Using the GT4123 & GT4123A
Video Mixer ICs

by Ian Ridpath, Senior Applications Eng., Video & Broadcast Group

APPLICATION NOTE

DEVICE DESCRIPTION

The GT4123 and GT4123A are the first dedicated single device, two input video mixer ICs available to the professional video and multimedia markets.

The internal topology of the devices is shown in Figure 1.

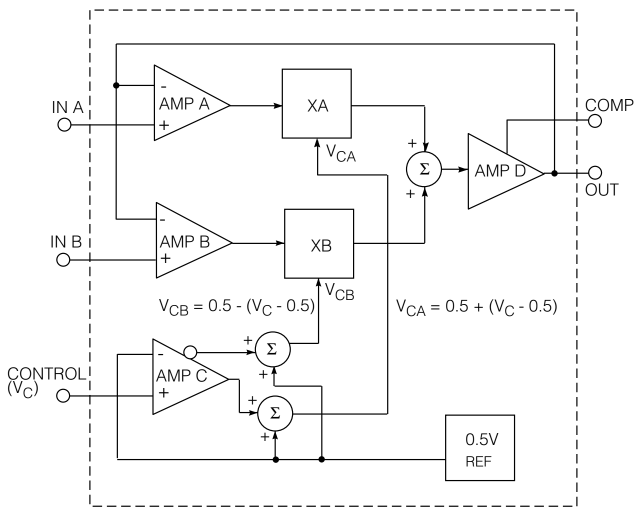


Fig. 1 Functional Block Diagram of the GT4123 and GT4123A

Each input signal is applied to a conventional differential amplifier (AMP A and AMP B). From the amplifiers, the signals are applied to analog multiplier circuits (XA and XB) whose outputs are the product of the input signals and internally generated controlling voltages V_{CA} and V_{CB}.

These voltages are derived from a unity gain differential amplifier (AMP C) whose outputs (true and invert) are the difference between an externally applied CONTROL voltage (V_C) and an internal 0.5 volt reference voltage. In addition, the internal DC offset of 0.5 volts is applied to the controlling voltages.

Therefore,

$$V_{CA} = 0.5V + (VC - 0.5V) \text{ and}$$

$$V_{CB} = 0.5V - (VC - 0.5V)$$

When the CONTROL input (V_C) equals 0.5 volts, V_{CA} and V_{CB} = 0.5 volts and exactly 50% of each input signal passes to the output of the multiplier stages.

When V_C is less than 0.5 volts, V_{CA} reduces and V_{CB} increases in proportion so that less of the Channel A signal and more of the Channel B signal is transferred. Similarly, when V_C is greater than 0.5 volts, the opposite occurs.

The SPAN or control range is internally set so that a CONTROL voltage of 0 volts completely cuts off Channel A and fully turns on Channel B. Similarly, a CONTROL voltage of 1 volt will fully turn on Channel A and completely turn Channel B off.

Figure 2 shows the CONTROL transfer characteristics of the GT4123 and GT4123A.

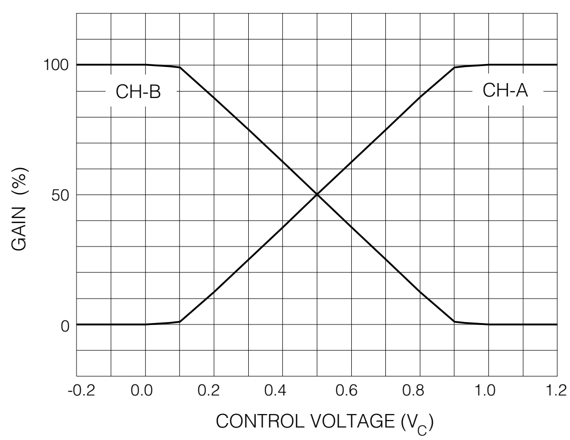


Fig. 2 Control Law

There is a small ‘dead band’ at either extreme of the CONTROL input. The amount of ‘dead band’ is about 100 mV and is shown in Figure 2. The CONTROL input can be preceded by an operational amplifier so biased as to overcome this ‘dead band’ as well as level shift the control signal so that other than 0 to 1 volt ranges can be used. The bandwidth of the CONTROL input is sufficient to allow very fast keying and is in the order of 20 MHz at -0.1 dB.

The linear portion of the transfer characteristic has a linearity of 1% or better.

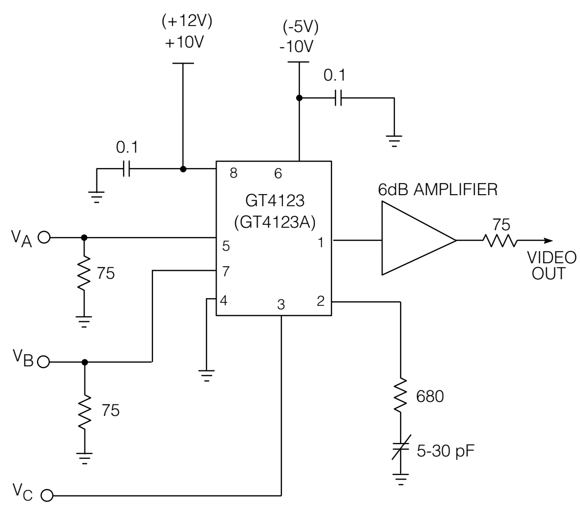
Referring again to Figure 1, the outputs from the multipliers are applied to an analog summing circuit (Σ) whose output feeds a wideband amplifier and presents the mixed signals to the outside world. The non-inverting inputs of each input amplifier are directly connected to the output.

In this manner the closed loop gain is nearly unity providing wideband, stable operation. Because the devices have only 8 pins and require virtually no external parts in order to function, they lend themselves to high density, multi-functional PC board layouts. Several devices can be used in parallel applications such as R-G-B mixers and four-layer keyers where close control law tracking is essential.

The only difference between the GT4123 and the GT4123A is the fact that the latter device can operate with non-equal power supplies. The negative supply can be as low as -3 volts unlike the GT4123 which can only operate down to ±9 volt supplies.

TEST SET-UP and MEASUREMENTS

Figure 3 shows a typical set up of a single device.



All resistors in ohms, all capacitors in microfarads unless otherwise stated

Fig. 3. GT4123A Test Set Up

The amplifier shown is only necessary when driving low impedance loads such as coaxial cables. For some applications the inputs can be driven directly from 75 Ω cables using suitable terminating resistors. For other applications the inputs can be preceded with clamp circuits such as the GB4550 sync-tip clamp or the GB4551 back-porch clamp. Both of these devices are manufactured by GENNUM.

In this case, the 75 Ω input resistors are not necessary.

The test circuit can be used to verify such parameters as frequency response, differential gain and differential phase, crossfade balance and channel to channel isolation (crosstalk). In the case of differential gain and differential phase, the output of the GT4123 must be AC coupled to the amplifier. A capacitor of 0.1 µF is suitable.

Crossfade balance is measured by grounding both the V INA and V INB inputs and applying a 1 volt peak to peak signal to the CONTROL input. This signal must have a 0.5V DC offset. The frequency is then varied across the band of interest. If there was a perfect balance between both signal channels, then the output would remain at zero volts with only a small amount of noise present. Typically the output of the GT4123 remains at least 45 dB below 1 volt up to the colorburst frequency.

Pin 2 of the GT4123A is a FREQUENCY COMPENSATION pin and is used to tailor the frequency response of the IC. A 680 Ω resistor in series with a small trimmer capacitor of about 5 to 25 pF is all that is needed.

Figure 4 shows the effect on the frequency response of varying the COMPENSATING capacitor over its range.

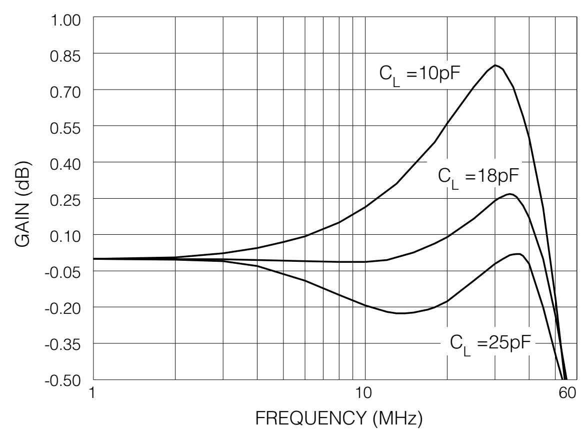


Fig. 4 Effect of C_{COMP} on the Frequency Response (10 mV Overdrive)

The frequency response is also dependant upon the load capacitance that the OUTPUT sees. In many applications the OUTPUT will be feeding an opamp or another GT4123A. The load capacitance will normally be made up of stray capacitance and should not exceed 22 pF.

With proper adjustment of the COMPENSATION circuit, in conjunction with a nominal load capacitance, a full power bandwidth (-3 dB) of at least 15 MHz is possible. The small signal flat response (-0.1dB) will be at least 20 to 25 MHz.

APPLICATION CIRCUIT

A PC board which uses two GT4123 mixers, two GB4551 back-porch clamps and a GX4314, 4x1 video switch is available from GENNUM. This board can be used to gain experience in using these devices in a simple Effects Generator application.

Figure 5 shows the circuit of this board which contains the video signal paths but does not include the control circuitry needed to perform the various functions such as a KEY, WIPE, RAMP or FADE. These control signals are generated from other circuitry using standard logic gates, monostable multivibrators and comparators.

The two video signals (VIDEO 1 and VIDEO 2) are applied to the GB4551 back-porch clamps via 0.1 μF capacitors C1 and C2. These inputs must be suitably terminated with 75 Ω resistors. The VIDEO 2 signal must also be applied to a sync separator circuit in order to produce a negative going back-porch pulse used by the GB4551s.

The clamped output from the first GB4551 feeds the V INA input (pin 5) of the first GT4123 mixer. It is also used to drive a comparator in order to produce a luminance key signal. The V INB input (pin 7) of this mixer is fed from the second GB4551. Both of these clamped video signals are applied to inputs of the GX4314, 4x1 video switch.

By linearly varying the voltage on pin 3 of the GT4123, a smooth A/B mix can be achieved and a resultant signal appears at the output (pin 1). The voltage on pin 3 can also be controlled by a chroma or luminance key signal or by an appropriate horizontal or vertical wipe waveform.

The only restriction on the control signal is that the peak to peak amplitude should be 1 volt centred around 0.5 volts.

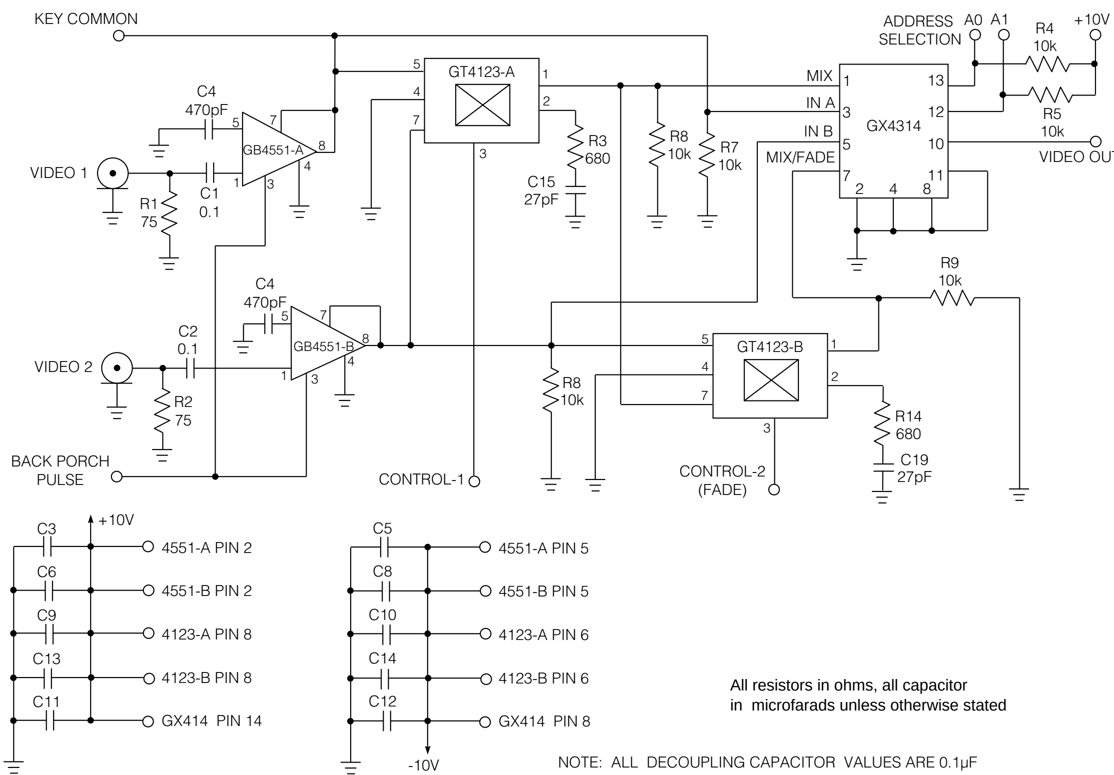


Fig. 5 Video Mixer Board - Circuit Diagram

The mixed video signal from the first GT4123 is also applied to the 4x1 video switch (GX4314) as well as to the V INA input (pin 5) of a second GT4123. The V INB input (pin 7) of this second GT4123 is fed from the output of the second GB4551.

This set up allows the mixing of the already mixed video signals with the VIDEO 2 signal itself. For example, when the control voltage on pin 3 of this GT4123 is zero volts, 100% of VIDEO 2 is present at the output. When the control voltage is one volt, 100% of the already keyed, wiped or ramped signal appears at the output.

By linearly ramping this voltage between zero and one volt, a clean FADE function can be achieved.

This new signal is also applied to the 4x1 video switch. The VIDEO OUTPUT from the board can thus be switched to VIDEO 1 alone, VIDEO 2 alone, VIDEO (1+2) or lastly, VIDEO (1+2)+2.

The inputs are selected by applying binary codes from 00 to 11 on the address pins 12 and 13.

Figure 6 shows one possible method of generating HORIZONTAL and VERTICAL WIPE waveforms which can be applied to the first GT4123.

The HORIZONTAL and VERTICAL WIPE circuit consists of two 74123 dual-retriggerable monostable multivibrators and four 7400-NAND gates. The horizontal monostable (74123-H) is triggered from a composite sync signal generated by the sync separator.

The start and stop timing is controlled by two potentiometers R23 and R27. The NAND gate (7400- A) combines the output pulses to provide the HORIZONTAL WIPE waveform.

In a similar manner, a second monostable (74123-V) is triggered from the vertical sync. The start and stop timing is again controlled by two potentiometers (R31 and R33). A second NAND gate (7400-B) combines the pulses to produce the VERTICAL WIPE waveform.

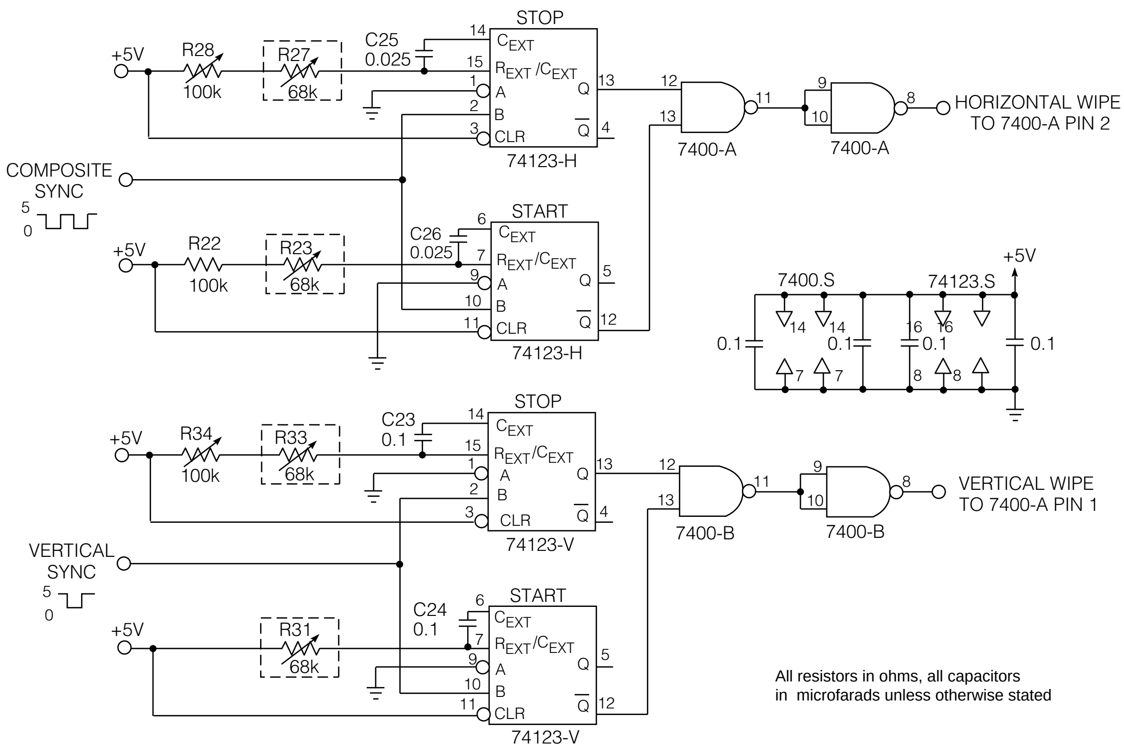


Fig. 6 Horizontal and Vertical Wipe Circuit

Figure 7 shows one method of generating the KEY and FADE control signals.

The circuit consists of a high speed comparator (LM710) whose output is gated through the 7408 AND gate to produce the KEY signal.

The HORIZONTAL WIPE and VERTICAL WIPE signals from the circuit in Figure 6, are combined and gated using the 7400 NAND and 7408 AND circuits.

In order to produce a linear RAMP function, a discrete ramp generator is made up of transistors Q1 through Q4.

The ramp generator is triggered by the vertical sync. In order to DC restore the ramp, a GB4550 DC Restorer is used. This device is available from GENNUM.

All the controlling signals are individually adjusted to have a range of zero to one volt and are selected by a 4-way MODE SELECT SWITCH. The FADE control is a simple potentiometer connected to a regulated supply.

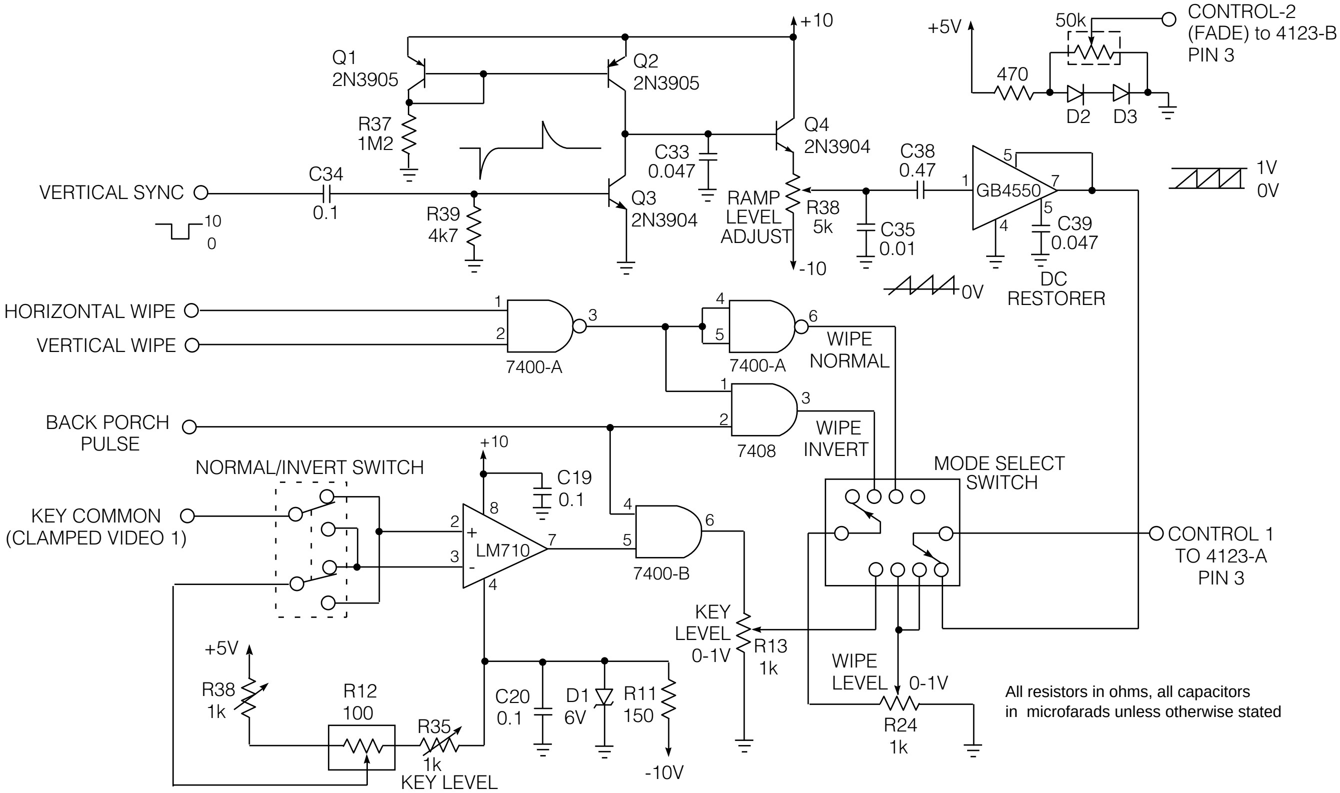


Fig. 7 Key and Fade Generator Circuit

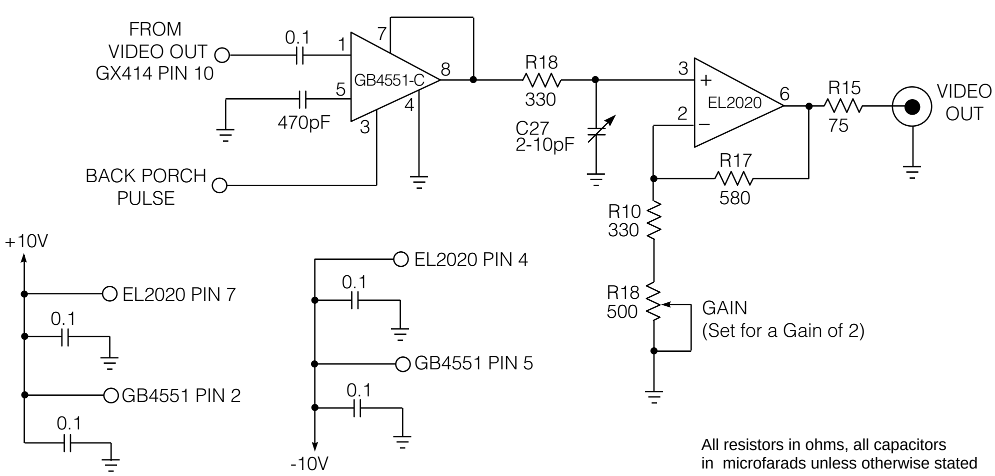


Fig. 8 Output Clamp and Driver Circuit

In order to drive a co-axial cable, a suitable cable driver circuit must be used. Figure 8 shows an EL-2020 amplifier being fed from a GB4551 back-porch clamp. The input of the clamp comes from the GX4314, 4x1 video switch on the video mixer board.

In this way, the resulting VIDEO OUTPUT is accurately clamped to the black level.

The combination of the video mixer board, the WIPE, KEY, FADE and RAMP circuits and the output driver circuit produce a simple Effects Generator that can be used to evaluate the GT4123 video mixer IC.