Configuring Repeaters for SAS/SATA Out-of-Band Signals

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ABSTRACT

This report summarizes the configuration and programming steps required to retransmit Out-of-Band (OOB) signals with minimal distortion.

Contents

1 Introduction

When used in SAS/SATA applications repeaters have two types of input signals to handle.

1. High Speed SAS/SATA data
2. Out of Band (OOB) data

The high speed data is a continuous 8B/10B encoded data pattern running up to 6 Gbps in SATA applications and 12 Gbps in SAS-3 systems. This type of serial link uses the repeater to help equalize or compensate for channel attenuation within the storage system. In many cases the storage components like SSDs lack the sophisticated receiver capability built into expensive system level components. Placing the TI repeater into the channel overcomes this storage component limitation by using linear equalization to help compensate for transmission line attenuation.

Out of Band signaling is much different, it is lower speed and presented to the repeater in a series of “active” and “idle” periods. These events allow the host system and storage element to negotiate the highest bandwidth SAS/SATA link possible for the connected pair. The repeater must receive and retransmit this information with disturbing the “active” and “idle” signal timing. Changes to the OOB timing can delay, alter, or even completely corrupt system configuration information between the host and connected storage elements.

Table 1. SATA OOB Timing

Parameter	Units	Limit	Electrical Specification
COMINIT/COMRESET and COMWAKE Transmit Burst Length	ns	Min	103.5
		Nom	106.7
		Max	109.9
COMINIT/COMRESET Transmit Gap Length	ns	Min	310.4
		Nom	320.0
		Max	329.6
COMWAKE Transmit Gap Length	ns	Min	103.5
		Nom	106.7
		Max	109.9

In system observation of OOB (Figure 1) highlights the various "active" or burst timing and "idle" periods from Table 1.

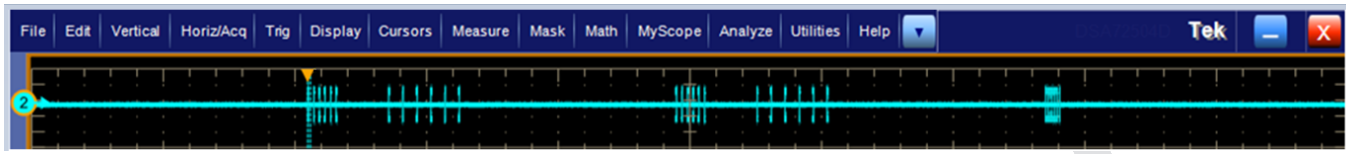

Figure 1. Typical OOB Waveforms (5µs/div)

2 Repeaters used in SAS/SATA Systems

The following list of devices can be applied to SAS/SATA applications. This report applies to all of these devices. While all the devices share a common digital programming interface, the 2-channel "BR" devices have additional OOB configuration possibilities in Pin Mode operation

Table 2. Repeaters used in SAS/SATA Applications

Device	Channels	Pinout
DS64BR111	2	1-Lane
DS100BR111	2	1-Lane
DS100BR111A	2	1-Lane
DS100BR210	2	2-Channels
DS125BR401	8	4-Lanes
DS125BR401A	8	4-Lanes
DS125BR800	8	8-Channels
DS125BR800A	8	8-Channels
DS100MB203	2-Ports	2x 1:2/2:1
DS125MB203	2-Ports	2x 1:2/2:1
DS80PCI102	2	1-Lane
DS80PCI402	8	4-Lanes
DS80PCI800	8	8-Channels

Note: The DS80PCIxxx devices can also work with SAS/SATA systems up to 6 Gbps.

3 Repeater Configuration

To overcome non-ideal system transitions between the "active" and "idle" periods of an OOB sequence, TI recommends using the repeater configuration described in this report. This configuration offers robust re-transmission of the OOB signaling even in the presence of "idle" noise or input "idle" voltage offset. The recommended configuration relies on the principles listed below to ensure robust OOB communication.

1. Force repeater signal detect "ON"
2. Disable the repeater DC offset correction

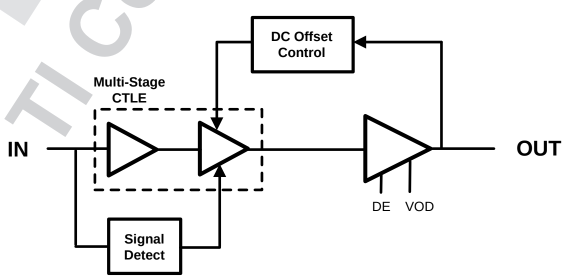

Figure 2. Signal Detect and DC Offset Control Paths

Signal Detect:
Signal Detect circuitry monitors the strength of the signal at the repeater input. If the signal strength is too low, the Signal Detect circuit declares a Loss of Signal or "LOS" event and relays the signal status to the repeater control circuits. The Signal Detect threshold can be adjusted with Pin, SMBus Slave, or EEPROM configuration methods. Only by using SMBus slave mode can Signal Detect be forced to remain "ON" with or without a signal present at the repeater input.

DC Offset Correction:
DC Offset monitors and corrects for differences between the P/N datapath. This function is not adjustable, but can be enabled or disabled using the SMBus registers or EEPROM configuration methods.

3.1 Repeater Circuit Interaction

As shown in Figure 2, the Signal Detect and DC Offset control both provide feedback to override and adjust the Continuous Time Linear Equalization (CTLE) output within the repeater. The Signal Detect circuit will override the CTLE output to exactly 0.000 Volts differential when it detects a LOS event on the input. The DC offset control feedback path also goes into the CTLE, this feedback path only makes small adjustments to the CTLE output voltage and is easily overridden by the Signal Detect control when a LOS event occurs.

When a full strength signal is present at the high speed input it is difficult to measure exactly how the internal offset correction is changing the output voltage. The actual output waveform relies heavily on the primary datapath signal coming from the CTLE input. Only without the primary signal present and the signal detect circuit still "ON" can the internal offset correction be observed at the output. This combination of events is shown at the trailing end of an "active" OOB signal. Immediately after the "active" OOB signal, there are several nanoseconds when the repeater input signal is "idle" and the signal detect is "ON" as shown in Figure 3.

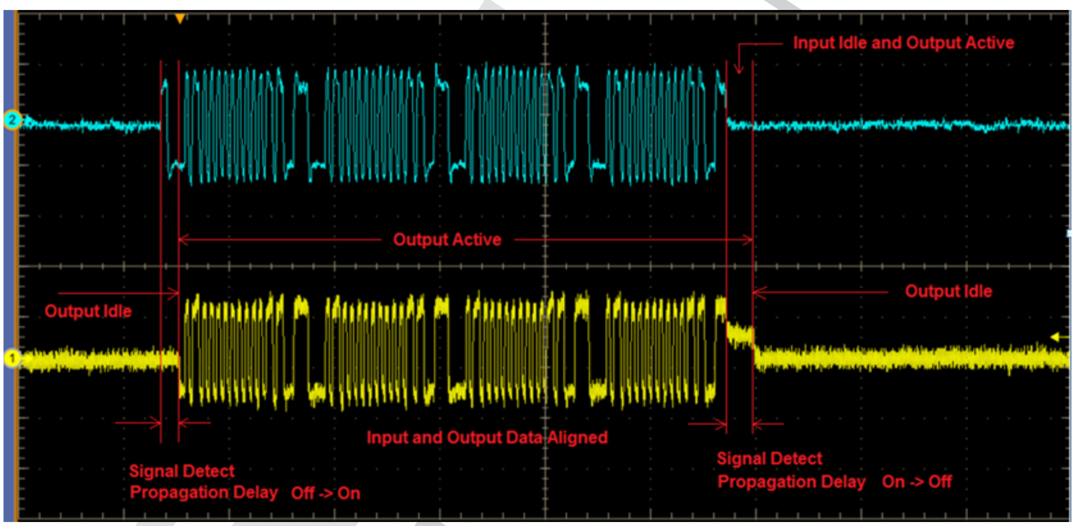

Figure 3. OOB Waveform (20ns/div) Entering (CH2, top) and Exiting (CH1, yellow) a Repeater

3.2 Forced Signal Detect Configuration

This setting is programmed into the TI repeater on a per channel basis using the SMBus slave interface.

By forcing the Signal Detect "ON", the repeater will continuously pass the input signal to the repeater output. This eliminates the short propagation delay needed to transition the signal detect between "active" and "idle" resulting in a repeater output waveform which immediately responds to both "active" and "idle" conditions at the repeater input, see Figure 4.

The 2 channel TI repeaters (DS64BR111, DS100BR111, DS100BR111A and DS100BR210) have an option to use pin control (ENSMB = 0) to force the signal detect function. These devices can force the signal detect "ON" for both outputs by setting MODE = 1. The 2-channel device datasheets call this mode "Continuous Talk".

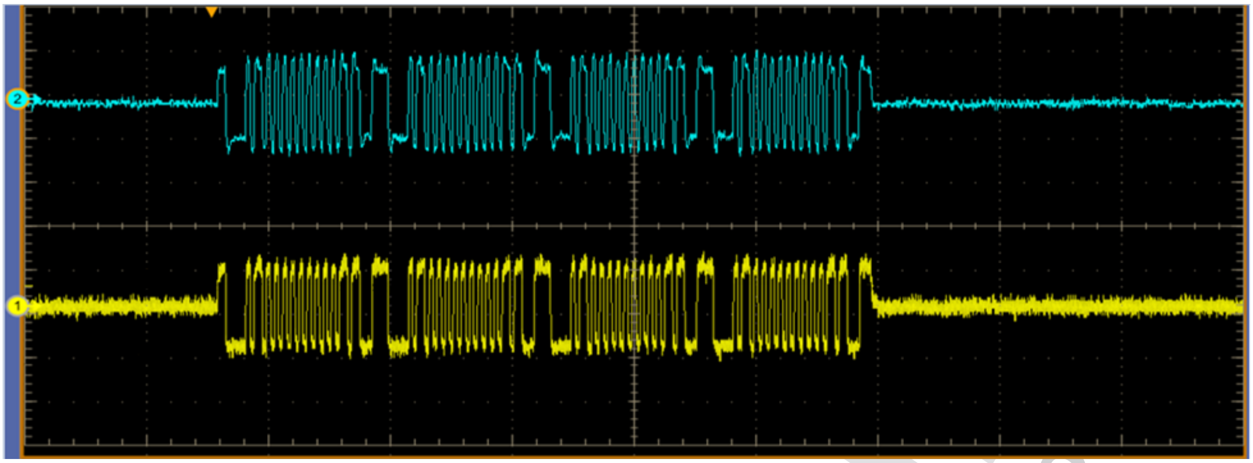

Figure 4. OOB Waveform with Signal Detect Forced “ON”

Using the DS125BR800A repeater as a programming model:

Table 3. Signal Detect Programming

SMBus Register	Write	Comment
0x06	0x18	Enable SMBus slave mode register control
0x0D	0x02	Channel 0; Force Signal Detect “ON”
0x14	0x02	Channel 1; Force Signal Detect “ON”
0x1B	0x02	Channel 2; Force Signal Detect “ON”
0x22	0x02	Channel 3; Force Signal Detect “ON”
0x2A	0x02	Channel 4; Force Signal Detect “ON”
0x31	0x02	Channel 5; Force Signal Detect “ON”
0x38	0x02	Channel 6; Force Signal Detect “ON”
0x3F	0x02	Channel 7; Force Signal Detect “ON”

3.3 Disable DC Offset Correction Configuration

This setting is programmed into the TI repeater using the SMBus register interface, a single register bit controls all device channels. Disabling the DC Offset correction, allows any signal offsets or changes in the signal offset to be transferred to the repeater output without adjustment. This eliminates any chance the actual system offset and the repeater offset correction will diverge from each other and produce a low amplitude signal immediately following an OOB “active” period. The result is a consistent low distortion response at the transitions between "active" and "idle" periods of the OOB waveform, Figure 6 (crossref) Figure 5.

Using the DS125BR800A repeater as a programming model:

Table 4. DC Offset Programming

SMBus Register	Write	Comment
0x06	0x18	Enable SMBus slave mode register control
0x4C	0x01	Disable DC Offset Correction

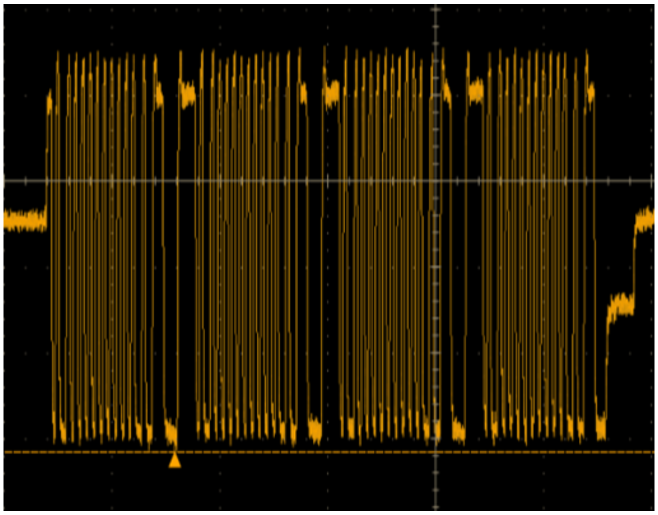

Figure 5. OOB Waveform With DC Offset Correction (0x4C[0] = 1'b)

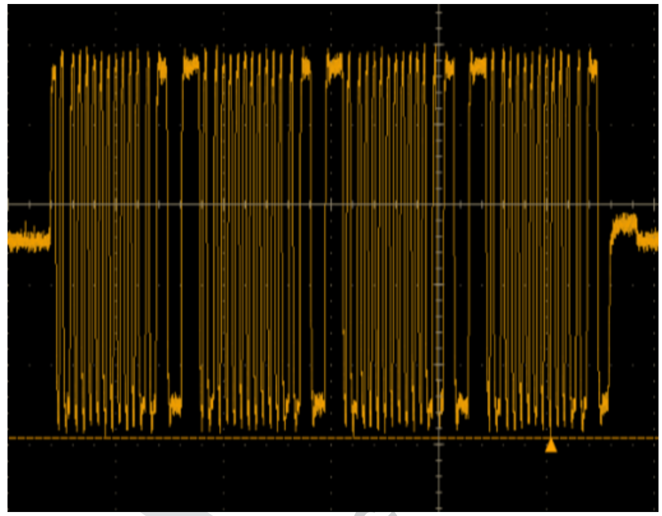

Figure 6. OOB Waveform Without DC Offset Correction (0x4C[0] = 0'b)

4 Summary

Interaction between SAS/SATA system components and TI repeaters which can cause distortion of the transmitted OOB waveform can be avoided using these configuration examples. Forcing Signal Detect "ON" and/or disabling DC Offset Correction will produce the most accurate OOB waveforms and is recommended for TI repeaters listed in this report.

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