

## Key Features

- SMPTE ST 2081, ST 424, ST 292, and ST 259-C compliant
- Supports retiming data at rates of 125Mb/s, 270Mb/s, 1.485 and 1.485/1.001Gb/s, 2.97 and 2.97/1.001Gb/s, 5.94 and 5.94/1.001Gb/s
- Supports retiming of DVB-ASI signals
- Automatic or Manual Rate Selection
  - ◆ Detected rate indication in Auto Mode
- 2:1 input selector
- Option of two reclocked data outputs
- Two configurable GPIO pins with ability to output device status, including:
  - ◆ Lock Detect
  - ◆ Loss of Signal (LOS)
  - ◆ Low/High bit-rate indication for slew-rate control of SDI cable drivers
- On-chip 100Ω differential input and output termination
- Bypass support for rates up to 5940Mb/s
  - ◆ Manual Bypass function
  - ◆ Configurable automatic Bypass when not locked
- Option to use external reference or operate referenceless
- Cascading reference buffer supports multiple CDRs using a single reference source
- Input signal equalization and output signal de-emphasis to compensate for trace dielectric losses
- Single power supply operation at 1.8V
- 130mW typical power consumption (150mW with second output enabled)
- Pb-free and RoHS compliant
- Operating temperature range: -40°C to 85°C

## Applications

- SMPTE ST 2081, SMPTE ST 424, SMPTE ST 292, SMPTE ST 259-C coaxial cable serial digital interfaces
- EN50083-9 DVB-ASI interfaces
- MADI standard

## Description

The GS6151 is a low-power, multi-rate serial digital CDR designed to automatically recover the embedded clock from a digital video signal and re-time the incoming video data.

The GS6151 will recover the embedded clock signal and re-time the data from 6G UHD-SDI signals compliant with SMPTE ST 2081. In addition, it can also re-time SMPTE ST 259-C, SMPTE ST 292, SMPTE ST 424 or DVB-ASI compliant digital video signals as well as MADI audio streams.

The GS6151 features two high-speed differential signal inputs feeding a 2:1 input selector. Input termination is on-chip for seamless matching to 100Ω differential transmission lines. The input selector is a component of a video switching system with tightly constrained timing requirements.

The GS6151 includes programmable trace equalization to compensate for high-frequency losses associated with board-level interconnect.

Two CML outputs interface seamlessly to devices with a CML input reference between 1.2V and 2.5V.

Programmable output swing and de-emphasis provide flexibility in managing signal integrity of the output signals.

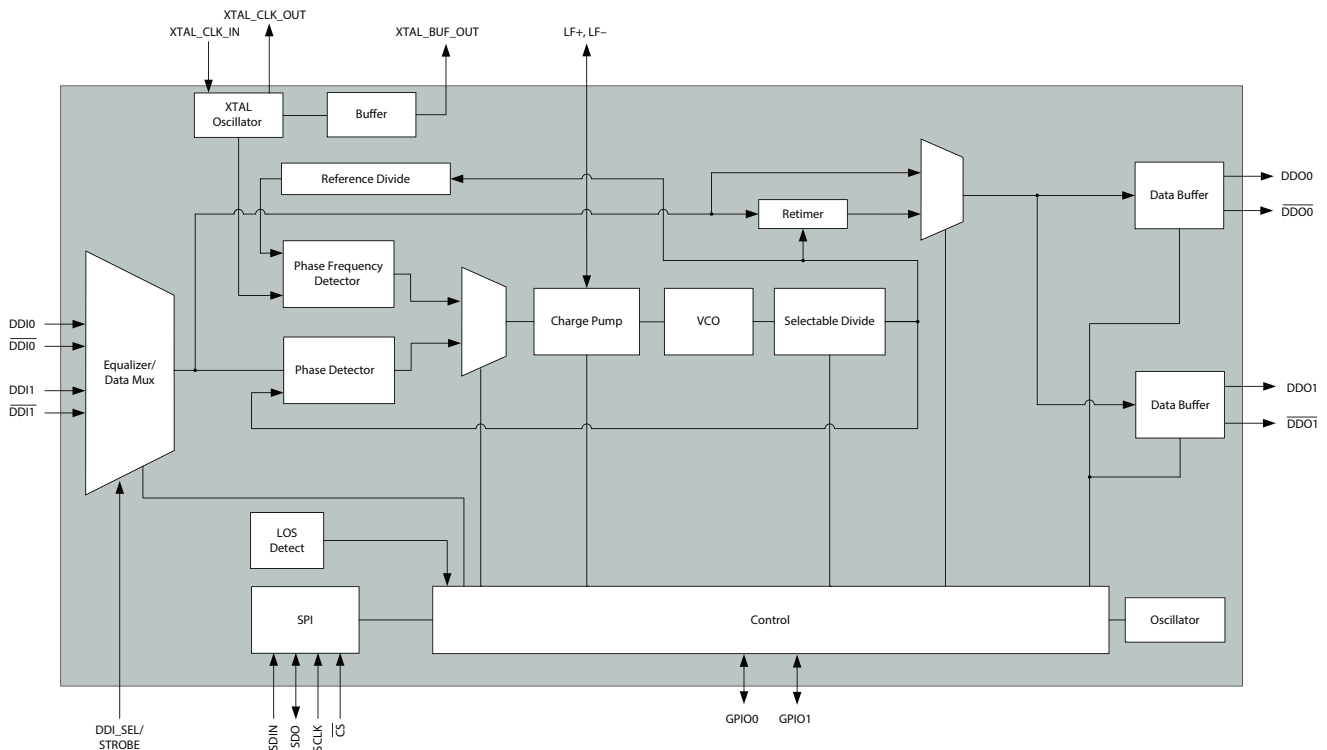
The GS6151 can operate in either automatic rate detection or manual rate selection mode. In auto mode the device will automatically detect and lock onto incoming data signals at any supported rate.

The device can operate without an external 27MHz frequency reference. For applications which require rapid signal lock, an external 27MHz reference may be used to set the VCO frequency when not locked to the input signal. The presence of an external reference crystal is automatically detected by the device.

In systems that require passing of non-supported data rates, the GS6151 can be configured to either automatically or manually enter a bypass mode in order to pass the signal without relocking.

A four-wire Gennum Serial Peripheral Interface (GSPI) facilitates configuration and status monitoring of the device. Multiple GS6151 devices can be daisy-chained together with a single 4-pin connection to the host system.

This device is Pb-free, and the encapsulation compound does not contain halogenated flame retardant. This component and all homogenous sub-components are RoHS compliant.



**GS6151 Functional Block Diagram**

## Revision History

Version	ECO	PCN	Date	Changes and/or Modifications
4	027137	—	August 2015	Updated date and revision number
3	027035	—	July 2015	Updated <a href="#">Table 2-2</a> , <a href="#">Table 2-3</a> , and <a href="#">Table 5-1</a> . Updated to Final Data Sheet.
2	026418	—	July 2015	Updated <a href="#">Table 2-2</a> , <a href="#">Table 2-3</a> , <a href="#">Section 4.12</a> and <a href="#">Table 5-1</a> .
1	024872	—	May 2015	Updated <a href="#">Table 5-1</a> .
0	022627	—	October 2014	New Document

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# 1. Pin Out

## 1.1 Pin Assignment

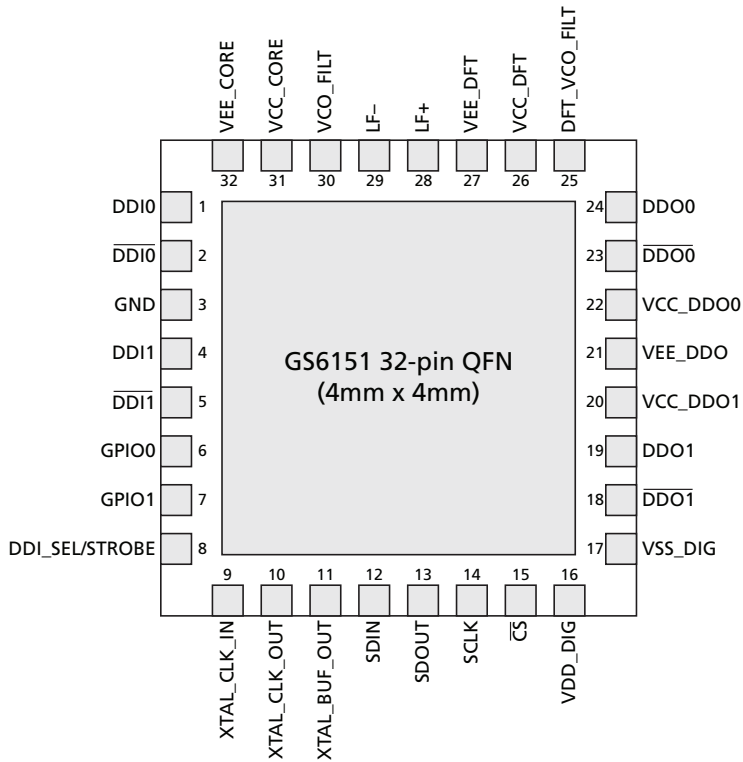


Figure 1-1: GS6151 Pin Out

## 1.2 Pin Descriptions

**Table 1-1: GS6151 Pin Descriptions**

Pin Number	Name	Type	Description
1, 2	DDI0, $\overline{\text{DDI0}}$	Input	Serial Digital Differential Input 0.
3	GND	Power	Input channel isolation. Connect to ground or leave unconnected.
4, 5	DDI1, $\overline{\text{DDI1}}$	Input	Serial Digital Differential Input 1.
6	GPIO0	Digital Input/Output	<p>Multi-function Control/Status Input/Output 0.</p> <p>Signal options are:</p> <ul style="list-style-type: none"> <li>LOS (output; default)</li> <li>LOCKED</li> <li>LBR_HBR</li> <li>RATE_DET0</li> <li>RATE_DET1</li> <li>RATE_DET2</li> <li>LOCKED_270M</li> <li>LOCKED_1G485</li> <li>LOCKED_2G97</li> <li>LOCKED_5G94</li> <li>RATE_CHANGE</li> <li>DDO0_DISABLE</li> <li>DDO1_DISABLE</li> </ul> <p>This pin is configured using the GPIO0_SELECT and GPIO0_IO_SELECT bits in the GPIO_CONTROL_REG_0 register.</p>
7	GPIO1	Digital Input/Output	<p>Multi-function Control/Status Input/Output 1.</p> <p>Signal options are:</p> <ul style="list-style-type: none"> <li>LOS</li> <li>LOCKED (output; default)</li> <li>LBR_HBR</li> <li>RATE_DET0</li> <li>RATE_DET1</li> <li>RATE_DET2</li> <li>LOCKED_270M</li> <li>LOCKED_1G485</li> <li>LOCKED_2G97</li> <li>LOCKED_5G94</li> <li>RATE_CHANGE</li> <li>DDO0_DISABLE</li> <li>DDO1_DISABLE</li> </ul> <p>This pin is configured using the GPIO1_SELECT and GPIO1_IO_SELECT bits in the GPIO_CONTROL_REG_0 register.</p>
8	DDI_SEL/STROBE	Digital Input	<p>Input selection control.</p> <p>Used to select the high-speed input for processing through the device. Refer to <a href="#">Table 4-2</a> for details on input selection.</p>
9	XTAL_CLK_IN	Input	<p>Reference Crystal Pin/27MHz clock input. Connect to an external circuit as shown in <a href="#">Figure 6-1: GS6151 Typical Application Circuit</a> or to a digital clock source (XTAL_BUF_OUT of another GS6150, GS6151, GS6152, or a 27MHz clock output from another device). Connect to ground if operating referenceless.</p>

**Table 1-1: GS6151 Pin Descriptions (Continued)**

Pin Number	Name	Type	Description
10	XTAL_CLK_OUT	Output	Reference Crystal Pin. Connect to a external circuit as shown in <a href="#">Figure 6-1: GS6151 Typical Application Circuit</a> , or leave unconnected if XTAL_CLK_IN is driven by an external clock source or is connected to ground (referenceless).
11	XTAL_BUF_OUT	Output	Buffered clock reference output. Leave unconnected if not used to drive 27MHz clock input of another device.
12	SDIN	Digital Input	Serial digital data input for the Genum Serial Peripheral Interface (GSPI) host control/status port. Refer to <a href="#">4.11 GSPI Host Interface</a> for more detail
13	SDOUT	Digital Output	Serial digital data output for the Genum Serial Peripheral Interface (GSPI) host control/status port. Refer to <a href="#">4.11 GSPI Host Interface</a> for more detail
14	SCLK	Digital Input	Burst-mode clock input for the Genum Serial Peripheral Interface (GSPI) host control/status port. Refer to <a href="#">4.11 GSPI Host Interface</a> for more detail
15	$\overline{CS}$	Digital Input	Chip select input for the Genum Serial Peripheral Interface (GSPI) host control/status port. Active-low input. Refer to <a href="#">4.11 GSPI Host Interface</a> for more detail
16	VDD_DIG	Power	Most positive power supply for the internal logic Connect to 1.8V.
17	VSS_DIG	Power	Most negative power supply for the internal logic Connect to ground.
18, 19	$\overline{DDO1}$ , DDO1	Output	Differential serial data output 1.
20	VCC_DDO1	Power	Most positive power supply connection for the DDO1/ $\overline{DDO1}$ output driver. Connect to any voltage between 1.2V and 2.5V.
21	VEE_DDO	Power	Most negative power supply connections for the output drivers. Connect to ground.
22	VCC_DDO0	Power	Most positive power supply connection for the DDO0/ $\overline{DDO0}$ output driver. Connect to any voltage between 1.2V and 2.5V.
23, 24	$\overline{DDO0}$ , DDO0	Output	Differential serial data output 0.
25	VCO_DFT_FILT	Power Decoupling	Connect through decoupling capacitor to ground.
26	VCC_DFT	Power	Connect to 1.8V.
27	VEE_DFT	Power	Connect to ground.
28	LF+	Passive	Connect to LF- through $C_{LF}$ Refer to <a href="#">Figure 6-1: GS6151 Typical Application Circuit</a> .
29	LF-	Passive	Connect to LF+ through $C_{LF}$ Refer to <a href="#">Figure 6-1: GS6151 Typical Application Circuit</a> .

**Table 1-1: GS6151 Pin Descriptions (Continued)**

Pin Number	Name	Type	Description
30	VCO_FILT	Power	External decoupling for the VCO. Refer to <a href="#">Figure 6-1: GS6151 Typical Application Circuit</a> .
31	VCC_CORE	Power	Most positive power supply connection for the analog core Connect to 1.8V.
32	VEE_CORE	Power	Most negative power supply connection to the analog core Connect to GND.
—	Center Pad	Power	Ground pad on bottom of package. Connect to ground.

## 2. Electrical Characteristics

### 2.1 Absolute Maximum Ratings

**Table 2-1: Absolute Maximum Ratings**

Parameter	Value
Supply Voltage – Core (VCC_CORE, VDD_DIG)	-0.5 to +2.1V <sub>DC</sub>
Supply Voltage – Output Driver (VCC_DDO0, VCC_DDO1)	-0.5 to +2.8V <sub>DC</sub>
Input ESD Voltage	4kV
Storage Temperature Range (T <sub>S</sub> )	-50°C to +125°C
Operating Temperature Range (T <sub>A</sub> )	-40°C to +85°C
Input Voltage Range (any input pin)	-0.3 to (V <sub>CC_CORE</sub> + 0.3)V <sub>DC</sub>
Solder Reflow Temperature	+260°C

**Note:** Absolute Maximum Ratings are those values beyond which damage may occur. Functional operation outside of the ranges shown in the AC/DC electrical characteristics tables is not guaranteed.



## 2.2 DC Electrical Characteristics

**Table 2-2: DC Electrical Characteristics**

VCC\_CORE, VDD\_DIG = +1.8V ± 5%, T<sub>A</sub> = -40°C to +85°C unless otherwise specified

Parameter	Symbol	Conditions	Min	Typ	Max	Units	Notes
Supply Voltage – Core (VCC_CORE, VDD_DIG)	V <sub>CC_CORE</sub> , V <sub>DD_DIG</sub>	—	1.710	1.8	1.890	V	
Supply Voltage – Output Driver (VCC_DDO0, VCC_DDO1)	V <sub>CC_DDO0</sub> , V <sub>CC_DDO1</sub>	—	1.140	—	2.625	V	
Power	P <sub>D</sub>	Data Rate 6G, DDO1/DDO1 disabled	—	140	185	mW	1, 2
		Data Rate <6G, DDO1/DDO1 disabled	—	130	170	mW	1, 2
		Data Rate 6G, Default Settings, DDO1/DDO1 enabled	—	210	280	mW	3, 4
		Data Rate <6G, Default Settings, DDO1/DDO1 enabled	—	190	255	mW	3, 4
		Maximum Supply and Power Settings with Diagnostic Features Off	—	280	360	mW	5
		Maximum Supply and Power Settings with Diagnostic Features On	—	575	630	mW	5
Power (Sleep operation)	P <sub>SLEEP</sub>	—	—	20	35	mW	
Power (Standby operation)	P <sub>STANDBY</sub>	—	—	80	110	mW	
Supply Current - Output Driver	I <sub>CC_DDO0</sub> , I <sub>CC_DDO1</sub>	Output Swing Register Setting = 0000 <sub>b</sub>	—	4.8	7	mA	6, 7
		Output Swing Register Setting = 0100 <sub>b</sub>	—	7.5	12	mA	6, 7
		Output Swing Register Setting = 1100 <sub>b</sub>	—	15	22	mA	6, 7

**Table 2-2: DC Electrical Characteristics (Continued)**VCC\_CORE, VDD\_DIG = +1.8V ± 5%, T<sub>A</sub> = -40°C to +85°C unless otherwise specified

Parameter	Symbol	Conditions	Min	Typ	Max	Units	Notes
Supply Current - Core	I <sub>CC_CORE</sub>	Output De-emphasis Disabled Data Rate 6G	—	82	—	mA	8
		Output De-emphasis Disabled Data Rate 3G	—	74	—	mA	8
		Output De-emphasis Enabled Data Rate 6G	—	90	—	mA	8
		Output De-emphasis Enabled Data Rate 3G	—	81	—	mA	8
Supply Current - Digital	I <sub>CC_DIG</sub>	External Crystal Referenced	—	7	12	mA	
Serial Input Termination		Differential	75	100	125	Ω	
Serial Output Termination		Differential	75	100	125	Ω	
Serial Input Common Mode Voltage	V <sub>CMIN</sub>	—	0.9	—	V <sub>CC_CORE</sub> - 50mV	V	9, 10
Input Voltage - Digital Pins (CS, SDIN, CLK, GPIO[0:1])	V <sub>IH</sub>	—	0.65* VDD_DIG	—	VDD_DIG	V	
	V <sub>IL</sub>	—	0	—	0.35* VDD_DIG	V	
Output Voltage - Digital Pins (SDOUT, GPIO[0:1])	V <sub>OH</sub>	I <sub>OH</sub> = -2mA	VDD_DIG - 0.45	—	—	V	
	V <sub>OL</sub>	I <sub>OL</sub> = 2mA	—	—	0.45	V	

**Notes:**

1. Normal operation in referenceless mode, minimum output swing with de-emphasis disabled
2. VCC\_DDO0/1 = 1.2V
3. The swing is default and de-emphasis is on
4. VCC\_DDO0/1 = 1.8V
5. DDO0/DDO0 and DDO1/DDO1 set to maximum swing setting, external crystal reference used
6. Consumption per enabled DDO output
7. Refer to Table 4-4 for the exact register settings for each ΔV<sub>DDO</sub> output swing listed
8. For two enabled outputs
9. Maximum input voltage level = 1.8V ± 5%
10. Up to a maximum swing of 800mV

## 2.3 AC Electrical Characteristics

**Table 2-3: AC Electrical Characteristics**

VCC\_CORE, VDD\_DIG = +1.8V ± 5%, T<sub>A</sub> = -40°C to +85°C unless otherwise specified

Parameter	Symbol	Conditions	Min	Typ	Max	Units	Notes
Input Data Rate (Bypass)	DR <sub>BYPASS</sub>	Bypass mode enabled	3	—	5940	Mb/s	1
Input Sensitivity	ΔV <sub>SDI</sub>	Differential	200	—	800	mV <sub>ppd</sub>	
Output Voltage Swing	ΔV <sub>DDO</sub>	Output Swing Register Setting = 0100 <sub>b</sub>	310	410	510	mV <sub>ppd</sub>	2
		Output Swing Register Setting = 1100 <sub>b</sub>	600	800	1000	mV <sub>ppd</sub>	2
Serial Input Jitter Tolerance	IJT	Square wave modulation	0.8	—	—	UI	
PLL Lock Time — Asynchronous	t <sub>ALOCK</sub>	Referenceless	—	—	50	ms	3
		With External Reference (MADI enabled)	—	—	30	ms	3
		With External Reference (MADI disabled)	—	—	20	ms	3
PLL Lock Time — Synchronous	t <sub>SLOCK</sub>	Referenceless	—	—	10	μs	3
		With External Reference	—	—	10	μs	3
Serial Data (DDO0 and DDO1) Output Rise And Fall Time	t <sub>riseDDO</sub>	20% ~ 80% rising edge into 50Ω load	—	—	80	ps	4
	t <sub>fallDDO</sub>	20% ~ 80% falling edge into 50Ω load	—	—	80	ps	4
Rise And Fall Time Mismatch (DDO0 and DDO1)	—	—	—	—	15	ps	4
Duty Cycle Distortion (DDO0 and DDO1)	—	—	—	—	5	%	
Serial Data Output Jitter Intrinsic	t <sub>OJ(125Mb/s)</sub>	BW = Nominal PRN 2 <sup>23</sup> - 1 test pattern	—	0.02	0.03	UI <sub>p-p</sub>	5, 6
	t <sub>OJ(270Mb/s)</sub>		—	0.02	0.03	UI <sub>p-p</sub>	5, 6
	t <sub>OJ(1485Mb/s)</sub>		—	0.03	0.06	UI <sub>p-p</sub>	5, 6
	t <sub>OJ(2970Mb/s)</sub>		—	0.04	0.09	UI <sub>p-p</sub>	5, 6
	t <sub>OJ(5940Mb/s)</sub>		—	0.07	0.13	UI <sub>p-p</sub>	5, 6
	t <sub>OJ(BYPASS)</sub>		—	—	37	ps	5, 6

**Table 2-3: AC Electrical Characteristics (Continued)**VCC\_CORE, VDD\_DIG = +1.8V ± 5%, T<sub>A</sub> = -40°C to +85°C unless otherwise specified

Parameter	Symbol	Conditions	Min	Typ	Max	Units	Notes
PLL Loop Bandwidth	BW <sub>LOOP(125Mb/s)</sub>	PLL_LOOP_BANDWIDTH = 00001	—	37	—	kHz	7
		PLL_LOOP_BANDWIDTH = 00010	—	74	—	kHz	7
		PLL_LOOP_BANDWIDTH = 00100 (default)	—	148	—	kHz	7
		PLL_LOOP_BANDWIDTH = 01000	—	296	—	kHz	7
		PLL_LOOP_BANDWIDTH = 10000	—	590	—	kHz	7
	BW <sub>LOOP(270Mb/s)</sub>	PLL_LOOP_BANDWIDTH = 00001	—	80	—	kHz	7
		PLL_LOOP_BANDWIDTH = 00010	—	160	—	kHz	7
		PLL_LOOP_BANDWIDTH = 00100 (default)	—	320	—	kHz	7
		PLL_LOOP_BANDWIDTH = 01000	—	640	—	kHz	7
		PLL_LOOP_BANDWIDTH = 10000	—	1.28	—	MHz	7
	BW <sub>LOOP(1485Mb/s)</sub>	PLL_LOOP_BANDWIDTH = 00001	—	438	—	kHz	7
		PLL_LOOP_BANDWIDTH = 00010	—	875	—	kHz	7
		PLL_LOOP_BANDWIDTH = 00100 (default)	—	1.75	—	MHz	7
		PLL_LOOP_BANDWIDTH = 01000	—	3.5	—	MHz	7
		PLL_LOOP_BANDWIDTH = 10000	—	7	—	MHz	7
	BW <sub>LOOP(2970Mb/s)</sub>	PLL_LOOP_BANDWIDTH = 00001	—	875	—	kHz	7
		PLL_LOOP_BANDWIDTH = 00010	—	1.75	—	MHz	7
		PLL_LOOP_BANDWIDTH = 00100 (default)	—	3.5	—	MHz	7
		PLL_LOOP_BANDWIDTH = 01000	—	7.0	—	MHz	7
		PLL_LOOP_BANDWIDTH = 10000	—	14.0	—	MHz	7

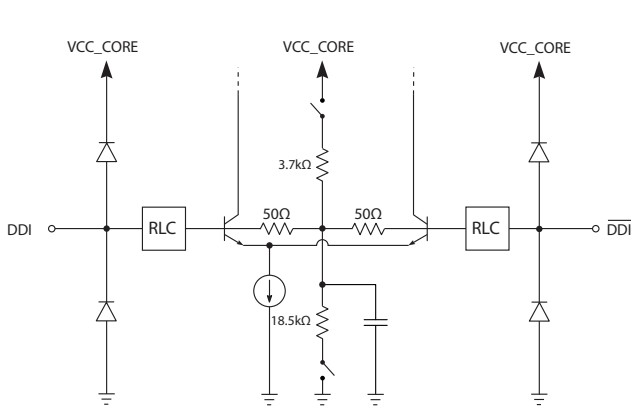
**Table 2-3: AC Electrical Characteristics (Continued)**VCC\_CORE, VDD\_DIG = +1.8V ± 5%, T<sub>A</sub> = -40°C to +85°C unless otherwise specified

Parameter	Symbol	Conditions	Min	Typ	Max	Units	Notes
PLL Loop Bandwidth	BW <sub>LOOP(5940Mb/s)</sub>	PLL_LOOP_BANDWIDTH = 00001	—	1.75	—	MHz	7
		PLL_LOOP_BANDWIDTH = 00010	—	3.5	—	MHz	7
		PLL_LOOP_BANDWIDTH = 00100 (default)	—	7.0	—	MHz	7
		PLL_LOOP_BANDWIDTH = 01000	—	14.0	—	MHz	7
		PLL_LOOP_BANDWIDTH = 10000	—	28.0	—	MHz	7

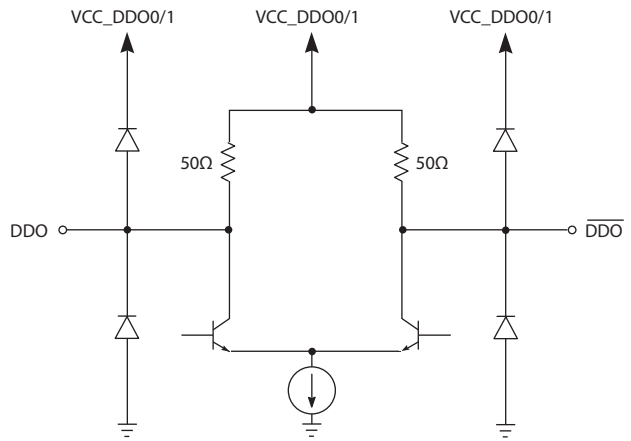
**Note:**

1. Edge detection method for LOS detection should be used for data rates below 20Mb/s
2. Refer to [Table 4-4](#) for the exact register settings for each ΔV<sub>DDO</sub> output swing listed
3. PRBS23 pattern used for supported video rates
4. At HD, 3G, and 6G rates
5. Jitter measured using an oscilloscope according to SMPTE RP-184
6. Accumulated jitter measured peak to peak differential over 2000 hits
7. Test pattern used is clock pattern with 100% toggle rate

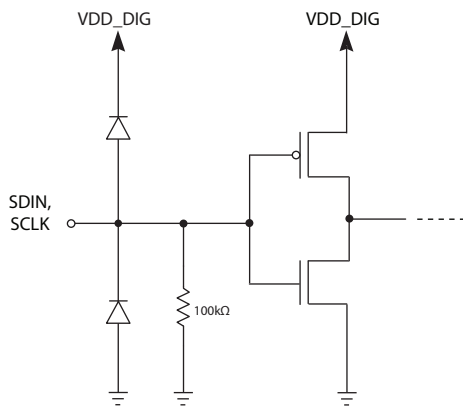
# 3. Input/Output Circuits



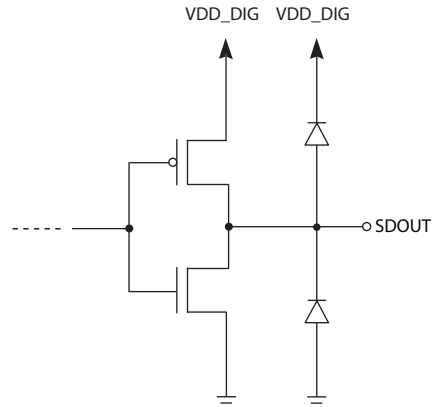
**Figure 3-1: DDI0,  $\overline{DDI0}$ , DDI1,  $\overline{DDI1}$  Serial Digital Differential Inputs**



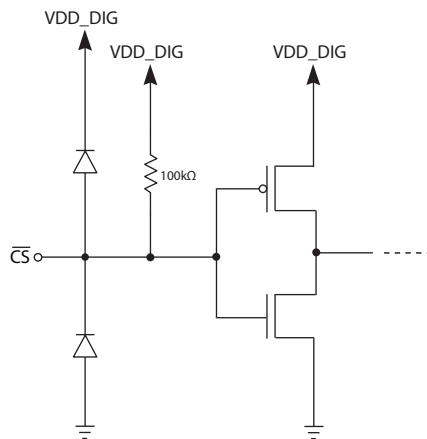
**Figure 3-2: DDO0,  $\overline{DDO0}$ , DDO1,  $\overline{DDO1}$  Serial Digital Differential Output**



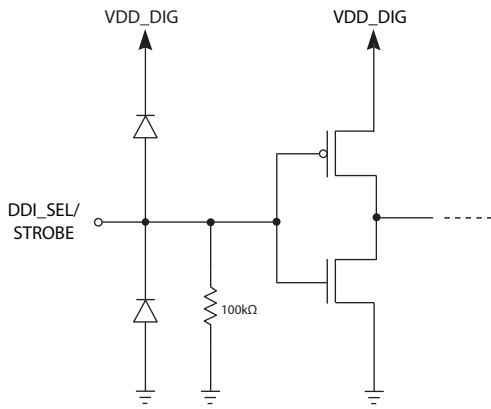
**Figure 3-3: SDIN and SCLK**



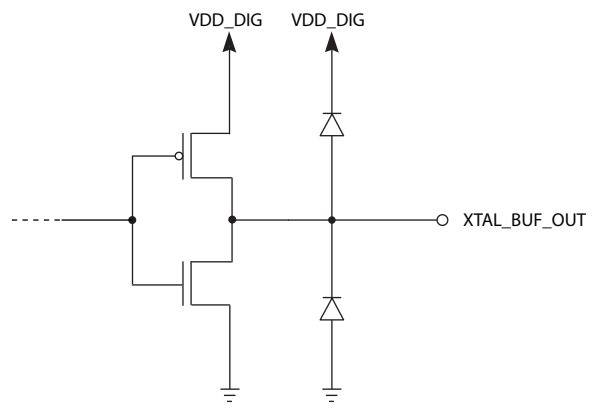
**Figure 3-4: SDOUT**



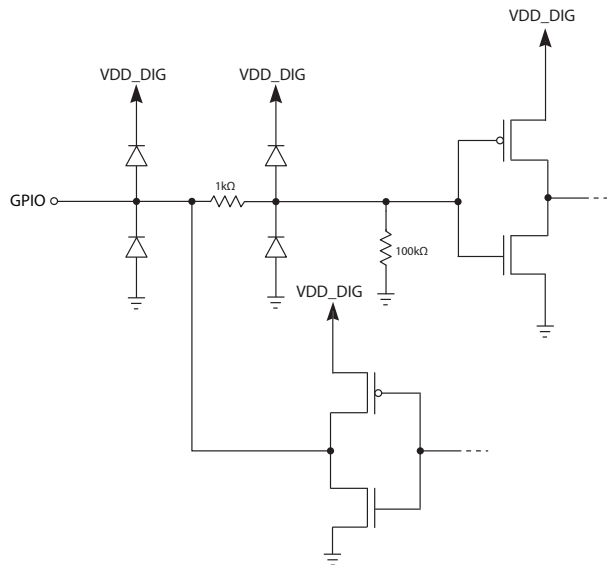
**Figure 3-5:  $\overline{CS}$**



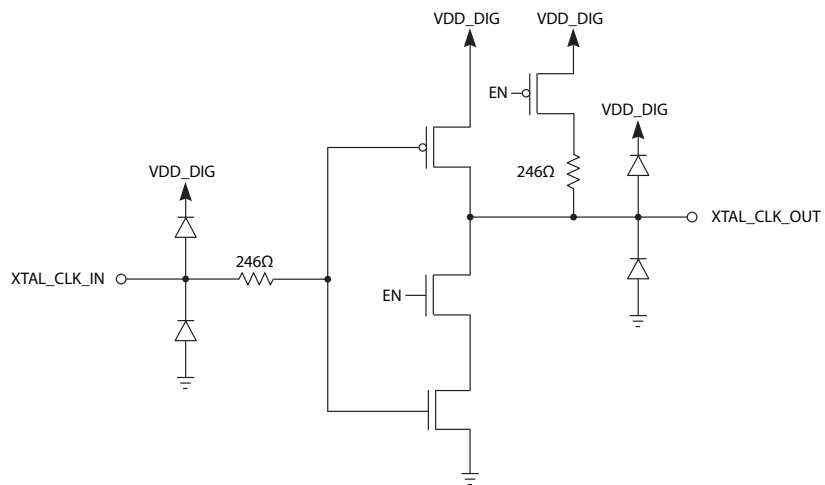
**Figure 3-6: DDI\_SEL/STROBE**



**Figure 3-7: XTAL\_BUF\_OUT**



**Figure 3-8: General Purpose Inputs/Outputs (GPIO)**



**Figure 3-9: XTAL\_CLK\_IN and XTAL\_CLK\_OUT**

## 4. Detailed Description

The GS6151 is a multi-standard CDR for signals operating at the following data rates: 125Mb/s, 270Mb/s, 1.485Gb/s, 1.485/1.001Gb/s, 2.97Gb/s, 2.97/1.001Gb/s, 5.94Gb/s, and 5.94/1.001Gb/s.

### 4.1 Serial Data Inputs

The GS6151 features two 100Ω terminated differential input buffers.

A serial data input signal may be connected to either of the two input pin pairs of the device:  $\overline{\text{DDI0}}/\overline{\text{DDI0}}$  and  $\overline{\text{DDI1}}/\overline{\text{DDI1}}$

By default, the self-biasing circuit at the input is enabled to allow AC coupling to upstream devices. To enable DC coupling of the inputs, the user must disable the self-biasing network by setting bits 4:4 through 5:5 to 0 in the register 7<sub>h</sub>: `DDI[0:1]_TRACE_EQ_DC_TERM_ENABLE`.

In order to select DC coupling, please ensure that the output common mode of the upstream device is in range of the input common mode voltage range shown in [Table 2-2](#).

The serial digital input buffer is capable of operating with any binary coded signal that meets the input signal level requirements defined below, with any data rate between 3Mb/s and 5.94Gb/s.

#### 4.1.1 Input Trace Equalization

The GS6151 features adjustable trace equalization to compensate for PCB trace dielectric losses up to half the maximum supported data rate, or 3GHz.

**Table 4-1: Equalization Settings**

Data Rate	Trace Loss	Settings
2.97Gb/s and below	0-7dB of trace loss at 1.5GHz	LOW (default)
5.94Gb/s	0-10dB of trace loss at 3GHz	
2.97Gb/s and below	7-12dB of trace loss at 1.5GHz	HIGH
—	negligible trace loss	0dB or EQ_BYPASS

These settings are selected using the `DDI0_TRACE_EQ_CONTROL` and `DDI1_TRACE_EQ_CONTROL` bits in the `INPUT_CONTROL_REG_0` register at address 5<sub>h</sub>.

The default state of the device is input trace equalization on all inputs set to LOW.

If system jitter profile allows, it is recommended that the loop bandwidth is reduced to the minimum setting to maximize performance.



## 4.1.2 Input Selection

The GS6151 incorporates a 2:1 input selector which allows the connection of two independent streams of video/data.

The selector is controllable in three separate ways:

1. The DDI\_SEL/STROBE pin can be used to select the input.
2. A GSPI accessible register can be used to select the input, with the state change occurring as soon as the register value changes.
3. A GSPI accessible register can be used to select the input, with a rising edge on the STROBE pin triggering a change to the next state.

Since these states are mutually exclusive, the DDI\_SEL pin is shared with the STROBE function.

In the case of using the DDI\_SEL/STROBE pin (#1 above) or the STROBE pre-select method (#3 above), the input selector will switch within 1  $\mu$ s of the change of state on the corresponding pin(s). This strict timing requirement is not maintained when using GSPI register selection (#2 above).

Each of the device's two inputs is selected as shown in [Table 4-2](#).

**Table 4-2: Pin and Register Settings for Input Selection**

Register Settings		DDI_SEL/STROBE	Differential High-speed Input Selected
INPUT_SELECTION_CONTROL 7 <sub>h</sub> [9:8]	DDI_SELECT 7 <sub>h</sub> [10]		
X0 (default)	X	LOW	DDI0, $\overline{\text{DDI0}}$
X0 (default)	X	HIGH	DDI1, $\overline{\text{DDI1}}$
01	0	X	DDI0, $\overline{\text{DDI0}}$
01	1	X	DDI1, $\overline{\text{DDI1}}$
11	0	on LOW-to-HIGH transition	DDI0, $\overline{\text{DDI0}}$
11	1	on LOW-to-HIGH transition	DDI1, $\overline{\text{DDI1}}$

**Note:** 'X' indicates 'Do Not Care'

The DDI\_SEL/STROBE pin includes an internal pull-down, which pulls the input voltage LOW if the pin is left unconnected.

When using the STROBE pre-select method (#3 above), the pre-selected input buffer and trace EQ is powered up in advance of the STROBE pulse.

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## 4.2 Reference Clock

The GS6151 can operate with or without an external frequency reference. For applications requiring rapid asynchronous locking, a 27MHz reference or crystal is required.

The PLL lock times for both referenceless and external crystal reference operation are given in [Table 2-3: AC Electrical Characteristics](#).

If a reference is connected to the XTAL\_CLK\_IN pin or a crystal is connected to the XTAL\_CLK\_IN and XTAL\_CLK\_OUT pins of the device, it will automatically be used as the reference frequency for rapid asynchronous lock. If XTAL\_CLK\_IN is not connected to a crystal, XTAL\_CLK\_OUT must be left unconnected.

The XTAL\_CLK\_IN pin operates correctly when connected directly to the XTAL\_BUF\_OUT from another GS6151, or a 27MHz output of a different device.

## 4.3 Signal Monitoring

The GS6151 measures and reports the following signal status and quality monitoring parameters:

- Loss of Signal
- Lock Detection
- Rate Detection
- Low/High Bit Rate Detection

### 4.3.1 Loss of Signal Detection

LOS (Loss of Signal) detection is an active HIGH output available to the application on either of the GPIO0 or GPIO1 multi-function status and control pins. It is selected for output using the GPIO[0:1]\_IO\_SELECT and GPIO[0:1]\_SELECT bits accessible in the GPIO\_CONTROL\_REG\_0 register at address 2<sub>h</sub>. It is the default output of the GPIO0 pin.

LOS indicates when the serial digital signal selected by the input selector is invalid. This function is always active.

The corresponding GPIO pin will be HIGH (signal lost) when the input signal amplitude within a predefined window falls below the threshold set by the bits DDI[0:1]\_LOS\_THRESHOLD\_CONTROL in the LOS\_CONTROL\_REG\_1 register at address 10<sub>h</sub>. The LOS threshold hysteresis can be set by the LOS\_HYSTERESIS bits in the LOS\_CONTROL\_REG\_0 register at address F<sub>h</sub>.

The corresponding GPIO pin will be LOW (signal present) when the input signal amplitude within a predefined window is above the defined threshold.

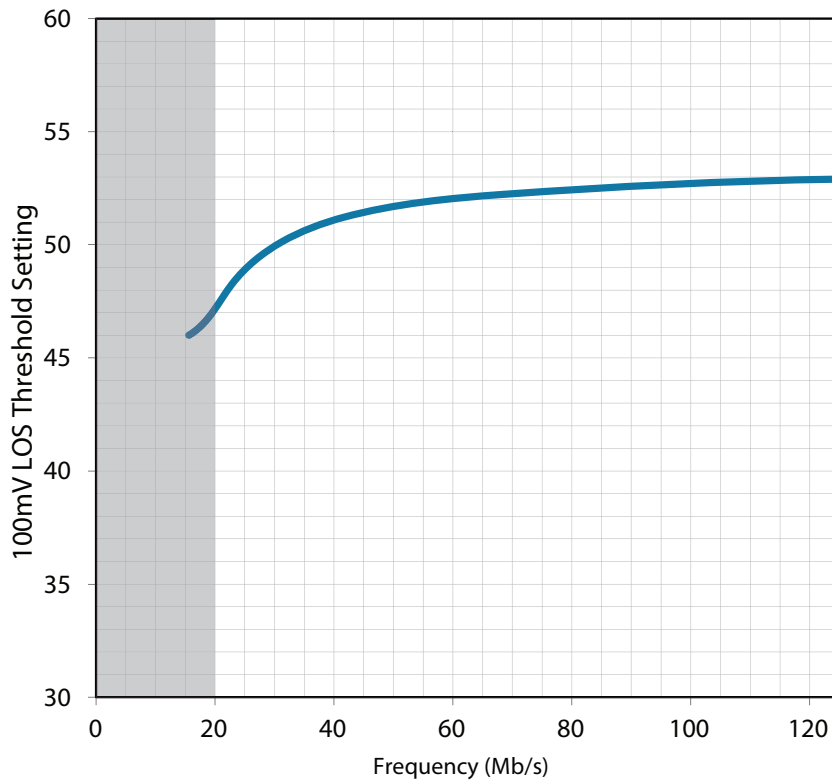
The LOS status is also available through the LOS bit in the PLL\_STATUS register at address 4F<sub>h</sub>, and as a sticky status through the LOS\_STICKY bit in the STICKY\_STATUS register at address 50<sub>h</sub>.

The corresponding GPIO pin will be LOW (signal present) when the input signal amplitude within a predefined window is above the defined threshold.

The method of strength detection is measurement of the average rectified differential voltage on the input pins. The strength detection method is therefore inherently dependent on the input signal's eye shape, particularly the rise/fall times of the input signal relative to the data rate. Additionally, the circuit has a lower bandwidth limit of operation (20Mb/s) below which it is recommended that the edge detection method is used. The absolute value of the threshold can be determined for any input swings according to Equation 4-1 below:

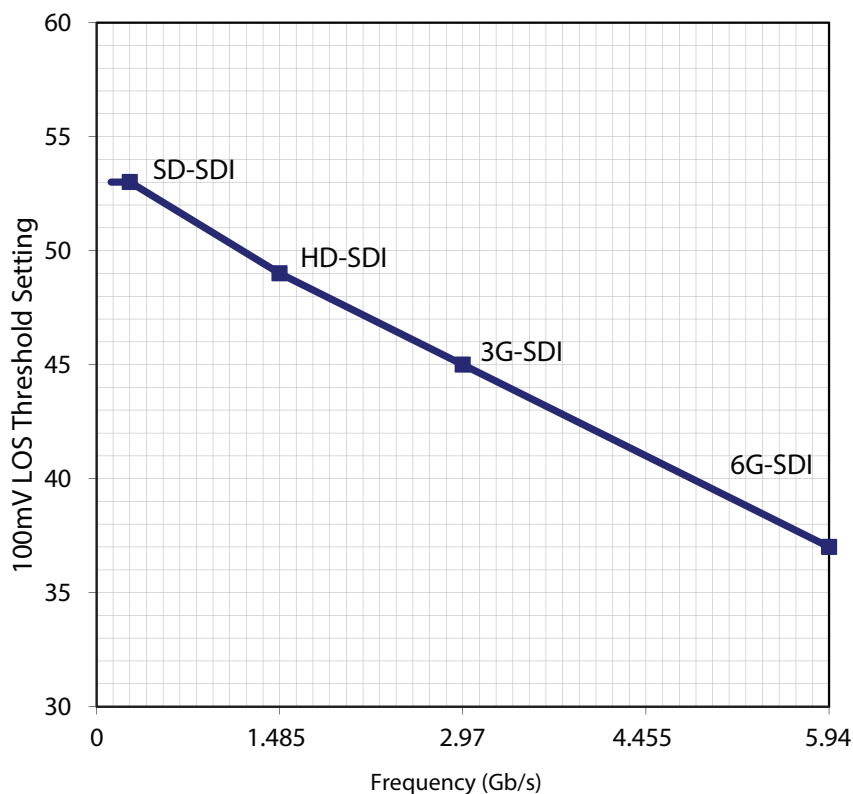
$$\text{Threshold} = \frac{1.9\text{mV} \times (\text{DDI}[0..3]_{\text{LOS\_THRESHOLD\_CONTROL}}) \times 53}{(\text{DEVICE\_SPECIFIC\_LOS\_THRESHOLD})} \quad \text{Equation 4-1}$$

where DEVICE\_SPECIFIC\_LOS\_THRESHOLD specifies the LOS threshold value for a 100mV input swing at SD-rate specific to each device. The other rates scale according to the fractional relationship given in Figure 4-1 and Figure 4-2 below.



**Figure 4-1: LOS Threshold at 100mV Input Swing vs. Low Frequency Rates for a Nominal DEVICE\_SPECIFIC\_LOS\_THRESHOLD of 53**

**Note:** Edge detection method is recommended for signals in shaded areas.



**Figure 4-2: LOS Threshold at 100mV Input Swing vs. SDI Data Rates for a Nominal DEVICE\_SPECIFIC\_LOS\_THRESHOLD of 53**

Strength detection is unaffected by the Trace EQ settings in INPUT\_CONTROL\_REG\_0.

When edge detection is used as the method of LOS detection the corresponding GPIO pin will be HIGH (signal lost) when no transitions are detected on the selected input. The corresponding GPIO pin will be LOW (signal present) when transitions are detected on the input. The LOS status is also available through the LOS bit in the PLL\_STATUS register, and as a sticky status through the LOS\_STICKY bit in the STICKY\_STATUS register at address 50<sub>h</sub>.

### 4.3.2 Lock Detection

The GS6151 lock detection circuitry outputs a LOCKED status signal which indicates that the CDR has achieved phase lock to the incoming data stream. The LOCKED signal is an active HIGH output available to the application on either of the GPIO[0:1] multi-function status and control pins. It is selected for output using the GPIO[0:1]\_IO\_SELECT and GPIO[0:1]\_SELECT bits accessible in the GPIO\_CONTROL\_REG\_0 register. By default, LOCKED is output on GPIO1.

The LOCKED status is also available from the LOCKED bit in the PLL\_STATUS register, and the LOCK\_LOST\_STICKY bit in the STICKY\_STATUS register indicates whether lock has been lost since the bit was last cleared.

### 4.3.2.1 Synchronous and Asynchronous Lock Time

Asynchronous lock time is defined as the time it takes the device to lock when a signal is first applied to the serial digital inputs, or when the signal rate changes.

The synchronous lock time is defined as the time it takes the device to lock to a signal which has been momentarily interrupted.

The asynchronous and synchronous lock times are defined in [Table 2-3: AC Electrical Characteristics](#).

To qualify for synchronous lock time, the maximum interruption time of the signal is 10µs for a 270Mb/s signal. 1.485Gb/s, 2.97Gb/s, and 5.94Gb/s signals, as well as their  $f/1.001$  components, have a maximum interruption time of 6µs. The new signal, after interruption, must have the same frequency as the original signal but can have arbitrary phase.

### 4.3.3 Rate Detection

The GS6151 can be manually forced to lock to a specific supported data rate, or automatically search for and lock to supported rates. The selection between manual and automatic rate selection is through the FORCE\_PLL\_RATE and FORCE\_PLL\_RATE\_ENABLE bits of the PLL\_CONTROL register at address 4C<sub>h</sub>. By default the device is set to automatically search for supported SDI rates.

When set to automatically detect supported data rates, the device repeatedly cycles through each supported rate that is enabled through the RATE\_ENABLE\_5G94, RATE\_ENABLE\_2G97, RATE\_ENABLE\_1G485, RATE\_ENABLE\_270M and RATE\_ENABLE\_125M bits of the PLL\_CONTROL register, until the device phase locks to one of the enabled rates. If lock is lost the rate search resumes, continuously testing for each rate in sequence until lock is regained.

The device reports the current data rate setting of the automatic rate search state machine through the DETECTED\_RATE bits in the PLL\_STATUS register at address 4F<sub>h</sub>. [Table 4-3](#) below shows the supported rate that can be detected.

**Table 4-3: Automatic Rate Detection - Supported Data Rates**

DETECTED_RATE	Data Rate
000	125Mb/s – MADI
001	270Mb/s – SD
010	1.485Gb/s – HD
011	2.97Gb/s – 3G
100	5.94Gb/s – 6G

### 4.3.4 Low/High Bit Rate Detection for Slew Rate Control

A status output named LBR\_HBR is provided to control the slew rate selection input of a downstream SDI cable driver. It can be connected to the SD\_EN input of drivers such as the GS6080 or GS6081 using the Semtech recommended application circuit.

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When this signal is HIGH, the data rate is 270Mb/s (SD) or 125Mb/s (MADI). This signal is LOW for all other supported data rates, and when the GS6151 is operating in Bypass Mode or any time the device is not locked.

The LBR\_HBR output signal is available on either of the GPIO[0:1] multifunction status and control pins. It is selected for output using the GPIO[0:1]\_IO\_SELECT and GPIO[0:1]\_SELECT bits accessible in the GPIO\_CONTROL\_REG\_0 register at address 2<sub>h</sub>.

## 4.4 Low Power Modes

The device can be programmed via the GSPI to operate in two different low power modes. SLEEP mode has minimum power consumption at the expense of recovery time upon de-assertion of the FORCE\_PWRDN\_SLEEP bit. STANDBY mode has higher power consumption relative to SLEEP mode but minimizes time to return to operation on de-assertion of the FORCE\_PWRDN\_STANDBY bit. The features affected by each mode are outlined below.

SLEEP mode:

- LOS detection remains functional
- The GSPI remains functional
- The reference oscillator remains functional

STANDBY mode:

- LOS detection remains functional
- The GSPI remains functional
- The reference oscillator remains functional
- The VCO and PLL remains functional so as to minimize the lock time when a signal is detected
- The rate detector remains set to the last valid data rate. On detection of a signal, the last valid rate is tested first by the rate detect state machine

The device can be programmed to automatically enter into SLEEP or STANDBY mode when LOS is asserted by programming the AUTO\_PWRDN\_DISABLE bit in the PWRDN\_CONTROL register at address 17<sub>h</sub>. The AUTO\_PWRDN\_MODE bit in the same register selects which mode, SLEEP or STANDBY, is entered into upon assertion of LOS.

The device also features a power-save feature that reduces power when the CDR is locked to HD, 3G or 6G rates. The HS\_LOCKED\_POWER\_SAVE parameter of register PWR\_CONTROL at address D2<sub>h</sub> can be set to 1 to enable this feature.

## 4.5 Serial Data Output

The GS6151 has two current-mode differential output drivers, each capable of driving up to 930mV<sub>pp</sub> differential into an external 100Ω differential load.

The output drivers operate with any binary coded signal with supported data rates up to 5.94Gb/s. This is applicable to both the serial data (DDO,  $\overline{DDO}$ , DDO1,  $\overline{DDO1}$ ) outputs of the device.

## 4.5.1 Output Impedance

Each of the GS6151's output buffers include two on-chip, 50Ω termination resistors.

## 4.5.2 Output Signal Interface Levels

The serial digital outputs operate within specification with an output CML power supply of 1.2V to 2.5V.

## 4.5.3 Adjustable Output Swing

Through the GSPI, the output swing can be set in the range from approximately 230mV<sub>ppd</sub> to 930mV<sub>ppd</sub> in 45mV<sub>ppd</sub> increments, when the outputs are terminated with 50Ω loads. For the exact values, please see [Table 4-4](#) below.

The output swing for each data rate is controlled using the bits in the DRIVER\_CONTROL\_REG\_3, DRIVER\_CONTROL\_REG\_4, DRIVER\_CONTROL\_REG\_5, and DRIVER\_CONTROL\_REG\_6 registers at addresses 1C<sub>h</sub> through 1F<sub>h</sub>.

The device automatically adjusts the swing setting depending on the state of the device (i.e. detected rate, bypass mode, or mute). There are separate register controls for mute, bypass and each data rate.

**Table 4-4: Serial Digital Output Swing Settings**

Register Setting (See Note 1)	Min	Typ	Max	Units
0000 <sub>b</sub>	175	230	290	mV
0001 <sub>b</sub>	205	275	345	mV
0010 <sub>b</sub>	245	325	405	mV
0011 <sub>b</sub> (default)	280	370	460	mV
0100 <sub>b</sub>	310	410	510	mV
0101 <sub>b</sub>	345	460	575	mV
0110 <sub>b</sub>	380	510	640	mV
0111 <sub>b</sub>	420	560	700	mV
1000 <sub>b</sub>	455	605	760	mV
1001 <sub>b</sub>	490	655	820	mV
1010 <sub>b</sub>	530	705	880	mV
1011 <sub>b</sub>	565	755	945	mV
1100 <sub>b</sub>	600	800	1000	mV

**Table 4-4: Serial Digital Output Swing Settings (Continued)**

Register Setting (See Note 1)	Min	Typ	Max	Units
1101 <sub>b</sub>	630	840	1050	mV
1110 <sub>b</sub>	670	890	1110	mV
1111 <sub>b</sub>	700	930	1160	mV

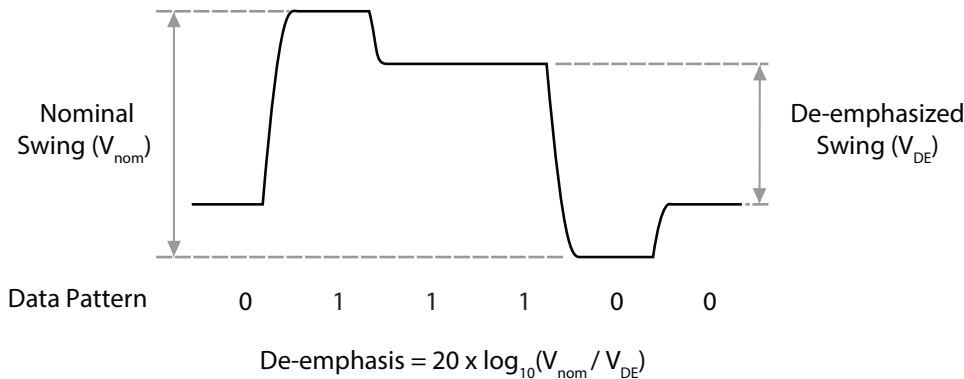
**Note:**

1. Applicable registers that can be programmed with the values shown above are DDO0\_SWING\_1G485, DDO0\_SWING\_270M, DDO0\_SWING\_125M, DDO0\_SWING\_BYPASS, DDO0\_SWING\_MUTE, DDO0\_SWING\_5G94, DDO0\_SWING\_2G97, DDO1\_SWING\_1G485, DDO1\_SWING\_270M, DDO1\_SWING\_125M, DDO1\_SWING\_BYPASS, DDO1\_SWING\_MUTE, DDO1\_SWING\_5G94, and DDO1\_SWING\_2G97

### 4.5.4 Output De-emphasis

The GS6151 features adjustable output de-emphasis to compensate for PCB dielectric trace loss. Each output can be independently set to a different de-emphasis setting for each detected rate through controls found in the DRIVER\_CONTROL\_REG\_1 and DRIVER\_CONTROL\_REG\_2 registers.

The effect of de-emphasis, illustrated in Figure 4-3, is to attenuate the swing of bits that do not follow a bit transition ( $V_{DE}$ ). The swing of bits that do follow a bit transition ( $V_{nom}$ ) is set by the output swing registers found in Section 4.5.3 and do not depend on the de-emphasis settings.

**Figure 4-3: De-emphasis Waveform**

The default de-emphasis settings for each rate are given in the register descriptions for DRIVER\_CONTROL\_REG\_1 and DRIVER\_CONTROL\_REG\_2 in Table 5-1. De-emphasis is disabled on both outputs in Bypass mode, when the output is muted, or when the device is not locked.



## 4.5.5 Output Common Mode Voltage

The output common mode voltage level ( $V_{CMOUT}$ ) is a function of the output voltage swing, the output driver supply voltage ( $V_{CC\_DDO}$ ) and how the transmission line is terminated. If the outputs are terminated through  $50\Omega$  resistors to a voltage  $V_{TERM}$  equal to  $V_{CC\_DDO}$ , as shown in Figure 4-5 below, the output common mode voltage is given by the following expression:

$$V_{CMOUT} = V_{CC\_DDO} - \frac{\Delta V_{DDO}}{4} \quad \text{Equation 4-2}$$

If the differential outputs are terminated across a  $100\Omega$  resistor, as shown in Figure 4-4 below, the output common mode voltage is given by the following expression:

$$V_{CMOUT} = V_{CC\_DDO} - \frac{\Delta V_{DDO}}{2} \quad \text{Equation 4-3}$$

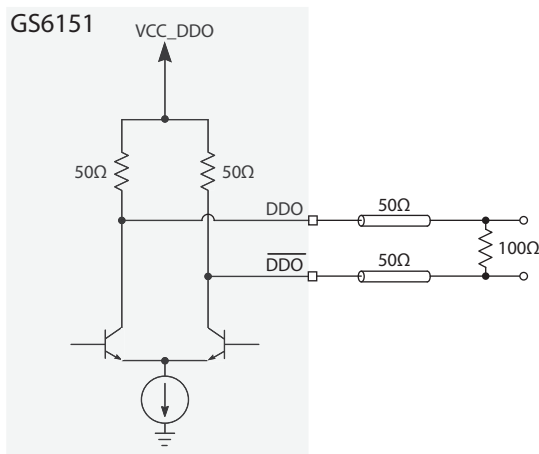


Figure 4-4:  $100\Omega$  Parallel Output Termination

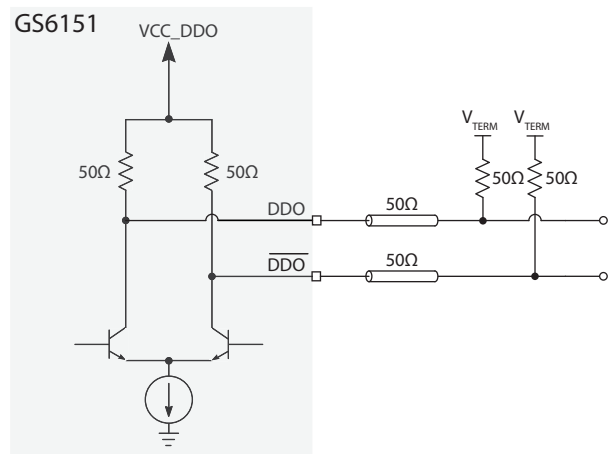


Figure 4-5:  $50\Omega$  Termination to  $V_{TERM}$

## 4.6 Output Mute and Disable

The GS6151 outputs can each be individually muted using the DDO0\_MUTE and DDO1\_MUTE bits in the DRIVER\_CONTROL\_REG\_0 register at address  $19_h$ .

Each output can also be independently disabled through either register or GPIO control. When disabled each pin of the output is pulled to  $V_{CC\_DDO}$ . Register DRIVER\_CONTROL\_REG\_0 contains both register based disable bits (DDO0\_DISABLE, DDO1\_DISABLE) and bits for selection between register and GPIO control (DDO0\_DISABLE\_SELECT, DDO1\_DISABLE\_SELECT). For GPIO control refer to Section 4.10. By default DDO0,  $\overline{DDO0}$  is enabled/disabled through register control and set to enabled. DDO1,  $\overline{DDO1}$  is enabled by default.

## 4.7 Bypass Mode

In Bypass mode, the GS6151 passes the input data to the outputs, bypassing the retiming functionality.

There are two bits in the control registers that control the bypass function: MANUAL\_BYPASS and AUTO\_BYPASS in the CDR\_BYPASS register at address 20<sub>h</sub>. The MANUAL\_BYPASS bit is inactive (set to 0) by default. The AUTO\_BYPASS bit is active (set to 1) by default, and places the GS6151 CDR into bypass mode when the PLL is not locked to a data rate. The bypass function does not affect the trace equalization function of the device.

**Note:** If MANUAL\_BYPASS is active, it overrides the AUTO\_BYPASS bit setting.

## 4.8 DVB-ASI

The GS6151 has the ability to reclock DVB-ASI signals at 270Mb/s. All relevant settings and control registers that apply to SD-SDI signals at 270Mb/s are also compatible with DVB-ASI signals at 270Mb/s.

## 4.9 Device Power Up

### 4.9.1 Power on Reset (POR)

The GS6151 features an on-chip power-on-reset that places all registers and internal state machines into their known, default states when the chip is powered up.

## 4.10 GPIO Pins Configuration

The GS6151 has two GPIO pins that can each be configured as outputs for various internal status signals, or as inputs to disable either output-driver via pin control. The bits GPIO[0:1]\_IO\_SELECT are used to configure the GPIO pins as outputs (0) or inputs (1). The signals that are output or input on the GPIO pins are selected by the GPIO[0:1]\_SELECT bits, in conjunction with the GPIO[0:1]\_IO\_SELECT bits of GPIO\_CONTROL\_REG\_0 at address 2<sub>h</sub>. The signals that can be output on the GPIO pins are listed in [Table 4-5](#) below and the signals that can be input are listed in [Table 4-6](#).

**Table 4-5: GPIO Status Outputs**

GPIO[0:1]_SELECT	Parameter	Description
0000	LOS	Loss of signal indication - High when there is no detected signal on the selected DDI input
0001	LOCKED	Phase lock indication - High when the CDR has phase-locked to a valid input signal
0010	LBR_HBR	Low bit-rate/High bit-rate - High when the part is locked to the SD data rate; low for all other data rates and in bypass.

**Table 4-5: GPIO Status Outputs (Continued)**

GPIO[0:1]_SELECT	Parameter	Description
0101	RATE_DET0	Rate Detect - Three bits used in conjunction that represent the data rate detected by the rate search state machine. Refer to <a href="#">Table 4-3</a> for rate encoding details.
0110	RATE_DET1	
0111	RATE_DET2	
1000	LOCKED_125M	High when the rate search state machine is locked to a MADl data rate (125Mb/s)
1001	LOCKED_270M	High when the rate search state machine is locked to an SD data rate (270Mb/s)
1010	LOCKED_1G485	High when the rate search state machine is locked to an HD data rate (1.485Gb/s)
1011	LOCKED_2G97	High when the rate search state machine is locked to a 3G data rate (2.97Gb/s)
1100	LOCKED_5G94	High when the rate search state machine is locked to a 6G data rate (5.94Gb/s)
1101	RATE_CHANGE	When a change in the data rate is detected by the rate search state machine, the RATE_CHANGE signal is pulsed high for a duration of 37ns

The signals that can be input on the GPIOs are listed in [Table 4-6](#) below.

**Table 4-6: GPIO Signal Inputs**

GPIO[0:1]_SELECT	Parameter	Description
0000	DDO0_DISABLE	Disables serial data output 0 ( $\overline{DDO0}$ , DDO0)
0001	DDO1_DISABLE	Disables serial data output 1 ( $\overline{DDO1}$ , DDO1)

By default, the GPIO pins are configured to the following parameters:

GPIO0: LOS (output)

GPIO1: LOCKED (output)

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## 4.11 GSPI Host Interface

The GS6151 is controlled via the Gennum Serial Peripheral Interface (GSPI).

The GSPI host interface is comprised of a serial data input signal (SDIN pin), serial data output signal (SDOUT pin), an active-low chip select ( $\overline{CS}$  pin) and a burst clock (SCLK pin).

The GS6151 is a slave device, therefore the SCLK, SDIN and  $\overline{CS}$  signals must be sourced by the application host processor.

All read and write access to the device is initiated and terminated by the application host processor.

It is strongly recommended to connect the GSPI pins of the GS6151 to a host/system processor/controller or FPGA to facilitate optimization of the device to meet specific application requirements. Modification of many device settings is only facilitated through the GSPI of the GS6151, and is not available on external pins.

### 4.11.1 $\overline{CS}$ Pin

The Chip Select pin ( $\overline{CS}$ ) is an active-low signal provided by the host processor to the GS6151.

The high-to-low transition of this pin marks the start of serial communication to the GS6151.

The low-to-high transition of this pin marks the end of serial communication to the GS6151.

There is an option for each device to use a separate unique Chip Select signal from the host processor or for up to 32 devices to be connected to a single Chip Select when making use of the Unit Address feature.

Only those devices whose Unit Address matches the UNIT ADDRESS in the GSPI Command Word will respond to communication from the host processor (unless the B'CAST ALL bit in the GSPI Command Word is set to 1).

### 4.11.2 SDIN Pin

The SDIN pin is the GSPI serial data input pin of the GS6151.

The 16-bit Command and Data Words from the host processor or from the SDOUT pin of other devices are shifted into the device on the rising edge of SCLK when the  $\overline{CS}$  pin is low.

### 4.11.3 SDOUT Pin

The SDOUT pin is the GSPI serial data output of the GS6151.

All data transfers out of the GS6151 to the host processor or to the SDIN pin of other connected devices occur from this pin.

By default at power up or after system reset, the SDOUT pin provides a non-clocked path directly from the SDIN pin, regardless of the  $\overline{CS}$  pin state, except during the GSPI Data

Word portion for read operations to the device. This allows multiple devices to be connected in Loop-Through configuration.

For read operations, the SDOUT pin is used to output data read from an internal Configuration and Status Register (CSR) when  $\overline{CS}$  is LOW. Data is shifted out of the device on the falling edge of SCLK, so that it can be read by the host processor or other downstream connected device on the subsequent SCLK rising edge.

### 4.11.3.1 GSPI Link Disable Operation

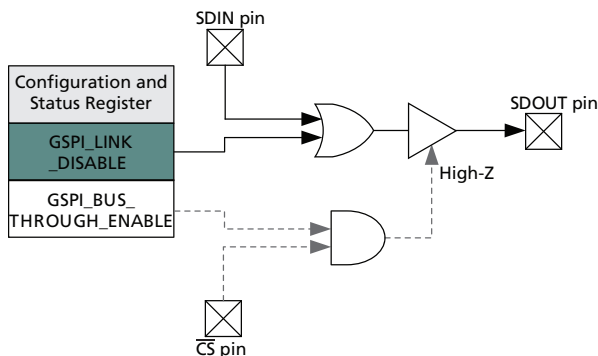
It is possible to disable the direct SDIN to SDOUT (Loop-Through) connection by writing a value of 1 to the GSPI\_LINK\_DISABLE bit in REGISTER\_0. When disabled, any data appearing at the SDIN pin will not appear at the SDOUT pin and the SDOUT pin is HIGH.

**Note:** Disabling the Loop-Through operation is temporarily required when initializing the Unit Address for up to 32 connected devices.

The time required to enable/disable the Loop-Through operation from assertion of the register bit is less than the GSPI configuration command delay as defined by the parameter  $t_{cmd\_GSPI\_config}$  (5 SCLK cycles).

**Table 4-7: GSPI\_LINK\_DISABLE Bit Operation**

Bit State	Description
0	SDIN pin is looped through to the SDOUT pin
1	Data appearing at SDIN does not appear at SDOUT, and SDOUT pin is HIGH.



**Figure 4-6: GSPI\_LINK\_DISABLE Operation**

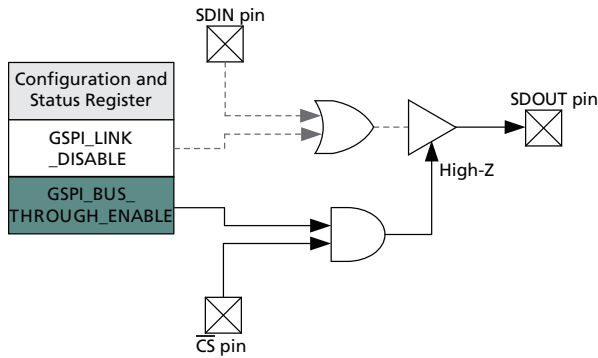
### 4.11.3.2 GSPI Bus-Through Operation

Using GSPI Bus-Through operation, the GS6151 can share a common PCB trace with other GSPI devices for SDOUT output.

When configured for Bus-Through operation, by setting GSPI\_BUS\_THROUGH\_ENABLE bit to 1, the SDOUT pin will be high-impedance when the  $\overline{CS}$  pin is HIGH.

When the  $\overline{CS}$  pin is LOW, the SDOUT pin will be driven and will follow regular read and write operation as described in [Section 4.11.3](#).

Multiple chains of GS6151 devices can share a single SDOOUT bus connection to host by configuring the devices for Bus-Through operation. In such configuration, each chain requires a separate Chip Select ( $\overline{CS}$ ).



**Figure 4-7: GSPI\_BUS\_THROUGH\_ENABLE Operation**

#### 4.11.4 SCLK Pin

The SCLK pin is the GSPI serial data shift clock input to the device, and must be provided by the host processor.

Serial data is clocked into the GS6151 SDIN pin on the rising edge of SCLK. Serial data is clocked out of the device from the SDOOUT pin on the falling edge of SCLK (read operation). SCLK is ignored when  $\overline{CS}$  is HIGH.

The maximum interface clock rate is 27MHz.

#### 4.11.5 Command Word Description

All GSPI accesses are a minimum of 32 bits in length (a 16-bit Command Word followed by a 16-bit Data Word) and the start of each access is indicated by the high-to-low transition of the chip select ( $\overline{CS}$ ) pin of the GS6151.

The format of the Command Word and Data Words are shown in [Figure 4-8](#).

Data received immediately following this high-to-low transition will be interpreted as a new Command Word.

##### 4.11.5.1 R/W bit - B15 Command Word

This bit indicates a read or write operation.

When  $R/\overline{W}$  is set to 1, a read operation is indicated, and data is read from the register specified by the ADDRESS field of the Command Word.

When  $R/\overline{W}$  is set to 0, a write operation is indicated, and data is written to the register specified by the ADDRESS field of the Command Word.

---

#### 4.11.5.2 B'CAST ALL - B14 Command Word

This bit is used in write operations to configure all devices connected in Loop-Through and Bus-Through configuration with a single command.

When B'CAST ALL is set to 1, the following Data Word (AUTOINC = 0) or Data Words (AUTOINC = 1) are written to the register specified by the ADDRESS field of the Command Word (and subsequent addresses when AUTOINC = 1), regardless of the setting of the UNIT ADDRESS(es).

When B'CAST ALL is set to 0, a normal write operation is indicated. Only those devices that have a Unit Address matching the UNIT ADDRESS field of the Command Word write the Data Word to the register specified by the ADDRESS field of the Command Word.

#### 4.11.5.3 EMEM - B13 Command Word

When the EMEM bit is 1 the Address Word is extended to 23 bits to allow access to registers located in the extended memory space.

When the EMEM bit is 0, the address word is limited to 7 bits.

#### 4.11.5.4 AUTOINC - B12 Command Word

When AUTOINC is set to 1, Auto-Increment read or write access is enabled.

In Auto-Increment Mode, the device automatically increments the register address for each contiguous read or write access, starting from the address defined in the ADDRESS field of the Command Word.

The internal address is incremented for each 16-bit read or write access until a low-to-high transition on the  $\overline{CS}$  pin is detected.

When AUTOINC is set to 0, single read or write access is required.

Auto-Increment write must not be used to update values in HOST\_CONFIG.

#### 4.11.5.5 UNIT ADDRESS - B11:B7 Command Word

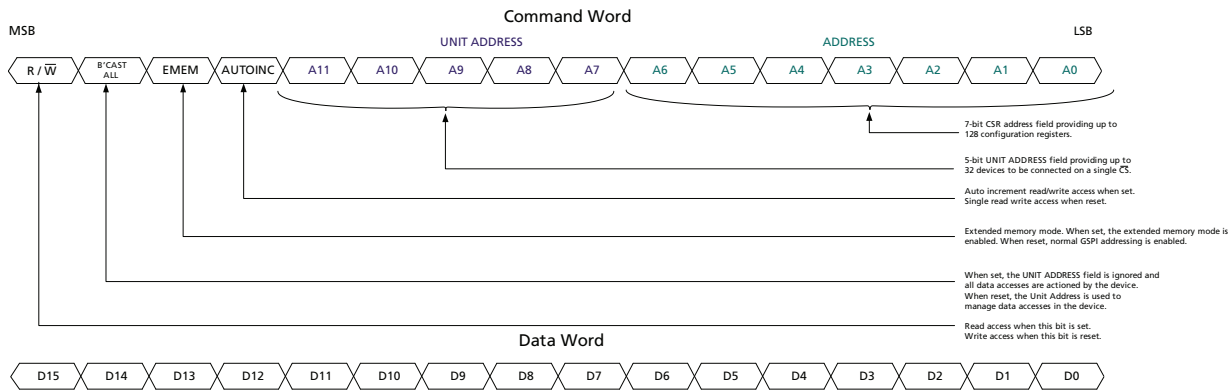
The 5 bits of the UNIT ADDRESS field of the Command Word are used to select one of 32 devices connected on a single chip select in Loop-Through or Bus-Through configurations.

Read and write accesses are only accepted if the UNIT ADDRESS field matches the programmed DEVICE\_UNIT\_ADDRESS in HOST\_CONFIG.

By default at power-up or after a device reset, the DEVICE\_UNIT\_ADDRESS is set to 00h

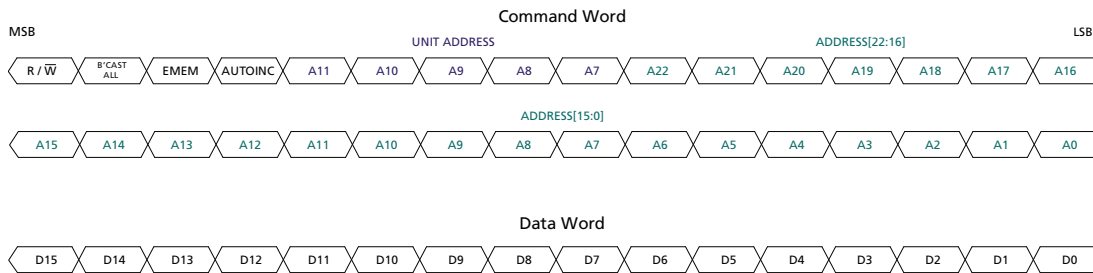
#### 4.11.5.6 ADDRESS - B6:B0 Command Word

If the extended memory is not being accessed (EMEM = 0), the 7 bits of the ADDRESS field are used to select one of 128 register addresses in the device in single read or write access mode, or to set the starting address for read or write accesses in Auto-Increment Mode.



**Figure 4-8: Command and Data Word Format**

When EMEM is set to 1, the Address Word is extended to 23 bits. The Command and Data Word format will be extended by another 16 bits, and is shown in Figure 4-9 below.



**Figure 4-9: Command and Data Word Format with EMEM set to 1**



## 4.11.6 GSPI Transaction Timing

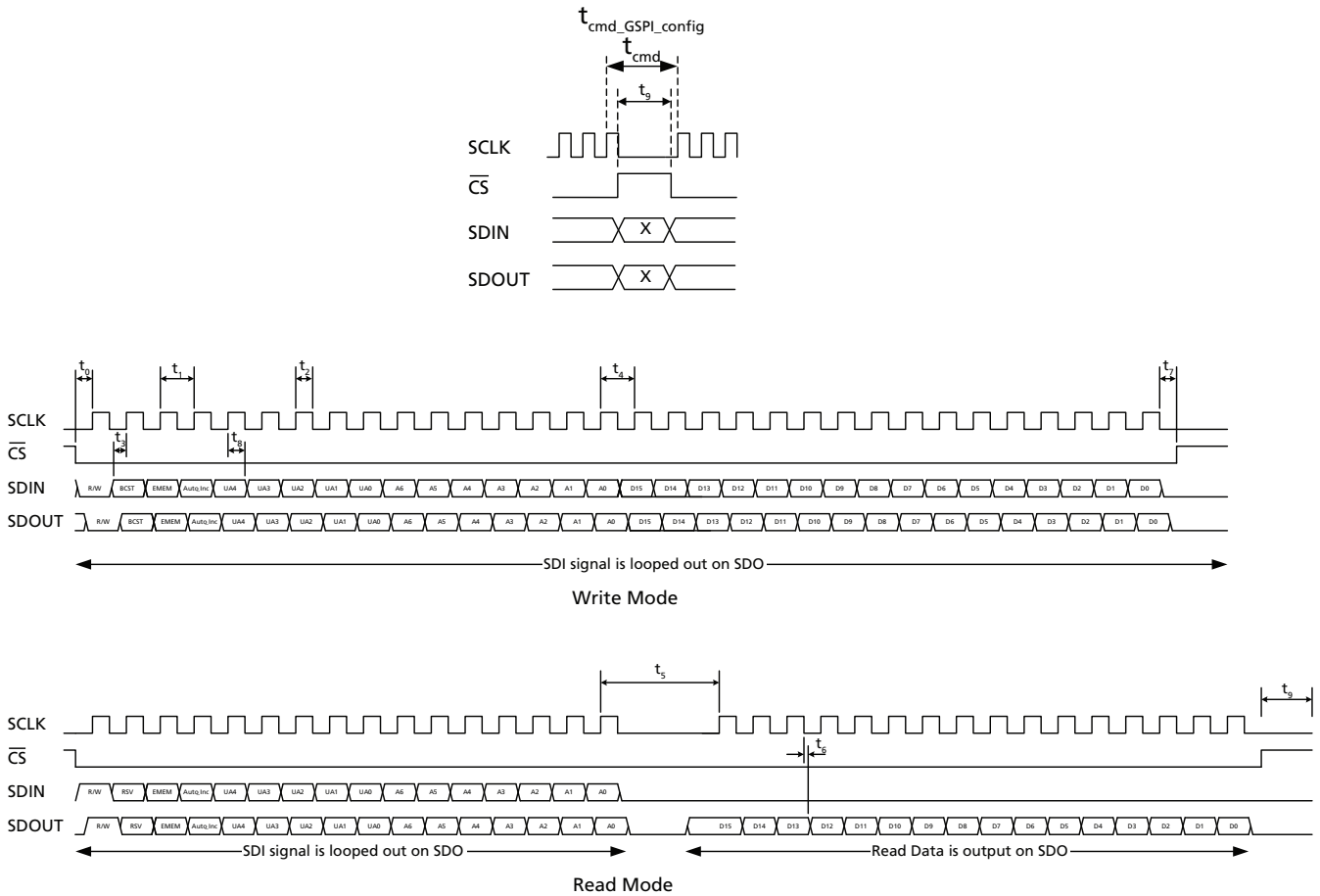


Figure 4-10: GSPI External Interface Timing

Table 4-8: GSPI Timing Parameters

Parameter	Symbol	Equivalent SCLK Cycles (at 27MHz)	Min	Typ	Max	Units
SCLK frequency			—	—	27	MHz
CS low before SCLK rising edge	$t_0$		2.0	—	—	ns
SCLK period	$t_1$		37	—	—	ns
SCLK duty cycle	$t_2$		40	50	60	%
Input data setup time	$t_3$		2.7	—	—	ns
SCLK idle time - write	$t_4$	1	37	—	—	ns
SCLK idle time - read	$t_5$	5	161.0	—	—	ns

**Table 4-8: GSPI Timing Parameters (Continued)**

Parameter	Symbol	Equivalent SCLK Cycles (at 27MHz)	Min	Typ	Max	Units
Inter-command delay time	$t_{cmd}$	4	120.0	—	—	ns
Inter-command delay time (after GSPI configuration write)	$t_{cmd\_GSPI\_conf}^1$	5	162.0	—	—	ns
SDO after SCLK falling edge	$t_6$		—	—	7.5	ns
CS high after final SCLK falling edge	$t_7$		0.0	—	—	ns
Input data hold time	$t_8$		1.0	—	—	ns
$\overline{CS}$ high time	$t_9$		57.0	—	—	ns
SDIN to SDOUT combinational delay			—	—	5.0	ns
Max. chips daisy chained at max SCLK frequency	When host clocks in SDOUT data on rising edge of SCLK		—	—	1	GS6151 chips
Max. frequency for 32 daisy-chained devices			—	—	2.1	MHz
Max. chips daisy-chained at max. SCLK frequency	When host clocks in SDOUT data on falling edge of SCLK		—	—	3	GS6151 chips
Max. frequency for 32 daisy-chained devices			—	—	2.2	MHz

Note:

- $t_{cmd\_GSPI\_conf}$  inter-command delay must be used whenever modifying HOST\_CONFIG register at address 0x00

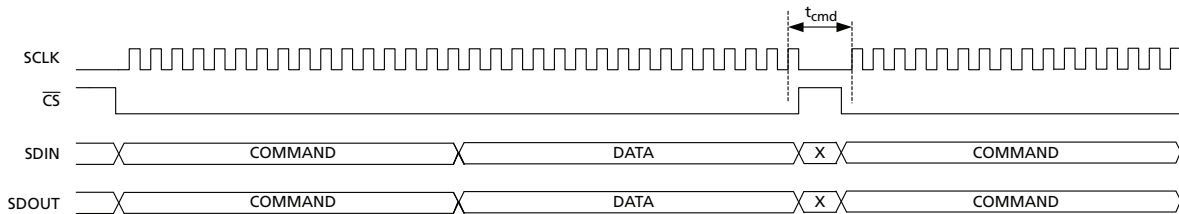
## 4.11.7 Single Read/Write Access

Single read/write access timing for the GSPI interface is shown in Figure 4-11 to Figure 4-15.

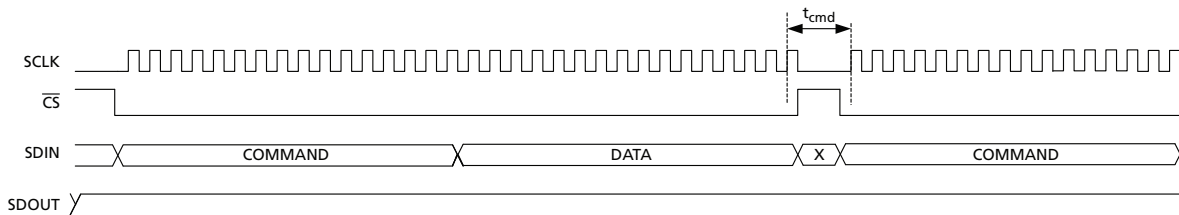
When performing a single read or write access, one Data Word is read from/written to the device per access. Each access is a minimum of 32-bits long, consisting of a Command Word and a single Data Word. The read or write cycle begins with a high-to-low transition of the  $\overline{CS}$  pin. The read or write access is terminated by a low-to-high transition of the  $\overline{CS}$  pin.

The maximum interface clock rate is 27MHz and the inter-command delay time indicated in the figures as  $t_{cmd}$ , is a minimum of 4 SCLK clock cycles. After modifying values in HOST\_CONFIG, the inter-command delay time,  $t_{cmd\_GSPI\_config}$ , is a minimum of 5 SCLK clock cycles.

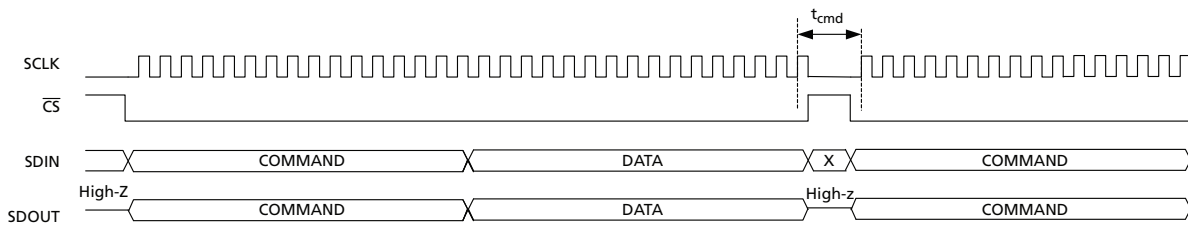
For read access, the time from the last bit of the Command Word to the start of the data output, as defined by  $t_5$ , corresponds to no less than 5 SCLK clock cycles at 27MHz.



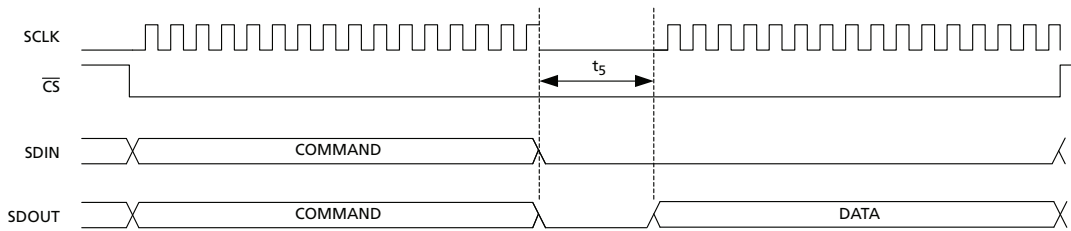
**Figure 4-11: GSPI Write Timing – Single Write Access with Loop-Through Operation (default)**



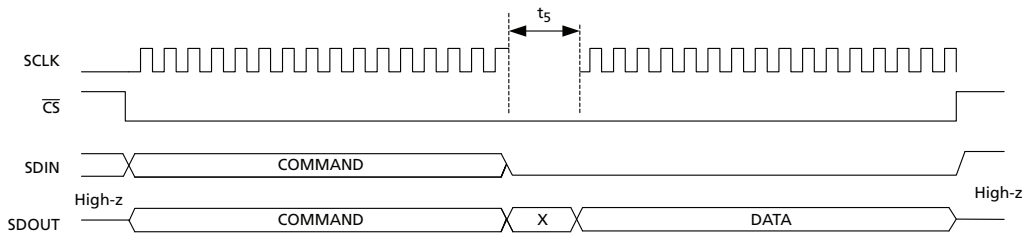
**Figure 4-12: GSPI Write Timing – Single Write Access with GSPI Link-Disable Operation**



**Figure 4-13: GSPI Write Timing – Single Write Access with Bus-Through Operation**



**Figure 4-14: GSPI Read Timing – Single Read Access with Loop-Through Operation (default)**



**Figure 4-15: GSPI Read Timing – Single Read Access with Bus-Through Operation**

### 4.11.8 Auto-increment Read/Write Access

Auto-increment read/write access timing for the GSPI interface is shown in [Figure 4-16](#) to [Figure 4-20](#).

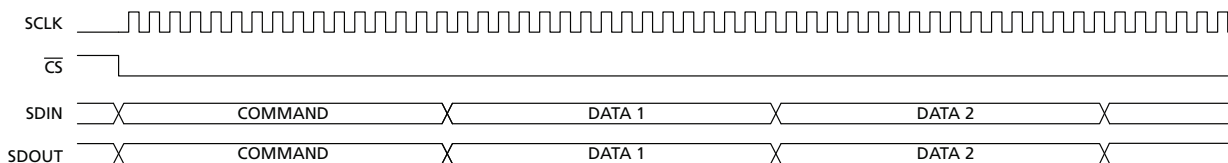
Auto-increment mode is enabled by the setting of the AUTOINC bit of the Command Word.

In this mode, multiple Data Words can be read from/written to the device using only one starting address. Each access is initiated by a high-to-low transition of the  $\overline{CS}$  pin, and consists of a Command Word and one or more Data Words. The internal address is automatically incremented after the first read or write Data Word, and continues to increment until the read or write access is terminated by a low-to-high transition of the  $\overline{CS}$  pin.

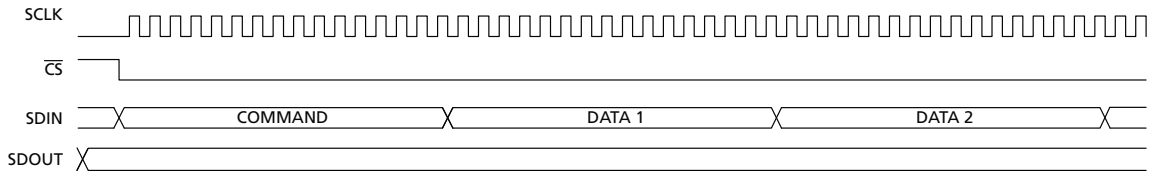
**Note:** Writing to HOST\_CONFIG using Auto-increment access is not allowed.

The maximum interface clock rate is 27MHz and the inter-command delay time indicated in the diagram as  $t_{cmd}$ , is a minimum of 4 SCLK clock cycles.

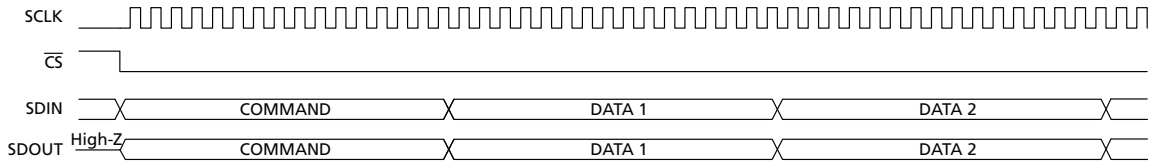
For read access, the time from the last bit of the first Command Word to the start of the data output of the first Data Word as defined by  $t_5$ , will be no less than 5 SCLK cycles at 27MHz. All subsequent read data accesses will not be subject to this delay during an Auto-Increment read.



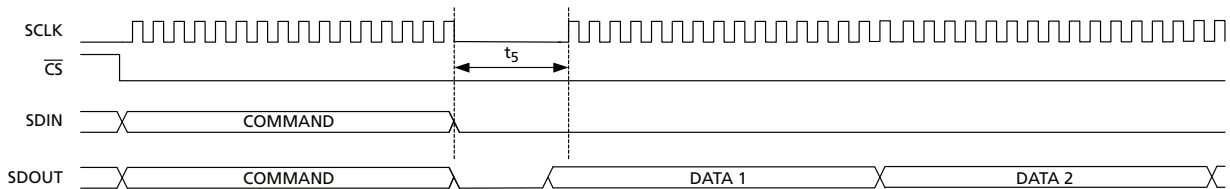
**Figure 4-16: GSPI Write Timing – Auto-Increment with Loop-Through Operation (default)**



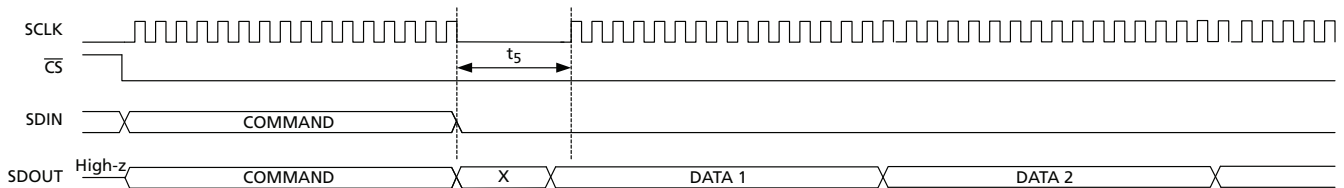
**Figure 4-17: GSPI Write Timing – Auto-Increment with GSPI Link Disable Operation**



**Figure 4-18: GSPI Write Timing – Auto-Increment with Bus-Through Operation**



**Figure 4-19: GSPI Read Timing – Auto-Increment Read with Loop-Through Operation (default)**



**Figure 4-20: GSPI Read Timing – Auto-Increment Read with Bus-through Operation**

### 4.11.9 Setting a Device Unit Address

Multiple (up to 32) GS6151 devices can be connected to a common Chip Select ( $\overline{CS}$ ) in Loop-Through or Bus-Through operation.

To ensure that each device selected by a common  $\overline{CS}$  can be separately addressed, a unique Unit Address must be programmed by the host processor at start-up as part of system initialization or following a device reset.

**Note:** By default at power up or after a device reset, the `DEVICE_UNIT_ADDRESS` of each device is set to 0h and the `SDIN->SDOUT` non-clocked loop-through for each device is enabled.

These are the steps required to set the `DEVICE_UNIT_ADDRESS` of devices in a chain to values other than 0:

1. Write to Unit Address 0 selecting `HOST_CONFIG` (`ADDRESS = 0`), with the `GSPI_LINK_DISABLE` bit set to 1 and the `DEVICE_UNIT_ADDRESS` field set to 0. This disables the direct `SDIN->SDOUT` non-clocked path for all devices on chip select.

- Write to Unit Address 0 selecting HOST\_CONFIG (ADDRESS = 0), with the GSPI\_LINK\_DISABLE bit set to 0 and the DEVICE\_UNIT\_ADDRESS field set to a unique Unit Address. This configures DEVICE\_UNIT\_ADDRESS for the first device in the chain. Each subsequent such write to Unit Address 0 will configure the next device in the chain. If there are 32 devices in a chain, the last (32nd) device in the chain must use DEVICE\_UNIT\_ADDRESS value 0.
- Repeat step 2 using new, unique values for the DEVICE\_UNIT\_ADDRESS field in HOST\_CONFIG until all devices in the chain have been configured with their own unique Unit Address value.

**Note:**  $t_{cmd\_GSPI\_conf}$  delay must be observed after every write that modifies HOST\_CONFIG.

All connected devices receive this command (by default the Unit Address of all devices is 0), and the Loop-Through operation will be re-established for all connected devices.

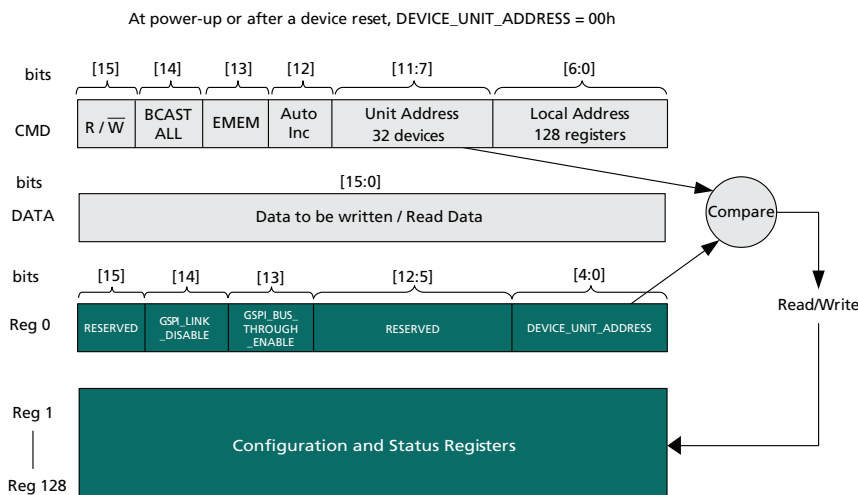
Once configured, each device will only respond to Command Words with a UNIT ADDRESS field matching the DEVICE\_UNIT\_ADDRESS in HOST\_CONFIG

**Note:** Although the Loop-Through and Bus-Through configurations are compatible with previous generation GSPI enabled devices (backward compatibility), only devices supporting Unit Addressing can share a chip select. All devices on any single chip select must be connected in a contiguous chain with only the last device's SDOUT connected to the application host processor. Multiple chains configured in Bus-Through mode can have their final SDOUT outputs connected to a single application host processor input.

#### 4.11.10 Default GSPI Operation

By default at power up or after a device reset, the GS6151 is set for Loop-Through Operation and the internal DEVICE\_UNIT\_ADDRESS field of the device is set to 0.

Figure 4-21 shows a functional block diagram of the Configuration and Status Register (CSR) map in the GS6151 for non-extended memory accesses (EMEM = 0).



**Figure 4-21: Internal Register Map Functional Block Diagram**

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The steps required for the application host processor to write to the Configuration and Status Registers via the GSPI, are as follows:

1. Set Command Word for write access ( $R/\overline{W} = 0$ ) to the local registers 0h-80h; set Auto Increment; set the Unit Address field in the Command Word to match the configured DEVICE\_UNIT\_ADDRESS which will be zero. Write the Command Word.
2. Write the Data Word to be written to the first register.
3. Write the Data Word to be written to the next register in Auto Increment mode, etc.

Read access is the same as the above with the exception of step 1, where the Command Word is set for read access ( $R/\overline{W} = 1$ ).

**Note:** The UNIT ADDRESS field of the Command Word must always match DEVICE\_UNIT\_ADDRESS for an access to be accepted by the device. Changing DEVICE\_UNIT\_ADDRESS to a value other than 0 is only required if multiple devices are connected to a single chip select (in Loop-Through or Bus-Through configuration.)

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## 4.12 Diagnostic Features

To aid in debug, the GS6151 has an on-chip eye monitoring, error counting and PRBS-signal generation features that can be used to check system links for error-free operation. The PRBS signal generator outputs a PRBS7 bit stream ( $x^7+x^6+1$  polynomial) or clock (at the reference or divided rates) which can be clocked from either an on-chip or off-chip source. The eye monitor is a 128-bit horizontal eye monitor (HEM) that can automatically detect the error-free eye width, the first error-free phase position and provide a bitmap of the error status of each phase without affecting the retiming capability of the CDR. Additionally, the HEM can be configured to manually count the number of errors at a given phase for a given time interval or to continually count errors until programmed to stop. In any of these three modes, described in the next section, [Section 4.12.1](#), the criteria for measuring a bit error can also be set to measure bit errors of arbitrary data (in which the input to the CDR is assumed to be BER-free at some phase) or by checking against a PRBS7 bit stream for measuring error-free performance of upstream devices. PRBS checking is described in [Section 4.12.2](#). The PRBS generator is described in [Section 4.12.3](#). The HEM and PRBSCHK features operate at 3Gb/s and HD data rates, while the PRBS generator operates at 3G, HD, SD and MADI rates.

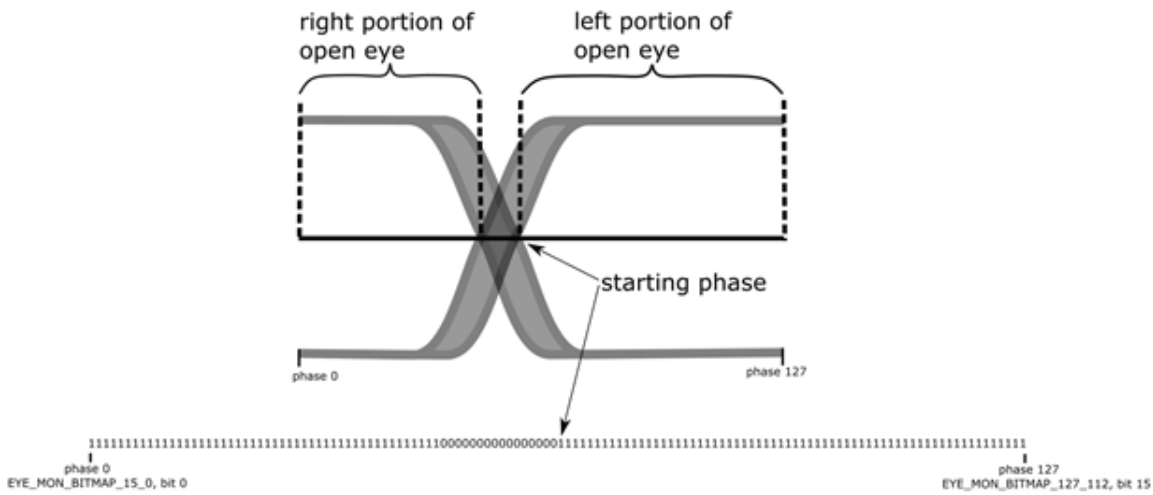
### 4.12.1 Horizontal Eye Monitor Modes

The three modes of bit error characterization of the HEM are described below. In this section it is assumed that arbitrary data is being input and checked. For each of these modes (and the PRBS7 input data checking mode in section 4.12.3) the Horizontal Eye Monitor must be enabled by setting the HORIZONTAL\_EYE\_MON\_ENABLE bit of the EYE\_MON\_ENABLE register at address 23<sub>h</sub>.

#### 4.12.1.1 Automatic Eye Scan

The automatic eye-scan mode measures the error-free eye width and first error-free phase (EYE\_WIDTH and STARTING\_PHASE bits, respectively, of EYE\_MON\_STATUS\_REG\_2) position as well as the resultant error bitmap of each of the 128 phases (EYE\_BITMAP bits of EYE\_MON\_STATUS\_REG\_4 to EYE\_MON\_STATUS\_REG\_11, least-significant bits correspond to leftmost bits). A bit value of 1 in the bitmap indicates error-free operation at the phase that corresponds to the bit. A bit value of 0 indicates more than the ERROR\_THRESHOLD number of errors have been counted and the bit is considered as an error bit. It should be noted that the eye is not necessarily centered in the results, i.e. the crossing may be in the center of the bitmap and the open eye can wrap around from phase 127 back to 0. The automatic eye scan takes this into account and calculates the value for the error-free eye across the wrapping while the error-free phase corresponds to the leftmost portion of the error-free eye rather than the leftmost error-free phase in the bitmap. Refer to [Figure 4-22](#) below.



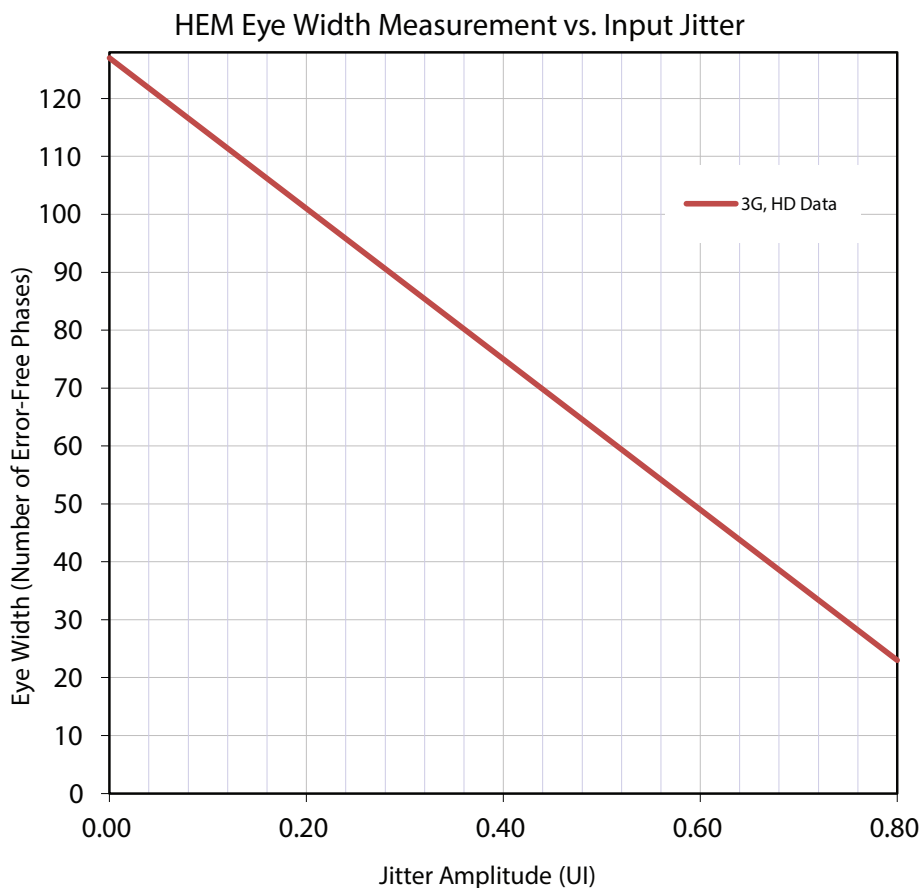


**Figure 4-22: Example Eye Monitor Bitmap**

With the eye monitor enabled by setting the `HORIZONTAL_EYE_MON_ENABLE` bit an eye scan is started by writing a 1 to the `AUTO_SCAN_START` bit of the `EYE_MON_SCAN_START` register. The eye-scan state machine then scans the eye and writes a 0 to the `AUTO_SCAN_START` bit when it completes. The values in the above registers are then valid if lock was not lost at any point during the eye scan. It is therefore recommended that the `LOCK_LOST_STICKY` bit of the `STICKY_STATUS` register is cleared before running the eye scan and checking its value after the eye scan is complete.

After a successful automatic eye scan, the `EYE_WIDTH` bits hold a value corresponding to the number of phases that had errors that did not exceed a predefined threshold. This error threshold is defined as the number of errors that must be observed before the phase is deemed to be not error-free and is set in the `ERROR_THRESHOLD` bits of the `EYE_MON_CONTROL_REG_4` register. By default the error threshold is set to 3.

A typical relationship between the `EYE_WIDTH` result and the input jitter amplitude is given in [Figure 4-22](#).



**Figure 4-23: HEM Eye Width vs. Input Jitter**

The eye scan state machine counts errors at each of the 128 phases to determine the above eye parameters, returning a 1 in the appropriate bit of the bitmap for an error-free measurement, and a 0 when an error has been detected. The length of each measurement, SAMPLE\_TIME, is determined by Equation 4-4 .

$$\text{SAMPLE\_TIME} = \text{MEASUREMENT\_PREDIVIDER} \times (\text{MEASUREMENT\_TIME} + 1) \times 1 / (108\text{MHz}) \quad \text{Equation 4-4}$$

In Equation 4-4 , MEASUREMENT\_PREDIVIDER and MEASUREMENT\_TIME are bits of the EYE\_MON\_CONTROL\_REG\_1 and EYE\_MON\_CONTROL\_REG\_2 registers, respectively. By default MEASUREMENT\_PREDIVIDER is set to 4x (bit value 0) and MEASUREMENT\_TIME is set to A8B<sub>h</sub> yielding a default measurement time per phase of 100µs. The length of time to complete a full eye scan is then approximately 128 bits x SAMPLE\_TIME x 2 passes. Two passes are executed by the state machine when checking arbitrary data to map the left and right portions of the eye separately.

The equivalent bit-error-rate is then defined as at least ERROR\_THRESHOLD / (data rate \* SAMPLE\_TIME) for phases with errors.

#### 4.12.1.2 Single Timed Measurement

A manual timed measurement can be used to count the number of errors at a single phase for a pre-defined length of time. The length of the measurement is defined by the number of bit errors recorded is stored in the ERROR\_COUNT bits of the

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EYE\_MON\_STATUS\_REG\_3 register. The phase to be measured is set by setting the MANUAL\_PHASE bit of EYE\_MON\_CONTROL\_REG\_5, and for arbitrary data the EYE\_MON\_WINDOW setting of the EYE\_MON\_CONTROL\_REG\_6.

For arbitrary data patterns the EYE\_MON\_WINDOW setting sets which portion of the eye is being measured. The result for any phase is the lesser result stored in ERROR\_COUNT of the measurements at each EYE\_MON\_WINDOW setting, 0 and 1.

For PRBS7 data only the MANUAL\_PHASE bit needs to be set and the EYE\_MON\_WINDOW bit can be arbitrarily set. The left and right portions of the eye are overlapped (wrap around the bit map).

Resetting the error indicator to 0 is done by programming the EYE\_MON\_FORCE\_CLEAR and EYE\_MON\_CLEAR bits of the EYE\_MON\_CONTROL\_REG\_6 register to 1. Both bits should be set to 0 before starting a new measurement.

### 4.12.1.3 Continuous Measurement

A manual continuous measurement can be used to continually count the number of errors at a single phase until explicitly stopped by disabling the manual continuous mode. A continuous measurement is started by first setting the MANUAL\_PHASE bit of EYE\_MON\_CONTROL\_REG\_5, and for arbitrary data the EYE\_MON\_WINDOW setting of the EYE\_MON\_CONTROL\_REG\_6, then enabling the measurement by setting the CONTINUOUS\_SCAN\_ENABLE bit of the EYE\_MON\_CONTROL\_REG\_0 register to 1 (enable measurement).

When it is desired to stop the measurement the CONTINUOUS\_SCAN\_ENABLE bit of the EYE\_MON\_CONTROL\_REG\_0 register should be set to 0 (disable measurement). The result, the number of errors counted, is stored in ERROR\_COUNT bits of the EYE\_MON\_STATUS\_REG\_3 register.

Resetting the error indicator to 0 is done by programming the EYE\_MON\_FORCE\_CLEAR and EYE\_MON\_CLEAR bits of the EYE\_MON\_CONTROL\_REG\_6 register to 1. Both bits should be set to 0 before starting a new measurement.

## 4.12.2 PRBS Checker

PRBS7 data streams can be checked for bit-errors at both the input of the CDR (non re-timed Trace EQ output) and output of the CDR (re-timed output). Although the general sequence for checking the input and output of the CDR are similar, different registers are used to program and check the results of each.

### 4.12.2.1 Input PRBS Checker

The Input PRBS checker checks the eye and/or counts bit errors at the Trace EQ output/input to the CDR. This feature can be used to optimize the Trace EQ setting, other upstream jitter optimizations or to simply check for error-free transmission to the CDR. The operation of the Input PRBS checker is similar to the Horizontal Eye Monitor for Arbitrary Data, in the previous section, providing the same functionality of automatic eye monitoring, manual timed error checking at a single phase and continuous error checking at a single phase. Because the same sequence and most of the same registers

are used to operate the Input PRBS checker (and in fact Input PRBS checking is automatically performed by the device when an Arbitrary Data eye scan or error check is performed) the user is referred to the previous section for details on programming the HEM. PRBS-specific registers which are additionally set or observed and their Arbitrary Data equivalents are given in [Table 4-9](#) below.

**Table 4-9: Arbitrary Data Checker Registers and Equivalent Input PRBS7 Checker Registers**

Arbitrary Data Checker		Input PRBS7 Checker	
Register	Parameter	Register	Parameter
Does Not Apply		EYE_MON_ENABLE	EYE_MON_PRBS_NODATA_SET
EYE_MON_CONTROL_REG_4	ERROR_THRESHOLD	EYE_MON_CONTROL_REG_3	EYE_MON_PRBS_ERROR_THRESHOLD
EYE_MON_CONTROL_REG_6	EYE_MON_WINDOW	Does Not Apply	
EYE_MON_CONTROL_REG_6	EYE_MON_FORCE_CLEAR	EYE_MON_CONTROL_REG_6	EYE_MON_PRBS_FORCE_CLEAR
EYE_MON_CONTROL_REG_6	EYE_MON_CLEAR	EYE_MON_CONTROL_REG_6	EYE_MON_PRBS_CLEAR
EYE_MON_STATUS_REG_2	STARTING_PHASE	EYE_MON_STATUS_REG_0	EYE_MON_PRBS_STARTING_PHASE
EYE_MON_STATUS_REG_2	EYE_WIDTH	EYE_MON_STATUS_REG_0	EYE_MON_PRBS_EYE_WIDTH
EYE_MON_STATUS_REG_2	ERROR_COUNT	EYE_MON_STATUS_REG_1	EYE_MON_PRBS_ERROR_COUNT
Does Not Apply		EYE_MON_STATUS_REG_12	EYE_MON_PRBS_NODATA

The eye bitmap registers in EYE\_MON\_STATUS\_REG\_4... EYE\_MON\_STATUS\_REG\_11 can be set to provide the bitmap when the PRBS checker is used as the criteria for bit errors when the EYE\_MON\_SELECT bit is set to 0 (PRBS7 bit stream).

Due to the nature of the PRBS polynomial an input without data transitions may be detected as error-free. To circumvent this possibility the EYE\_MON\_PRBS\_NODATA bit of the EYE\_MON\_STATUS\_REG\_12 register indicates if no data transitions have been detected if the bit remains high after the EYE\_MON\_PRBS\_NODATA\_SET bit of the EYE\_MON\_ENABLE register has been toggled high, then low.

#### 4.12.2.2 Re-timed Data PRBS Checker

The re-timed bit stream is checked using a separate PRBS checker which is controlled and checked with separate registers from either the arbitrary eye monitor or Input PRBS7 checker and is enabled by setting the PRBS\_MON\_ENABLE bit of the PRBS\_CHK\_CTRL register and controlled with registers PRBS\_CTRL\_0 ..., PRBS\_CTRL\_8. The results are stored in PRBS\_STATUS\_REG\_0 and PRBS\_STATUS\_REG\_1. The operation of the Re-timed Data PRBS checker is very similar to the Arbitrary Data HEM and Input PRBS checker and the user is referred to the previous sections for equivalent registers are given in [Table 4-10](#) below.

**Table 4-10: Arbitrary Data Checker/Input PRBS7 Checker Registers and Equivalent Re-timed PRBS7 Checker Registers**

Arbitrary Data Checker/Input PRBS7 Checker		Re-timed PRBS7 Checker	
Register	Parameter	Register	Parameter
EYE_MON_ENABLE	HORIZONTAL_EYE_MON_ENABLE	PRBS_CHK_CTRL	PRBS_MON_ENABLE
EYE_MON_ENABLE	EYE_MON_PRBS_NODATA_SET	PRBS_CHK_CTRL	PRBS_MON_NODATA_SET
EYE_MON_SCAN_START	MANUAL_SCAN_START	PRBS_CTRL_0	PRBS_MON_MANUAL_START
EYE_MON_SCAN_START	AUTO_SCAN_START	PRBS_CTRL_0	PRBS_MON_AUTO_SCAN_START
EYE_MON_CONTROL_REG_0	CONTINUOUS_SCAN_ENABLE	PRBS_CTRL_1	PRBS_MON_CONTINUOUS_ENABLE
EYE_MON_CONTROL_REG_0	EYE_MON_SOFT_RESET	PRBS_CTRL_1	PRBS_MON_SOFT_RESET
EYE_MON_CONTROL_REG_1	MEASUREMENT_PREDIVIDER	PRBS_CTRL_2	PRBS_MON_MEASUREMENT_PREDIVIDER
EYE_MON_CONTROL_REG_1	SAMPLE_INTERVAL	PRBS_CTRL_2	PRBS_MON_SAMPLE_INTERVAL
EYE_MON_CONTROL_REG_2	MEASUREMENT_TIME	PRBS_CTRL_3	PRBS_MON_MEASUREMENT_TIME
EYE_MON_CONTROL_REG_4	ERROR_THRESHOLD	PRBS_CTRL_4	PRBS_MON_PRBS_ERROR_THRESHOLD
EYE_MON_CONTROL_REG_5	MANUAL_PHASE	PRBS_CTRL_5	PRBS_MON_MANUAL_PHASE
EYE_MON_CONTROL_REG_6	EYE_MON_WINDOW	Does Not Apply	
EYE_MON_CONTROL_REG_6	EYE_MON_CLEAR	PRBS_CTRL_6	PRBS_MON_CLEAR
EYE_MON_CONTROL_REG_6	EYE_MON_FORCE_CLEAR	PRBS_CTRL_6	PRBS_MON_FORCE_CLEAR
EYE_MON_STATUS_REG_2	EYE_WIDTH	PRBS_STATUS_REG_0	PRBS_MON_EYE_WIDTH
EYE_MON_STATUS_REG_2	STARTING_PHASE	PRBS_STATUS_REG_0	PRBS_MON_STARTING_PHASE
EYE_MON_STATUS_REG_3	ERROR_COUNT	PRBS_STATUS_REG_1	PRBS_MON_ERROR_COUNT
EYE_MON_STATUS_REG_12	EYE_MON_PRBS_NODATA	PRBS_STATUS_REG_11	PRBS_MON_NODATA

**Note:** For all PRBS7 measurements two errors are counted for each error observed. The EYE\_MON\_ERROR\_THRESHOLD and/or PRBS\_MON\_ERROR\_THRESHOLD values should be adjusted appropriately to get the desired BER criteria.

### 4.12.3 PRBS Generator

A signal generator, capable of generating PRBS7 or clock pattern data, is integrated in the device. The pattern generator can be clocked by external pins (DFT\_CLK\_IN, DFT\_CLK\_IN, GS6151 only), re-timed clock from input arbitrary data or by an on-chip open-loop VCO (default). When the on-chip VCO is selected the data rate must be selected by programming the PRBSGEN\_RATESEL bits of the PRBS\_GEN\_CTRL register.

It is important to note that while the on-chip VCO is trimmed to within 0.5% of SMPTE data rates, VT variation may extend the deviation from exact SMPTE data rates. If frequency precision is required it is recommended to use the external pins or retimed clock to provide a clock reference for the PRBS generator. The selection of reference clock for the PRBS generator is done through programming the bits as in [Table 4-11](#).

**Table 4-11: Reference Clock for the PRBS Generator**

PRBS_EXT_CLK	PRBSGEN_CLKSEL	Clock Reference
0	0	On-chip PRBSGEN VCO
0	1	CDR re-timed clock
1	X	Clock reference pins (GS6151 only)

To enable the PRBS generator the PRBSGEN\_ENABLE bit of the PRBS\_GEN\_CTRL register must be set high. The PRBS bit stream starts on the falling edge of the PRBSGEN\_START bit. To output the PRBS generator on the trace driver output the OUTPUT\_PRBS\_DATA0 and/or OUTPUT\_PRBS\_DATA1 bits of the DRIVER\_CONTROL\_REG\_0 register need to be set to 1.

The PRBS generator can also output a clock instead of a PRBS7 bit stream. The clock output is selected by setting the PRBSGEN\_DATASEL bit of the PRBS\_GEN\_CTRL register to 0. Both the PRBS7 generator and clock output can have their frequency of operation divided by 1, 2, 4 or 8 by setting the PRBSGEN\_DIV bits of the PRBS\_GEN\_CTRL register, down to an output data rate of 125Mb/s.

Additionally, when either the On-Chip PRBSGEN VCO or the re-timed clock is used as the clock reference for the PRBS generator the phase of the output can be coarsely adjusted to 0, 90, 180 or 270° by programming PRBSGEN\_PHASE bit of the PRBS\_GEN\_CTRL register.

**Note:** It is recommended that the AUTO\_LOS\_MUTE\_ENABLE and AUTO\_PWRDN\_DISABLE parameters are set to disabled when the PRBS generator uses the on-chip PRBSGEN VCO or the external clock pins to avoid muting the (PRBS generator) output upon loss of signal on the input pins.

# 5. Host Interface Register Map

**Table 5-1: Register Descriptions - Standard Address Space**

Address	Register Name	Parameter Name	Bit Slice	R/W	Reset Value	Description
0 <sub>h</sub>	HOST_CONFIG	RSVD	15:15	RW	0 <sub>h</sub>	Reserved. Do not change.
		GSPI_LINK_DISABLE	14:14	RW	0 <sub>h</sub>	GSPI loop-through disable.
		GSPI_BUS_THROUGH_ENABLE	13:13	RW	0 <sub>h</sub>	GSPI bus-through enable.
		RSVD	12:5	RW	0 <sub>h</sub>	Reserved. Do not change.
		DEVICE_UNIT_ADDRESS	4:0	RW	—	Device address programmed by application.
1 <sub>h</sub>	DEVICE_INFO	RSVD	15:8	RO	0 <sub>h</sub>	Reserved. Do not change.
		DEVICE_VERSION_ID	7:0	RO	—	Device Version Identifier.
2 <sub>h</sub>	GPIO_CONTROL_REG_0	RSVD	15:14	RW	0 <sub>h</sub>	Reserved. Do not change.
		GPIO1_IO_SELECT	13:13	RW	0 <sub>h</sub>	GPIO1 Input/Output Select. 00 <sub>b</sub> : Output 01 <sub>b</sub> : Input
		RSVD	12:11	RW	0 <sub>h</sub>	Reserved. Do not change.
		GPIO1_SELECT	10:7	RW	1 <sub>h</sub>	GPIO1 Signal Selection If GPIO1_IO_SELECT is set to 0: 0000 <sub>b</sub> : LOS 0001 <sub>b</sub> : LOCKED (default) 0010 <sub>b</sub> : LBR_HBR 0011 <sub>b</sub> : Reserved 0100 <sub>b</sub> : Reserved 0101 <sub>b</sub> : RATE_DET0 0110 <sub>b</sub> : RATE_DET1 0111 <sub>b</sub> : RATE_DET2 1000 <sub>b</sub> : LOCKED_125M 1001 <sub>b</sub> : LOCKED_270M 1010 <sub>b</sub> : LOCKED_1G485 1011 <sub>b</sub> : LOCKED_2G97 1100 <sub>b</sub> : LOCKED_5G94 1101 <sub>b</sub> : RATE_CHANGE  If GPIO1_IO_SELECT is set to 1: 0000 <sub>b</sub> : DDO0_DISABLE 0001 <sub>b</sub> : DDO1_DISABLE
		GPIO0_IO_SELECT	6:6	RW	0 <sub>h</sub>	GPIO0 Input/Output Select. 00 <sub>b</sub> : Output 01 <sub>b</sub> : Input
RSVD	5:4	RW	0 <sub>h</sub>	Reserved. Do not change.		

**Table 5-1: Register Descriptions - Standard Address Space (Continued)**

Address	Register Name	Parameter Name	Bit Slice	R/W	Reset Value	Description
2 <sub>h</sub>	GPIO_CONTROL_REG_0	GPIO0_SELECT	3:0	RW	0 <sub>h</sub>	<p>GPIO0 Signal Selection</p> <p>If GPIO0_IO_SELECT is set to 0:</p> <p>0000<sub>b</sub>: LOS (default)</p> <p>0001<sub>b</sub>: LOCKED</p> <p>0010<sub>b</sub>: LBR_HBR</p> <p>0011<sub>b</sub>: Reserved</p> <p>0100<sub>b</sub>: Reserved</p> <p>0101<sub>b</sub>: RATE_DET0</p> <p>0110<sub>b</sub>: RATE_DET1</p> <p>0111<sub>b</sub>: RATE_DET2</p> <p>1000<sub>b</sub>: LOCKED_125M</p> <p>1001<sub>b</sub>: LOCKED_270M</p> <p>1010<sub>b</sub>: LOCKED_1G485</p> <p>1011<sub>b</sub>: LOCKED_2G97</p> <p>1100<sub>b</sub>: LOCKED_5G94</p> <p>1101<sub>b</sub>: RATE_CHANGE</p> <p>If GPIO0_IO_SELECT is set to 1:</p> <p>0000<sub>b</sub>: DDO0_DISABLE</p> <p>0001<sub>b</sub>: DDO1_DISABLE</p>
3 <sub>h</sub>	RESERVED	RSVD	15:14	RW	2082 <sub>h</sub>	Reserved. Do not change.
4 <sub>h</sub>	RESERVED	RSVD	15:0	RW	1C <sub>h</sub>	Reserved. Do not change.
		RSVD	15:4	RW	A <sub>h</sub>	Reserved. Do not change.
5 <sub>h</sub>	INPUT_CONTROL_REG_0	DDI1_TRACE_EQ_CONTROL	3:2	RW	2 <sub>h</sub>	<p>DDI1 Trace-EQ Configuration</p> <p>00<sub>b</sub>: OFF</p> <p>01<sub>b</sub>: 0dB/EQ BYPASS</p> <p>10<sub>b</sub>: LOW</p> <p>11<sub>b</sub>: HIGH</p>
		DDIO_TRACE_EQ_CONTROL	1:0	RW	2 <sub>h</sub>	<p>DDIO Trace-EQ Configuration</p> <p>00<sub>b</sub>: OFF</p> <p>01<sub>b</sub>: 0dB/EQ BYPASS</p> <p>10<sub>b</sub>: LOW</p> <p>11<sub>b</sub>: HIGH</p>
6 <sub>h</sub>	RESERVED	RSVD	15:0	RW	0 <sub>h</sub>	Reserved. Do not change.



**Table 5-1: Register Descriptions - Standard Address Space (Continued)**

Address	Register Name	Parameter Name	Bit Slice	R/W	Reset Value	Description
		RSVD	15:12	RW	0 <sub>h</sub>	Reserved. Do not change.
		DDI_SELECT	11:10	RW	0 <sub>h</sub>	Input Selection 00 <sub>b</sub> : DDI0 01 <sub>b</sub> : DDI1 Used when INPUT_SELECTION_CONTROL is set to 01 <sub>b</sub> or 11 <sub>b</sub>
7 <sub>h</sub>	INPUT_CONTROL_REG_2	INPUT_SELECTION_CONTROL	9:8	RW	0 <sub>h</sub>	Determines the source for the input selection block. X0 <sub>b</sub> : Use the DDI_SEL/STROBE pin 01 <sub>b</sub> : Use the DDI_SELECT bit 11 <sub>b</sub> : Use the DDI_SELECT bit; update occurs on low-to-high transition of DDI_SEL/STROBE pin.
		RSVD	7:6	RW	3 <sub>h</sub>	Reserved. Do not change.
		DDI1_TRACE_EQ_DC_TERM_ENABLE	5:5	RW	1 <sub>h</sub>	Enable DDI1 on-chip Trace-EQ DC termination. 00 <sub>b</sub> : Disabled 01 <sub>b</sub> : Enabled
		DDI0_TRACE_EQ_DC_TERM_ENABLE	4:4	RW	1 <sub>h</sub>	Enable DDI0 on-chip Trace-EQ DC termination. 00 <sub>b</sub> : Disabled 01 <sub>b</sub> : Enabled
		RSVD	3:0	RW	0 <sub>h</sub>	Reserved. Do not change.
8 <sub>h</sub>	RESERVED	RSVD	15:0	ROCW	—	Reserved. Do not change.
9 <sub>h</sub>	RESERVED	RSVD	15:0	RO	—	Reserved. Do not change.
A <sub>h</sub>	RESERVED	RSVD	15:0	RO	—	Reserved. Do not change.
B <sub>h</sub>	RESERVED	RSVD	15:0	RO	—	Reserved. Do not change.
C <sub>h</sub>	RESERVED	RSVD	15:0	RO	—	Reserved. Do not change.
D <sub>h</sub>	RESERVED	RSVD	15:0	RO	—	Reserved. Do not change.
E <sub>h</sub>	RESERVED	RSVD	15:0	RO	—	Reserved. Do not change.

**Table 5-1: Register Descriptions - Standard Address Space (Continued)**

Address	Register Name	Parameter Name	Bit Slice	R/W	Reset Value	Description
		RSVD	15:10	RW	0 <sub>h</sub>	Reserved. Do not change.
		LOS_THRESHOLD_CONTROL_ENABLE	9:9	RW	0 <sub>h</sub>	Enables LOS threshold adjustment based on the settings in the DDI[0:1]_LOS_THRESHOLD_CONTROL bits in the LOS_CONTROL_REG_1 register. 00 <sub>b</sub> : Default internal thresholds are used 01 <sub>b</sub> : Thresholds used in the LOS_CONTROL_REG_1 register
		LOS_DEASSERT_TIME	8:7	RW	2 <sub>h</sub>	LOS De-Assert Time Delay: 00 <sub>b</sub> : 2.30μs 01 <sub>b</sub> : 1.50μs 10 <sub>b</sub> : 1.20μs 11 <sub>b</sub> : 0.90μs
		LOS_ASSERT_TIME	6:5	RW	2 <sub>h</sub>	LOS Assert Time Delay: 00 <sub>b</sub> : 68μs 01 <sub>b</sub> : 64μs 10 <sub>b</sub> : 62μs 11 <sub>b</sub> : 61μs
F <sub>h</sub>	LOS_CONTROL_REG_0	LOS_HYSTERESIS	4:1	RW	0 <sub>h</sub>	LOS Threshold Hysteresis Adjustment: 0000 <sub>b</sub> : 0 dB 0001 <sub>b</sub> : 0.32 dB 0010 <sub>b</sub> : 0.64 dB 0011 <sub>b</sub> : 0.98 dB 0100 <sub>b</sub> : 1.34 dB 0101 <sub>b</sub> : 1.70 dB 0110 <sub>b</sub> : 2.09 dB 0111 <sub>b</sub> : 2.49 dB 1000 <sub>b</sub> : 2.84 dB 1001 <sub>b</sub> : 3.28 dB 1010 <sub>b</sub> : 3.74 dB 1011 <sub>b</sub> : 4.23 dB 1100 <sub>b</sub> : 4.75 dB 1101 <sub>b</sub> : 5.30 dB 1110 <sub>b</sub> : 5.89 dB 1111 <sub>b</sub> : 6.53 dB
		LOS_PWRDN_OVERRIDE	0:0	RW	0 <sub>h</sub>	Override the internal power-down control for the LOS circuit. 00 <sub>b</sub> : LOS active 01 <sub>b</sub> : LOS powered down

**Table 5-1: Register Descriptions - Standard Address Space (Continued)**

Address	Register Name	Parameter Name	Bit Slice	R/W	Reset Value	Description
10 <sub>h</sub>	LOS_CONTROL_REG_1	DDI1_LOS_THRESHOLD_CONTROL	15:8	RW	5A <sub>h</sub>	LOS signal threshold for input DDI1 at device pins is: 1.9mV <sub>ppd</sub> x DDI1_LOS_THRESHOLD_CONTROL x (53/DEVICE_SPECIFIC_LOS_THRESHOLD) (All above values are in decimal)
		DDIO_LOS_THRESHOLD_CONTROL	7:0	RW	5A <sub>h</sub>	LOS signal threshold for input DDIO at device pins is: 1.9mV <sub>ppd</sub> x DDIO_LOS_THRESHOLD_CONTROL x (53/DEVICE_SPECIFIC_LOS_THRESHOLD) (All above values are in decimal)
11 <sub>h</sub>	RESERVED	RSVD	15:0	RW	5A5A <sub>h</sub>	Reserved. Do not change.
12 <sub>h</sub>	LOS_STATUS	RSVD	15:8	RO	—	Reserved. Do not change.
		DEVICE_SPECIFIC_LOS_THRESHOLD	7:0	RO	—	Trimmed setting to achieve LOS threshold of 100mV <sub>ppd</sub>
13 <sub>h</sub>	RESERVED	RSVD	15:0	RW	280 <sub>h</sub>	Reserved. Do not change.
14 <sub>h</sub>	RESERVED	RSVD	15:0	RO	—	Reserved. Do not change.
		RSVD	15:3	RW	0 <sub>h</sub>	Reserved. Do not change.
15 <sub>h</sub>	REF_CLK_CONTROL	XTAL_BUF_OUT_ENABLE	2:2	RW	1 <sub>h</sub>	Enables/Disables the reference buffer output. 00 <sub>b</sub> : XTAL_BUF_OUT disabled 01 <sub>b</sub> : XTAL_BUF_OUT enabled
		RSVD	1:1	RW	0 <sub>h</sub>	Reserved. Do not change.
		RSVD	0:0	RW	0 <sub>h</sub>	Reserved. Do not change.
		RSVD	15:1	RO	—	Reserved. Do not change.
16 <sub>h</sub>	REF_CLK_STATUS	XTAL_CLK_DET	0:0	RO	—	Indicates whether an external 27MHz reference is being used by the device or its internal oscillator. 00 <sub>b</sub> : Internal oscillator being used 01 <sub>b</sub> : External crystal being used

**Table 5-1: Register Descriptions - Standard Address Space (Continued)**

Address	Register Name	Parameter Name	Bit Slice	R/W	Reset Value	Description
17 <sub>h</sub>	PWRDN_CONTROL	AUTO_PWRDN_MODE	3:3	RW	0 <sub>h</sub>	Selects the low power mode, SLEEP or STANDBY that is entered into when AUTO_PWRDN_DISABLE is set to 0 and LOS is asserted. 00 <sub>b</sub> : SLEEP mode is selected (default) 01 <sub>b</sub> : STANDBY mode is selected
		FORCE_PWRDN_STANDBY	2:2	RW	0 <sub>h</sub>	Forces the device into STANDBY mode when FORCE_PWRDN_SLEEP is set to 0. 00 <sub>b</sub> : Device not in STANDBY mode 01 <sub>b</sub> : Device in STANDBY mode
		FORCE_PWRDN_SLEEP	1:1	RW	0 <sub>h</sub>	Forces the device into SLEEP mode when AUTO_PWRDN_DISABLE is set to 1. 00 <sub>b</sub> : Device not in SLEEP mode 01 <sub>b</sub> : Device in SLEEP mode When FORCE_PWRDN_SLEEP is set to 1, it takes precedence over the FORCE_PWRDN_STANDBY bit.
		AUTO_PWRDN_DISABLE	0:0	RW	1 <sub>h</sub>	Disables Auto Powerdown mode which automatically enters SLEEP or STANDBY mode when LOS is asserted. 00 <sub>b</sub> : Device automatically enters SLEEP or STANDBY on a rising edge of the LOS signal 01 <sub>b</sub> : Device only enters SLEEP or STANDBY when FORCE_PWRDN_SLEEP or FORCE_PWRDN_STANDBY are set to 1
18 <sub>h</sub>	RESERVED	RSVD	15:0	RO	—	Reserved. Do not change.

**Table 5-1: Register Descriptions - Standard Address Space (Continued)**

Address	Register Name	Parameter Name	Bit Slice	R/W	Reset Value	Description
		RSVD	15:8	RW	0 <sub>h</sub>	Reserved. Do not change.
		OUTPUT_PRBS_DATA1	9:9	RW	0	Selects either CDR or PRBSgen data to output on DDO1. 00 <sub>b</sub> : CDR data 01 <sub>b</sub> : PRBSgen data
		OUTPUT_PRBS_DATA0	8:8	RW	0	Selects either CDR or PRBSgen data to output on DDO0. 00 <sub>b</sub> : CDR data 01 <sub>b</sub> : PRBSgen data
		RSVD	7:7	RW	1 <sub>h</sub>	Reserved. Do not change.
		AUTO_LOS_MUTE_ENABLE	6:6	RW	1 <sub>h</sub>	Auto-Mute Enable on LOS. 00 <sub>b</sub> : Output is unaffected by LOS 01 <sub>b</sub> : Output is muted when LOS is asserted
		DDO1_MUTE	5:5	RW	0 <sub>h</sub>	Mute control for the DDO1 output. 00 <sub>b</sub> : DDO1 output not muted 01 <sub>b</sub> : DDO1 output muted Output across DDO1 and $\overline{DDO1}$ is DDO1_SWING_MUTE/2 when DDO1_DISABLE is set to 0.
19 <sub>h</sub>	DRIVER_CONTROL_REG_0	DDO0_MUTE	4:4	RW	0 <sub>h</sub>	Mute control for the DDO0 output. 00 <sub>b</sub> : DDO0 output not muted 01 <sub>b</sub> : DDO0 output muted Output across DDO0 and $\overline{DDO0}$ is DDO0_SWING_MUTE/2 when DDO1_DISABLE is set to 0.
		DDO1_DISABLE	3:3	RW	0 <sub>h</sub>	Disable control for the DDO1 output. 00 <sub>b</sub> : DDO1 output not disabled 01 <sub>b</sub> : DDO1 output disabled Output of both DDO1 and $\overline{DDO1}$ is VCC_DDO1. This bit takes precedence over DDO1_MUTE.
		DDO0_DISABLE	2:2	RW	0 <sub>h</sub>	Disable control for the DDO0 output. 00 <sub>b</sub> : DDO0 output not disabled 01 <sub>b</sub> : DDO0 output disabled Output of both DDO0 and $\overline{DDO0}$ is VCC_DDO0. This bit takes precedence over DDO0_MUTE.
		DDO1_DISABLE_SELECT	1:1	RW	0 <sub>h</sub>	Controls whether DDO1 is disabled using an assigned GPIO pin or the DDO1_DISABLE bit. 00 <sub>b</sub> : DDO1 is disabled using assigned GPIO 01 <sub>b</sub> : DDO1 is disabled using the DDO1_DISABLE bit
		DDO0_DISABLE_SELECT	0:0	RW	1 <sub>h</sub>	Controls whether DDO0 is disabled using an assigned GPIO pin or the DDO0_DISABLE bit. 00 <sub>b</sub> : DDO0 is disabled using assigned GPIO 01 <sub>b</sub> : DDO0 is disabled using the DDO0_DISABLE bit

**Table 5-1: Register Descriptions - Standard Address Space (Continued)**

Address	Register Name	Parameter Name	Bit Slice	R/W	Reset Value	Description
		RSVD	15:15	RW	0 <sub>h</sub>	Reserved. Do not change.
		DDO0_DEEMPHASIS_5G94	14:12	RW	2 <sub>h</sub>	De-emphasis control for 5.94Gb/s (6Gb/s UHD-SDI) signals output on DDO0. 000 <sub>b</sub> : 0dB 001 <sub>b</sub> : 0.3dB 010 <sub>b</sub> : 0.6dB (default) 011 <sub>b</sub> : 2.3 B 100 <sub>b</sub> : 4.0dB 101 <sub>b</sub> : 6.6dB 110 <sub>b</sub> : 10.0dB
		DDO0_DEEMPHASIS_2G97	11:9	RW	1 <sub>h</sub>	De-emphasis control for 2.97Gb/s (3Gb/s SDI) signals output on DDO0. 000 <sub>b</sub> : 0dB 001 <sub>b</sub> : 0.4dB (default) 010 <sub>b</sub> : 1.5dB 011 <sub>b</sub> : 3.2dB 100 <sub>b</sub> : 4.9dB 101 <sub>b</sub> : 7.6dB 110 <sub>b</sub> : 11.0dB
1A <sub>h</sub>	DRIVER_CONTROL_REG_1	DDO0_DEEMPHASIS_1G485	8:6	RW	1 <sub>h</sub>	De-emphasis control for 1.485Gb/s (HD-SDI) signals output on DDO0. 000 <sub>b</sub> : 0dB 001 <sub>b</sub> : 1.1dB (default) 010 <sub>b</sub> : 2.4dB 011 <sub>b</sub> : 4.0dB 100 <sub>b</sub> : 5.7dB 101 <sub>b</sub> : 8.2dB 110 <sub>b</sub> : 11.5dB
		DDO0_DEEMPHASIS_270M	5:3	RW	0 <sub>h</sub>	De-emphasis control for 0.27Gb/s (SD-SDI) signals output on DDO0. 000 <sub>b</sub> : 0dB (default) 001 <sub>b</sub> : 1.2dB 010 <sub>b</sub> : 2.5dB 011 <sub>b</sub> : 4.1dB 100 <sub>b</sub> : 6.0dB 101 <sub>b</sub> : 8.5dB 110 <sub>b</sub> : 12.0dB
		DDO0_DEEMPHASIS_125M	2:0	RW	0 <sub>h</sub>	De-emphasis control for 0.125Gb/s (MADI) signals output on DDO0. 000 <sub>b</sub> : 0dB (default) 001 <sub>b</sub> : 1.2dB 010 <sub>b</sub> : 2.5dB 011 <sub>b</sub> : 4.1dB 100 <sub>b</sub> : 6.0dB 101 <sub>b</sub> : 8.5dB 110 <sub>b</sub> : 12.0dB

**Table 5-1: Register Descriptions - Standard Address Space (Continued)**

Address	Register Name	Parameter Name	Bit Slice	R/W	Reset Value	Description
		RSVD	15:15	RW	0 <sub>h</sub>	Reserved. Do not change.
		DDO1_DEEMPHASIS_5G94	14:12	RW	2 <sub>h</sub>	De-emphasis control for 5.94Gb/s (6Gb/s UHD-SDI) signals output on DDO1. 000 <sub>b</sub> : 0dB 001 <sub>b</sub> : 0.3dB 010 <sub>b</sub> : 0.6dB (default) 011 <sub>b</sub> : 2.3 B 100 <sub>b</sub> : 4.0dB 101 <sub>b</sub> : 6.6dB 110 <sub>b</sub> : 10.0dB
		DDO1_DEEMPHASIS_2G97	11:9	RW	1 <sub>h</sub>	De-emphasis control for 2.97Gb/s (3Gb/s SDI) signals output on DDO1. 000 <sub>b</sub> : 0dB 001 <sub>b</sub> : 0.4dB (default) 010 <sub>b</sub> : 1.5dB 011 <sub>b</sub> : 3.2dB 100 <sub>b</sub> : 4.9dB 101 <sub>b</sub> : 7.6dB 110 <sub>b</sub> : 11.0dB
1B <sub>h</sub>	DRIVER_CONTROL_REG_2	DDO1_DEEMPHASIS_1G485	8:6	RW	1 <sub>h</sub>	De-emphasis control for 1.485Gb/s (HD-SDI) signals output on DDO1. 000 <sub>b</sub> : 0dB 001 <sub>b</sub> : 1.1dB (default) 010 <sub>b</sub> : 2.4dB 011 <sub>b</sub> : 4.0dB 100 <sub>b</sub> : 5.7dB 101 <sub>b</sub> : 8.2dB 110 <sub>b</sub> : 11.5dB
		DDO1_DEEMPHASIS_270M	5:3	RW	0 <sub>h</sub>	De-emphasis control for 0.27Gb/s (SD-SDI) signals output on DDO1. 000 <sub>b</sub> : 0dB (default) 001 <sub>b</sub> : 1.2dB 010 <sub>b</sub> : 2.5dB 011 <sub>b</sub> : 4.1dB 100 <sub>b</sub> : 6.0dB 101 <sub>b</sub> : 8.5dB 110 <sub>b</sub> : 12.0dB
		DDO1_DEEMPHASIS_125M	2:0	RW	0 <sub>h</sub>	De-emphasis control for 0.125Gb/s (MADI) signals output on DDO1. 000 <sub>b</sub> : 0dB (default) 001 <sub>b</sub> : 1.2dB 010 <sub>b</sub> : 2.5dB 011 <sub>b</sub> : 4.1dB 100 <sub>b</sub> : 6.0dB 101 <sub>b</sub> : 8.5dB 110 <sub>b</sub> : 12.0dB

**Table 5-1: Register Descriptions - Standard Address Space (Continued)**

Address	Register Name	Parameter Name	Bit Slice	R/W	Reset Value	Description
		RSVD	15:12	RW	0 <sub>h</sub>	Reserved. Do not change.
1C <sub>h</sub>	DRIVER_CONTROL_REG_3	DDO0_SWING_1G485	11:8	RW	3 <sub>h</sub>	Differential swing (amplitude) control for 1.485Gb/s (HD-SDI) signals output on DDO0. For details refer to <a href="#">Section 4.5.3</a> .
		DDO0_SWING_270M	7:4	RW	3 <sub>h</sub>	Differential swing (amplitude) control for 0.27Gb/s (SD-SDI) signals output on DDO0. For details refer to <a href="#">Section 4.5.3</a> .
		DDO0_SWING_125M	3:0	RW	3 <sub>h</sub>	Differential swing (amplitude) control for 0.125Gb/s (MADI) signals output on DDO0. For details refer to <a href="#">Section 4.5.3</a> .
1D <sub>h</sub>	DRIVER_CONTROL_REG_4	DDO0_SWING_BYPASS	15:12	RW	3 <sub>h</sub>	Differential swing (amplitude) control for unlocked signals output on DDO0 (when CDR is operating in BYPASS mode). For details refer to <a href="#">Section 4.5.3</a> . Takes precedence over rate-specific swing controls
		DDO0_SWING_MUTE	11:8	RW	3 <sub>h</sub>	Differential static amplitude control for DDO0 when the output is muted. For details refer to <a href="#">Section 4.5.3</a> . Takes precedence over rate-specific swing controls and bypass swing control
1D <sub>h</sub>	DRIVER_CONTROL_REG_4	DDO0_SWING_5G94	7:4	RW	3 <sub>h</sub>	Differential swing (amplitude) control for 5.94Gb/s (6G UHD-SDI) signals output on DDO0. For details refer to <a href="#">Section 4.5.3</a> .
		DDO0_SWING_2G97	3:0	RW	3 <sub>h</sub>	Differential swing (amplitude) control for 2.97Gb/s (3Gb/s SDI) signals output on DDO0. For details refer to <a href="#">Section 4.5.3</a> .
		RSVD	15:12	RW	0 <sub>h</sub>	Reserved. Do not change.
1E <sub>h</sub>	DRIVER_CONTROL_REG_5	DDO1_SWING_1G485	11:8	RW	3 <sub>h</sub>	Differential swing (amplitude) control for 1.485Gb/s (HD-SDI) signals output on DDO1. For details refer to <a href="#">Section 4.5.3</a> .
		DDO1_SWING_270M	7:4	RW	3 <sub>h</sub>	Differential swing (amplitude) control for 0.27Gb/s (SD-SDI) signals output on DDO1. For details refer to <a href="#">Section 4.5.3</a> .
		DDO1_SWING_125M	3:0	RW	3 <sub>h</sub>	Differential swing (amplitude) control for 0.125Gb/s (MADI) signals output on DDO1. For details refer to <a href="#">Section 4.5.3</a> .



**Table 5-1: Register Descriptions - Standard Address Space (Continued)**

Address	Register Name	Parameter Name	Bit Slice	R/W	Reset Value	Description
1F <sub>h</sub>	DRIVER_CONTROL_REG_6	DDO1_SWING_BYPASS	15:12	RW	3 <sub>h</sub>	Differential swing (amplitude) control for unlocked signals output on DDO1 (when CDR is operating in BYPASS mode). For details refer to <a href="#">Section 4.5.3</a> . Also applies when the device is not locked. Takes precedence over rate-specific swing controls
		DDO1_SWING_MUTE	11:8	RW	3 <sub>h</sub>	Differential static amplitude control for DDO1 when the output is muted. For details refer to <a href="#">Section 4.5.3</a> . Takes precedence over rate-specific swing controls and bypass swing control
		DDO1_SWING_5G94	7:4	RW	3 <sub>h</sub>	Differential swing (amplitude) control for 5.94Gb/s (6G UHD-SDI) signals output on DDO1. For details refer to <a href="#">Section 4.5.3</a> .
		DDO1_SWING_2G97	3:0	RW	3 <sub>h</sub>	Differential swing (amplitude) control for 2.97Gb/s (3Gb/s SDI) signals output on DDO1. For details refer to <a href="#">Section 4.5.3</a> .
		RSVD	15:2	RW	0 <sub>h</sub>	Reserved. Do not change.
20 <sub>h</sub>	CDR_BYPASS	MANUAL_BYPASS	1:1	RW	0 <sub>h</sub>	Used to manually bypass the retiming block in the CDR. 00 <sub>b</sub> : Re-timer not bypassed 01 <sub>b</sub> : Re-timer bypassed The assertion of MANUAL_BYPASS takes precedence irrespective of the setting of AUTO_BYPASS
		AUTO_BYPASS	0:0	RW	1 <sub>h</sub>	Selects between automatic and manual bypass of the retiming block when the CDR is not locked. 00 <sub>b</sub> : Auto-Bypass is disabled 01 <sub>b</sub> : Auto-Bypass is enabled Even if AUTO_BYPASS is asserted, the assertion of MANUAL_BYPASS will still cause the re-timer to be bypassed.
		RSVD	15:11	RW	0 <sub>h</sub>	Reserved. Do not change.
21 <sub>h</sub>	PD_CONTROL	OUTPUT_POLARITY_INVERT	10:10	RW	0 <sub>h</sub>	Signal polarity invert at output of CDR/bypass. 00 <sub>b</sub> : Not inverted 01 <sub>b</sub> : Inverted
		RSVD	9:6	RW	2 <sub>h</sub>	Reserved. Do not change.
		RSVD	5:1	RW	0 <sub>h</sub>	Reserved. Do not change.
		INPUT_POLARITY_INVERT	0:0	RW	0 <sub>h</sub>	Signal polarity invert at input to CDR/bypass. 00 <sub>b</sub> : Not inverted 01 <sub>b</sub> : Inverted

**Table 5-1: Register Descriptions - Standard Address Space (Continued)**

Address	Register Name	Parameter Name	Bit Slice	R/W	Reset Value	Description
22 <sub>h</sub>	PRBS_GEN_CTRL	PRBSGEN_DATASEL	14:14	RW	1 <sub>h</sub>	Determines the DFT data output. 00 <sub>b</sub> : Clock 01 <sub>b</sub> : PRBS7 data
		PRBSGEN_DIV	13:12	RW	0 <sub>h</sub>	Divide ratio for the DFT clock. 00 <sub>b</sub> : divide by 1 01 <sub>b</sub> : divide by 2 10 <sub>b</sub> : divide by 4 11 <sub>b</sub> : divide by 8
		PRBSGEN_START	11:11	RW	0 <sub>h</sub>	When toggled HIGH then LOW starts the internal PRBS7 data source.
		PRBSGEN_EXT_CLK	10:10	RW	0 <sub>h</sub>	Selects the source for the DFT clock: 00 <sub>b</sub> : Internally generated clock 01 <sub>b</sub> : External clock
		PRBSGEN_PHASE	9:8	RW	2 <sub>h</sub>	Controls the phase of the internally generated DFT clock. 00 <sub>b</sub> : 0 degree phase 01 <sub>b</sub> : 90 degree phase 10 <sub>b</sub> : 180 degree phase 11 <sub>b</sub> : 270 degree phase
		PRBSGEN_CLKSEL	7:7	RW	0 <sub>h</sub>	Determines the source clock used by the PRBS generator when PRBSGEN_EXT = 0 (internally generated clock). 00 <sub>b</sub> : DFT VCO clock 01 <sub>b</sub> : CDR clock
		PRBSGEN_RATESEL	6:2	RW	2 <sub>h</sub>	One-hot encoded rate indicator for the dividers in PRBS generator circuit. 00001 <sub>b</sub> : MAD1 00010 <sub>b</sub> : SD 00100 <sub>b</sub> : HD 01000 <sub>b</sub> : 3G 10000 <sub>b</sub> : 6G
		PRBSGEN_VCO_POWERDOWN	1:1	RW	0 <sub>h</sub>	When HIGH, causes the open-loop PRBSGEN VCO to be shut off even if PRBSGEN_ENABLE = 1. Has no effect when PRBSGEN_ENABLE = 0.
		PRBSGEN_ENABLE	0:0	RW	0 <sub>h</sub>	When HIGH, the PRBS7 generator circuit is enabled. Must be enabled when using any feature in the PRBS_GEN_CTRL register.

**Table 5-1: Register Descriptions - Standard Address Space (Continued)**

Address	Register Name	Parameter Name	Bit Slice	R/W	Reset Value	Description
		RSVD	15:2	RW	0 <sub>h</sub>	Reserved. Do not change.
23 <sub>h</sub>	EYE_MON_ENABLE	EYE_MON_PRBS_NODATA_SET	1:1	RW	0 <sub>h</sub>	When HIGH, sets a latch in the Input PRBS checker (EYE_MON_PRBS_NODATA bit of EYE_MON_STATUS_REG_12) HIGH. This bit must be set LOW before checking the EYE_MON_PRBS_NODATA bit. The EYE_MON_PRBS_NODATA bit will then be automatically set LOW if transitions are detected.
		HORIZONTAL_EYE_MON_ENABLE	0:0	RW	0 <sub>h</sub>	Enables the horizontal eye monitor. 00 <sub>b</sub> : Horizontal Eye Monitor disabled 01 <sub>b</sub> : Horizontal Eye Monitor enabled
		RSVD	15:2	ROSW	0 <sub>h</sub>	Reserved. Do not change.
24 <sub>h</sub>	EYE_MON_SCAN_START	MANUAL_SCAN_START	1:1	ROSW	0 <sub>h</sub>	Writing a 1 to this bit triggers the start of a manually timed horizontal eye scan using the parameters defined in EYE_MON_CONTROL_REG_[0:6] registers. The bit then becomes read-only, and will be reset to a value of 0 by the device to indicate when the scan is complete.
		AUTO_SCAN_START	0:0	ROSW	0 <sub>h</sub>	Writing a 1 to this bit triggers the start of an automatic horizontal eye scan using the device's default parameters. The bit then becomes read-only, and will be reset to a value of 0 by the device to indicate when the scan is complete.

**Table 5-1: Register Descriptions - Standard Address Space (Continued)**

Address	Register Name	Parameter Name	Bit Slice	R/W	Reset Value	Description
		RSVD	15:2	RW	0 <sub>h</sub>	Reserved. Do not change.
25 <sub>h</sub>	EYE_MON_CONTROL_REG_0	CONTINUOUS_SCAN_ENABLE	1:1	RW	0 <sub>h</sub>	<p>Enables a continuous, manually timed horizontal eye scan using the parameters defined in EYE_MON_CONTROL_REG_[0:6] registers.</p> <p>Setting CONTINUOUS_SCAN_ENABLE to 1 clears the ERROR_COUNT bits and starts a new measurement.</p> <p>Error counting continues until CONTINUOUS_SCAN_ENABLE is set to 0, at which point the ERROR_COUNT bits may be read.</p> <p>The ERROR_COUNT bits hold their value until any new scan is started using AUTO_SCAN_START, MANUAL_SCAN_START, or CONTINUOUS_SCAN_ENABLE.</p>
		EYE_MON_SOFT_RESET	0:0	RW	0 <sub>h</sub>	<p>Synchronous soft-reset for the horizontal eye monitor block and its associated registers (EYE_MON_CONTROL_REG_[0:6] and EYE_MON_STATUS_REG_[2:12]).</p> <p>00<sub>b</sub>: Normal operation of the horizontal eye monitor</p> <p>01<sub>b</sub>: Resets the horizontal eye monitor</p>
		RSVD	15:8	RW	0 <sub>h</sub>	Reserved. Do not change.
26 <sub>h</sub>	EYE_MON_CONTROL_REG_1	MEASUREMENT_PREDIVIDER	7:4	RW	0 <sub>h</sub>	<p>Selects the pre-divider value for the sampling interval.</p> <p>0000<sub>b</sub>: 4</p> <p>0001<sub>b</sub>: 8</p> <p>0010<sub>b</sub>: 16</p> <p>0011<sub>b</sub>: 32</p> <p>0100<sub>b</sub>: 64</p> <p>0101<sub>b</sub>: 128</p> <p>0110<sub>b</sub>: 256</p> <p>0111<sub>b</sub>: 512</p> <p>1000<sub>b</sub>: 1024</p> <p>1001<sub>b</sub>: 2048</p> <p>1010<sub>b</sub>-1111<sub>b</sub>: INVALID</p> <p>This parameter, combined with MEASUREMENT_TIME, defines the length of time per phase for an auto eye scan</p>
		SAMPLE_INTERVAL	3:0	RW	2 <sub>h</sub>	<p>Controls the sampling interval in device clock cycles.</p> <p>Sampling interval = SAMPLE_INTERVAL + 1 device clock cycle.</p>

**Table 5-1: Register Descriptions - Standard Address Space (Continued)**

Address	Register Name	Parameter Name	Bit Slice	R/W	Reset Value	Description
27 <sub>h</sub>	EYE_MON_CONTROL_REG_2	MEASUREMENT_TIME	15:0	RW	A8B <sub>h</sub>	<p>Selects measurement interval in multiples of SAMPLE_INTERVAL_PREDIVIDER cycles.</p> <p>The measurement time for a single phase and bypass setting is:            MEASUREMENT_PREDIVIDER x (MEASUREMENT_TIME + 1) x (1/108MHz)</p> <p>The default value sets 100µs per sample, which is approximately 25.6ms for a full scan of 128 phases * 2 bypass settings.</p> <p>The maximum MEASUREMENT_TIME value results in a full scan taking approximately 1.25 seconds.</p>
28 <sub>h</sub>	EYE_MON_CONTROL_REG_3	EYE_MON_PRBS_ERROR_THRESHOLD	15:0	RW	3 <sub>h</sub>	<p>Error count threshold for pass/fail. The phase being tested is considered to pass if EYE_MON_PRBS_ERROR_COUNT is less than or equal to EYE_MON_PRBS_ERROR_THRESHOLD. The phase fails if the EYE_MON_PRBS_ERROR_COUNT exceeds EYE_MON_PRBS_ERROR_THRESHOLD. The default value of EYE_MON_PRBS_ERROR_THRESHOLD corresponds to a bit error rate of 3.37x10<sup>-6</sup> at a data rate of 5.94Gb/s using the default MEASUREMENT_TIME of 100µs.</p>
29 <sub>h</sub>	EYE_MON_CONTROL_REG_4	ERROR_THRESHOLD	15:0	RW	3 <sub>h</sub>	<p>Error count threshold for pass/fail. The phase being tested is considered to pass if ERROR_COUNT is less than or equal to ERROR_THRESHOLD. The phase fails if the ERROR_COUNT exceeds ERROR_THRESHOLD.</p> <p>The default value of ERROR_THRESHOLD corresponds to a bit error rate of 6.73x10<sup>-6</sup> at a data rate of 5.94Gb/s using the default MEASUREMENT_TIME of 100µs.</p>
2A <sub>h</sub>	EYE_MON_CONTROL_REG_5	MANUAL_PHASE	10:4	RW	0 <sub>h</sub>	Phase setting for manually timed (MANUAL_SCAN_START) and continuous (CONTINUOUS_SCAN_ENABLE) scan measurements.
		RSVD	3:0	RW	3 <sub>h</sub>	Reserved. Do not change.

**Table 5-1: Register Descriptions - Standard Address Space (Continued)**

Address	Register Name	Parameter Name	Bit Slice	R/W	Reset Value	Description
2B <sub>h</sub>	EYE_MON_CONTROL_REG_6	RSVD	15:6	RW	0 <sub>h</sub>	Reserved. Do not change.
		EYE_MON_CLEAR	5:5	RW	0 <sub>h</sub>	Override value for EYE_MON_PRBS_CLEAR. Only used when EYE_MON_FORCE_PRBS_CLEAR = 1.
		EYE_MON_FORCE_CLEAR	4:4	RW	0 <sub>h</sub>	01 <sub>b</sub> : Overrides the EYE_MON_CLEAR output with the PRBS_MON_CLEAR value Allows host interface to directly control the PRBS/eye monitor bypassing the PRBS_MON_CTRL state machines.
		EYE_MON_PRBS_CLEAR	3:3	RW	0 <sub>h</sub>	Override value for EYE_MON_PRBS_CLEAR. Only used when EYE_MON_FORCE_PRBS_CLEAR = 1.
		EYE_MON_PRBS_FORCE_CLEAR	2:2	RW	0 <sub>h</sub>	01 <sub>b</sub> : Overrides the EYE_MON_PRBS_CLEAR output with the EYE_MON_PRBS_CLEAR value Allows host interface to directly control the PRBS/eye monitor bypassing the EYE_MON_CTRL state machines.
		EYE_MON_SELECT	1:1	RW	1 <sub>h</sub>	Selects which criteria is used to populate the eye bitmap. 00 <sub>b</sub> : PRBS7 check 01 <sub>b</sub> : Arbitrary data check
		EYE_MON_WINDOW	0:0	RW	0 <sub>h</sub>	Sets which portion of the eye is to be sampled for manually timed and continuous scan measurements. Result for the phase is the lesser count of errors at each EYE_MON_WINDOW setting.
		2C <sub>h</sub>	EYE_MON_STATUS_REG_0	RSVD	15:15	RO
EYE_MON_PRBS_STARTING_PHASE	14:8			RO	0 <sub>h</sub>	Starting (leftmost) phase of EYE_MON_PRBS_EYE_WIDTH in the most recent scan. This parameter only applies to automatic (AUTO_SCAN_START) measurements.
EYE_MON_PRBS_EYE_WIDTH	7:0			RO	0 <sub>h</sub>	Widest open portion of the eye in the most recent scan, based on the EYE_MON_PRBS_ERROR_COUNT indication. The value of EYE_MON_PRBS_EYE_WIDTH is the number of contiguous phases with EYE_MON_PRBS_ERROR_COUNT less than or equal to EYE_MON_PRBS_ERROR_THRESHOLD. This parameter only applies to automatic (AUTO_SCAN_START) measurements.

**Table 5-1: Register Descriptions - Standard Address Space (Continued)**

Address	Register Name	Parameter Name	Bit Slice	R/W	Reset Value	Description
2D <sub>h</sub>	EYE_MON_STATUS_REG_1	EYE_MON_PRBS_ERROR_COUNT	15:0	RO	0 <sub>h</sub>	Twice the PRBS Error count from the most recent manually timed (MANUAL_SCAN_START) or continuous (CONTINUOUS_SCAN_ENABLE) scan measurements.  This value is not defined for automatic (AUTO_SCAN_START) scan measurements.
		RSVD	15:15	RO	0 <sub>h</sub>	Reserved. Do not change.
		STARTING_PHASE	14:8	RO	0 <sub>h</sub>	Starting (leftmost) phase of EYE_WIDTH in the most recent scan.  This parameter only applies to automatic (AUTO_SCAN_START) measurements.
2E <sub>h</sub>	EYE_MON_STATUS_REG_2	EYE_WIDTH	7:0	RO	0 <sub>h</sub>	Widest open portion of the eye in the most recent scan, based on the ERROR_COUNT indication.  The value of EYE_WIDTH is the number of contiguous phases with ERROR_COUNT less than or equal to ERROR_THRESHOLD.  This parameter only applies to automatic (AUTO_SCAN_START) measurements.
2F <sub>h</sub>	EYE_MON_STATUS_REG_3	ERROR_COUNT	15:0	RO	0 <sub>h</sub>	Error count from the most recent manually timed (MANUAL_SCAN_START) or continuous (CONTINUOUS_SCAN_ENABLE) scan measurements.  This value is not defined for automatic (AUTO_SCAN_START) scan measurements.
30 <sub>h</sub>	EYE_MON_STATUS_REG_4	EYE_BITMAP_127_112	15:0	RO	0 <sub>h</sub>	Bitmap of the per-phase pass/fail result from the most recent automatic (AUTO_SCAN_START) scan measurement for phases 127 to 112.  A value of 1 in each bit indicates a pass for the corresponding phase, while a value of 0 indicates a fail for that phase.  The order of the numbers shown in the Parameter Name field corresponds to the bit orientation for each phase being reported in this register.
31 <sub>h</sub>	EYE_MON_STATUS_REG_5	EYE_BITMAP_111_96	15:0	RO	0 <sub>h</sub>	Bitmap of the per-phase pass/fail result from the most recent automatic (AUTO_SCAN_START) scan measurement for phases 111 to 96.  A value of 1 in each bit indicates a pass for the corresponding phase, while a value of 0 indicates a fail for that phase.  The order of the numbers shown in the Parameter Name field corresponds to the bit orientation for each phase being reported in this register.

**Table 5-1: Register Descriptions - Standard Address Space (Continued)**

Address	Register Name	Parameter Name	Bit Slice	R/W	Reset Value	Description
32 <sub>h</sub>	EYE_MON_STATUS_REG_6	EYE_BITMAP_95_80	15:0	RO	0 <sub>h</sub>	<p>Bitmap of the per-phase pass/fail result from the most recent automatic (AUTO_SCAN_START) scan measurement for phases 95 to 80.</p> <p>A value of 1 in each bit indicates a pass for the corresponding phase, while a value of 0 indicates a fail for that phase.</p> <p>The order of the numbers shown in the Parameter Name field corresponds to the bit orientation for each phase being reported in this register.</p>
33 <sub>h</sub>	EYE_MON_STATUS_REG_7	EYE_BITMAP_79_64	15:0	RO	0 <sub>h</sub>	<p>Bitmap of the per-phase pass/fail result from the most recent automatic (AUTO_SCAN_START) scan measurement for phases 79 to 64.</p> <p>A value of 1 in each bit indicates a pass for the corresponding phase, while a value of 0 indicates a fail for that phase.</p> <p>The order of the numbers shown in the Parameter Name field corresponds to the bit orientation for each phase being reported in this register.</p>
34 <sub>h</sub>	EYE_MON_STATUS_REG_8	EYE_BITMAP_63_48	15:0	RO	0 <sub>h</sub>	<p>Bitmap of the per-phase pass/fail result from the most recent automatic (AUTO_SCAN_START) scan measurement for phases 63 to 48.</p> <p>A value of 1 in each bit indicates a pass for the corresponding phase, while a value of 0 indicates a fail for that phase.</p> <p>The order of the numbers shown in the Parameter Name field corresponds to the bit orientation for each phase being reported in this register.</p>
35 <sub>h</sub>	EYE_MON_STATUS_REG_9	EYE_BITMAP_47_32	15:0	RO	0 <sub>h</sub>	<p>Bitmap of the per-phase pass/fail result from the most recent automatic (AUTO_SCAN_START) scan measurement for phases 47 to 32.</p> <p>A value of 1 in each bit indicates a pass for the corresponding phase, while a value of 0 indicates a fail for that phase.</p> <p>The order of the numbers shown in the Parameter Name field corresponds to the bit orientation for each phase being reported in this register.</p>



**Table 5-1: Register Descriptions - Standard Address Space (Continued)**

Address	Register Name	Parameter Name	Bit Slice	R/W	Reset Value	Description
36 <sub>h</sub>	EYE_MON_STATUS_REG_10	EYE_BITMAP_31_16	15:0	RO	0 <sub>h</sub>	<p>Bitmap of the per-phase pass/fail result from the most recent automatic (AUTO_SCAN_START) scan measurement for phases 31 to 16.</p> <p>A value of 1 in each bit indicates a pass for the corresponding phase, while a value of 0 indicates a fail for that phase.</p> <p>The order of the numbers shown in the Parameter Name field corresponds to the bit orientation for each phase being reported in this register.</p>
37 <sub>h</sub>	EYE_MON_STATUS_REG_11	EYE_BITMAP_15_0	15:0	RO	0 <sub>h</sub>	<p>Bitmap of the per-phase pass/fail result from the most recent automatic (AUTO_SCAN_START) scan measurement for phases 15 to 0.</p> <p>A value of 1 in each bit indicates a pass for the corresponding phase, while a value of 0 indicates a fail for that phase.</p> <p>The order of the numbers shown in the Parameter Name field corresponds to the bit orientation for each phase being reported in this register.</p>
		RSVD	15:11	RO	0 <sub>h</sub>	Reserved. Do not change.
38 <sub>h</sub>	EYE_MON_STATUS_REG_12	EYE_MON_PRBS_NODATA	10:10	RO	0 <sub>h</sub>	When HIGH, indicates that no data transitions have been detected in the PRBS checker since the EYE_MON_PRBS_NODATA_SET was last set to 1.
		RSVD	9:0	RO	0 <sub>h</sub>	Reserved. Do not change.
		RSVD	15:4	RW	0 <sub>h</sub>	Reserved. Do not change.
39 <sub>h</sub>	PRBS_CHK_CTRL	PRBS_MON_NODATA_SET	3:3	RW	0 <sub>h</sub>	When HIGH, sets a latch in the Retime PRBS checker (PRBS_MON_NODATA bit of PRBS_STATUS_REG_11) HIGH. This bit must be set LOW before checking the PRBS_MON_NODATA bit. The PRBS_MON_NODATA bit will then be automatically set LOW if transitions are detected.
		RSVD	2:1	RW	1 <sub>h</sub>	Reserved. Do not change.
		PRBS_MON_ENABLE	0:0	RW	0 <sub>h</sub>	When asserted the Re-time PRBS7 checker circuit is enabled.

**Table 5-1: Register Descriptions - Standard Address Space (Continued)**

Address	Register Name	Parameter Name	Bit Slice	R/W	Reset Value	Description
3A <sub>h</sub>	PRBS_CTRL_0	PRBS_MON_MANUAL_START	1:1	ROSW	0 <sub>h</sub>	Enable for manual timed measurement using the Re-time PRBS checker. 01 <sub>b</sub> : Triggers a scan Automatically cleared to 0 when the scan completes.
		PRBS_MON_AUTO_SCAN_START	0:0	ROSW	0 <sub>h</sub>	Enable for automatic eye scan using the Re-time PRBS checker. 01 <sub>b</sub> : Triggers a scan Automatically cleared to 0 when the scan completes.
3B <sub>h</sub>	PRBS_CTRL_1	PRBS_MON_CONTINUOUS_ENABLE	1:1	RW	0 <sub>h</sub>	Enable for manual continuous measurement using the Re-time PRBS checker. Rising edge clears the error counter and starts a measurement. Error counting continues until PRBS_MON_CONTINUOUS_ENABLE is set to 0, at which point the error counter PRBS_MON_ERROR_COUNT can be read. The error counter holds its value until any new scan is started (manual or auto).
		PRBS_MON_SOFT_RESET	0:0	RW	0 <sub>h</sub>	When HIGH, the logic in PRBS monitor state machine is synchronously reset.
3C <sub>h</sub>	PRBS_CTRL_2	PRBS_MON_MEASUREMENT_PREDIVIDER	7:4	RW	0 <sub>h</sub>	Along with PRBS_MON_MEASUREMENT_TIME, determines the length of time of a measurement for a given phase in automatic or manual timed modes (PRBS_MON_AUTO_SCAN_START = 1 or PRBS_MON_MANUAL_START = 1). Pre-divider value vs. sampling interval: 0000 <sub>b</sub> : 4 0001 <sub>b</sub> : 8 0010 <sub>b</sub> : 16 0011 <sub>b</sub> : 32 0100 <sub>b</sub> : 64 0101 <sub>b</sub> : 128 0110 <sub>b</sub> : 256 0111 <sub>b</sub> : 512 1000 <sub>b</sub> : 1024 1001 <sub>b</sub> : 2048 1010 <sub>b</sub> -1111 <sub>b</sub> : INVALID
		PRBS_MON_SAMPLE_INTERVAL	3:0	RW	2 <sub>h</sub>	Controls sampling interval for an error signal. The sampling interval is PRBS_MON_SAMPLE_INTERVAL + 1 clock cycles. The minimum allowable value is 1 (sampling interval of 2).

**Table 5-1: Register Descriptions - Standard Address Space (Continued)**

Address	Register Name	Parameter Name	Bit Slice	R/W	Reset Value	Description
3D <sub>h</sub>	PRBS_CTRL_3	PRBS_MON_MEASUREMENT_TIME	15:0	RW	A8B <sub>h</sub>	<p>Selects measurement interval in multiples of pre-divider cycles. The measurement time for a single phase is:  <math>PRBS\_MON\_MEASURE\_PREDIVIDER * (PRBS\_MON\_MEASUREMENT\_TIME + 1) * (1/108MHz)</math>.</p> <p>The default value results in a 100µs measurement time or roughly 12.8ms for a full scan of 128 phases. The maximum measurement time is ~1.25 seconds.</p>
3E <sub>h</sub>	PRBS_CTRL_4	PRBS_MON_PRBS_ERROR_THRESHOLD	15:0	RW	3 <sub>h</sub>	<p>PRBS error count threshold for good/bad BER for automatic eye scan. A measurement is considered to pass if PRBS_ERROR_COUNT is less than or equal to this threshold. It fails if the count is greater. The default threshold corresponds to a bit error rate of 6.67E-6 at 6G using the default measurement interval of 100µs.</p>
		RSVD	15:11	RW	0 <sub>h</sub>	Reserved. Do not change.
3F <sub>h</sub>	PRBS_CTRL_5	PRBS_MON_MANUAL_PHASE	10:4	RW	0 <sub>h</sub>	Phase setting for manual timed or continuous scans
		RSVD	3:0	RW	3 <sub>h</sub>	Reserved. Do not change.
		PRBS_MON_CLEAR	1:1	RW	0 <sub>h</sub>	<p>00<sub>b</sub>: No effect                      01<sub>b</sub>: Manually clear error indication                      Only used when PRBS_MON_FORCE_CLEAR = 1</p>
40 <sub>h</sub>	PRBS_CTRL_6	PRBS_MON_FORCE_CLEAR	0:0	RW	0 <sub>h</sub>	<p>00<sub>b</sub>: Manual error clearing is disabled                      01<sub>b</sub>: Enables error clearing through PRBS_MON_CLEAR                      Allows host interface to directly control the PRBS error counting algorithm, bypassing the PRBS_MON_CTRL state machine.</p>

**Table 5-1: Register Descriptions - Standard Address Space (Continued)**

Address	Register Name	Parameter Name	Bit Slice	R/W	Reset Value	Description
		RSVD	15:15	RO	0 <sub>h</sub>	Reserved. Do not change.
41 <sub>h</sub>	PRBS_STATUS_REG_0	PRBS_MON_STARTING_PHASE	14:8	RO	0 <sub>h</sub>	Starting (leftmost) phase of PRBS_MON_EYE_WIDTH in the most recent scan. This parameter only applies to automatic (AUTO_SCAN_START) measurements.
		PRBS_MON_ERROR_COUNT				Widest open portion of the eye in the most recent scan, based on the PRBS_MON_ERROR_COUNT indication.
		PRBS_MON_EYE_WIDTH	7:0	RO	0 <sub>h</sub>	The value of PRBS_MON_EYE_WIDTH is the number of contiguous phases with PRBS_MON_ERROR_COUNT less than or equal to PRBS_MON_ERROR_THRESHOLD. This parameter only applies to automatic (AUTO_SCAN_START) measurements.
42 <sub>h</sub>	PRBS_STATUS_REG_1	PRBS_MON_ERROR_COUNT	15:0	RO	0 <sub>h</sub>	Twice the PRBS error count from the most recent manually timed (MANUAL_SCAN_START) or continuous (CONTINUOUS_SCAN_ENABLE) scan measurements. This value is not defined for automatic (AUTO_SCAN_START) scan measurements when a PRBS7 bit stream is input.
43 <sub>h</sub>	RESERVED	RSVD	15:0	RO	0 <sub>h</sub>	Reserved. Do not change.
44 <sub>h</sub>	RESERVED	RSVD	15:0	RO	0 <sub>h</sub>	Reserved. Do not change.
45 <sub>h</sub>	RESERVED	RSVD	15:0	RO	0 <sub>h</sub>	Reserved. Do not change.
46 <sub>h</sub>	RESERVED	RSVD	15:0	RO	0 <sub>h</sub>	Reserved. Do not change.
47 <sub>h</sub>	RESERVED	RSVD	15:0	RO	0 <sub>h</sub>	Reserved. Do not change.
48 <sub>h</sub>	RESERVED	RSVD	15:0	RO	0 <sub>h</sub>	Reserved. Do not change.
49 <sub>h</sub>	RESERVED	RSVD	15:0	RO	0 <sub>h</sub>	Reserved. Do not change.
4A <sub>h</sub>	RESERVED	RSVD	15:0	RO	0 <sub>h</sub>	Reserved. Do not change.
		RSVD	15:9	RO	0 <sub>h</sub>	Reserved. Do not change.
4B <sub>h</sub>	PRBS_STATUS_REG_11	PRBS_MON_NODATA	8:8	RO	0 <sub>h</sub>	When HIGH, indicates that no data transitions have been detected in the PRBS checker since the PRBS_MON_NODATA_SET was last set to 1.
		RSVD	7:0	RO	0 <sub>h</sub>	Reserved. Do not change.

**Table 5-1: Register Descriptions - Standard Address Space (Continued)**

Address	Register Name	Parameter Name	Bit Slice	R/W	Reset Value	Description
		RSVD	15:12	RW	0 <sub>h</sub>	Reserved. Do not change.
		LOS_DETECTION_METHOD	11:10	RW	1 <sub>h</sub>	Determines the source of CARRIER_DETECT. 00 <sub>b</sub> : Edge detection 01 <sub>b</sub> : Strength detection
		FORCE_PLL_RATE	9:7	RW	1 <sub>h</sub>	Force the PLL to retune a specific data rate. 000 <sub>b</sub> : Reserved 001 <sub>b</sub> : 0.270Gb/s 010 <sub>b</sub> : 1.485Gb/s 011 <sub>b</sub> : 2.97Gb/s 100 <sub>b</sub> : 5.94Gb/s 101 <sub>b</sub> : Reserved 110 <sub>b</sub> : Reserved 111 <sub>b</sub> : Reserved Used when FORCE_PLL_RATE_ENABLE is set to 1.
		FORCE_PLL_RATE_ENABLE	6:6	RW	0 <sub>h</sub>	Enables the forced PLL rate override set using the FORCE_PLL_RATE bits.
4C <sub>h</sub>	PLL_CONTROL	RATE_ENABLE_125M	5:5	RW	0 <sub>h</sub>	Enables auto-detection of 0.125Gb/s (MADI) signals 00 <sub>b</sub> : 0.125Gb/s signals will not be detected 01 <sub>b</sub> : 0.125Gb/s signals will be detected
		RATE_ENABLE_5G94	4:4	RW	1 <sub>h</sub>	Enables auto-detection of 5.94Gb/s (6G UHD-SDI) signals. 00 <sub>b</sub> : 5.94Gb/s signals will not be detected 01 <sub>b</sub> : 5.94Gb/s signals will be detected
		RATE_ENABLE_2G97	3:3	RW	1 <sub>h</sub>	Enables auto-detection of 2.97Gb/s (3G SDI) signals. 00 <sub>b</sub> : 2.97Gb/s signals will not be detected 01 <sub>b</sub> : 2.97Gb/s signals will be detected
		RATE_ENABLE_1G485	2:2	RW	1 <sub>h</sub>	Enables auto-detection of 1.485Gb/s (HD-SDI) signals. 00 <sub>b</sub> : 1.485Gb/s signals will not be detected 01 <sub>b</sub> : 1.485Gb/s signals will be detected
		RATE_ENABLE_270M	1:1	RW	1 <sub>h</sub>	Enables auto-detection of 0.27Gb/s (SD-SDI) signals. 00 <sub>b</sub> : 0.27Gb/s signals will not be detected 01 <sub>b</sub> : 0.27Gb/s signals will be detected
		PLL_SOFT_RESET	0:0	RW	0 <sub>h</sub>	Synchronous soft-reset for the PLL rate detection state machine. 00 <sub>b</sub> : Normal operation of the PLL rate detection state machine 01 <sub>b</sub> : Resets the PLL rate detection state machine
4D <sub>h</sub>	RESERVED	RSVD	15:0	RW	110 <sub>h</sub>	Reserved. Do not change.

**Table 5-1: Register Descriptions - Standard Address Space (Continued)**

Address	Register Name	Parameter Name	Bit Slice	R/W	Reset Value	Description
4E <sub>h</sub>	RESERVED	RSVD	15:0	RW	110 <sub>h</sub>	Reserved. Do not change.
		RETIMER_BYPASS	15:15	RO	—	Indicates whether the re-timer is active or bypassed. 00 <sub>b</sub> : Re-timer is active 01 <sub>b</sub> : Re-timer is bypassed
		LBR_HBR	14:14	RO	—	Indicates high-bit-rate versus low-bit-rate. 00 <sub>b</sub> : Input data rate is 5.94Gb/s, 2.97Gb/s, 1.485Gb/s, or BYPASS 01 <sub>b</sub> : Input data rate is 270Mb/s or 125Mb/s
4F <sub>h</sub>	PLL_STATUS	DETECTED_RATE	13:11	RO	—	Indicates the current rate found by the PLL rate detection state machine. 000 <sub>b</sub> : 0.125Gb/s 001 <sub>b</sub> : 0.270Gb/s 010 <sub>b</sub> : 1.485Gb/s 011 <sub>b</sub> : 2.97Gb/s 100 <sub>b</sub> : 5.94Gb/s 101 <sub>b</sub> : Reserved 110 <sub>b</sub> : Reserved 111 <sub>b</sub> : Reserved
		RSVD	10:10	RO	—	Reserved. Do not change.
		LOCKED	9:9	RO	—	Indicates if the CDR is locked or unlocked. 00 <sub>b</sub> : CDR is unlocked 01 <sub>b</sub> : CDR is locked
		LOS	8:8	RO	—	Indicates whether or not the CDR has lost the signal. 00 <sub>b</sub> : Signal is present 01 <sub>b</sub> : Loss of signal
		RSVD	7:0	RO	—	Reserved. Do not change.

**Table 5-1: Register Descriptions - Standard Address Space (Continued)**

Address	Register Name	Parameter Name	Bit Slice	R/W	Reset Value	Description
50 <sub>h</sub>	STICKY_STATUS	STANDBY_STICKY	11:11	ROCW	—	Sticky bit indicating that the device entered STANDBY mode at least once. 00 <sub>b</sub> : Device has not entered STANDBY mode since this bit was last cleared 01 <sub>b</sub> : Device has entered STANDBY mode since this bit was last cleared
		SLEEP_STICKY	10:10	ROCW	—	Sticky bit indicating that the device entered SLEEP mode at least once 00 <sub>b</sub> : Device has not entered SLEEP mode since this bit was last cleared 01 <sub>b</sub> : Device has entered SLEEP mode since this bit was last cleared
		RETIMER_BYPASS_STICKY	9:9	ROCW	—	Sticky bit indicating that the re-timer is/has been bypassed. 00 <sub>b</sub> : Re-timer has not been bypassed since this bit was last cleared 01 <sub>b</sub> : Re-timer has been bypassed since this bit was last cleared This bit is cleared by writing any value to it.
		LBR_HBR_STICKY	8:8	ROCW	—	Sticky bit indicating that the rate is/has been 270Mb/s (low bit-rate). 00 <sub>b</sub> : Rate has not been 270Mb/s since this bit was last cleared 01 <sub>b</sub> : Rate has been 270Mb/s since this bit was last cleared This bit is cleared by writing any value to it.
		RATE_CHANGE_STICKY	7:7	ROCW	—	Sticky bit indicating that a rate change has occurred. 00 <sub>b</sub> : Rate has not changed since this bit was last cleared 01 <sub>b</sub> : Rate has changed since this bit was last cleared This bit is cleared by writing any value to it.
		LOCK_LOST_STICKY	6:6	ROCW	—	Sticky bit indicating that lock was lost. 00 <sub>b</sub> : Lock has not been lost since this bit was last cleared 01 <sub>b</sub> : Lock has been lost since this bit was last cleared This bit is cleared by writing any value to it.
		RSVD	5:5	ROCW	—	Reserved. Do not change.
		LOS_STICKY	4:4	ROCW	—	Sticky bit indicating a loss of signal. 00 <sub>b</sub> : Signal has not been lost since this bit was last cleared 01 <sub>b</sub> : Signal has been lost since this bit was last cleared This bit is cleared by writing any value to it.
		RSVD	3:0	ROCW	—	Reserved. Do not change.

**Table 5-2: Register Descriptions - Extended Address Space**

Address	Register Name	Parameter Name	Bit Slice	R/W	Reset Value (Dec)	Description
D2 <sub>h</sub>	PWR_CONTROL	RSVD	15:2	RW	0 <sub>h</sub>	Reserved. Do not change.
		HS_LOCKED_POWER_SAVE	1:1	RW	0 <sub>h</sub>	When enabled, reduces power when locked to a rate of HD, 3G or 6G.
		RSVD	0:0	RW	1 <sub>h</sub>	Reserved. Do not change.
E4 <sub>h</sub>	PLL_LBW_CONTROL_REG_0	RSVD	15:5	RW	4 <sub>h</sub>	Reserved. Do not change.
		PLL_LOOP_BANDWIDTH	4:0	RW	4 <sub>h</sub>	<p>Sets the rate specific PLL loop-bandwidth when the device is locked.</p> <p>00001<sub>b</sub>: Nominal / 4                      00010<sub>b</sub>: Nominal / 2                      00100<sub>b</sub>: Nominal (default)                      01000<sub>b</sub>: Nominal x 2                      11100<sub>b</sub>: Nominal x 4</p> <p>See <a href="#">Table 2-3: AC Electrical Characteristics</a> for the PLL loop-bandwidth value set at each rate by each of these settings.</p>

RW = Read/Write

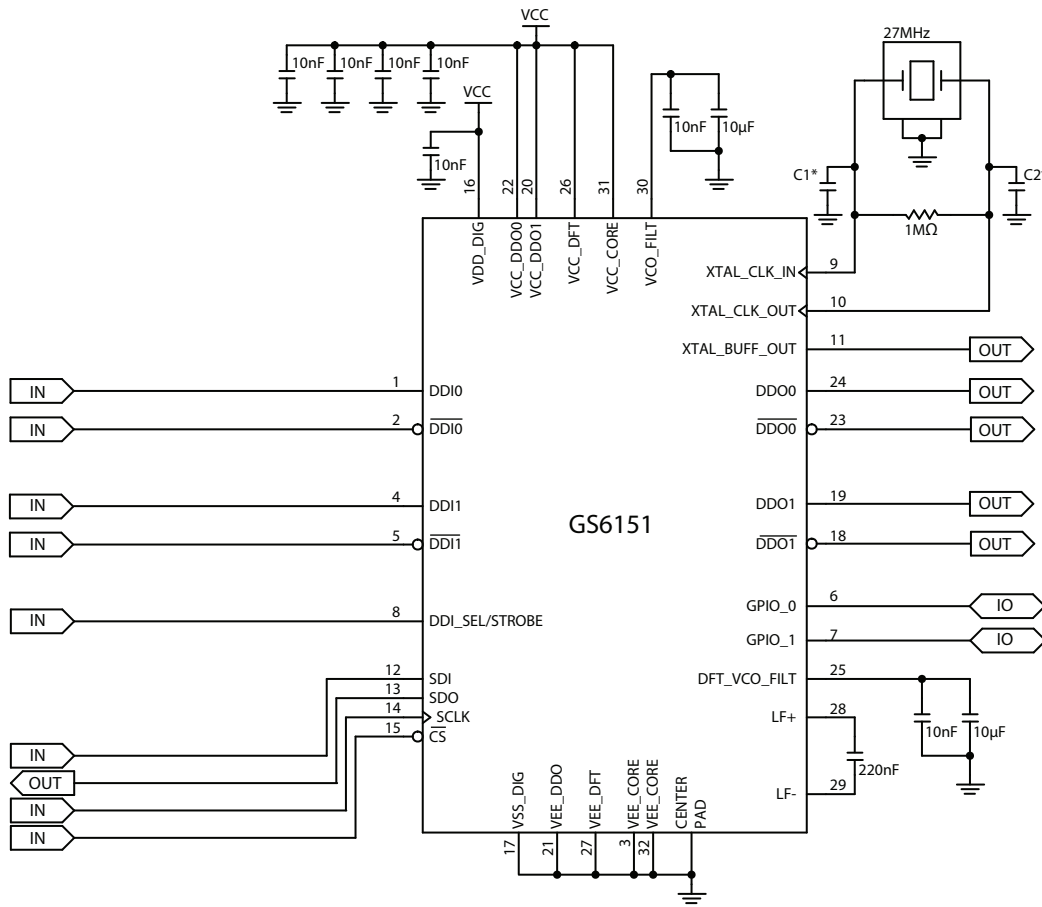
RO = Read Only

ROCW = Read Only/ Clear on Write

ROSW = Read Only/ Set on Write



# 6. Typical Application Circuit

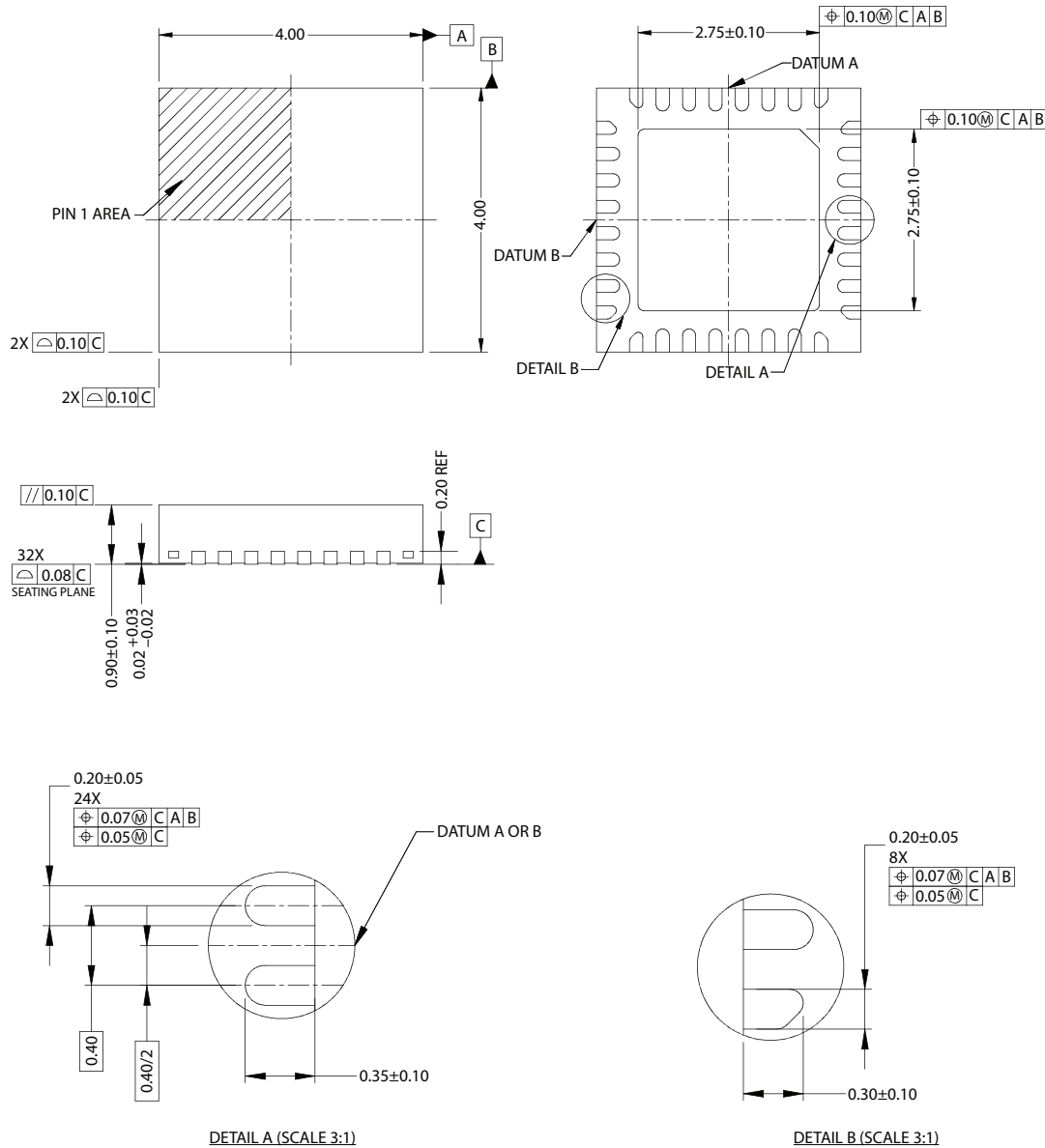


Notes:  
 VCC IS 1.8V  
 VCC\_DDO0 AND VCC\_DDO1 ARE IN THE RANGE +1.2V TO +2.5V  
 IF XTAL\_CLK\_IN IS NOT CONNECTED TO A CRYSTAL, XTAL\_CLK\_OUT MUST BE LEFT UNCONNECTED.  
 \*VALUES FOR C1 AND C2 ARE CHOSEN BASED ON THE REQUIRED LOADING FOR THE SELECTED CRYSTAL  
 IF AC COUPLING IS REQUIRED ON THE HIGH-SPEED SERIAL INPUTS AND OUTPUTS BY THE APPLICATION, A CERAMIC CAPACITOR 4.7µF OR HIGHER WITH A STABLE DIELECTRIC IS RECOMMENDED

**Figure 6-1: GS6151 Typical Application Circuit**

# 7. Package and Ordering Information

## 7.1 Package Dimensions



NOTES:

1. DIMENSIONING AND TOLERANCE IS IN CONFORMANCE TO ASME Y14.5-1994. ALL DIMENSIONS ARE IN MILLIMETERS, ° IN DEGREES.
2. DIMENSION OF LEAD WIDTH APPLIES TO METALLIZED TERMINAL AND IS MEASURED BETWEEN 0.15mm AND 0.30mm FROM THE TERMINAL TIP (BOTH ROWS). IF THE TERMINAL HAS OPTIONAL RADIUS ON THE END OF THE TERMINAL, THE LEAD WIDTH DIMENSION SHOULD NOT BE MEASURED IN THAT RADIUS AREA.

**Figure 7-1: GS6151 Package Dimensions**

## 7.2 Recommended PCB Footprint

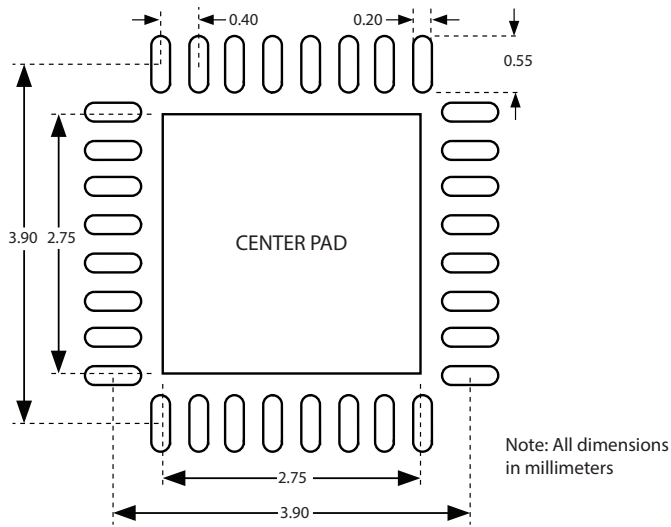


Figure 7-2: GS6151 PCB Footprint

## 7.3 Packaging Data

Table 7-1: Packaging Data

Parameter	Value
Package Type	32-pin QFN / 4mm x 4mm / 0.4mm pad pitch
Moisture Sensitivity Level (Note 1)	3
Junction to Case Thermal Resistance, $\theta_{j-c}$	29.8°C/W
Junction to Air Thermal Resistance, $\theta_{j-a}$	35.4°C/W
Junction to Board Thermal Resistance, $\theta_{j-b}$	12.0°C/W
Psi, $\Psi$	0.3°C/W
Pb-free and RoHS Compliant	Yes

**Note:**

1. Value per JEDEC J-STD-020C

## 7.4 Marking Diagram

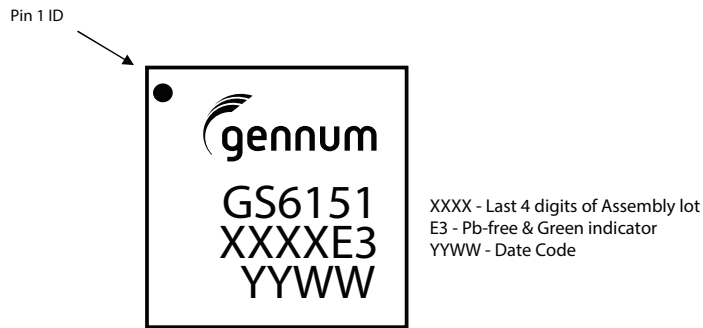


Figure 7-3: GS6151 Marking Diagram

## 7.5 Solder Reflow Profile

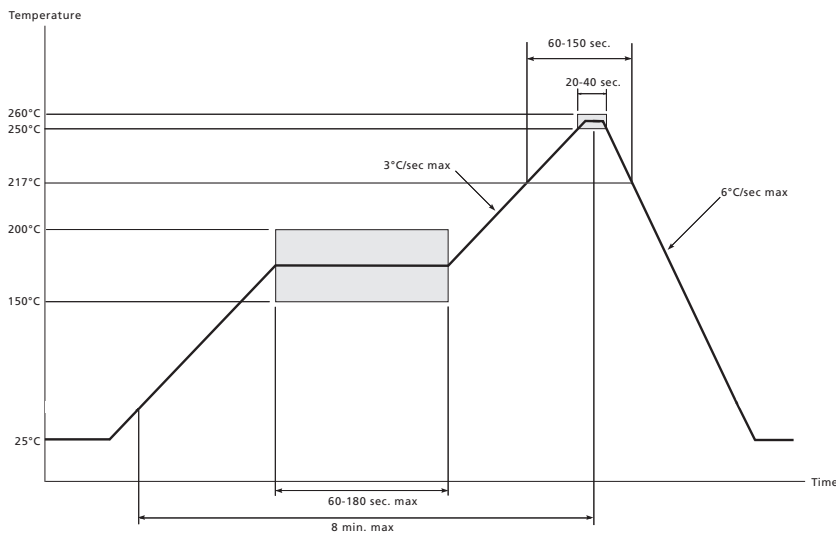


Figure 7-4: Maximum Pb-free Solder Reflow Profile

## 7.6 Ordering Information

Table 7-2: Ordering Information

Part Number	Package	Temperature Range
GS6151-INE3	Pb-free 32-pin QFN (490 piece tray)	-40°C to 85°C
GS6151-INTE3	Pb-free 32-pin QFN (250 piece reel)	-40°C to 85°C
GS6151-INTE3Z	Pb-free 32-pin QFN (2500 piece reel)	-40°C to 85°C



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