SKeyeSPY Data Insertion/Extraction Analog Theory of Operation

I. Data Insertion

Overview:
This circuit is designed to selectively add an offset voltage to the video
waveform. The external agent that is attempting to place the data on the video
signal is responsible for determining the appropriate place to add the data. The
expected data insertion location is in the vertical retrace interval at the end
of each video field.

Circuit Components:

A.) Power Supply Connections: This circuit expects the following power
connections:
        Vop   12V
        Vcc   5V
        GND   Common ground for 12V and 5V supplies.

B.) Video Input: Resistor R100 is a 75 ohm termination to match the
output/cable of the camera transmission line. Capacitor C101 is used to block
any DC offset on the video signal.

C.) Video Signal DC Shift: Resistor R103 is used to shift and center the video
signal around 5V.

Typically the video signal peak-to-peak (p-p) amplitude will be between 1V and
2V. Since the DC voltage was stripped off the video signal using C101, portions
of the video signal will be negative (relative to the circuit gnd). Op-amp U102
will not operate correctly if the voltage on the "+" input is outside it's
"common-mode" voltage range. On this particular component (CLC430), the common
mode range is [(neg_supply+2.7V) -> (pos_supply-2.7V)] or [2.7V -> 9.3V when
powered from +12V]. Centering the video waveform around 5V should keep the
entire video signal in the common mode voltage range.

D.) Offset Voltage Generation: Op-amp U101 is a fixed voltage supply that is
selectively enabled or disabled by N-channel transistor Q100. The voltage that
this supply generates is dependent on potentiometer R106. The voltage should be
initially set to approximately 0.5V (potentiometer ~ 1K). The data that is
riding on the video signal will switch between this voltage and black level
voltage.

When transistor Q100 is on, Op-amp U101 is disabled. This means that the "-"
input and the output of the amplifier are high impedance. To turn on transistor
Q1, a logic high voltage (> 4V) must be applied to it's input (gate).

_Data_in   Offset Power supply
    0   On
    1   Disabled

E.) Video Signal Summing Junction: Op-amp U102 acts as an analog adder. When
the offset voltage generation is disabled, Op-amp U102 passes the video signal
without modification. When the offset voltage generation is enabled, the offset
voltage is added to the video signal.

F.) Video Output: R111 provides the appropriate 75 ohm output impedance
Capacitor C106 is used to strip the DC level from the video signal.

II. Data Extraction:

Overview:
This circuit is designed to capture the data inserted into the vertical
retrace lines of a video signal. A reference voltage is generated from the black
level and a fixed voltage that will allow a voltage comparator to distinguish
between 0 and 1. During the portions of the video signal, an amplifier can be
enabled that passes the black level voltage to effectively strip the data from
the waveform.

Circuit Components:

A.) Power Supply Connections: This circuit expects the following power
connections:
        Vop   12V
        Vcc   5V
        GND   Common ground for 12V and 5V supplies.

B.) Video Input: Resistor R200 is a 75 ohm termination to match the output/cable
of the camera transmission line. Capacitor C201 is used to block any DC offset
on the video signal.

C.) Video Signal DC Shift: Resistor R201 is used to shift and center the video
signal around 5V.

D.) Black Level Capture: Op-amp U201 is used to capture the voltage level of
"reference black" on capacitors C205 and C206. The capacitors will need to be
re-
charged for each video line due to the relatively high input offset current of
U203 and U204.

Transistor Q200 controls the black level sampling. Applying a logic 0 to the
gate of Q200 causes U201 to turn on and charge the capture caps.

_Capture_Black_Level   U201 Output
    0   On
    1   Off

It is recommended that _Capture_Black_Level is asserted for at least 5uS to
fully
charge the capacitors. This means that no data should be inserted in the first
5uS of the 59.5uS line interval. _Capture_Black_Level should be asserted during
this time.

E.) Offset Voltage Generation: The bit sampling level is generated in a very
similar fashion to the insertion circuit. Op-amp U202 is a fixed supply that is
used to generate the level. This level should be 0.5 of the level that the data
was inserted or approx. 0.25V. This voltage can be adjusted using potentiometer
R207. Initially set the potentiometer to 526 ohms.

Op-amp U203 adds the offset voltage to the black level. This provides the
reference voltage that will be used by the comparator U206 to determine when
the data on the video signal is logic high or logic low.

F.) Data Comparator: Comparator U206 takes the video signal and the data
reference voltage (black level + 0.5*max_high_voltage) as inputs. The comparator
has an open-collector output that is asserted (pulled low) when the video signal

is greater than the reference.

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Video Signal > reference      Data_out = 0;
Video Signal < reference      Data_out = 1;
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G.) Video Signal Cleanup: Op-amp U204 is used to pass the black level to VIDEO_OUT during the video lines that include data. This will insure that no data artifacts are displayed during the vertical retrace. Op-amp U205 is used to pass the video signal during all time where U204 is not enabled.

Transistors Q201, Q202, and Q203 control which Op-amp (U204/U205) is enabled. Signal SCRUB_DATA_FROM_VIDEO is used to enable the appropriate transistors.

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SCRUB_DATA_FROM_VIDEO           SIGNAL PASSED
        0                   Normal Video Signal
        1                       Black Level
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F.) Video Output: R216 and R217 provide the appropriate 75 ohm output impedance. Capacitor C210 is used to strip the DC level from the video signal.