DD2100

Video Delay Detector

PIXEL INSTRUMENTS CORPORATION

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STANDARD EQUIPMENT WARRANTY

Pixel warrants that the goods sold under this contract will be free from defects in material and workmanship for a period of one year from purchase, and this warranty will be limited to the repair and/or replacement of parts and the necessary labor and services required to repair the goods in our location.

Customer will be responsible for shipping the unit to Pixel freight and Pixel will repair or replace the unit at its option and return to the customer via prepaid freight.

IT IS EXPRESSLY AGREED THAT THIS WARRANTY WILL BE IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING THE WARRANTIES OF FITNESS AND MERCHANTABILITY.

Safety Summary

The general safety information in this part to summary is for both operating in series in personnel.

Power Source

This product is intended to operate from a power module connected to a power source that do not apply more than 125 V RMS (or 250 V when unit is wired to operate from 220V or 240V supplies) between the supply conductors or between either, supply conductor and ground. A protective ground connection by way of the grounding conductor in the power cord is essential for safe operation.

Ground the Product

This product is grounded through the grounding conductor of the power module of power cord. To avoid electrical shock, plug the power cord into a properly wired receptacle before connecting to the product input or output terminals. A protective ground connection by way of the grounding conductor in the power module cord is essential for safe operation.

Danger Arising From Loss of Ground

Upon loss of the protective ground connection, all accessible conductive parts (including knobs and controls that may appear to be insulating) can render an electric shock.

Use the Proper Fuse

To avoid fire hazard, use only the fuse of correct type (Pixel products use slow-blow fuses), voltage rating, and current rating as specified in the parts list for your product. Refer fuse replacement to qualified service personnel.

Do Not Operate in Explosive Atmospheres

To avoid explosion, do not operate this product in an explosive atmosphere.

To Not Operate Without Covers

To avoid the personal injury, do not remove product covers or panels. To not operate the product without the covers and panels properly installed.

Do Not Service Alone

Do not perform internal service or adjustment of this product unless another person capable of rendering first aid in resuscitation is present. When performing a service use isolation transformer to provide power. Replace parts with the same voltage ratings, and current ratings as specified in the parts list for your product. And current

Introduction

The Pixel Instruments DD2100 Video Delay Detector is used to measure the delay of video signals which are passed through video processing instruments. In today's television systems, it is quite common for the video signal to undergo several substantial delays such as those caused by video synchronizers, noise reducers and color correctors. Each processing step can add several fields of delay to the video, which causes the corresponding audio to be advanced with respect to the video. Such audio to video synchrony errors can cause visible "lip sync" problems, which may be consciously perceived by the viewer. The DD2100 measures the actual video delay and controls Pixel Instruments AD2100 or AD3100 Audio Synchronizer for automatic lip sync correction.

The DD2100 operates by comparing frames of video which are input to a video device with frames of video which come out of a device. A given input video frame is stored in memory and all the output frames are compared to the stored frame until an output frame which matches the stored input frame is found. By counting the number of frames which are output until the matching frame is detected, a coarse measurement of delay is obtained.

The phase of the input and output vertical syncs are compared to determine the fine delay, which is added to the coarse delay to generate a very accurate delay measurement.

The delay can even be measured with static images (e.g. captions) because the highly refined digital signal processing circuitry in the DD2100 can lock to the random noise which is present on video signals to determine delay on otherwise identical frames. In addition, the DD2100 can recognize and accommodate static changes in the video signal such as luma gain and setup, or chroma gain and phase differences. Because of the immunity to static changes, the DD2100 can be used with color correctors, noise reducers and frame synchronizers which provide operator or automatic adjustments of the video processing parameters.

It has been demonstrated in psychological tests at Stanford University that viewers who watch television commercials having a five field audio advance perceive the commercials more negatively (e.g. less interesting, more unpleasant, less influential, more aggravating, less successful) than the same commercials which are played with the audio in sync with the video. It was also found that several test subjects were unable to detect the delay consciously and thus were completely unaware that there was an audio to video synchronization problem.

In addition to any visible "lip sync" problems, the mistiming of audio and video will cause a subconscious reduction of the program's entertainment quality to the viewer. The cause of this effect is believed to be the unnatural advanced sound relationship. In our natural environment we are used to hearing audio slightly delayed with respect to images due to the slower speed of sound waves as compared to light. Advanced audio is unnatural and therefore believed to cause subconscious stress to the viewer which creates a loss of enjoyment of the program.

Single channel (DD2100) and dual channel versions (DD2102) are available.

Technical specifications

Features

¤ Measures video delays up to 8.99 fields in 525 or 625 line systems
¤ Works with any video synchronizer or video processing device
¤ PAL and NTSC compatible
¤ Provides steering for companion audio delay

Specifications:

Maximum Detectable Delay:	8.99 Fields (switch selectable .99-8.99 fields)
Minimum Time to Field Acquisition:	12 seconds (with suitable scene change)
Internal Measurement Resolution:	102.4 µS

Inputs

Non-delayed Video (high impedance loop-through)
1 Volt p-p ±10 %

Delayed Video (high impedance loop-through)
1 Volt p-p ±10 %

Outputs

TTL Pulse, Positive Going Matching Delay Serial Data, Communicates with AD2100 or AD3100 Audio Delay

Power

115/220 VAC, 50/60 Hz
30 Watts Max.

Mechanical

Width 19.0" (48.3 cm)
Depth 18.5" (47.5 cm)
Height 1.75" (4.5 cm)
Weight 6.5 lb. (2.5kg)

Front Panel Display

Type:	Alphanumeric, 2 line x 20 character
Delay Display Format:	Internal Measurement converted to nearest .1mS, updated twice per second
Display Indicators:	Field Correlation Update Time Since Last Correlation Alarm: Undelayed Video Error* Alarm: Delayed Video Error*

***An alarm indication indicates a sync phase lock error and/or loss of sync.**

Operating Temperature:

0°C to 45°C

Storage Temperature:

-25°C to 75°C

Humidity:

10% - 95%, non-condensing

Note: Specifications subject to change without notice.

Scope

This document describes the functionality of the Pixel DD2100 Video Delay Detector. The DD2100 measures the time of delay between a video source and a delayed version of the video source. The measurement, along with certain status indicators, is presented on a front panel LCD display. Additionally, rear panel DDO pulse and serial data delay outputs are available. The DDO pulse or serial data outputs may be directly used to control the desired delay of the Pixel AD2100 Audio Delay Synchronizer. A delay of between 0 and 8.99 fields may be measured.

In operation, non-delayed video and delayed video are input to the DD2100 via rear panel high-impedance loop-through connectors. Vertical sync is counted to establish candidate delays for 0 through 8.99 fields. Delay is counted to a nominal resolution of 102.4 microseconds (1024/10MHz). Sixty-three pixels from each field of both video signals are digitized, and a correlation is performed. Under conditions of significant motion or scene changes, correlation differences between fields are used to select the most likely of the candidate fields. Redundant time-diversified measurements are performed to reduce the incidence of measurement errors.

Rear Panel Connectors

This section describes the rear panel signal connectors and functions.

1. NON-DELAYED VIDEO INPUT: Two BNC female connectors, for high impedance loop through. The non-delayed video source should be connected here.

2. DELAYED VIDEO INPUT: Two BNC female connectors, for high impedance loop through. The delayed video source should be connected here.

3. DDO PULSE OUT: A BNC female connector, which outputs a periodic rectangular, with high period equal to measured delay. Should be connected to REMOTE DELAY connector on the Pixel AD2100, if remote pulse width control of the AD2100 is desired.

4. SERIAL OUT: A modular handset connector, which outputs serial measured delay data. Should be connected to SERIAL IN connector of the AD2100 if remote serial data control of the AD2100 is desired.

Maximum Expected Delay DIP Switch

This switch, located on the rear panel, is used to limit the range of correlation measurements. The maximum expected delay in fields is selected as a four bit binary number. The valid range is 0.99 to 8.99 fields. Measurements beyond the setting are ignored. Please see the "Setup and Adjustment" section for more information.

LCD Display

A backlit LCD display is utilized which displays 2 lines of 20 characters each.

In normal operation, the top line shows the most recently measured delay in seconds, and the bottom line shows elapsed time, in hours:minutes:seconds format, since the last measurement update:

Delay: .xxxx Sec.
Last Update xx:xx:xx

When an update event is detected, the lower line will flash an indication:

Delay: .xxxx Sec.
*****New Update*****

When a video alarm is detected, the lower line will alternate continuously between normal display and an alarm message:

Delay: .xxxx Sec.
Alarm: Undly'd Video

or

Delay: .xxxx Sec.
Alarm: Dly'd Video

This display condition will persist until the alarm is cleared. In the event both video alarms are detected, the lower line will sequentially display all three messages.

If ten or more consecutive raw measurements, as explained in the next subsection, corresponding to fields beyond the Maximum Expected Delay DIP switch setting occur, a warning is displayed:

Delay: .xxxx Sec.
WARN: Max Dly Switch

The lower line will alternate sequentially with other messages. If This warning is observed, the setting of the rear panel Maximum Expected Delay DIP Switch should be checked.

Display Interpretation / General Characteristics

The displayed delay is the most decent delay count for the delayed video field determined to have the best correlation measurement relative to an undelayed video field. The delay count is measured internally in increments of 102.4 microseconds, and converted to the nearest .1 mS for presentation by the LCD display. Five consecutive raw measurements, spaced a minimum of 2.4 seconds each apart, all returning the same relative field, are required for field determination. Whenever a raw measurement agreeing with all four previous raw measurements is obtained the *****New Update***** indication will flash, and the elapsed time indication will reset. At power up, delay is initialized to zero. Once five raw measurements in agreement are obtained, the delay of the determined field, based on vertical sync timing, is presented. A new displayed reading will continue to become available once per second, in response to vertical sync timing, as long as the most recent five raw measurements agree, subject to limitations described below..

If the most recent five raw measurements are not all the same, the displayed reading will hold at the last known number. This will occur during initial field acquisition, field re-acquisition after an anomalous raw measurement, or new field acquisition. New field acquisition is required when the non-delayed and delayed video vertical syncs roll through one another. New field acquisition may also be required when large delay discontinuities occur. Because of the redundant time-diversified measurement technique, a minimum of 12 seconds is required for field acquisition or re-acquisition.

Field acquisition or re-acquisition is also required if the delay of the determined field becomes removed from the last raw measurement value by approximately 8mS or more, in the absence of an alarm condition. In the presence of an alarm condition, acquisition or re-acquisition is required if the delay of the determined field becomes removed from the last raw measurement value by approximately 1mS or more. In these cases, a minimum of four raw measurements, covering a minimum of 9.6 seconds, is required. As before, the displayed reading will hold at the last known number until acquisition or re-acquisition is complete.

The pulse width of the DDO output signal corresponds to the displayed delay reading. SERIAL OUT data also corresponds to the displayed reading. These two signals retain the internal 102.4 microseconds resolution. The DDO pulse width is equal to the measured delay for all delays except zero. In the case of zero measured delay, the DDO pulse width is 102.4 microseconds. The repetition period of the DDO pulse is 840 miliseconds plus the pulse width. The repetition period of SERIAL OUT data is one second.

An abrupt scene change, rapid motion within a scene, or an abrupt brightness change within a scene, may be required to produce a raw measurement. Slow fades of subdued motion may not always produce a raw measurement. Program material of low brightness may produce fewer raw measurement opportunities.

Alarm indicators result from loss of composite sync, or the assertion of the internal sync PLL lock alarms. During any alarm condition, all measurements are suspended, and the display reading, DDO width, and SERIAL OUT data are held at the last known value.

Rear Panel Setup

1. Setting Maximum Expected Delay

The Maximum Expected Delay DIP Switch, S1, is located on the rear panel. It is used to limit raw measurements to those within expected valid range. When set, S1 will prevent possible anomalous measurements beyond the maximum anticipated number of fields of delay. The minimum delay which can be measured is zero and is unaffected by this switch setting. It should be noted that if S1 is set below the actual maximum delay to be encountered, valid measurements may also be inhibited. The settings are as follows ("x" indicates "don't care"):

MAXIMUM EXPECTED DELAY IN FIELDS	SWITCH POSITION 4	3	2	1
1.99	OFF	OFF	OFF	ON
2.99	OFF	OFF	ON	OFF
3.99	OFF	OFF	ON	ON
4.99	OFF	ON	OFF	OFF
5.99	OFF	ON	OFF	ON
6.99	OFF	ON	ON	OFF
7.99	OFF	ON	ON	ON
8.99	ON	X	X	X

PC Board Setup

1. PC Board Jumper/Connector Settings:

1.1. JP3: Jumper must be installed from pins 1 to 2. JP3 selects the source of the DDO pulse. JP3-1 to JP3-2 selects the SPROC™, JP3-2 to JP3-3 selects the microcontroller. The microcontroller mode is not supported.

1.2. J14: J14 is not used. Must not have any jumpers installed.

1.3. JP1: Selects one of two SPROC signal processing programs. The DD-2100 is normally operated with the jumper installed from pins 1 to 2 of JP1. This will select the program with the operational characteristics described in the **Operation** section of this manual.

An alternative program may be selected by installing the JP1 jumper from pins 2 to 3. Operational characteristics will be identical to those of the other program, except for the following two differences:

1. The minimum time interval between raw measurements is 6 seconds, instead of 2.4 seconds. Thus, the minimum time to field acquisition is 30 seconds, instead of 12 seconds.

2. A higher degree of brightness change, motion, or scene change difference, is required to produce measurement.

The program selected by JP1 is loaded at power-up.

1.4. JP2: Selects SPROC™ master or slave mode. Jumper omitted selects master mode, jumper installed selects slave mode. Must be omitted.

1.5. J7, J8, J9, J10, and J12: Not used in normal operation. Must not have any jumpers or connectors installed.

1.6. JP20: Selects NTSC (the two pins closest the “NTSC” marking jumpered) or PAL B/G (the two pins closest to the “PAL” marking jumpered) mode. The front panel display indicates the selected mode at power-up.

2. PC Board Adjustments

1. LCD Display Viewing Angle: While observing the LCD display, adjust VR1 until the desired result is obtained.

2. Adjustment of High Frequency Common Mode Rejection: Allow unit to warm up for 20 minutes before making this adjustment. Apply a sine wave signal of amplitude approximately 1 V_{p-p} and frequency approximately 1 MHz simultaneously to both the center and outer contacts of J1. Monitor TP4 on an oscilloscope, using a 10X probe. Connect the probe ground lead to TP8. Adjust VC1 for minimum signal. Apply the same signal to both the center and outer contacts of J3. Monitor TP6 on an oscilloscope, using a 10X probe. Connect the probe ground lead to TP8. Adjust VC2 for minimum signal.

3. Adjustment of Video A/D Converter Offsets: Allow unit to warm up for 20 minutes before making this adjustment. Apply a 0 IRE video signal to both inputs. Adjust VR2 such that U4 produces an average output word of 25 hex. Some toggling of the two lowest-order bits may be observed. The U4 output word may be observed at J17. J17 pin 8 is the MSB. U4’s convert signal may be monitored at TP36. The input signal is sampled at the falling edge of the convert signal, and the corresponding output word becomes available after a rising edge of the convert signal, delayed by 2 ½ convert signal cycles. Accuracy of the adjustment will be highest if samples taken near the end of a video line are used, since significant low-pass filtering is present ahead of U4. Similarly, adjust VR4 such that U15 produces an average output word of 25 hex. The U15 output word may be observed at J18. J18 pin 8 is the MSB. U15’s convert signal may be monitored at TP37.

Application Note

Using the DD2100 Video Delay Detector with Video Production Switchers

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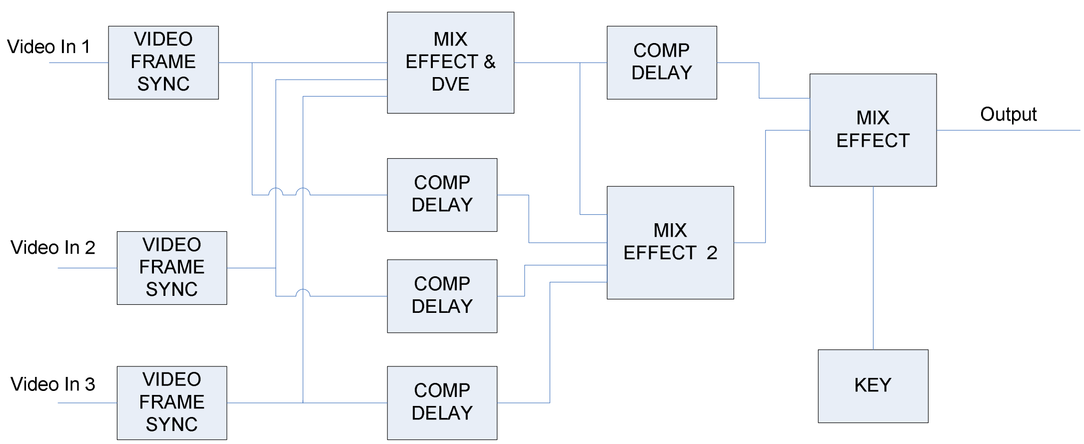
June 8, 1995

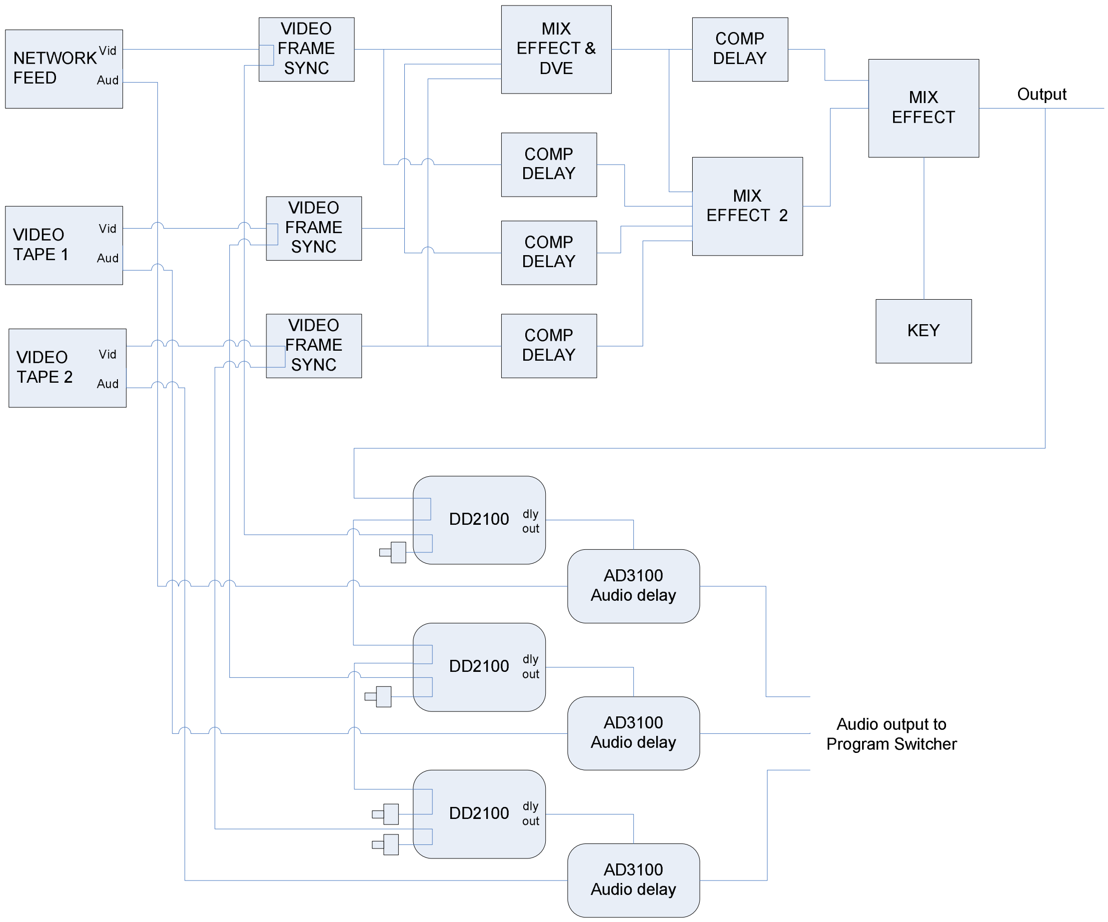
As the cost of digital video processing decreases it becomes possible to integrate devices such as video frame synchronizers, noise reducers, color correctors, and digital effects to produce high performance and cost effective production switchers and systems. A typical system might look like this block diagram:



Since many switchers integrate video frame synchronizers in their inputs, a variable video delay which ranges from almost none to one frame is added to the video. In addition, many DVE circuits add an additional delay of one frame, and this delay is changed as the DVE is switched in and out of operation. It is not uncommon for this production systems to add variable delays to the video which range from a few hundred miliseconds to over 4 frames, depending on the path the video signal takes through the switcher.

Obviously, a delay of 4 frames will create a lip-sync problem. Even delays of 1 frame can be noticeable and will detract from the program quality. In order to prevent this problem, the audio program which is associated with the video signal being output from the production system must be delayed to match the video delay, but how is it to be accomplished when the delay is constantly changing?

When a typical video production installation is analyzed, it will often be the case that there is a separate audio source associated with each video input. For example, Video 1 might be a network feed from a satellite and Video 2 and Video 3 might be from two VTRs. It is important that as each video is passed through the production switcher that its corresponding audio be delayed to match the video delay. This can be accomplished by using DD2100 to measure the delay and the AD2100 or AD3100 to delay the audio. A diagram of a production systems that meets this need is shown below:



As can be seen from this diagram, each video input is coupled to the undelayed input of DD2100 delay detector, with the output of the production switcher coupled to the delayed inputs of all of the DD2100s. The delay detector can then measure the delay of each video signal and provide a steering signal to companion audio synchronizer.

For example, when the network video signal is selected by the video switcher, the #1 DD2100 will compare the undelayed network video which is input to the switcher to the delayed network video which is output from the switcher. The DD2100 compares the two video signals with a powerful correlation technique to measure the delay between them. The delay steering pulse from the #1 DD2100 delay detector then causes the companion audio synchronizer to delay the network audio by the matching amount. The delayed network audio is then passed on to the program switcher where is selected and sent on to the transmitter or recording tape machine.

Similarly, when VTR1 or VTR2 is selected, its corresponding audio from that source is delayed by the proper amount.

The operation of the DD2100 is specifically designed for applications such as these, and has several design enhancements which make it highly desirable for such use.

Some of the questions which frequently come to mind are answered below:

QUESTION: What happens when the video delay undergoes an instant change, such as when the DVE is switched in, or when the input video synchronizer undergoes a pointer crossing?

ANSWER: Instant delay changes, especially pointer crossings in four field synchronizers, can cause delay changes up to 66ms. This large change places a difficult burden on the audio synchronizer since it must acquire the new delay value without losing audio, causing pops and clicks or pitch artifacts. Older types of audio synchronizers handled the problem by simply jumping to the new delay value in small1ms or so steps, but this created pops and clicks. Fortunately these artifacts only lasted for a few seconds, at best and up to a minute in extreme instances.

All pre 1995 audio synchronizers controlled pitch artifacts by combinations of limiting the rate of delay change and/or making changes during silence periods. As a consequence of this action, when rapid or instant video delay changes occurred, the audio synchronizer would take several seconds to chase the new delay. If the audio program contained music or other continuous audio, this slowed the rate of change so that it could take a few minutes for the audio synchronizer to catch up to the new delay. During that period of time the lip sync would be out by a noticeable amount.

The AD3100 has a pitch correction circuit which makes it capable of making delay changes of over 2 frames in under 1 second without any missing audio, pops, clicks, pitch change or other artifacts. This capability allows extremely fast response to instant changes, keeping audio in sync at all times.

QUESTION: What if there are video feeds from character generators or other sources when no delay is needed?

ANSWER: There is a two wire remote control dump which forces the delay to zero. This can be wired to the tally system, or other switch contacts to provide this capability.

QUESTION: What happens to the DD2100 when it does not have the same video present at the delayed and un-delayed inputs?

ANSWER: In this instance, the DD2100 instantly recognizes that there is no correlation at all between the two video signals, and the delay output is held at the last valid value. This value is held until the DD2100 senses matching delayed and undelayed video signals again at which time it again calculates the proper delay.

QUESTION: What happens if a color corrector, noise reducer or proc amp is switched into the production system to make video corrections?

ANSWER: As long as the delayed video signal is reasonably similar to the input video signal, the DD2100 correlation is capable of determining the delay. Changes to the delayed video such as noise reduction, color correction, hue, saturation, luma gain and luma offset frequently have no negative effect on the correlation capability of the DD2100.

QUESTION: What happens if a key or matt is created in the delayed video?

ANSWER: Again, as long as the delayed video signal is similar to the input video signal, the DD2100 correlation is capable of determining the delay. Normal keying & matting of station logos and titles frequently have no negative effect on the correlation capability of the DD2100.

QUESTION: What happens when the video signal is altered by rotation or other special effects?

ANSWER: Effects which spatially alter the video, such as rotations, flips and compression are detected as gross changes to the video and the last valid delay value before the effect is held by the DD2100 until the video returns to its normal state. It might be noted here that such gross changes rarely last for more than a few seconds and the change of video delay during that time is usually quite small. In addition, it is difficult for viewers to detect any lip sync error on video images which have experienced these effects.

QUESTION: Will the DD2100 operate with live camera feeds that are chroma keyed, such as with a weather caster which is chroma keyed over a weather map?

ANSWER: With effects such as chroma keys the DD2100 is capable of detecting delays providing a significant portion of the undelayed signal is keyed into the delayed signal. If it is desired to guarantee operation of the DD2100 under all key conditions, such as when only a small amount of the undelayed video is keyed into the delayed video, it is suggested to use a switcher ME output or a preview output which is upstream of the chroma keyer and the delayed video input to the DD2100. If necessary, a fixed offset can be added to the AD3100 to compensate for any delay which the chroma key adds to the video, however chroma key delays are usually very small.

QUESTION: Why can't one delay detector be used for all the video signals?

ANSWER: Each video signal is asynchronous, and undergoes a unique delay in its frame synchronizer. Consequently, a delay detector is needed for each source. It is however possible to lock a single AD3100 to a tally driven delay pulse generator to compensate for the average delay of each video signal through the production system.