250MHz RGB Video Multiplexer in Space-Saving Package Drives Cables, Switches Pixels at 100MHz

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Introduction

One of the first products from LTC's new proprietary high speed bipolar process is a 250MHz RGB (red, green, blue) multiplexer that is optimized for switching speed and makes excellent use of the new complementary 6GHz transistors. This new MUX, the LT1675, is designed for pixel switching in video graphics and for RGB routing. It is configured with three SPDT (single pole, double throw) RGB video switches and three current feedback amplifiers for direct driving of cables.

The new RGB MUX is similar to the LT1203/LT1205 video switches combined with the LT1260 triple CFA, but with greatly enhanced performance in far less space. The boost over the older configuration is a factor of five in switching speed and a factor of 2.5 in bandwidth, while the PCB footprint is reduced by more than five. This "juiced" performance is accomplished with one-third less supply current than required by the equivalent multichip design.

Dense Process Yields Big Performance from Tiny PC Board Space

One advantage of the dense, high speed bipolar process is that it results in a reduced die size for the LT1675, even though it has well over 300 active devices. The benefit to the user is that the LT1675 comes in a small 16-pin SSOP package, which is the same size as an SO-8. To enhance the small PC board theme, the LT1675 is configured for a fixed gain of two, eliminating six external gain setting resistors. The fixed gain of two in the CFA is ideal for driving double terminated 50Ω or 75Ω cables. Additionally, stray PCB capacitance on the sensitive feedback node is no longer a problem. Figure 1 shows a typical application switching between two RGB sources and driving 75Ω cables. In contrast, some competitive solutions are housed in bulky 24-pin, wide-SO packages and draw significantly more supply current.

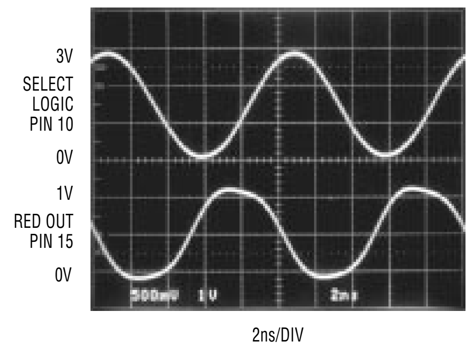

Figure 2. Select pin switches inputs at 100MHz. RED 1 = 0V, RED 2 = 1V, R_L = 100Ω, 10pF scope probe; measured between 50Ω back termination and 50Ω load

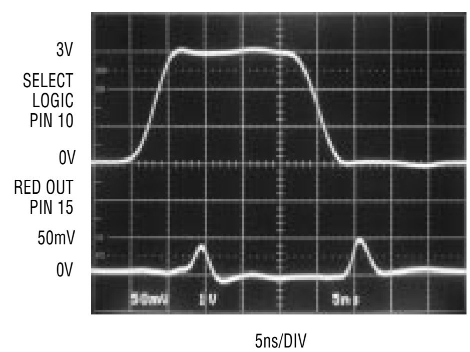

Figure 3. Input-referred switching transient. R_L = 150Ω, 10pF scope probe

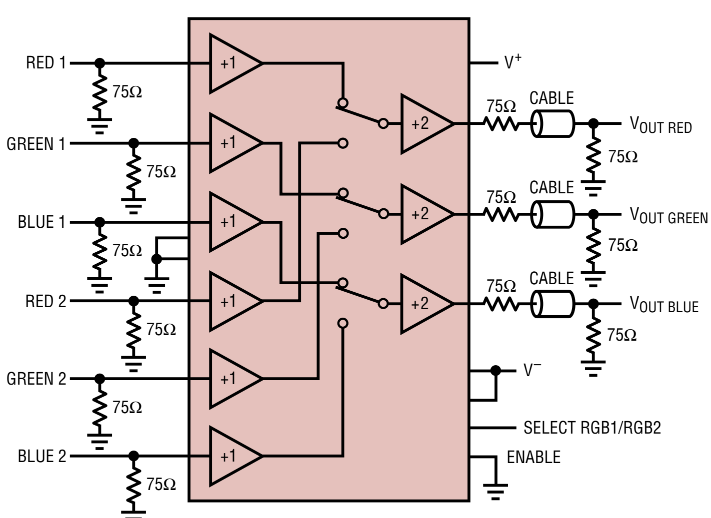

Figure 1. LT1675 typical application: switching between two RGB sources and driving three cables

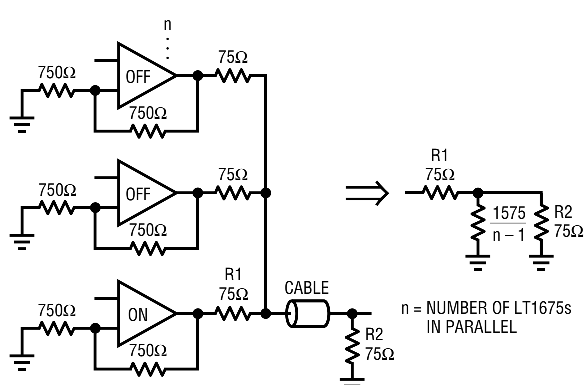

Figure 4. Each off channel loads the cable termination with the 1575Ω.

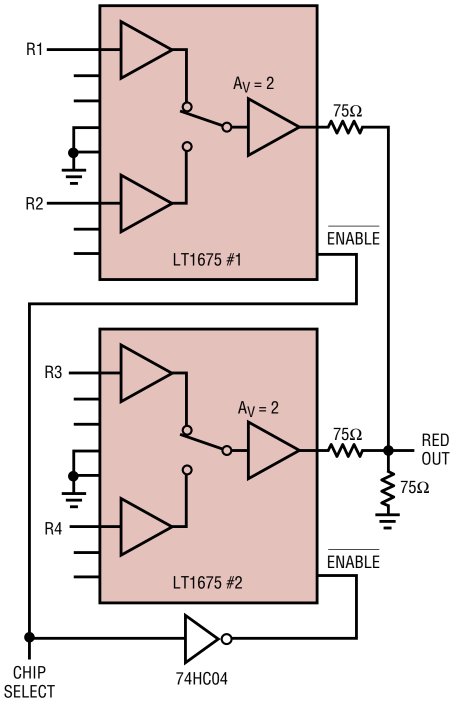

Figure 5. Two LT1675s build a 4-input RGB router.

The LT1675's internal switches change state in less than 1ns but the output of the MUX switches in 2.5ns. This increased time is due to the finite bandwidth of the current feedback amplifier that drives the cable. To toggle at 100MHz, as shown in Figure 2, implies a pixel width of 5ns; accomplishing this requires a slew rate in excess of 1000V/µs. In Figure 2, the Select pin (pin 10) is driven from a sine wave generator, since only crossings of the logic threshold are required.

The fast current steering break-before-make SPDT tee switches minimize switching glitches. The switching transients of Figure 3, measured between the 75Ω back termination and the 75Ω load, show what the monitor receives. The glitch is only 50mV$_{p\text{-}p}$, the duration is only 5ns and nature of this transient is small and fast enough to not be visible even on quality graphics terminals. Additionally, the break-before-make SPDT switch is open before the alternate channel is connected, which means there is no input feedthrough or crosstalk during switching.

Expanding Inputs Does Not Increase Power Dissipation

In video routing applications, where the ultimate in speed is not mandatory, as it is in pixel switching, it is possible to expand the number of MUX inputs by shorting the LT1675 outputs together and switching with the $\overline{\text{ENABLE}}$ pins. This technique does not increase the power dissipation because LT1675s draw virtually zero current when disabled. The internal gain-set resistors have a nominal value of 750Ω and cause a 1500Ω shunt across the 75Ω cable termination. Figure 4 shows schematically the effect of expanding the number of inputs. The effect of this loading is to cause a gain error that can be calculated by the following formula:

$$\text{GAIN ERROR (dB)} = 6\text{dB} + 20\log\left(\frac{\frac{1575\Omega}{n-1} \,\|\, 75\Omega}{75\Omega + \frac{1575\Omega}{n-1} \,\|\, 75\Omega}\right)\text{dB}$$

where n is the total number of LT1675s.

For example, using ten LT1675s (20 red, 20 green, 20 blue) the gain error is only –1.7dB per channel.

Figure 5 shows a 4-input RGB router. The response from red 1 input to red output is shown in Figure 6, for a 25MHz square wave with Chip Select = 0V. In this example, the gain error is just –0.23dB. The response to toggling between IC1 and IC2 with Chip Select is shown in Figure 7. In this case red 1 input is connected to 0V, and red 3 is connected to an uncorrelated sine wave.

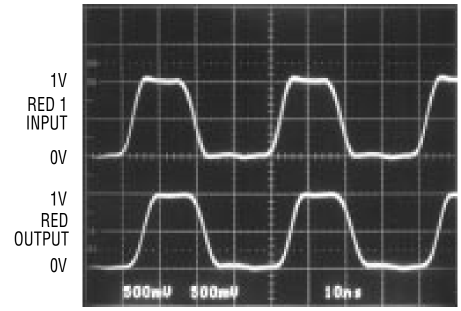

Figure 6. Square wave response: chip select = 0V, IC 2 disabled

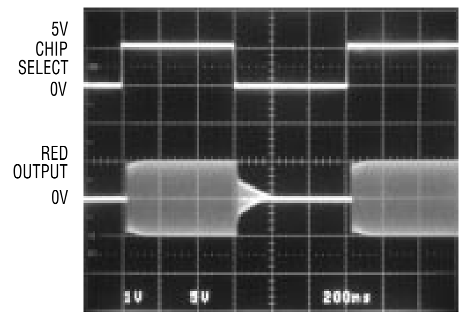

Figure 7. Toggling the 4-input router: Red 1 input = 0V; Red 3 input = uncorrelated sine wave

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Table 1. LT1675 performance, V_S = ±5V

Parameter	Conditions	Typical Values
–3dB Bandwidth	R_L = 150Ω	250MHz
0.1dB Gain Flatness	R_L = 150Ω	70MHz
Crosstalk	Between Active Channels at 10MHz	–60dB
Slew Rate	R_L = 150Ω	1100V/µs
Differential Gain	R_L = 150Ω	0.07%
Differential Phase	R_L = 150Ω	0.05°
Channel Select Time	R_L = 150Ω, V_{IN} = 1V	2.5ns
Enable Time	R_L = 150Ω	10ns
Output Voltage Swing	R_L = 150Ω	±3V
Gain Error	R_L = 150Ω, V_{IN} = ±1V	4%
Output Offset Voltage		20mV
Supply Current	All Three Channels Active	30mA
Supply Current Disabled		1µA

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Performance

Table 1 summarizes the major performance specifications of the LT1675; Figure 8 shows a graph of crosstalk.

Conclusion

By taking full advantage of LTC's new complementary high speed bipolar process, the LT1675 RGB multiplexer dramatically raises the level of performance while saving PC board space. A channel-to-channel toggle rate of 100MHz makes the LT1675 perfect for pixel switching and the simple expansion feature using the $\overline{\text{ENABLE}}$ pin is ideal for RGB routing. A fixed gain of two for driving double terminated cables simplifies PC board layout and boosts performance. These high performance multiplexers complement the large number of video products offered by LTC.

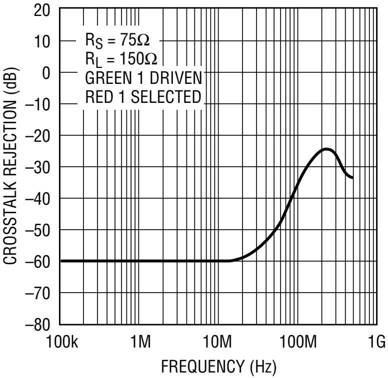

Figure 8. LT1675 crosstalk rejection vs frequency