

## SDI Video: 10 Things You Need to Know

### Introduction

Life used to be a lot simpler.

The days of composite video, a standard that goes back 60 years, are coming to a rapid end. After three generations, video engineers became familiar with the intricacies and subtle nuances of the video signal and what could be expected in a distribution system. Test and measurement equipment became ubiquitous and inexpensive along with our ability to use them with great effectiveness to analyze problems and efficiently correct them. But today, as we move video sources and destinations to all-digital platforms, the analog composite video has reached its limits in spite of decades of innovation to minimize distortions and improve resolution.

And now we have Serial Data Interface, or SDI video; an uncompressed, full bandwidth signal that can be carried on just one wire. Even though it is now being used as the signal of choice for high definition TV, its roots go back many years to standard definition, or SD video. Today, we have many flavors of SDI that differ primarily in their serial data rate and the resolution of the video signal they carry.

But, before you begin to deploy or expand SDI in your facility, there are several things that you should know that will help you to understand SDI better and take full advantage of all its capabilities. Let's begin.



## 1 SDI is Not Just For Video.

The composite video signal was very clever in its ability to combine luminance, color and synchronization information in one signal. SDI takes this even further by supporting, in addition to the video, the capability to transport up to 16 channels of audio (either digital AES or analog converted to AES), metadata about the video content itself and other ancillary data. All this is done in a defined, non-proprietary manner according to a suite of SMPTE standards which include using SDI standards to transport compressed video standards and even 3D-TV. The implications of this are vast. One signal can now be used for transporting video and audio saving on cable costs. Technically, the audio and video can remain in lip-sync as long as they are transported together throughout the distribution network.

### TIP

Look for products that embed and de-embed audio in the SDI signal according to SMPTE standards and do not use proprietary methods. This will insure interoperability with all compatible products in your system.

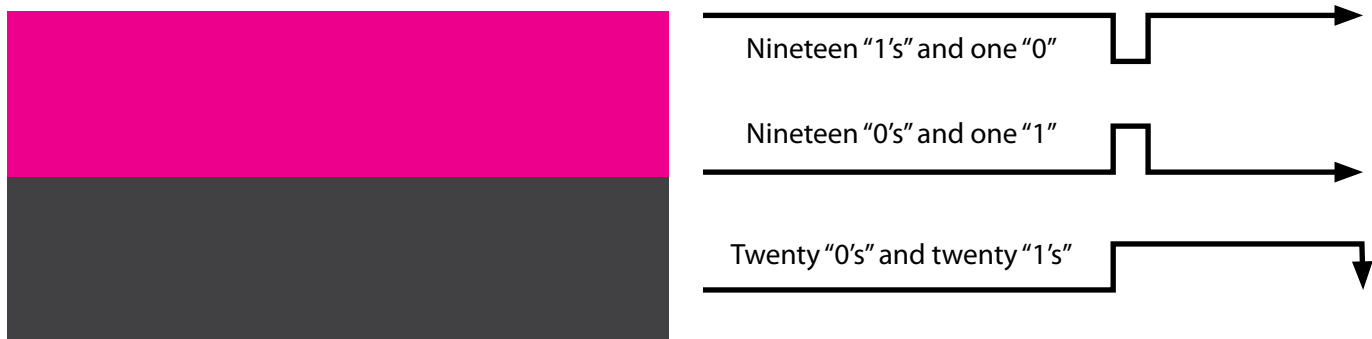
## 2 Donate Your Old Test Signal Generator.

Color bars, grey scale, 2T pulse, modulated steps – the basic test signals of composite video systems we have become all too familiar with. So what are the new test signals we need to use with SDI? Without doubt the most important and unique SDI test signal is Checkfield. This seemingly benign signal is composed of a magenta flat field in the upper half of the frame and a dark grey flat field in the lower half.



*Checkfield Test Pattern*

The purpose of this pattern is to stress the SDI signal path to make sure it can pass video signals without pathological results. These special colors that are generated by the Checkfield pattern will test all the active circuits in the SDI path to insure that they can accurately recover the 1's and 0's that make up the SDI signal. These potentially pathological conditions with long low duty-cycle strings of 1's or 0's or with DC balanced but low frequency repeating strings of twenty 1's followed by twenty 0's can be difficult to decode properly.



If errors occur they can manifest themselves as transient dropouts in the video signal as shown below or, worse yet, a complete loss of synchronization.

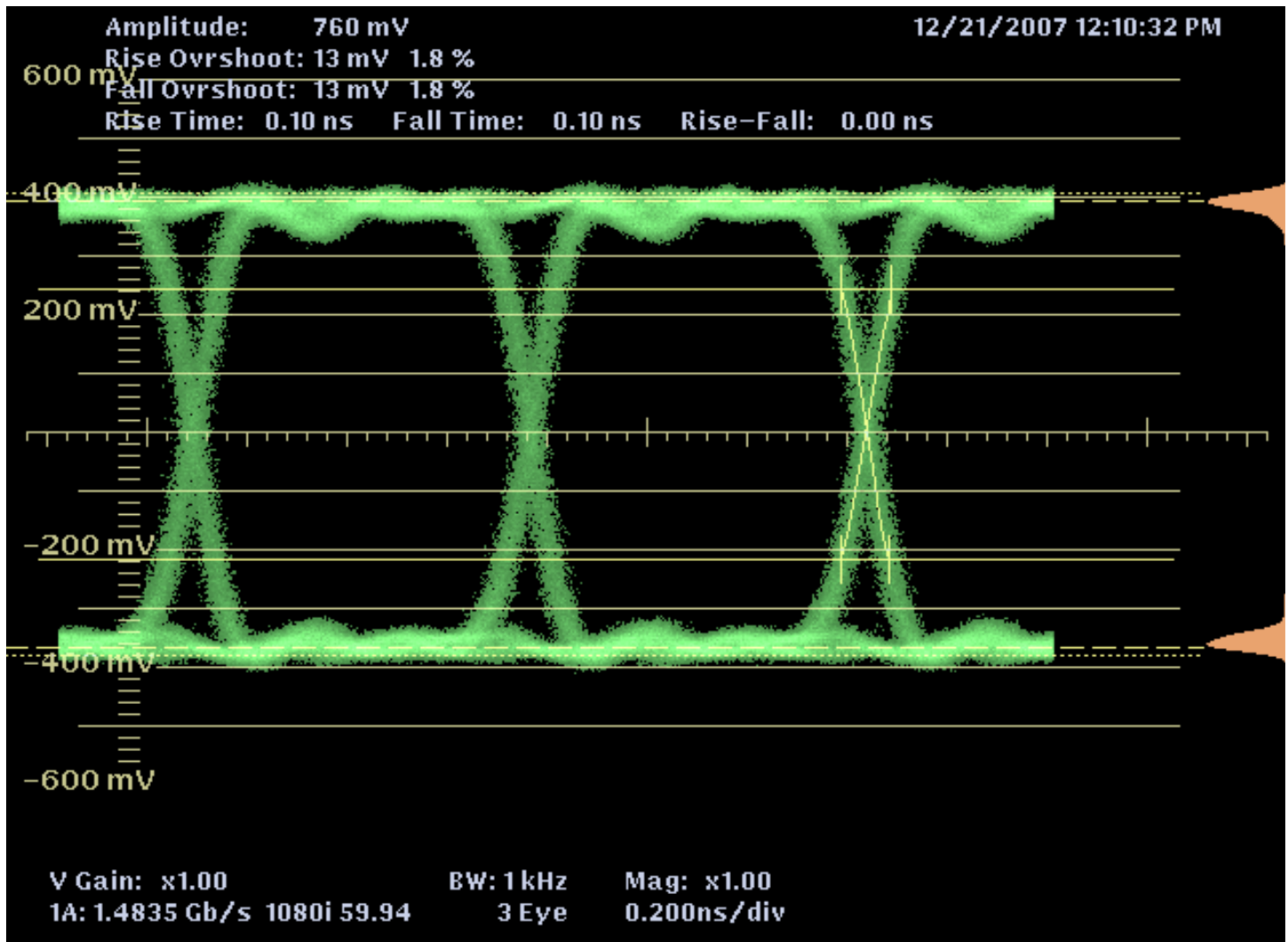


**TIP**

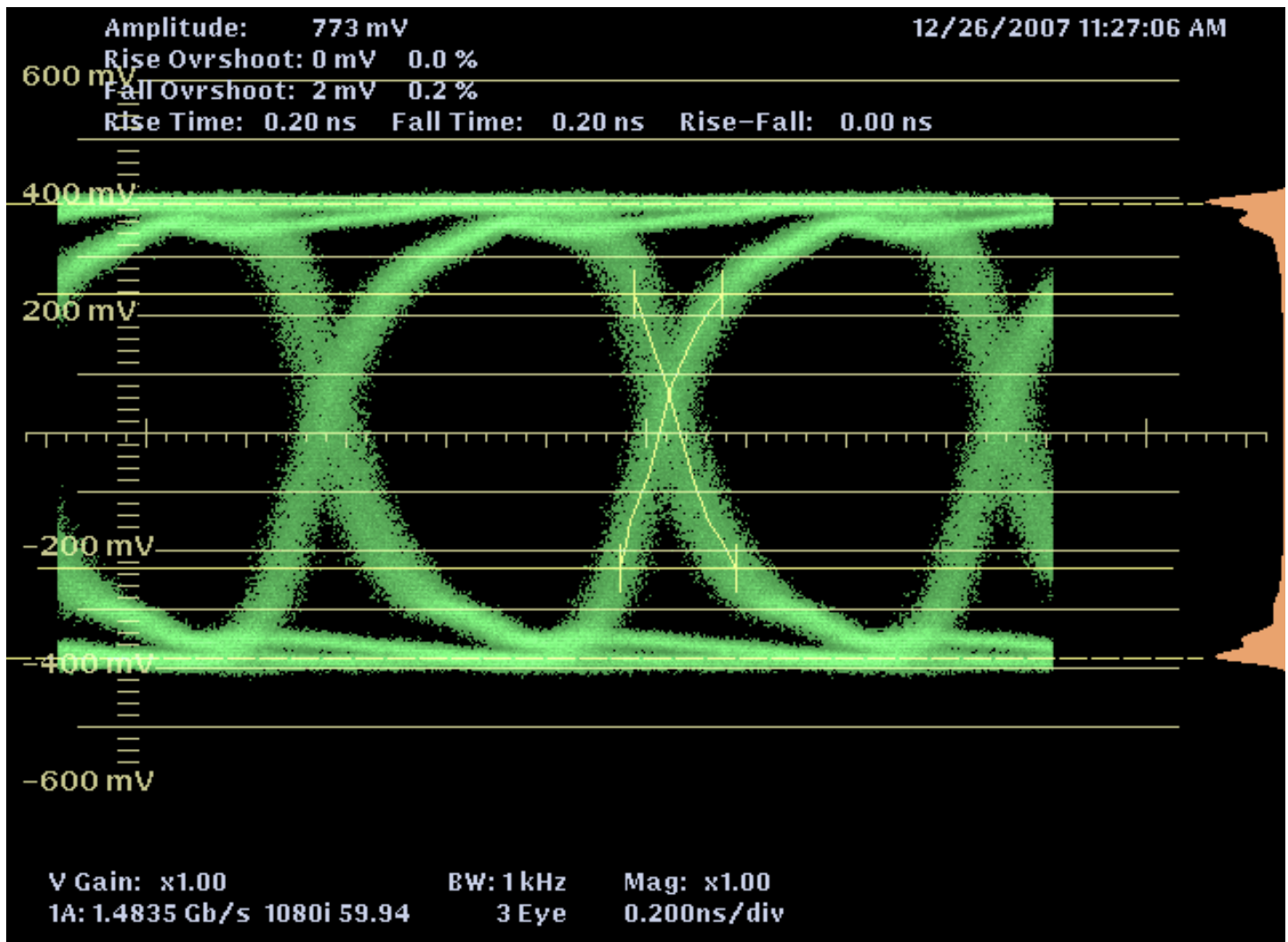
In fiber optic transmitters and receivers, pathological signals are of greater concern. Many optical circuits were not designed to properly handle the unique properties of SDI signal construction. Be sure to ask the SDI fiber optic product vendor if the products can properly handle pathological signals under all operational conditions including fiber length and operating temperature ranges.

### 3 The “Eyes” Have It.

When digging into the low level details of the SDI signal you should be concerned with the eye pattern. Viewable on a high-speed oscilloscope or more specialized SDI waveform monitors and analyzers, the eye pattern is a representation of the SDI signal showing voltage versus time. When viewed properly, it looks like an eye and how “open” (good) or “closed” (bad) the eye is when displayed is an excellent indication of how well the SDI will survive subsequent transmission with a minimal probability of error. At the end of a transmission line or fiber optic link, it can indicate the types of distortion and in some cases actually measure the resulting bit-error-rate.



Example of a good quality signal/eye pattern



*Example of a poor quality signal/eye pattern*

With composite, signal distortions would actually manifest themselves in the displayed video. However, with SDI there is no one-for-one correlation between the nature of the signal distortion and the viewable image unless it is severe enough. In those cases the video may become completely unusable. Don't be fooled into thinking that a distorted SDI eye pattern is OK because you "can still see the picture". The signal may not produce the desired results in a real world system or be recognizable by another piece of equipment in the system. The common results being a loss of synchronization or loss of video by the equipment receiving the SDI signal.

**TIP**

Always be diligent when evaluating a product by measuring its electrical properties and viewing its waveform to see the low-level signal characteristics and to what extent they comply with SMPTE standards.

**4****Now You See It. Now You Don't.**

SDI video is very robust. It can survive a wide array of transmission-induced distortion to its signal and still produce a perfect video image. But go too far with these transmission signal distortions and you get nothing at all. The SDI signal is actually a stream of digital 1s and 0s that define a complex structure of codes that, among other things, identify the start and stop points of the active video and imply its synchronization. Destroy a couple of these bits and your display or SDI device will ignore the whole signal and video will be lost entirely.

**TIP**

Unlike composite video where some signal distortion may be acceptable in some applications, SDI signals need to insure that certain types of transmission distortions are not severe enough to cause signal loss or do not take place at all. Distortions can be cumulative in a modern facility. Take care to use industry standard design and installation practices.

**5****Re-clock it? Maybe...**

In the world of composite video we usually have a box somewhere in the signal distribution system affectionately called a “proc amp”, or processing amplifier. Its job is to clean up the accumulated distortions that the signal underwent to restore things like video and sync amplitude, color phase, sync rise and fall times and blanking. In SDI, its electrical 1s and 0s can also be restored using a process known as re-clocking. In this process a circuit (it usually is not a separate “box”) will lock onto the fundamental frequency of the SDI signal and use it to regenerate a new SDI serial data stream with restored rise and fall times, signal amplitude and, perhaps most importantly, reduced short and long term jitter. Jitter can be thought of as the instability of the timing of the SDI signal when compared to a stable reference clock (if it existed as a separate signal).

While this may seem like a process we always want to do in any system, keep in mind that re-clocking may add unwanted delay to the transmission path or upset the phase relationship between the signal being re-clocked and reference signal. It will also add to the cost of the product, which may be significant in simple products such as SDI distribution amplifiers.

**TIP**

Look for products that re-clock the SDI signal, especially when the product is part of a more complex distribution system. While re-clocking may add to the cost of the product, the value of re-clocking in system performance and reliability under a wide range of signal conditions will more than outweigh its cost over the life of the system. If re-clocking is not desired, look for products where the re-clocking feature is absent or can be by-passed.

## 6 Equalize it? Definitely.

Any SDI signal traversing a coaxial cable will undergo distortion that attenuates its amplitude and closes its “eye”. The longer the cable or poorer the bandwidth of the cable or higher the SDI data rate the more distortion it will undergo. Fortunately, there are circuits built into some products that will “equalize” or reverse virtually all the effects of the coaxial cable. These circuits are typically placed at the copper SDI input to the device to clean up the signal before any further processing takes place inside the product.

This is not a simple process and these circuits are quite sophisticated especially given the wide range of data rates over which SDI can operate and may not be present in all products due to their cost. But, just like re-clocking, they are worth it to insure proper operation of the device under a wide range of signal conditions.

### TIP

Equalization is a functional parameter not often explicitly specified for a product even if it is present. Also, equalization is only effective over a maximum length of input coaxial cable that is determined by the cable type and the SDI data rate. Read the specs for the device very carefully.

## 7 Get a Bigger Pipe.

As any video engineer will tell you, signal fidelity is all about bandwidth. If the transmission system doesn’t have enough bandwidth required by the video signal then the resulting image will be distorted in one or more ways. Usually detail or resolution is lost but other distortion will surface too. With composite video, signal paths of 10 MHz were considered more than satisfactory to pass NTSC or PAL virtually distortion-free. But with SDI, transmission bandwidths into the gigahertz range may be needed. Consider standard definition SDI, the digital serialization of NTSC or PAL, which is a 270 Mbps signal. Then there is HD-SDI for 1080i and 720p, which is a 1.5 Gbps signal, and 1080p, which is twice that at 3 Gbps. These very high-speed signals require much thicker coax cable that has less signal loss or even fiber to adequately transmit them over the distances common in professional video.

### TIP

Plan ahead. When installing any permanent cable structure make sure you can still use it as bandwidth requirements increase over the years ahead. What may be satisfactory for today’s needs may not work tomorrow. Single mode fiber has virtually infinite bandwidth. It can satisfy today’s bandwidth requirements over the intended life of the cable installation and can even send 3G-SDI dozens of kilometers away.

**8****What Goes “In” Must Go “Out”**

You would think it would be pretty simple. SDI comes into a device and it goes out the back. Well, let’s consider that “out” for a moment. Just as we are concerned with equalizing the input SDI signal coming off the coaxial cable, the same must be true when feeding a coaxial cable from the output of a device. A line driver circuit should be used to match the SDI signal to the coaxial cable connected to the device. This is not an easy task for the manufacturer, especially when HD-SDI is the signal at 1.5 or 3G-SDI at 3 Gbps! The precise layout of the printed circuit board, the component values used and even the design of the BNC connector all play a role in insuring that the SDI signal integrity will be as perfect as possible before it is coupled into the cable.

Ultimately, there are two things to consider in the SDI output. First, is it non-inverting? While the polarity of an SDI signal can be inverted and still be properly interpreted, such is not the case with an DVB-ASI signal, a method for transporting compressed video at an SD-SDI rate of 270 Mbps. Second, if there is more than one output on the device it is important that these outputs be independently buffered to isolate one output from another. This is so that if one output is connected to a cable and left unterminated, its signal reflections will not distort the outputs that are in use.

**TIP**

Always look for non-inverting, independently buffered outputs particularly in a general-purpose device such as an SDI distribution amplifier. You never know how it will be used or what may be connected to it.

**9****Keep It Stable.**

SDI is what is known as a self-clocking serial data stream. That is, there is only one signal used and the clock reference is contained within, and must be derived from, the SDI data stream itself. There is no separate signal that is just the reference clock. While this makes for simple distribution of just one signal it makes the derivation of that reference clock tricky and, in some situations, downright difficult. Contributing to this problem is jitter. Jitter can be thought of as the instability of the timing of the SDI signal when compared to a stable reference clock (if it existed as a separate signal). If SDI signal jitter is excessive it will be difficult for a circuit to determine what is an intended 1 or a 0 at any instant of time. There are two types of SDI jitter: alignment and timing. Alignment jitter is the variation in the SDI signal transitions (i.e. going from a 0 to a 1) relative to the reference clock derived from the signal. Timing jitter is the variation in an SDI signal’s transitions that occur greater than a specified rate, usually 10 Hz or less. Re-clocking circuits and devices are designed to eliminate almost all of the jitter to within SMPTE specifications.

**TIP**

If you plan on working with SDI systems and maintaining SDI distribution systems make sure you have the right test equipment to be able to measure jitter. It is not easy to do, especially at 3 Gbps. But with the right test equipment designed for SDI it will be very easy to measure.



**10****Look For Differentiation.**

If you think that all SDI products are the same, guess again. While standard definition (SD-SDI) products have been available for some time, high definition (HD-SDI) and especially 3G (3G-SDI) products are relatively new. There are functions and application needs that exist today for SDI that never existed for analog video. The technology itself has created new applications and possibilities. Even though the SDI standard is well defined to insure interoperability, the execution within a product and its actual functionality will vary greatly. Product manufacturers are constantly innovating and trying to match the functionality of a product with the constantly changing demands of the marketplace. Products will continue to differentiate themselves in performance, features, functionality and value and no one manufacturer has all the answers.

**TIP**

Assume nothing. Examine data sheets thoroughly and look for what is not stated as a red flag to be reason to be cautious. Look for products that offer differentiation in various ways to meet your exact needs. Better yet, put the product on the bench and use the points described in this article to gauge a product's true, real-world performance.

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## Fiberlink® 3350 3G/HD/SD-SDI Series

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The Fiberlink 3350 Series allows you to transmit 3G, HD or SD-SDI as per SMPTE 424M-2006, 292 and 259, with or without embedded audio and data, as well as DVB-ASI over one single mode or multimode fiber. Signals are equalized and re-clocked prior to fiber optic transmission. The 3350 transmitter features a re-clocked and equalized SDI loop through and the 3351 receiver features two re-clocked and equalized SDI outputs. The 3350 Series is compliant with SMPTE 297-2006 and has the ability to operate seamlessly with Fiberlink Matrix and other SMPTE 297-2006 fiber optic compliant devices.



The 3350 Series is immune to pathological signals over the entire budget link and operating temperature range. Available in card versions and a small footprint box version, it is ideal for broadcast or corporate studios, OB vans, rental and staging, auditoriums, stadiums and theaters, airport or transportation hubs, distance learning, surgical or medical imaging and more!

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