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SATA Technology and Transient Protection Scheme

by

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In today's electronic technology, fast data processing capability is one of the essential functions that customers look for. From USB 2.0 to HDMI, customers are interested in technology that can help them accomplish their tasks more efficiently in a shorter amount of time. Serial Advanced Technology Attachment, also known as SATA, is the emerging data storage technology that will enable consumers to do just this. However, the higher the data speed and the more advanced the technology is, it is also harder to protect the IC adequately from over-voltage stresses caused by ESD or CDE. The following application note discusses SATA's technology, and the method to sufficiently protect SATA interfaces from the transient threats.

SATA is a high-speed serial link designed to replace Parallel ATA, or PATA. The name "SATA" itself often refers to drives that are installed internally. SATA that are implemented externally are referred to as external SATA or eSATA accordingly. For both locations of implementation, there are two different generations of SATA available: Gen 1, which can operate at 1.5Gbps, and Gen 2, which can operate at 3Gbps. While some use the terms SATA I and SATA II interchangeably with Gen 1 and Gen 2 to refer to the operating speed, SATA I and SATA II are actually the names for SATA standard organization.

Regardless of data transfer speed, both SATA Gen 1 and SATA Gen 2 use low voltage differential signaling, or LVDS. In other words, the state of the signal is determined by the relationship of these lines to each other rather than to the commonly referenced ground. The voltage swing used is 0.125V about the common-mode voltage, and the minimum common-mode voltage is 0.25V. With each SATA connection, there are 2 differential signal pairs and 3 ground pins, making it a 7-pin connection set. Table 1 shows the pin arrangement of one SATA connection set.

Pin Name	Type	Description
S1	GND	Ground
S2	A+	Differential Signal Pair A
S3	A-	
S4	GND	Ground
S5	B-	Differential Signal Pair B
S6	B+	
S7	GND	Ground

Table 1 – SATA Pin Out

In a SATA link, the Host device uses signal pair "A" to transmit data and signal pair "B" to receive data from the Peripheral device. The Peripheral device has the reverse function for signal pair A and B. Figure 1 demonstrates the signal pair functions described above.



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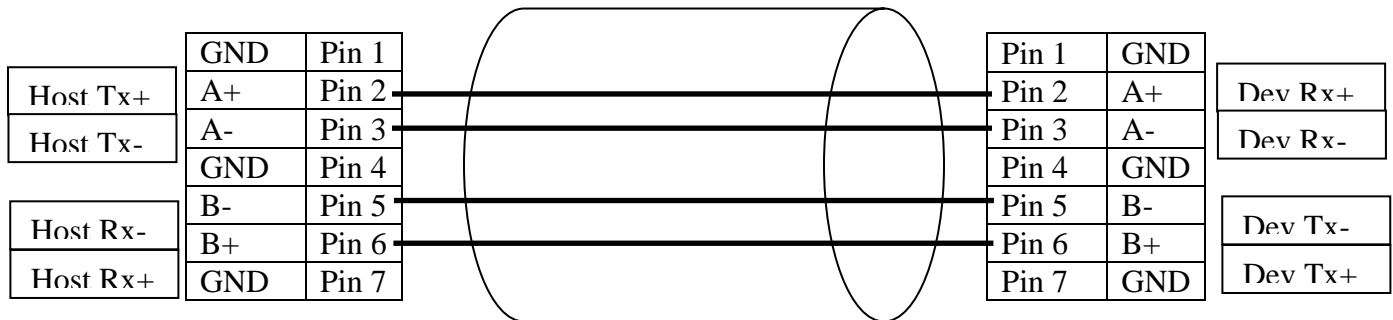


Figure 1 – SATA Signal Pairing between Host and Device

Since SATA has very high-speed data transfer rate and very low differential signal voltage, it is crucial to use both electrical and mechanical means to maintain its signal integrity. In addition to connector and cabling tolerance and specifications, SATA requires its signal differential impedance to meet 100 Ohm +/- 15% with 100ps of test signal rise time.

Like any external interface, eSATA is susceptible to ESD and CDE events. In order to protect SATA adequately from transient threat, such as ESD, without violating SATA signaling specification, the chosen protection device must have minimum parametric capacitance and parasitic inductance while still offering maximum transient protection capability. Semtech RClamp0524P is designed with these specific requirements in mind.

Semtech RClamp0524P is housed in a 2.5x1.0x0.58mm package with flow-through layout capability. Its narrow form and layout design allows RClamp0524P to occupy minimum board space without introducing interruptions in the signal layout. Furthermore, RClamp0524P offers 0.3pF typical line-to-line capacitance allowing this device to be used on 100 Ohm differential impedance signal lines without layout compensation and without causing impedance change. This is an important attribute of SATA protection device because it is difficult to maintain constant signal impedance over required routing distance when layout compensation is needed. Thus, without layout compensation, designers can layout 100 Ohm differential impedance traces per their specified board stack without additional concerns. Although RClamp0524P has ultra-low capacitance, it does not compromise its ESD capability; RClamp0524P can protect to IEC61000-4-2, Level 4 and beyond. With ease of layout, minimum package size and board impedance effect, and maximum ESD protection capability, Semtech RClamp0524P is an optimal ESD protection for high-speed data lines, including SATA. Figure 2 shows the schematic of using RClamp0524P to protect SATA data lines.



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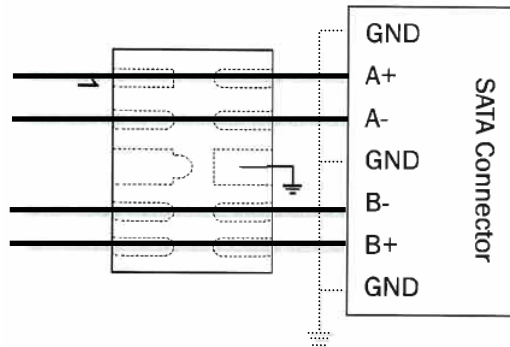
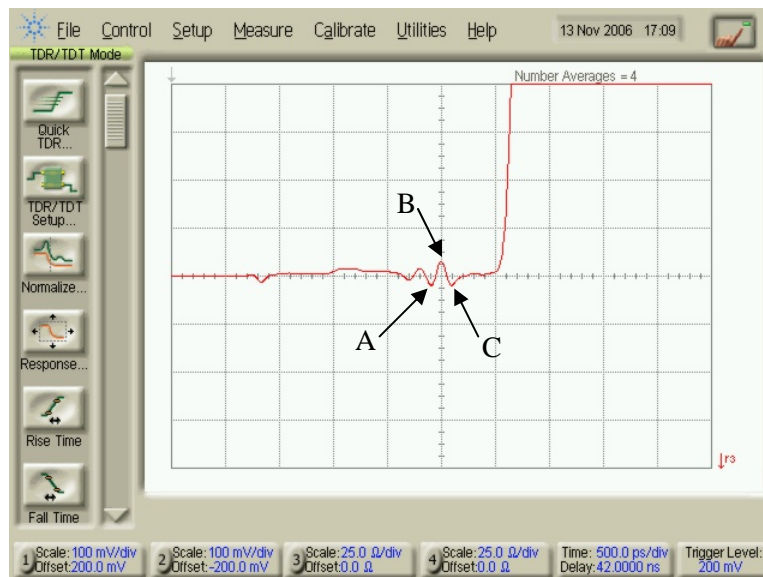


Figure 2 – Semtech RClamp0524P for SATA Protection

Figure 3 shows the TDR measurement of Semtech RClamp0524P used on traces with 100 Ohm differential impedance. The measurement is done using 100ps rise time for the test signal per SATA's requirement. The TDR measurement shows that the trace impedance meets SATA's requirement with the use of Semtech RClamp0524P.



	A	B	C	
X-axis	1.713	1.801	1.898	(nsec)
Y-axis	95	108	95	(Ohm)

Figure 3 – TDR Measurement of RClamp0524P on 100 Ohm Differential Impedance

Since SATA can be installed both internally and externally, it is important to maintain signal integrity and provide ESD protection for internal SATA, and it is even more crucial for the



external SATA. This is because with external SATA, not only the mechanical specification tolerance is tightened when compared to internal SATA, external SATA is also directly exposed to transient threats, such as ESD. Thus, regardless of the application of SATA, it is imperative to use a protection device, such as Semtech RClamp0524P, that will not interfere with signal integrity and can maintain differential impedance requirement and provide optimal ESD protection at the same time.