DLPC150 Programmer’s Guide

User's Guide

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About This Manual

This document specifies the command and control interface to the DLPC150. It also defines all applicable commands, default settings, and control register bit definitions to communicate with the DLP2010 and DLP2010NIR.

Note that reserved bit fields must be written with zero values.

Related Documents from Texas Instruments

- DLP2010NIR Data Sheet
- DLP2010 Data Sheet
- DLPC150 Data Sheet

If You Need Assistance

See the DLP and MEMS TI E2E Community support forums.

Interface Protocol

This chapter describes the interface protocol between the DLPC150 and a host processor. The DLPC150 supports an inter-IC control (I^2C) bus host interface protocol.

1.1 I^2C Interface

The DLPC150 controller uses the I^2C bus to exchange commands and data with a host processor. The I^2C bus protocol is a two-wire serial data bus that conforms to the NXP I^2C specification, up to 100 kHz. One wire, SCL, serves as a serial clock, while the second wire, SDA, serves as serial data. Several different devices can be connected together in an I^2C bus. Each device is software addressable by a unique address. Communication between devices occurs in a simple master-to-slave relationship.

1.1.1 I^2C Transaction Structure

All I^2C transactions are composed of a number of bytes, combined in the following order:

START Condition, Slave Address Byte (Slave Address + R/W Bit), Command Byte, Data Payload (N-Data Bytes), STOP Condition

where N in "N-Data Bytes" varies based on the command. All I^2C transactions must start after the HOST_IRQ signal is driven low by the DLPC150.

DLPC150 supports three type of transactions, shown in Table 1-1.

Table 1-1. DLPC150 Transaction Types

TRANSACTION TYPE	SLAVE ADDRESS BYTE		COMMAND BYTE	DATA PAYLOAD (N-DATA BYTES)
	SLAVE ADDRESS	R/W BIT		
Write	0x1B	0	Command Number	Command Parameters
Read Request	0x1B	0	Command Number	Command Parameters
Read Response	0x1B	1	—	Command Parameters

1.1.1.1 I^2C START Condition

All I^2C transactions begin with a START condition. A START condition is defined by a high-to-low transition on the SDA line, while the SCL line is high.

1.1.1.2 DLPC150 Slave Address Byte

The DLPC150 slave address is 0x1B. Because the first 8-bit I^2C packet includes the 7-bit slave address appended by a read (high) or write (low) bit, a read command to the DLPC150 concatenates the slave address with a 1. A write command to the DLPC150 concatenates the slave address with a 0. Thus, the DLPC150 first byte packet of an I^2C command is 0x37 for read and 0x36 for write command.

1.1.1.3 DLPC150 Command Byte

The DLPC150 command byte corresponds to a command number for the DLPC150.

1.1.2 DLPC150 Data Payload

Each command requires a certain number of parameters. Thus, a command byte is followed by variable length data. These bytes contain the command parameters transmitted, with the most significant byte first.

1.1.3 I²C STOP Condition

All I²C transactions end with a STOP condition. A STOP condition is defined by a low-to-high transition on the SDA line while the SCL line is high.

1.1.4 I²C Read Transaction Sequence

To issue a DLPC150 command, the host must perform the following steps:

1. Host sends a START condition followed by the DLPC150 address with the I²C read/write bit cleared (0x36).
2. Host sends a sub-address byte that contains the command of the desired DLPC150 function.
3. Host sends a STOP condition.
4. Host sends another I²C START condition followed by the DLPC150 address with the I²C read/write bit set (0x37).
5. Host repeatedly issues a Read Short Status command until the returned byte is 0x00.
6. Host reads the necessary bytes for each command.
7. Host issues a STOP condition to terminate the command read access.

1.1.4.1 Example Read Transaction Sequence

An example of a host issuing a read command to DLPC150 is shown in Figure 1-1. In this example, the host writes command 0x06 by transmitting a start condition (S), followed by the DLPC150 address with the read/write bit cleared (0x36), then the parameter 0x06, then a stop condition (P). This is followed by a host reading parameters 0x01 and 0x00 by transmitting a start condition (S), followed by the DLPC150 address with read/write bit set (0x37), then a read of parameters 0x01 and 0x00, then a stop condition (P).

Example:

S 36 06 P

S 37 01 00 P

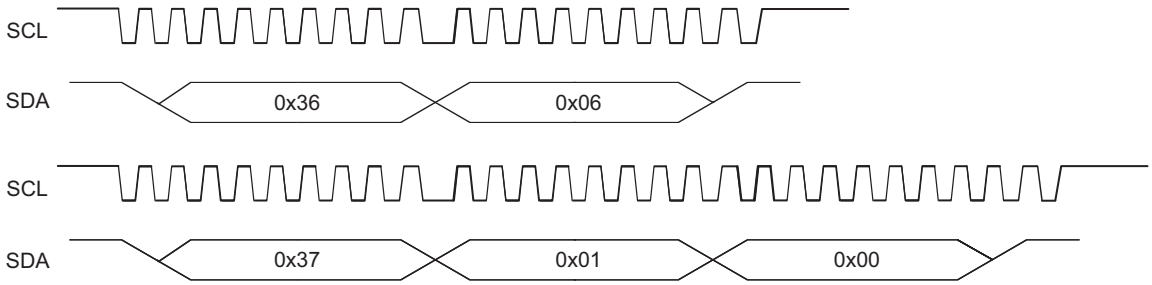

Figure 1-1. I²C Read Transaction Sequence

1.1.5 I²C Write Transaction Sequence

To issue a command to set a DLPC150 value, the host must perform the following steps:

1. Host sends a START condition followed by the DLPC150 address with the I²C read/write bit cleared (0x36).
2. Host sends a sub-address byte that contains the command of the desired DLPC150 function.
3. Host sends the necessary bytes for the desired DLPC150 function.
4. Host issues a STOP condition to terminate the command write access.

1.1.5.1 Example Write Transaction Sequence

An example of a host issuing a write command to DLPC150 is shown in Figure 1-2. In this example, the host issues command 0x05 and writes one byte parameter 0x00 by transmitting a start condition (S), followed by the DLPC150 address with read/write bit cleared (0x36), then the command 0x05, and the value 0x00, then a stop condition (P).

Example:

S 36 05 00 P

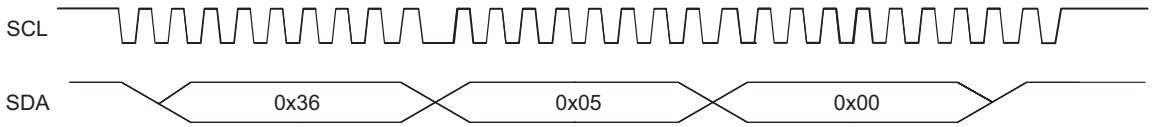

Figure 1-2. I²C Write Transaction Sequence

DLPC150 Control Commands

This chapter lists the DLPC150 control commands.

The Reset column in all of the following command tables is the default value after power up. These values may be overwritten after power up.

2.1 Input Source Commands

The Input Source Selection determines the input source for the DLPC150 data display.

2.1.1 Set Input Source Selection Command (0x05)

The Set Input Source Selection Command selects the input source for the DLPC150.

Table 2-1. Input Source Selection Command

BYTE	BITS	DESCRIPTION	RESET
0	1:0	Input Source 0: Parallel Port 1: Test Pattern Generator 2: Serial Flash Memory 3: Reserved	01h
	7:2	Reserved	

The input source supports a set of associated commands that are only applicable to specific input source selections. These associations are also shown in Table 2-2.

Table 2-2. Allowed Input Source Associated Commands by Source

INPUT SOURCE ASSOCIATED COMMANDS	PARALLEL PORT	TEST PATTERN GENERATOR	SERIAL FLASH MEMORY
Parallel Port Data Format Selection Command	Only	N/A	N/A
Parallel Port Input Image Size Command	Only	N/A	N/A
Parallel Port Manual Image Framing Command	Only	N/A	N/A
Parallel Port SYNC Polarity Command	Only	N/A	N/A
Parallel Port Auto Framing Information Command	Only	N/A	N/A
δ Test Pattern Selection Command	N/A	Only	N/A
Serial Flash Memory Selection Command	N/A	N/A	Only
Retrieve Serial Flash Memory Command	N/A	N/A	Special: No state is stored

These commands (except for Retrieve Serial Flash Memory Command) describe the unique characteristics of their associated source. After defining these settings, the DLPC150 stores them for future commands. After selecting an input source through the Set Input Source Selection Command, the DLPC150 will use the previous associated command settings of the selected source. Therefore, the DLPC150 must receive these associated commands when the source is selected, or when the source characteristics for that input source changes.

The source associated commands must be sent prior to sending the Set Input Source Selection Command. Any input source associated commands sent to an input source that is not active will be saved for future application when that source becomes active through a Set Input Source Selection Command. For example, Table 2-3 provides the set of commands to change from Test Pattern Generator to Parallel Port interface input source.

Table 2-3. Example Command Sequence when Changing Input Source from Test Pattern Generator to Parallel Port

ORDER	COMMAND	DESCRIPTION
1	0x36 0x1A 0x01	Image Freeze Command to hide any artifacts while changing input modes
2	0x36 0xF1 0x60 0x22 0x00 0x40 0x01 0x00 0x00 x00	Stop sequencer
3	0x36 0x07 0x43	Set Parallel Port Source Format Selection Command. Note that settings are stored for future use since the input source has not changed from Test Pattern Generator.
4	0x36 0x2E 0x56 0x03 0xE0 0x01	Set Parallel Port Input Image Size Command with 854 (0x0356) columns by 480 (0x01E0) rows. Note that settings are stored for future use since the input source has not changed from Test Pattern Generator.
5	0x36 0xB8 0x01 0x56 0x03 0xE0 0x01	Set Parallel Port Manual Image Framing Command, if required. This command enables manual image framing mode for an image 854 (0x0356) columns by 480 (0x01E0) rows. Note that settings are stored for future use since the input source has not changed from Test Pattern Generator.
6	0x36 0x05 0x00	Set Input Source Selection Command to Parallel Port. Note that the previously Parallel Port stored settings in commands 2 3, and 4 are now applied
7	0x36 0x1A 0x00	Image Unfreeze Command to show the changed image.

The DLPC150 requires the active data size for all parallel port input sources to be specified with the Parallel Port Input Image Size command. In addition, for input image data on the Parallel bus that doesn't provide data framing information, the DLPC150 requires manual framing using the Parallel Port Manual Image Framing command.

When a test pattern is selected, the DLPC150 will generate it at the resolution of the DLP2010 or DLP2010NIR and modify it by the settings specified in the Image Crop Command, and display it at the resolution specified by the Display Size command.

To hide artifacts when selecting an input source, the Image Freeze command and the DLPC150 sequencer must be stopped.

2.1.2 Read Input Source Selection Command (0x06)

The Read Input Source Selection command reports the input source for the DLPC150.

Table 2-4. Read Input Source Selection Command

BYTE	BITS	DESCRIPTION	RESET
0	1:0	Input Source 0h: Parallel Port Interface 1h: Test Pattern Generator 2h: Serial Flash Memory 3h: Reserved	0x01
	7:2	Reserved	

2.1.3 Parallel Port Interface Commands

2.1.3.1 Set Parallel Port Data Format Selection Command (0x07)

The Set Parallel Port Data Format Selection command specifies the source data type for the Parallel Port interface of the DLPC150. This command is used in conjunction with the Set Input Source Selection command selects the Parallel Port interface as the image source.

The settings for this command are retained until another command overwrites the settings. These settings are automatically applied each time the Parallel Port interface is selected as the input source.

Table 2-5. Set Parallel Port Data Format Selection Command

BYTE	BITS	DESCRIPTION	RESET
0	7:0	0x40: RGB565, 16-bits per pixel	0x43
		0x43: RGB888, 24-bits per pixel	
		0x00-0x39, 0x41-0x42, 0x43-0xFF: Reserved	

2.1.3.2 Read Parallel Port Data Format Selection Command (0x08)

The Read Parallel Port Data Format Selection command reports the source data type for the Parallel Port interface of the DLPC150.

Table 2-6. Read Parallel Port Data Format Selection Command

BYTE	BITS	DESCRIPTION	RESET
0	7:0	0x40: RGB565, 16-bits per pixel	0x43
		0x43: RGB888, 24-bits per pixel	
		0x00-0x39, 0x41-0x42, 0x43-0xFF: Reserved	

2.1.3.3 Set Parallel Port Input Image Size Command (0x2E)

The Set Parallel Port Input Image Size command specifies the data size of the Parallel Port interface input image of the DPLC150. This command is used in conjunction with the Set Input Source Select command. This command specifies the active data size of the input image to the system for the Parallel Port interface when the Set Input Source Select command selects the Parallel Port interface as the image source. When the source data for the parallel interface does not provide an active data framing signal, the user must specify where the active data is located within the frame using the Set Parallel I/F Manual Image Framing command in addition to this command.

The settings for this command are to be retained until changed using this command. These settings will be automatically applied each time the External Video Port is selected.

Table 2-7. Set Parallel Port Input Image Size Command

BYTE	BITS	DESCRIPTION	RESET
0	7:0	Pixels per Line (LSByte)	0x56
1	7:0	Pixels per Line (MSByte)	0x03
2	7:0	Lines per Frame (LSByte)	0xE0
3	7:0	Lines per Frame (MSByte)	0x01

The parameter values are to be ‘1’ based, meaning that a value of 854 pixels will specify 854 pixels per line.

The maximum and minimum input values are shown in Table 2-8. Values outside of these ranges will be flagged as an error with an invalid command parameter, and the command will not be executed.

Table 2-8. Input Source Limits for Active Data

Parameter	Minimum Value	Maximum Value
Input Source Active Pixels per Line	320	1280
Input Source Active Lines per Frame	200	800

2.1.3.4 Read Parallel Port Input Image Size Command (0x2F)

The Read Parallel Port Input Image Size command reports the data size of the Parallel Port interface input image of the DLPC150. This command returns the value specified by the Set Parallel Port Input Image Size command.

Table 2-9. Read Parallel Port Input Image Size Command

BYTE	BITS	DESCRIPTION	RESET
0	7:0	Pixels per Line (LSByte)	0x56
1	7:0	Pixels per Line (MSByte)	0x03
2	7:0	Lines per Frame (LSByte)	0xE0
3	7:0	Lines per Frame (MSByte)	0x01

The parameter values are to be ‘1’ based, meaning that a value of 854 pixels will specify 854 pixels per line.

2.1.3.5 Set Parallel Port SYNC Polarity Command (0xB6)

The Set Parallel Port SYNC Polarity command specifies the SYNC polarity for the Parallel Port interface of the DLPC150. This command is required whenever the source input is set to the Parallel Port interface. In Automatic mode, the DLPC150 determines the appropriate polarity of the syncs. Manual Parallel Port Sync Polarity mode is available for debugging purposes to override the Parallel Port interface with a specific sync polarity.

Table 2-10. Set Parallel Port SYNC Polarity Command

BYTE	BITS	DESCRIPTION	RESET
0	0	Parallel Port Sync Polarity Mode	0x00
		0: Automatic Mode	
		1: Manual Mode	
	1	Manual Mode – Parallel Port VSYNC Polarity	
		0: Falling Edge Active (Negative Pulse)	
		1: Rising Edge Active (Positive Pulse)	
	2	Manual Mode – Parallel Port HSYNC Polarity	
		0: Falling Edge Active (Negative Pulse)	
		1: Rising Edge Active (Positive Pulse)	
	7:3	Reserved	

2.1.3.6 Read Parallel Port SYNC Polarity Command (0xB7)

The Read Parallel Port SYNC Polarity command reports the state of the SYNC polarity for the Parallel Port interface of the DLPC150.

Table 2-11. Read Parallel Port SYNC Polarity Command

BYTE	BITS	DESCRIPTION	RESET
0	0	Parallel Port VSYNC Polarity	0x00
		0: Falling Edge Active (Negative Pulse)	
		1: Rising Edge Active (Positive Pulse)	
	1	Parallel Port HSYNC Polarity	
		0: Falling Edge Active (Negative Pulse)	
		1: Rising Edge Active (Positive Pulse)	
	7:2	Reserved	

2.1.3.7 Set Parallel Port Manual Image Framing Command (0xB8)

The Set Parallel Port Manual Image Framing command specifies the Parallel Port interface manual image framing parameters for the DLPC150. This command is only required when the source data for the Parallel Port interface doesn't provide an active data valid framing signal. However, vertical and horizontal syncs are still required. These framing parameters are referenced to the appropriate sync signal (e.g. start pixel referenced to each horizontal sync). This command is used in conjunction with the Set Video Input Image Size command. The user must enable or disable manual framing as appropriate. If manual framing is specified, it will be used even if an active data valid framing signal is provided with the input, overriding the active data valid signal of the DATAEN_CMD pin.

The settings for this command are retained until another command overwrites the settings. These settings are automatically applied each time the Parallel Port interface is selected as input source.

Table 2-12. Set Parallel Port Manual Image Framing Command

BYTE	BITS	DESCRIPTION	RESET
0	0	0: Disable Parallel Port Manual Image Framing	0x00
		1: Enable Parallel Port Manual Image Framing	
	7:1	Reserved	
1	7:0	Start Pixel (LSByte)	0x00
2	7:0	Start Pixel (MSByte)	0x00
3	7:0	Start Line (LSByte)	0x00
4	7:0	Start Line (MSByte)	0x00

The start pixel and line parameters are '1' based, meaning that a value of 1 will specify the first pixel of a line in the first line of the frame.

This function is NOT applicable to BT656 sources. Framing for these sources will be handled automatically by the system.

2.1.3.8 Read Parallel Port Manual Image Framing Command (0xB9)

The Read Parallel Port Manual Image Framing command reports the state of the Parallel Port interface manual image framing parameters for the DLPC150.

Table 2-13. Read Parallel Port Manual Image Framing Command

BYTE	BITS	DESCRIPTION	RESET
0	0	0: Disable Parallel Port Manual Image Framing	0x00
		1: Enable Parallel Port Manual Image Framing	
	7:1	Reserved	
1	7:0	Start Pixel (LSByte)	0x00
2	7:0	Start Pixel (MSByte)	0x00
3	7:0	Start Line (LSByte)	0x00
4	7:0	Start Line (MSByte)	0x00

The start pixel and line parameters are ‘1’ based, meaning that a value of 1 will specify the first pixel of a line in the first line of the frame.

2.1.4 Test Pattern Commands

2.1.4.1 Set Test Pattern Selection Command (0x0B)

The Set Test Pattern Selection command specifies the internal test pattern used by the DLPC150. This command is used in conjunction with the Set Input Source Selection command. This command, shown in Table 2-14, specifies which test pattern is displayed when the Set Input Source Selection command selects Test Pattern Generator as the image source. Test Patterns are created at the resolution of the DLP2010 or DLP2010NIR, 854 columns by 480 rows. However, the resolution can be modified by the Set Image Crop command and are displayed at the resolution specified by the Set Display Size command. The Test Pattern border selection creates a single pixel wide/tall white border around the specified test pattern. As shown in Table 2-15, some test patterns can have a foreground and background color specified.

When a Foreground or Background Color is not used, the bit values will be ignored (See Table 2-16). If both Foreground and Background Color are not used, or when a Parameter Byte (Bytes 2 thru 5) is not used, the byte should not be sent. This is shown in Table 2-17 which shows the number of bytes required based on the specified pattern.

The settings for this command are retained until another command overwrites the settings. These settings are automatically applied each time the Test Pattern Generator is selected as input source.

Table 2-14. Set Test Pattern Selection Command

BYTE	BITS	PATTERN TYPE	DESCRIPTION	RESET
0	3:0	Pattern Selection	0x0: Solid Field	0x00
			0x1-0x02: Reserved	
			0x3: Horizontal Lines	
			0x4: Diagonal Lines	
			0x5: Vertical Lines	
			0x6: Horizontal & Vertical Grid	
			0x7: Checkerboard	
			0x8-0xF: Reserved	
	6:4		Reserved	
	7	Test Pattern Border	0x00: Disabled	
			0x01: Enabled	

Table 2-14. Set Test Pattern Selection Command (continued)

BYTE	BITS	PATTERN TYPE	DESCRIPTION	RESET
1	2:0	Background Color	0x0: Black	0x70
			0x1-0x6: Reserved	
			0x7: White	
	3		Reserved	
	6:4	Foreground Color	0x0: Black	
			0x1-0x6: Reserved	
			0x7: White	
	7		Reserved	
2	7:0		Parameter 1 (See Table 2-16)	0x00
3	7:0		Parameter 2 (See Table 2-16)	0x00
4	7:0		Parameter 3 (See Table 2-16)	0x00
5	7:0		Parameter 4 (See Table 2-16)	0x00

Table 2-15. Foreground and Background Color

Pattern	Foreground Color	Background Color
Solid Field	Yes	No
Horizontal Lines	Yes	Yes
Vertical Lines	Yes	Yes
Diagonal Lines	Yes	Yes
Grid Lines	Yes	Yes
Checkerboard	Yes	Yes

Table 2-16. Descriptions and Bit Assignments for Parameters 1-4

	Byte 5 (Parameter 4)		Byte 4 (Parameter 3)		Byte 3 (Parameter 2)		Byte 3 (Parameter 1)	
Pattern	Description	Bits	Description	Bits	Description	Bits	Description	Bits
Solid Field	n/a		n/a		n/a		n/a	
Horizontal Lines	n/a		n/a		Background Line Width	8	Foreground Line Width	8
Vertical Lines	n/a		n/a		Background Line Width	8	Foreground Line Width	8
Diagonal Lines	n/a		n/a		Vertical Spacing	8	Horizontal Spacing	8
Grid Lines	Vertical Background Line Width	8	Vertical Foreground Line Width	8	Horizontal Background Line Width	8	Horizontal Foreground Line Width	8
Checkerboard	Number of Vertical Checkers	3	Number of Vertical Checkers	8	Number of Horizontal Checkers	3	Number of Horizontal Checkers	8

Table 2-17. Number of Bytes Required based on Pattern Selection

Specified Pattern	Solid Field	Horizontal Lines	Vertical Lines	Diagonal Lines	Grid Lines	Checker board
Number of Bytes Required	2	4	4	4	6	6

The appearance for the Horizontal Lines test pattern is specified using both the Foreground and Background colors. The foreground color is used for the horizontal lines, and the background color is used for the space between the lines. As an example, if the foreground line width = 1, and the background line width = 9, there would be a single pixel horizontal line on every 10th line. An example of a Horizontal Lines pattern is shown in Figure 2-1.

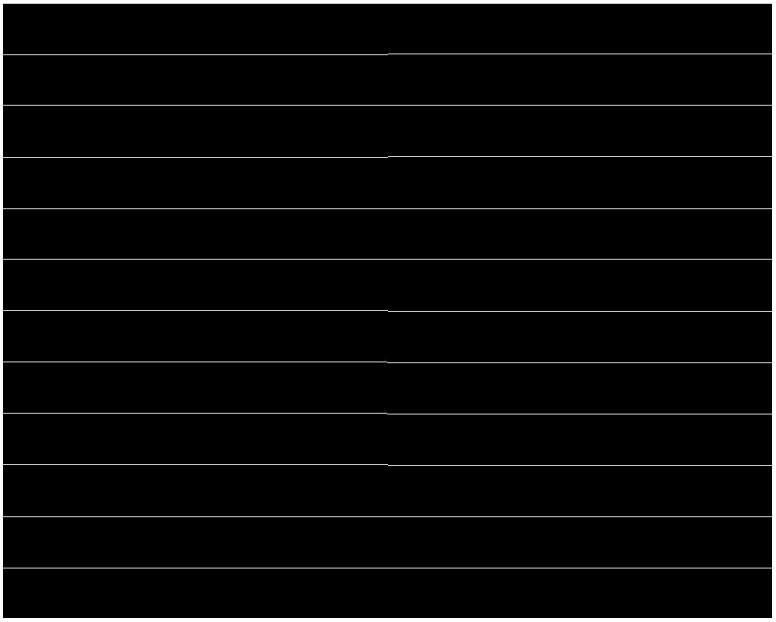

Figure 2-1. Example of Horizontal Lines Test Pattern

The appearance for the Vertical Lines test pattern is specified using both the Foreground and Background colors. The foreground color is used for the vertical lines, and the background color is used for the space between the lines. As an example, if the foreground line width = 1, and the background line width = 9, there would be a single pixel vertical line on every 10th line. An example of a Vertical Lines pattern is shown in Figure 2-2.

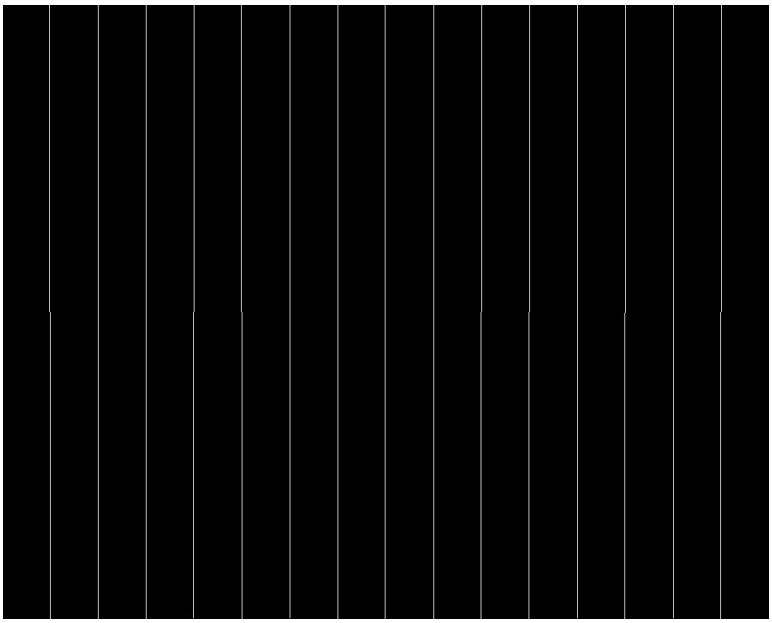

Figure 2-2. Example of Vertical Lines Test Pattern

The appearance for the Diagonal Lines pattern is specified using both the Foreground and Background colors. The foreground color is used for the diagonal lines, and the background color is used for the space between the lines. The line width will always be one pixel. It should be noted that both horizontal and vertical line spacing must use the same value, and are limited to values of 3, 7, 15, 31, 63, 127, 255. Invalid values will result in a communication error with invalid command parameter. An example of a Diagonal Lines pattern is shown in Figure 2-3.

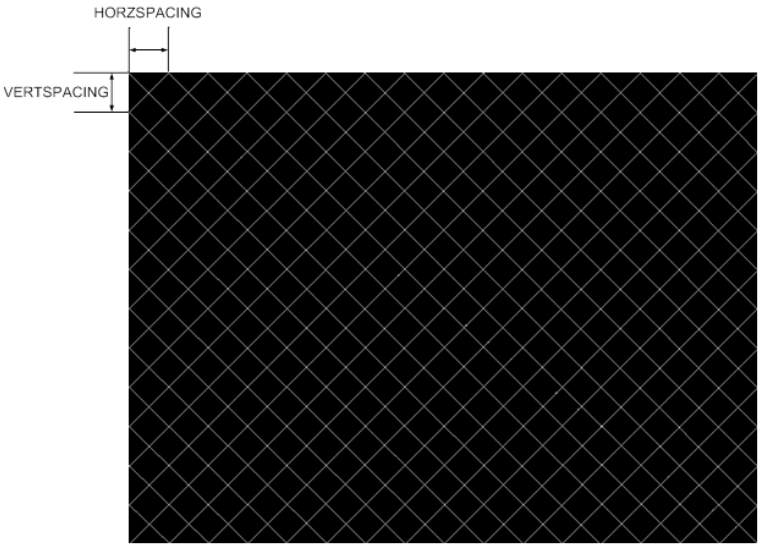

Figure 2-3. Example of Diagonal Lines Test Pattern

The appearance for the Grid Lines pattern is specified using both the Foreground and Background colors. The foreground color is used for the grid lines, and the background color is used for the space between the lines. As an example, if the horizontal foreground line width = 1, and background line width = 9, there would be a single pixel horizontal line on every 10th line. Furthermore, if the vertical foreground line width = 1, and background line width = 9, there would be a single pixel vertical line on every 10th line. An example of a Grid Lines pattern is shown in Figure 2-4.

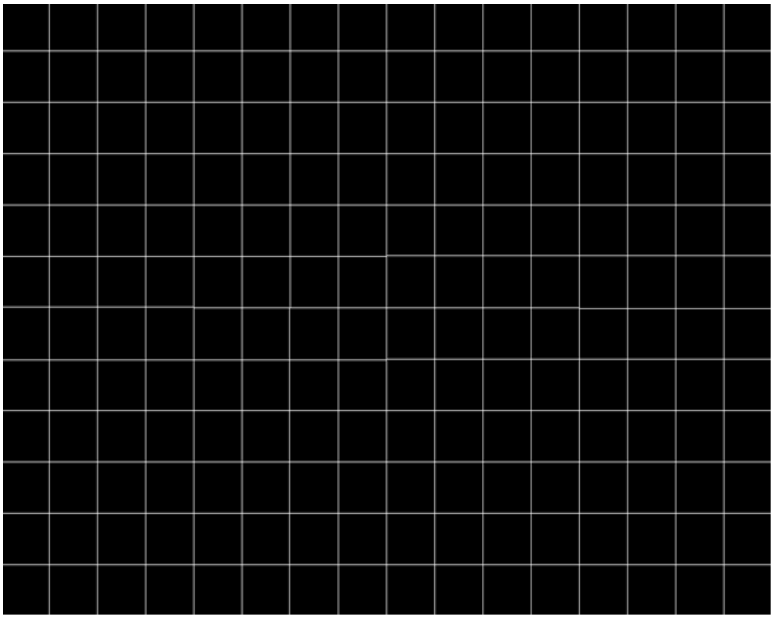

Figure 2-4. Example of Grid Lines Test Pattern

The appearance for the Checkerboard pattern is specified using both the Foreground and Background colors. The foreground color is used for one of the checkers, and the background color is used for the alternating checker. For this pattern, the system will automatically determine the checker size in each direction based on the number of checkers and the size of the DLP2010 or DLP2010NIR. As an example, if the number of horizontal checkers = 4, the number of vertical checkers = 4, and the DMD resolution is 854x480, then the size of the horizontal checkers would be 213 pixels, and the size of the vertical checkers would be 120 pixels (854 pixels / 4 checkers = 213 pixels: 480 pixels / 4 checkers = 120 pixels). An example of a Checkerboard pattern (16 checkers by 12 checkers) is shown in Figure 2-5.

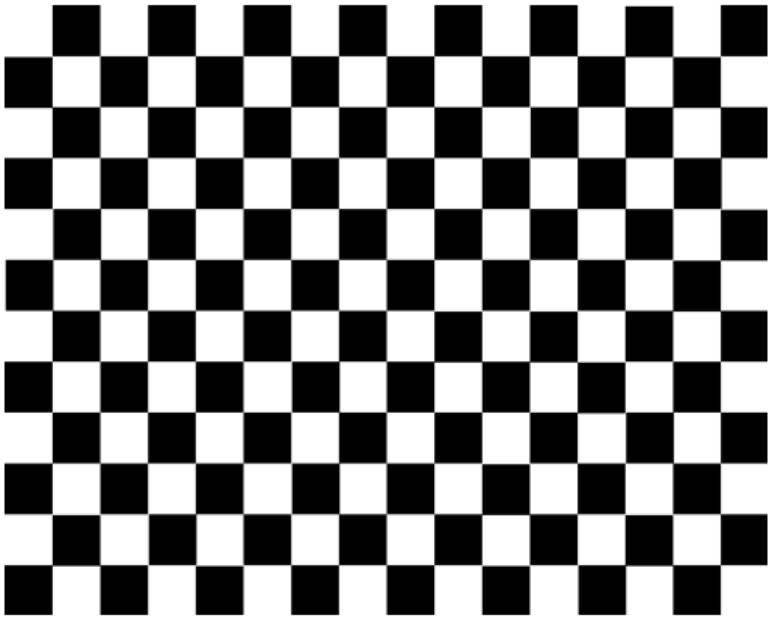

Figure 2-5. Example of Checkerboard Test Pattern

2.1.4.2 Read Test Pattern Selection (0x0C)

The Read Test Pattern Selection command reports the test pattern selected by the DLPC150.

Table 2-18. Read Test Pattern Selection Command

BYTE	BITS	PATTERN TYPE	DESCRIPTION	RESET
0	3:0	Pattern Selection	0x0: Solid Field	0x00
			0x1-0x02: Reserved	
			0x3: Horizontal Lines	
			0x4: Diagonal Lines	
			0x5: Vertical Lines	
			0x6: Horizontal & Vertical Grid	
			0x7: Checkerboard	
			0x8-0xF: Reserved	
	6:4		Reserved	
	7	Test Pattern Border	0x00: Disabled	
			0x01: Enabled	

Table 2-18. Read Test Pattern Selection Command (continued)

BYTE	BITS	PATTERN TYPE	DESCRIPTION	RESET
1	2:0	Background Color	0x0: Black	0x70
			0x1-0x6: Reserved	
			0x7: White	
	3		Reserved	
	6:4	Foreground Color	0x0: Black	
			0x1-0x6: Reserved	
			0x7: White	
	7		Reserved	
2	7:0		Parameter 1 (See Table 2-16)	0x00
3	7:0		Parameter 2 (See Table 2-16)	0x00
4	7:0		Parameter 3 (See Table 2-16)	0x00
5	7:0		Parameter 4 (See Table 2-16)	0x00

This command returns six bytes. All unneeded bytes (See Table 2-17) will be set to “0”.

2.1.5 Serial Flash Pattern Commands

2.1.5.1 Set Serial Flash Pattern Selection Command (0x0D)

The Set Serial Flash Pattern Selection command selects a pattern stored in the serial Flash memory of the DLPC150. This command is used in conjunction with the Set Input Source Selection and the Retrieve Serial Flash Pattern commands. It specifies the serial Flash memory pattern to be displayed by the DLPC150 when the Input Source Selection command selects serial Flash memory as the image source. All image processing settings-image crop, image orientation, display size, serial Flash pattern, and input source-must be set before executing the Retrieve Serial Flash Pattern command.

The settings for this command are retained until another command overwrites the settings. These settings are automatically applied each time the serial Flash memory is selected as the input source.

The availability of patterns in serial Flash memory is limited by the available space in flash memory and by the compression of the pattern. the minimum pattern image size allowed for flash storage is 427 × 240, while the maximum image size is the resolution of the DLP2010 or DLP2010NIR, 854 × 480.

Table 2-19. Set Serial Flash Pattern Selection Command

BYTE	BITS	DESCRIPTION	RESET
0	7:0	Pattern Number in DLPC150 Serial Flash Memory	0x00

To display a pattern from serial Flash memory, the steps shown in Table 2-20 are required.

Table 2-20. Example Command Sequence to Display a Pattern from Serial Flash Memory

ORDER	COMMAND	DESCRIPTION
1	0x36 0x1A 0x01	Image Freeze Command to hide any artifacts while changing input modes
2	0x36 0x0D 0x00	Set Serial Flash Pattern Selection Command to select the desired serial Flash memory pattern #0.
3	0x37 0x35	Retrieve Serial Flash Pattern Command to retrieve the pattern.
4	0x36 0x1A 0x00	Image Unfreeze Command to show the changed image.

2.1.5.2 Read Serial Flash Pattern Command (0x0E)

The Read Serial Flash Pattern command reports the pattern selected from the serial Flash memory of the DLPC150.

Table 2-21. Read Serial Flash Pattern Command

BYTE	BITS	DESCRIPTION	RESET
0	7:0	Pattern Number in DLPC150 Serial Flash Memory	0x00

2.1.5.3 Retrieve Serial Flash Pattern Command (0x35)

The Retrieve Serial Flash Memory Pattern command starts the DLPC150 process of retrieving a pattern from serial Flash memory. Due to the serial Flash memory interface connection, retrieval of a pattern from flash might take up to 350 ms to complete. Therefore, this command must be completed before subsequent commands are issued.

This command is used in conjunction with the Set Input Source Selection and the Set Serial Flash Pattern Selection commands. All image processing settings-image crop, image orientation, display size, serial Flash pattern, and input source-must be set before executing the Retrieve Serial Flash Pattern command.

This command has no command parameters.

2.2 Image Control Commands

Image control commands determine the display size, crop portion, and freeze of the image or pattern displayed by the DLPC150.

2.2.1 Set Display Size Command (0x12)

The Set Display Size command specifies the starting size of the pattern or image to be displayed by the DLPC150.

Table 2-22. Set Display Size Command

BYTE	BITS	DESCRIPTION	RESET
0	7:0	Columns or Pixels per Line (LSByte)	0x56
1	7:0	Columns or Pixels per Line (MSByte)	0x03
2	7:0	Rows or Lines per Frame (LSByte)	0xE0
3	7:0	Rows or Lines per Frame (MSByte)	0x01

The parameter values are ‘1’ based, meaning that a value of 854 pixels will display 854 pixels per line.

2.2.2 Read Display Size Command (0x13)

The Read Display Size command reports the size of the pattern or image displayed by the DLPC150.

Table 2-23. Read Display Size Command

BYTE	BITS	DESCRIPTION	RESET
0	7:0	Columns or Pixels per Line (LSByte)	0x56
1	7:0	Columns or Pixels per Line (MSByte)	0x03
2	7:0	Rows or Lines per Frame (LSByte)	0xE0
3	7:0	Rows or Lines per Frame (MSByte)	0x01

The parameter values are ‘1’ based, meaning that a value of 854 pixels will display 854 pixels per line.

2.2.3 Set Image Crop Command (0x10)

The Set Image Crop command specifies which portion of the input image is to be captured and outputted from the cropping function of the DLPC150.This command applies to all input sources: test patterns, serial flash patterns, and Parallel Port interface. Changing the input source does not impact the application of this command.

Table 2-24. Set Image Crop Command

BYTE	BITS	DESCRIPTION	RESET
0	7:0	Capture Start Pixel (LSByte)	0x00
1	7:0	Capture Start Pixel (MSByte)	0x00
2	7:0	Capture Start Line (LSByte)	0x00
3	7:0	Capture Start Line (MSByte)	0x00
4	7:0	Pixels per Line (LSByte)	0xFF
5	7:0	Pixels per Line (MSByte)	0xFF
6	7:0	Lines per Frame (LSByte)	0xFF
7	7:0	Lines per Frame (MSByte)	0xFF

The Capture Start parameters for this command are ‘0’ based , meaning that specifying the capture start pixel with a value of zero would specify the first active pixel of a line. However, the Pixel/Line and Lines/Frame parameters are ‘1’ based, meaning that specifying the pixels/line value with a value of 640 would specify 640 pixels to be captured.

If a crop size parameter exceeds the size of the input image, the input image size minus the Capture Start Pixel/Line will be used, as shown in Figure 2-6. Regardless, the crop size parameters returned by the Read Image Crop command will always be the values specified by the Set Image Crop command.

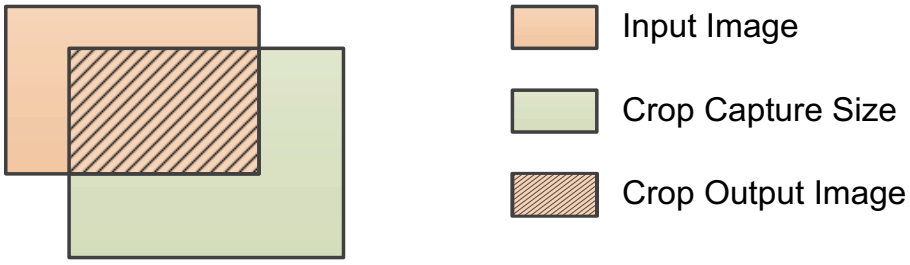

Figure 2-6. Cropping Rules when Crop Size exceeds Input Size

2.2.4 Read Image Crop Command (0x11)

The Read Image Crop command reports the portion of the input image or pattern that is cropped by the DLPC150.

Table 2-25. Read Image Crop Command

BYTE	BITS	DESCRIPTION	RESET
0	7:0	Capture Start Pixel (LSByte)	0x00
1	7:0	Capture Start Pixel (MSByte)	0x00
2	7:0	Capture Start Line (LSByte)	0x00
3	7:0	Capture Start Line (MSByte)	0x00
4	7:0	Pixels per Line (LSByte)	0xFF
5	7:0	Pixels per Line (MSByte)	0xFF
6	7:0	Lines per Frame (LSByte)	0xFF
7	7:0	Lines per Frame (MSByte)	0xFF

All parameters for this command are ‘1’ based, meaning that specifying the capture start pixel with a value of one would specify the first active pixel of a line.

2.2.5 Set Image Freeze Command (0x1A)

The Set Image Freeze command enables or disables the image freeze function of the DLPC150. The DLPC150 allows the image to be frozen to prevent artifacts from being displayed by the DLPC150 during configuration changes. A typical sequence of commands to prevent artifacts from being displayed is:

1. Set Image Freeze command to enable freezing the pattern or image on the DLP2010 or DLP2010NIR.
2. Send commands that take a long time to process, require data to be loaded from serial Flash memory, or change the frame timing of the system.
3. Send Set Image Freeze command to disable freezing the pattern or image on the DLP2010 or DLP2010NIR.

When the image is unfrozen, the DLPC150 displays the most resent input image. Thus input data between the freeze point and the unfreeze point is never displayed.

WARNING

Commands that take a long time to process, require data to be loaded from serial Flash memory, or change the frame timing of the system, have the potential to create artifacts on the DLP2010 or DLP210NIR. The Set Image Freeze command prevents artifacts from being displayef by the DLPC150 during configuration changes.

Table 2-26. Set Image Freeze Command

BYTE	BITS	DESCRIPTION	RESET
0	0	Image Freeze ‘0’: Image Freeze Disabled ’1’: Image Freeze Enabled	0x00
	7:1	Reserved	

Table 2-27 lists commands that benefit from the use of image freeze.

Table 2-27. Commands that Benefit from Image Freeze

COMMAND	DESCRIPTION	NOTES
0x05	Set Input Source Selection Command	
0x07	Set Parallel Port Data Format Selection Command	Freeze the image when using this command while the Parallel Port is set as the input source.
0x0B	Set Parallel Port Data Format Selection Command	
0x0D	Set Serial Flash Pattern Selection Command	Freeze the image when using this command while the serial Flash memory is set as the input source.

Table 2-28 and Table 2-29 show examples using image freeze command.

Table 2-28. Example Using Image Freeze While Setting Serial Flash Parameters

ORDER	COMMAND	DESCRIPTION
1	0x36 0x1A 0x01	Image Freeze Command to hide any artifacts while changing serial Flash parameters
2	0x36 0x10 0x00 0x00 0x00 0x00 0x56 0x03 0xE0 0x01	Set Image Crop Command to set image crop to start at 0, 0 and end at 854, 480.
3	0x36 0x0D 0x00	Set Serial Flash Pattern Selection to pattern 0.
4	0x37 0x35	Retrieve Serial Flash Pattern. Serial Flash Patten 0 will be displayed on the DLP2010 or DLP210NIR regardless of the image freeze setting. However, the unfreeze command must still be executed.
5	wait 350 ms	
6	0x36 0x1A 0x00	Image Unfreeze Command to show the changed image.

Table 2-29. Example Using Image Freeze While Setting Test Pattern Generator Parameters

ORDER	COMMAND	DESCRIPTION
1	0x36 0x1A 0x01	Image Freeze Command to hide any artifacts while changing serial Flash parameters
2	0x36 0xF1 0x60 0x22 0x00 0x40 0x01 0x00 0x00 x00	Stop sequencer
3	0x36 0x10 0x00 0x00 0x00 0x00 0x56 0x03 0xE0 0x01	Set Image Crop Command to set image crop to start at 0, 0 and end at 854, 480.
4	0x36 0x0B 0x07 0x70 0x10 0x00 0x0C 0x00	Set Test Pattern Selection to checkboard with 16 horizontal and 12 vertical checkers.
5	0x36 0x05 0x01	Set Input Source Selection to Test Pattern Generator.
6	0x36 0x1A 0x00	Image Unfreeze Command to show the changed image.

2.2.6 Read Image Freeze Status Command (0x1B)

The Read Image Freeze command reports the state of the image freeze function of the DLPC150.

Table 2-30. Read Image Freeze Command

BYTE	BITS	DESCRIPTION	RESET
0	0	Image Freeze '0': Image Freeze Disabled '1': Image Freeze Enabled	00h
	7:1	Reserved	

2.3 Status Commands

2.3.1 Read Short Status Command (0xD0)

The Read Short Status command reports the overall system status summary of the DLPC150. To prevent impacting system performance, the Read Short Status command should only be checked periodically, not continuously.

Table 2-31. Read Short Status Command

BYTE	BITS	DESCRIPTION	RESET
0	0	System Initialization '0': Not Complete '1': Complete	0x00
	1	Communication Error '0': No Error '1': Error on I2C command interface. Issue Read Communication Status command to find more information about the error.	
	2	Reserved	
	3	System Error, not including Communication nor Flash error. '0': No Error '1': Error. Issue Read System Status command to find more information about the error.	
	4	Flash Erase Complete '0': Complete '1': Not Complete	
	5	Flash Error 0: No Error 1: Error	
	6	Reserved	
	7	Boot/Main Application '0': Boot '1': Main	

2.3.2 Read System Status Command (0xD1)

The Read Status command reports the system status information for the DLPC150. All system status error bits are cleared when the command is executed.

BYTE	Description
0	DMD Interface Status
1	Reserved
2	Reserved
3	Reserved

Table 2-32. System Status Byte 0

BYTE	BITS	DESCRIPTION	RESET
0	0	DMD Device Error '0': No Error '1': Error, cannot read DLP2010 or DLP2010NIR Device ID	0x00
	1	DMD Interface Error '0': No Error '1': Error on PMIC setup	
	2	DMD Training Error '0': No Error '1': Error, data does not specifications	
	7:3	Reserved	

2.3.3 Read System Software Version Command (0xD2)

The Read System Software Version command reports the firmware software version information for the DLPC150.

Table 2-33. Read System Software Version Command

BYTE	BITS	DESCRIPTION	RESET
0	7:0	DLPC150 Application Software Version – Patch LSByte	0x00
1	7:0	DLPC150 Application Software Version – Patch MSByte	0x00
2	7:0	DLPC150 Application Software Version – Minor	0x00
3	7:0	DLPC150 Application Software Version – Major	0x00

2.3.4 Read Communication Status Command (0xD3)

The Read Communication Status command reports the I²C communication status of the DLPC150. This command returns six bytes shown in Table 2-35. For example, the host isssues command 0x36 0xD3 0x2 followed by six byte read 0x37 byte1 byte2 byte3 byte4 byte5 byte6.

Table 2-34. Read Communication Status Command Parameter

BYTE	BITS	DESCRIPTION	RESET
0	1:0	0x2: I²C communication	0x02
	7:2	Reserved	

Table 2-35. Communication Status Bytes Returned

BYTE	BITS	DESCRIPTION	RESET
1	7:0	Reserved	
2	7:0	Reserved	
3	7:0	Reserved	
4	7:0	Reserved	
5	0	Invalid Command Error. The command number is not recognized. 0x0: No Error 0x1: Error	
	1	Invalid Command Parameter Value. The parameter value is not recognized or out of range. 0x0: No Error 0x1: Error	
	2	Command Processing Error. 0x0: No Error 0x1: Error	
	3	Reserved	
	4	Read Command Error. Host terminated read operation before all the data was read by the host or the host continues to request read data after all the data has been provided. 0x0: No Error 0x1: Error	
	5	Invalid Number of Command Parameters. Too many or too few command parameters are received. When this error occurs, the command is aborted and the DLPC150 proceed to process the next command. The command number associated with the error is reported in byte 6 0x0: No Error 0x1: Error	
	6	Bus Timeout by DMD Error. DMD released control of the bus when the timeout value has been exceeded. 0x0: No Error 0x1: Error	
	7	Reserved	
6	7:0	I²C command number that produced an invalid number of command parameters error.	

2.3.5 GPIO Control

The DLPC150 includes 13 pins with general purpose input and output (GPIO) functionality. Each one of these GPIO pins can be individually programmed to an input or output pin.

2.3.5.1 Set GPIO Control Command (0x31)

The Set GPIO Control command specifies the function of programmable GPIO_19, GPIO_17 through GPIO_09, and GPIO_07 through GPIO_05 of the DLPC150.

Table 2-36. Set GPIO Control Command

BYTE	BITS	DESCRIPTION	RESET
0	1:0	GPIO_09	
		0: LS_PWR	
		1: Input	
		2: Output (Standard)	
		3: Output (Open Drain)	
	3:2	GPIO_10	
		0: RC_CHARGE	
		1: Input	
		2: Output (Standard)	
		3: Output (Open Drain)	
	5:4	GPIO_11	
		0: Thermistor power enable	
		1: Input	
		2: Output (Standard)	
		3: Output (Open Drain)	
	7:6	GPIO_12	
		0: Reserved	
		1: Input	
		2: Output (Standard)	
		3: Output (Open Drain)	
1	1:0	GPIO_13	
		0: CAL_PWR	
		1: Input	
		2: Output (Standard)	
		3: Output (Open Drain)	
	3:2	GPIO_14	
		0: Reserved	
		1: Input	
		2: Output (Standard)	
		3: Output (Open Drain)	
	5:4	GPIO_15	
		0: KEYPAD_0	
		1: Input	
		2: Output (Standard)	
		3: Output (Open Drain)	
	7:6	Reserved	

Table 2-36. Set GPIO Control Command (continued)

BYTE	BITS	DESCRIPTION	RESET
2	1:0	GPIO_17	
		0: KEYPAD_2	
		1: Input	
		2: Output (Standard)	
		3: Output (Open Drain)	
	3:2	GPIO_18	
		0: KEYPAD_2	
		1: Input	
		2: Output (Standard)	
		3: Output (Open Drain)	
	5:4	GPIO_19	
		0: KEYPAD_4	
		1: Input	
		2: Output (Standard)	
		3: Output (Open Drain)	
	7:6	Reserved	
3	1:0	Reserved	
	3:2	GPIO_05	
		0: Reserved	
		1: Input	
		2: Output (Standard)	
		3: Output (Open Drain)	
	5:4	GPIO_06	
		0: Reserved	
		1: Input	
		2: Output (Standard)	
		3: Output (Open Drain)	
	7:6	GPIO_07	
		0: LED_ENABLE	
		1: Input	
		2: Output (Standard)	
		3: Output (Open Drain)	

2.3.5.2 Read GPIO Control (0x32)

The Read GPIO Control command reports the function of programmable GPIO_19, GPIO_17 through GPIO_09, and GPIO_07 through GPIO_05 of the DLPC150.

Table 2-37. Read GPIO Control Command

BYTE	BITS	DESCRIPTION	RESET
0	1:0	GPIO_09	
		0: LS_PWR	
		1: Input	
		2: Output (Standard)	
		3: Output (Open Drain)	
	3:2	GPIO_10	
		0: RC_CHARGE	
		1: Input	
		2: Output (Standard)	
		3: Output (Open Drain)	
	5:4	GPIO_11	
		0: Thermistor power enable	
		1: Input	
		2: Output (Standard)	
		3: Output (Open Drain)	
	7:6	GPIO_12	
		0: Reserved	
		1: Input	
		2: Output (Standard)	
		3: Output (Open Drain)	
1	1:0	GPIO_13	
		0: CAL_PWR	
		1: Input	
		2: Output (Standard)	
		3: Output (Open Drain)	
	3:2	GPIO_14	
		0: Reserved	
		1: Input	
		2: Output (Standard)	
		3: Output (Open Drain)	
	5:4	GPIO_15	
		0: KEYPAD_0	
		1: Input	
		2: Output (Standard)	
		3: Output (Open Drain)	
	7:6	Reserved	

Table 2-37. Read GPIO Control Command (continued)

BYTE	BITS	DESCRIPTION	RESET
2	1:0	GPIO_17	
		0: KEYPAD_2	
		1: Input	
		2: Output (Standard)	
		3: Output (Open Drain)	
	3:2	GPIO_18	
		0: KEYPAD_3	
		1: Input	
		2: Output (Standard)	
		3: Output (Open Drain)	
	5:4	GPIO_19	
		0: KEYPAD_4	
		1: Input	
		2: Output (Standard)	
		3: Output (Open Drain)	
	7:6	Reserved	
3	1:0	Reserved	
	3:2	GPIO_05	
		0: Reserved	
		1: Input	
		2: Output (Standard)	
		3: Output (Open Drain)	
	5:4	GPIO_06	
		0: Reserved	
		1: Input	
		2: Output (Standard)	
		3: Output (Open Drain)	
	7:6	GPIO_07	
		0: LED_ENABLE	
		1: Input	
		2: Output (Standard)	
		3: Output (Open Drain)	

2.3.5.3 Set GPIO Output (0x33)

The Set GPIO Output command specifies the configured outputs and output values of programmable GPIO_19, GPIO_17 through GPIO_09, and GPIO_07 through GPIO_05 of the DLPC150. In order to set the value of a GPIO, the GPIO must be selected using bytes 1 to 3 of this command, with the appropriate value then being specified using bytes 3 to 6.

Table 2-38. Set GPIO Output Command

BYTE	BITS	DESCRIPTION	RESET
0	0	Reserved	
	1	Reserved	
	2	Reserved	
	3	Reserved	
	4	Reserved	
	5	GPIO_5	
		0h: Not Selected	
		1h: Selected	
	6	GPIO_6	
		0h: Not Selected	
		1h: Selected	
	7	GPIO_7	
		0h: Not Selected	
		1h: Selected	
1	0	GPIO_9	
		0h: Not Selected	
		1h: Selected	
	1	GPIO_10	
		0h: Not Selected	
		1h: Selected	
	2	GPIO_11	
		0h: Not Selected	
		1h: Selected	
	3	GPIO_12	
		0h: Not Selected	
		1h: Selected	
	4	GPIO_13	
		0h: Not Selected	
		1h: Selected	
	5	GPIO_14	
		0h: Not Selected	
		1h: Selected	
	6	GPIO_15	
		0h: Not Selected	
		1h: Selected	
	7	Reserved	

Table 2-38. Set GPIO Output Command (continued)

BYTE	BITS	DESCRIPTION	RESET
2	0	GPIO_17	
		0h: Not Selected	
		1h: Selected	
	1	GPIO_18	
		0h: Not Selected	
		1h: Selected	
	2	GPIO_19	
		0h: Not Selected	
		1h: Selected	
	7:3	Reserved	
3	0	Reserved	
	1	Reserved	
	2	Reserved	
	3	Reserved	
	4	Reserved	
	5	GPIO_5	
	6	GPIO_6	
	7	GPIO_7	
4	0	GPIO_9	
	1	GPIO_10	
	2	GPIO_11	
	3	GPIO_12	
	4	GPIO_13	
	5	GPIO_14	
	6	GPIO_15	
	7	Reserved	
5	0	GPIO_17	
	1	GPIO_18	
	2	GPIO_19	
	7:3	Reserved	

2.3.5.4 Read GPIO Output Command (0x33h)

The Read GPIO Output command reports the output values of the currently programmed outputs of the GPIO(19), GPIO(17:09), and GPIO(07:05) of the DLPC150.

Table 2-39. Read GPIO Output Command

BYTE	BITS	DESCRIPTION	RESET
0	0	Reserved	00h
	1	Reserved	
	2	Reserved	
	3	Reserved	
	4	Reserved	
	5	GPIO_5	
	6	GPIO_6	
	7	GPIO_7	
1	0	GPIO_9	00h
	1	GPIO_10	
	2	GPIO_11	
	3	GPIO_12	
	4	GPIO_13	
	5	GPIO_14	
	6	GPIO_15	
	7	Reserved	
2	0	GPIO_17	00h
	1	GPIO_18	
	2	GPIO_19	
	7:3	Reserved	

2.4 Sequencer Commands

The DLPC150 includes a sequencer that directs the operations to load and control of the DLP2010 or DLP2010NIR in real-time. Four sequencer commands control loading a sequence vector, disabling and enabling the sequencer, and reading the sequencer state of the DLPC150.

2.4.1 Disable Sequencer Command

The Disable Sequencer command disables the sequencer. The 9-byte I²C command is shown in Table 2-40. This command must be the first when reconfiguring the sequencer.

Table 2-40. Disable Sequencer Command

BYTE	BITS	DESCRIPTION	RESET
0	7:0	0xF1: Sequencer command	
1	7:0	0x00: Disable sequencer command parameters	
2	7:0	0x22	
3	7:0	0x00	
4	7:0	0x40	
5	7:0	0x20	
6	7:0	0x10	
7	7:0	0x00	
8	7:0	0x00	

2.4.2 Enable Sequencer Command

The Enable Sequencer command enables the sequencer. The 9-byte I²C command is shown in Table 2-41. This command must be the last when reconfiguring the sequencer.

Table 2-41. Enable Sequencer Command

BYTE	BITS	DESCRIPTION	RESET
0	7:0	0xF1: Sequencer command	
1	7:0	0x00: Enable sequencer command parameters	
2	7:0	0x22	
3	7:0	0x00	
4	7:0	0x40	
5	7:0	0x21	
6	7:0	0x10	
7	7:0	0x00	
8	7:0	0x00	

2.4.3 Stop Sequencer Command

The Stop Sequencer command stops the sequencer. The 9-byte I²C command is shown in Table 2-42. This command must be issued a 100 ms after a change of the input source with the Set Input Source command.

Table 2-42. Stop Sequencer Command

BYTE	BITS	DESCRIPTION	RESET
0	7:0	0xF1: Sequencer command	
1	7:0	0x60: Stop sequencer command parameters	
2	7:0	0x22	
3	7:0	0x00	

Table 2-42. Stop Sequencer Command (continued)

BYTE	BITS	DESCRIPTION	RESET
4	7:0	0x40	
5	7:0	0x01	
6	7:0	0x00	
7	7:0	0x00	
8	7:0	0x00	

2.4.4 Select Sequencer Vector Command

The Select Sequencer Vector command loads a predetermined sequence of operations to control the display of the DLP2010 and DLP2010NIR. The DLPC150 supports four display sequences described in Section 2.5. The 9-byte I^2C command is shown in Table 2-43.

Table 2-43. Stop Sequencer Command

BYTE	BITS	DESCRIPTION	RESET
0	7:0	0xF1: Sequencer command	
1	7:0	0x14: Select display sequence vector parameters	
2	7:0	0x22	
3	7:0	0x00	
4	7:0	0x40	
5	7:0	0x00	
6	7:0	Vector Number LSB 0x00: Pattern load from Serial Flash Memory with 16-bit RGB565 Data Format	
		0x01: Pattern Streamed through the Parallel Port Interface with 16-bit RGB565 Data Format	
		0x02: Pattern Streamed through the Parallel Port Interface with 24-bit RGB888 Data Format	
		0x03: Pattern Streamed through the Parallel Port Interface with External Trigger input and 24-bit RGB888 Data Format	
7	7:0	Vector Number MSB 0x01: Pattern load from Serial Flash Memory with 16-bit RGB565 Data Format	
		0x01: Pattern Streamed through the Parallel Port Interface with 16-bit RGB565 Data Format	
		0x01: Pattern Streamed through the Parallel Port Interface with 24-bit RGB888 Data Format	
		0x18: Pattern Streamed through the Parallel Port Interface with External Trigger input and 24-bit RGB888 Data Format	
8	7:0	0x00	

2.5 Display Sequences

A DLP display sequence consists of several parameters that dictate how the DLPC150 loads the DLP2010 or DLP2010NIR. When loading from serial Flash memory, the DLPC150 stores a 24-bit frame in its internal memory buffer and then it is sent to the DLP2010 or DLP2010NIR. When streaming data from the Parallel Port interface, the DLPC150 takes advantage of a second 24-bit buffer to pipeline the data to the DLP2010 or DLP2010NIR: one buffer sends data to the DLP2010 or DLP2010NIR while the second buffer is filled from the Parallel Port interface. After a 24-bit frame is displayed, the buffer rotates providing the next 24-bit frame to the DLP2010 or DLP2010NIR, while the previously used one is filled with new data. Therefore, the displayed image is a 24-bit frame behind the data streamed through the Parallel Port interface. The DLPC150 supports the following sequence modes:

- Pattern load from serial Flash memory with 16-bit RGB565 data format.
- Pattern streamed through the Parallel Port interface with 16-bit RGB565 data format.
- Pattern streamed through the Parallel Port interface with 24-bit RGB888 data format.
- Pattern streamed through the Parallel Port interface with external trigger input and 24-bit RGB888 data format.

The DLPC150 includes a sequencer that directs the operations to load and control of the DLP2010 or DLP2010NIR in real-time. Four sets of sequencer commands control loading the patterns in Flash memory or streamed through the Parallel Port interface.

NOTE: The trigger output (TRIG_OUT_1) signal remains undefined from the reset of DLPC150 until the last command to configure the display sequence is interpreted by the DLPC150. During this time ignore any spurious TRIG_OUT_1 signals.

2.5.1 Pattern Load from Serial Flash Memory with 16-bit RGB565 Data Format (0xF4)

The DLPC150 retrieves patterns stored in serial Flash memory with 16-bit RGB565 data format with the I^2C commands shown in Table 2-44.

Table 2-44. Pattern Load from Serial Flash Memory Command Sequence

ORDER	COMMAND	DESCRIPTION
1	0x36 0x05 0x02	Set input source select to serial Flash memory
2	0x36 0xF4	Pattern Load from Serial Flash Memory with 16-bit RGB565 Data Format

The pattern display behavior and output trigger behavior in this mode is illustrated in Figure 2-7. In this figure R, G, and B refers to the corresponding bit-plane when a 16 binary patterns are combined into a single 16-bit RGB565 image and stored in SPI Flash memory. Dark refers to a black bit plane to measure dark time of a detector. This sequence supports a pattern exposure of 933.7 µs.

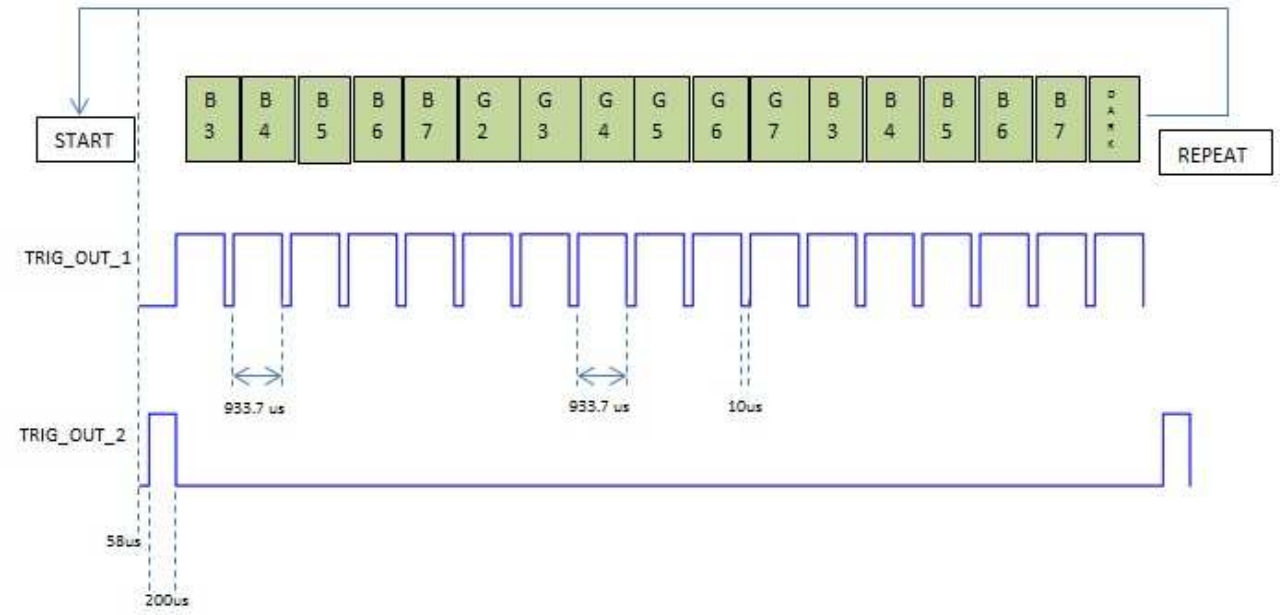

Figure 2-7. Flash Pattern Display Behavior

2.5.2 Pattern Streamed through the Parallel Port Interface with 16-bit RGB565 Data Format (0xF5)

The DLPC150 displays streamed patterns through the Parallel Port interface with 16-bit RGB565 data format with the I^2C commands shown in Table 2-45.

Table 2-45. 16-bit Parallel Port Streaming Pattern Mode Command Sequence

ORDER	COMMAND	DESCRIPTION
1	0x36 0x10 0x00 0x00 0x00 0x00 0x56 0x03 0xE0 0x01	Set image crop to start at 0, 0 and end at 854, 480
2	0x36 0x12 0x56 0x03 0xE0 0x01	Set display size to 854 × 480
3	0x36 0x2E 0x56 0x03 0xE0 0x01	Set image size to 854 × 480
4	0x36 0x05 0x00	Set input source select to Parallel Port
5	0x36 0xF5 0x00	Pattern Streamed through the Parallel Port Interface with 16-bit RGB565 Data Format

The pattern display behavior and output trigger behavior in this mode is illustrated in Figure 2-8. In this figure, R, G, and B refers to the corresponding bit plane when a 16 binary patterns are combined into a single 16-bit RGB565 image and streamed through the Parallel Port. Dark refers to a black bit plane to measure dark time of a detector. This sequence supports a pattern exposure of 933.7 µs.

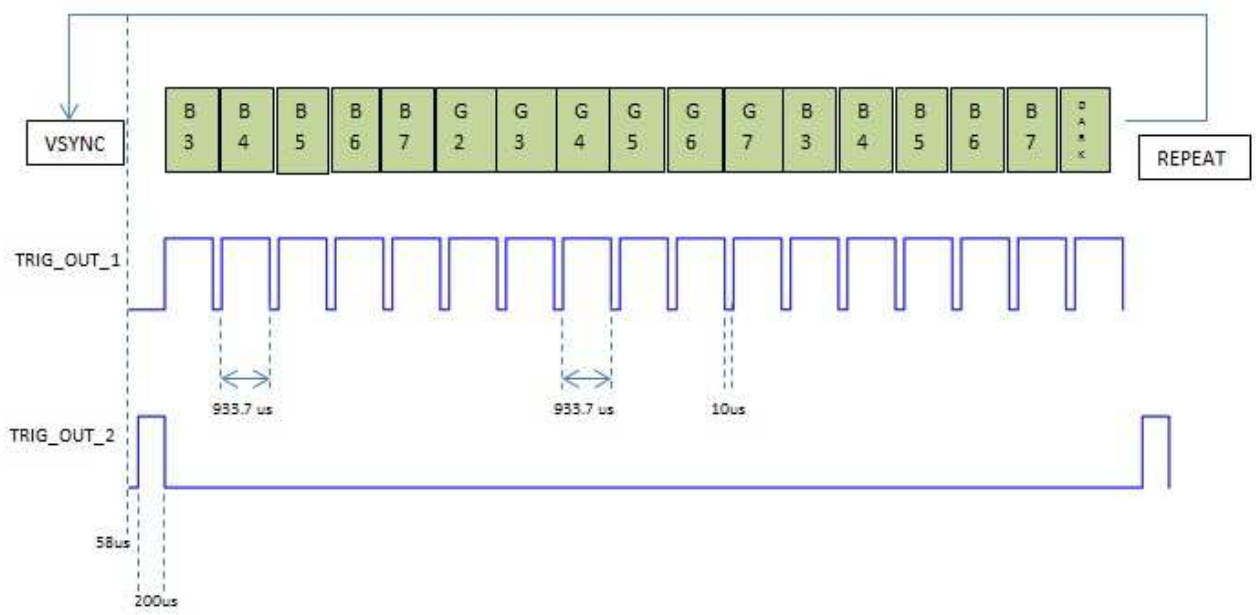

Figure 2-8. 16-bit Parallel Port Streaming Pattern Behavior

2.5.3 Pattern Streamed through the Parallel Port Interface with 24-bit RGB888 Data Format (0xF5)

The DLPC150 displays streamed patterns through the Parallel Port interface with 24-bit RGB888 data format with the I^2C commands shown in Table 2-46.

Table 2-46. 24-bit Parallel Port Streaming Pattern Mode Command Sequence

ORDER	COMMAND	DESCRIPTION
1	0x36 0x10 0x00 0x00 0x00 0x00 0x56 0x03 0xE0 0x01	Set image crop to start at 0, 0 and end at 854, 480
2	0x36 0x12 0x56 0x03 0xE0 0x01	Set display size to 854 × 480
3	0x36 0x2E 0x56 0x03 0xE0 0x01	Set image size to 854 × 480
4	0x36 0x05 0x00	Set input source select to Parallel Port
5	0x36 0xF5 0x01	Pattern Streamed through the Parallel Port Interface with 24-bit RGB888 Data Format

The pattern display behavior and output trigger behavior in this mode is illustrated in Figure 2-9. In this figure, R, G, and B refers to the corresponding bit plane when a 24 binary patterns are combined into a single 24-bit RGB888 image and streamed through the Parallel Port. Dark refers to a black bit plane to measure dark time of a detector. This sequence supports a pattern exposure of 625 µs.

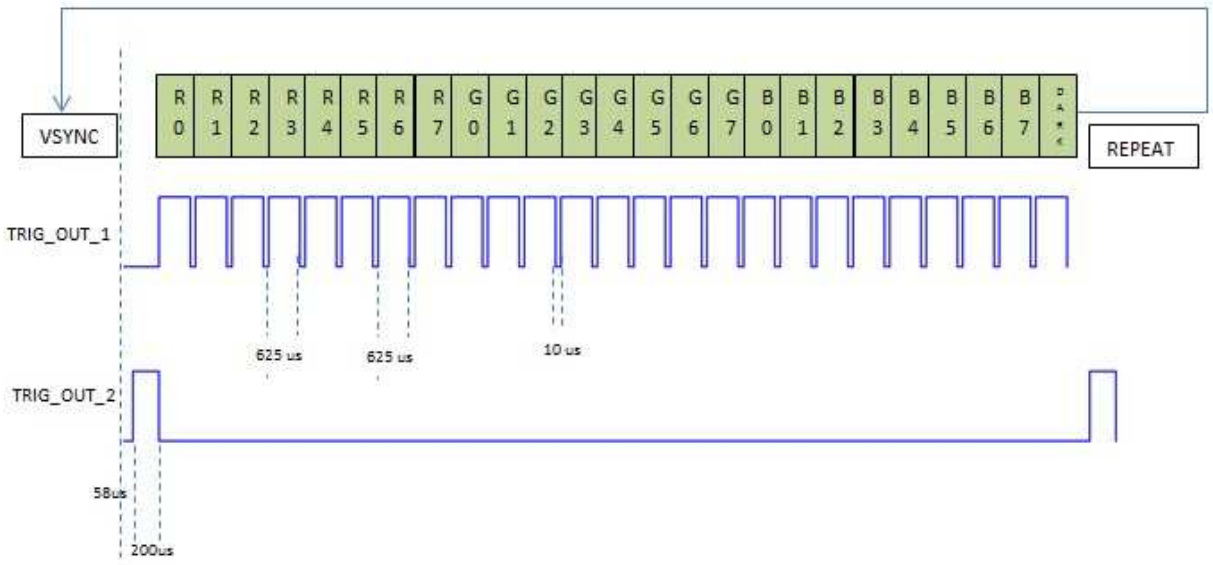

Figure 2-9. 24-bit Parallel Port Streaming Pattern Behavior

2.5.4 Pattern Streamed through the Parallel Port Interface with External Trigger input and 24-bit RGB888 Data Format (0xF6)

The DLPC150 displays streamed patterns through the Parallel Port interface with external trigger input (TRIG_IN_1) and 24-bit RGB888 data format with the I^2C commands shown in Table 2-47. This mode supports a pattern exposure greater than 350 µs.

Table 2-47. 24-bit Parallel Port Streaming Pattern Mode with External Trigger Command Sequence

ORDER	COMMAND	DESCRIPTION
1	0x36 0x10 0x00 0x00 0x00 0x00 0x56 0x03 0xE0 0x01	Set image crop to start at 0, 0 and end at 854, 480
2	0x36 0x12 0x56 0x03 0xE0 0x01	Set display size to 854 × 480
3	0x36 0x2E 0x56 0x03 0xE0 0x01	Set image size to 854 × 480
4	0x36 0x05 0x00	Set input source select to Parallel Port
5	0x36 0xF6 0x00	Pattern Streamed through the Parallel Port Interface with External Trigger input and 24-bit RGB888 Data Format

The pattern display behavior and output trigger behavior in this mode is illustrated in Figure 2-10.

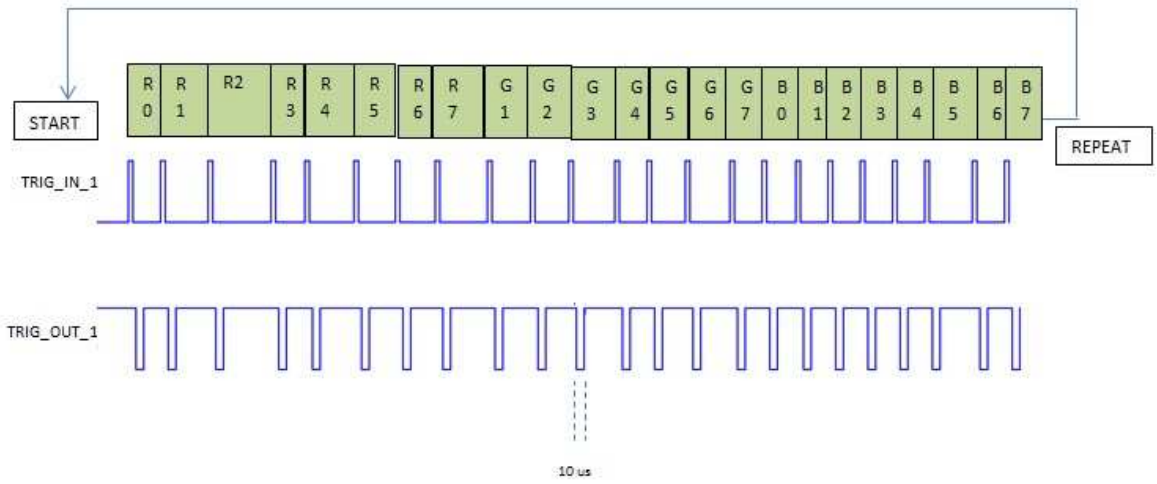

Figure 2-10. 24-bit Parallel Port Streaming Pattern with External Trigger Behavior

I²C Command Reference Summary

A.1 I²C Command Reference

This appendix provides a quick reference summary of all available I²C commands.

Table A-1. I²C Command Quick Reference

COMMAND NUMBER	DESCRIPTION	TYPE	RESET VALUE	ACTION
INPUT SOURCE COMMANDS				
0x05	Set Input Source Selection Command	Write	0x01	Selects the input source: Parallel Port, Test Pattern Generator, or SPI Flash Memory.
0x06	Read Input Source Selection Command	Read	0x01	Reports the currently selected input source: Parallel Port, Test Pattern Generator, or SPI Flash Memory.
PARALLEL PORT COMMANDS				
0x07	Set Parallel Port Data Format Selection Command	Write	0x43	Specifies the source data type for the Parallel Port interface: 16-bit RGB565 or 24-bit RGB888.
0x08	Read Parallel Port Data Format Selection Command	Read	0x43	Reports the source data type for the Parallel Port interface: 16-bit RGB565 or 24-bit RGB888.
0x2E	Set Parallel Port Input Image Size Command	Write	0x56 0x03 0xE0 0x01	Specifies the data size of the Parallel Port input image of the DPLC150.
0x2F	Read Parallel Port Input Image Size Command	Read	0x56 0x03 0xE0 0x01	Reports the data size of the Parallel Port input image of the DPLC150.
0xB6	Set Parallel Port SYNC Polarity Command	Write	0x00	Specifies the SYNC polarity for the Parallel Port interface of the DLPC150.
0xB7	Read Parallel Port SYNC Polarity Command	Read	0x00	Reports the state of the SYNC polarity for the Parallel Port interface of the DLPC150.
0xB8	Set Parallel Port Manual Image Framing Command	Write	0x00	Specifies the Parallel Port interface manual image framing parameters for the DLPC150.
0xB9	Read Parallel Port Manual Image Framing Command	Read	0x00	Reports the Parallel Port interface manual image framing parameters for the DLPC150.
0xBA	Read Auto Framing Information Command	Read	0x00	Reports the input framing information for the Parallel Port interface.
TEST PATTERN GENERATOR COMMANDS				
0x0B	Set Test Pattern Selection Command	Write	Parameter Dependent	Specifies the internal test pattern used by the DLPC150: solid filed, horizontal lines, vertical lines, horizontal and vertical grid, or checkerboard.
0x0C	Read Test Pattern Selection	Read	Parameter Dependent	Reports the internal test pattern used by the DLPC150: solid filed, horizontal lines, vertical lines, horizontal and vertical grid, or checkerboard.
SERIAL FLASH PATTERN COMMANDS				
0x0D	Set Serial Flash Pattern Selection Command	Write	0x00	Selects a pattern stored in the serial Flash memory of the DLPC150.
0x0E	Read Serial Flash Pattern Selection Command	Read	0x00	Reports the pattern selected from the serial Flash memory of the DLPC150.
0x35	Retrieve Serial Flash Pattern Command	Read	-	Starts the DLPC150 process of retrieving a pattern from serial Flash memory.

Table A-1. I²C Command Quick Reference (continued)

COMMAND NUMBER	DESCRIPTION	TYPE	RESET VALUE	ACTION
IMAGE CONTROL COMMANDS				
0x12	Set Display Size Command	Write	0x56 0x03 0xE0 0x01	Specifies the size of the pattern or image to be displayed by the DLPC150.
0x13	Read Display Size Command	Read	0x56 0x03 0xE0 0x01	Reports the size of the pattern or image to be displayed by the DLPC150.
0x10	Set Image Crop Command	Write	0xFF	Specifies which portion of the input image is to be captured and output from the cropping function of the DLPC150.
0x11	Read Image Crop Command	Read	0xFF	Reports the portion of the input image or pattern that is cropped by the DLPC150.
0x1A	Set Image Freeze Command	Write	0x00	Enables or disables the image freeze function of the DLPC150.
0x1B	Read Image Freeze Status Command	Read	0x00	Reports the state of the image freeze function of the DLPC150.
STATUS COMMANDS				
0xD0	Read Short Status Command	Read	0x00	Reports the overall system status summary of the DLPC150.
0xD1	Read System Status Command	Read	0x00	Reports the system status information for the DLPC150.
0xD2	Read System Software Version Command	Read	0x00	Reports the firmware software version information for the DLPC150.
0xD3	Read Communication Status	Read	0x00	reports the I²C communication status of the DLPC150
GPIO CONTROL COMMANDS				
0x31	Set GPIO Control	Write	0x00	Specifies the function of programmable GPIO(19), GPIO(17:09), and GPIO(07:05) of the DLPC150.
0x32	Read GPIO Control	Read	0x00	Reports the current function selected of the programmable GPIO(19), GPIO(17:09), and GPIO(07:05) of the DLPC150.
0x33	Set GPIO Outputs	Write	0x00	Specifies the configured outputs and output values of programmable GPIO(19), GPIO(17:09), and GPIO(07:05) of the DLPC150.
0x34	Read GPIO Outputs	Read	0x00	Reports the output values of the currently programmed outputs GPIO(19), GPIO(17:09), and GPIO(07:05) of the DLPC150.
DISPLAY SEQUENCES COMMANDS				
0xF4	Pattern Load from Serial Flash Memory	Write	0x00	Loads a 16-bit RGB565 pattern from serial Flash memory
0xF5	Pattern Load from Parallel Port Interface	Write	0x00	Streams a 16-bit RGB565 or 24-bit RGB888 pattern from the Parallel Port interface
0xF6	Pattern Load from Parallel Port Interface with External Trigger Input	Write	0x00	Streams a 16-bit RGB565 or 24-bit RGB888 pattern from the Parallel Port interface with an external trigger input

Revision History

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

Changes from Original (March 2015) to A Revision **Page**

- Updated Section 1.1.4.1 and Section 1.1.5.1 for clarification 6
- Added note of spurious trgigger outputs while display sequence is configured. 35
- Updated Section 2.5 to support v1.1 and later of DLPC150 firmware changes 35
- Updated pattern control commands in Table 2-44, Table 2-45, Table 2-46, and Table 2-47 to support v1.1 and later of DLPC150 firmware changes 36
- Added pattern exposure timing for 24-bit RGB888 display sequence. 38
- Added pattern exposure timing for 24-bit RGB888 with external trigger display sequence. 38
- Changed 24-bit RGB888 with external trigger behaviour figure 39

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