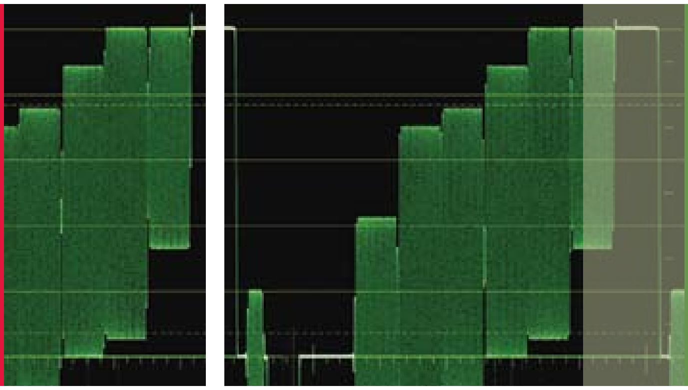


Using Stay GenLock®

Video Reference Timing with Tektronix Signal Generators

Technical Brief

Digital video systems require synchronization and test signal sources with low jitter and high stability. The Tektronix TG700 TV Signal Generator Platform with Stay GenLock technology can provide a robust reference signal solution for broadcast and post-production facilities.

Tektronix®

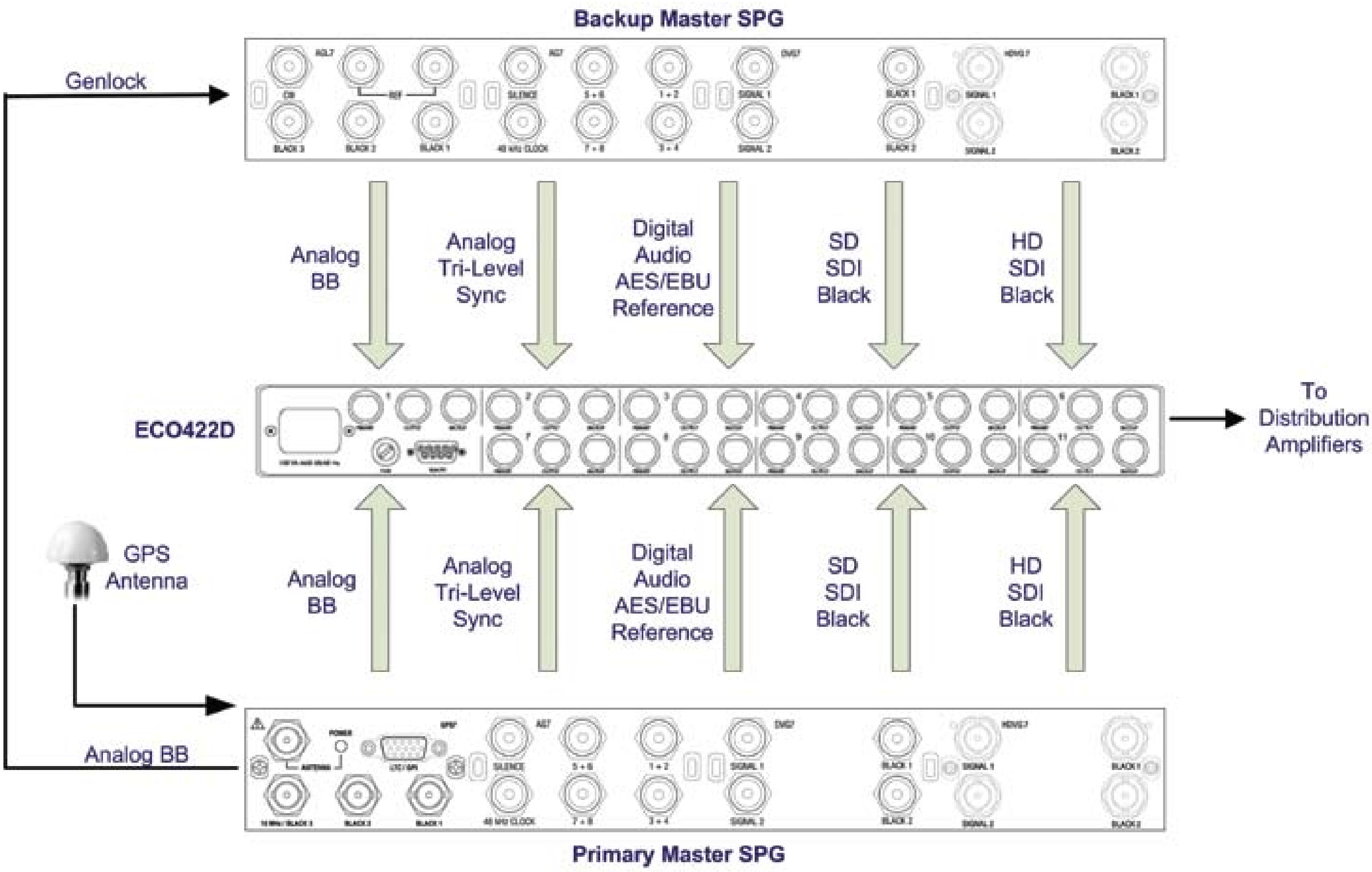


Figure 1. Dual Sync Pulse Generators with emergency change-over unit.

Overview of Facility Timing

Most equipment in a video facility such as cameras, VTRs, and switchers, must be synchronized with each other for proper operation. Black burst and HD tri-level synchronization signals are typically used for “house references,” and are distributed throughout the facility via dedicated infrastructure. These signals can originate from a master sync pulse generator (SPG) that has an internal oven-controlled crystal oscillator (OCXO), or derived from an external source such as a GPS signal or an atomic clock utilizing the rubidium standard.

GPS-based synchronization is an attractive option for many installations because of its high stability at a relatively low cost. A GPS receiver that is optimized for timing applications produces a 10 MHz sine wave signal that is used for the frequency reference for the system. Since the signal is derived from the continuous average frequency of each of the atomic clocks orbiting the earth in the GPS satellite constellation, it is free of long-term frequency drift. The SPG will generate video synchronization signals that are genlocked to the 10 MHz reference.

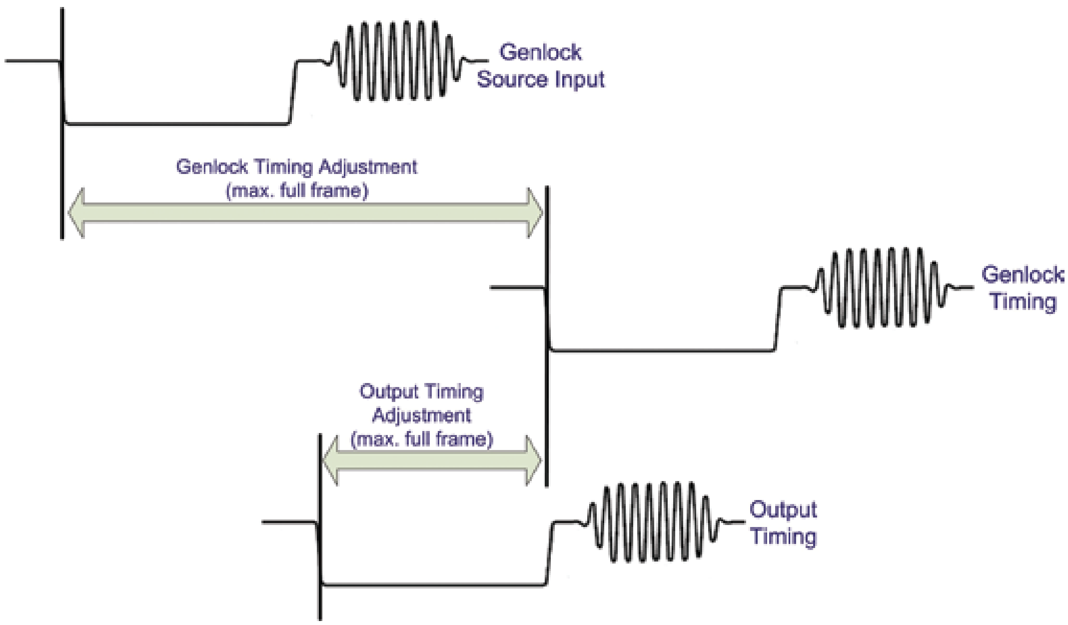


Figure 2. System timing and output timing adjustment.

A high-reliability timing reference system is configured with redundant SPGs and a changeover unit. In case of failure on the primary SPG, the changeover will automatically switch critical reference signals to the backup SPG. It is essential that both SPGs are synchronized to avoid any disruption in case of changeover. The backup SPG could be genlocked to the master, or both could be synchronized to the same source, such as GPS.

Distribution amplifiers are often used to extend the range and quantity of available sync signals outputs. In larger facilities, a master-slave configuration may be deployed, in which multiple slave SPGs are genlocked to the master system. This approach has the benefit of increased flexibility in system timing. The timing of slave SPGs relative to the timing of the master SPG can be adjusted to compensate for cable or switching delays. Individual SPG outputs can also be adjusted relative to the SPG clock for additional control.

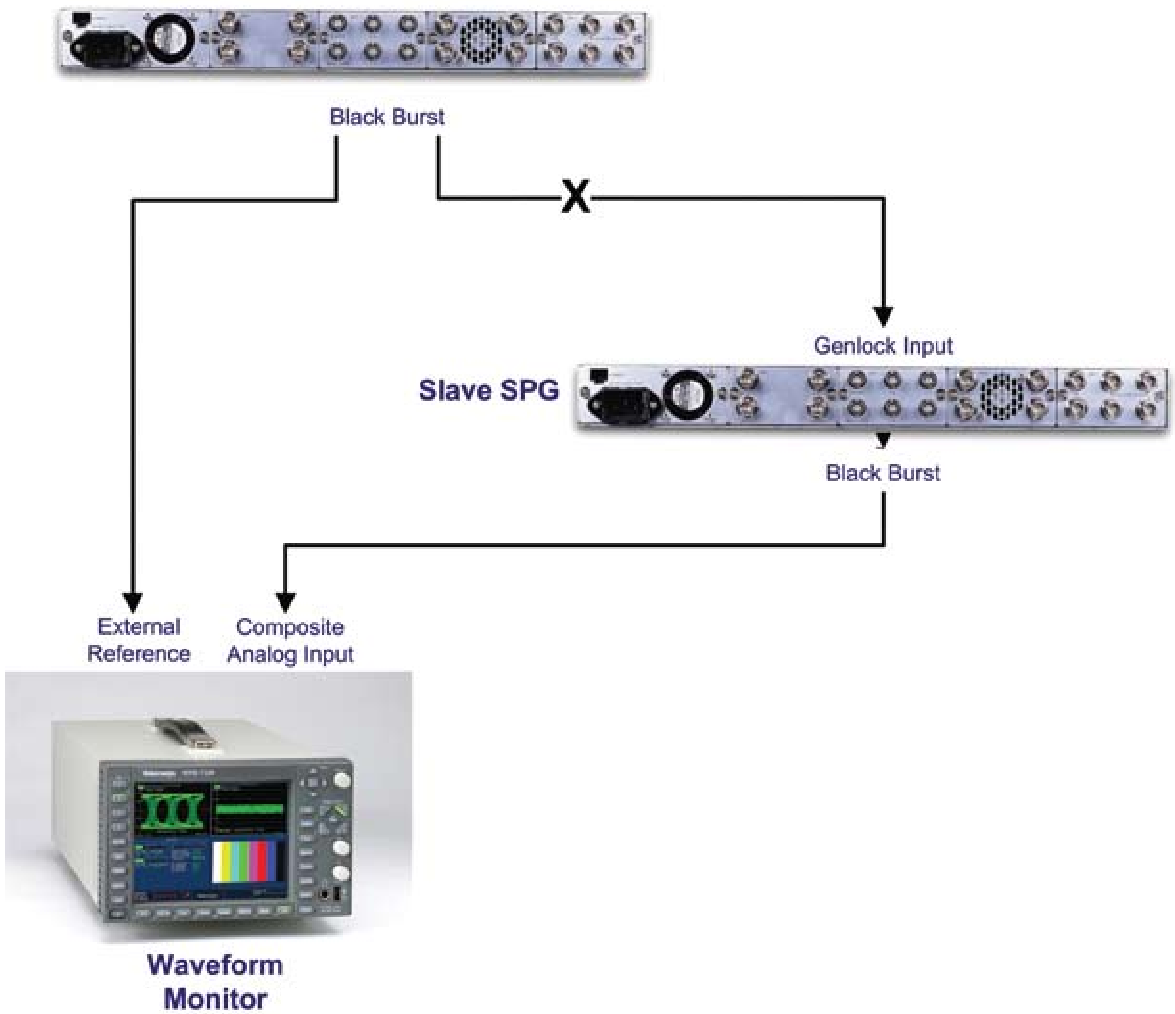


Figure 3. Observing Stay Genlock behavior on a waveform monitor.

About Stay GenLock®

Stay GenLock is a digital genlock technology developed by Tektronix for the TG700 TV Signal Generator Platform and for the SPG600/SPG300 series of Sync Pulse Generators. It provides additional robustness and stability for genlocked SPGs, as in a master/slave configuration.

If the external reference is removed from the genlock input, the SPG must use the internal oscillator as a frequency reference. Although the OXCO is a precision component, small frequency differences are inevitable. However, the Stay GenLock technology maintains a history of the clock frequency, and therefore attempts to hold the last stable frequency before genlock was lost.

This behavior can be demonstrated and observed using a vectorscope display on a waveform monitor. If the waveform monitor is externally referenced to the same master SPG as the slave SPG, the color burst vector of an analog black burst sync signal will appear stable and have no phase offset.

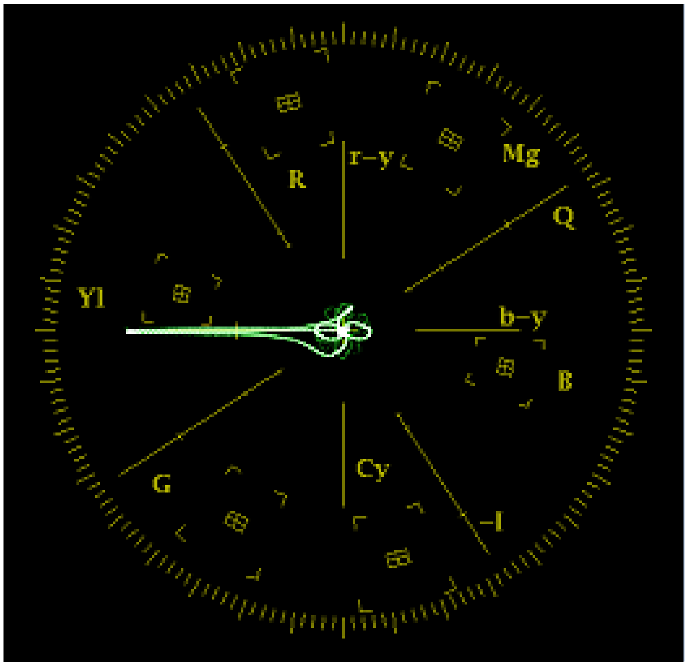


Figure 4. With Stay Genlock, the color burst vector is stable.

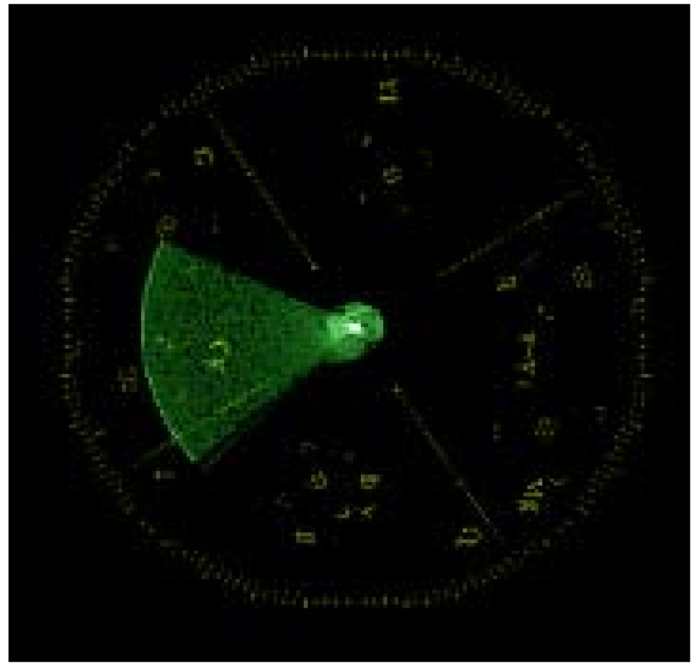


Figure 5. Without Stay Genlock, the color burst vector rotates.

If the genlock input to the slave SPG is removed, the color burst vector will rotate because the genlock reference and internal reference frequencies are not exactly the same.

On the TG700's AGL7 Analog Genlock Module, the Stay GenLock mode can be enabled to minimize this effect. The color burst vector would remain stable because the frequency offset from the genlock reference is kept to a minimum. When the external timing reference returns, the genlock circuitry will attempt to relock. When the timing offset is about 20 ns or less (corresponding to 25 degrees of NTSC subcarrier or 30 degrees of PAL subcarrier), synchronization shock will be avoided. This will also be the case when Stay Genlock is used by a backup SPG that is genlocked to the primary SPG. If the primary SPG fails, the changeover unit will switch to the backup SPG without any disturbance to the sync and reference signals.

Effect of Random Noise on HD-SDI Timing Jitter

The digital Stay GenLock technology has an additional benefit in that output signals from the generator are unaffected by the quality of the genlock reference signal. The SPG has a high tolerance for random noise, impulse noise, hum and other impairments to the genlock input signal, and these impairments do not affect output signal quality. The result is that the timing and alignment jitter on HD-SDI test signals is the same when the system clock is genlocked from an external reference as when the internal clock is used.

When the reference genlock input signal is noisy, the system clock may be affected in an analog genlock system, causing HD-SDI test signals to show unacceptable timing jitter. With Stay GenLock, the system clock is stable and the HD-SDI test signal has no discernable jitter.

The following waveform displays demonstrate this difference. The genlock input is a standard NTSC black burst signal to which noise has been added. With a traditional genlock system, the timing jitter of the HD-SDI test signal increases as the signal-to-noise ratio of the genlock reference signal degrades. At –30dB, the black burst input is unacceptable as a genlock reference. With the TG700 using Stay Genlock, the timing jitter of the HD-SDI signal shows a very small increase as the noise level of the genlock reference signal increases beyond acceptable limits.

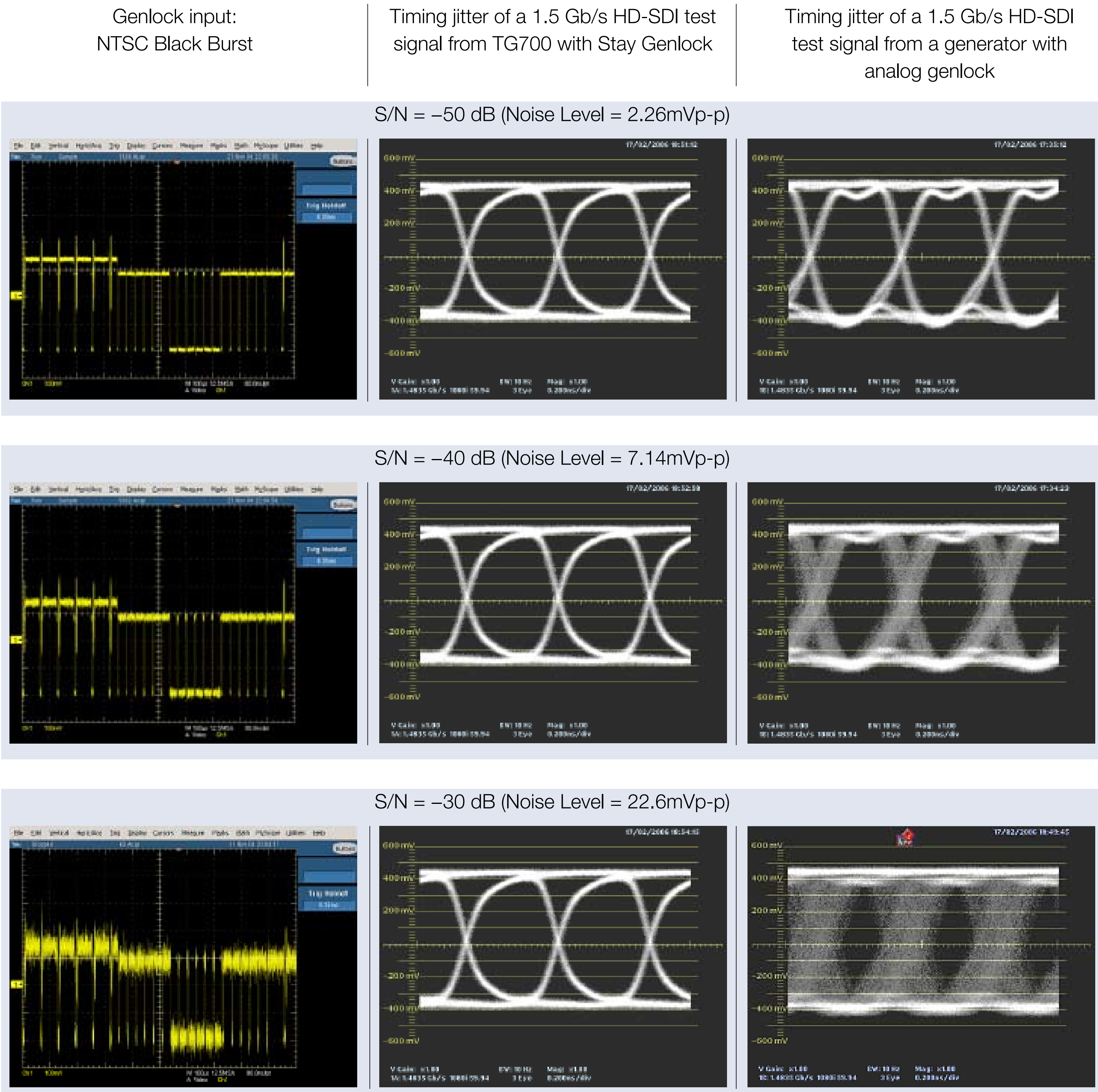


Figure 6. Effect of Random Noise on the Genlock Input.

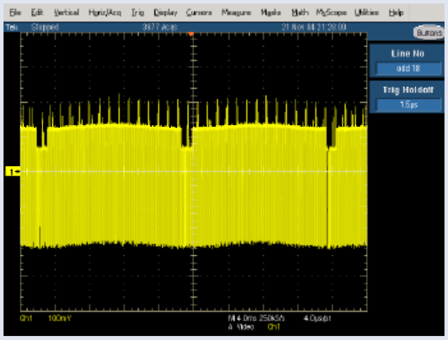
Effect of Hum on HD-SDI Timing Jitter

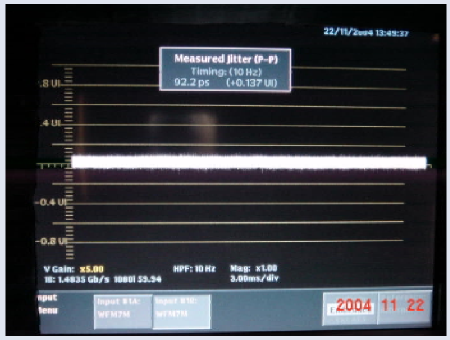
Hum is an oscillation at the frequency of the AC mains circuit (usually 50 Hz or 60 Hz) and can be introduced by ground loops in the system. Hum can be reduced by a DC restorer circuit, but effects of remaining hum may still be present.

In a traditional genlock system, the timing jitter of HD-SDI test signals increases as the hum level of the genlock reference signal increases, because it is very difficult to reject the effect of hum completely. With the TG700 and Stay GenLock, large amounts of hum on the genlock reference signal have negligible effect on the timing jitter of the HD-SDI output signal. Stay Genlock effectively rejects effects of big hum as demonstrated at the 0dB hum level.

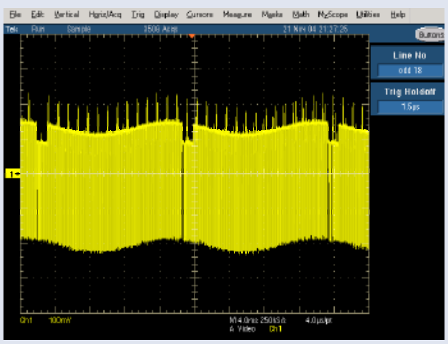
Genlock input: NTSC Black Burst	Timing jitter of a 1.5 Gb/s HD-SDI test signal from TG700 with Stay Genlock	Timing jitter of a 1.5 Gb/s HD-SDI test signal from a generator with analog genlock

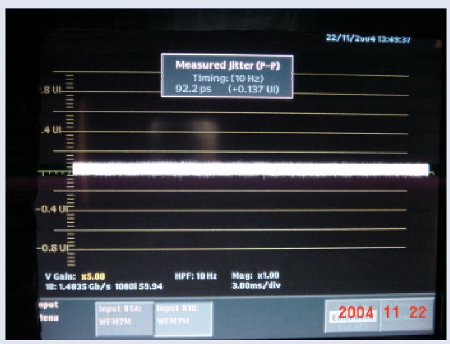
Hum = –50 dB (Hum Level = 2.26mVp-p)

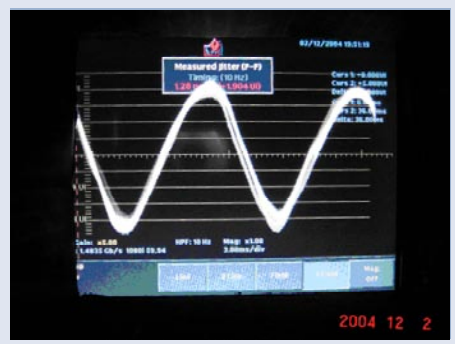




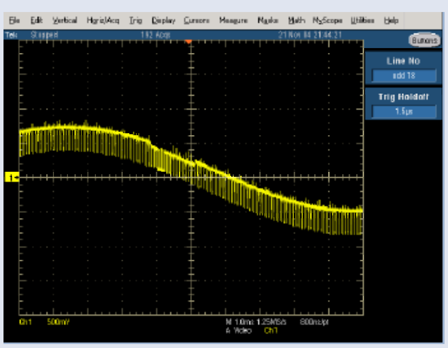
Hum = –40 dB (Hum Level = 7.14mVp-p)

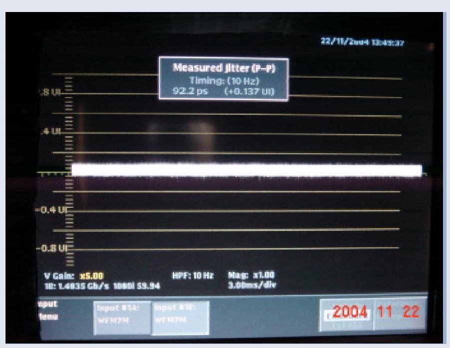






Hum = –30 dB (Hum Level = 22.6mVp-p)





No Data (loss of lock)

Figure 7. Effect of Hum on the Genlock Input.

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