250MHz, RGB Multiplexer with Current Feedback Amplifiers

September 1998

FEATURES

- **100MHz Pixel Switching**
- **–3dB Bandwidth: 250MHz**
- **Small 16-Pin SSOP Package**
- Channel Switching Time: 2.5ns
- Expandable to Larger Arrays
- Drives Cables Directly
- High Slew Rate: 1100V/µs
- Low Switching Transient: 50mV
- Shutdown Supply Current: 0mA
- Output Short-Circuit Protected

APPLICATIONS

- RGB Switching
- Workstation Graphics
- Pixel Switching
- Coaxial Cable Drivers
- High Speed Signal Processing

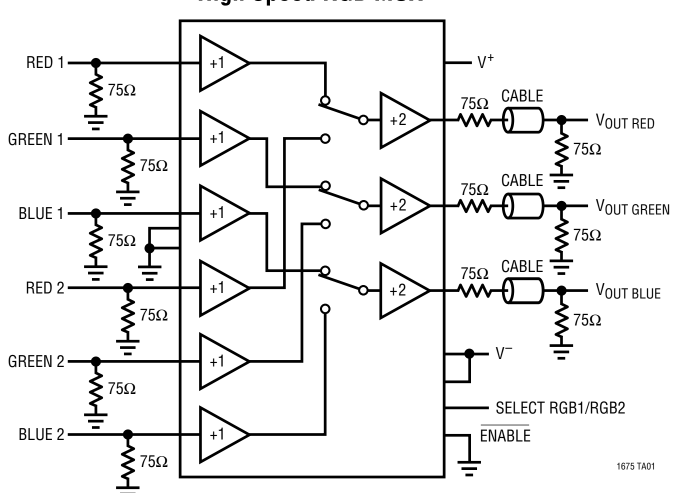
DESCRIPTION

The LT®1675 is a high speed RGB multiplexer designed for pixel switching and fast workstation graphics. Included on chip are three SPDT switches and three current feedback amplifiers. The current feedback amplifiers drive double-terminated 50Ω or 75Ω cables and are configured for a fixed gain of 2, eliminating six external gain setting resistors. The SPDT switches are designed to be break-before-make to minimize unwanted signals coupling to the input.

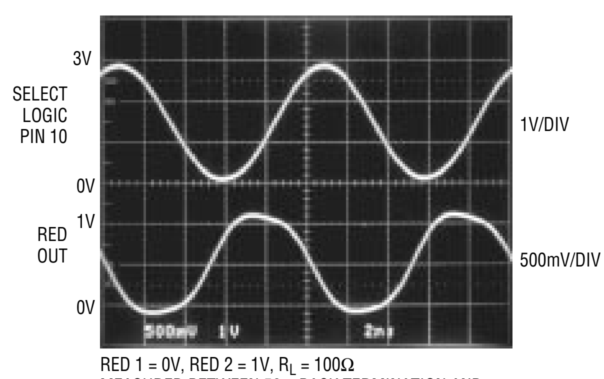
The key to the LT1675 fast switching speed is Linear Technology's proprietary high speed bipolar process. This MUX can toggle between sources in excess of 100MHz, has a slew rate over 1000V/µs and has a –3dB bandwidth of 250MHz. The speed and ease of use of the LT1675 make it ideal for high performance PCs, workstations and professional video monitors. The input-referred switching transient is only $50mV_{P-P}$ and lasts just 5ns, making it virtually undetectable. Power supply requirements are ±4V to ±6V and power dissipation is only 300mW on ±5V. The expandable feature uses the disable pin to reduce the power dissipation to near 0mW in the off parts. Unlike competitive solutions that are in bulky high pin count packages, the LT1675 is in a 16-lead narrow body SSOP. This small footprint, the size of an SO-8, results in a very clean high performance solution.

TYPICAL APPLICATION

High Speed RGB MUX



Select Pin Switches Inputs at 100MHz



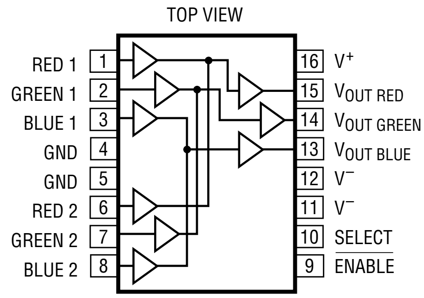
RED 1 = 0V, RED 2 = 1V, R_L = 100Ω
MEASURED BETWEEN 50Ω BACK TERMINATION AND 50Ω LOAD

ABSOLUTE MAXIMUM RATINGS

(Note 1)

Supply Voltage .... ±6.3V
Inputs, ENABLE and SELECT, Current ....±20mA
Output Short-Circuit Duration (Note 2).........Continuous
Specified Temperature Range (Note 3)....... 0°C to 70°C
Operating Temperature Range .... –40°C to 85°C
Storage Temperature Range .... –65°C to 150°C
Junction Temperature (Note 4)............................ 150°C
Lead Temperature (Soldering, 10 sec)..................300°C

PACKAGE/ORDER INFORMATION



GN PACKAGE
16-LEAD PLASTIC SSOP NARROW
T_{JMAX} = 150°C, θ_{JA} = 120°C/W

ORDER PART NUMBER
LT1675CGN
GN PART MARKING
1675C

Consult factory for Industrial and Military grade parts.

ELECTRICAL CHARACTERISTICS

0°C ≤ T_A ≤ 70°C, V_S = ±5V, R_L = ∞, V_{IN} = 0V (Pins 1,2,3,6,7,8), $\overline{\text{ENABLE}}$ = 0V, unless otherwise specified.

PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
Output Offset Voltage	Any Input Selected	●		20	40	mV
Output Offset Matching	Between Outputs R1 to R2, G1 to G2, B1 to B2	●		5	20	mV
Input Current	Any Input Selected	●		–12	–30	μA
Input Resistance	V_{IN} = ±1V	●	100	700		kΩ
PSRR	V_S =±2.6V to ±6V, Measured at Output	●	38	50		dB
DC Gain Error 0V to 1V	V_{IN} = 1V, R_L = ∞ V_{IN} = 1V, R_L = 150Ω V_{IN} = 1V, R_L = 75Ω	● ● ●		3 4 5	6 8 10	% % %
DC Gain Error 0V to –1V	V_{IN} = –1V, R_L = ∞ V_{IN} = –1V, R_L = 150Ω V_{IN} = –1V, R_L = 75Ω	● ● ●		3 4 8	6 8 20	% % %
Output Voltage	V_{IN} = 2V, R_L = ∞ V_{IN} = 2V, R_L = 150Ω V_{IN} = 2V, R_L = 75Ω	● ● ●	3.1 2.8 2.5	3.4 3.0 2.8		V V V
	V_{IN} = –2V, R_L = ∞ V_{IN} = –2V, R_L = 150Ω V_{IN} = –2V, R_L = 75Ω	● ● ●	–3.1 –2.7 –2.4	–3.3 –3.0 –2.6		V V V
Disabled Output Impedance	$\overline{\text{ENABLE}}$ Open	●	1.1	1.5	2.0	kΩ
Maximum Output Current	V_{IN} = ±1V, V_O = 0V	●	50	70		mA
Supply Current	$\overline{\text{ENABLE}}$ = 0V $\overline{\text{ENABLE}}$ = 4.7V	● ●	25	33 1	42 100	mA μA
$\overline{\text{ENABLE}}$ Pin Current	$\overline{\text{ENABLE}}$= 0V	●		450	600	μA
SELECT Pin Current	SELECT = 0V	●		90	180	μA
SELECT Low	SELECT (See Truth Table)	●			0.8	V
SELECT High	SELECT (See Truth Table)	●	2			V

AC CHARACTERISTICS

$0°C \le T_A \le 70°C$, $V_S = \pm5V$, $R_L = 150\Omega$, V_{IN} = 0V (Pins 1,2,3,6,7,8), $\overline{ENABLE}$ = 0V, unless otherwise specified.

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Slew Rate	$V_{OUT} = 5V_{P-P}$		1100		V/µs
Full Power Bandwidth (Note 5)	$V_{OUT} = 6V_{P-P}$		58		MHz
Small-Signal –3dB Bandwidth	Less Than 1dB Peaking		250		MHz
Gain Flatness	Less Than 0.1dB		70		MHz
Gain Matching	R to G to B R1 to R2, G1 to G2, B1 to B2		0.10 0.01		dB dB
Channel-to-Channel Select Time Delay Time Switching Time	R1 = 0V, R2 = 1V Measured from Time SELECT Pin Crosses Logic Threshold Time for V_{OUT} to Go from 0V to 1V		 5.0 2.5		 ns ns
Enable Time			10		ns
Disable Time			100		ns
Input Pin Capacitance			2		pF
SELECT Pin Capacitance			2.2		pF
$\overline{ENABLE}$ Pin Capacitance			2.1		pF
Output Pin Capacitance (Disabled)	$\overline{ENABLE}$ Open		4.4		pF
Small-Signal Rise Time	$V_{IN} = 300mV_{P-P}$, $R_L = 100\Omega$		1.85		ns
Propagation Delay	$V_{IN} = 300mV_{P-P}$, $R_L = 100\Omega$		3		ns
Overshoot	$V_{IN} = 300mV_{P-P}$, $R_L = 100\Omega$		10		%
On-Channel to Off-Channel Crosstalk	Measured at 10MHz		60		dB
Chip Disable Crosstalk	Measured at 10MHz, $\overline{ENABLE}$ Open		90		dB
Channel Select Output Transient	Measured Between Back Termination and Load		50		mV_{P-P}
Differential Gain (Note 6)			0.07		%
Differential Phase (Note 6)			0.05		DEG

The ● denotes specifications that apply over the specified temperature range.

Note 1: Absolute Maximum Ratings are those values beyond which the life of a device may be impaired.

Note 2: May require a heat sink.

Note 3: The LT1675 is guaranteed to meet specified performance from 0°C to 70°C and is designed, characterized and expected to meet these extended temperature limits, but are not tested at –40°C and 85°C. Guaranteed I grade parts are available; consult factory.

Note 4: T_J is calculated from the ambient temperature T_A and power dissipation P_D according to the following formula:

$$T_J = T_A + (P_D)(120°C/W)$$

Note 5: Full power bandwidth is calculated from the slew rate measurement:

$$FPBW = SR/2\pi V_{PEAK}.$$

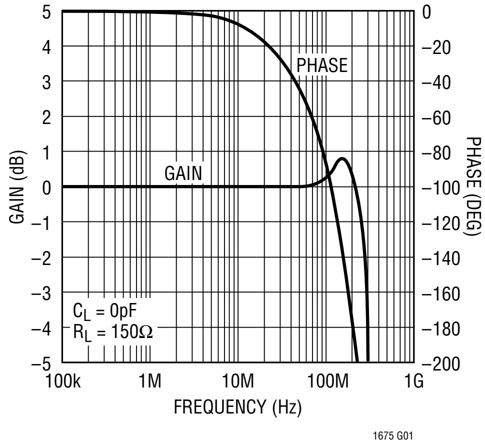
Note 6: Differential Gain and Phase are measured using a Tektronix TSG120 YC/NTSC signal generator and a Tektronix 1780R Video Measurement Set. The resolution of this equipment is 0.1% and 0.1°. Nine identical MUXs were cascaded giving an effective resolution of 0.011% and 0.011°.

Truth Table

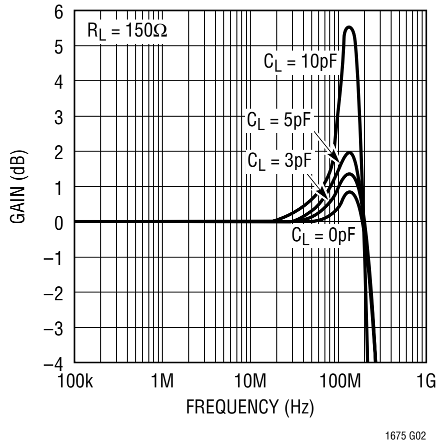
SELECT	$\overline{ENABLE}$	RED OUT	GREEN OUT	BLUE OUT
1	0	RED 1	GREEN 1	BLUE 1
0	0	RED 2	GREEN 2	BLUE 2
X	1	OFF	OFF	OFF

TYPICAL PERFORMANCE CHARACTERISTICS

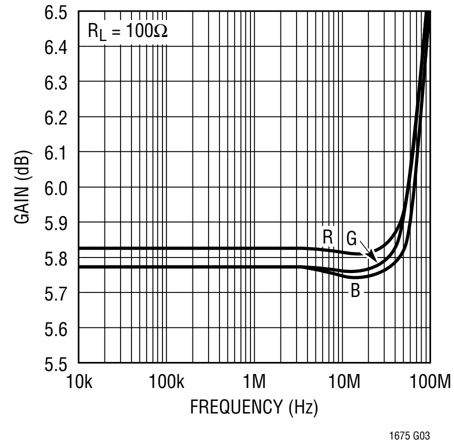
Gain and Phase vs Frequency



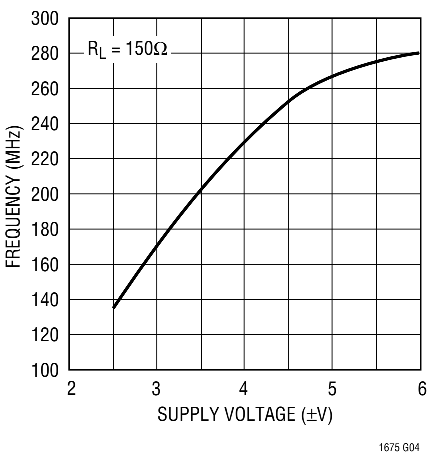
Frequency Response with Capacitive Loads



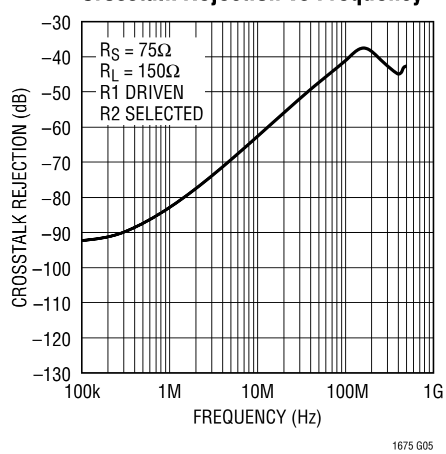
Gain vs Frequency



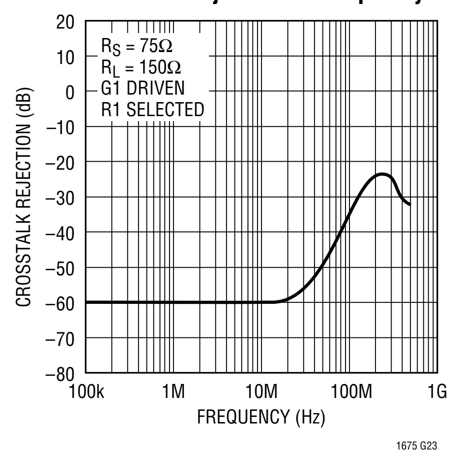
–3dB Bandwidth vs Supply Voltage



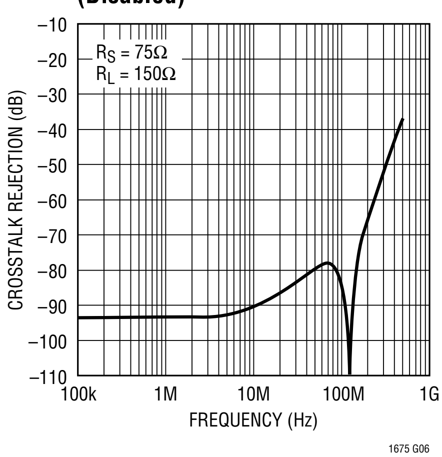
Crosstalk Rejection vs Frequency



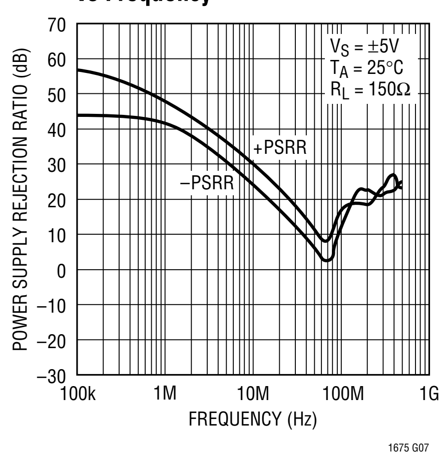
Crosstalk Rejection vs Frequency



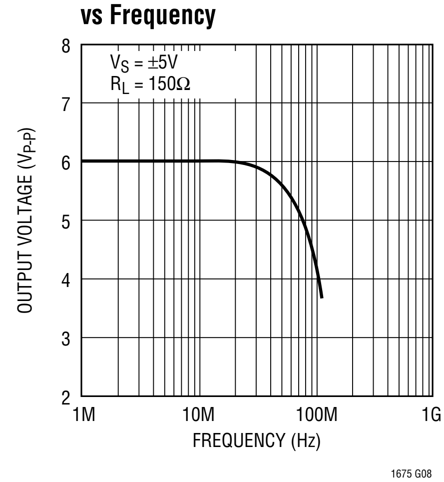
Crosstalk Rejection vs Frequency (Disabled)



Power Supply Rejection Ratio vs Frequency

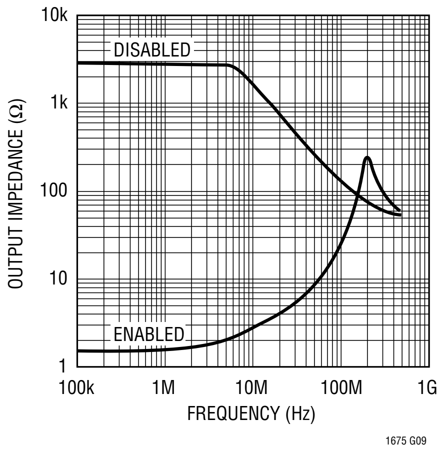


Undistorted Output Swing vs Frequency

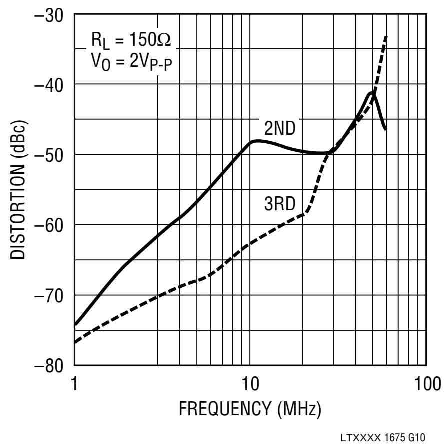


TYPICAL PERFORMANCE CHARACTERISTICS

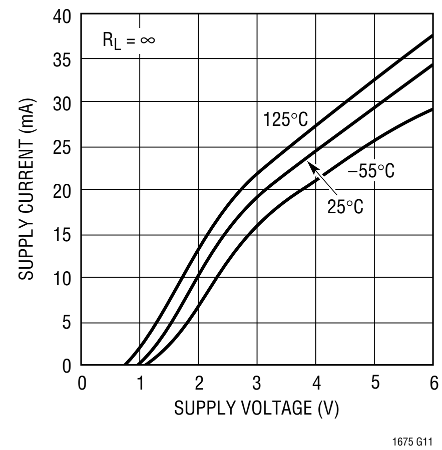
Output Impedance vs Frequency



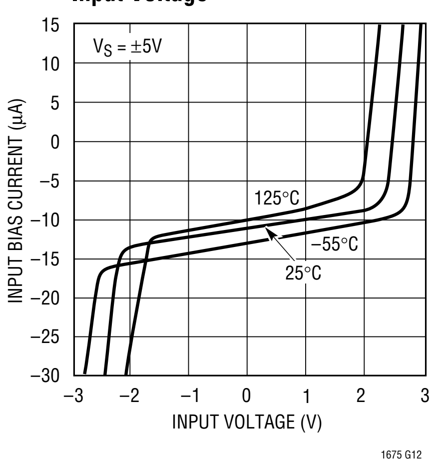
2nd and 3rd Harmonic Distortion vs Frequency



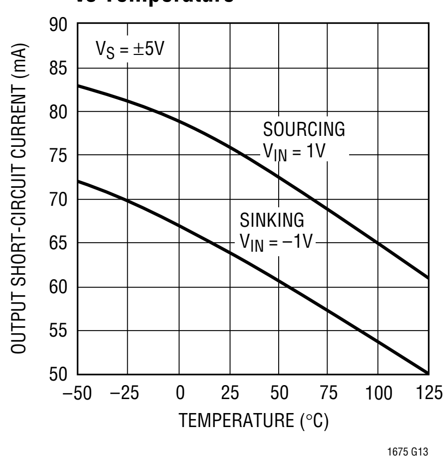
Supply Current vs Supply Voltage



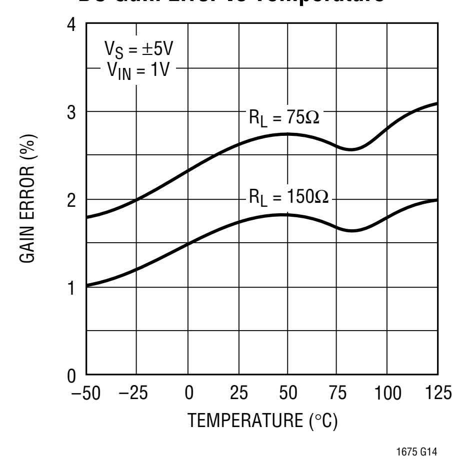
Input Bias Current vs Input Voltage



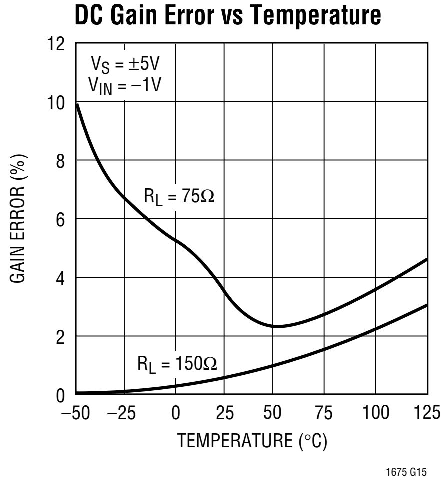
Output Short-Circuit Current vs Temperature



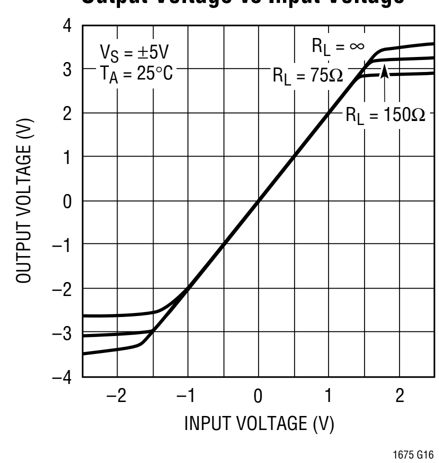
DC Gain Error vs Temperature



DC Gain Error vs Temperature

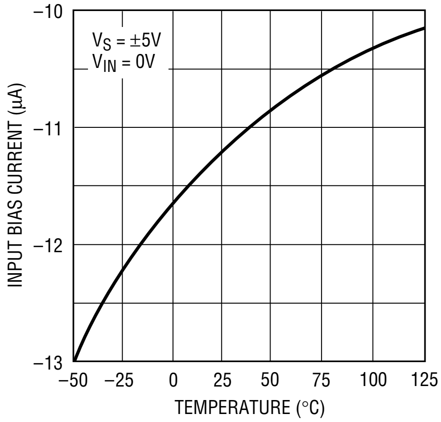


Output Voltage vs Input Voltage



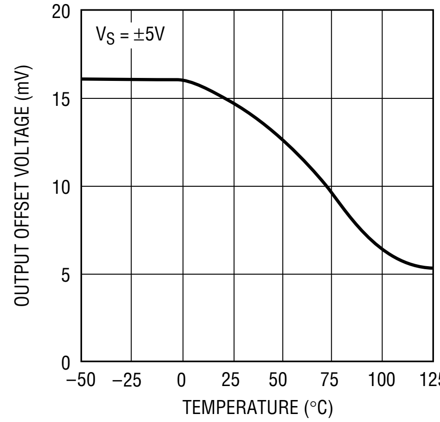
TYPICAL PERFORMANCE CHARACTERISTICS

Input Bias Current vs Temperature



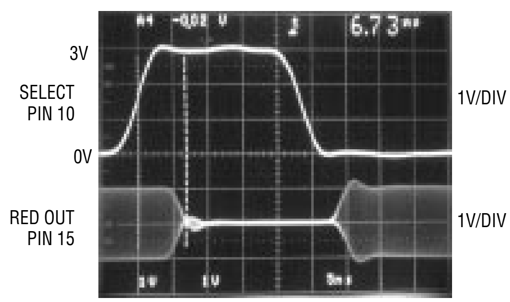
1675 G17

Output Offset Voltage vs Temperature



1675 G18

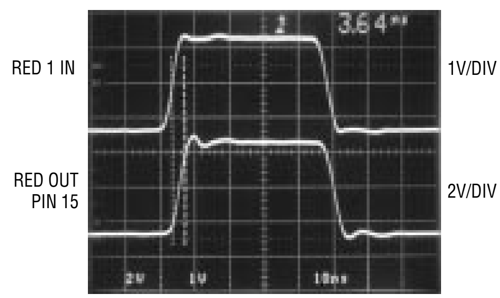
Toggling RED 2 to RED 1



RED 1 = 0V
RED 2 = UNCORRELATED SINEWAVE
R_L = 150Ω, 10pF SCOPE PROBE

1675 G19

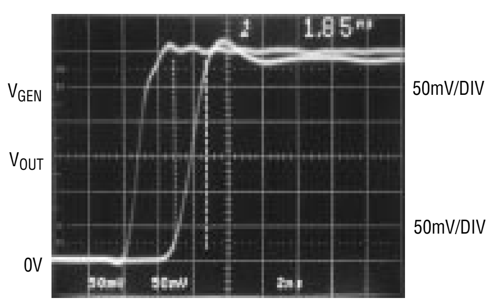
Slew Rate



MEASURED AT PIN 15
R_L = 150Ω, 10pF SCOPE PROBE
SR = 1100V/µs

1675 G20

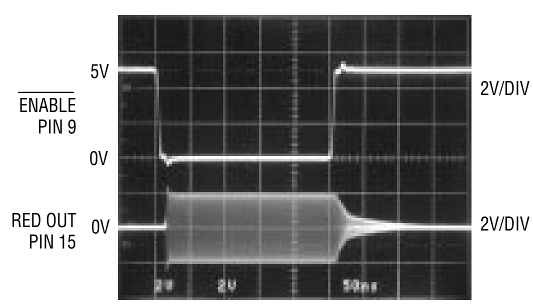
Small-Signal Rise Time



R_L = 100Ω
MEASURED WITH FET PROBES

1675 G21

Enable and Disable



ENABLE AND DISABLE OF UNCORRELATED SINEWAVE
R_L = 150Ω

1675 G22

PIN FUNCTIONS

RED 1 (Pin 1): Red 1 Input. The 1V video input signal to be switched is applied to this pin. If 2V are applied to this pin, $V_{OUT\ RED}$ will clip. The input must be terminated.

GREEN 1 (Pin 2): Green 1 Input. The 1V video input signal to be switched is applied to this pin. If 2V are applied to this pin, $V_{OUT\ GREEN}$ will clip. The input must be terminated.

BLUE 1 (Pin 3): Blue 1 Input. The 1V video input signal to be switched is applied to this pin. If 2V are applied to this pin, $V_{OUT\ BLUE}$ will clip. The input must be terminated.

GND (Pins 4, 5): Signal Ground. Connect to ground plane.

RED 2 (Pin 6): Red 2 Input. The 1V video input signal to be switched is applied to this pin. If 2V are applied to this pin, $V_{OUT\ RED}$ will clip. The input must be terminated.

GREEN 2 (Pin 7): Green 2 Input. The 1V video input signal to be switched is applied to this pin. If 2V are applied to this pin, $V_{OUT\ GREEN}$ will clip. The input must be terminated.

BLUE 2 (Pin 8): Blue 2 Input. The 1V video input signal to be switched is applied to this pin. If 2V are applied to this pin, $V_{OUT\ BLUE}$ will clip. The input must be terminated.

$\overline{\text{ENABLE}}$ (Pin 9): Chip Enable. Ground this pin for normal operation. Take this pin to within 300mV of V^+, or open to shut down the part. This pin is also used for router applications. When the part is disabled, the supply current is 10μA.

SELECT (Pin 10): Channel Select. Use this pin to select between RGB1 inputs and RGB2 inputs. Use this pin for fast toggling. HIGH Selects RGB1.

V^- (Pins 11, 12): Negative Power Supply. Connect these pins to –5V and bypass with good tantalum capacitor (4.7μF). The pin may also require a 0.1μF or 0.01μF depending on layout.

$V_{OUT\ BLUE}$ (Pin 13): Blue Output. It is twice BLUE 1 or BLUE 2 depending on which channel is selected by Pin 10. $V_{OUT\ BLUE}$ drives 50Ω or 75Ω double-terminated cables. Do not add capacitance to this pin.

$V_{OUT\ GREEN}$ (Pin 14): Green Output. It is twice GREEN 1 or GREEN 2 depending on which channel is selected by Pin 10. $V_{OUT\ GREEN}$ drives 50Ω or 75Ω double-terminated cables. Do not add capacitance to this pin.

$V_{OUT\ RED}$ (Pin 15): Red Output. It is twice RED 1 or RED 2 depending on which channel is selected by Pin 10. $V_{OUT\ RED}$ drives 50Ω or 75Ω double-terminated cables. Do not add capacitance to this pin.

V^+ (Pin 16): Positive Power Supply. Connect this pin to 5V and bypass with good tantalum capacitor (4.7μF). The pin may also require a 0.1μF or 0.01μF depending on layout.

APPLICATIONS INFORMATION

Power Supplies

The LT1675 will function with supply voltages below ±2V (4V total), however, to ensure a full $1V_{P-P}$ video signal ($2V_{P-P}$ at the output pins), the power supply voltage should be between ±4V to ±6V. The LT1675 is designed to operate on ±5V, and at no time should the supplies exceed ±6V. The power supplies should be bypassed with quality tantalum capacitors. It may be necessary to add 0.01μF or 0.1μF in parallel with the tantalum capacitors if there is excessive ringing on the output waveform. Even though the LT1675 is well behaved, bypass capacitors should be placed as close to the LT1675 as possible.

Smallest Package and PC Board Space

The LT1675 has the internal gain set for +2V/V or 6dB, because it is designed to drive a double-terminated 50Ω or 75Ω cable that has an inherent 6dB loss. There are several advantages to setting the gain internally. This topology eliminates six gain set resistors, reduces the pin count of the package and eliminates stray capacitance on the sensitivity feedback node. The LT1675 fits into the small SSOP package, and these advantages lead to the smallest PC board footprint with enhanced performance.

APPLICATIONS INFORMATION

Fast Switching

The key to the LT1675 fast switching speed is Linear Technology's proprietary high speed bipolar process. Internal switches can change state in less than 1ns, but the output of the MUX switches in about 2.5ns, as shown in Figure 1. The additional delay is due to the finite bandwidth and the slew rate of the current feedback amplifier that drives the cable.

For minimum ringing, it is important to minimize the load capacitance on the output of the part. This is normally not a problem in a controlled impedance environment, but stray PC board capacitance and scope probe capacitance can degrade the pulse fidelity. Figure 2 shows the response of the output to various capacitive loads measured with a 10pF scope probe.

Switching Transients

This MUX includes fast current steering break-before-make SPDT switches that minimize switching glitches. The switching transients of Figure 3 are input-referred (measured between 75Ω back termination and the 75Ω load). The glitch is only $50mV_{P-P}$ and the duration is just 5ns. This transient is small and fast enough to not be visible on quality graphics terminals. Additionally, the break-before-make SPDT switch is open before the alternate channel is connected. This means there is no input feedthrough during switching. Figure 4 shows the amount of alternate channel that is coupled at the input.

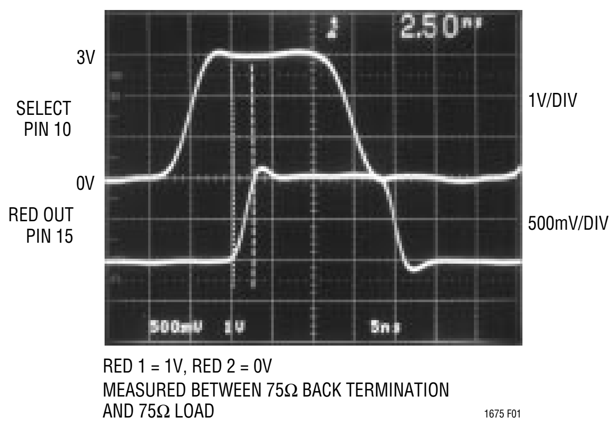


Figure 1. Toggling at 25MHz

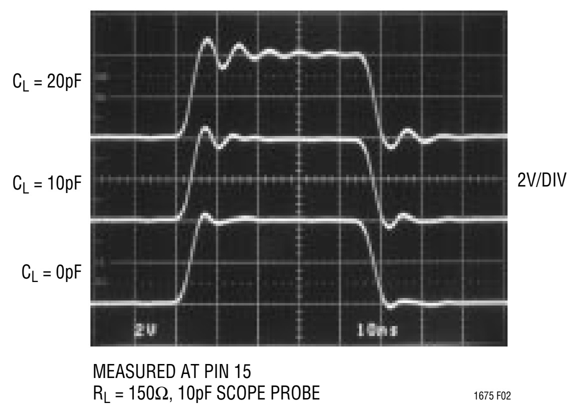


Figure 2. Response to Capacitive Loads

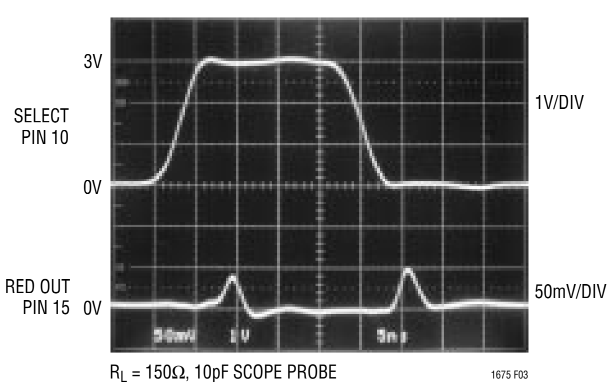


Figure 3. Input-Referred Switching Transient

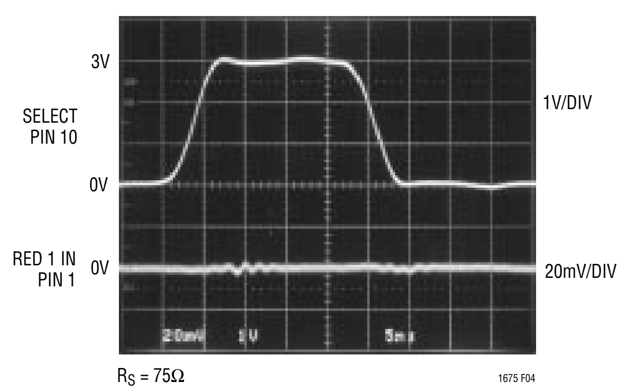


Figure 4. Switching Transient at RED 1 (Pin 1)

APPLICATIONS INFORMATION

Expanding Inputs

In video routing applications where the ultimate 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. The internal gain set resistors have a nominal value of 750Ω and cause a 1500Ω shunt across the 75Ω cable termination. Figure 5 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:

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

where n is total number of LT1675s. For example, using ten LTC1675s (20 Red, 20 Green and 20 Blue) the Gain Error is only –1.7dB per channel.

Figure 6 shows a 4-input RGB router. The response from RED 1 Input to Red Output is shown in Figure 7 for a 25MHz square wave with Chip Select = 0V. In this case the Gain Error is –0.23dB. Toggling with Chip Select between IC #1 and IC #2 is shown in Figure 8. In this case RED 1 Input is connected to 0V and RED 3 Input is connected to an uncorrelated sinewave.

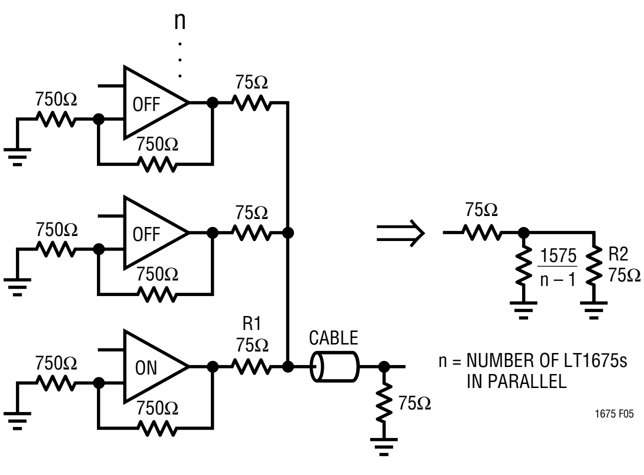


Figure 5. Off Channels Load the Cable Termination with 1575Ω Each

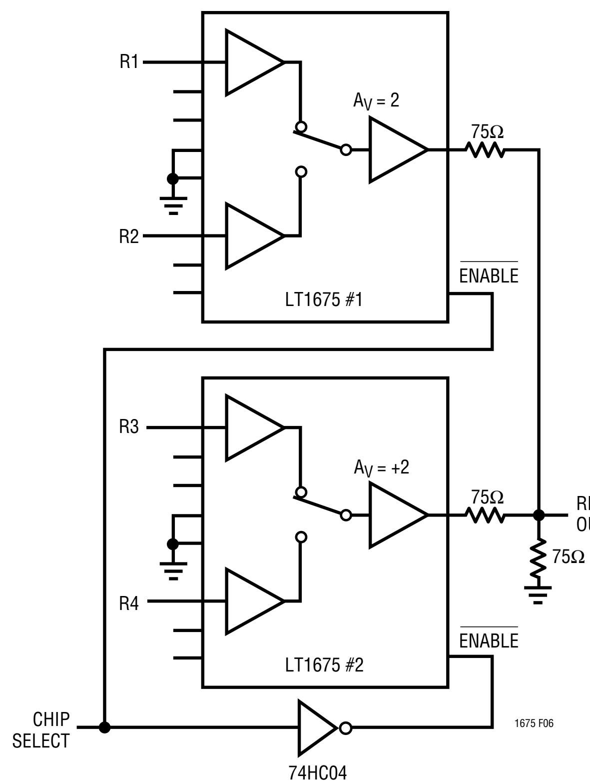


Figure 6. Two LT1675s Build a 4-Input RGB Router

APPLICATIONS INFORMATION

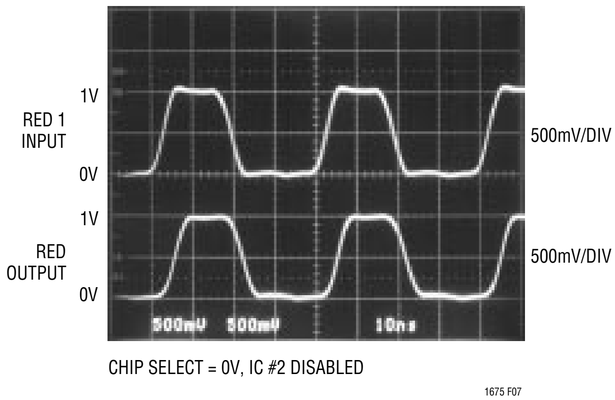


Figure 7. 4-Input Router Response

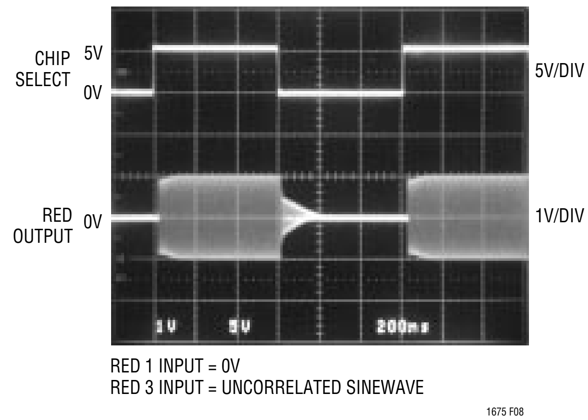
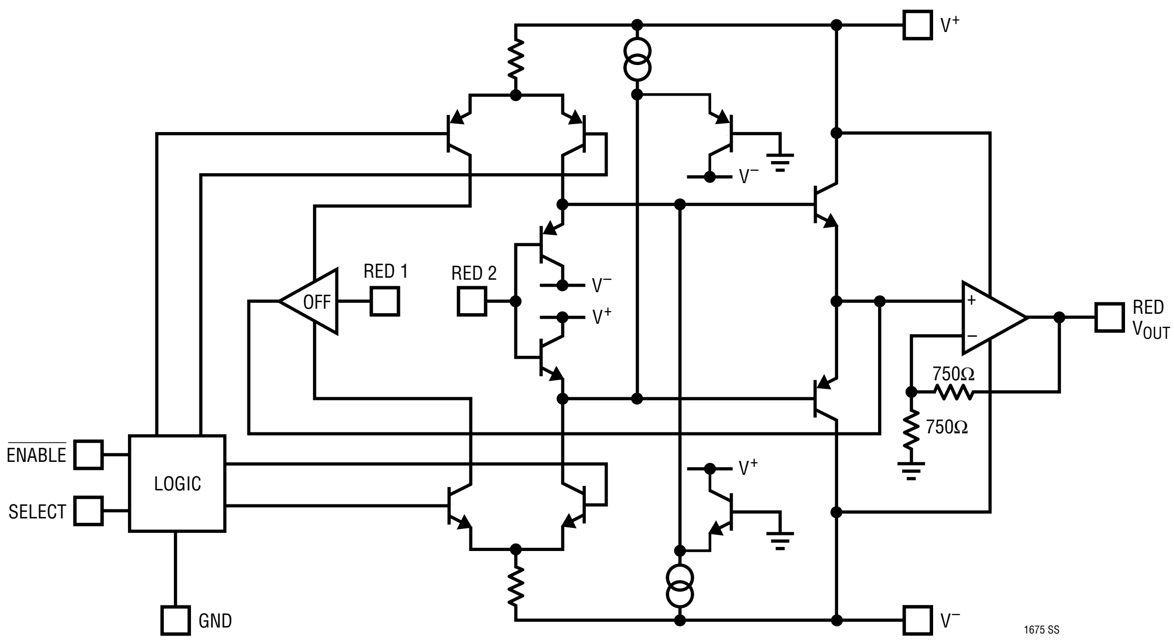


Figure 8. 4-Input Router Toggling

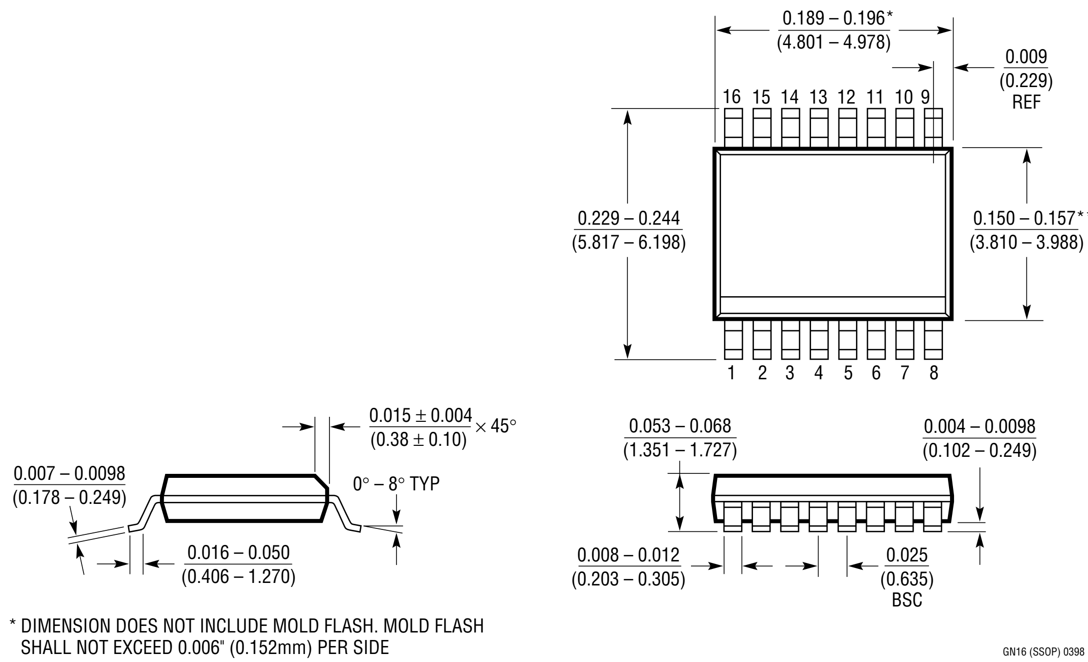
SIMPLIFIED SCHEMATIC (One Channel)



PACKAGE DESCRIPTION

Dimensions in inches (millimeters) unless otherwise noted.

GN Package
16-Lead Plastic SSOP (Narrow 0.150)
(LTC DWG # 05-08-1641)

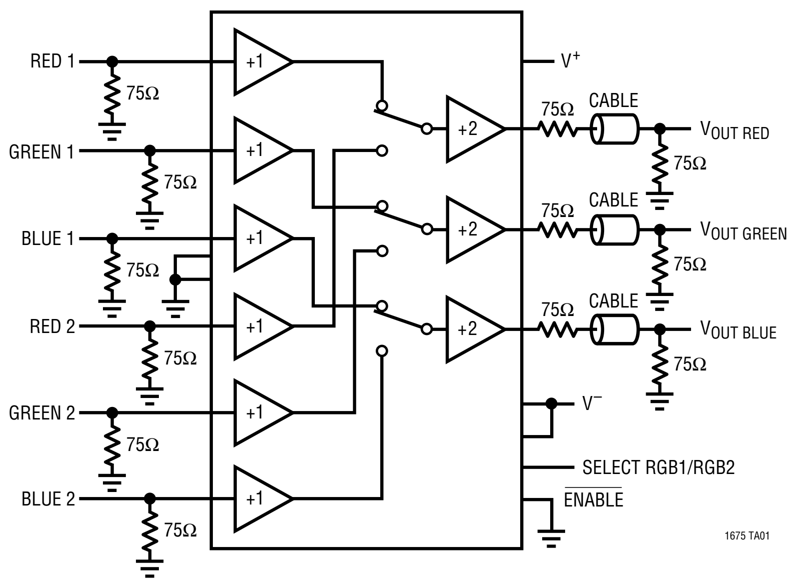


* DIMENSION DOES NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED 0.006" (0.152mm) PER SIDE

** DIMENSION DOES NOT INCLUDE INTERLEAD FLASH. INTERLEAD FLASH SHALL NOT EXCEED 0.010" (0.254mm) PER SIDE

TYPICAL APPLICATION

High Speed RGB MUX



RELATED PARTS

PART NUMBER	DESCRIPTION	COMMENTS
LT1203/LT1205	150MHz Video MUX	2-Input and 4-Input, 90dB Channel Separation, Wide Supply Range
LT1204	4-Input Video MUX with 75MHz Current Feedback Amp	Drives Cables, Adjustable Gain, 90dB Channel Separation
LT1260	Low Cost Dual and Triple 130MHz Current Feedback Amp with Shutdown	Drives Cables, Wide Supply Range, 0μA Shutdown Current

Linear Technology Corporation
1630 McCarthy Blvd., Milpitas, CA 95035-7417
(408)432-1900 • FAX: (408) 434-0507 • www.linear-tech.com
1675i LT/TP 0998 4K • PRINTED IN USA