Programmer's Guide

DLPC3434 Software Programmer's Guide

Abstract

This is the programmer's guide for the DLPC3434 DLP display controllers for the DLP230KP DMD. This guide primarily discusses the I^{2}C interface of these controllers. For additional information please visit the desired device product folder on ti.com.

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1 Introduction

1.1 System Overview

A typical TI DLP® Pico™ chipset consists of the controller, the PMIC, and the DMD. The DMD and PMIC are controlled by the DLPC3434 controller. An example system is shown in Figure 1-1. The controller communicates with the outside world with I^{2}C commands.

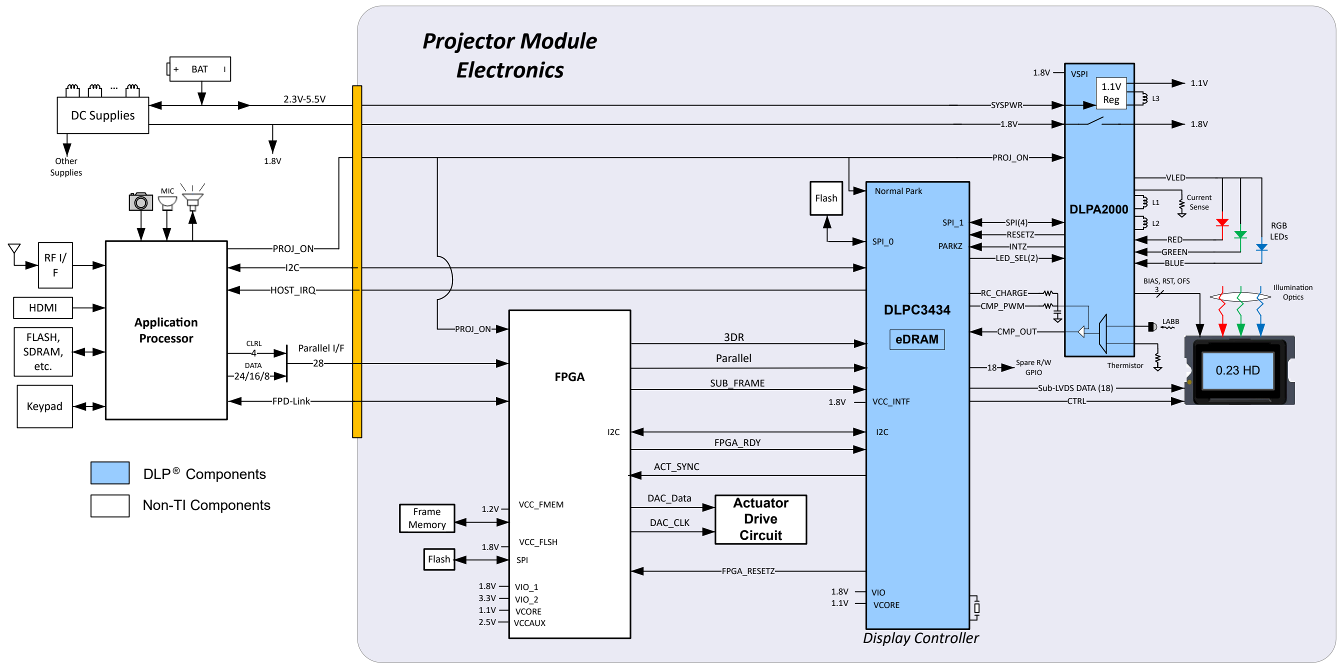


Figure 1-1. DLPC3434 Embedded Configuration

1.2 Software Overview

The DLPC3434 controller contains an Arm® Cortex®-M3 processor with additional functional blocks to enable video processing and control. TI provides software as a firmware image. The firmware consists of the main application code (used by the Arm processor) along with other configuration and operational data required by the system for normal operation. The controller and its accompanying DLP chipset components require this proprietary software to operate.

The firmware must be programmed into the SPI flash memory. The DLPC3434 controller loads the main application into the Arm processor which periodically accesses the operational data. The available controller functions depend on the firmware version installed. Different firmware is required for different chipset combinations (such as when using different PMIC devices). Visit the applicable controller product folder on ti.com, visit the DLP Pico Firmware Selector, or contact TI for the latest firmware.

1.2.1 I^{2}C Overview

The protocol used in communicating information to DLPC3434 controller consist of a serial data bus conforming to the Philips I^{2}C specification. The controller can be configured at runtime by using these I^{2}C commands. The DLPC3434 behaves as an I^{2}C follower operating at up to 100 kHz.

1.2.2 I^{2}C Transactions

Since all I^{2}C commands are processed by software, only one type of I^{2}C transaction is supported. This transaction type is shown in Table 1-1 for both writes and reads. The I^{2}C interface supports variably-sized transactions (for example, a one byte transaction or a nine byte transaction) to match the commands discussed later in this document.

Table 1-1. I²C Write and Read Transactions

Transaction		Address(1)	Sub-Address(2)	Remaining Data Bytes(3)
Write	Size	8-bits	8-bits	8-bit parameter bytes (0 → N)
	Value	36h (or 3Ah)	Command value	Parameter values
Read Request	Size	8-bits	8-bits	8-bit parameter bytes (0 → N)
	Value	36h (or 3Ah)	Command value	Parameter values
Read Response	Size	8-bits		8-bit parameter bytes (0 → N)
	Value	37h (or 3Bh)		Parameter values

(1) The address corresponds to the chip address of the controller. The address is dependent upon the firmware image with the default value of 36h.
(2) The subaddress corresponds to a TI command.
(3) The data (if present) corresponds to any required command parameters.

1.2.3 Data Flow Control

While the I²C interface inherently supports flow control by holding the clock, this is not sufficient for all transactions (for example, sequence and some other updates). In this case, the host software will need to execute the *Read Short Status* command to determine if the system is busy.

1.3 Related Documentation

- *DLPC3434 Display Controller Data Sheet*
- *DLP230KP 0.23 1080p DMD Data Sheet*
- *DLPA2000 Power Management and LED/Lamp Driver IC Data Sheet*
- *DLPA2005 Power Management and LED/Lamp Driver IC Data Sheet*
- *DLPA3000 Power Management and LED/Lamp Driver IC Data Sheet*

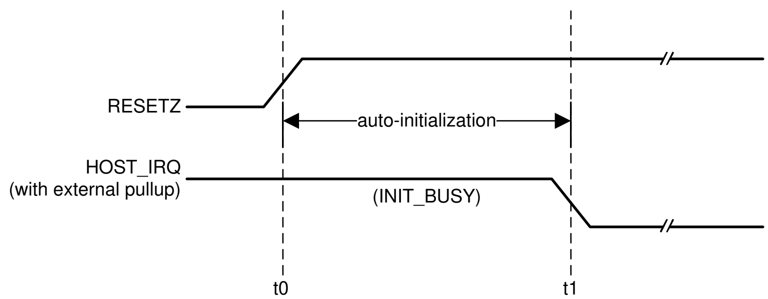
2 System Initialization

2.1 Boot ROM

The DLPC3434 employs a boot ROM and associated boot software. This resident boot code consists of the minimum code necessary to load the software from flash to internal RAM for execution. For most DLPC3434 product configurations, an external flash device can store the main application code, along with the other configuration and operational data required by the system for normal operation.

2.2 Device Startup

- The HOST_IRQ signal is provided to indicated when the system has completed auto-initialization.
- While reset is applied, HOST_IRQ is tri-stated (an external pullup resistor pulls the line high).
- HOST_IRQ remains tri-stated (pulled high externally) until the boot process completes. While the signal is pulled high, this indicates that the controller is performing boot-up and auto-initialization.
- As soon as possible after the controller boots-up, the controller drives HOST_IRQ to a logic high state to indicate that the controller is continuing to perform auto-initialization (no real state changes occur on the external signal).
- The software sets HOST_IRQ to a logic low state at the completion of the auto-initialization process. At the falling edge of the signal, the initialization is complete.
- The DLPC3434 controller is ready to receive commands through I^{2}C or accept video over the DSI or the parallel interface only after auto-initialization is complete.
- The controller initialization typically completes (HOST_IRQ goes low) within 500ms of RESETZ being asserted. However, this time varies depending on the software version and the contents of the user configurable auto initialization file.



t0: rising edge of RESETZ; auto-initialization begins

t1: falling edge of HOST_IRQ; auto-initialization is complete

Figure 2-1. HOST_IRQ Timing

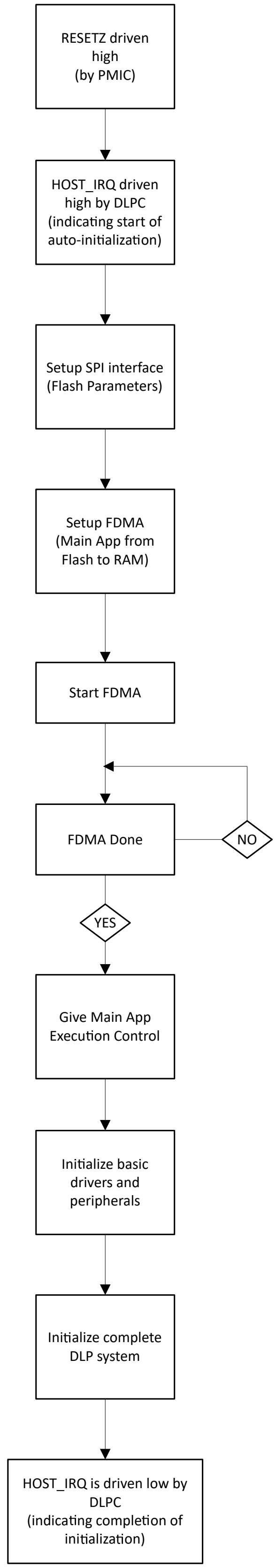


Figure 2-2. Startup Flow

3 I^2C Commands

Table 3-1. List of System Write/Read Software Commands

Command Type	Command Description	OpCode (hex)	Reference
General Operation Commands			
Write	Write Input Source Select	05	Write Input Source Select (05h)
Read	Read Input Source Select	06	Read Input Source Select (06h)
Write	Write Splash Screen Select	0D	Write Splash Screen Select (0Dh)
Read	Read Splash Screen Select	0E	Read Splash Screen Select (0Eh)
Read	Read Splash Screen Header	0F	Read Splash Screen Header (0Fh)
Write	Write Display Image Orientation	14	Write Display Image Orientation (14h)
Read	Read Display Image Orientation	15	Read Display Image Orientation (15h)
Write	Write Display Image Curtain	16	Write Display Image Curtain (16h)
Read	Read Display Image Curtain	17	Read Display Image Curtain (17h)
Write	Write Image Freeze	1A	Write Image Freeze (1Ah)
Read	Read Image Freeze	1B	Read Image Freeze (1Bh)
Write	Write 3-D Control	20	Write 3-D Control (20h)
Read	Read 3-D Control	21	Read 3-D Control (21h)
Write	Write Look Select	22	Write Look Select (22h)
Read	Read Look Select	23	Read Look Select (23h)
Read	Read Sequence Header Attributes	26	Read Sequence Header Attributes (26h)
Write	Write Degamma/CMT Select	27	Write Degamma/CMT Select (27h)
Read	Read Degamma/CMT Select	28	Read Degamma/CMT Select (28h)
Write	Write CCA Select	29	Write CCA Select (29h)
Read	Read CCA Select	2A	Read CCA Select (2Ah)
Read	Read DMD Sequencer Sync Mode	2C	Read DMD Sequencer Sync Mode (2Ch)
Write	Write Execute Flash Batch File	2D	Write Execute Flash Batch File (2Dh)
Write	Write 3-D Reference	30	Write 3-D Reference (30h)
Write	Write Mirrors Lock Command	39	Write Mirrors Lock Command (39h)
Read	Read Mirrors Lock Command	3A	Read Mirrors Lock Command (3Ah)
Write	Write FPD Link Pixel Map Mode	4B	Write FPD Link Pixel Map Mode (4Bh)
Read	Read FPD Link Pixel Map Mode	4C	Read FPD Link Pixel Map Mode (4Ch)
Write	Write FPGA Input Video Chroma Processing Select	4D	Write FPGA Input Video Chroma Processing Select (4Dh)
Read	Read FPGA Input Video Chroma Processing Select	4E	Read FPGA Input Video Chroma Processing Select (4Eh)
Illumination Control Commands			
Write	Write LED Output Control Method	50	Write LED Output Control Method (50h)
Read	Read LED Output Control Method	51	Read LED Output Control Method (51h)
Write	Write RGB LED Enable	52	Write RGB LED Enable (52h)
Read	Read RGB LED Enable	53	Read RGB LED Enable (53h)
Write	Write RGB LED Current	54	Write RGB LED Current (54h)
Read	Read RGB LED Current	55	Read RGB LED Current (55h)
Read	Read CAIC LED Max Available Power	57	Read CAIC LED Max Available Power (57h)
Write	Write RGB LED Max Current	5C	Write RGB LED Max Current (5Ch)
Read	Read RGB LED Max Current	5D	Read RGB LED Max Current (5Dh)
Read	Read CAIC RGB LED Current	5F	Read CAIC RGB LED Current (5Fh)

Table 3-1. List of System Write/Read Software Commands (continued)

Command Type	Command Description	OpCode (hex)	Reference
XPR Commands			
Write	Write XPR FPGA Input Image Size	60	Write XPR FPGA Input Image Size (60h)
Read	Read XPR FPGA Input Image Size	61	Read XPR FPGA Input Image Size (61h)
Read	Read XPR FPGA Version	64	Read XPR FPGA Version (64h)
Write	Write XPR FPGA Test Pattern Select	67	Write XPR FPGA Test Pattern Select (67h)
Read	Read XPR FPGA Test Pattern Select	68	Read XPR FPGA Test Pattern Select (68h)
Write	Write XPR FPGA Parallel Video Control	6B	Write XPR FPGA Parallel Video Control (6Bh)
Read	Read XPR FPGA Parallel Video Control	6C	Read XPR FPGA Parallel Video Control (6Ch)
Write	Write XPR FPGA Video Format Select	6D	Write XPR FPGA Video Format Select (6Dh)
Read	Read XPR FPGA Video Format Select	6E	Read XPR FPGA Video Format Select (6Eh)
Read	Read XPR FPGA Status	6F	Read XPR FPGA Status (6Fh)
Write	Write Actuator Latency	70	Write Actuator Latency (70h)
Read	Read Actuator Latency	71	Read Actuator Latency (71h)
Write	Write Actuator Gain	72	Write Actuator Gain (72h)
Read	Read Actuator Gain	73	Read Actuator Gain (73h)
Write	Write Segment Length	74	Write Segment Length (74h)
Read	Read Segment Length	75	Read Segment Length (75h)
Write	Write Manual Actuator Sync Delay	76	Write Manual Actuator Sync Delay (76h)
Read	Read Manual Actuator Sync Delay	77	Read Manual Actuator Sync Delay (77h)
Write	Write Manual Actuator Offset	78	Write Manual Actuator Offset (78h)
Read	Read Manual Actuator Offset	79	Read Manual Actuator Offset (79h)
Image Processing Control Commands			
Write	Write Local Area Brightness Boost Control	80	Write Local Area Brightness Boost Control (80h)
Read	Read Local Area Brightness Boost Control	81	Read Local Area Brightness Boost Control (81h)
Write	Write CAIC Image Processing Control	84	Write CAIC Image Processing Control (84h)
Read	Read CAIC Image Processing Control	85	Read CAIC Image Processing Control (85h)
Write	Write Color Coordinate Adjustment Control	86	Write Color Coordinate Adjustment Control (86h)
Read	Read Color Coordinate Adjustment Control	87	Read Color Coordinate Adjustment Control (87h)
Write	Write Keystone Correction Control	88	Write Keystone Correction Control (88h)
Read	Read Keystone Correction Control	89	Read Keystone Correction Control (89h)
General Setup Commands			
Write	Write Actuator Number of Segments	A0	Write Actuator Number of Segments (A0h)
Read	Read Actuator Number of Segments	A1	Read Actuator Number of Segments (A1h)
Write	Write Actuator Configuration Select	A2	Write Actuator Configuration Select (A2h)
Read	Read Actuator Configuration Select	A3	Read Actuator Configuration Select (A3h)
Write	Write Actuator Fixed Level Value	A4	Write Actuator Fixed Level Value (A4h)
Read	Read Actuator Fixed Level Value	A5	Read Actuator Fixed Level Value (A5h)
Write	Write Actuator Period Stretch Value	A6	Write Actuator Period Stretch Value (A6h)
Read	Read Actuator Period Stretch Value	A7	Read Actuator Period Stretch Value (A7h)
Write	Write Actuator Reference Value	A8	Write Actuator Reference Value (A8h)
Read	Read Actuator Reference Value	A9	Read Actuator Reference Value (A9h)
Write	Write Actuator Output Select	AA	Write Actuator Output Select (AAh)
Read	Read Actuator Output Select	AB	Read Actuator Output Select (ABh)
Write	Write Actuator Edge Table Address Mode	AC	Write Actuator Edge Table Address Mode (ACh)
Read	Read Actuator Edge Table Address Mode	AD	Read Actuator Edge Table Address Mode (ADh)
Write	Write Actuator DAC Enable	AE	Write Actuator DAC Enable (AEh)

Table 3-1. List of System Write/Read Software Commands (continued)

Command Type	Command Description	OpCode (hex)	Reference
Read	Read Actuator DAC Enable	AF	Read Actuator DAC Enable (AFh)
Read	Read Auto Framing Information	BA	Read Auto Framing Information (BAh)
Write	Write Keystone Projection Pitch Angle	BB	Write Keystone Projection Pitch Angle (BBh)
Read	Read Keystone Projection Pitch Angle	BC	Read Keystone Projection Pitch Angle (BCh)
Write	Write Actuator Watchdog Window Width	C2	Write Actuator Watchdog Window Width (C2h)
Read	Read Actuator Watchdog Window Width	C3	Read Actuator Watchdog Window Width (C3h)
Write	Write Actuator Subframe Filter Width	C4	Write Actuator Subframe Filter Width (C4h)
Read	Read Actuator Subframe Filter Width	C5	Read Actuator Subframe Filter Width (C5h)
Write	Write Actuator Stepped/Fixed Output Invert Enable	C6	Write Actuator Stepped/Fixed Output Invert Enable (C6h)
Read	Read Actuator Stepped/Fixed Output Invert Enable	C7	Read Actuator Stepped/Fixed Output Invert Enable (C7h)
Write	Write Actuator Orientation	C8	Write Actuator Orientation (C8h)
Read	Read Actuator Orientation	C9	Read Actuator Orientation (C9h)
Administrative Commands			
Read	Read Short Status	D0	Read Short Status (D0h)
Read	Read System Status	D1	Read System Status (D1h)
Read	Read System Software Version	D2	Read System Software Version (D2h)
Read	Read Communication Status	D3	Read Communication Status (D3h)
Read	Read Controller Device ID	D4	Read Controller Device ID (D4h)
Read	Read DMD Device ID	D5	Read DMD Device ID (D5h)
Read	Read System Temperature	D6	Read System Temperature (D6h)
Read	Read Flash Build Version	D9	Read Flash Build Version (D9h)
Write	Write Flash Batch File Delay	DB	Write Flash Batch File Delay (DBh)
Read	Read DMD I/F Training Data	DC	Read DMD I/F Training Data (DCh)
Flash Update Commands			
Read	Read Flash Update PreCheck	DD	Read Flash Update PreCheck (DDh)
Write	Write Flash Data Type Select	DE	Write Flash Data Type Select (DEh)
Write	Write Flash Data Length	DF	Write Flash Data Length (DFh)
Write	Write Erase Flash Data	E0	Write Erase Flash Data (E0h)
Write	Write Flash Start	E1	Write Flash Start (E1h)
Write	Write Flash Continue	E2	Write Flash Continue (E2h)
Read	Read Flash Start	E3	Read Flash Start (E3h)
Read	Read Flash Continue	E4	Read Flash Continue (E4h)

The following sections describe each of the above listed commands in detail.

3.1 General Operation Commands

3.1.1 Write Input Source Select (05h)

This command selects the input source of the system.

3.1.1.1 Write Parameters

Table 3-2 describes the write parameters.

Table 3-2. Write Parameters

MSB	**Byte 1**						**LSB**
b7	b6	b5	b4	b3	b2	b1	b0

Bit	Type	Description
7-3	R	Reserved
2-0	W	Input Source 0h = Test Pattern Generator from XPR FPGA 1h = External Parallel Video from XPR FPGA 2h = FPD-Link or LVDS Source from XPR FPGA 3h = Internal Controller Splash Screen 4h = Internal Controller Test Pattern 5h - 7h = Reserved

MSB	**Byte 2**						**LSB**
b7	b6	b5	b4	b3	b2	b1	b0

Bit	Type	Description
7-1	R	Reserved
0	W	External Calibration Setting 0h = External Calibration Disabled 1h = External Calibration Enabled

Note

When selecting the Test Pattern Generator from FPGA, there is one associated command that is only applicable to this source selection. This associated command is the Write XPR FPGA Test Pattern Select (67h) command.

When selecting the Splash Screen, there is one associated command that is only applicable to this source selection. This associated command is the Write Splash Screen Select (0Dh) command.

When "External Calibration" is enabled, the system is reconfigured to disable all FPGA image processing. This allows the user to inject their own test patterns for calibration purposes.

The following commands are shared among "External Video Port", "Test Pattern Generator" and "Splash Screen" input select options:

- Write Display Image Orientation
- Write Display Image Curtain
- Write Look Select
- Write Local Area Brightness Boost Control
- Write CAIC Image Processing Control

While the values for these commands may be the same across the different input source types, the hardware settings may change. For example, if the user changes to a "Test Pattern Generator" Input Source, the size of the test pattern must match the size of the DMD. Therefore, the display scaler settings may need to be changed.

Note

The user is required to specify the active data size for all external input sources using the Write Input Image Size command. In addition, for input image data on the Parallel bus that doesn't provide data framing information, the user is required to provide manual framing data using the Parallel I/F Manual Image Framing command.

Note

When a test pattern is selected, it will be generated at the resolution of the DMD.

Note

The user should see the Write Image Freeze (1Ah) command for information on hiding on-screen artifacts when selecting an input source.

3.1.2 Read Input Source Select (06h)

This command reads the input source of the system.

3.1.2.1 Read Parameters

This command has no read parameters.

3.1.2.2 Return Parameters

Table 3-3 describes the return parameters.

Table 3-3. Return Parameters

MSB	Byte 1						LSB
b7	b6	b5	b4	b3	b2	b1	b0

Bit	Type	Description
7-3	R	Reserved
2-0	W	Input Source 0h = Test Pattern Generator from XPR FPGA 1h = External Parallel Video from XPR FPGA 2h = FPD-Link or LVDS Source from XPR FPGA 3h = Internal Controller Splash Screen 4h = Internal Controller Test Pattern 5h - 7h = Reserved

MSB	Byte 2						LSB
b7	b6	b5	b4	b3	b2	b1	b0

Bit	Type	Description
7-1	R	Reserved
0	W	External Calibration Setting 0h = External Calibration Disabled 1h = External Calibration Enabled

3.1.3 Write Splash Screen Select (0Dh)

This command selects a stored splash screen to be displayed on the display module.

3.1.3.1 Write Parameters

Table 3-4 describes the write parameters.

Table 3-4. Write Parameters

Parameter Bytes	Description
Byte 1	Splash screen reference number (integer)

This command is used in conjunction with the *Write Input Source Select* and the *Write Splash Screen Execute* commands, and specifies which splash screen is selected by the *Input Source Select* command. The settings for this command are retained until changed using this command.

The steps required to display a splash screen are:

1. Select the desired splash screen (using this command)
2. Change the input source to splash screen (using *Write Input Source Select*)
3. Start the splash screen retrieval process (using *Write Splash Screen Execute*).

The splash screen is read from flash and sent down the processing path of the controller once, to be stored in memory for display at the end of the processing path. As such, all image processing settings (such as image crop, image orientation, display size, splash screen select, splash screen as input source, and so forth) must be set by the user before executing the *Write Splash Screen Execute* command.

The user must review the notes for the *Write Input Source Select* command to understand the concept of source-associated commands. This concept determines when source-associated commands are executed by the system. This command is a source-associated command.

The availability of the splash screen is limited by the available space in flash memory. All splash screens must be landscape oriented.

For single controller applications which support DMD resolutions up to 1280 x 720, the minimum splash image size allowed for flash storage is 427 x 240, with the maximum being the resolution of the DMD. Typical splash image sizes for flash are 427 x 240 and 640 x 360. The full resolution size is typically used to support an “Optical Test” splash screen.

The user must specify how the splash image is displayed on the screen. Key commands for this are *Write Image Crop* and *Write Display Size*.

When this command is received while splash screen is the active source, other than storing the specified splash screen value, the only action taken by the controller software is to obtain the header information from the selected splash screen and store this in internal memory. When the *Write Splash Screen Execute* command is received, the controller software uses this stored information to set up the processing path prior to pulling the splash data from flash.

3.1.4 Read Splash Screen Select (0Eh)

This command reads the state of the *Splash Screen Select* command of the display module.

3.1.4.1 Read Parameters

This command has no read parameters.

3.1.4.2 Return Parameters

Table 3-5 describes the return parameters.

Table 3-5. Return Parameters

Parameter Bytes	Description
Byte 1	Splash screen selected (integer)

3.1.5 Read Splash Screen Header (0Fh)

This command reads the splash screen header information for the selected splash screen of the display module.

3.1.5.1 Read Parameters

The read parameter specifies the splash screen for which the header parameters are returned. If a splash screen value is provided for an unavailable splash screen, this is considered an error (invalid command parameter value – communication status).

Table 3-6. Read Parameters

Parameter Bytes	Description
Byte 1	Splash screen reference number (integer)

3.1.5.2 Return Parameters

Table 3-7 describes the return parameters.

Table 3-7. Return Parameters

Parameter Bytes	Description
Byte 1	Splash image width in pixels (LSByte)
Byte 2	Splash image width in pixels (MSByte)
Byte 3	Splash image height in pixels (LSByte)
Byte 4	Splash image height in pixels (MSByte)
Byte 5	Splash image size in bytes (LSByte)
Byte 6	Splash image size in bytes
Byte 7	Splash image size in bytes
Byte 8	Splash image size in bytes (MSByte)
Byte 9	Pixel format
Byte 10	Compression type
Byte 11	Color order
Byte 12	Chroma order
Byte 13	Byte order

Parameter definitions are referenced in Table 3-8.

Table 3-8. Splash Screen Header Definitions

Parameter	Values
Pixel format	0h = 24-bit RGB unpacked (not used) 1h = 24-bit RGB packed (not used) 2h = 16-bit RGB 5-6-5 3h = 16-bit YCbCr 4:2:2
Compression type	0h = Uncompressed 1h = RGB RLE compressed 2h = User-defined (not used) 3h = YUV RLE compressed
Color order	0h = 00RRGGBB 1h = 00GGRRBB
Chroma order	0h = Cr is first pixel 1h = Cb is first pixel
Byte order	0h = Little endian 1h = Big endian

3.1.6 Write Display Image Orientation (14h)

This command specifies the image orientation of the displayed image.

3.1.6.1 Write Parameters

Table 3-9 describes the write parameters.

Table 3-9. Write Parameters

MSB	Byte 1						LSB
b7	b6	b5	b4	b3	b2	b1	b0

Parameter Byte	
b(7:3)	*Reserved*
b(2)	Short axis image flip: • 0: Image not flipped. • 1: Image flipped.
b(1)	Long axis image flip: • 0: Image not flipped. • 1: Image flipped.
b(0)	Reserved

Figure 3-1. Long-Axis Flip

Figure 3-2 shows the short-axis flip.

Figure 3-2. Short-Axis Flip

3.1.7 Read Display Image Orientation (15h)

This command reads the state of the displayed image orientation function for the display module.

3.1.7.1 Read Parameters

This command has no read parameters.

3.1.7.2 Return Parameters

Table 3-10 describes the return parameters.

Table 3-10. Return Parameters

MSB	Byte 1						LSB
b7	b6	b5	b4	b3	b2	b1	b0

b(7:3)	Reserved

b(2)	Short-axis image flip: • 0: Image not flipped. • 1: Image flipped.
b(1)	Long-axis image flip: • 0: Image not flipped. • 1: Image flipped.
b(0)	Reserved

3.1.8 Write Display Image Curtain (16h)

This command controls the display image curtain for the display module.

3.1.8.1 Write Parameters

Table 3-11 shows the write parameters.

Table 3-11. Write Parameters

MSB	Byte 1						LSB
b7	b6	b5	b4	b3	b2	b1	b0

b(7:4)	Reserved
b(3:1)	Select curtain color: • 0h: Black • 1h: Red • 2h: Green • 3h: Blue • 4h: Cyan • 5h: Magenta • 6h: Yellow • 7h: White
b(0)	Curtain enable: • 0: Curtain disabled • 1: Curtain enabled

The image curtain fills the entire display with a user-specified color. The curtain color specified by this command is separate from the border color defined in the *Write Border Color* command, though both are displayed using the curtain capability.

3.1.9 Read Display Image Curtain (17h)

This command reads the state of the image curtain control function for the display module.

3.1.9.1 Read Parameters

This command has no read parameters.

3.1.9.2 Return Parameters

Table 3-12 describes the return parameters.

Table 3-12. Return Parameters

MSB	Byte 1						LSB
b7	b6	b5	b4	b3	b2	b1	b0

b(7:4)	Reserved

b(3:1)	Select curtain color: • 0h: Black • 1h: Red • 2h: Green • 3h: Blue • 4h: Cyan • 5h: Magenta • 6h: Yellow • 7h: White
b(0)	Curtain enable: • 0: Curtain disabled • 1: Curtain enabled

3.1.10 Write Image Freeze (1Ah)

This command enables or disables the image freeze function for the display module.

3.1.10.1 Write Parameters

Table 3-13 describes the write parameters.

Table 3-13. Write Parameters

MSB	Byte 1						LSB
b7	b6	b5	b4	b3	b2	b1	b0

b(7:1)	Reserved
b(0)	Image freeze: • 0: Image freeze disabled • 1: Image freeze enabled

The image freeze capability has two main uses. The first use is to simply freeze the current image on the screen. The second use is to assist the user in reducing display artifacts during system changes. In this second case, the image is frozen, system changes are made, and the image is unfrozen when complete. In all cases, when the image is unfrozen, the display shows the most resent input image. Input data between the freeze point and the unfreeze point is lost.

The controller software does not freeze or unfreeze the image except when explicitly commanded by the *Write Image Freeze* command. The controller software may execute the *Write Image Freeze* when the software is making updates to the system on its own volition, and for any operation commanded via the I^2C interface.

The user must review the notes for the *Write Input Source Select* command to understand the concept of source-associated commands. This concept determines when source-associated commands are executed by the system.

If the user chooses not to make use of image freeze, they must change the source before changing the image parameters, to minimize transition artifacts.

3.1.10.2 Use of Image Freeze to Reduce On-Screen Artifacts

Commands that take a long time to process, require a lot a data to be loaded from flash, or change the frame timing of the system may create on-screen artifacts. The *Write Image Freeze* command can try and minimize, if not eliminate, these artifacts. The process is:

1. Send a *Write Image Freeze* command to enable freeze.
2. Send commands with the potential to create image artifacts.
3. Embedded software executes *Write Image Freeze* command to disable freeze.

Because commands to the controller process serially, no special timing or delay is required between these commands. The number of commands placed between the freeze and unfreeze must be small, as it is not desirable for the image to be frozen for a long period of time. A list of commands that may produce image artifacts is listed in Table 3-14, which is not an all-inclusive list. The user is responsible for determining the correct use of the image freeze command.

Table 3-14. Partial List of Commands that May Benefit from the Use of Image Freeze

Command
Write Input Source Select (05h)
Write XPR FPGA Video Format Select (6Dh)
Write Look Select (22h)

Table 3-15 and Table 3-16 show a few examples of how to use the image freeze command.

Table 3-15. Splash Screen Example Using Image Freeze

Command	Notes
Write Display Image Curtain = enable	May want to apply curtain if already displaying an unwanted image (such as a broken source)
Write Image Freeze = freeze	
Write Image Crop, Write Display Size, Write Display Image Orientation	Potential data processing commands that may be required for proper display of splash image. These must be set prior to write splash screen execute command to affect the splash screen image.
Write Splash Screen Select Write Input Source Select = splash	These must be set prior to write splash screen execute
Write Splash Screen Execute	Retrieves the desired splash screen image for display

The new splash image displays when the *Write Splash Screen Execute* command executes, regardless of the state of the *Write Image Freeze* command (due to the one time nature of the splash image). Embedded software disables image freeze after this command is executed.

Table 3-16. Test Pattern Generator Example Using Image Freeze

Command	Notes
Write Image Freeze = freeze	
Write Image Crop, Write Display Size, Write Display Image Orientation, Write Test Pattern Select	Potential data processing commands that may be required for proper display of test pattern image. These must be set before the Write Input Source Select command.
Write Input Source Select = test pattern generator	
Write Image Freeze = unfreeze	

3.1.11 Read Image Freeze (1Bh)

This command reads the state of the image freeze function for the display module.

3.1.11.1 Read Parameters

This command has no read parameters.

3.1.11.2 Return Parameters

Table 3-17 describes the return parameters.

Table 3-17. Return Parameters

MSB	Byte 1						LSB
b7	b6	b5	b4	b3	b2	b1	b0

b(7:1)	Reserved

b(0)	Image freeze: • 0: Image freeze disabled • 1: Image freeze enabled

3.1.12 Write 3-D Control (20h)

This command controls the 3-D functionality of the display module.

Write Parameters

Table 3-18 describes the write parameters

Table 3-18. Write Parameters

MSB	Byte 1						LSB
b7	b6	b5	b4	b3	b2	b1	b0

Bit	Type	Description
7	R	Reserved
6	W	Polarity of 3-D Reference (External Only) 0h = Correct – No Inversion Required. 1h = Incorrect – Inversion Required.
5	W	Frame Dominance 0h = Left Dominant. (Data sent left eye first)
4-2	R	Reserved
1	W	Source of 3-D Reference 0h = Internal Reference Generator NOT supported 1h = External (SLT_3DR Pin)
0	R	Reserved

When appropriate, the system will automatically enable 3-D operation based on source frame rate and whether 3-D sequences are loaded in flash. The 3-D parameters specified by this command will take effect following the next VSYNC.

3-D image data must always be sent frame sequential. Syncs and blanking are sent between every eye frame at frame rates greater than approximately 94Hz. DLPC3434 does not support frame rate multiplication.

Internal reference generator is not supported on dual ASIC DLPC3439.

The 3-D Reference is used to specify whether a frame of data contains left eye data or right eye data. This 3-D reference can be provided to the display by an external hardware signal. Table 3-19 shows which 3-D Reference source can be used with which image data port.

When using the external hardware signal as the reference, it must be provided for every frame of data. If the external 3-D Reference is misaligned with the data, it can be corrected using the *Polarity of 3-D Reference (External Only)* parameter. As noted, the *Polarity of 3-D Reference* parameter is only applicable when the External Signal is selected as the 3-D Reference source.

Table 3-19. 3D Control

Display Data Port	3-D Reference Source	Applicable	Notes
Parallel	External Hardware Signal	Yes	Recommended
Parallel	Internal Reference Generator	No	

The Write 3-D Reference (30h) command should be use with this selection.

For frame sequential 3-D, Frame Dominance determines which eye frames in the data stream go together to create a single 3-D image. Left Dominance indicates that the first eye frame of a pair is Left and the second eye frame is Right. Right Dominance indicates that the first eye frame of a pair is Right and the second eye frame is

Left. Frame dominance is essential for correct operation of display histograms, which span both eye frames of a single image. When the image is frozen, proper Frame Dominance ensures the correct display of two eye frames together. Frame dominance control must not be used to attempt correction for misalignment of the 3-D reference signal to the image data.

3.1.13 Read 3-D Control (21h)

This command is used to read the state of the 3-D control function for the display module.

3.1.13.1 Read Parameters

This command has no read parameters.

Return Parameters

Table 3-20 describes the return parameters.

Table 3-20. Return Parameters

MSB	Byte 1						LSB
b7	b6	b5	b4	b3	b2	b1	b0

Bit	Type	Description
7	R	Reserved
6	R	Polarity of 3-D Reference (External Only) 0h = Correct – No Inversion Required. 1h = Incorrect – Inversion Required.
5	R	Frame Dominance 0h = Left Dominant. (Data sent left eye first) 1h = Right Dominant. (Data sent right eye first)
4-2	R	Reserved
1	R	Source of 3-D Reference 0h = Internal Reference Generator NOT supported 1h = External (SLT_3DR Pin)
0	R	3-D Mode Control 0h = 2-D Operation 1h = 3-D Operation

Note

The system automatically enables and disables 3-D operation. Bit(0) indicates the state of 2-D/3-D operation.

3.1.14 Write Look Select (22h)

This command specifies the Look for the image on the display module.

3.1.14.1 Write Parameters

Table 3-21 describes the write parameters.

Table 3-21. Write Parameters

MSB	Byte 1						LSB
b7	b6	b5	b4	b3	b2	b1	b0

b(7:0)	Look number

In this product, a Look typically specifies a target white point. The number of Looks available may be limited by the available space in flash memory.

This command allows the host to select a Look (target white point) from a number of Looks stored in flash.

Looks are specified in this byte by an enumerated value (such as 0,1,2,3). There must always be at least one Look, with an enumerated value of 0.

There are two other items that the host must specify when determining a white point. These are:

- A desired degamma curve, achieved by selecting the appropriate degamma/CMT, which has the desired degamma curve and correct bit weights for the sequence selected.
- The desired color points, achieved by selecting the appropriate CCA parameters using the CCA select command.

3.1.15 Read Look Select (23h)

This command reads the state of the Look select command for the display module.

3.1.15.1 Read Parameters

This command has no read parameters.

3.1.15.2 Return Parameters

Table 3-22 describes the return parameters.

Table 3-22. Return Parameters

Parameter Bytes	Description
Byte 1	Look Number. See the following notes.
Byte 2	Sequence number. See the following notes.
Byte 3	Current Sequence Frame Rate (LSB). See the following notes.
Byte 4	Current Sequence Frame Rate.
Byte 5	Current Sequence Frame Rate.
Byte 6	Current Sequence Frame Rate (MSB).

MSB	Byte 1 and 2						LSB
b7	b6	b5	b4	b3	b2	b1	b0

Table 3-23. Byte 1 Read Look Select Register Field Descriptions

Bit	Type	Description
7-0	R	look number

Table 3-24. Byte 2 Read Look Select Register Field Descriptions

Bit	Type	Description
7-0	R	Sequence number

Looks are specified by an enumerated value (such as 0, 1, 2, 3).

Sequences are specified by an enumerated value (such as 0, 1, 2, 3). The value returned by this command is the sequence currently selected by the Look algorithm when the command is received.

The current sequence frame rate is returned as a count specified in units of 66.67 ns. This is based on the internal 15-MHz clock used to time between input frame syncs. The frame rate is specified in this manner to enable the software to make quick and simple comparisons to the frame count. Either the controller software or the user can make sequence frame rate and duty cycle selections.

3.1.16 Read Sequence Header Attributes (26h)

This command reads sequence header information for the active sequence of the display module.

3.1.16.1 Read Parameters

This command has no read parameters.

3.1.16.2 Return Parameters

Table 3-25 describes the return parameters.

Table 3-25. Return Parameters

Parameter Bytes	Description
Byte 1	Red duty cycle (LSByte) (Look structure)
Byte 2	Red duty cycle (MSByte) (Look structure)
Byte 3	Green duty cycle (LSByte)(Look structure)
Byte 4	Green duty cycle (MSByte) (Look structure)
Byte 5	Blue duty cycle (LSByte) (Look structure)
Byte 6	Blue duty cycle (MSByte) (Look structure)
Byte 7	Maximum frame count (LSByte) (Look structure)
Byte 8	Maximum frame count (Look structure)
Byte 9	Maximum frame count (Look structure)
Byte 10	Maximum frame count (MSByte) (Look structure)
Byte 11	Minimum frame count (LSByte) (Look structure)
Byte 12	Minimum frame count (Look structure)
Byte 13	Minimum frame count (Look structure)
Byte 14	Minimum frame count (MSByte) (Look structure)
Byte 15	Maximum number of sequence vectors (Look structure)
Byte 16	Red duty cycle (LSByte) (Sequence structure)
Byte 17	Red duty cycle (MSByte) (Sequence structure)
Byte 18	Green duty cycle (LSByte) (Sequence structure)
Byte 19	Green duty cycle (MSByte) (Sequence structure)
Byte 20	Blue duty cycle (LSByte) (Sequence structure)
Byte 21	Blue duty cycle (MSByte) (Sequence structure)
Byte 22	Maximum frame count (LSByte) (Sequence structure)
Byte 23	Maximum frame count (Sequence structure)
Byte 24	Maximum frame count (Sequence structure)
Byte 25	Maximum frame count (MSByte) (Sequence structure)
Byte 26	Minimum frame count (LSByte) (Sequence structure)
Byte 27	Minimum frame count (Sequence structure)
Byte 28	Minimum frame count (Sequence structure)
Byte 29	Minimum frame count (MSByte) (Sequence structure)
Byte 30	Maximum number of sequence vectors (Sequence structure)

The sequence header data is stored in two separate flash data structures (the Look structure and the sequence structure), and the values from each must match.

The bit weight and bit order for the duty cycle data is shown in Table 3-26.

Table 3-26. Bit Weight and Bit Order for Duty Cycle Data

MSB	Byte 2						LSB	*MSB*	Byte 1						LSB
b15 2^7	b14 2^6	b13 2^5	b12 2^4	b11 2^3	b10 2^2	b9 2^1	b8 2^0	b7 2^{-1}	b6 2^{-2}	b5 2^{-3}	b4 2^{-4}	b3 2^{-5}	b2 2^{-6}	b1 2^{-7}	b0 2^{-8}

The duty cycle data is specified as each color percent of the frame time. The sum of the three duty cycles must add up to 100. An example possibility is, R = 30.5 = 1E80h, G = 50 = 3200h, and B = 19.5 = 1380h)

The sequence maximum and minimum frame counts are specified in units of 66.67 ns. This is based on the internal 15-MHz clock used to time between input frame syncs. The frame rate is specified in this manner to enable the software to make quick and simple comparisons to the frame count.

The maximum number of sequence vectors byte is defined in Table 3-27.

Table 3-27. Maximum Number of Sequence Vectors

MSB	Byte 15 and 30						LSB
b7	b6	b5	b4	b3	b2	b1	b0

b(7:4)	Reserved
b(3:0)	Maximum number of sequence vectors

3.1.17 Write Degamma/CMT Select (27h)

This command is used to select a specific Degamma/CMT LUT for the display module.

3.1.17.1 Write Parameters

Table 3-28 describes the write parameters.

Table 3-28. Write Parameters

MSB	Byte 1						LSB
b7	b6	b5	b4	b3	b2	b1	b0

b(7:0)	Degamma/CMT LUT index number (0-255)

3.1.18 Read Degamma/CMT Select (28h)

This command is used to read the Degamma/CMT LUT index for the display module.

3.1.18.1 Read Parameters

This command has no read parameters.

3.1.18.2 Return Parameters

Table 3-29 describes the return parameters.

Table 3-29. Return Parameters

MSB	Byte 1						LSB
b7	b6	b5	b4	b3	b2	b1	b0

b(7:0)	Degamma/CMT LUT index number

3.1.19 Write CCA Select (29h)

This command specifies which set of CCA (color coordinate adjustment) parameters to use.

3.1.19.1 Write Parameters

Table 3-30 describes the write parameters.

Table 3-30. Write Parameters

MSB	Byte 1						LSB
b7	b6	b5	b4	b3	b2	b1	b0

b(7:0)	CCA Parameter Set Index

One or more CCA parameter sets may be included in a firmware image. Each CCA parameter set is intended to specify a target color point in the system. This command enables selection from multiple CCA sets by an enumerated value (such as 0,1,2,3). A CCA parameter set must exist for it to be selected. This command may be used in conjunction with *Write Color Coordinate Adjustment Control*.

3.1.20 Read CCA Select (2Ah)

This command reads the state of the CCA Parameter Set Index.

3.1.20.1 Read Parameters

This command has no read parameters.

3.1.20.2 Return Parameters

Table 3-31 describes the return parameters.

Table 3-31. Return Parameters

MSB	Byte 1						LSB
b7	b6	b5	b4	b3	b2	b1	b0

b(7:0)	CCA Parameter Set Index

3.1.21 Read DMD Sequencer Sync Mode (2Ch)

This command reads the state of the DMD sequencer sync mode function of the display module.

3.1.21.1 Read Parameters

This command has no read parameters.

3.1.21.2 Return Parameters

Table 3-32 describes the return parameters.

Table 3-32. Return Parameters

MSB	Byte 1						LSB
b7	b6	b5	b4	b3	b2	b1	b0

b(7:2)	Reserved
b(1)	System auto-sync setting: • 0h: Lock to external VSYNC (auto-sync) • 1h: Lock to internal VSYNC (auto-sync)
b(0)	DMD sequencer sync mode: • 0h: Auto-sync • 1h: Force lock to internal VSYNC

The DMD sequencer sync mode response indicates the setting specified by the *Write DMD Mode* command.

System auto-sync setting response is only valid when the DMD sequencer sync mode is set to auto-sync (otherwise set to 0). The lock to the external VSYNC (auto-sync) option indicates that the system is using the externally provided VSYNC to drive the display module. The lock to the internal VSYNC option indicates that the system is using the internal VSYNC generator to drive the display module.

3.1.22 Write Execute Flash Batch File (2Dh)

This command executes a flash batch file for the display module.

3.1.22.1 Write Parameters

Table 3-33 describes the write parameters.

Table 3-33. Write Parameters

Parameter Bytes	Description
Byte 1	Batch file number

This command executes a batch file stored in the flash of the display module. Any system write command that can be sent by itself can be grouped together with other system commands or write parameters into a flash batch file, with the exception of all read commands.

The flash batch file numbers specified in this byte are enumerated values (such as 0,1,2,3). Flash batch file 0 is a special auto-initialization batch file that runs automatically by the DLPC34x6 software immediately after system initialization is complete. The flash batch file 0 is typically not called using the *Write Execute Batch File* command (although the system allows it). This special flash batch file specifies the source to be used (such as splash screen or data port) once the system initializes.

Embedding flash batch file calls within a flash batch file is not allowed (for example, calling another batch file from within a batch file is not allowed). To execute two batch files back to back, use back to back execute batch file commands.

The system allows adding an execution delay between commands within a flash batch file, which is done using the Write Flash Batch File Delay (DBh) command.

The order of command execution for commands within a flash batch file is the same as if the commands are received over the I^2C port.

3.1.23 Write 3-D Reference (30h)

This command is used to provide a 3-D reference for the display module.

3.1.23.1 Write Parameters

Table 3-34 describes the write parameters.

Table 3-34. Write Parameters

Parameter Bytes	Description
Byte 1	Batch file number

MSB	Byte 1						LSB
b7	b6	b5	b4	b3	b2	b1	b0

Table 3-35. Write Execute Flash Batch File Register Field Descriptions

Bit	Type	Description
7-1	R	Reserved
0	W	3-D Reference 0h = Next Frame Left 1h = Next Frame Right

The 3-D Reference is used to specify whether a frame of data contains left eye data or right eye data. The 3-D reference is provided to the display as either a GPIO hardware signal or through sending this command. The selection is made using the Write 3-D Control command. When using this command as the reference, it is recommended that the command be sent every frame, or at the minimum, at the start of each eye pair. For example, the command can be sent before each left eye frame. At a minimum, it must be sent once at the start of 3-D operation. If the 3-D Reference is misaligned with the data, it can be corrected using this command or by using the *Polarity of 3-D Reference* parameter in the Write 3-D Control (20h) command.

When the Write 3-D Reference command is received, its parameter value will be applied to the image data following the next VSYNC or Start of Frame command.

When this command is received, software must set up the internal 3-D reference generator. If the command is sent every frame, software will ensure that the output of the internal 3-D reference generator remains accurate.

3.1.24 Write Mirrors Lock Command (39h)

This command writes the Mirrors Lock command to lock/unlock the DMD interface for Optical Alignment.

3.1.24.1 Write Parameters

Table 3-36 describes the write parameters.

Table 3-36. Write Parameters

MSB	Byte 1						LSB
b7	b6	b5	b4	b3	b2	b1	b0

7-2	Reserved
1-0	Mirror Lock State Selection 0h = Reserved 1h = DMD Interface Lock 2h = DMD Interface Unlock 3h = DMD Interface Unlock, Delay 100ms, DMD Interface Lock

This command is only used in factory to prevent DMD damage.

3.1.25 Read Mirrors Lock Command (3Ah)

This command reads the status of the Mirrors Lock.

3.1.25.1 Read Parameters

This command has no read parameters.

3.1.25.2 Return Parameters

Table 3-37 describes the return parameters.

Table 3-37. Return Parameters

MSB	Byte 1						LSB
b7	b6	b5	b4	b3	b2	b1	b0

7-2	Reserved
1-0	Mirror Lock State Selection 0h = Reserved 1h = DMD Interface Lock 2h = DMD Interface Unlock 3h = DMD Interface Unlock, Delay 100ms, DMD Interface Lock

3.1.26 Write FPD Link Pixel Map Mode (4Bh)

This command is used to configure the FPD link display bit rate and Map mode.

Write Parameters

Table 3-38 describes the write parameters.

Table 3-38. Write Parameters

Parameter Bytes	Description
Byte 1	Reserved
Byte 2	Reserved
Byte 3	See below

MSB	Byte 3						LSB
b7	b6	b5	b4	b3	b2	b1	b0

Bit	Type	Description
7-4	R	Reserved
3-0	W	Pixel Map Mode 1h = Mode #1 2h = Mode #2 3h = Mode #3 4h = Mode #4 5h = Mode #5 6h = Mode #6 7h = Mode #7 8h = Mode #8

Input video data is encoded into the FPD data buses as indicated in the following tables.

Table 3-39. FPD LVDS Data Bus Encoding

	Mode 1	Mode 2	Mode 3	Mode 4	Mode 5	Mode 6
FPD Bus A - Data_A Channel						
FPD_A_DATA_A_6	Green_4	Green_2	Green_0	Green_4	Green_0	Green_2
FPD_A_DATA_A_5	Red_9	Red_7	Red_5	Red_9	Red_5	Red_7
FPD_A_DATA_A_4	Red_8	Red_6	Red_4	Red_8	Red_4	Red_6
FPD_A_DATA_A_3	Red_7	Red_5	Red_3	Red_7	Red_3	Red_5
FPD_A_DATA_A_2	Red_6	Red_4	Red_2	Red_6	Red_2	Red_4
FPD_A_DATA_A_1	Red_5	Red_3	Red_1	Red_5	Red_1	Red_3
FPD_A_DATA_A_0	Red_4	Red_2	Red_0	Red_4	Red_0	Red_2
FPD Bus A - Data_B Channel						
FPD_A_DATA_B_6	Blue_5	Blue_3	Blue_1	Blue_5	Blue_1	Blue_3
FPD_A_DATA_B_5	Blue_4	Blue_2	Blue_0	Blue_4	Blue_0	Blue_2
FPD_A_DATA_B_4	Green_9	Green_7	Green_5	Green_9	Green_5	Green_7
FPD_A_DATA_B_3	Green_8	Green_6	Green_4	Green_8	Green_4	Green_6
FPD_A_DATA_B_2	Green_7	Green_5	Green_3	Green_7	Green_3	Green_5
FPD_A_DATA_B_1	Green_6	Green_4	Green_2	Green_6	Green_2	Green_4
FPD_A_DATA_B_0	Green_5	Green_3	Green_1	Green_5	Green_1	Green_3

Table 3-39. FPD LVDS Data Bus Encoding (continued)

	Mode 1	Mode 2	Mode 3	Mode 4	Mode 5	Mode 6
FPD Bus A - Data_C Channel						
FPD_A_DATA_C_6	DEN	DEN	DEN	DEN	DEN	DEN
FPD_A_DATA_C_5	VSYNC	VSYNC	VSYNC	VSYNC	VSYNC	VSYNC
FPD_A_DATA_C_4	HSYNC	HSYNC	HSYNC	HSYNC	HSYNC	HSYNC
FPD_A_DATA_C_3	Blue_9	Blue_7	Blue_5	Blue_9	Blue_5	Blue_7
FPD_A_DATA_C_2	Blue_8	Blue_6	Blue_4	Blue_8	Blue_4	Blue_6
FPD_A_DATA_C_1	Blue_7	Blue_5	Blue_3	Blue_7	Blue_3	Blue_5
FPD_A_DATA_C_0	Blue_6	Blue_4	Blue_2	Blue_6	Blue_2	Blue_4
FPD Bus A - Data_D Channel						
FPD_A_DATA_D_6	Map to Field	Map to Field	Map to Field	Map to Field	Map to Field	Map to Field
FPD_A_DATA_D_5	Blue_3	Blue_9	Blue_7	not used	Blue_7	Blue_1
FPD_A_DATA_D_4	Blue_2	Blue_8	Blue_6	not used	Blue_6	Blue_0
FPD_A_DATA_D_3	Green_3	Green_9	Green_7	not used	Green_7	Green_1
FPD_A_DATA_D_2	Green_2	Green_8	Green_6	not used	Green_6	Green_0
FPD_A_DATA_D_1	Red_3	Red_9	Red_7	not used	Red_7	Red_1
FPD_A_DATA_D_0	Red_2	Red_8	Red_6	not used	Red_6	Red_0
FPD Bus A - Data_E Channel						
FPD_A_DATA_E_6	Map to Field	Map to Field	Map to Field	Map to Field	not used	not used
FPD_A_DATA_E_5	Blue_1	Blue_1	Blue_9	not used	not used	not used
FPD_A_DATA_E_4	Blue_0	Blue_0	Blue_8	not used	not used	not used
FPD_A_DATA_E_3	Green_1	Green_1	Green_9	not used	not used	not used
FPD_A_DATA_E_2	Green_0	Green_0	Green_8	not used	not used	not used
FPD_A_DATA_E_1	Red_1	Red_1	Red_9	not used	not used	not used
FPD_A_DATA_E_0	Red_0	Red_0	Red_8	not used	not used	not used
FPD Bus B						
FPD Bus B is unused in Modes 1 through 6						

Mode 7 (AM8280 Mode 9-1)				
FPD Bus A - Data_A Channel			**FPD Bus B - Data_A Channel**	
FPD_A_DATA_A_6	Odd_Green_0		FPD_B_DATA_A_6	Even_Green_0
FPD_A_DATA_A_5	Odd_Red_5		FPD_B_DATA_A_5	Even_Red_5
FPD_A_DATA_A_4	Odd_Red_4		FPD_B_DATA_A_4	Even_Red_4
FPD_A_DATA_A_3	Odd_Red_3		FPD_B_DATA_A_3	Even_Red_3
FPD_A_DATA_A_2	Odd_Red_2		FPD_B_DATA_A_2	Even_Red_2
FPD_A_DATA_A_1	Odd_Red_1		FPD_B_DATA_A_1	Even_Red_1
FPD_A_DATA_A_0	Odd_Red_0		FPD_B_DATA_A_0	Even_Red_0
FPD Bus A - Data_B Channel			**FPD Bus B - Data_B Channel**	
FPD_A_DATA_B_6	Odd_Blue_1		FPD_B_DATA_B_6	Even_Blue_1
FPD_A_DATA_B_5	Odd_Blue_0		FPD_B_DATA_B_5	Even_Blue_0
FPD_A_DATA_B_4	Odd_Green_5		FPD_B_DATA_B_4	Even_Green_5
FPD_A_DATA_B_3	Odd_Green_4		FPD_B_DATA_B_3	Even_Green_4
FPD_A_DATA_B_2	Odd_Green_3		FPD_B_DATA_B_2	Even_Green_3
FPD_A_DATA_B_1	Odd_Green_2		FPD_B_DATA_B_1	Even_Green_2
FPD_A_DATA_B_0	Odd_Green_1		FPD_B_DATA_B_0	Even_Green_1

Mode 7 (AM8280 Mode 9-1)			
FPD Bus A - Data_C Channel		**FPD Bus B - Data_C Channel**	
FPD_A_DATA_C_6	DEN	FPD_B_DATA_C_6	DEN
FPD_A_DATA_C_5	VSYNC	FPD_B_DATA_C_5	VSYNC
FPD_A_DATA_C_4	HSYNC	FPD_B_DATA_C_4	HSYNC
FPD_A_DATA_C_3	Odd_Blue_5	FPD_B_DATA_C_3	Even_Blue_5
FPD_A_DATA_C_2	Odd_Blue_4	FPD_B_DATA_C_2	Even_Blue_4
FPD_A_DATA_C_1	Odd_Blue_3	FPD_B_DATA_C_1	Even_Blue_3
FPD_A_DATA_C_0	Odd_Blue_2	FPD_B_DATA_C_0	Even_Blue_2
FPD Bus A - Data_D Channel		**FPD Bus B - Data_D Channel**	
FPD_A_DATA_D_6	Map to Field	FPD_B_DATA_D_6	Map to Field
FPD_A_DATA_D_5	Odd_Blue_7	FPD_B_DATA_D_5	Even_Blue_7
FPD_A_DATA_D_4	Odd_Blue_6	FPD_B_DATA_D_4	Even_Blue_6
FPD_A_DATA_D_3	Odd_Green_7	FPD_B_DATA_D_3	Even_Green_7
FPD_A_DATA_D_2	Odd_Green_6	FPD_B_DATA_D_2	Even_Green_6
FPD_A_DATA_D_1	Odd_Red_7	FPD_B_DATA_D_1	Even_Red_7
FPD_A_DATA_D_0	Odd_Red_6	FPD_B_DATA_D_0	Even_Red_6
FPD Bus A - Data_E Channel		**FPD Bus B - Data_E Channel**	
FPD_A_DATA_E_6	not used	FPD_B_DATA_E_6	not used
FPD_A_DATA_E_5	not used	FPD_B_DATA_E_5	not used
FPD_A_DATA_E_4	not used	FPD_B_DATA_E_4	not used
FPD_A_DATA_E_3	not used	FPD_B_DATA_E_3	not used
FPD_A_DATA_E_2	not used	FPD_B_DATA_E_2	not used
FPD_A_DATA_E_1	not used	FPD_B_DATA_E_1	not used
FPD_A_DATA_E_0	not used	FPD_B_DATA_E_0	not used

Mode 8 (AM8280 Mode 9-2)			
FPD Bus A - Data_A Channel		**FPD Bus B - Data_A Channel**	
FPD_A_DATA_A_6	Odd_Green_2	FPD_B_DATA_A_6	Even_Green_2
FPD_A_DATA_A_5	Odd_Red_7	FPD_B_DATA_A_5	Even_Red_7
FPD_A_DATA_A_4	Odd_Red_6	FPD_B_DATA_A_4	Even_Red_6
FPD_A_DATA_A_3	Odd_Red_5	FPD_B_DATA_A_3	Even_Red_5
FPD_A_DATA_A_2	Odd_Red_4	FPD_B_DATA_A_2	Even_Red_4
FPD_A_DATA_A_1	Odd_Red_3	FPD_B_DATA_A_1	Even_Red_3
FPD_A_DATA_A_0	Odd_Red_2	FPD_B_DATA_A_0	Even_Red_2
FPD Bus A - Data_B Channel		**FPD Bus B - Data_B Channel**	
FPD_A_DATA_B_6	Odd_Blue_3	FPD_B_DATA_B_6	Even_Blue_3
FPD_A_DATA_B_5	Odd_Blue_2	FPD_B_DATA_B_5	Even_Blue_2
FPD_A_DATA_B_4	Odd_Green_7	FPD_B_DATA_B_4	Even_Green_7
FPD_A_DATA_B_3	Odd_Green_6	FPD_B_DATA_B_3	Even_Green_6
FPD_A_DATA_B_2	Odd_Green_5	FPD_B_DATA_B_2	Even_Green_5
FPD_A_DATA_B_1	Odd_Green_4	FPD_B_DATA_B_1	Even_Green_4
FPD_A_DATA_B_0	Odd_Green_3	FPD_B_DATA_B_0	Even_Green_3

Mode 8 (AM8280 Mode 9-2)				
FPD Bus A - Data_C Channel			**FPD Bus B - Data_C Channel**	
FPD_A_DATA_C_6	DEN		FPD_B_DATA_C_6	DEN
FPD_A_DATA_C_5	VSYNC		FPD_B_DATA_C_5	VSYNC
FPD_A_DATA_C_4	HSYNC		FPD_B_DATA_C_4	HSYNC
FPD_A_DATA_C_3	Odd_Blue_7		FPD_B_DATA_C_3	Even_Blue_7
FPD_A_DATA_C_2	Odd_Blue_6		FPD_B_DATA_C_2	Even_Blue_6
FPD_A_DATA_C_1	Odd_Blue_5		FPD_B_DATA_C_1	Even_Blue_5
FPD_A_DATA_C_0	Odd_Blue_4		FPD_B_DATA_C_0	Even_Blue_4
FPD Bus A - Data_D Channel			**FPD Bus B - Data_D Channel**	
FPD_A_DATA_D_6	Map to Field		FPD_B_DATA_D_6	Map to Field
FPD_A_DATA_D_5	Odd_Blue_1		FPD_B_DATA_D_5	Even_Blue_1
FPD_A_DATA_D_4	Odd_Blue_0		FPD_B_DATA_D_4	Even_Blue_0
FPD_A_DATA_D_3	Odd_Green_1		FPD_B_DATA_D_3	Even_Green_1
FPD_A_DATA_D_2	Odd_Green_0		FPD_B_DATA_D_2	Even_Green_0
FPD_A_DATA_D_1	Odd_Red_1		FPD_B_DATA_D_1	Even_Red_1
FPD_A_DATA_D_0	Odd_Red_0		FPD_B_DATA_D_0	Even_Red_0
FPD Bus A - Data_E Channel			**FPD Bus B - Data_E Channel**	
FPD_A_DATA_E_6	not used		FPD_B_DATA_E_6	not used
FPD_A_DATA_E_5	not used		FPD_B_DATA_E_5	not used
FPD_A_DATA_E_4	not used		FPD_B_DATA_E_4	not used
FPD_A_DATA_E_3	not used		FPD_B_DATA_E_3	not used
FPD_A_DATA_E_2	not used		FPD_B_DATA_E_2	not used
FPD_A_DATA_E_1	not used		FPD_B_DATA_E_1	not used
FPD_A_DATA_E_0	not used		FPD_B_DATA_E_0	not used

3.1.27 Read FPD Link Pixel Map Mode (4Ch)

This command is used to read the FPD link display Pixel Map mode.

3.1.27.1 Read Parameters

This command has no read parameters.

Return Parameters

Table 3-40 describes the return parameters.

Table 3-40. Return Parameters

Parameter Bytes	Description
Byte 1	Reserved
Byte 2	Reserved
Byte 3	See below

MSB	Byte 3						LSB
b7	b6	b5	b4	b3	b2	b1	b0

Bit	Type	Description
7-4	R	Reserved

Bit	Type	Description
3-0	R	Pixel Map Mode 1h = Mode #1 2h = Mode #2 3h = Mode #3 4h = Mode #4 5h = Mode #5 6h = Mode #6 7h = Mode #7 8h = Mode #8

3.1.28 Write FPGA Input Video Chroma Processing Select (4Dh)

This command is used to specify Chroma processing select for the YUV422 source input to the FPGA.

Write Parameters

Table 3-41 describes the write parameters.

Table 3-41. Write Parameters

MSB	Byte 2						LSB
b7	b6	b5	b4	b3	b2	b1	b0

Bit	Type	Description
7-4	R	Reserved
3	W	Chroma Channel Swap 0h = CbCr 1h = CrCb
2-0	R	Reserved

3.1.29 Read FPGA Input Video Chroma Processing Select (4Eh)

This command is used to read the Chroma processing select for the YUV422 source input to the FPGA.

3.1.29.1 Read Parameters

This command has no read parameters.

Return Parameters

Table 3-42 describes the return parameters.

Table 3-42. Return Parameters

MSB	Byte 2						LSB
b7	b6	b5	b4	b3	b2	b1	b0

Bit	Type	Description
7-4	R	Reserved
3	R	Chroma Channel Swap 0h = CbCr 1h = CrCb
2-0	R	Reserved

3.2 Illumination Control Commands

3.2.1 Write LED Output Control Method (50h)

This command specifies the method for controlling the LED outputs for the display module.

3.2.1.1 Write Parameters

Table 3-43 describes the write parameters.

Table 3-43. Write Parameters

MSB	Byte 1						LSB
b7	b6	b5	b4	b3	b2	b1	b0

b(7:2)	Reserved
b(1:0)	LED control method: • 00: Manual RGB LED currents (disables CAIC algorithm) • 01: CAIC (automatic) RGB LED power (enables CAIC algorithm) • 10: Reserved • 11: Reserved

This command selects the method used to control the output of the red, green, and blue LEDs. Based on the method chosen, a specific set of commands are available for controlling the LED outputs. These are shown in Table 3-44.

The manual RGB LED currents method provides for manual control of the LED currents, and disables the CAIC algorithm. The CAIC (automatic) RGB LED current control method provides automatic control of the LED currents using the CAIC algorithm.

Table 3-44. Available Commands Based on LED Control Method

LED Control Method	Available Commands
Manual RGB LED current control	Write RGB LED Enable (52h) Read RGB LED Enable (53h) Write RGB LED Current (54h) Read RGB LED Current (55h) Write RGB LED Max Current (5Ch) Read RGB LED Max Current (5Dh))
CAIC (automatic) RGB LED current control	Write RGB LED Enable (52h) Read RGB LED Enable (53h) Read CAIC LED Max Available Power (57h) Read CAIC RGB LED Current (5Fh)

3.2.2 Read LED Output Control Method (51h)

This command reads the selected LED output control method for the display module.

3.2.2.1 Read Parameters

This command has no read parameters.

3.2.2.2 Return Parameters

Table 3-45 describes the return parameters.

Table 3-45. Return Parameters

MSB	Byte 1						LSB
b7	b6	b5	b4	b3	b2	b1	b0

b(7:2)	Reserved

b(1:0)	LED control method: • 00: Manual RGB LED currents (CAIC algorithm disabled) • 01: CAIC (automatic) RGB LED current control (CAIC algorithm enabled) • 10: Reserved • 11: Reserved

3.2.3 Write RGB LED Enable (52h)

This command enables the LEDs for the display module.

3.2.3.1 Write Parameters

Table 3-46 describes the write parameters.

Table 3-46. Write Parameters

MSB	Byte 1						LSB
b7	b6	b5	b4	b3	b2	b1	b0

b(7:3)	Reserved
b(2)	Blue LED enable: • 0: Blue LED disabled • 1: Blue LED enabled
b(1)	Green LED enable: • 0: Green LED disabled • 1: Green LED enabled
b(0)	Red LED enable: • 0: Red LED disabled • 1: Red LED enabled

3.2.4 Read RGB LED Enable (53h)

This command reads the state of the LED enables for the display module.

3.2.4.1 Read Parameters

This command has no read parameters.

3.2.4.2 Return Parameters

Table 3-47 describes the return parameters.

Table 3-47. Return Parameters

MSB	Byte 1						LSB
b7	b6	b5	b4	b3	b2	b1	b0

b(7:3)	Reserved
b(2)	Blue LED enable: • 0: Blue LED disabled • 1: Blue LED enabled
b(1)	Green LED enable: • 0: Green LED disabled • 1: Green LED enabled
b(0)	Red LED enable: • 0: Red LED disabled • 1: Red LED enabled

3.2.5 Write RGB LED Current (54h)

This command sets the current for the red, green, and blue LEDs of the display module.

3.2.5.1 Write Parameters

Table 3-48 describes the write parameters.

Table 3-48. Write Parameters

Parameter Bytes	Description
Byte 1	Red LED current parameter (LSByte)
Byte 2	Red LED current parameter (MSByte)
Byte 3	Green LED current parameter (LSByte)
Byte 4	Green LED current parameter (MSByte)
Byte 5	Blue LED current parameter (LSByte)
Byte 6	Blue LED current parameter (MSByte)

When an all-white image is displayed, this command allows the system white point to be adjusted while establishing the total LED power whether the CAIC algorithm is enabled or disabled.

The parameters specified by this command have a resolution of 10 bits, and are defined by the appropriate DLPA200x specification.

When the CAIC algorithm is disabled, this command directly sets the LED currents (the R, G, and B values provided are sent directly to the DLPA200x device) regardless of the image being displayed.

When the CAIC algorithm is enabled:

- This command directly sets the LED currents when an all-white image is displayed. If the image is changed from an all-white image, depending on the image the CAIC algorithm may alter one or more of the LED currents from those specified by this command, and the total LED power may drop. The *Read CAIC RGB LED Current* command can read the actual LED currents for the image currently displayed.
- In the case of an all-white image, the values read by the *Read CAIC RGB LED Current* command closely match, but may not exactly match, those requested using the *Write RGB LED Current* command. For an all-white image, the *Read CAIC RGB LED Current* command gives currents within +/-4 DLPA200x device current steps for each LED color relative to those requested by the *Write RGB LED Current* command.
- When the *Write RGB LED Current* command changes the LED currents, the LED current for any color must not be changed by more than +/-25% from the nominal current used for that color when the CAIC LUTs were created. No LED current can be set to a current value beyond the maximum value supported in the CAIC intensity-to-current LUT for the corresponding color.
- The maximum total LED power for any displayed image occurs for an all-white image, since the CAIC algorithm requests the CAIC LED maximum available power. The maximum available LED power for the CAIC is controlled by the *Write RGB LED Current* command, as this command controls currents for an all-white image. After the currents are adjusted, the *Read CAIC LED Max Available Power* command is used to see the maximum power in watts derived from the CAIC.

3.2.6 Read RGB LED Current (55h)

This command reads the state of the current for the red, green, and blue LEDs of the display module.

3.2.6.1 Read Parameters

This command has no read parameters.

3.2.6.2 Return Parameters

Table 3-49 describes the return parameters.

Table 3-49. Return Parameters

Parameter Bytes	Description
Byte 1	Red LED current parameter (LSByte)
Byte 2	Red LED current parameter (MSByte)

Table 3-49. Return Parameters (continued)

Parameter Bytes	Description
Byte 3	Green LED current parameter (LSByte)
Byte 4	Green LED current parameter (MSByte)
Byte 5	Blue LED current parameter (LSByte)
Byte 6	Blue LED current parameter (MSByte)

See *Write RGB LED Current (54h)* for a detailed description of the return parameters.

Unused most significant bits are set to 0.

3.2.7 Read CAIC LED Max Available Power (57h)

This command reads the specified maximum LED power allowed for the display module.

3.2.7.1 Read Parameters

This command has no read parameters.

3.2.7.2 Return Parameters

Table 3-50 describes the return parameters.

Table 3-50. Return Parameters

Parameter Bytes	Description
Byte 1	Maximum LED power (LSByte)
Byte 2	Maximum LED power (MSByte)

The value is specified in watts × 100 (for example: 25.75 W = A0Fh). This command is only applicable when CAIC is enabled.

The CAIC maximum available LED power pertains if an all-white image is displayed where LED currents are set by the *Write RGB LED Current* command. The calculation is:

R duty cycle × R LED current × R LED voltage + G duty cycle × G LED current × G LED voltage + B duty cycle × B LED current × B LED voltage

For example: (.30 × .49 A × 2.0 V) + (.50 × .39 A × 3.1 V) + (.20 × .39 A × 3.1 V) = (.30 × .980 W) + (.50 × 1.209 W) + (.20 × 1.209 W) = 1.140 W

3.2.8 Write RGB LED Max Current (5Ch)

This command specifies the maximum LED current allowed for each LED in the display module.

3.2.8.1 Write Parameters

Table 3-51 describes the write parameters.

Table 3-51. Write Parameters

Parameter Bytes	Description
Byte 1	Maximum red LED current (LSByte)
Byte 2	Maximum red LED current (MSByte)
Byte 3	Maximum green LED current (LSByte)
Byte 4	Maximum green LED current (MSByte)
Byte 5	Maximum blue LED current (LSByte)
Byte 6	Maximum blue LED current (MSByte)

This command sets the maximum LED currents that can be used when CAIC is enabled or disabled. When CAIC is enabled, the maximum LED currents may be further limited by the CAIC LUTs stored in the flash. The parameter specified by this commands has a resolution of 10 bits. The unused most significant bits should be set to 0.

3.2.9 Read RGB LED Max Current (5Dh)

This command reads the specified maximum LED current allowed for each LED in the display module.

3.2.9.1 Read Parameters

This command has no read parameters.

3.2.9.2 Return Parameters

Table 3-52 describes the return parameters.

Table 3-52. Return Parameters

Parameter Bytes	Description
Byte 1	Maximum red LED current (LSByte)
Byte 2	Maximum red LED current (MSByte)
Byte 3	Maximum green LED current (LSByte)
Byte 4	Maximum green LED current (MSByte)
Byte 5	Maximum blue LED current (LSByte)
Byte 6	Maximum blue LED current (MSByte)

See the *Write RGB LED Current (54h)* for a detailed description of the return parameters.

Unused most significant bits are set to 0.

3.2.10 Read CAIC RGB LED Current (5Fh)

This command reads the state of the current for the red, green, and blue LEDs of the display module.

3.2.10.1 Read Parameters

This command has no read parameters.

3.2.10.2 Return Parameters

Table 3-53 describes the return parameters.

Table 3-53. Return Parameters

Parameter Bytes	Description
Byte 1	Red LED current parameter (LSByte)
Byte 2	Red LED current parameter (MSByte)
Byte 3	Green LED current parameter (LSByte)
Byte 4	Green LED current parameter (MSByte)
Byte 5	Blue LED current parameter (LSByte)
Byte 6	Blue LED current parameter (MSByte)

The parameters returned by this command have a resolution of 10 bits, and are defined by the appropriate DLPA200x specification.

When the CAIC algorithm is enabled using the *LED Output Control Method* command:

- The *Write RGB LED Current* command directly sets the LED currents when an all-white image is displayed. If the image changes from an all-white image, depending on the image, the CAIC algorithm may alter one or more of the LED currents from those specified by the *Write RGB LED Current* command, and the total LED power may drop. The actual LED currents for the image currently displayed are read using the *Read CAIC RGB LED Current* command.
- In the case of an all-white image, the values returned by this command closely match, but may not exactly match, those specified using the *Write RGB LED Current* command. For an all-white image, this command provides values within +/- 4 DLPA200x device current steps for each LED color relative to those specified with the *Write RGB LED Current* command.

Use of this command is only appropriate when the LED output control method is set to CAIC (automatic) RGB LED current control.

Unused most significant bits are set to 0.

3.2.11 Write XPR FPGA Input Image Size (60h)

This command is used to specify the active data size of the external input image that goes to the XPR FPGA. Supported resolutions are 1280×720, 1366×768, and 1920×1080.

Write Parameters

Table 3-54 describes the write parameters.

Table 3-54. Write Parameters

Parameter Bytes	Description
Byte 1	Pixels per line (LSByte)
Byte 2	Pixels per line (MSByte)
Byte 3	Lines per frame (LSByte)
Byte 4	Lines per frame (MSByte)

3.2.12 Read XPR FPGA Input Image Size (61h)

This command is used to read specified data size of the external input image to the display module.

3.2.12.1 Read Parameters

This command has no read parameters.

3.2.12.2 Return Parameters

Table 3-55 describes the return parameters.

Table 3-55. Return Parameters

Parameter Bytes	Description
Byte 1	Pixels per line (LSByte)
Byte 2	Pixels per line (MSByte)
Byte 3	Lines per frame (LSByte)
Byte 4	Lines per frame (MSByte)

3.2.13 Read XPR FPGA Version (64h)

This command is used to read the XPR FPGA software and bitstream version.

3.2.13.1 Read Parameters

This command has no read parameters.

Return Parameters

Table 3-56 describes the return parameters.

Table 3-56. Return Parameters

Parameter Bytes	Description
Byte 4:1	• b(31:28) = FPGA Firmware Version – Build Level • b(27:20) = FPGA Firmware Version – Minor • b(19:12) = FPGA Firmware Version – Major • b(11:0) = FPGA Firmware Version – Build Number
Byte 5	b(7:0) = FPGA ECO Revision
Byte 6	• b(7:0) = FPGA ARM Software Version - Major

3.2.14 Write XPR FPGA Test Pattern Select (67h)

This command is used to specify an internal test pattern from XPR FPGA for display on the display module.

Write Parameters

Table 3-57 describes the write parameters.

Table 3-57. Write Parameters

Parameter Bytes	Description
Byte 1	TPG pattern select (LSByte)
Byte 2	TPG pattern options (MSByte)

MSB	Byte 1 and 2						LSB
b7	b6	b5	b4	b3	b2	b1	b0

Bit	Type	Description
7	W	Test Pattern Boarder 0h = Disabled (default) 1h = Enabled
6-4	W	Color 0h = Black 1h = Blue 2h = Red 3h = Magenta 4h = Green 5h = Cyan 6h = Yellow 7h = White
3-0	W	Pattern Select 0h = Solid Field 1h = Grids 2h = Horizontal Ramp 4h = Checkerboard 5h = Horizontal Lines 6h = Vertical Lines 7h = Diagonal Lines 8h = Actuator Calibration Pattern 9h = 3D Test Pattern Ah = Color Bars Bh = Frame & Cross Ch - Fh = Reserved

Byte 2: Varies depending on configuration selected. It is ignored for Solid Field, Grids, Horizontal, Vertical and Diagonal lines, 3D test patterns and Color Bars.

For Horizontal and Vertical Ramps, Byte 2 represents the pixel level intensity at the brightest part of the ramp ranging from 0-255.

For Checkerboards, Byte 2 specifies the size of each checker in 4 pixel resolution so a value of 10 would generate 40 pixel checkers.

For Actuator Calibration test patterns, Byte 2 specifies the sub-frames to be displayed:

- Byte 2 (7:0) = 0: Actuator Calibration Pattern - Sub-Frame 0 and 1 Only (HD only)
- Byte 2 (7:0) = 3: Actuator Calibration Pattern - Sub-Frames 0, 1, 2, 3 (Full HD only)

For Frame & Cross, Byte 2 is divided into two nibbles. Each nibble is a pixel position from the upper left corner of the image with a resolution of (Pixel Count / 16). So 720p has 80 pixel increments horizontally and 45 pixel increments vertically. 1080p has 120 pixel increments horizontally and 68 pixel increments vertically.

- MS-Nibble (7:4): Horizontal position
- LS-Nibble (3:0): Vertical position

3.2.15 Read XPR FPGA Test Pattern Select (68h)

This command is used to an internal test pattern from XPR FPGA.

3.2.15.1 Read Parameters

This command has no read parameters.

Return Parameters

Table 3-58 describes the return parameters.

Table 3-58. Return Parameters

Parameter Bytes	Description
Byte 1	TPG pattern select (LSByte)
Byte 2	TPG pattern options (MSByte)

MSB	Byte 1 and 2						LSB
b7	b6	b5	b4	b3	b2	b1	b0

Bit	Type	Description
7	R	Test Pattern Boarder 0h = Disabled (default) 1h = Enabled
6-4	R	Color 0h = Black 1h = Blue 2h = Red 3h = Magenta 4h = Green 5h = Cyan 6h = Yellow 7h = White
3-0	R	Pattern Select 0h = Solid Field 1h = Grids 2h = Horizontal Ramp 4h = Checkerboard 5h = Horizontal Lines 6h = Vertical Lines 7h = Diagonal Lines 8h = Actuator Calibration Pattern 9h = 3D Test Pattern Ah = Color Bars Bh = Frame & Cross Ch - Fh = Reserved

Byte 2: Varies depending on configuration selected. It is ignored for Solid Field, Grids, Horizontal, Vertical and Diagonal lines, 3D test patterns and Color Bars.

For Horizontal and Vertical Ramps, Byte 2 represents the pixel level intensity at the brightest part of the ramp ranging from 0-255.

For Checkerboards, Byte 2 specifies the size of each checker in 4 pixel resolution so a value of 10 would generate 40 pixel checkers.

For Actuator Calibration test patterns, Byte 2 specifies the sub-frame(s) to be displayed:

- Byte 2 (7:0) = 0: Actuator Calibration Pattern - Sub-Frame 0 and 1 Only (HD only)
- Byte 2 (7:0) = 3: Actuator Calibration Pattern - Sub-Frames 0, 1, 2, 3 (Full HD only)

For Frame & Cross, Byte 2 is divided into two nibbles. Each nibble is a pixel position from the upper left corner of the image with a resolution of (Pixel Count / 16). So 720p has 80 pixel increments horizontally and 45 pixel increments vertically. 1080p has 120 pixel increments horizontally and 68 pixel increments vertically.

- MS-Nibble (7:4): Horizontal position
- LS-Nibble (3:0): Vertical position

3.2.16 Write XPR FPGA Parallel Video Control (6Bh)

This command is used to configure polarity of syncs and sampling edge of the pixel clock in XPR FPGA.

Write Parameters

Table 3-59 describes the write parameters.

Table 3-59. Write Parameters

MSB	Byte 1						LSB
b7	b6	b5	b4	b3	b2	b1	b0

Bit	Type	Description
7-4	R	Reserved
3	W	VSync Polarity 0h = Active Low 1h = Active High
2	W	HSync Polarity 0h = Active Low 1h = Active High
1	W	IValid Polarity 0h = Active Low 1h = Active High
0	W	Pixel Clock Sampling Edge 0h = Falling Edge 1h = Rising Edge

3.2.17 Read XPR FPGA Parallel Video Control (6Ch)

This command is used to read XPR FPGA video format.

3.2.17.1 Read Parameters

This command has no read parameters.

Return Parameters

Table 3-60 describes the return parameters.

Table 3-60. Return Parameters

MSB	Byte 1						LSB
b7	b6	b5	b4	b3	b2	b1	b0

Bit	Type	Description
7-4	R	Reserved
3	R	VSync Polarity 0h = Active Low 1h = Active High
2	R	HSync Polarity 0h = Active Low 1h = Active High
1	R	IValid Polarity 0h = Active Low 1h = Active High
0	R	Pixel Clock Sampling Edge 0h = Falling Edge 1h = Rising Edge

3.2.18 Write XPR FPGA Video Format Select (6Dh)

This command is used to specify XPR FPGA video format.

Write Parameters

Table 3-61 describes the write parameters.

Table 3-61. Write Parameters

MSB	Byte 1						LSB
b7	b6	b5	b4	b3	b2	b1	b0

Bit	Type	Description
7:3	R	Reserved
2:0	W	Input source format • 0h = RGB888 • 1h = RGB565 • 2h = RGB666 • 3h = YCbCr422 • 4h = YCbCr444 • 5h = YCbCr565 • 6h = YCbCr666

When adjusting the XPR FPGA Video Format selection, the parallel video data input must be properly aligned with the 24-bit bus of the FPGA. The appropriate data encoding format is provided in Figure 3-3.

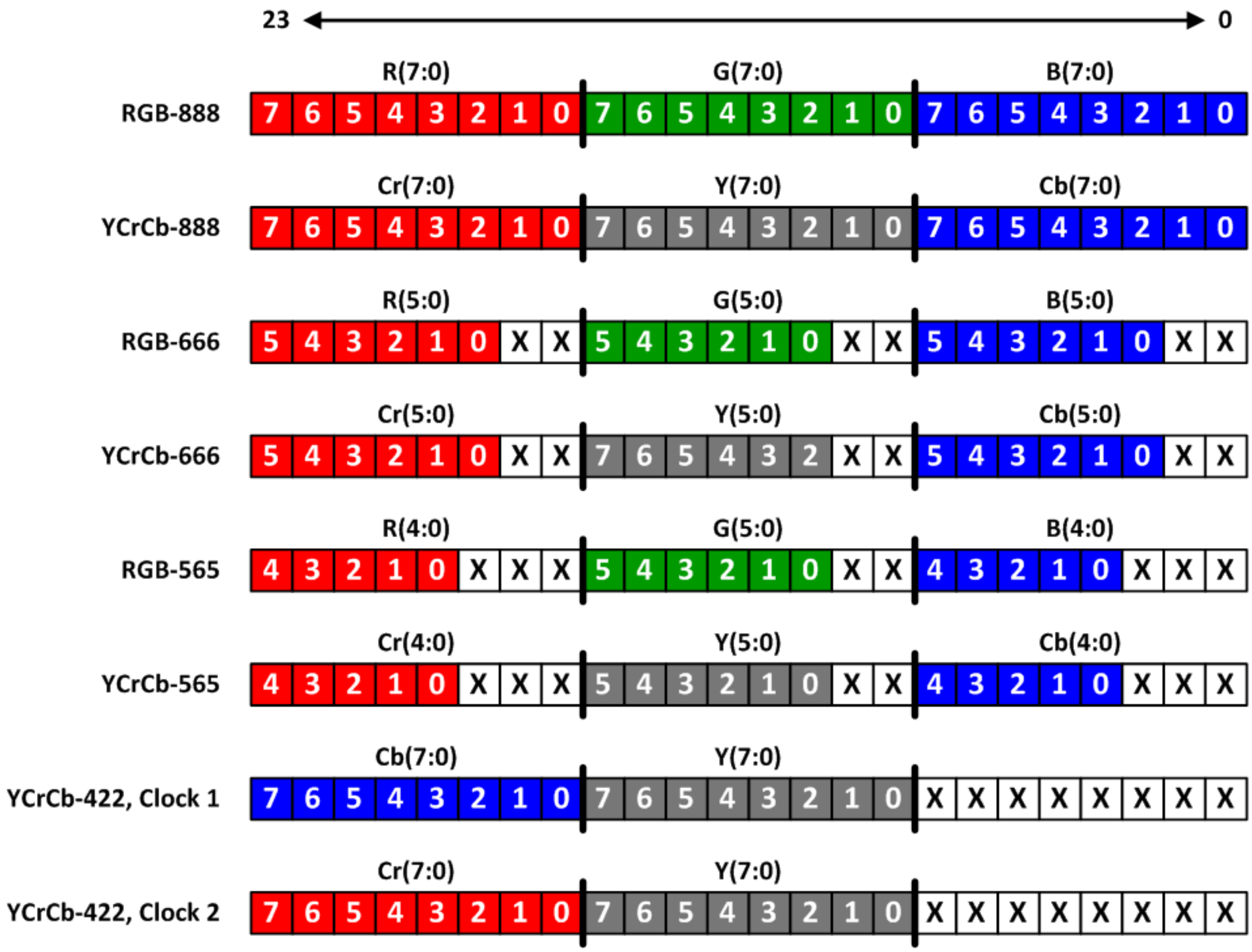


Figure 3-3. Parallel Data Bus (23:0) Encoding Options

3.2.19 Read XPR FPGA Video Format Select (6Eh)

This command is used to read XPR FPGA video format.

3.2.19.1 Read Parameters

This command has no read parameters.

Return Parameters

Table 3-62 describes the return parameters.

Table 3-62. Return Parameters

MSB	Byte 1						LSB
b7	b6	b5	b4	b3	b2	b1	b0

Bit	Type	Description
7:3	R	Reserved

Bit	Type	Description
2:0	W	Input source format • 0h = RGB888 • 1h = RGB565 • 2h = RGB666 • 3h = YCbCr422 • 4h = YCbCr444 • 5h = YCbCr565 • 6h = YCbCr666

3.2.20 Read XPR FPGA Status (6Fh)

This command is used to read XPR FPGA status.

3.2.20.1 Read Parameters

This command has no read parameters.

Return Parameters

Table 3-63 describes the return parameters.

Table 3-63. Return Parameters

MSB	Byte 1						LSB
b7	b6	b5	b4	b3	b2	b1	b0

Bit	Type	Description
7-2	R	Reserved
1	R	Display Mode 0h = Non-XPR Mode 1h = XPR Mode
0	R	FPGA Keying Status 0h = Failed 1h = Passed

3.2.21 Write Actuator Latency (70h)

This command is used to specify the Actuator Latency. This command is required for Actuator calibration.

The reset value is the latency value in the sequence header.

3.2.21.1 Write Parameters

Table 3-64 describes the write parameters.

Table 3-64. Write Parameters

Parameter Bytes	Description
Byte 1	Latency (LSByte)
Byte 2	Latency
Byte 3	Latency (MSByte)
Byte 4	See below

Note

Valid latency input values range from 000h to 3FFh, with a step size of 133.333 ns. This yields a minimum latency of 0 ns and a maximum latency of 34952312.619 ns.

MSB	Byte 4						LSB
b7	b6	b5	b4	b3	b2	b1	b0

Bit	Type	Description
7-2	R	Reserved
1	W	Latency Auto Scaling Enable 0h = Auto scaling disabled -- No clock dropping scaling is applied 1h = Auto scaling enabled
0	W	Manual Latency Enable 0h = Manual Latency disabled – Latency value stored in the sequence header is used. 1h = Latency value provided in Bytes 1-3 is used.

3.2.22 Read Actuator Latency (71h)

This command is used to read the Actuator Latency. This command is required for Actuator calibration.

The reset value is the latency value in the sequence header.

3.2.22.1 Read Parameters

This command has no read parameters.

Return Parameters

Table 3-65 describes the return parameters.

Table 3-65. Return Parameters

Parameter Bytes	Description
Byte 1	Latency (LSByte)
Byte 2	Latency
Byte 3	Latency (MSByte)
Byte 4	See below

Bit	Type	Description
7-2	R	Reserved
1	W	Latency Auto Scaling Enable 0h = Auto scaling disabled -- No clock dropping scaling is applied 1h = Auto scaling enabled
0	W	Manual Latency Enable 0h = Manual Latency disabled – Latency value stored in the sequence header will be used. 1h = Latency value used provided in Byte 1-3.

3.2.23 Write Actuator Gain (72h)

This command is used to specify the Actuator Gain parameter.

Write Parameters

Table 3-66 describes the write parameters.

Table 3-66. Write Parameters

Parameter Bytes	Description
Byte 1	Actuator Gain

Note

Value is presented in fixed point format.

1 = 0.007813

Valid range (0 to 1.9921875)

3.2.24 Read Actuator Gain (73h)

This command is used to read the Actuator Gain parameter.

3.2.24.1 Read Parameters

This command has no read parameters.

Return Parameters

Table 3-67 describes the return parameters.

Table 3-67. Return Parameters

Parameter Bytes	Description
Byte 1	Actuator Gain

Note

Value is presented in fixed point format.

1 = 0.007813

Valid range (0 to 1.9921875)

3.2.25 Write Segment Length (74h)

This command is used to specify the Actuator Segment Length parameter.

Write Parameters

Table 3-68 describes the write parameters.

Table 3-68. Write Parameters

Parameter Bytes	Description
Byte 1	Segment Length (LSByte)
Byte 2	Segment Length (MSByte)

Note

Valid segment length is 2 to 65535.

3.2.26 Read Segment Length (75h)

This command is used to read the Actuator Segment Length parameter.

3.2.26.1 Read Parameters

This command has no read parameters.

3.2.26.2 Return Parameters

Table 3-69 describes the return parameters.

Table 3-69. Return Parameters

Parameter Bytes	Description
Byte 1	Segment Length (LSByte)

Table 3-69. Return Parameters (continued)

Parameter Bytes	Description
Byte 2	Segment Length (MSByte)

Note

Valid segment length is 2 to 65535.

3.2.27 Write Manual Actuator Sync Delay (76h)

This command is used to specify the Actuator Sync Delay parameter.

The reset value is pre-configured in the sequence header.

3.2.27.1 Write Parameters

Table 3-70 describes the write parameters.

Table 3-70. Write Parameters

Parameter Bytes	Description
Byte 1	Actuator Sync Delay (LSByte)
Byte 2	Actuator Sync Delay
Byte 3	Actuator Sync Delay (MSByte)
Byte 4	Manual / Auto Actuator Sync Delay enable

MSB	Byte 4						LSB
b7	b6	b5	b4	b3	b2	b1	b0

Table 3-71. Write Manual Actuator Sync Delay Register Field Descriptions

Bit	Type	Description
7-2	R	Reserved
1	W	Auto-scaling enable. Applicable only when manual Actuator Sync Delay override mode is enabled, b(0)=1. 0h = No scaling is performed. Actuator Sync delay is applied as defined in Byte 1-3 1h = Auto scaling is performed with frame rate change.
0	W	Manual Actuator Sync Delay override enable 0h = Actuator Sync Delay defined in Byte 1 to 3 is not applied only when this bit is disabled. Instead, the Actuator Sync Delay defined in the flash as part of the sequence data is applied. 1h = Actuator Sync Delay defined in Byte 1 to 3 is applied only when this bit is enabled.

Note

This command is executed in conjunction with Write Actuator Latency command. Latency corrections are always made to the Actuator delay before writing to the hardware register. In case Latency correction is not required, then Latency should be set to 0.

3.2.28 Read Manual Actuator Sync Delay (77h)

This command is used to read Manual Actuator Sync Delay parameter.

The reset value is pre-configured in the sequence header.

3.2.28.1 Read Parameters

This command has no read parameters.

3.2.28.2 Return Parameters

Table 3-72 describes the return parameters.

Table 3-72. Return Parameters

Parameter Bytes	Description
Byte 1	Actuator Sync Delay (LSByte)
Byte 2	Actuator Sync Delay
Byte 3	Actuator Sync Delay (MSByte)
Byte 4	Manual / Auto Actuator Sync Delay enable

MSB	Byte 4						LSB
b7	b6	b5	b4	b3	b2	b1	b0

Bit	Type	Description
7-2	R	Reserved
1	R	Auto-scaling enable. Applicable only when manual Actuator Sync Delay override mode is enabled, b(0)=1. 0h = No scaling is performed. Actuator Sync delay is applied as defined in Byte 1-3 1h = Auto scaling is performed with frame rate change.
0	R	Manual Actuator Sync Delay override enable 0h = Actuator Sync Delay defined in Byte 1 to 3 is not applied only when this bit is disabled. Instead, the Actuator Sync Delay defined in the flash as part of the sequence data is applied. 1h = Actuator Sync Delay defined in Byte 1 to 3 is applied only when this bit is enabled.

Note

This command is executed in conjunction with Write Actuator Latency command. Latency corrections are always made to the Actuator delay before writing to the hardware register. In case Latency correction is not required, then Latency should be set to 0.

3.2.29 Write Manual Actuator Offset (78h)

This command is used to specify the Manual Actuator Offset parameter.

3.2.29.1 Write Parameters

Table 3-73 describes the write parameters.

Table 3-73. Write Parameters

Parameter Bytes	Description
Byte 1	Manual Actuator Offset (LSByte)
Byte 2	Manual Actuator Offset (MSByte)
Byte 3	Reserved
Byte 4	See Below

MSB	Byte 4						LSB
b7	b6	b5	b4	b3	b2	b1	b0

Bit	Type	Description
7-1	R	Reserved
0	W	Auto DC Offset Enable 0h = Auto DC offset disabled 1h = Auto DC offset enabled

Note

This Actuator Manual Offset is presented in 16-bit signed 9.7 format (01h = 00.0078130)

Valid values of Actuator Manual Offset range from -255 to +255.

The sum of the Auto-DC offset and the Manual offset cannot be less than -255 or greater than +255.

3.2.30 Read Manual Actuator Offset (79h)

This command is used to read the Manual Actuator Offset parameter.

3.2.30.1 Read Parameters

This command has no read parameters.

3.2.30.2 Return Parameters

Table 3-74 describes the return parameters.

Table 3-74. Return Parameters

Parameter Bytes	Description
Byte 1	Manual Actuator Offset (LSByte)
Byte 2	Manual Actuator Offset (MSByte)
Byte 3	Reserved
Byte 4	See Below

MSB	Byte 4						LSB
b7	b6	b5	b4	b3	b2	b1	b0

Bit	Type	Description
7-1	R	Reserved
0	W	Auto DC Offset Enable 0h = Auto DC offset disabled 1h = Auto DC offset enabled

Note

This Actuator Manual Offset is presented in 16-bit signed 9.7 format (01h = 00.0078130)

Valid values of Actuator Manual Offset range from -256 to 256.

3.3 Image Processing Control Commands

3.3.1 Write Local Area Brightness Boost Control (80h)

This command controls the LABB image processing functionality for the display module.

3.3.1.1 Write Parameters

Table 3-75 describes the write parameters.

Table 3-75. Write Parameters

Parameter Bytes	Description
Byte 1	See Table 3-76
Byte 2	LABB strength setting

Table 3-76. Byte 1 Return Parameters

MSB	Byte 1						LSB
b7	b6	b5	b4	b3	b2	b1	b0

b(7:4)	Sharpness strength
b(3:2)	Reserved
b(1:0)	LABB control: • 0h: Disabled • 1h: Enabled: Manual strength control • 2h: Reserved • 3h: Reserved

The key function of the LABB is to adaptively gain up darker parts of the image to achieve an overall brighter image.

For LABB strength, 0 indicates no boost applied and 255 indicates the maximum boost viable in a product. The strength is not a direct indication of the gain, since the gain varies depending on the image content.

Sharpness strength ranges from 0 to 15, with 0 indicating sharpness disabled and 15 indicating the maximum sharpness. The LABB function must be enabled to make use of sharpness.

LABB is supported in TPG, splash, and external input mode, but auto-disabled in curtain mode.

3.3.2 Read Local Area Brightness Boost Control (81h)

This command reads the state of the LABB image processing functionality for the display module.

3.3.2.1 Read Parameters

This command has no read parameters.

3.3.2.2 Return Parameters

Table 3-77 describes the return parameters.

Table 3-77. Return Parameters

Parameter Bytes	Description
Byte 1	See Table 3-78
Byte 2	LABB strength setting
Byte 3	LABB gain value

Table 3-78. Byte 1 Return Parameters

MSB	Byte 1						LSB
b7	b6	b5	b4	b3	b2	b1	b0

b(7:4)	Sharpness strength

b(3:2)	Reserved
b(1:0)	LABB control: • 0h: Disabled • 1h: Enabled: Manual strength control • 2h: Reserved • 3h: Reserved

Table 3-79 shows the bit order and weighting for the LABB gain value, which ranges from 1 to 8 (the controller software limits the lower value to 1).

Table 3-79. Bit Weight Definition for LABB Gain Value

b7	b6	b5	b4	b3	b2	b1	b0
2^2	2^1	2^0	2^{-1}	2^{-2}	2^{-3}	2^{-4}	2^{-5}

The software equation to calculate LABB Gain as a fixed point value is shown below:

```
LABB_gain = add_8lsb(APL) / pre_LABB_APL      (//add 8 LSBs (u8.0 / u8.0 = u8.8 / u8.0 = u8.8)
```

3.3.3 Write CAIC Image Processing Control (84h)

This command controls the CAIC functionality for the display module.

3.3.3.1 Write Parameters

Table 3-80 describes the write parameters.

Table 3-80. Write Parameters

Parameter Bytes	Description
Byte 1	See Table 3-81
Byte 2	CAIC maximum lumens gain
Byte 3	CAIC clipping threshold

Table 3-81. Byte 1 Write Parameters

MSB	Byte 1						LSB
b7	b6	b5	b4	b3	b2	b1	b0

b(7)	CAIC gain display enable: • 0h: Disabled • 1h: Enabled
b(6)	CAIC gain display scale: • 0h: 100% = 1024 pixels • 1h: 100% = 512 pixels
b(5:0)	Reserved

The CAIC algorithm (Content Adaptive Illumination Control) provides adaptive control of the LED currents and the digital gain applied to the image.

The CAIC algorithm is enabled or disabled based on the method of LED current control selected by the user using the *Write LED Output Control Method* command. When enabled, the CAIC algorithm provides automatic control of the LED currents as specified by this command and the *Write LED Output Control Method* command.

The CAIC gain display provides a visual presentation of the instantaneous gain provided by the CAIC algorithm. The CAIC gain display is typically used as a debug tool and to show the performance of the algorithm. The CAIC gain display must never be used for normal operation. The display is composed of five bars, with the bottom three bars (green, red, and blue) showing the respective CAIC gain for each color. The top two bars are for TI debug use only.

Table 3-82 shows the bit order and weighting for the CAIC maximum lumens gain value, which has a valid range from 1.0 to 4.0. Values outside of this range are considered an error (invalid write parameter value – communication status) and the command does not execute.

Table 3-82. Bit Weight Definition for the CAIC Maximum Gain Value

b7	b6	b5	b4	b3	b2	b1	b0
2^2	2^1	2^0	2^{-1}	2^{-2}	2^{-3}	2^{-4}	2^{-5}

The CAIC maximum lumens gain parameter sets the maximum lumens gain for a pixel as a result of both digital gain and increasing LED currents. The CAIC maximum lumens gain parameter also serves to bias the CAIC algorithm towards either constant power (variable brightness) or constant lumens (variable power). Some examples are listed below:

- Maximum gain value = 1.0: This biases performance to constant lumens. In this case, LED power is reduced for those images where this is possible, but lumens do not increase or decrease.
- Maximum lumens gain value = 4.0: This biases performance to constant power. In this case, power is held constant for most images, while the lumens are gained up. For the small percent of images where the gain exceeds 4.0, lumens stop increasing and the power is reduced.

Table 3-83 shows the bit order and weighting for the CAIC clipping threshold value, which has a valid range from 0.0% to 4.0%. Values outside of this range are considered an error (invalid write parameter value – communication status) and the command does not execute.

Table 3-83. Bit Weight Definition for the CAIC Clipping Threshold Value

b7	b6	b5	b4	b3	b2	b1	b0
2^1	2^0	2^{-1}	2^{-2}	2^{-3}	2^{-4}	2^{-5}	2^{-6}

The CAIC clipping threshold parameter sets the percentage of pixels clipped by the CAIC algorithm over the full frame of active data, due to the digital gain applied by the CAIC algorithm.

Table 3-84 shows the bit order and weighting for the CAIC RGB intensity gain values, which have a valid range from 0.0 to almost 1.0. Values outside of this range are considered an error (invalid write parameter value – communication status) and the command does not execute.

Table 3-84. Bit Weight Definition for the CAIC RGB Intensity Gain Values

b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
Res	Res	Res	Res	Res	Res	2^{-1}	2^{-2}	2^{-3}	2^{-4}	2^{-5}	2^{-6}	2^{-7}	2^{-8}	2^{-9}	2^{-10}

CAIC can be enabled in TPG and external input mode, but auto-disabled in splash and curtain mode.

Table 3-85. LABB and CAIC Modes

Feature	TPG	Splash	Curtain	External Input
LABB	Supported	Supported	Auto-disabled	Supported
CAIC	Supported	Auto-disabled	Auto-disabled	Supported
Manual idle mode	Supported	Supported	Auto-disabled	Supported

3.3.4 Read CAIC Image Processing Control (85h)

This command reads the state of the CAIC functionality within the display module.

3.3.4.1 Read Parameters

This command has no read parameters.

3.3.4.2 Return Parameters

Table 3-86 describes the return parameters.

Table 3-86. Return Parameters

Parameter Bytes	Description
Byte 1	See Table 3-87
Byte 2	CAIC maximum lumens gain
Byte 3	CAIC clipping threshold

Table 3-87. Byte 1 Return Parameters

MSB	Byte 1						LSB
b7	b6	b5	b4	b3	b2	b1	b0

b(7)	CAIC gain display enable: • 0h: Disabled • 1h: Enabled
b(6)	CAIC gain display scale: • 0h: 100% = 1024 pixels • 1h: 100% = 512 pixels
b(5:0)	Reserved

Information on these parameters can be found in *Write CAIC Image Processing Control (84h)*.

3.3.5 Write Color Coordinate Adjustment Control (86h)

This command controls the CCA image processing functionality for the display module.

3.3.5.1 Write Parameters

Table 3-88 describes the write parameters.

Table 3-88. Write Parameters

MSB	Byte 1						LSB
b7	b6	b5	b4	b3	b2	b1	b0

b(7:1)	Reserved
b(0)	CCA enable: • 0: Disabled • 1: Enabled

This function must remain enabled during normal operation.

When CCA is disabled, an identity matrix is used.

3.3.6 Read Color Coordinate Adjustment Control (87h)

This command reads the state of the CCA image processing within the display module.

3.3.6.1 Read Parameters

This command has no read parameters.

3.3.6.2 Return Parameters

Table 3-89 describes the return parameters.

Table 3-89. Return Parameters

MSB	Byte 1						LSB
b7	b6	b5	b4	b3	b2	b1	b0

b(7:1)	Reserved

b(0)	CCA enable: • 0: Disabled • 1: Enabled

3.3.7 Write Keystone Correction Control (88h)

This command controls the keystone correction image processing functionality for the display module.

3.3.7.1 Write Parameters

Table 3-90 describes the write parameters.

Table 3-90. Write Parameters

Parameter Bytes	Description
Byte 1	See Table 3-91
Byte 2	Optical throw ratio (LSByte)
Byte 3	Optical throw ratio (MSByte)
Byte 4	Optical DMD offset (LSByte)
Byte 5	Optical DMD offset (MSByte)

Table 3-91. Byte 1 Write Parameters

MSB	Byte 1						LSB
b7	b6	b5	b4	b3	b2	b1	b0

b(7:1)	Reserved
b(0)	Keystone correction enable: • 0: Disabled • 1: Enabled

Keystone correction digitally compensates for distorted images when the projector is tilted up or down. Keystone correction is specified by the pitch angle (described in the *Write Keystone Projection Pitch Angle* command) and based on the throw ratio, vertical offset, and projector orientation. Each parameter is provided by this command. With this information, keystone correction corrects for both overall and local area aspect ratio distortion. For both full screen images and sub-images, the full active area of the DMD is keystone-corrected.

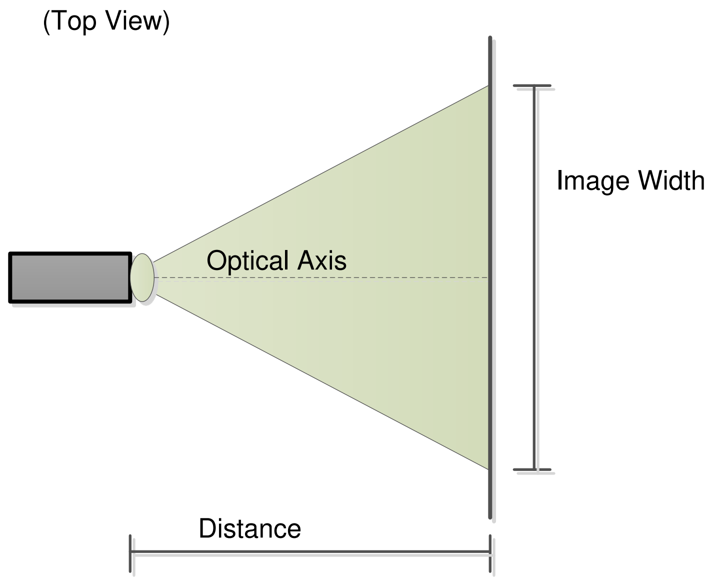
When keystone correction is enabled, the *Write Border Color* command sets the border color to black. Setting this parameter to any other color produces undesirable results.

Image rotation is allowed while keystone correction is enabled, but it may not be appropriate for all situations or configurations. The user is responsible for determining if the result is acceptable.

Table 3-92 shows the bit order and weighting for the optical throw ratio data. Figure 3-4 defines how this data is determined.

Table 3-92. Bit Weight Definition for the Optical Throw Ratio Data

b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0	2^{-1}	2^{-2}	2^{-3}	2^{-4}	2^{-5}	2^{-6}	2^{-7}	2^{-8}



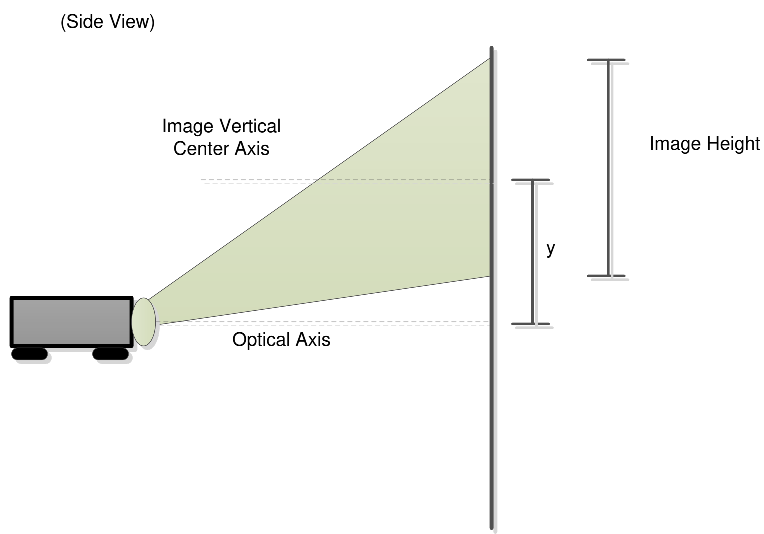
Throw Ratio = Distance / Image Width
Throw Ratio Register Value = 256 × Throw Ratio

Figure 3-4. Visual Definition and Calculation for Optical Throw Ratio Data

Table 3-93 shows the bit order and weighting for the two's complement optical DMD offset data. Figure 3-5 shows how this data is calculated, while Figure 3-6 shows how the sign of the offset data is determined. The user must insure that both the value and the sign of the offset data are correctly determined.

Table 3-93. Bit Weight Definition for the Optical DMD Offset Data

b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0	2^{-1}	2^{-2}	2^{-3}	2^{-4}	2^{-5}	2^{-6}	2^{-7}	2^{-8}



Vertical Offset = 2 × y / Image Height
Vertical Offset Register Value = 256 × Vertical Offset
(Image Height is always a positive value, while 'y' can be positive or negative)

Figure 3-5. Method for Calculation for Optical DMD Offset Data

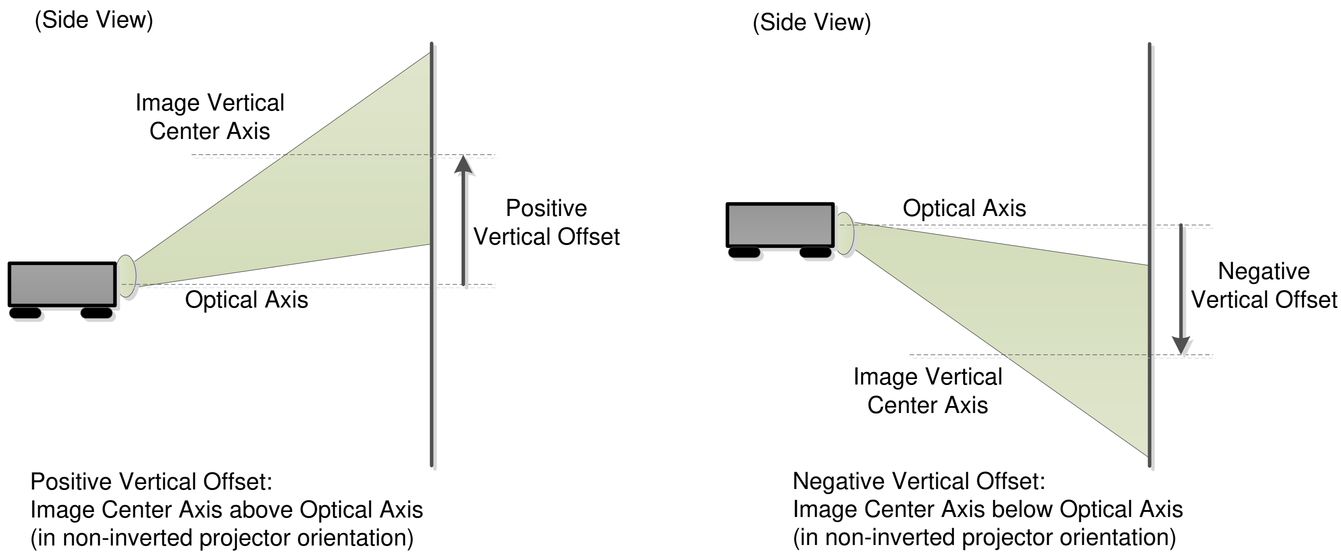


Figure 3-6. Sign Determination for Optical DMD Offset Data

Figure 3-7 shows examples of non-inverted and inverted projector orientation. This information is required for byte 1 of this command.

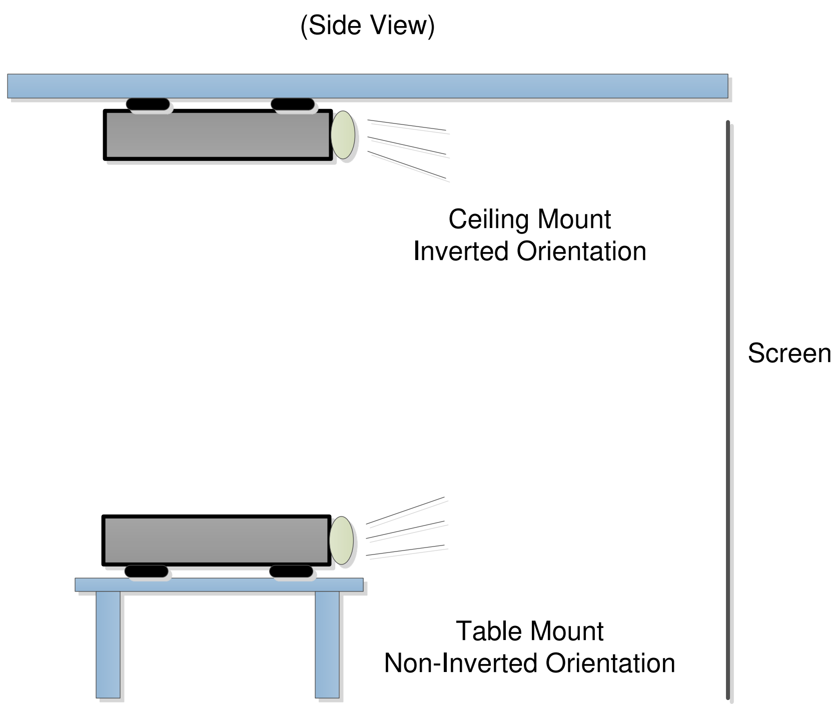


Figure 3-7. Examples of Non-Inverted and Inverted Projector Orientations

3.3.8 Read Keystone Correction Control (89h)

This command reads the state of the keystone correction image processing within the display module.

3.3.8.1 Read Parameters

This command has no read parameters.

3.3.8.2 Return Parameters

Table 3-94 describes the return parameters.

Table 3-94. Return Parameters

Parameter Bytes	Description
Byte 1	See Table 3-95
Byte 2	Optical throw ratio (LSByte)
Byte 3	Optical throw ratio (MSByte)
Byte 4	Optical DMD offset (LSByte)
Byte 5	Optical DMD offset (MSByte)

Table 3-95. Byte 1 Return Parameters

MSB	Byte 1						LSB
b7	b6	b5	b4	b3	b2	b1	b0

b(7:1)	Reserved
b(0)	Keystone correction enable: • 0: Disabled • 1: Enabled

3.4 General Setup Commands

3.4.1 Write Actuator Number of Segments (A0h)

This command defines the number of steps (or levels) in the actuator waveform.

3.4.1.1 Write Parameters

Table 3-96 describes the write parameters.

Table 3-96. Write Parameters

Parameter Bytes	Description
Byte 1	Number of Segments (Range is 2 to 255)

This command is applied to the default voice coil or the one most recently selected via the Write Actuator Configuration Select (A2h) command.

The command is programmed when transmitted and therefore applies to any waveform programmed until this command is sent again.

3.4.2 Read Actuator Number of Segments (A1h)

This command returns the number of steps (levels) in the actuator waveform as specified by default or by the most recent Write Actuator Number of Segments (A0h) command.

3.4.2.1 Read Parameters

This command has no read parameters.

3.4.2.2 Return Parameters

Table 3-97 describes the return parameters.

Table 3-97. Return Parameters

Parameter Bytes	Description
Byte 1	Number of Segments (Range is 2 to 255)

This command is associated with the default voice coil or the one most recently selected via the Write Actuator Configuration Select (A2h) command.

3.4.3 Write Actuator Configuration Select (A2h)

This command specifies which voice coil and which tilt axis orientation are to be configured by subsequent commands.

3.4.3.1 Write Parameters

Table 3-98 describes the write parameters.

Table 3-98. Write Parameters

MSB	Byte 1						LSB
b7	b6	b5	b4	b3	b2	b1	b0

Bit	Type	Description
7-4	R	Reserved
3-2	W	Tilt Axis Orientation 0h = Axis 1 1h = Axis 2 2h = Axis 3
1-0	W	Voice Coil 0h = Voice Coil A 1h = Voice Coil B

This command simply stores the selected actuator configuration information in global data. When a subsequent command arrives that depends on an axis or voice coil selection, this global data is used to configure the appropriate actuator components.

3.4.4 Read Actuator Configuration Select (A3h)

This command specifies which voice coil and which tilt axis orientation are to be configured by subsequent commands.

3.4.4.1 Read Parameters

This command has no read parameters.

3.4.4.2 Return Parameters

Table 3-99 describes the return parameters.

Table 3-99. Return Parameters

MSB	Byte 1						LSB
b7	b6	b5	b4	b3	b2	b1	b0

Bit	Type	Description
7-4	R	Reserved
3-2	W	Tilt Axis Orientation 0h = Axis 1 1h = Axis 2 2h = Axis 3
1-0	W	Voice Coil 0h = Voice Coil A 1h = Voice Coil B

3.4.5 Write Actuator Fixed Level Value (A4h)

This command specifies the fixed value to be output by the actuator waveform generator.

3.4.5.1 Write Parameters

Table 3-100 describes the write parameters.

Table 3-100. Write Parameters

Parameter Bytes	Description
Byte 1	Fixed Level Value (Range is 0 to 255)

This command is applied to the default voice coil or the one most recently selected via the Write Actuator Configuration Select (A2h) command.

The command is programmed when transmitted and therefore applies to any waveform programmed until this command is sent again.

3.4.6 Read Actuator Fixed Level Value (A5h)

This command returns the fixed value to be output by the actuator waveform generator.

3.4.6.1 Read Parameters

This command has no read parameters.

3.4.6.2 Return Parameters

Table 3-101 describes the return parameters.

Table 3-101. Return Parameters

Parameter Bytes	Description
Byte 1	Fixed Level Value (Range is 0 to 255)

This command is associated with the default voice coil or the one most recently selected via the *Write Actuator Configuration Select* command.

3.4.7 Write Actuator Period Stretch Value (A6h)

This command defines the high and low time for the Waveform Generator DAC clock output.

3.4.7.1 Write Parameters

Table 3-102 describes the write parameters.

Table 3-102. Write Parameters

MSB	Byte 1						LSB
b7	b6	b5	b4	b3	b2	b1	b0

Bit	Type	Description
7-3	R	Reserved
2-0	W	Clock Stretch Value (Range is 0 to 7). The clock period equals: 2 × (Clock Stretch Value+1).

The DAC Clock Generator function generates a 50% duty cycle clock signal for driving the external digital to analog converter (DAC). The LSB of this configuration parameter represents the stretch value for DAC input clock. A DAC output clock period 2 to 16 times the DAC input clock is supported.

This command is applied to the default axis or the one most recently selected via the Write Actuator Configuration Select (A2h) command.

3.4.8 Read Actuator Period Stretch Value (A7h)

This command returns the high and low time for the Waveform Generator DAC clock output as specified by default or by the most recent Write Actuator Period Stretch Value (A6h) command.

3.4.8.1 Read Parameters

This command has no read parameters.

3.4.8.2 Return Parameters

Table 3-103 describes the return parameters.

Table 3-103. Return Parameters

MSB	Byte 1						LSB
b7	b6	b5	b4	b3	b2	b1	b0

Bit	Type	Description
7-3	R	Reserved
2-0	W	Clock Stretch Value (Range is 0 to 7). The clock period equals: 2 × (Clock Stretch Value+1).

This return value is associated with the default voice coil or the one most recently selected via the Write Actuator Configuration Select (A2h) command.

3.4.9 Write Actuator Reference Value (A8h)

This command specifies the Reference DAC fixed output value.

3.4.9.1 Write Parameters

Table 3-104 describes the write parameters.

Table 3-104. Write Parameters

Parameter Bytes	Description
Byte 1	Reference Value (Range is 0 to 255)

3.4.10 Read Actuator Reference Value (A9h)

This command returns the Reference DAC fixed output value.

3.4.10.1 Read Parameters

This command has no read parameters.

3.4.10.2 Return Parameters

Table 3-105 describes the return parameters.

Table 3-105. Return Parameters

Parameter Bytes	Description
Byte 1	Reference Value (Range is 0 to 255)

3.4.11 Write Actuator Output Select (AAh)

This command is used to specify the Actuator Fixed Output parameter.

3.4.11.1 Write Parameters

Table 3-106 describes the write parameters.

Table 3-106. Write Parameters

MSB	Byte 1						LSB
b7	b6	b5	b4	b3	b2	b1	b0

Bit	Type	Description
7-1	R	Reserved
0	W	Enable Fixed Output 0h = Disable Fixed Output (means switch to auto output mode) 1h = Enable Fixed Output (Fixed output state is defined in flash)

3.4.12 Read Actuator Output Select (ABh)

This command is used to read the Actuator Fixed Output parameter.

3.4.12.1 Read Parameters

This command has no read parameters.

3.4.12.2 Return Parameters

Table 3-107 describes the return parameters.

Table 3-107. Return Parameters

MSB	Byte 1						LSB
b7	b6	b5	b4	b3	b2	b1	b0

Bit	Type	Description
7-1	R	Reserved

Bit	Type	Description
0	W	Enable Fixed Output 0h = Disable Fixed Output (means switch to auto output mode) 1h = Enable Fixed Output (Fixed output state is defined in flash)

3.4.13 Write Actuator Edge Table Address Mode (ACh)

This command is used to specify the Actuator Waveform Address Mode parameter.

3.4.13.1 Write Parameters

Table 3-108 describes the write parameters.

Table 3-108. Write Parameters

MSB	Byte 1						LSB
b7	b6	b5	b4	b3	b2	b1	b0

Bit	Type	Description
7-2	R	Reserved
1-0	W	Actuator Edge Table Address Mode 0h = Read Down & Read Up 1h = Read Up Inverted & Read Up 2h = Read Up & Read Down 3h = Read Up & Read Up Inverted

3.4.14 Read Actuator Edge Table Address Mode (ADh)

This command is used to read the Actuator Waveform Address Mode parameter.

3.4.14.1 Read Parameters

This command has no read parameters.

3.4.14.2 Return Parameters

Table 3-109 describes the return parameters.

Table 3-109. Return Parameters

MSB	Byte 1						LSB
b7	b6	b5	b4	b3	b2	b1	b0

Bit	Type	Description
7-2	R	Reserved
1-0	W	Actuator Edge Table Address Mode 0h = Read Down & Read Up 1h = Read Up Inverted & Read Up 2h = Read Up & Read Down 3h = Read Up & Read Up Inverted

3.4.15 Write Actuator DAC Enable (AEh)

This command is used to specify the Actuator DAC Enable parameter.

3.4.15.1 Write Parameters

Table 3-110 describes the write parameters.

Table 3-110. Write Parameters

MSB	Byte 1						LSB
b7	b6	b5	b4	b3	b2	b1	b0

Bit	Type	Description
7-1	R	Reserved
0	W	Actuator Waveform DAC Setting 0h = Disabled 1h = Enabled

3.4.16 Read Actuator DAC Enable (AFh)

This command is used to read the Actuator DAC Enable parameter.

3.4.16.1 Read Parameters

This command has no read parameters.

3.4.16.2 Return Parameters

Table 3-111 describes the return parameters.

Table 3-111. Return Parameters

MSB	Byte 1						LSB
b7	b6	b5	b4	b3	b2	b1	b0

Bit	Type	Description
7-1	R	Reserved
0	R	Actuator Waveform DAC Setting 0h = Disabled 1h = Enabled

3.4.17 Read Auto Framing Information (BAh)

This command is used to read data from the flash for the display module.

3.4.17.1 Read Parameters

This command has no read parameters.

3.4.17.2 Return Parameters

Table 3-112 describes the return parameters.

Table 3-112. Return Parameters

Parameter Bytes	Description
Byte 1	External Input VSYNC Rate (LSByte)
Byte 2	External Input VSYNC Rate
Byte 3	External Input VSYNC Rate
Byte 4	External Input VSYNC Rate (MSByte)
Byte 5	External Input Total Pixels per Line (LSByte)
Byte 6	External Input Total Pixels per Line (MSByte)
Byte 7	External Input Total Lines per Frame (LSByte)
Byte 8	External Input Total Lines per Frame (MSByte)
Byte 9	External Input Active Pixels per Line (LSByte)
Byte 10	External Input Active Pixels per Line (MSByte)
Byte 11	External Input Active Lines per Frame (LSByte)
Byte 12	External Input Active Lines per Frame (MSByte)
Byte 13	Pixel/Line Reference Clock Rate (LSByte)
Byte 14	Pixel/Line Reference Clock Rate (MSByte)

- In most cases, the above data can be measured by the system (even when manual data framing is used). *This data is provided for debug purposes only.*
- The external input frame rate is returned as a count that is specified in units of 66.67ns (based on the internal 15MHz clock used to time between input frame syncs).
- The pixels per line and lines per frame parameters are to be ‘1’ based (for example, a value of 1280 active pixels indicates that there are 1280 active pixels per line).
- The pixels per line and lines per frame parameters are based on an internal sample clock (for DSI and CPU Bus) or a measurement of the actual input pixel clock (for the Parallel Bus). This clock rate is returned as the *Pixel/Line Reference Clock Rate*. This parameter value is the clock rate multiplied by 100 in MHz. For example, the parameter value for 60.00MHz is 60 x 100 = 1770h (6000).

3.4.18 Write Keystone Projection Pitch Angle (BBh)

This command specifies the projection pitch angle for the display module.

3.4.18.1 Write Parameters

Table 3-113 describes the write parameters.

Table 3-113. Write Parameters

Parameter Bytes	Description
Byte 1	Projection pitch angle (LSByte)
Byte 2	Projection pitch angle (MSByte)

Default: 0000h

Table 3-114 shows the bit order and weighting for the 2’s complement projection pitch angle data.

Table 3-114. Bit Weight Definition for the Projection Pitch Angle Data

b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0	2^{-1}	2^{-2}	2^{-3}	2^{-4}	2^{-5}	2^{-6}	2^{-7}	2^{-8}

This command is used in conjunction with the Write Keystone Correction Control (88h) command.

The projection pitch angle is limited to the range of –40 to 40 degrees. Figure 3-8 shows examples of the projection pitch angle.

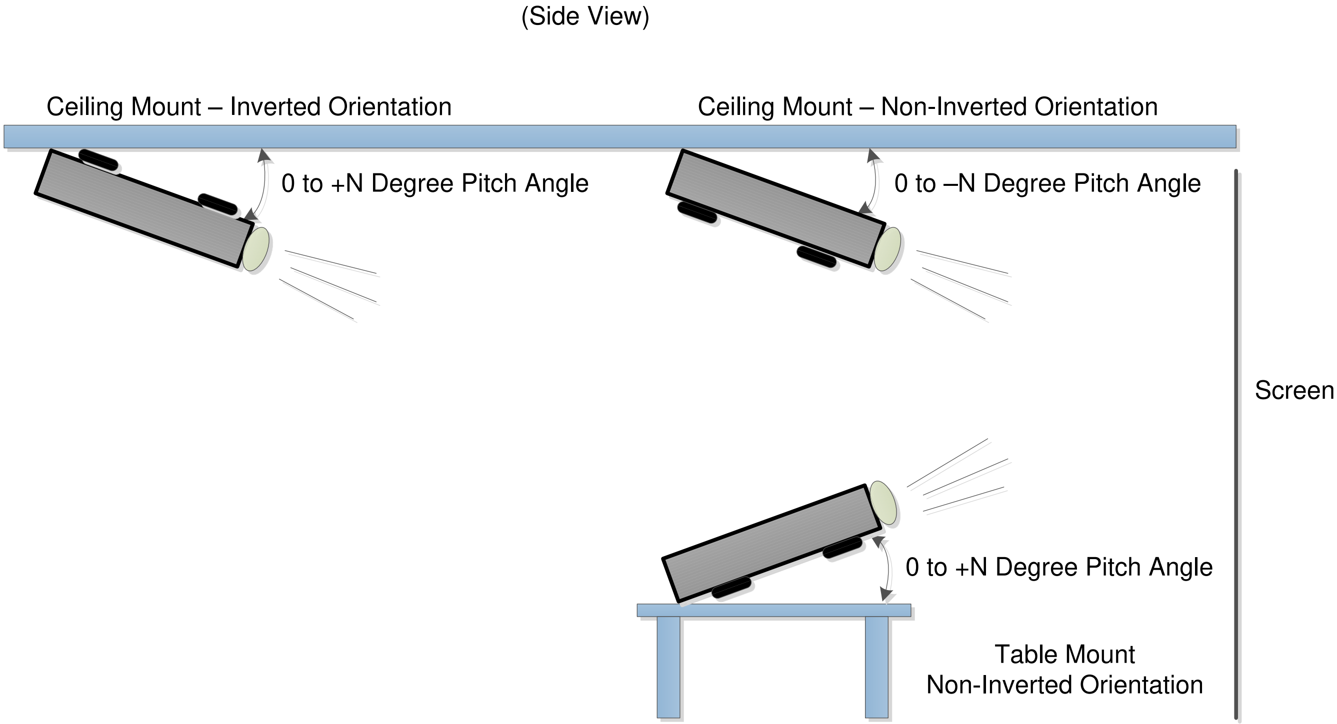


Figure 3-8. Examples of Projection Pitch Angle

3.4.19 Read Keystone Projection Pitch Angle (BCh)

This command reads the specified projection pitch angle for the display module.

3.4.19.1 Read Parameters

This command has no read parameters.

3.4.19.2 Return Parameters

Table 3-115 describes the return parameters.

Table 3-115. Return Parameters

Parameter Bytes	Description
Byte 1	Projection pitch angle (LSByte)
Byte 2	Projection pitch angle (MSByte)

3.4.20 Write Actuator Watchdog Window Width (C2h)

This command specifies the amount of time that must pass before edges of the INT_SUBFRAME signal, which are artificially inserted ensuring the edges never stop completely. The input parameters are applied separately to the axes defined by AWG_12 and AWG_34.

3.4.20.1 Write Parameters

Table 3-116 describes the write parameters.

Table 3-116. Write Parameters

Bit	Type	Description
15-10	W	Reserved
9-0	W	Watchdog window width value (LSB = 100 us) applied to AWG_12

Bit	Type	Description
15-10	W	Reserved

Bit	Type	Description
9-0	W	Watchdog window width value (LSB = 100 us) applied to AWG_34

When either of the AWG values equals zero, the device disables the auto-calculation for Actuator Subframe Filter Width and Actuator Watchdog Window Width. If a system error is encountered as a result of incorrectly configuring either of these values, ensure all fields are nonzero to resume auto-calculation mode. Flash download cannot be initiated while this system error is present.

3.4.21 Read Actuator Watchdog Window Width (C3h)

This command returns the value for the watchdog window width for each axis (AWG_12 and AWG_34).

3.4.21.1 Read Parameters

This command has no read parameters.

3.4.21.2 Return Parameters

Table 3-117 and Table 3-118 describe the return parameters.

Table 3-117. Return Parameters - Byte 0 and 1

Bit	Type	Description
15-10	R	Reserved
9-0	R	Watchdog window width value (LSB = 100 us) applied to AWG_12

Table 3-118. Return Parameters - Byte 2 and 3

Bit	Type	Description
15-10	R	Reserved
9-0	R	Watchdog window width value (LSB = 100 us) applied to AWG_34

When either of the AWG values equals zero, the device disables the auto-calculation for Actuator Subframe Filter Width and Actuator Watchdog Window Width. If a system error is encountered as a result of incorrectly configuring either of these values, ensure all fields are nonzero to resume auto-calculation mode. Flash download cannot be initiated while this system error is present.

3.4.22 Write Actuator Subframe Filter Width (C4h)

This command specifies the amount of time that must pass before edges of the INT_SUBFRAME signal, which are allowed to toggle. This function suppresses an edge that occurs too close to the previous edge. The input parameters are applied separately to the axes defined by AWG_12 and AWG_34.

3.4.22.1 Write Parameters

Table 3-119 and Table 3-120 describe the write parameters.

Table 3-119. Write Parameters- Byte 0 and 1

Bit	Type	Description
15-10	W	Reserved
9-0	W	Subframe filter width value (LSB = 100 us) applied to AWG_12

Table 3-120. Write Parameters - Byte 2 and 3

Bit	Type	Description
15-10	W	Reserved
9-0	W	Subframe filter width value (LSB = 100 us) applied to AWG_34

When either of the AWG values equals zero, the device disables the auto-calculation for Actuator Subframe Filter Width and Actuator Watchdog Window Width. If a system error is encountered as a result of incorrectly configuring either of these values, ensure all fields are nonzero to resume auto-calculation mode. Flash download cannot be initiated while this system error is present.

3.4.23 Read Actuator Subframe Filter Width (C5h)

This command returns the value of the subframe filter width for each axis (AWG_12 and AWG_34).

3.4.23.1 Read Parameters

This command has no read parameters.

3.4.23.2 Return Parameters

Table 3-121 and Table 3-122 describe the return parameters.

Table 3-121. Return Parameters - Byte 0 and 1

Bit	Type	Description
15-10	R	Reserved
9-0	R	Subframe filter width value (LSB = 100 us) applied to AWG_12

Table 3-122. Return Parameters - Byte 2 and 3

Bit	Type	Description
15-10	R	Reserved
9-0	R	Subframe filter width value (LSB = 100 us) applied to AWG_34

When either of the AWG values equals zero, the device disables the auto-calculation for Actuator Subframe Filter Width and Actuator Watchdog Window Width. If a system error is encountered as a result of incorrectly configuring either of these values, ensure all fields are nonzero to resume auto-calculation mode. Flash download cannot be initiated while this system error is present.

3.4.24 Write Actuator Stepped/Fixed Output Invert Enable (C6h)

This command inverts the value of the stepped/fixed output (2's complement).

3.4.24.1 Write Parameters

Table 3-123 describes the write parameters.

Table 3-123. Write Parameters

MSB	Byte 1						LSB
b7	b6	b5	b4	b3	b2	b1	b0

Bit	Type	Description
7-2	R	Reserved
1	W	Actuator Stepped Output Invert Enable 0h = Disable (Stepped output is not inverted) 1h = Enable (Stepped output is inverted)
0	W	Actuator Fixed Output Invert Enable 0h = Disable (Fixed output is not inverted) 1h = Enable (Fixed output is inverted)

3.4.25 Read Actuator Stepped/Fixed Output Invert Enable (C7h)

This command is used to read the state of the stepped/fixed output invert function for the default coil or the coil most recently selected via the Write Actuator Configuration (A2h).

3.4.25.1 Read Parameters

This command has no read parameters.

3.4.25.2 Return Parameters

Table 3-124 describes the return parameters.

Table 3-124. Return Parameters

MSB	Byte 1						LSB
b7	b6	b5	b4	b3	b2	b1	b0

Bit	Type	Description
7-2	R	Reserved
1	R	Actuator Stepped Output Invert Enable 0h = Disable (Stepped output is not inverted) 1h = Enable (Stepped output is inverted)
0	R	Actuator Fixed Output Invert Enable 0h = Disable (Fixed output is not inverted) 1h = Enable (Fixed output is inverted)

3.4.26 Write Actuator Orientation (C8h)

This command specifies the actuator orientation value. The command input value represents 1 of the 24 possible combinations in which 4 subframes can be ordered. Internally, the input is further modified by the current image orientation. Therefore, the input maps to 4 different subframe orderings.

3.4.26.1 Write Parameters

Table 3-125 describes the write parameters.

Table 3-125. Write Parameters

Parameter Bytes	Description
Byte 1	Actuator Subframe - Decode
Byte 2	Actuator Subframe - No Flip
Byte 3	Actuator Subframe - Horizontal Flip
Byte 4	Actuator Subframe - Vertical Flip
Byte 5	Actuator Subframe - Horizontal/Vertical Flip

Note

Value ranges from 0 to 23 for each byte.

3.4.27 Read Actuator Orientation (C9h)

This command is used to read the specified actuator orientation value.

3.4.27.1 Read Parameters

This command has no read parameters.

3.4.27.2 Return Parameters

Table 3-126 describes the return parameters.

Table 3-126. Return Parameters

Parameter Bytes	Description
Byte 1	Actuator Subframe - Decode
Byte 2	Actuator Subframe - No Flip
Byte 3	Actuator Subframe - Horizontal Flip
Byte 4	Actuator Subframe - Vertical Flip
Byte 5	Actuator Subframe - Horizontal/Vertical Flip

Note

Value ranges from 0 to 23 for each byte.

3.5 Administrative Commands

3.5.1 Read Short Status (D0h)

This command provides a short system status for the display module.

3.5.1.1 Read Parameters

This command has no read parameters.

3.5.1.2 Return Parameters

Table 3-127 describes the return parameters.

Table 3-127. Return Parameters

Parameter Bytes	Description
Byte 1	Short System Status

Table 3-128. Byte 1 Return Parameters

MSB	Byte 1 – General Status						LSB
b7	b6	b5	b4	b3	b2	b1	b0

b(7)	Boot/main application: • 0: Boot • 1: Main
b(6)	Sensing Sequence error: • 0: No error • 1: Error
b(5)	Flash error: • 0: No error • 1: Error
b(4)	Flash erase Complete: • 0: Not Complete • 1: Complete
b(3)	System error: • 0: No error • 1: Error
b(2)	Reserved
b(1)	Communication error: • 0: No error • 1: Error
b(0)	System initialization: • 0: Not complete • 1: Complete

The communication error bit indicates any error on the I^2C command interfaces. Specific details about communication errors are available using the *Read Communication Status* command. Any errors other than a communication error are indicated by the system error bit. Specific details about system errors are available using the *Read System Status* command.

The communication error, and system error bits are cleared when the *Read Short Status* is read. The *Read Short Status* command must only be checked periodically, not continuously. Continuous access may severely impact system performance.

3.5.2 Read System Status (D1h)

This command reads system status information for the display module.

3.5.2.1 Read Parameters

This command has no read parameters.

3.5.2.2 Return Parameters

Table 3-129 describes the return parameters.

Table 3-129. Return Parameters

Parameter Bytes	Description
Byte 1	DMD interface status
Byte 2	LED status
Byte 3	Internal interrupt status
Byte 4	Misc. status

All system status error bits are cleared when the read system status is read.

Table 3-130. Byte 1 Return Parameters

MSB	Byte 1 – DMD Interface Status						LSB
b7	b6	b5	b4	b3	b2	b1	b0

b(7:3)	Reserved
b(2)	DMD training error: • 0h: No error • 1h: Error
b(1)	DMD interface error: • 0h: No error • 1h: Error
b(0)	DMD device error: • 0h: No error • 1h: Error

The system sets the DMD device error for the following conditions:

- The system cannot read the DMD device ID from the DMD.
- The system-specified DMD device ID does not match the actual DMD device ID.

The system sets the DMD interface error when there are power management setup conflicts on this interface.

The system sets the DMD training error when the training algorithm cannot find a data eye that meets the specified requirements. For controller pins selected for training, DMD training will fail if less than 20 out of 50 continuous response values pass.

Table 3-131. Byte 2 Return Parameters

MSB	Byte 2 – LED Status						LSB
b7	b6	b5	b4	b3	b2	b1	b0

b(7)	Reserved
b(6)	LED no connection error: • 0h: No error • 1h: Error
b(5:3)	Reserved

b(2)	Blue LED state: • 0h: Off • 1h: On
b(1)	Green LED state: • 0h: Off • 1h: On
b(0)	Red LED state: • 0h: Off • 1h: On

Table 3-132. Byte 3 Return Parameters

MSB	Byte 3 – Internal Interrupt Status						LSB
b7	b6	b5	b4	b3	b2	b1	b0

b(7:3)	Reserved
b(2)	DC Power Low Voltage: • 0h: Supply voltage is normal • 1h: Supply voltage is low
b(1)	Sequence error: • 0h: No error • 1h: Error
b(0)	Sequence abort error: • 0h: No error • 1h: Error

The system reports **Sequence abort error** if Pulse Width Modulation (PWM) sequencer aborts the operation due to an error.

The system reports **Sequence error** if PWM sequencer encounter an error.

Table 3-133. Byte 4 Return Parameters

MSB	Byte 4 – Misc. Status						LSB
b7	b6	b5	b4	b3	b2	b1	b0

b(7:6)	Reserved
b(5)	Watchdog timer timeout: • 0h: No timeout • 1h: Timeout
b(4)	Product configuration error: • 0h: No error • 1h: Error
b(3)	Reserved
b(2)	Single versus dual controller configuration: • 0h: Single • 1h: Dual
b(1:0)	Reserved

The DLP3434 chip set is a single controller solution. The system should report "Single" configuration

The system sets the product configuration error bit if it determines that some piece of the product configuration is not correct. Some examples are:

- Invalid controller or DMD combination
- Invalid controller or Power Management IC (DLPA200X or DLPA300X) combination
- Invalid flash build for the current controller, DMD, or Power Management IC configuration

The system sets the watchdog timer timeout bit if the system has been reset due to a watchdog timer timeout.

3.5.3 Read System Software Version (D2h)

This command reads the main application software version information for the display module.

3.5.3.1 Read Parameters

This command has no read parameters.

3.5.3.2 Return Parameters

Table 3-134 describes the return parameters.

Table 3-134. Return Parameters

Parameter Bytes	Description
Byte 1	Controller main application software version – patch LSByte
Byte 2	Controller main application software version – patch MSByte
Byte 3	Controller main application software version – Minor
Byte 4	Controller main application software version – Major
Bytes 5 - 8	Reserved

3.5.4 Read Communication Status (D3h)

This command reads system status information for the display module.

3.5.4.1 Read Parameters

The read parameters are described in Table 3-135.

Table 3-135. Read Parameters

Parameter Bytes	Description
Byte 1	Command bus status selection

Table 3-136. Byte 1 Read Parameters

MSB	Byte 1 – Command Bus Status Selection						LSB
b7	b6	b5	b4	b3	b2	b1	b0

b(7:2)	Reserved
b(1:0)	Command bus status selection: • 00: Reserved • 01: Reserved • 10: I^{2}C only • 11: Reserved

This command returns the communication status for the specified command bus. For I^{2}C only: This selection returns status bytes 5 through 6.

3.5.4.2 Return Parameters

Table 3-137 describes the return parameters.

Table 3-137. Return Parameters

Parameter Bytes	Description
Byte 1 - 4	Reserved
Byte 5	Communication status

Table 3-137. Return Parameters (continued)

Parameter Bytes	Description
Byte 6	Aborted op-code

All communication status error bits are cleared when the *Read Communication Status* is read.

Table 3-138. Byte 5 Return Parameters

MSB	Byte 5 – Communication Status						LSB
b7	b6	b5	b4	b3	b2	b1	b0

b(7)	Reserved
b(6)	Bus timeout by display error: • 0: No error • 1: Error
b(5)	Invalid number of command parameters: • 0: No error • 1: Error
b(4)	Read command error: • 0: No error • 1: Error
b(3)	Flash batch file error: • 0: No error • 1: Error
b(2)	Command processing error: • 0: No error • 1: Error
b(1)	Invalid command parameter value: • 0: No error • 1: Error
b(0)	Invalid command error: • 0: No error • 1: Error

The system sets the invalid command error bit when it does not recognize the command op-code. The invalid command op-code is reported in the I^2C CMD error op-code byte of this status.

The system sets the invalid command parameter error bit when it detects that the value of a command parameter is not valid (for example, out of the allowed range).

The system sets the command processing error bit when a fault is detected when processing a command. In this case, the command aborts and the system moves on to the next command. The op-code for the aborted command is reported in the I^2C CMD error op-code byte of this status.

The system sets the flash batch file error bit when an error occurs during the processing of a flash batch file. When this bit is set, typically another bit is set to indicate what kind of error was detected (for example, an invalid command error).

The system sets the read command error bit when the host terminates the read operation before all of the requested data has been provided, or if the host continues to request read data after all of the requested data has been provided.

The system sets the invalid number of command parameters error bit when too many or too few command parameters are received. In this case, the command aborts and the system moves on to the next command. The op-code for the aborted command is reported in the I²C CMD error op-code byte of this status.

The system sets the bus timeout by display error bit when the display releases control of the bus after the bus timeout value is exceeded.

Table 3-139. Byte 6 Return Parameters

MSB	Byte 6 – CMD Error Op-Code						LSB
b7	b6	b5	b4	b3	b2	b1	b0

b(7:0)	I²C CMD error op-code

The CMD error op-code is associated with various I²C communication status bits, and reports the op-code for an I²C command as noted.

3.5.5 Read Controller Device ID (D4h)

This command reads the Controller Device ID for the display module.

3.5.5.1 Read Parameters

This command has no read parameters.

3.5.5.2 Return Parameters

Table 3-140 describes the return parameters.

Table 3-140. Return Parameters

MSB	Byte 1						LSB
b7	b6	b5	b4	b3	b2	b1	b0

b(7:4)	Reserved
b(3:0)	Controller device ID

The controller device ID are decoded using Table 3-141.

Table 3-141. Controller Device ID Decode

Controller Device ID	Device Number	Application
00h	DLPC3430	Embedded (SD)
01h	DLPC3433	Embedded (SD)
02h	DLPC3432	Embedded (SD)
03h	DLPC3434	Embedded (SD)
04h	DLPC3435	Standalone (SD)
05h	DLPC3438	Standalone (SD)

Unused controller device ID values are reserved.

3.5.6 Read DMD Device ID (D5h)

This command reads the DMD device ID for the display module.

3.5.6.1 Read Parameters

The read parameters are described in Table 3-142.

Table 3-142. Read Parameters

MSB	Byte 1 – DMD Register Selection						LSB
b7	b6	b5	b4	b3	b2	b1	b0

b(7:3)	Reserved
b(2:0)	DMD data selection: • 0h: DMD device ID • 1h – 7h: Reserved

3.5.6.2 Return Parameters

Table 3-143 describes the return parameters.

Table 3-143. DMD Device ID Reference Table

DMD Device ID				Device Description
Byte 1 (Identifier)	Byte 2 (Byte Count)	Byte 3 (ID-msbyte)	Byte 4 (ID-lsbyte)	Resolution and Type
60h	0Dh	00h	89h	0.23 qHD (960x540, Sub-LVDS)

3.5.7 Read System Temperature (D6h)

This command is used to read the system temperature using an external thermistor (if available).

3.5.7.1 Read Parameters

The command has no read parameters.

3.5.7.2 Return Parameters

Table 3-144 describes the return parameters.

Table 3-144. Return Parameters

Parameter Bytes	Description
Byte 1	LSByte
Byte 2	MSByte

Figure 3-9 shows the bit order and definition for the signed magnitude system temperature data, which will be returned in degrees C. The unspecified msbits (bits 15:12) will be set to ‘0’.

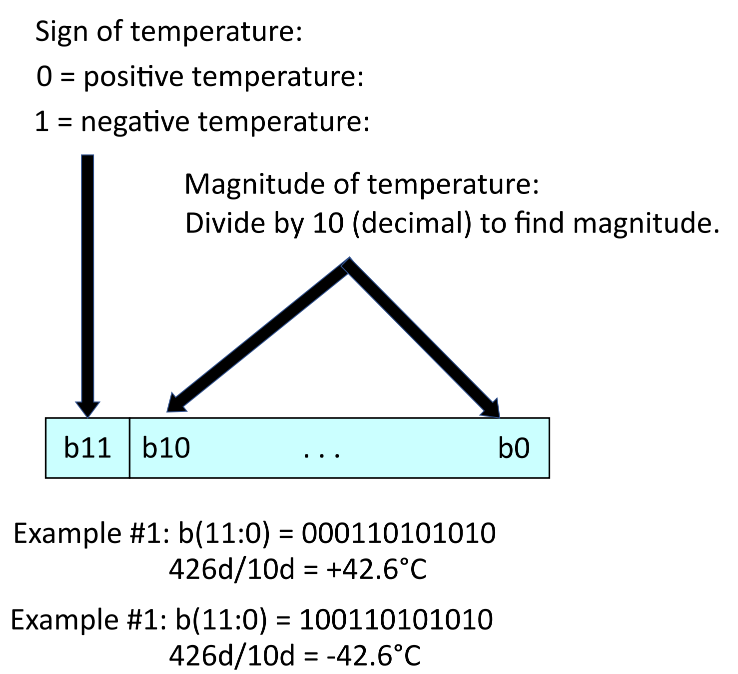


Figure 3-9. Bit Order and Definition for System Temperature

3.5.8 Read Flash Build Version (D9h)

This command reads the controller flash version for the display module.

3.5.8.1 Read Parameters

The command has no read parameters.

3.5.8.2 Return Parameters

Table 3-145 describes the return parameters.

Table 3-145. Return Parameters

Parameter Bytes	Description
Byte 1	Flash build version – patch LSByte
Byte 2	Flash build version – patch MSByte
Byte 3	Flash build version – Minor
Byte 4	Flash build version – Major

The user specifies a version number for the controller flash build in the format specified by this command. This command allows the user to read back this version information.

3.5.9 Write Flash Batch File Delay (DBh)

This command is used to specify an execution time delay within a flash batch file for the display module.

3.5.9.1 Write Parameters (DBh)

Table 3-146 describes the write parameters.

Table 3-146. Write Parameters

Parameter Bytes	Description
Byte 1	Flash batch file delay (LSB)
Byte 2	Flash batch file delay (MSB)

This command is used to specify an execution delay time within a flash batch file. It can only be used within a flash batch file, and is not a valid command on the I^2C interfaces.

The flash batch file delay is to be specified in units of 1ms (for example, 500ms = 1F4h).

Typical use of this command is in the auto-init flash batch file (batch file 0), but is valid for use in any batch file (See Write Execute Flash Batch File (2Dh)).

3.5.10 Read DMD I/F Training Data (DCh)

This command is used to read back the DMD interface training data for the display module.

3.5.10.1 Read Parameters

Table 3-147 describes the command read parameters.

Table 3-147. Read Parameters

Parameter Bytes	Description
Byte 1	DMD I/F training data selection (see below)

MSB	Byte 1 – DMD I/F Data Selection						LSB
b7	b6	b5	b4	b3	b2	b1	b0

Table 3-148. Byte 1 Read DMD I/F Training Data (DCh) Register Field Descriptions

Bit	Type	Description
7-5	R	Reserved

Table 3-148. Byte 1 Read DMD I/F Training Data (DCh) Register Field Descriptions (continued)

Bit	Type	Description
4	R	Training data selection 0h = High/Low/Selected 1h = Full profile
3-0	R	Controller pin pair selection 0h = A 1h = B 2h = C 3h = D 4h = E 5h = F 6h = G 7h = H 8h - Fh = Reserved

This command returns the DMD I/F training data specified for the controller pin pair specified.

- High/Low/Selected: This selection returns bytes 1 through 4
- Full profile: This selection returns bytes 5 though 11

3.5.10.2 Return Parameters

Table 3-149 describes the return parameters.

Table 3-149. DMD I/F Training Data Return Parameters

Parameter Bytes	Description
Byte 1	High/Low/Selected (see below) (LSB)
Byte 2	High/Low/Selected (see below)
Byte 3	High/Low/Selected (see below)
Byte 4	High/Low/Selected (see below) (MSB)
Byte 5	Full profile (bits 7-0) (LSB)
Byte 6	Full profile (bits 15-8)
Byte 7	Full profile (bits 23-16)
Byte 8	Full profile (bits 31-24)
Byte 9	Full profile (bits 39-32)
Byte 10	Full profile (bits 47-40)
Byte 11	Full profile (bits 50-48) (MSB)

MSB	Byte 1 - 4						LSB
b7	b6	b5	b4	b3	b2	b1	b0

Table 3-150. Byte 1 Read DMD I/F Training Data (DCh) Register Field Descriptions

Bit	Type	Description
7-6	R	Reserved
5	R	Training error 0h = No error 1h = Error
4	R	Pin pair selected for training 0h = No 1h = Yes

Table 3-150. Byte 1 Read DMD I/F Training Data (DCh) Register Field Descriptions (continued)

Bit	Type	Description
3-0	R	Controller pin pair selection 0h = A 1h = B 2h = C 3h = D 4h = E 5h = F 6h = G 7h = H 8h - Fh = Reserved

Table 3-151. Byte 2 Read DMD I/F Training Data (DCh) Register Field Descriptions

Bit	Type	Description
7-6	R	Reserved
5-0	R	Selected DLL (delay-locked loop) value

Table 3-152. Byte 3 Read DMD I/F Training Data (DCh) Register Field Descriptions

Bit	Type	Description
7-6	R	Reserved
5-0	R	Low pass DLL value

Table 3-153. Byte 4 Read DMD I/F Training Data (DCh) Register Field Descriptions

Bit	Type	Description
7-6	R	Reserved
5-0	R	High pass DLL value

This command is typically used for debug or characterization of the controller to DMD interface.

The return data is specified by the read parameter data.

DMD I/F training tests/calibrates the DLL that is associated with each controller pin pair, trying each of the DLL parameter values (0 to 50), looking for a pass (‘0’) or fail (‘1’) response for each value. Thus, the full training profile for each pin pair is made up of a 51 bit pass/fail result. This result is provided on full profile bits 50:0.

The full profile response has a region of passing DLL values. The highest DLL value for this region is returned as the high pass DLL value, the smallest DLL value is returned as the low pass DLL value, and the algorithm selected value as the selected DLL value.

This command does not run the DMD I/F training algorithm. This is done automatically by the system. This command returns the result from the most recent training event.

3.6 Flash Update Commands

Note that the flash commands described in this section cannot be used within batch files.

3.6.1 Read Flash Update PreCheck (DDh)

This command is used to verify that a pending flash update (write) is appropriate for the specified block of the display module flash.

3.6.1.1 Read Parameters

Table 3-154 describes the read parameters.

Table 3-154. Read Parameters

Parameter Bytes	Description
Byte 1	Flash build data size (LSB)
Byte 2	Flash build data size
Byte 3	Flash build data size
Byte 4	Flash build data size (MSB)

3.6.1.2 Return Parameters

Table 3-155 describes the return parameters.

Table 3-155. Return Parameters

MSB	Byte 1 - Flash PreCheck Results						LSB
b7	b6	b5	b4	b3	b2	b1	b0

Table 3-156. Flash Update PreCheck Register Field Descriptions

Bit	Type	Description
7-3	R	Reserved
2	R	Package configuration (identifier) 0h = No error 1h = Error
1	R	Package configuration (collapsed) 0h = No error 1h = Error
0	R	Package size 0h = No error 1h = Error

This command is used in conjunction with the flash data type select command. This command would be sent after the flash data type has been selected, but before any other flash operation. The purpose is to verify that the desired flash update is compatible, and will fit within the existing flash space, for the current flash configuration.

The flash build data size specifies the size of the flash update package in bytes.

When the controller software receives the flash build data size, it will verify that the package is appropriate for the specified location. This includes size, identifier, sequence build type, and so forth.

A package size error indicates that the flash package is too large to fit into the specified location. A few examples are listed:

- If replacing the entire flash, the size of the flash build exceeds the size of the flash device in the system.
- If replacing the entire flash except for the user blocks, the size of the flash build will either overwrite some portion of the existing user blocks, or exceed the size of the flash device in the system.
- If replacing the look block, the size of the flash build exceeds the size of the existing look block in the flash.
- If replacing a single sequence (for example, a partial update), the size of the flash build exceeds the size of the existing splash screen.

A package configuration error indicates that the flash package is not appropriate for the flash update requested. An example is listed below.

- If replacing a single splash screen (for example, a partial update), and the specified splash screen index value (identifier) is not being used in the flash build. Partial updates can only replace an existing flash entity.

If an error is returned by this command, the user is responsible for correcting the error before updating the flash. If the user chooses to ignore the error and update the flash anyway, the system will allow this. In this case, the user is responsible for any problems or system behaviors that arise from this. It should also be noted that this pre-check does *not* cover all possible mismatches that might arise when replacing blocks or partial blocks in the flash.

3.6.2 Write Flash Data Type Select (DEh)

This command is used to specify the type of data that will be written to or read from the flash of the display module.

3.6.2.1 Write Parameters

Table 3-157 describes the write parameters.

Table 3-157. Write Parameters

Parameter Bytes	Description
Byte 1	Flash data type (See below)
Byte 2	Optional: Partial data identifier (See Byte 1 Below)
Byte 3	Optional: Partial data identifier (See Byte 1 Below)
Byte 4	Optional: Partial data identifier (See Byte 1 Below)

MSB	Byte 1						LSB
b7	b6	b5	b4	b3	b2	b1	b0

Table 3-158. Flash Data Type Select Register Field Descriptions

Bit	Type	Description
7-0	W	**Entire flash** Entire flash 00h = Entire flash 01h = Reserved 02h = Entire flash except user calibration data and user scratchpad data 03h - 0Fh = Reserved **TI software** 10h = Main software application 11h - 1Fh = Reserved **TI application data** 20h = TI application data set (AOM) 21h - 2Fh = Reserved **User batch files** 30h = User batch files 31h - 3Fh = Reserved **Look data** 40h = Look data set 41h - 4Fh = Reserved **Sequence data** 50h = Entire sequence data set 51h = Entire sequence data set (Reads only) 52h - 5Fh = Reserved **Degamma/CMT data** 60h = Entire degamma/CMT data set 61h = Partial degamma/CMT data set (reads only) 62h - 6Fh = Reserved **CCA data** 70h = CCA data set 71h - 7Fh = Reserved **General LUT data** 80h = CCA data set

The flash data type command must be provided each time a new flash write or read operation is desired to ensure that the appropriate data type parameters are provided. The system expects four parameter bytes regardless of whether all four bytes are needed. Any unused bytes should be set to zero.

The flash data length must be provided to indicate the amount of flash data that will be provided for each write or read transaction.

The specified flash data will be written to or read from flash using the Write Flash Start (E1h), Write Flash Continue (E2h), Read Flash Start (E3h), and Read Flash Continue (E4h) commands.

While all of the flash data sets indicated can be written/replaced in their entirety, a few will also support partial writes/updates. Partial update command parameters will use an “odd” command number (for example, 91h, B1h) which will indicate that one to three additional command parameter bytes of information must be provided to specify which subset of data is to be updated. The additional command parameter data required is described below.

Table 3-159. Command Parameters for Partial Flash Data Set

Data Type (Writes Only)	2nd CMD Parameter (Byte 2)	3rd CMD Parameter (Byte 2)	4th CMD Parameter (Byte 2)	Comments
Partial user splash screen set	Splash number	N/A	N/A	A splash screen will be specified by its splash screen number

Table 3-159. Command Parameters for Partial Flash Data Set (continued)

Data Type (Writes Only)	2nd CMD Parameter (Byte 2)	3rd CMD Parameter (Byte 2)	4th CMD Parameter (Byte 2)	Comments
Partial user scratchpad data set	Sector number	N/A	N/A	If this data set is allocated more than one sector, each sector can be specified (0 = 1st sector, 1 = 2nd sector, and so forth)
Partial sequence data set	Look number	Sequence index number		A sequence data set will be specified by its sequence index number.
Partial CMT data set	Look number	Sequence index number		A CMT data set will be specified by its CMT index number.
Partial user splash screen set	Splash number	N/A	N/A	A Splash screen will be specified by its Splash screen number.
Partial user scratchpad data set	Splash number	Sub-sector address (LSB)	Sub-sector address (MSB)	If this data set is allocated more than one sector, each sector can be specified (0 = 1st sector, 1 = 2nd sector, and so forth) The host is also allowed to specify the start address within the sector specified in byte 2. This address needs to be a relative address within the specified sector (that is, the value can range from 0 to 4096), and must be a 32-bit aligned byte address.

While all of the flash data sets indicated can be read starting at the beginning of the data set, a few will also support read starts at the beginning of a data subset. The partial update command parameters which use an “odd” command number (for example, 41h, 43h, 75h) will indicate that one to three additional command parameter bytes must be provided to specify the start location for these reads. The additional command parameter data required is described in the previous table.

It is expected that all TI formatted factory calibration data, including the golden ratio, the power-up RGB currents, and the user thermister LUT trim data, will be stored in the user calibration block of the flash. It will be the responsibility of the user to manage updates to this block, which may require the user to read the entire block, modify, and then rewrite the entire block when making an update within the block.

While flash processing requires that flash commands be executed in the proper order (for example, flash must be erased prior to being written), due to the flexibility provided for flash updates, command order checking is not provided.

It is recommended that the user make use of the Read Flash Update PreCheck (DDh) command before updating an existing flash build.

The system allows the user to allocate up to four separable blocks of flash space for their own use (user scratchpad data). The user can also specify the size of each of these blocks, where each block can be one or more sectors in (one sector = 4 kB). This is all defined via the GUI. It is the responsibility of the user to manage these data sets, including updates, which may require the user to read an entire sector, modify, and then rewrite the entire sector when making an update within a sector. References to an unavailable data set will result in an invalid command parameter value error in the communication status.

3.6.3 Write Flash Data Length (DFh)

This command is used to specify the length of the data that will be written to or read from the flash of the display module.

3.6.3.1 Write Parameters

Table 3-160 describes the write parameters.

Table 3-160. Write Parameters

Parameter Bytes	Description
Byte 1	Flash data length (LSB)
Byte 2	Flash data length (MSB)

Flash data length must be a multiple of four bytes.

The flash data length applies to each write or read transaction, not to the length of the data type selected.

The maximum data length allowed for each write transaction is 1024 bytes. The maximum data length allowed for each read transaction is 256 bytes.

While flash processing requires that flash commands be executed in the proper order (for example, flash must be erased prior to being written), due to the flexibility provided for flash updates, command order checking is not provided.

3.6.4 Write Erase Flash Data (E0h)

This command directs the display module to erase the specified flash data.

3.6.4.1 Write Parameters

Table 3-161 describes the write parameters.

Table 3-161. Write Parameters

Parameter Bytes	Description
Byte 1	Signature: Value = AAh
Byte 2	Signature: Value = BBh
Byte 3	Signature: Value = CCh
Byte 4	Signature: Value = DDh

When this command is executed, the system will erase all sectors associated with the data type specified by the flash data type select command. As such, this command does not make use of the flash data length parameter

Since the process of erasing flash sectors can take a significant amount of time, the flash erase complete status bit in the read short status command should be checked periodically (not continuously) to determine when this task has been completed. This bit will be set at the start of the erase process, and will be cleared when the erase process is complete. Flash writes should not be started before the erase process has been completed.

While flash processing requires that flash commands be executed in the proper order (for example, flash must be erased prior to being written), due to the flexibility provided for flash updates, command order checking is not provided.

The signature bytes are used to minimize unintended flash erases. The command opcode and four signature bytes must be received correctly before this command will be recognized and executed.

3.6.5 Write Flash Start (E1h)

This command is used to write data to the flash for the display module.

3.6.5.1 Write Parameters

Table 3-162 describes the write parameters.

Table 3-162. Write Parameters

Parameter Bytes	Description
Byte 1	Data byte 1
Byte 2	Data byte 2
Byte 3	Data byte 3
Byte 4	Data byte 4
Byte 5 … n	Data byte 5 … n

The flash data length command must be used to specify how much data will be sent by the write flash start command.

The write flash start command is used to write up to 1024 bytes of data starting at the first address of the data type selected. If more than 1024 bytes are to be written, the write flash continue command must be used. Up to 1024 bytes of data can be written with each write flash continue command, which starts at the end of the last data written.

The flash error bit of the write short status command will indicate if the flash update was successful. This bit will be set for an error at the end of each write transaction, however, once an error has been detected, this bit will remain in the error state until a new data type is selected (selecting a new data type will clear this bit). This will allow the user the option of checking the status between each write transaction, or at the end of the update of a specific data type. Once a write transaction has started, the flash status (and this error bit) will not be accessible until the write transaction has completed.

While flash processing requires that flash commands be executed in the proper order (for example, flash must be erased prior to being written), due to the flexibility provided for flash updates, command order checking is not provided.

3.6.6 Write Flash Continue (E2h)

This command is used if more than 1024 bytes of data has to be written to flash of the display module.

3.6.6.1 Write Parameters

Table 3-163 describes the write parameters.

Table 3-163. Write Parameters

Parameter Bytes	Description
Byte 1	Data byte 1
Byte 2	Data byte 2
Byte 3	Data byte 3
Byte 4	Data byte 4
Byte 5 … n	Data byte 5 … n

The flash data length command must be used to specify how much data will be sent by the write flash start command.

The Write Flash Start (E1h) command is used to write up to 1024 bytes of data starting at the first address of the data type selected. If more than 1024 bytes are to be written, the write flash continue command must be used. Up to 1024 bytes of data can be written with each write flash continue command, which starts at the end of the last data written.

The flash error bit of the write short status command will indicate if the flash update was successful. This bit will be set for an error at the end of each write transaction, however, once an error has been detected, this bit will remain in the error state until a new data type is selected (selecting a new data type will clear this bit). This will allow the user the option of checking the status between each write transaction, or at the end of the update of a specific data type. Once a write transaction has started, the flash status (and this error bit) will not be accessible until the write transaction has completed.

While flash processing requires that flash commands be executed in the proper order (for example, flash must be erased prior to being written), due to the flexibility provided for flash updates, command order checking is not provided.

3.6.7 Read Flash Start (E3h)

This command is used to read data from the flash for the display module.

3.6.7.1 Read Parameters

The command has no read parameters.

3.6.7.2 Return Parameters

Table 3-164 describes the return parameters.

Table 3-164. Return Parameters

Parameter Bytes	Description
Byte 1	Data byte 1
Byte 2	Data byte 2
Byte 3	Data byte 3

Table 3-164. Return Parameters (continued)

Parameter Bytes	Description
Byte 4	Data byte 4
Byte 5 … n	Data byte 5 … n

The flash data length command must be used to specify how much data is to be read by the read flash start command.

The read flash start command is used to read up to 256 bytes of data starting at the specified address, or at the first address of the data type selected. If more than 256 bytes are to be read, the read flash continue command must be used. Up to 256 bytes of data can be read with each read flash continue command, which starts at the end of the last data read.

While flash processing requires that flash commands be executed in the proper order (for example, flash must be erased prior to being written), due to the flexibility provided for flash updates, command order checking is not provided.

3.6.8 Read Flash Continue (E4h)

This command is used to continue to read data (if more than 256 bytes) from the flash for the display module.

3.6.8.1 Read Parameters

The command has no read parameters.

3.6.8.2 Return Parameters

Table 3-165 describes the return parameters.

Table 3-165. Return Parameters

Parameter Bytes	Description
Byte 1	Data byte 1
Byte 2	Data byte 2
Byte 3	Data byte 3
Byte 4	Data byte 4
Byte 5 … n	Data byte 5 … n

The flash data length command must be used to specify how much data is to be read by the read flash continue command.

The read flash start command is used to read up to 256 bytes of data starting at the specified address, or at the first address of the data type selected. If more than 256 bytes are to be read, the read flash continue command must be used. Up to 256 bytes of data can be read with each read flash continue command, which starts at the end of the last data read.

While flash processing requires that flash commands be executed in the proper order (for example, flash must be erased prior to being written), due to the flexibility provided for flash updates, command order checking is not provided.

4 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Revision B (March 2019) to Revision C (January 2024)	Page
• Updates throughout document for consistency across related products	1