

Simplify High-Resolution Video Designs with Fixed-Gain Triple Multiplexers

by Jon Munson

Introduction

The LT6555 and LT6556 triple video multiplexers offer up to 750MHz performance in compact packages, requiring no external gain-setting resistors to establish a gain of two or unity. A single integrated circuit, in a choice of either 24-lead SSOP or 24-contact QFN (4mm x 4mm), performs fast switching between a pair of three-channel video sources, such as RGB or component HDTV.

The LT6555 provides a built-in gain of two that is ideal for driving back-terminated cables in playback or signal routing equipment. The LT6556 provides a unity-gain function, in the same footprints, that is ideal as an input selector in high-performance video displays and projectors.

The three video channels exhibit excellent isolation between themselves (50dB typical at 100MHz) and the inactive inputs (70dB typical at 100MHz) for the highest quality video transmission. Excellent channel-to-channel gain-matching preserves high fidelity color balance.

The increasing popularity of the UXGA professional graphics format (1600 x 1200), which generates a whopping 200-megapixel-per-second flow, has put exceptional demands on the frequency response of video amplifiers. For instance, pulse-amplitude

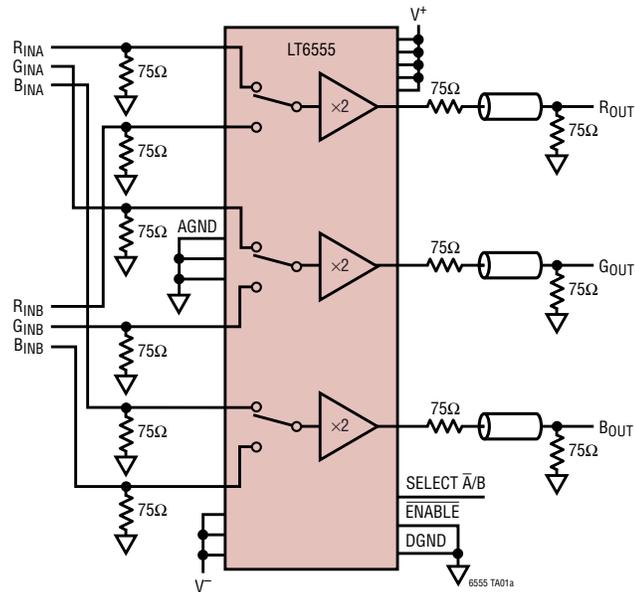


Figure 1. The LT6555 in an RGB cable driving multiplexer circuit

waveforms like those of RGB baseband video, generally require reproduction of high-frequency content to at least the 5th harmonic of the fundamental frequency component, which is 2.5 times the video pixel rate, accounting for the 2-pixels-per-fundamental-cycle relationship. This means that UXGA requires a flat frequency response to beyond 0.5GHz! The wide bandwidth performance of the LT6555 and LT6556 makes them ideally suited to such high performance video applications.

response and crosstalk anomalies can plague the circuit development process. The LT6555 and LT6556 conveniently solve these problems by providing internal factory-matched resistors and an efficient 3-channel, 2-input group, flow-through layout arrangement.

Figure 1 shows the typical RGB cable driver application of an LT6555, and its excellent frequency and time response plots are shown in Figures 2 and 3 (as implemented on demo

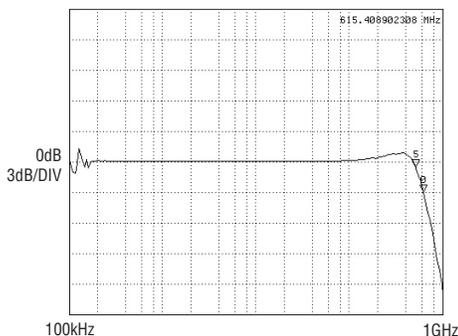


Figure 2. Wide frequency response of circuit in Figure 1

Easy Solution for Multi-Channel Video Applications

Baseband video generated at these higher rates is processed in either native red, green and blue (RGB) domain or encoded into component luma plus blue and red chroma channels (YPbPr); three channels of information in either case. With frequency response requirements extending to beyond 500MHz, amplifier layouts that require external resistors for gain setting tend to be real-estate inefficient, and frequency

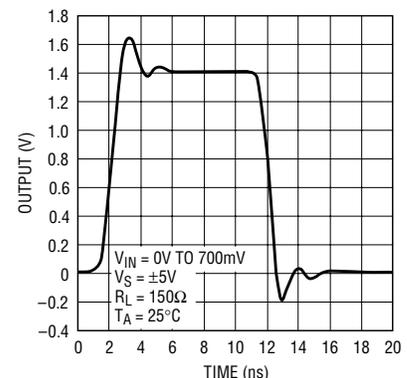


Figure 3. Fast pulse response of circuit in Figure 1

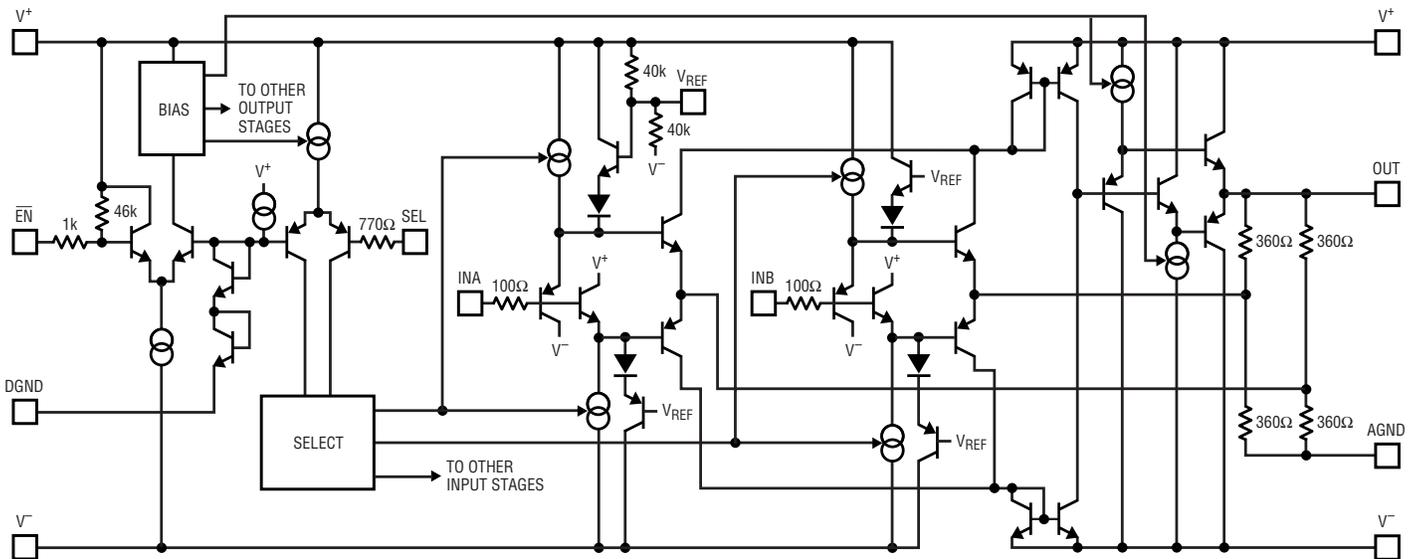


Figure 4. Simplified internal circuit functionality of the LT6555 and LT6556

circuit 892A-A). Frequency markers in Figure 2 show the small-signal -0.5dB response beyond 500MHz and -3dB response above 600MHz . The LT6556, when used to drive high impedances, provides bandwidth to 750MHz , though the LT6556 demo circuit 892A-B uses 75Ω back termination (rather than $1\text{k}\Omega$), resulting in performance similar to the LT6555.

Taking a Look at the Internal Details

The LT6555 and LT6556 integrate three independent sections of circuitry that form classic current-feedback amplifier (CFA) gain blocks, but with switchable input sections, all implemented on a very high-speed fabrication process. The diagram in Figure 4 shows the equivalent internal circuitry (one LT6555 section shown).

Feedback resistors are provided on-chip to set the closed-loop gain to either unity or two, depending on the part. The nominal feedback resistances are chosen to optimize flat frequency response. The LT6555 is intended to drive back-terminated 50Ω or 75Ω cables (for effective loading of 100Ω to 150Ω respectively), while the LT6556 is designed to drive ADCs or other high impedance loads (characterized with $1\text{k}\Omega$ as a reference loading condition).

Common to all three CFAs in each part is a bias control section with a power-down command input. The input select logic steers bias current to the appropriate input circuitry, enabling the input function of the selected signal. The shutdown function includes an internal on-chip pull-up resistance to provide a default disable command, which when invoked, reduces typical power consumption to less than $125\mu\text{A}$ for an entire three-channel part. During shutdown mode the amplifier outputs become high impedance, though in the case of the LT6555, the feedback resistor string to AGND is still present. The parts come into full-power operation when the enable input voltage is brought within 1.3V above the DGND pin. The typical on-state supply current of about 9mA per amplifier provides for ample cable-drive capacity ($>40\text{mA}$) and ultra-fast 2.2V per nanosecond slew rate performance.

Expanding MUX Input Selection

The power-down feature of the LT6555 and LT6556 may be used to control multiple ICs in a configuration that provides additional input selections. Figure 5 shows a simple 4-input RGB selecting cable driver using two LT6555 devices with the enable pins driven by complementary logic signals. The

shared-output connections between the devices need to be kept as short as possible to minimize printed-circuit parasitics that might affect frequency response. This circuit would be ideal in an A/V control-unit for driving the component-video output, for example. The same basic expansion concept applied to an LT6556 pair would be ideal at the input section of a four-source HD video display.

Operating with the Right Power Supplies

The LT6555 and LT6556 require a total power supply of at least 4.5V , but depending on the input and output swings required, may need more to avoid clipping the signal. The LT6556, having unity gain, makes the analysis simple—the maximum output swing is $(V^+ - V^- - 2.6)V_{P-P}$ and governed only by the output saturation voltages. This means a total supply of 5V is adequate for standard video ($1V_{P-P}$). For the LT6555, extra allowance is required for load-driving, so the output swing is $(V^+ - V^- - 3.8)V$. This means a total supply of about 6V is required for the output to swing $2V_{P-P}$, as when driving cables. For best dynamic range along with reasonable power consumption, a good choice of supplies would be $\pm 3\text{V}$ for the LT6556 and $+5\text{V}/-3\text{V}$ for the LT6555.

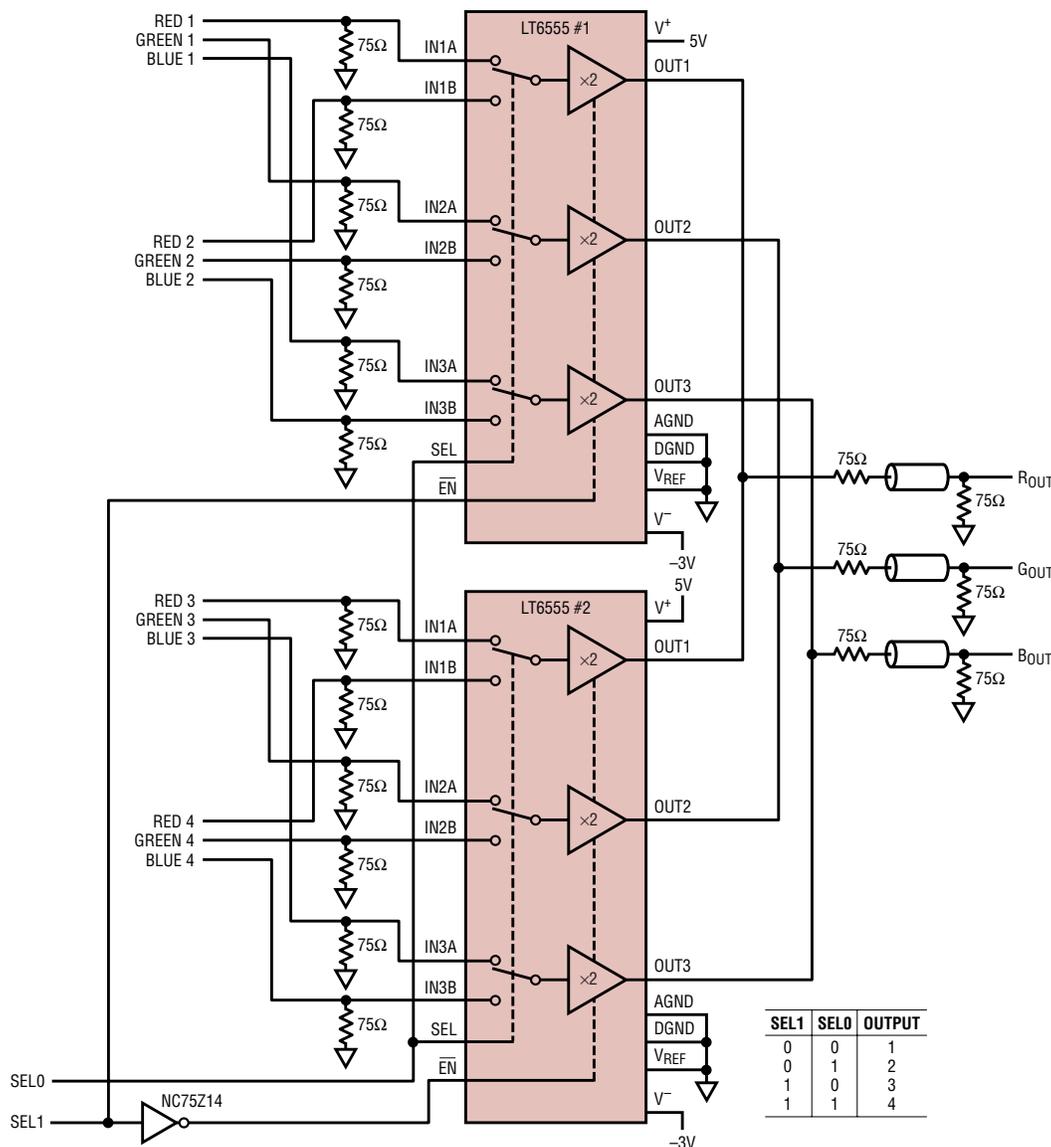


Figure 5. A 4-to-1 video multiplexer using the shutdown feature for expansion

Since many systems today lack a negative supply rail, a small LTC1983-3 solution can be used to generate a simple -3V rail for local use, as shown in Figure 6. The LTC1983-3 solution is more cost effective and performs

at high frequencies better than AC-coupling and resistor network biasing techniques that might otherwise be employed. For example, Figure 7 shows the typical AC-coupling networks used when operating from a

single supply. With six input networks and three large output capacitors required, the AC-coupled method uses more board space and adds parasitics to the signal path that can degrade frequency response.

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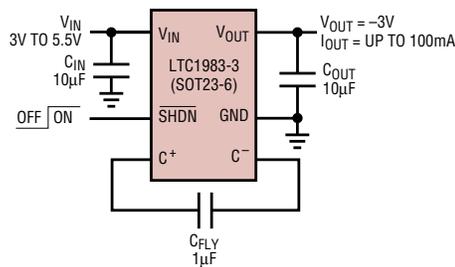


Figure 6. Generating a local -3V supply with four tiny components

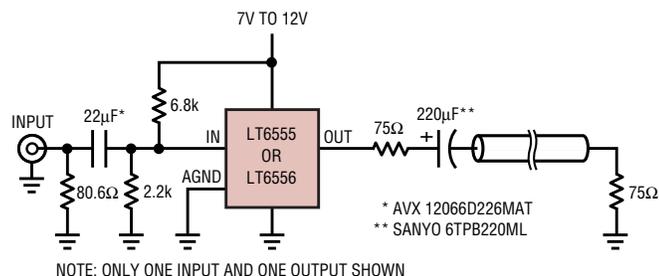


Figure 7. AC-coupling techniques for single-supply operation

IGBT Drive

Most camera flashes are capable of reeye reduction and light-feedback flashing. These features quench, or stop, the flash before the capacitor drains completely. This added level of control requires a high current, high voltage Insulated Gate Bipolar Transistor (IGBT). An IGBT has the advantage of a BJT's high voltage and high current capabilities but does not need base current since it has a MOSFET gate as the input. The tradeoff for these two advantages is speed. Since a flash is on the order of milliseconds, speed is not an issue in this application and an IGBT fits perfectly for the role.

Like a MOSFET, the gate acts like a capacitor. The IGBT driver's job is to charge and discharge the gate. The IGBT driver does not need to be fast, and actually a fast driver can potentially destroy the device. The IGBT turns on when the IGBTIN pin is above 1.5V and turns off when the IGBTIN pin is below 0.3V. When the input is high, the driver draws a small amount of current to hold the gate high with a PNP. When the input is low, the driver has zero quiescent current. During transitions the driver is capable of delivering 150mA of current.

The speed of the driver needs to be carefully controlled or the IGBT may be destroyed. The IGBT driver does not need to pull up the gate fast because of the inherently slow nature of the IGBT. A rise time of 2 μ s is sufficient to charge the gate of the IGBT and create a trigger pulse. With slower rise times, the trigger circuitry does not have a fast enough edge to create the required 4kV pulse. The fall time of the IGBT drive is critical to the safe operation of the IGBT. The IGBT gate

is a network of resistors and capacitors. When the gate terminal is pulled low too quickly, the capacitance closest to the terminal goes low but the capacitance further from the terminal remains high, causing a small portion of the IGBT device to handle the full 100A of current which quickly destroys the device. The pull down circuitry therefore needs to be slower than the internal RC time constant in the gate of the IGBT. To slow down the driver, a 20 Ω series resistor is integrated into the LT3485.

Which Part to Use

The LT3484 and LT3485 families of photoflash capacitor chargers suit about any photoflash need. The basic photoflash functionality in each part is identical and both parts are capable of operating from 2AA cells. The integrated IGBT drive and voltage output monitor differentiate the LT3485 from the LT3484, along with its higher current capabilities. The LT3484 is the smallest solution available if quenching the bulb is not needed. When using an IGBT to trigger the flash, the LT3485 offers valuable board space savings over the LT3484 by eliminating several external components. Table 1 shows the major functional differences between these seven parts.

Once the decision is made on the integrated IGBT driver, choosing a current option is a matter of balancing the inherent trade-off between input current and charge time. For a given photoflash capacitor size, the device which results in the highest input current offers the fastest charge time. The limit on how much current the photoflash charger can draw is usually set by the battery technology used, and how much load they

can handle. The LT3485-3 offers the fastest charge times of the chargers discussed here.

The following equation predicts the charge times (T) in seconds for the seven parts:

$$T = \frac{C_{OUT} \cdot (V_{OUT(FINAL)}^2 - V_{OUT(INIT)}^2)}{\tau \cdot V_{IN}}$$

where C_{OUT} is the value of the photoflash capacitor in Farads, $V_{OUT(FINAL)}$ is the target output voltage, $V_{OUT(INIT)}$ is the initial output voltage, V_{IN} is the battery voltage to which the flyback transformer is connected, and τ is the charge time coefficient listed in Table 1.

The charge time coefficients for each part are different depending on the transformer due to differences in efficiency and average input current. The charge time coefficients are given for Kijima Musen and TDK transformers, with part numbers and typical specifications for these transformers listed in Table 2.

Conclusion

The LT3484 and LT3485 provide simple, efficient capacitor charging solutions for digital still cameras and integrated digital cameras in cell phones. The high level of integration reduces the amount of external components while also producing tightly controlled output voltage and average input current distributions. The three current limits in the LT3484 family and the four current limits in the LT3485 family allow for flexibility in the trade-off between input current and charge time. The LT3485 saves even more space for some applications by integrating an IGBT driver and voltage output monitor. 

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Demonstration Circuits Available

The LT6555 and LT6556 have Demo Boards available that make evaluation of these parts a simple plug-and-play operation. To evaluate the LT6555 ask for DC858A (SSOP-24 package) or DC892A-A (QFN package). To evalu-

ate the LT6556 ask for DC892A-B (in QFN package). All three of these demo circuits have high-quality 75 Ω BNC connections for best performance and illustrate high-frequency layout practices that are important to obtaining the best performance from these super-fast amplifiers. 

For further information on any of the devices mentioned in this issue of *Linear Technology*, visit www.linear.com, use the reader service card or call the LTC literature service number:

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