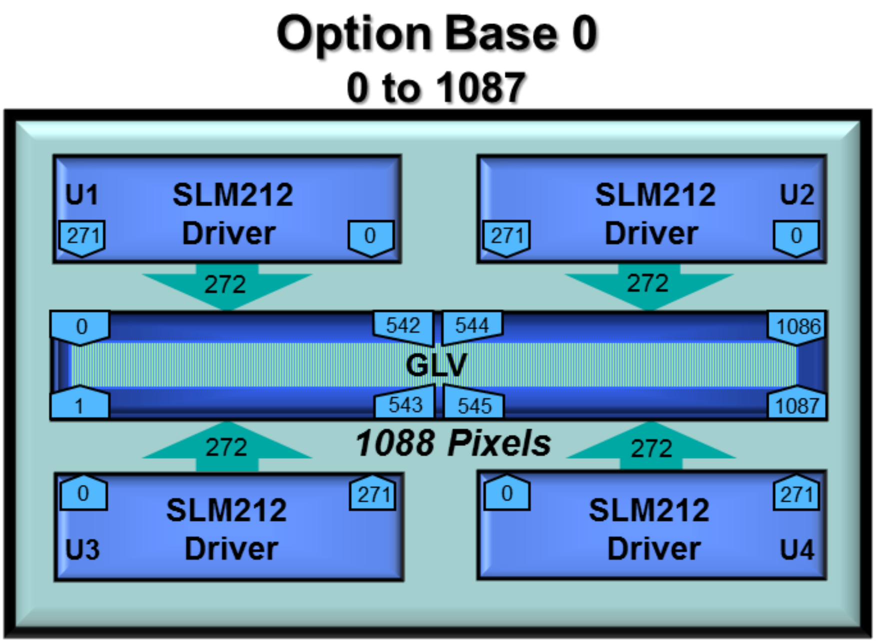
- BOOTUP command is only required if Module has not been powered-up and initialized.
- Use "/" to stop test patterns.

Appendix A: Pixel Numbering

The GLV pixel array contains 1088 pixels and is numbered from 1 to 1088. The following diagram shows the GLV pixel number and the how the 4 SLM212 Drivers channels are connected to the GLV pixels.



As most software array are enumerated, the Cosmo software numbers the GLV starting at zero (option base 0), so the 1088 pixels are numbered from 0 to 1087. All parameters in the Cosmo ASCII commands are entered using option base 0. The following diagram is provided to as a reference to the Cosmo pixel numbering.



Revision history

Revision	Date	Description
A	10/29/15	Preliminary Release
B	12/29/15	1st release
C	6/24/16	Added ASCII command summary tables in section 4. Revised the following figures to show the data packet relative to the GLV intensity change: Figure 6-8, Figure 6-9 & Figure 6-10. Added Figure 7-2 State Machine for Downlink Packet Sequencer.
D	5/02/17	Figure 7-1 and text was modified to show Column_En signal is reserved for future growth.
E	10/9/17	Revision E documents modifications made in ARM firmware Version 1.00 Build 986 and FPGA version 1.0070. Section 3: Reduced power supply current capacity requirements for both 24V and 5V power supplies. Power cable and hot plug warnings have been added in section 3.1. LAN Interface: Explained uses of "EEPROM Download Program" and "Cosmo Downloader". Section 4 & 5: Section 4 introduction describes the BOOTUP command. General purpose commands have been separated into 4 sub-types: Control commands, GLV Module BOOTUP Commands, Status & Information Commands and Advanced User Commands. The following commands that use the control interface (I2C) were referenced to the appropriate HSB Operating Manual section: READNV, WRITENV, VDDAH, COMMON, BIAS, ADC, READADC, PSOC, POWERDOWN, POWERUP LOW, POWERUP, DESKEW, RSTFPGA. VDDAH command: Recommended and maximum VDDAH settings are described. TRIGCSOURCE: The source of column trigger output can now be selected as a gated column trigger so that the column trigger is only pulsed when the GLV has received a new packet of pixel data and the gated column trigger indicates that the GLV has been updated with the new packet data. The TRIGCSOURCE C5_src parameters

were modified to GAT or NOG to accommodate the gated column trigger modification.

COLTRIGDELAY: The column trigger output can now be delayed relative to the GLV optical output update. The COLTRIGDELAY command was added to support the column trigger output delay.

The following commands had some modifications to the descriptions: COMMON, BIAS, ECREF, SLOPES, DRIVER, WRITENV

Section 7:

The Timing Block Diagram (Figure 7-1) and associated text were modified to illustrate the change listed above.

SAVETIME & RECALLTIME: The firmware has been modified to remove the automatic store and the automatic recall on boot-up of the timing control parameters. This ability to save and recall parameters is now provided to the user with two new commands: SAVETIME & RECALLTIME.

Example 1 was added to illustrated that the Cosmo board automatically executes the BOOTUP command on power up (or reset).