Boxlight E-Cinema Projector
PRO 80S3
Customer
Operations Manual

for Controller Firmware Revision 0.73
and Motor Control Firmware Revision 1.0

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1. Introduction

The *Boxlight Electronics E-Cinema Projector* is a three-chip DLP projector with a native resolution of 1280x720 pixels (16:9 aspect ratio). The projector accepts 720p video through a DVI-D connector on the rear panel.

1.1 Controllers

The projector is controlled by a pair of *MTV312M64* microcomputers. The first is the main controller and is responsible for lamp ballast and formatter initialization. It continuously monitors the state of the formatters, the ballast and the video input primarily to prevent the lamp from extinguishing due to loss of video or unintentional resetting of the formatters due to power fluctuations. Communication with the controller is through an RS-232 interface using a simple command/parameter protocol. The second processor manages the IR remote control functions: lens shift, focus and zoom. It has no external communications interface except the IR receiver.

1.2 Rear Panel Connectors and Switches and Displays

There are four I/O connectors, two switches and nine LEDs on the rear panel.

Rear Panel Connectors and Switches and Displays	
Connector/Switch/LED	**Purpose**
Connectors	
Connector/Switch/LED	**Purpose**
DVI-D	720p Video Input. There is no scaler on board.
DB-9F	Serial Communications with main µC – 9600,8,N,1
	Film Projector Lockout Connector
RJ-45	NIC
Switches	
2-position Rocker Switch	Located just above the power connector – System Power ON/OFF
3-position Rocker Switch	Soft Power ON/OFF and Shutter Control
LEDs	
RED/GREEN LED	Power State - located to the left of the Power/Shutter Control Switch
8 GREEN LEDs	Projector Status - Located to the left of the DVI Connector

Multicolor LED Power Sequence State

Color	State
RED	Standby
GREEN	Power On or Power-up sequence
YELLOW (GREEN + RED)	IF some STATUS LEDs ON – 5 minute power-down ELSE power-off sequence

Status LED Operation		
STATUS LED	**When ON Continuously**	**When Flashing (or OFF)**
LAMP DOOR	Lamp Door Interlock OK Lamp Thermal Switch Closed	Lamp Door Open or Lamp Thermal Switch Open - Shutdown
FAN	Fans OK	Fan Failure - Shutdown
LAMP	Lamp Struck and Operating	Lamp Extinguished Lamp Life time over system limited. (1470 hours)
VIDEO SIGNAL	Video Signal Detected	No Video
FORMATTER	Formatters Initialized and Operating	Formatter Failure (usually a communication failure) - Shutdown
BALLAST TEMP	Ballast Temperature OK	Ballast Temperature High - Shutdown
READY	90 Second Lamp Cool-down Timer Expired READY for Power-up or Re-strike	**[READY OFF]** 90 Second Lamp Cool-down Cycle in Progress
SHUTTER	Shutter OPEN NORMAL Projection Mode	Shutter CLOSED CURTAIN Mode

NOTE: There may be as much as a 2 second delay between an event that will cause a change in the STATUS LEDs, e.g., SHUTTER OPEN, and the actual display update.

1.3 Power Sequencing

1.3.1 STANDBY

When the main power switch is turned ON, the projector comes up in STANDBY mode. It may be left in this state indefinitely. Both controllers and the RS-232 circuitry are powered so that the unit can respond to serial commands, the IR Remote Control or the rear panel switch. The ballasts, fans and formatters are not energized.

Note: The IR Remote POWER button is always active but the other buttons may be disabled. If the unit is powered up using the IR Remote, all IR commands will be enabled. If the unit is powered up using the rear panel switch or via the serial port, only the IR POWER button will be active. IR Remote buttons may be enabled or disabled with the **`IR+`** and **`IR-`** serial commands.

The projector may then be powered UP or DOWN using any of the methods above. The rear panel switch is multifunctional. The following operation description assumes that the main power switch is ON:

If the projector is in STANDBY, the multicolor LED to the left of the switch will glow RED and on the 8 LED status display, the READY LED will be ON. (*If there were any problems encountered during the previous power-on cycle, other LEDs may be flashing*.) Depressing the left side of the switch momentarily (1/2 second or more) will power up the unit, turning on the lamp and initializing the formatters. The multicolor LED will glow GREEN. The projector will come up in CURTAIN projection mode with the shutter closed. The STATUS LEDs will display the progress of the power-up sequence. When all of the LEDs except for the SHUTTER LED are lit, the shutter may be opened.

1.3.2 POWER ON

If the projector is POWERED UP, a momentary depression of the right side of the switch (1/2 second or more) will open the SHUTTER and put the formatters in NORMAL PROJECTION MODE. Subsequent depressions will toggle between NORMAL MODE/SHUTTER OPEN and CURTAIN MODE/SHUTTER CLOSED.

Depressing the left side of the rocker switch will cause the SHUTTER to close and the formatters to go to CURTAIN MODE and also initiates a 5-MINUTE POWER DOWN cycle. During this time the lamp, fans and formatters remain active. The multicolor LED will glow YELLOW (both the RED and GREEN are ON). The STATUS LEDs should all be ON except for SHUTTER. If no other action is taken for the next 5 minutes, the projector will go through the 60 SECOND POWER OFF sequence: the lamp is extinguished and the fans are left running for 60 seconds before going back to STANDBY. If the shutdown was not due to some anomaly, e.g., a fan failure, all of the STATUS LEDs will be OFF. If there was an anomaly, one or more may be flashing.

The READY LED will go OFF when the lamp is extinguished. It will go back ON after 90 seconds indicating that the lamp may be re-struck. A command to re-strike via any of the three methods - serial, IR or switch – may be issued at any time but the re-strike will not occur until the 90-second lamp cool-down has expired.

1.3.3 5 MINUTE POWER DOWN

If the projector is in the 5 MINUTE POWER DOWN sequence, a momentary depression of the left side of the switch (1/2 second or more) will initiate the 60 SECOND POWER OFF sequence. The 5 MINUTE POWER DOWN may be cancelled by issuing an **ON** or **OPEN** command through the serial port, by depressing the right side of the rocker switch or – if the IR remote is enabled - depressing the **BLANK** button to open the SHUTTER. The multicolor LED will again glow GREEN.

1.3.4 60 SECOND POWER OFF

The 60 SECOND POWER OFF sequence first extinguishes the lamp, extinguishes the STATUS LEDs and resets the 90 second lamp cool-down timer. No re-strike will be permitted until it times out. If no further action is taken, after 60 seconds the main power will be turned off – the fans go OFF - and the projector will be back in STANDBY.

Commands to restart the projector may be issued before the 60 SECOND POWER OFF sequence completes: serial **ON** command, IR **POWER** button or left rocker switch. 60 SECOND POWER OFF will be cancelled but the lamp will not re-strike until the 90 second cool-down period has expired. The POWR STATE LED will show GREEN.

Power and Shutter Operation

Current State	Power LED	Action	Resulting State
STANDBY	**RED**	Serial Command – **ON** Rocker Switch - depress Left Side ½ second or more IR Remote - depress **POWER** 2 seconds or more	**POWER ON**
POWER ON	**GREEN**	Serial Command – **OFF** Rocker Switch - depress Left Side ½ second or more IR Remote - depress **POWER** 2 seconds or more	**5 MINUTE POWER DOWN**
5 MINUTE POWER DOWN	**YELLOW**	Serial Command – **ON** or **OPEN** Rocker Switch - depress Right Side ½ second or more (shutter OPEN) IR Remote – depress **BLANK** (if IR enabled)	**POWER ON** Power Down Cancelled
		Serial Command – **OFF** Rocker Switch - depress Left Side ½ second or more IR Remote - depress **POWER** 2 seconds or more	**60 SECOND POWER OFF**
60 SECOND POWER OFF	**YELLOW**	Wait 60 seconds – no additional action required	**STANDBY**
		Serial Command – **ON** Rocker Switch - depress Left Side ½ second or more IR Remote - depress **POWER** 2 seconds or more	**POWER ON** Lamp re-strike after 90 second lamp cool-down
SHUTTER CLOSED	**GREEN or YELLOW**	Serial Command – **OPEN** Rocker Switch - depress Right Side ½ second or more (shutter OPEN) IR Remote - depress **BLANK** (if IR enabled)	**SHUTTER OPEN** Cancel 5 MINUTE POWER DOWN if in progress
SHUTTER OPEN	**GREEN**	Serial Command – **CLOSE** Rocker Switch - depress Right Side ½ second or more (shutter OPEN) IR Remote - depress **FREEZE** (if IR enabled)	**SHUTTER CLOSED**
POWER ON, SHUTTER CLOSED, FILM PROJECTOR INTERLOCK ACTIVE	**GREEN**	Serial Command – no command available Rocker Switch - depress Right Side 5 seconds or more to override Film Projector Interlock IR Remote - no command available	**SHUTTER OPEN** Override Film Projector Lockout

1.4 Serial Communications

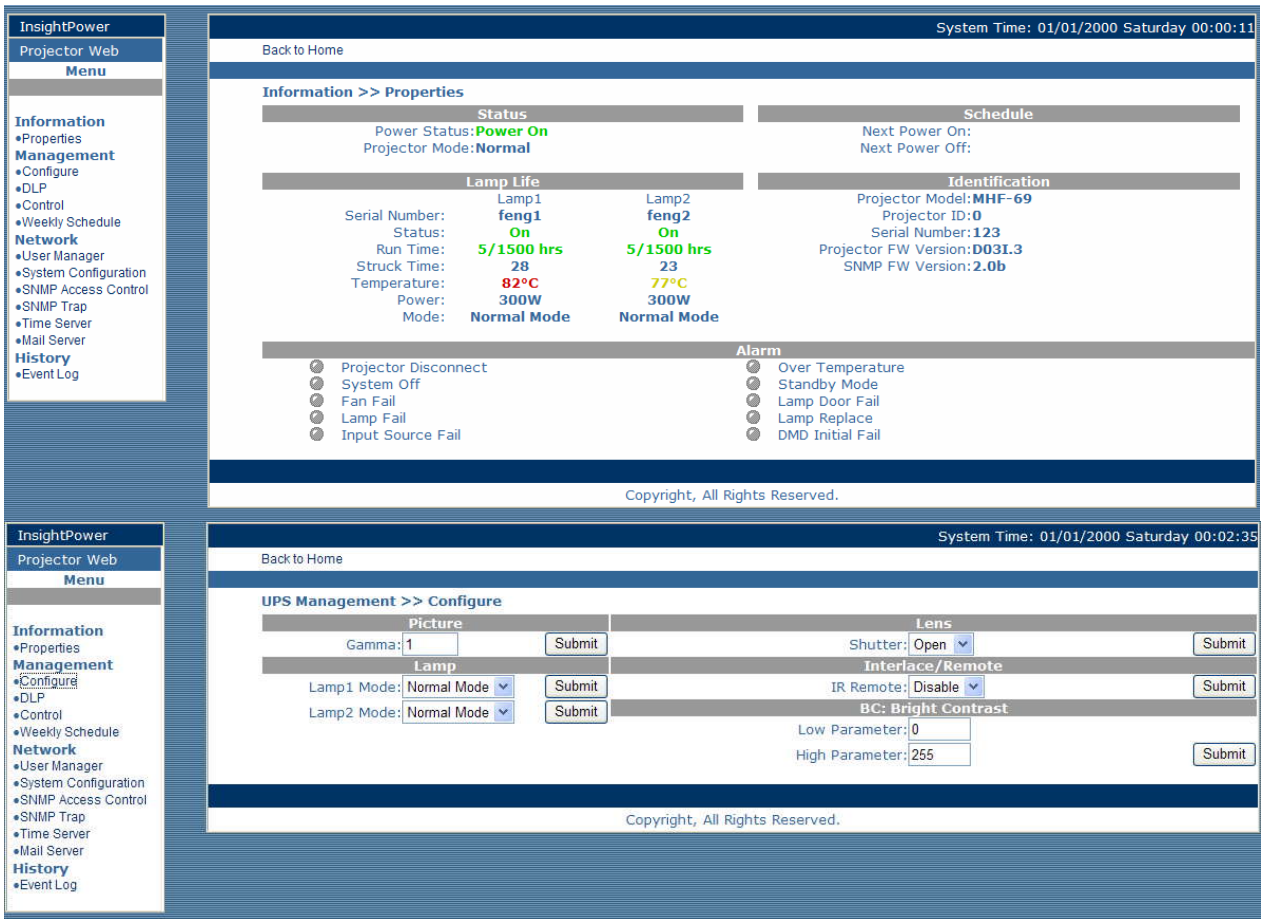
The controller UART must service communications from two sources: the RS-232 interface via the DB-9 connector on the rear panel and the NIC interface. The NIC card controls a multiplexed that switches the UART between these two sources. The controller firmware services three different command sets: one from the NIC card (which is not specified in this document) and two from the RS-232 port. These two will be referred to as *human* and *machine* commands. The *human* interface is a verbose natural language interface that is intended for manufacturing and maintenance operations via a PC running a terminal program attached to the port. Incoming character are typically echoed back to the terminal and a variety of status messages are routinely sent, especially during power-up up and down sequences and when system anomalies are detected and corrected. The *machine* interface is a terse command set. Incoming characters are not echoed and no data is sent to the host unless requested.

The controller's UART is selectable at 9600 or 19200 baud, 8-bits, no parity and 1 stop bit. The receiver is interrupt driven with a 64 byte queue. The transmitter is polled and has no queue. XON/XOFF (**^Q/^S**) flow control is implemented in both directions. The DB9-F connector is wired as a standard PC computer peripheral and may be connected to a PC running an ASCII terminal program with a straight-through serial extension cable – not a null-modem.

1.5 System Monitoring

1.6 Film Projector Lockout

1.7 Network Interface



1.8 Enhanced Color Correction (P7)

Commands have been included to utilize Texas Instruments' Enhanced Color Correction Algorithm.

2. *Human* Command Interface

The receive routine masks bit 7 of all characters received and buffers and echoes all printable ASCII characters. **<TAB>**s are converted to **<SPACE>**s. Several other control characters are recognized or transmitted:

Name	Designation	HEX	Operation
Backspace	**<BKSP>**	08_{16}	Queue pointer decremented; echoed
TAB	**<TAB>**	09_{16}	Converted to **<SPACE>**
Line Feed	**<LF>**	$0A_{16}$	Placed in queue, not echoed, otherwise ignored
Carriage Return	**<CR>**	$0D_{16}$	Placed in queue, not echoed, command terminator
DC1 - XON	**<CTRL-Q>**	11_{16}	Flow Control – Re-enable xmtr/rcvr
DC3 - XOFF	**<CTRL-S>**	13_{16}	Flow Control – Disable xmtr/rcvr
Escape	**<ESC>**	$1B_{16}$	Not placed in queue. Terminates current operations, flush queue

A number of control characters are set up as *hot keys* to perform the function of the Mode, Pattern, etc. buttons on the PCB and on the rear panel switch via the serial interface. No **<CR>** terminator is required for these commands to execute. See the first entry in Section 3.2 of the commands descriptions.

2.1 The ! Hot Key

Typing or sending a single exclamation point (**!**) immediately after the prompt with no whitespace or control characters – will repeat the last command (the exclamation point is not echoed). If ANY characters are sent between the prompt and the " **!** " – even a **<CR>** - the previous command will be lost and cannot be repeated using the " **!** " option. " **!** " just re-processes the current contents of the command buffer so it will also repeat illegal commands or commands with illegal or missing parameters.

2.2 ASCII Control Characters

In almost all cases sending an **<ESC>** character will terminate current operations and return a command prompt. It can also be used when sending commands manually through a terminal to cancel any characters typed in after the prompt.

Whitespace characters - **<TAB>** and **<SPACE>** - are treated identically. Line feeds - **<LF>** - are queued but are otherwise ignored by the code. A "newline" is always a **<CR><LF>** pair. The prompt is a newline followed by a **>** and a space.

Single **<BKSP>** characters are echoed and back up the queue pointer. A **<BKSP>** sent to the projector is <u>not</u> converted to a "destructive" backspace string - **<BKSP><SPACE><BKSP>** when echoed. Only a single ASCII **<BKSP>** will be echoed. If the terminal program can be configured to send **<BKSP><SPACE><BKSP>** when the Backspace Key is pressed, this option should be selected.

Commands sent to the board in either mode can be terminated with either a single **<CR>** or a **<CR><LF>** pair. The **<LF>** character triggers command parsing and execution. The **<LF>** is ignored. Neither commands nor hex data is case-sensitive.

2.3 ZOOM, FOCUS and Lens Shift Commands

ZOOM, FOCUS and Lens Shift Serial Commands

The following commands turn on the specified motors. The motors will stay energized until an **<ESC>** character is sent to the projector. The last character of each command is an ASCII digit from **0** to **3** with no intervening whitespace. This determines motor speed with **0** being the slowest and **3** the fastest. All of the motors have clutches or limit switches to prevent damage if they are allowed to run after reaching a mechanical limit.

Command `0 ≤ n ≤ 3`	**Description**
Dn	Move image **D**OWN
Ln	Move image to the **L**EFT
FFn	Move FOCUS away from Projector – **F**OCUS **F**AR
FNn	Move FOCUS toward Projector – **F**OCUS **N**EAR
Rn	Move image to the **R**IGHT
Un	Move image **U**P
ZIn	**Z**OOM **I**N – Projected Image Smaller
ZOn	**Z**OOM **O**UT – Projected Image Larger

The following **NUDGE** commands turn on the specified motors for a short period. No <ESC> character need be sent. The last character of each command is an ASCII digit from **0** to **3** with no intervening whitespace. This determines period the motor is energized with **0** being the shortest and **3** the longest.

Command `0 ≤ n ≤ 3`	**Description**
NDn	**N**udge image **D**OWN
NLn	**N**udge image to the **L**EFT
NFFn	**N**udge FOCUS away from Projector – **F**OCUS **F**AR
NFNn	**N**udge FOCUS toward Projector – **F**OCUS **N**EAR
NRn	**N**udge image to the **R**IGHT
NUn	**N**udge image **U**P
NZIn	**N**udge **Z**OOM **I**N – Nudge Projected Image Smaller
NZOn	**N**udge **Z**OOM **O**UT – Nudge Projected Image Larger

2.4 User Commands

User Serial Commands	
Command	**Brief Description**
CLOSE	Close Shutter and put Formatters in Curtain Mode
DGAMMA	DGAMMA Download
FPOL	TOGGLE the Film Projector Lockout Polarity
Gamma	Select Gamma Table
GETP	Get Lamp power Mode
IR+	Enable IR Remote
IR-	Disable IR Remote **except** POWER Button (default at Power-up)
LH	Display Lamp 1 or 2 Age Data
LAMPON1	Turn On Lamp1*
LAMPON2	Turn On Lamp2*
LAMPOFF1	Turn Off Lamp1*
LAMPOFF2	Turn Off Lamp2*
M+	If **V-** enable display of non-critical (informational) messages – preceded by **%**
M-	If **V-** disable display of non-critical (informational) messages – preceded by **%**
OFF	Main Power Shutdown
ON	Main Power ON
ONS	Main Power ON and Start Signal Lamp mode*[1]
OND	Main Power ON and Start Dual Lamp mode*
OPEN	Open Shutter and put Formatters in Normal Projection Mode
P_ID	Check Projector Serial Number
SIZE	Set Display Size
SETP	Set Lamp Power Mode*
STS	Check Shutter Status
V+	Enable Verbose Mode
V-	Disable Verbose Mode (see **M+** and **M-** above also)
VER	Display Controller Firmware Revision

2.5 Enhanced Color Correction Commands

DEBUG/Maintenance Serial Commands	
Command	**Brief Description**
ECC	Enable/Disable P7 Color Correction and Select Target data
MDNLD	Download Measured Color Gamut Data for Storage in BLUE Formatter EEPROM
RDMCGD	Display Measured Color Gamut Data
RDTCGD	Display Specified Target Color Gamut Data
TDNLD	Download User-Defined Target Color Gamut Data for storage in EEPROM

[1] *:mark for MH-69 only.

2.6 DEBUG/Maintenance Commands

DEBUG/Maintenance Serial Commands	
Command	**Brief Description**
BAUD	Change immediate and power-up baud clock
FH	Display the FORMATTER Register Help Table
FR	Read Register from ALL Formatters
FRB	Read BLUE Formatter Register
FRG	Read GREEN Formatter Register
FRR	Read RED Formatter Register
FW	Write Register to ALL Formatters
FWB	Write to BLUE Formatter Register
FWG	Write to GREEN Formatter Register
FWR	Write to RED Formatter Register
OCMD	Send Command to Osram Ballast and Display Response
RST	Reset and Reinitialize Formatters

3. *Human* Command Descriptions

3.1 Lens Shift, ZOOM and FOCUS Commands

The following commands turn on the specified motors. The motor will stay energized until an **<ESC>** character is sent to the projector. The last character of each command is an ASCII digit from **0** to **3** with no intervening whitespace. This determines motor speed with **0** being the slowest and **3** the fastest.

If an **N** prefix is appended to the command mnemonic the command is a **NUDGE**. **NUDGE** commands turn on the specified motors at full speed for a timed period. An **<ESC>** character is not needed to terminate the command. The purpose is to generate small changes in image position, focus or size. The last numeric character of the command determines period the motor is energized with **0** being the shortest and **3** the longest. Due to backlash in the motor/drive assemblies, a single NUDGE – especially a **0** or **1** - may not generate any noticeable change.

All of the motors have clutches or limit switches to prevent damage if they are allowed to run after reaching a mechanical limit.

Un,Dn,Ln,Rn, NUn,NDn,NLn,NRn	**Lens Shift**	**Un,Dn,Ln,Rn, NUn,NDn,NLn,NRn**

UP, DOWN, LEFT and RIGHT. Move the projected image.

Example:
```
U3
NL1
```

FFn,FNn,NFFn,NFNn	**FOCUS**	**FFn,FNn,NFFn,NFNn**

FOCUS FAR and FOCUS NEAR. FOCUS FAR move the focus away from the projector while FOCUS NEAR moves it toward the projector.

Example:
```
FN0
NFF3
```

ZIn,ZOn,NZIn,NZOn	**ZOOM**	**ZIn,ZOn,NZIn,NZOn**

ZOOM IN and ZOOM OUT. ZOOM IN makes the projected image smaller while ZOOM OUT makes it larger.

Example:
```
ZI2
NZO1
```

3.2 User Commands

Control Characters

Several ASCII Control characters are recognized to control Brightness, Contrast, Display Mode, Patterns, and Orientation. These are *hot keys* – i.e., no need to press ENTER.

<CTRL-Z> Brightness – Decrement Lower Level

>
R/G/B Brightness= 1D/1D/1D

<CTRL-X> Brightness – Increment Lower Level

>
R/G/B Brightness= 1C/1C/1C

<CTRL-W> Contrast – Decrement Upper Level

>
R/G/B Contrast= 03/03/03

<CTRL-E> Contrast – Increment Upper Level

>
R/G/B Contrast= 02/02/02

<CTRL-N> Cycles through the Projection modes

>
CURTAIN

<CTRL-O> Cycles through the Projection orientations (FRONT, REAR, CEILING, etc.)

>
REAR - CEILING

<CTRL-P> Cycles through the Patterns (when in PATTERN MODE)

>
PATTERN = 6

CLOSE,OPEN **SHUTTER Control** **CLOSE,OPEN**

OPEN opens the *E-Cinema Projector's* shutter and puts the formatters in NORMAL projection mode if:

a) The power is ON AND

b) The Film projector interlock is inactive

OPEN cancels a 5 MINUTE POWER DOWN sequence if it has been initiated.

CLOSE closes the *E-Cinema Projector's* shutter and puts the formatters in CURTAIN projection mode if the main power ON, i.e., the fans are running.

Syntax: **open**
close

DGAMMA **Download to De-gamma Mailbox** **DGAMMA**

Download de-gamma tables to the formatter's degamma mailbox. DGAMMA takes three parameters. The first is a single letter (**r**, **g**, **b** or **a**) specifying which formatter (or all of them) gets the table. The second is also a single letter (**b** or **w**) specifying whether the table is formatted as bytes or words (16 bits). The last is a decimal parameter which specifies the number of entries (1/2 the total number of bytes). Valid values for this parameter are **256**, **512**, **1024**, or **2048**. After the command is issued, the user will be prompted to send the table as a series of hexadecimal bytes or words. Each entry is 16 bits. If byte mode is selected, send the LSB first. The table can be formatted rather loosely. Any ASCII character less than **'0'** ($\mathbf{30}_{16}$) is treated as a terminator. Any number of terminators may be inserted between values so the table can be a single

column of values separated by “newlines” or a column of comma separated values or even a string of hex digits without any terminations as long as leading zeros are included with each byte or word.

If all formatters are to be loaded, a prompt will be issued after each successful download and a total of three separate tables will have to be sent.

Syntax: **dgamma {r|g|b|a} {b|w} {256,512,1024,2048}**

```
> dgamma
Invalid De-Gamma Destination
> dgamma b 256
Data Size must be 'B' or 'W'
> dgamma b b 256
De-Gamma Download to BLUE FormatterXMIT EXACTLY 512 bytes of hexadecimal data
~~~
~~~
```

FPOL — Film Projector Interlock — FPOL

The film projector interlock feature operates in two modes: *lockout* mode and *power control* mode. **FPOL** takes either one or no parameters.

In *lockout* mode the film projector interlock circuitry senses current in the External Interlock connector that is attached to the Feature Film Projector. The lockout, when active, closes the shutter on the *E-Cinema Projector* and puts its formatters in CURTAIN mode and prevents the shutter from being re-opened until the lockout becomes inactive. Depending on the installation, the Feature Film Projector could be active or inactive when a voltage of about 5 volts is applied to the External Interlock connector. **FPOL** sets or toggles the polarity of the sensing circuitry between *active-when-energized* [**FPOL 0**] and *active-when-not-energized* [**FPOL 1**]. The unit is shipped with the polarity set to 0 [*active-when-energized*] so that if the interlock is not connected, the *E-Cinema Projector* will not be locked out. There is a way to override the lockout by depressing the right side of the Power/Shutter rocker switch for more than 5 seconds.

In *power control* mode [**FPOL 2**], the polarity is nor selectable. When the External Interlock connector is energized – a voltage of about 5 volts is applied – the projector will turn on and will remain on until the voltage is removed. The shutter will automatically open at completion of the power-up sequence whether or not there is any active video.

If the projector is in power *control* mode, to take it out of this mode attach a terminal to the serial port and type:

fpol 0	[set lockout *active-when-energized*]	or
fpol 1	[set lockout *active-when-not-energized*]	

Typing **fpol** without a parameter will have no effect.

If the projector is in *lockout* mode:

fpol	[toggle lockout polarity: **0 ⇒ 1, 1 ⇒ 0**]	or
fpol 0	[set lockout *active-when-energized*]	or
fpol 1	[set lockout *active-when-not-energized*]	or
fpol 2	[set *power control* mode]	

The polarity parameter is stored in EEPROM and once established it is not necessary to set it again.

NOTE: When the projector is in* power control *mode, the External Interlock has absolute control over the projector power. It locks out the other power on/off methods – serial port commands (on and off), the rear panel rocker switch and the IR remote. To control the power or enable the IR remote during setup or testing, a terminal must be connected to the serial

***interface and serial commands (*fpol, ir+, etc.*) must be issued. The projector can be returned to* power control *mode with* fpol 2.

Syntax: **fpol [0 | 1 | 2]**

```
> fpol
FP Polarity = 1
>
Film Projector ON

IR= 08
> fpol
FP Polarity = 0
>
Film Projector OFF
> fpol 0
FP Polarity = 0
> fpol 1
FP Polarity = 1
>
Film Projector ON
> fpol 2
FP Polarity = 2
```

GAMMA — GAMMA Table Select — GAMMA

Select GAMMA Table. It will store to EEPROM, and when system boot up will reload the gamma setting.

Syntax: **GAMMA {Table Num} 0 < num < n**

```
> gamma 2
Set Gamma index =2
```

SETP / GETP — LAMP POWER MODE — SETP / GETP

OSRAM Lamp support change lamp Output power. The output wattage of the lampdriver can be adjusted by command. SETP is used to setup the lamp output wattage. For now, user can adjust 2 mode, 250W or 300W.
And if system is working in dual lamp mode, then it is set for dual lamp. It can't separately set lamp setting.
GETP is used to read lamp output wattage. It can separately read the lamp setting.

Syntax: **SETP {Power Mode} 0:250W ; 1:300W**
GETP {Lamp Num} 1:Lamp1 ; 2: Lamp2

```
> setp 0
Set Lamp1 250W!
Set Lamp2 250W!

> getp 1
Lamp1 = 250W
```

IR+,IR- IR Remote Enable/Disable IR+,IR-

Enable (**IR+**) or disable (**IR-**) the infrared remote control interface. The IR remote **POWER** button is always enabled. If the projector is power up using the IR remote, all other IR buttons are also enabled until an **IR-** command is issued or POWER OFF.

Syntax: **ir+**
ir-

```
> ir+
IR Enable !!
> ir-
IR Disable !!
```

LH Lamp Age LH

Display lamp age and re-strike count:

```
> lh 1
Lamp1 S/N     = feng1
Lamp1 Time    = 0:48
Lamp1 Strikes = 1017
Lamp1 is Off !
> lh 2
Lamp2 S/N     = feng2
Lamp2 Time    = 9:22
Lamp2 Strikes = 1064
Lamp2 is Off !
```

Syntax: **lh 1 ➔ for Lamp1**
lh 2 ➔ for Lamp2

LAMPON1 LAMPON2 LAMPOFF1 LAMPOFF2 LAMP On/Off LAMPON1 LAMPON2 LAMPOFF1 LAMPOFF2

Turn On/ OFF the lamp, when system is power on. LAMPON1 is turn lamp 1 on; LAMPOFF1 is turn lamp1 off. LAMPON2 is turn lamp2 on; LAMPOFF2 is turn lamp2 off. In dual-lamp mode user turn off one lamp, the system Will switch to signal-lamp mode, and store the mode to EEPROM.

Syntax: LAMPON1
LAMPOFF1
LAMPON2
LAMPOFF2

```
> lampoff1
LAMP1 OFF!
> lampoff2
LAMP2 OFF!
> lampon1
LAMP1 ON!
> lampon2
LAMP2 ON!
```

M+,M- Informational Message Reporting Control M+,M-

Syntax: **m+**
m-

```
> m+
Monitor Info. On !!
> m-
Monitor Info. Off !!
```

ON,OFF,ONS,OND POWER Control ON,OFF,ONS,OND

Power sequencing commands. See section 1.3 for more details.

ON and OFF Power Sequencing Commands

Command	Current State	Resulting State
ON ONS OND	**STANDBY [RED]**	**POWER ON**
	POWER ON [GREEN]	**NO CHANGE**
	5 MINUTE POWER DOWN [YELLOW]	**POWER ON** Power Down Cancelled
	60 SECOND POWER OFF [YELLOW]	**POWER ON** Lamp re-strike after 90 second lamp cool-down
OFF	**STANDBY [RED]**	**NO CHANGE**
	POWER ON [GREEN]	**5 MINUTE POWER DOWN** Shutter closed
	5 MINUTE POWER DOWN [YELLOW]	**60 SECOND POWER OFF** Lamp OFF, Shutter closed
	60 SECOND POWER OFF [YELLOW]	**NO CHANGE**

System boot up will reload those setting, like below:
a. Gamma setting
b. P7 setting
c. MCGD & TCGD
d. Lamp mode
e. Brightness & Contrast
f. Image Orientation

Syntax: **ON** ➔ Main Power On and Turn On lamp which last power off select lamp mode. If lame mode is Signal lamp mode, then turn on the lamp which lifetime is small then the other one.
OFF ➔ Main Power Off.
ONS ➔ Main Power On and Turn On Signal lamp mode which lifetime is small then the other one.
OND ➔ Main Power On and Turn On dual lamp

> on
Power On -Dual_Lamp

```
Lamp1 S/N     = feng1
Lamp1 Time    = 9:21
Lamp1 Strikes = 45
Lamp1 is Off !
Lamp2 S/N     = feng2
Lamp2 Time    = 9:43
Lamp2 Strikes = 74
Lamp2 is Off !
>
Powering Up

> ond
Power On -Dual_Lamp
Lamp1 S/N     = feng1
Lamp1 Time    = 3:15
Lamp1 Strikes = 35
Lamp1 is Off !
Lamp2 S/N     = feng2
Lamp2 Time    = 3:37
Lamp2 Strikes = 64
Lamp2 is Off !
>
Powering Up

> ons
Power On -Signal_Lamp Lamp 1
Lamp1 S/N     = feng1
Lamp1 Time    = 9:23
Lamp1 Strikes = 46
Lamp1 is Off !
Lamp2 S/N     = feng2
Lamp2 Time    = 9:45
Lamp2 Strikes = 75
Lamp2 is Off !
>
Powering Up
```

P_ID — Show Projector ID — P_ID

Read Projector ID.

Syntax: p_id

```
>p_id
Projector Serial Number = 1235456
```

SIZE — Display Size — SIZE

Native image size on the HD2+ engine is 1280x720. Parameters are entered in decimal.

Syntax: **`size {HSIZE} {VSIZE}`** **`- 640 ≤ HSIZE ≤ 1280, 480 ≤ VSIZE ≤ 720`**

```
> size 1280 720
Size =  1280X720
```

STS — Display Shutter Status — SIZE

Display Shutter Status.

Syntax: STS

> STS
Shutter is On !

V+,V- — VERBOSE Mode Control — V+,V-

Enable (**V+**) or disable (**V-**) VERBOSE mode on the serial interface. When VERBOSE is enabled all messages – informational, error and status, etc. – are sent as human readable text. When disabled those messages are sent as a 6 character ASCII group. There are two types of messages: critical and non-critical. Non-critical messages can be enabled or disabled using the M+ and M- commands. The first character of non-critical messages is a percent sign (**%**). Critical messages are headed by an exclamation point (**!**). The next two characters form a unique 8-bit hexadecimal code identifying the message (see below). The last three characters are a dollar sign (**$**) followed by a **<CR>** and **<LF>**.

DGAMMA *and most of the DEBUG/Maintenance commands output verbose messages regardless of whether VERBOSE is enabled or disabled.*

Non-Verbose Message Codes

Non-critical (Informational) Messages [M+ and V-]	
%01$	LAMP Door Closed and Lamp TEMP OK
%02$	FANS OK
%03$	Film Projector ON - During Power-up
%04$	Film Projector OFF - During Power-up
%05$	Video Signal Detected - During Power-up
%06$	Striking Lamp - During Power-up
%07$	Restrike - Ballast RESET
%08$	Restrike - Lamp Restrike
%09$	Restrike - Restrike Fail
%0A$	Ballast COMM Failure – typically non-critical unless it leads to !88$

Critical Messages / Shutdown Messages [V-]	
!80$	Lamp Door Open or Lamp Overtemp – if after Power-up ► Shutdown
!81$	FAN Problem – if after Power-up ► Shutdown
!82$	NO Video – during or after Power-up
!83$	Video Signal Detected - Video Restored
!84$	Lamp Lit - During Power-up
!85$	Formatter COMM Disabled - Check SW500 – Power-up sequence halted
!86$	Restrike - Lamp Lit - After Power-up - 30 second Warm up before Shutter OPEN
!87$	Restrike Count Exceeded ► Shutdown
!88$	Ballast not Responding - After Power-up ► try Restrike
!89$	Ballast OVERTEMP ► Shutdown
!8A$	Lamp Extinguished - After Power-up ► try Restrike
!8B$	Resetting Formatters – usually non-critical
!8C$	LAMP SYNC Signal Inactive – usually non-critical
!8D$	LAMP SYNC Detected – usually non-critical
!8E$	Film Projector ON - After Power-up – Shutter CLOSED

!8F$	Film Projector OFF - After Power-up
!90$	RED FORMATTER Status Read Error – usually non-critical
!91$	GREEN FORMATTER Status Read Error – usually non-critical
!92$	BLUE FORMATTER Status Read Error – usually non-critical
!A0$	Power-up Sequence Complete – Ready for shutter OPEN
!E0$	Invalid Parameter in Command line
!E1$	Missing Parameter(s) in Command line
!E2$	Unknown Command
!F0$	Lamp Time Read from EEPROM – Lamp Hour EEPROM Read Error
!F1$	Strike Count Read from EEPROM – Lamp Hour EEPROM Read Error
!F2$	Power Off – MAIN Power OFF – System in Standby Mode
!F3$	5 Minute Power Down Cancelled by OPEN or ON Command
!F4$	5 Minute Power Down Initiated – Lamp OFF and 60 second cool down in 5 minutes
!F5$	Powering Up – Main Power ON - Initiating Power-up Sequence
!F6$	Powering Down – Lamp OFF – 60 second cool down

Syntax: **v+**
v-

VER VERSION VER

Display Controller Firmware Revision:

```
> ver

* 720p  MHF-69 Monitor - Rev. D03J   *
*      17 Nor 2006        *Syntax:    ver
```

3.3 Enhanced Color Correction (P7) Commands

ECC — Select P7 TARGET DATA — ECC

Select the Target Color Data. This command takes a parameter – the target index – between **0** and **13**. The following table lists the GRBW CIE color coordinates for the selected ECC index. Note that indicates 1 through 9 do not specify the Magenta, Cyan or Yellow CIE values. Indices 10 through 13 specify user-definable tables which may include the CMY coordinates as well as GAIN values for each of the colors and WHITE. See TI document – *Product Specification for DDP1000, DDP1010, DDP1011 Based Modular Formatter Component Set* [Dwg #2503986, Rev. J or later] for details.

Target Color Gamut Data

Index	Description	GREEN		RED		BLUE		WHITE	
		X	Y	X	Y	X	Y	X	Y
0	OFF	ECC OFF							
1	EBU - 3200°K	.290	.600	.640	.330	.150	.060	.423	.399
2	EBU -5400°K							.335	.349
3	EBU - 6500°K							.313	.329
4	EBU - 9300°K							.283	.297
5	User 0	User Selectable GREEN, RED, BLUE, MAGENTA, CYAN, YELLOW and WHITE CIE Indices stored in EEPROM (See TDNLD)							
6	User 1								
7	User 2								
8	User 3								
9	Native	.316	.651	.655	.341	.147	.044	.296	.337

Syntax: **ecc {target index}**

```
> ecc 2
ECC Set Index 2
ECC Enable
Freeze Frame On
Freeze Frame Off
```

MDNLD — Download Measured Color Gamut Data — MDNLD

Download Measured Color data for storage on the BLUE Formatter's EEPROM. When the command is entered, the operator is prompted to send **16** bytes of data: the X and Y CIE coordinates of the un-enhanced GREEN, RED, BLUE and WHITE colors. Each coordinate is 16 bits - 2 bytes - sent least significant byte first in hexadecimal. For each coordinate, first multiply by **65536** and convert to hexadecimal. Output two hexadecimal bytes, LS byte first, for each of the 8 coordinates in order: G_x, G_y, R_x, R_y, B_x, B_y, W_x, W_y, B_x B_y ,WY and BY. The values can be manually typed from the terminal or stored in a file and sent to the controller board using the terminal's "Send Text File" utility. Characters typed of sent will NOT be echoed. The 16 bytes sent may be **<SPACE>, <TAB>**, **<CR>** or **<LF>** separated.

After the data is downloaded the coordinates will be displayed in decimal format for confirmation.

Syntax: **mdnld**

```
> mdnld
Enter Gx,Gy,Rx,Ry,Bx,By,Wx,Wy,Bx,By,WB,BB(x100) 12 datas:
.323,.649,.664,.334,.146,.041,.291,.307,.310,.000,3000,123
```

```
GREEN   = .323,.649
RED     = .664,.334
BLUE    = .146,.041
WHITE   = .291,.307
BLACK   = .310,.037
CONTRAST= 2439
```

RDMCGD — Display Measured Color Gamut Data in Use — RDMCGD

Display the Measured Color Gamut Data that is currently in use. If the calibrated data in the EEPROM on the BLUE Formatter has not been loaded or has been corrupted, a default table is loaded.

Syntax: **rdmcgd**

```
> rdmcgd
GREEN   = .340,.650
RED     = .640,.350
BLUE    = .140,.033
WHITE   = .290,.330
```

RDTCGD — Display Target Color Gamut Data — RDTCGD

Display the Target Color Gamut Data for the specified index. This command takes a parameter – the target index – between **1** and **9**.

Syntax: **rdtcgd {1 ≤ target index ≤ 9}**

For indices **1** through **4** (in this example index **4**) the following will be output to the terminal:

```
> rdtcgd 4
GREEN   = .210,.710
RED     = .670,.330
BLUE    = .140,.080
WHITE   = .423,.399
TOLBOX = .010
```

For indices **5** through **8** (in this example index **8**) the full contents of the used-definable table will be displayed. The third value for each color is the GAIN. See TI document – *Product Specification for DDP1000, DDP1010, DDP1011 Based Modular Formatter Component Set* [Dwg #2503986, Rev. J or later] for details on the tolerance box specification and the Copyright notice.

```
> rdtcgd 8
GREEN   = .337,.642,.000
RED     = .642,.353,.000
BLUE    = .140,.034,.000
MAGENTA = .000,.000,.000
CYAN    = .000,.000,.000
YELLOW  = .000,.000,.000
WHITE   = .287,.326,.000
TOLBOX0 = .277,.336
TOLBOX1 = .297,.336
TOLBOX2 = .297,.316
TOLBOX3 = .277,.316
Use TOL BOX
Notice: 'P7 TCGD Data - 6300K - Copyright (c) 2006 Boxlight Products Corp.'
```

TDNLD

Download User-Defined Target Color Gamut Data

TDNLD

Download a User-definer Target Color Gamut Data Set for storage in controller board's EEPROM. The command takes a decimal parameter – the target index between **10** and **13** corresponding to the index used in the **ECC** command. When the command is entered, the operator is prompted to send **140** bytes of data. A description of the data packet can be found in the Texas Instruments document – *Product Specification for DDP1000, DDP1010, DDP1011 Based Modular Formatter Component Set* [Dwg #2503986, Rev. J or later] in the **Target Color Gamut Data** command description. Note that the first byte listed here is 88_{16}. This is used when actually communicating with the Formatters and should not be sent with the **TDNLD** command. Byte **2** – the LS Byte of the GREEN CIE X coordinate is the first value sent. The command description only defines bytes **2** through **140** – a total of **139**. Add an extra **0** byte to the end so that full **140** bytes are sent. Unspecified parameters such as GAIN values, CMY coordinates or the Copyright Notice should be sent as zeroes

The values can be manually typed from the terminal or stored in a file and sent to the controller board using the terminal's "Send Text File" utility. The **140** bytes sent may be **<SPACE>, <TAB>**, **<CR>** or **<LF>** separated.
Characters typed of sent will NOT be echoed.

TDNLD Data Format

Field Contents		BYTES	Positions
GREEN	X	2	Bytes 1-2
	Y	2	Bytes 3-4
	GAIN	2	Bytes 5-6
RED	X	2	Bytes 7-8
	Y	2	Bytes 9-10
	GAIN	2	Bytes 11-12
BLUE	X	2	Bytes 13-14
	Y	2	Bytes 15-16
	GAIN	2	Bytes 17-18
MAGENTA	X	2	Bytes 19-20
	Y	2	Bytes 21-22
	GAIN	2	Bytes 23-24
CYAN	X	2	Bytes 25-26
	Y	2	Bytes 27-28
	GAIN	2	Bytes 29-30
YELLOW	X	2	Bytes 31-32
	Y	2	Bytes 33-34
	GAIN	2	Bytes 35-36
WHITE	X	2	Bytes 37-38
	Y	2	Bytes 39-40
	GAIN	2	Bytes 41-42

Field Contents		BYTES	Positions
RESERVED – 00H		6	Bytes 43-48
W TOL BOX 1	X	2	Bytes 49-50
	Y	2	Bytes 51-52
W TOL BOX 2	X	2	Bytes 53-54
	Y	2	Bytes 55-56
W TOL BOX 3	X	2	Bytes 57-58
	Y	2	Bytes 59-60
W TOL BOX 4	X	2	Bytes 61-62
	Y	2	Bytes 63-64
RESERVED – 00H		6	Bytes 65-70
TOL BOX MODE		1	Byte 71
RESERVED – 00H		1	Byte 72
Copyright Notice – ASCII – 0 PADDED		64	Bytes 73-136
RESERVED – 00H		4	Bytes 137-140

Syntax: **tdnld {5 ≤ target index ≤ 8}**

```
> tdnld 5
XMIT EXACTLY 140 bytes of hexadecimal data
Download TCGD 5
 down !!
GREEN   = .265,.690,.513
RED     = .665,.312,.150
BLUE    = .140,.070,.078
```

```
MAGENTA = .373,.178,.270
CYAN    = .176,.337,.659
YELLOW  = .457,.522,.916
WHITE   = .314,.351,.:00
TOLBOX0 = .309,.355
TOLBOX1 = .318,.362
TOLBOX2 = .319,.347
TOLBOX3 = .311,.341
Use TOL BOX
Notice: 'c)Copyright 2002 Texas Instruments Inc.'
>
>
>
```

3.4 DEBUG/Maintenance Commands

BAUD **Switch BAUD Clock** **BAUD**

Immediate BAUD clock change. Only two rates are supported – 9600 and 19200. The clock rate on the terminal programmed will have to be changed to continue. This command also sets the BAUD clock that will be set at start-up.

Syntax: **baud {9600 | 19200}**

FH **FORMATTER Register Help** **FH**

This command prints the register numbers, R/W status and name of the accessible DDP1011 formatter registers:

Syntax: **fh**

```
> fh
00 RW Brightness
01 RW Contrast
02 RW Projection Mode
03 RW Image Orientation
04 RW Mirror Park
05 RW Image Freeze
06 RW Vertical Frequency
07 RW Vertical Frequency Offset
08 RW Color Temperature Gain
09 RW Input Image Size
0A RW Image Position
0B RW Test Pattern Select
0C RW Formatter Input Data Type
0F RW 3D Sequence Set Select
10 RW Pulsed Lamp Data
11 RW Pulsed Lamp Ballast Sel
31 RW Color Space Matrix Select
32 WO Color Space Matrix Dnld
33 RO Color Space Matrix Read
34 RW De-Gamma Table Select
35 RW De-Gamma Dnld Dest
36 WO De-Gamma Dnld Mailbox
```

```
40 RO System Configuration
41 RW DMD Bin Voltage Method Sel
42 RW DMD Bin Voltage Level Sel
43 RW Convergence
44 RW Formatter Color
45 RW Processing Path Select
46 RW Sequence Set Select
47 RO Sequence Sets Available
48 RO Sequence Set Data
49 RW Select LAMPSYNC Output
4A RW Flash MEM Access Time Sel
4C RW Command Sync ENABLE
50 RO System Status
51 WO System RESET
53 RO VERSION
55 RO Special Feature STATUS
60 WO Target Color Gamut Data
61 WO Measured Color Gamut Data
63 RW Enhanced Color Corr. Disable
```

FR,FRR, FRG,FRB | **FORMATTER Register Read** | **FR,FRR, FRG,FRB**

Read formatter registers:

- **FR** - Read all formatters
- **FRR** - Read RED formatter
- **FRG** - Read GREEN formatter
- **FRB** - Read BLUE formatter

The required parameter is the hexadecimal register number. The output is formatted as a stream of 8-bit or 16-bit hexadecimal values as specified in the TI document – *Product Specification for DDP1000, DDP1010, DDP1011 Based Modular Formatter Component Set* [Dwg #2503986, Rev. J]. See **FW** below.

Syntax: **fr[r|g|b] {register number}**

```
> fr 0
RED FormatterBrightness Register:  1500 1500 1500
GREEN FormatterBrightness Register:  1500 1500 1500
BLUE FormatterBrightness Register:  1500 1500 1500
> frr 0
RED FormatterBrightness Register:  1500 1500 1500
> frg 0
GREEN FormatterBrightness Register:  1500 1500 1500
> frb 0
BLUE FormatterBrightness Register:  1500 1500 1500
```

FW,FWR, FWG,FWB | **FORMATTER Register Write** | **FW,FWR, FWG,FWB**

Write formatter registers:

FW - Write all formatters
FWR - Write RED formatter
FWG - Write GREEN formatter
FWB - Write BLUE formatter

The first parameter is the hexadecimal register number. One or more additional parameters are required – the data to be written. See the TI document – *Product Specification for DDP1000, DDP1010, DDP1011 Based Modular Formatter Component Set* [Dwg #2503986, Rev. J] – for details. The first byte in the spec – *Number of bytes being sent* – and the *Protocol Pad* bytes are not entered in the parameter list. As an example, the Brightness Register ($\mathbf{00_{16}}$) lists the following data:

Byte	Description
1	Number of data bytes being sent (06h)
2	Green (lsb)
3	Green (msb)
4	Red (lsb)
5	Red (msb)
6	Blue (lsb)
7	Blue (msb)
8	Protocol Pad

Thus three words are required. To write the following data to the BLUE formatter BRIGHTNESS register:

Green = $\mathbf{1484_{16}}$, Red = $\mathbf{18E0_{16}}$ and Blue = $\mathbf{0AF9_{16}}$

type:

```
fwb 0 1484 18e0 af9
```

To write to all Test Pattern Select register ($\mathbf{0B_{16}}$):

Byte	Description
1	Number of data bytes being sent (03h)
2	Test Pattern Number
3	Vertical Frequency Value (lsb)
4	Vertical Frequency Value (msb)
5	Protocol Pad
6	Protocol Pad
7	Protocol Pad
8	Protocol Pad

with Test Pattern select = $\mathbf{06_{16}}$ and Vertical Frequency Value = $\mathbf{1771_{16}}$ type:

```
fw b 6 1771
```

Syntax: **fw[r|g|b] {register number} {data1 [data2]…[datan]}**

```
To write the Brightness or Contrast in R/G/B channel,please follow the below command.
 R/G/B Brightness:
        Fw {Brightness} {Green-Brightness}{Red-Brightness}{Blue-Brightness}
            >fw 0 7000 8000 9000
             RED FormatterBrightness Register : 7000 8000 9000
             GREEN FormatterBrightness Register : 7000 8000 9000
             BLUE FormatterBrightness Register : 7000 8000 9000
  R/G/B Contrast:
        Fw {Contrast} {Green-Contrast}{Red-Contrast}{Blue-Contrast}
            >fw 0 8000 9000 7000
             RED FormatterContrast Register : 7000 8000 9000
             GREEN FormatterContrast Register : 7000 8000 9000
```

OCMD — Ballast Communications — OCMD

This command is used for sending commands to the Osram Lamp ballast. The first parameter determines which of the two ballast ports is addressed. The second is the ballast register address (hexadecimal – e.g., STATUS = $\mathbf{22_{16}}$). See the Osram documentation for register details. If the command requires data to sent those bytes are appended to the command (hexadecimal and space delimited). If the command causes the ballast to return data – no just echo the command – the response will be output in hexadecimal bytes. The ballast status command is special in that the status bits are decoded (see below). Examples:

Syntax: **ocmd { 1 | 2 } {ballast command} [data$_1$] [data$_2$] … [data$_n$]**

```
> ocmd 2 22
Command response = E0
LAMP BALLAST 2 STATUS BYTE:
RUN UP IN PROGRESS
MAX IGN TIME EXCEEDED
LAMP BURNING
> ocmd 2 3e
Command has no response.
> ocmd 2 60 96
Command response = 9D
> ocmd 2 60 98
Command response = D9
```

RST — Reset and Re-initialize the Formatters — RST

Perform hardware RESET of the 3 formatters and re-initialize them

Syntax: **rst**

```
> rst
Reset Formatter Board Now !!
MCGD OK to Read
ECC Index 2
ECC Enable
Freeze Frame On
Freeze Frame Off
Reload Gamma Index = 1
```

4. Infrared Remote Control Interface

An IR interface is included for Lens Positioning, Zoom and Focusing adjustments. The IR remote control that is handled by the firmware is Model T320L by Umate Corp., Taipai, Taiwan. It emits the following *RECS80* codes:

Button	Code Assuming LSB First	Operation/Action
POWER	**$8C73817E_{16}$**	**Toggle Main Power**
Mouse Knob	N.A.	Not decoded
L Mouse Button	N.A.	Not decoded
R Mouse Button	N.A.	Not decoded
UP Arrow	**$8C73837C_{16}$**	**Pan UP**
DOWN Arrow	**$8C7343BC_{16}$**	**Pan DOWN**
RIGHT Arrow	**$8C7323DC_{16}$**	**Pan RIGHT**
LEFT Arrow	**$8C73C33C_{16}$**	**Pan LEFT**
ENTER	$8C73A35C_{16}$	Reserved
Keystone UP	**$8C73A15E_{16}$**	**Brightness/Contrast - Increment Lower Level**
Keystone DOWN	**$8C7321DE_{16}$**	**Brightness/Contrast - Decrement Lower Level**
Volume UP	**$8C7331CE_{16}$**	**Brightness/Contrast - Increment Upper Level**
Volume DOWN	**$8C73F10E_{16}$**	**Brightness/Contrast - Decrement Upper Level**
MENU	**$8C73E11E_{16}$**	**Change Mode – same as <CTRL-N>**
STATUS	**$8C7311EE_{16}$**	**Change Pattern – same as <CTRL-P>**
MUTE	**$8C73916E_{16}$**	**Change Orientation – same as <CTRL-O>**
AUTO	**$8C73619E_{16}$**	**Focus FAR**
SOURCE	**$8C73C13E_{16}$**	**Focus NEAR**
ZOOM+	**$8C7385AE_{16}$**	**ZOOM OUT – Image larger**
ZOOM-	**$8C73B14E_{16}$**	**ZOOM IN – Image smaller**
BLANK	**$8C738D2E_{16}$**	**Open Shutter – same as OPEN**
FREEZE	**$8C73718E_{16}$**	**Close Shutter – same as CLOSE**

Control buttons other that those listed in **BOLD** above generate no activity.

4.1 Pan, Zoom and Focus Speed and Nudge Functions

The Pan, Zoom and Focus buttons can be used to manually control the projected image. All of the motors may be driven at one of four speeds to make small incremental adjustments. In addition a **nudge** function is implemented. When any of the control keys are pressed and released, the associated motors will be turned on for a short period of time, causing a small incremental change in the image. In the following descriptions this nomenclature is used:

P = a quick button press and release – press and release time each less that about 0.25 seconds
H = the button is held down
PP = two quick button presses and releases – down times and intervening up times each less that about 0.25 seconds, etc.
..PH = One or more quick button presses and releases followed by a hold

The nudge function generates small changes in lens position,etc., by applying power to the associated motor for one of four time intervals: 12.5, 25, 50 or 100 milliseconds. Nudges are generated by a number of quick button depressions and releases. Nudge increments are controlled by the number of quick button presses – up to four. More than four are treated the same as four.

P – smallest change – 12.5 msec
PP – 25 msec
PPP – 50 msec
PPPP – largest change – 100 msec
PP..PP – largest change – 100 msec

Continuous changes are generated by a number of quick presses followed by a hold. Motor speeds are determined by the number of quick button presses – up to three – before holding the button down.

H – very slow
PH – slow
PPH – medium
PPPH – fast
PP..PH – fast

Release the button to stop the motor. Note that there is about a 0.25 to 0.35 second delay between button release and motor off.