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AN-42041

5th-Order S-Video Filter/Driver Reduces NTSC/PAL System Parts Count

Introduction

The FMS6400 IC is an 8-pin, SOIC, 5th-order, dual video filter designed to replace bulky discrete passive filters (Figure 1) or the handful of video integrated circuits commonly required to properly reconstruct DAC-generated video signals.

The FMS6400 operates from a single +5V ± 5% supply. In addition to Y/C filtering of DAC outputs, the FMS6400 contains circuitry for sync tip clamping and restoration. Further, the filters internally sum the luma and chroma channels, providing a third filtered output: the composite video signal.

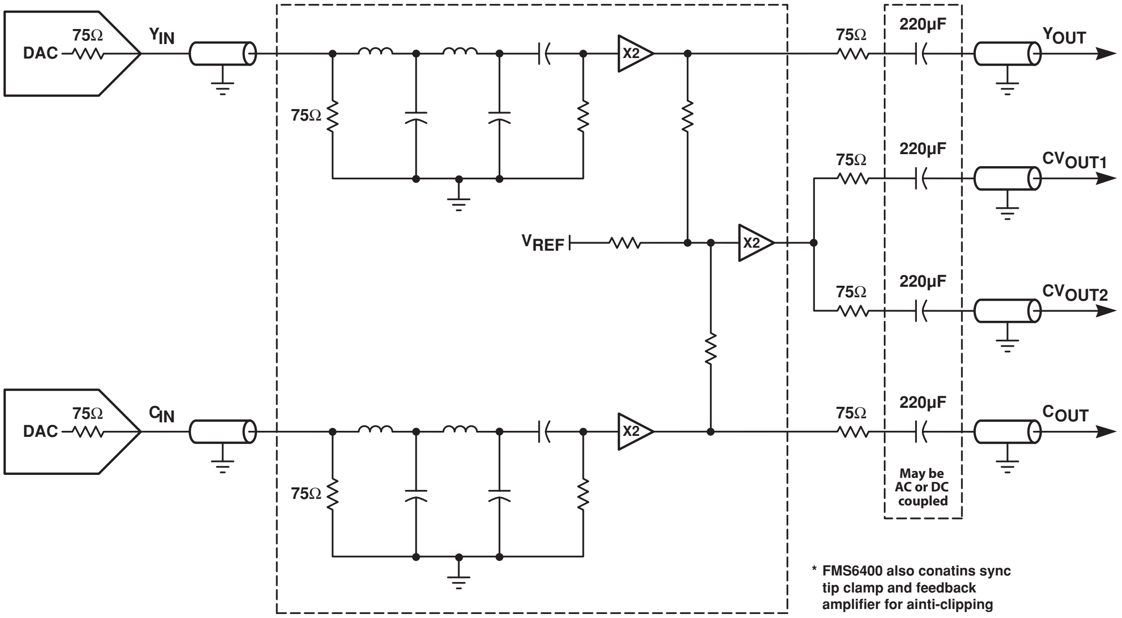
The FMS6400 is designed for AC- or DC-coupled output applications, but requires capacitive coupling (0.1µF) of the input signals. All output channels are fully buffered, capable of driving $2V_{pp}$ into a 150Ω load or $1V_{pp}$ into a 75Ω load. The FMS6400 also offers gain selections of 0dB or 6dB. This provides flexibility to drive directly into an ADC, limiting the number of discrete components. The FMS6400 is fully protected from load shorting, providing the maximum junction temperature of the part is not exceeded, and may drive two separate loads each.

This application note contains performance results and design information collected from an FMS6400 design utilizing a four-layer PC board. The schematic of the board used to evaluate this device is shown in Figure 9.

Application Board Testing

Test Equipment

- One power supply: 5V ±10%, 200mA maximum
- One 14-inch (or larger), high-resolution CRT monitor: Sony PVM-14M2U
- One Y/C video signal source: JVC HR-S7100UV VCR set for "Live Feed" from a local television station
- One HP 3577A network analyzer
- One Tektronix TDS640A oscilloscope
- One FMS6400 demo board
- Assorted video cables



* FMS6400 also conatins sync tip clamp and feedback amplifier for ainti-clipping

Figure 1. S-Video Filter Discrete Solution

Procedure

Do not turn the power supply on until all connections shown in Figure 2 are completed.

1. Set the power supply to 0V. Connect the power supply to the FMS6400 Demo Board.

NOTE:
Use the shortest possible cables (50Ω or 75Ω) for all the following video connections.

2. Connect the video source "S-Video Out" to the "Y_{IN}" and "C_{IN}" connectors on the demo board.
3. Connect "Y_{OUT}" and "C_{OUT}" from the test board to S-Video input of the monitor.
4. Connect "CV_{OUT}" from the test board to line A of the monitor.
5. Adjust the input voltage to 5V. Verify that the test board is not drawing excessive current (≤75mA).
6. Apply the video test signal to the test board. A high-quality image should appear on the monitor screen.

NOTE:
It may be necessary to connect the video test signal directly into Line C of the monitor to ensure the test signal is present and of high quality.

7. Switch the monitor input to line A (Y and C_{OUT}).
8. Note the effect of the filter action on the video signal.
9. Switch the monitor input to Line B (CV_{OUT}).
10. Note the effect of the filter action on the video signal.

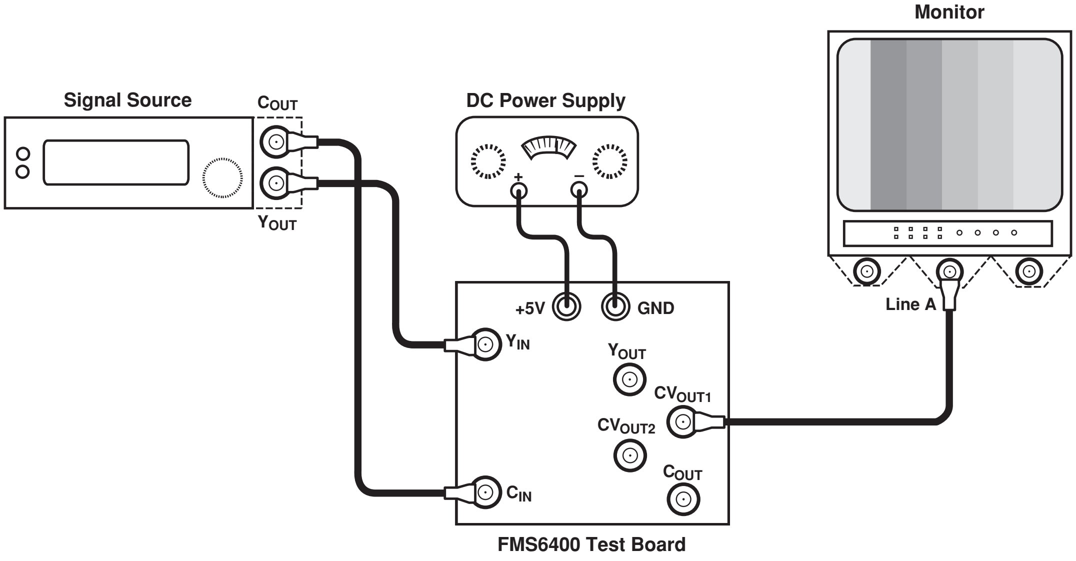


Figure 2. Connection Diagram

Results

The Bode plot in Figure 3 is a non-subjective measure of the FMS6400 filtering action. A network analyzer was connected to either input channel with a 200mV RMS test signal and a plot was made of the frequency response of output vs. input. The resulting amplitude vs. frequency plot demonstrates the accuracy of the FMS6400 regarding flatness of response: 3dB (cutoff) point at 7.1MHz and linear 50dB/decade rolloff above cutoff.

Time domain measurements are shown in Figures 4 and 5. Note the filtering action performed on the 'choppy' DAC input signal. The video signal was a standard color-bar pattern. The luma channel (Figure 4) contains the video signal amplitude, while the chroma channel (Figure 5) carries the color information. Note that the D/A artifacts are reduced by at least a factor of 10. Though not shown, the composite output is the filtered arithmetic sum of the luma and chroma channels.

Figure 6 illustrates applications where the video signal is undersampled or requires a steeper rolloff. Two filters are cascaded for a 160dB/decade rolloff. Note the use of 150Ω termination resistors on U1's output (Figure 7). This is done to reduce the loading on U1 and preserve the DC restoration capability of U2. Do not increase the termination resistor values above 240Ω. If the resistor values are increased, decrease the series capacitors proportionately. This cascading technique can be used with additional filters to obtain even steeper rolloffs with minimal effect on the -3dB point.

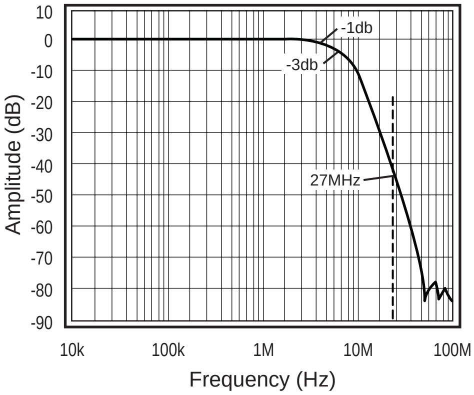


Figure 3. FMS6400 Bode Plot

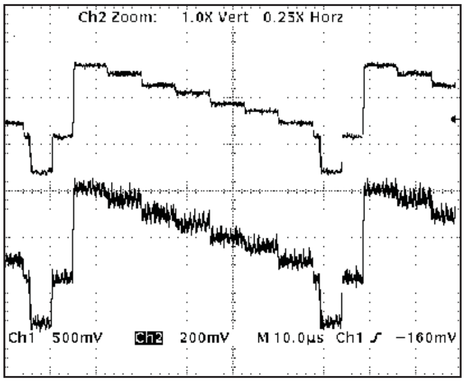


Figure 4. Luma Channel Filtering

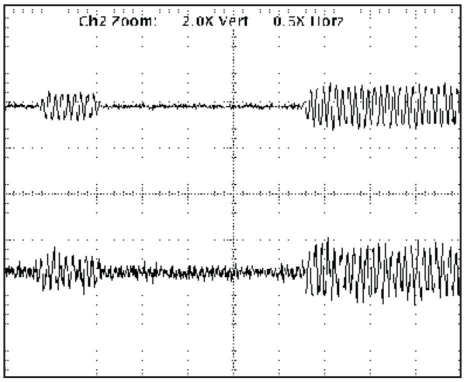


Figure 5. Chroma Channel Filtering

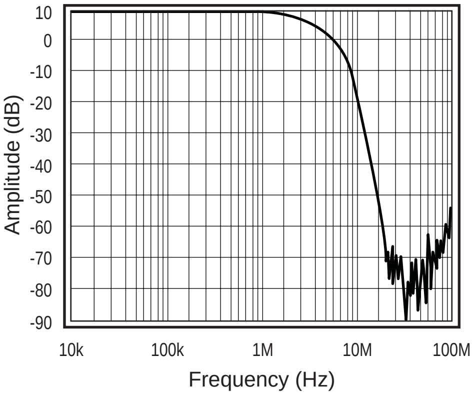


Figure 6. FMS6400 Bode Plot (2 Parts Cascaded)

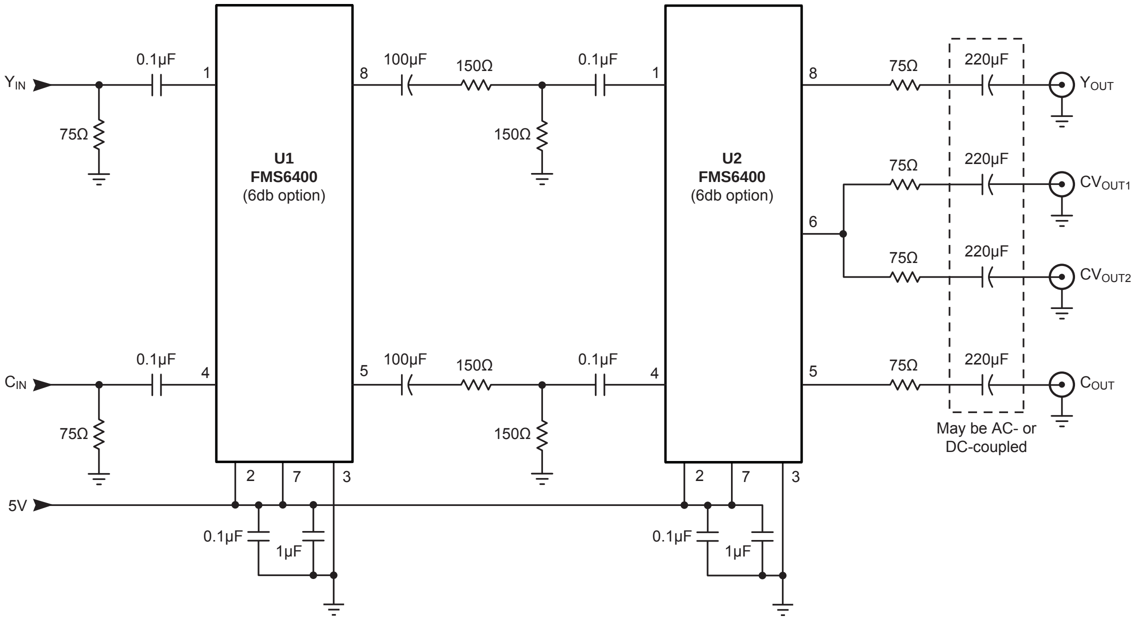


Figure 7. Cascading Two FMS6400s with 6dB Gain for Increased Filtering

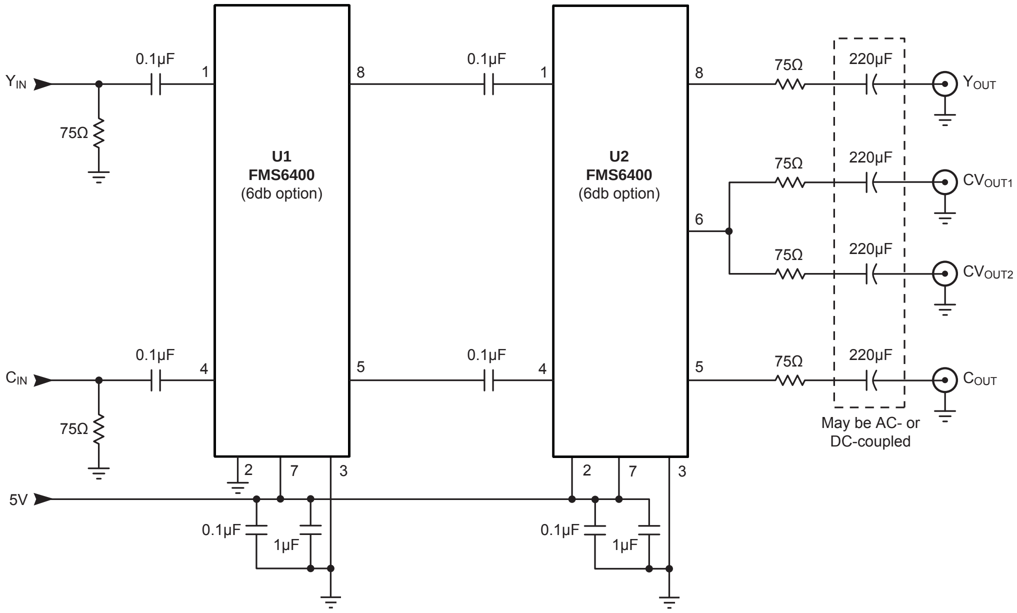


Figure 8. Cascading Two FMS6400s, 1- 0dB and 1 – 6dB Gain for Increased Filtering

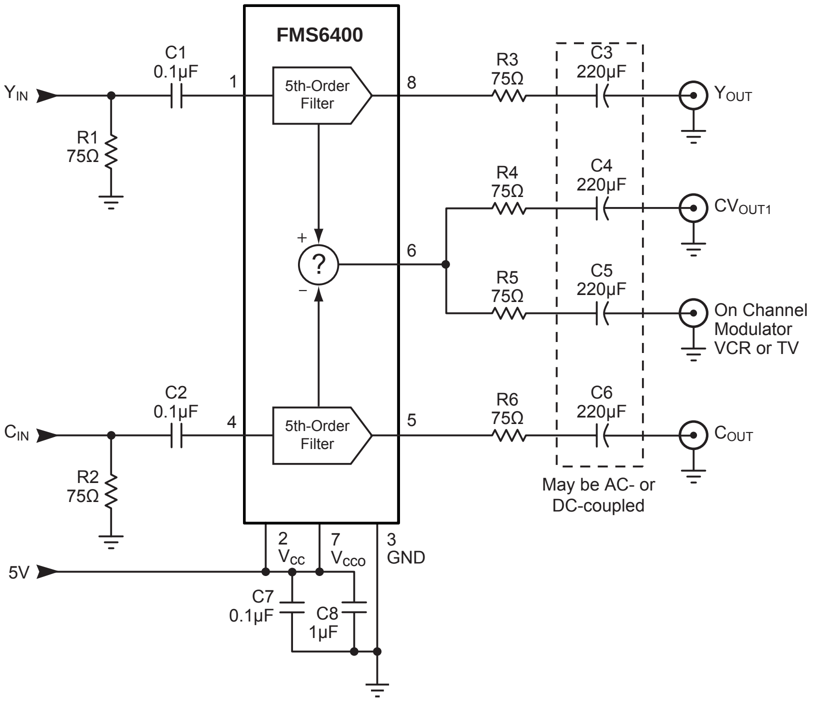


Figure 9. FMS6400 Typical Application Schematic

Comments and Precautions

Figure 9 is the FMS6400 test board schematic.

A PC board similar to the test board may be used for system evaluation, providing the size of the board allows for low-noise connections. The video and power connectors can be removed and direct solder connections made to the board.

Capacitors C3 through C6 were specified as tantalum because of their low-parasitic elements (ESR, ESL). High-grade, low-ESR electrolytic capacitors may be substituted with no loss in performance. Use care in choosing these capacitors to ensure the ESR is both low and guaranteed. As with tantalums, observe polarity when installing in the circuit.

The values of input capacitors C1 and C2 are optimized for the method in which the FMS6400 restores the sync information. Changing these values has an effect on the amount of ‘tilt’ on the luma channel only.

Conclusion

Video systems design engineers now have an inexpensive and space-efficient solution for filtering video signals. The existing passive discrete and active solutions are no longer viable because cost and physical space limitations top the list of priorities in new and revamped designs. The FMS6400 presents a turnkey solution to the challenge of designing a system that not only performs according to specification, but also comes in well below cost and space goals.