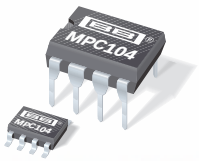
BURR-BROWN®



MPC104

Wide-Bandwidth 2 x 1 VIDEO MULTIPLEXER

FEATURES

- BANDWIDTH: 210MHz (1.4Vp-p)
- LOW INTERCHANNEL CROSSTALK: –79dB (30MHz, SO); –77dB (30MHz, DIP)
- LOW SWITCHING TRANSIENTS: +13mV/–4mV
- LOW DIFFERENTIAL GAIN/PHASE ERRORS: 0.03%, 0.01°
- LOW QUIESCENT CURRENT: One Channel Selected: ±4.6mA No Channel Selected: ±120µA

APPLICATIONS

- VIDEO ROUTING AND MULTIPLEXING (CROSSPOINTS)
- RADAR SYSTEMS
- DATA ACQUISITION
- INFORMATION TERMINALS
- SATELLITE OR RADIO LINK IF ROUTING

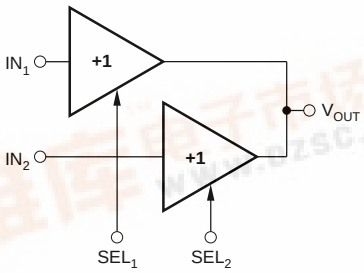
DESCRIPTION

The MPC104 is a wide-bandwidth, 2-to-1 channel video signal multiplexer, which can be used in a wide variety of applications.

It was designed for wide-bandwidth systems, including high-definition television and broadcast equipment. Although it is primarily used to route video signals, the harmonic and dynamic attributes of the MPC104 also make it appropriate for other analog signal routing applications such as radar, communications, computer graphics, and data acquisition systems.

The MPC104 consists of two identical monolithic, integrated, open-loop buffer amplifiers, which are connected internally at the output. The bipolar complementary buffers form a unidirectional transmission path and offer extremely high output-to-input isolation. The MPC104 multiplexer enables the user to connect one of two input signals to the output. The output of the multiplexer is in a high-impedance state when no channel is selected. When one channel is selected with a digital "1" at the corresponding SEL input, the component acts as a buffer with high input impedance and low output impedance.

The wide bandwidth of over 210MHz at 1.4Vp-p signal level, high linearity and low distortion, and low input voltage noise of 5nV/√Hz make this crosspoint switch suitable for RF and video applications. All performance is specified with ±5V supply voltage, which reduces power consumption in comparison with ±15V designs. The multiplexer is available in a space-saving 8-pin SO and DIP packages. Both are designed and specified for operation over the industrial temperature range (–40°C to +85°C.)



TRUTH TABLE

SEL_1	SEL_2	V_{OUT}
0	0	HI-Z
1	0	IN_1
0	1	IN_2

International Airport Industrial Park • Mailing Address: PO Box 11400, Tucson, AZ 85734 • Street Address: 6730 S. Tucson Blvd., Tucson, AZ 85706 • Tel: (520) 746-1111 • Twx: 910-952-1111
Internet: http://www.burr-brown.com/ • FAXLine: (800) 548-6133 (US/Canada Only) • Cable: BBRCORP • Telex: 066-6491 • FAX: (520) 889-1510 • Immediate Product Info: (800) 548-6132

PDS-1230C Printed in U.S.A. July, 1994

SPECIFICATIONS–DC CHARACTERISTICS

At V_{CC} = ±5VDC, R_L = 10kΩ, R_{IN} = 100Ω, R_{SOURCE} = 50Ω, and T_A = +25°C, unless otherwise noted.

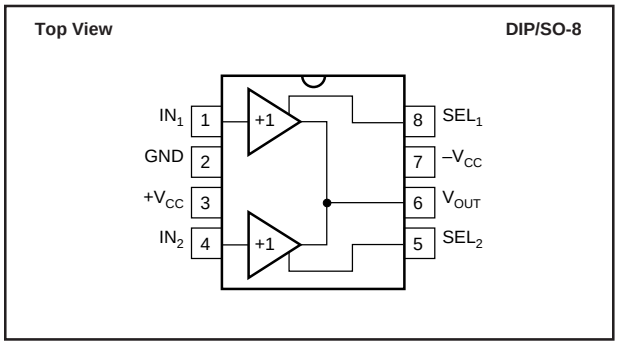
PARAMETER	CONDITIONS	MPC104AP, AU			UNITS
		MIN	TYP	MAX	
INPUT OFFSET VOLTAGE					
Initial			14	±30	mV
vs Temperature			60		µV/°C
vs Supply (Tracking)	V_{CC} = ±4.5V to ±5.5V	–40	–80		dB
vs Supply (Non-tracking)	V_{CC} = +4.5V to +5.5V		–50		dB
vs Supply (Non-tracking)	V_{CC} = –4.5V to –5.5V		–50		dB
Initial Matching	All Buffers		3		mV
INPUT BIAS CURRENT					
Initial			5	±10	µA
vs Temperature			20		nA/°C
vs Supply (Tracking)	V_{CC} = ±4.5V to ±5.5V		±710		nA/V
vs Supply (Non-tracking)	V_{CC} = +4.5V to +5.5V		0.26		µA/V
vs Supply (Non-tracking)	V_{CC} = –4.5V to –5.5V		1.7		µA/V
INPUT IMPEDANCE					
Resistance	Channel On		0.88		MΩ
Capacitance	Channel On		1.0		pF
Capacitance	Channel Off		1.0		pF
INPUT NOISE					
Voltage Noise Density	f_{OUT} = 20kHz to 10MHz		5		nV/√Hz
Signal-to-Noise Ratio	S/N = 0.7/V_N • √5MHz		96		dB
INPUT VOLTAGE RANGE	Gain Error ≤ 10%		±3.6		V
TRANSFER CHARACTERISTICS					
Voltage Gain	R_L = 1kΩ, V_{IN} = ±2V		0.982		V/V
	R_L = 10kΩ, V_{IN} = ±2.8V	0.98	0.992		V/V
RATED OUTPUT					
Voltage	V_{IN} = ±3V	±2.8	±2.97		V
Resistance	One Channel Selected		12.5		Ω
Resistance	No Channel Selected		900		MΩ
Capacitance	No Channel Selected		1.2		pF
CHANNEL SELECTION INPUTS					
Logic 1 Voltage		+2		V_{CC} +0.6	V
Logic 0 Voltage				+0.8	V
Logic 1 Current	V_{SEL} = 5.0V	75	100	125	µA
Logic 0 Current	V_{SEL} = 0.8V		0.002	5	µA
SWITCHING CHARACTERISTICS	V_I = –0.3V to +0.7V, f = 5MHz				
SEL to Channel ON Time	90% Point of V_{OUT} = 1Vp-p		0.13		µs
SEL to Channel OFF Time	10% Point of V_{OUT} = 1Vp-p		0.17		µs
Switching Transient, Positive	(Measured While Switching		+13		mV
Switching Transient, Negative	Between Two Grounded Channels)		–4		mV
POWER SUPPLY					
Rated Voltage			±5		V
Derated Performance		±4.5		±5.5	V
Quiescent Current	One Channel Selected, Over Temperature		±4.6	±5.3	mA
	No Channel Selected, Over Temperature		±120	±175	µA
Rejection Ratio			–80		dB

SPECIFICATIONS– AC CHARACTERISTICS

At V_{CC} = ±5VDC, R_L = 10kΩ, R_{IN} = 100Ω, R_{SOURCE} = 50Ω, and T_A = +25°C, unless otherwise noted.

PARAMETER	CONDITIONS	MPC104AP, AU			UNITS
		MIN	TYP	MAX	
LARGE SIGNAL BANDWIDTH (–3dB)	V_{OUT} = 5.0Vp-p, C_{OUT} = 1pF		55		MHz
	V_{OUT} = 2.8Vp-p, C_{OUT} = 1pF		101		MHz
	V_{OUT} = 1.4Vp-p, C_{OUT} = 1pF		210		MHz
SMALL SIGNAL BANDWIDTH	V_{OUT} = 0.2Vp-p, C_{OUT} = 1pF		590		MHz
GROUP DELAY TIME			550		ps
DIFFERENTIAL GAIN	f = 4.43MHz, V_{IN} = 0.3Vp-p				
	VDC = 0 to 0.7V		0.03		%
DIFFERENTIAL PHASE	f = 4.43MHz, V_{IN} = 0.3Vp-p				
	VDC = 0 to 0.7V		0.01		Degrees
GAIN FLATNESS PEAKING	V_{OUT} = 0.2Vp-p, DC to 30MHz		0.05		dB
	V_{OUT} = 0.2Vp-p, DC to 100MHz		0.07		dB
HARMONIC DISTORTION	f = 30MHz, V_{OUT} = 1.4Vp-p				
Second Harmonic			–63		dBc
Third Harmonic			–65		dBc
CROSSTALK	V_{IN} = 1.4Vp-p				
MPC104AP Channel-to-Channel	f = 5MHz,		–90		dB
	f = 30MHz,		–77		dB
Off Isolation	f = 5MHz,		–93		dB
	f = 30MHz,		–81		dB
MPC104AU Channel-to-Channel	f = 5MHz,		–95		dB
	f = 30MHz,		–79		dB
Off Isolation	f = 5MHz,		–93		dB
	f = 30MHz		–86		dB
RISE/FALL TIME	V_{OUT} = 1.4Vp-p, Step 10% to 90%				
	C_{OUT} = 1pF, R_{OUT} = 22Ω		2.3		ns
SLEW RATE	V_{OUT} = 1.4Vp-p				
	C_{OUT} = 1pF		500		V/µs
	C_{OUT} = 22pF		360		V/µs
	C_{OUT} = 47pF		260		V/µs

CONNECTION DIAGRAM



ABSOLUTE MAXIMUM RATINGS

Power Supply Voltage ($\pm V_{CC}$)	±6VDC
Analog Input Voltage (IN_1 through IN_2)	$\pm V_{CC}$, ±0.7V
Operating Temperature	–40°C to +85°C
Storage Temperature	–40°C to +125°C
Output Current	±6mA
Junction Temperature	+175°C
Lead Temperature (soldering, 10s)	+300°C
Digital Input Voltages (SEL_1 through SEL_2)	–0.5V to $+V_{CC}$ +0.7V

PACKAGE/ORDERING INFORMATION

PRODUCT	PACKAGE	PACKAGE DRAWING NUMBER(1)	TEMPERATURE RANGE
MPC104AP	8-Pin Plastic DIP	006	–40°C to +85°C
MPC104AU	SO-8 Surface Mount	182	–40°C to +85°C

NOTE: (1) For detailed drawing and dimension table, please see end of data sheet, or Appendix C of Burr-Brown IC Data Book.

PIN DESCRIPTION

PIN	DESCRIPTION
IN_1, IN_2	Analog Input Channels
GND	Analog Input Shielding Grounds, Connect to System Ground
SEL_1, SEL_2	Channel Selection Inputs
V_{OUT}	Analog Output; tracks selected channel
$-V_{CC}$	Negative Supply Voltage; typical –5VDC
$+V_{CC}$	Positive Supply Voltage; typical +5VDC

ELECTROSTATIC DISCHARGE SENSITIVITY

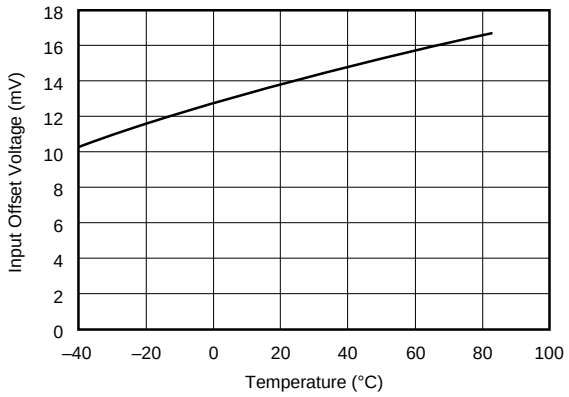
This integrated circuit can be damaged by ESD. Burr-Brown recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

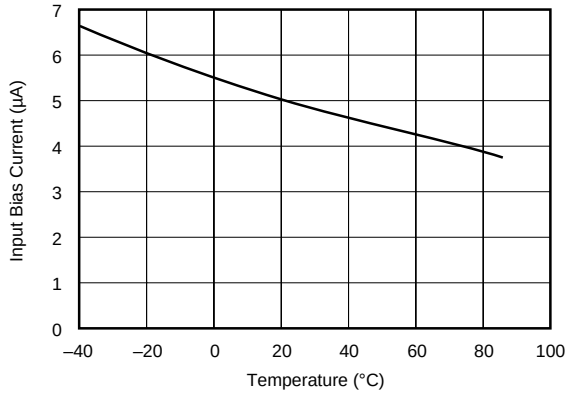
TYPICAL PERFORMANCE CURVES

At V_{CC} = ±5VDC, R_L = 10kΩ, R_{IN} = 100Ω, R_{SOURCE} = 50Ω, and T_A = +25°C, unless otherwise noted.

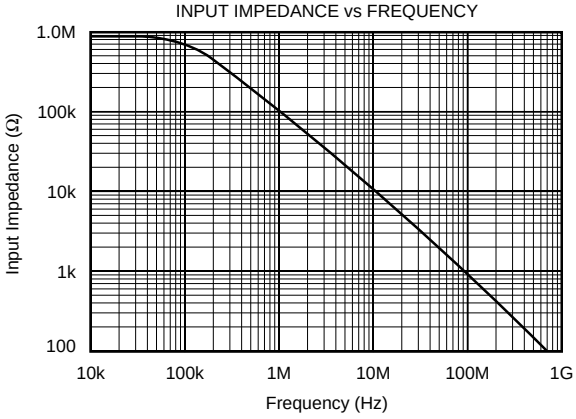
INPUT OFFSET VOLTAGE vs TEMPERATURE



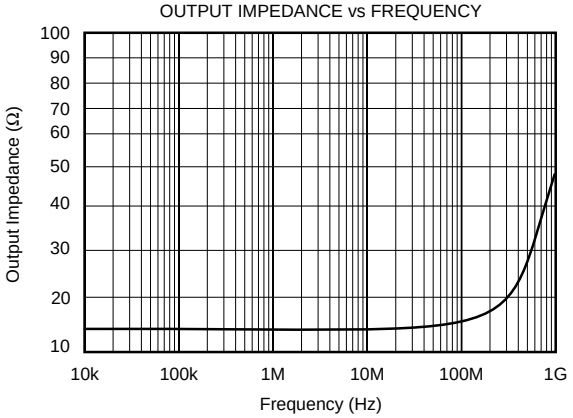
INPUT BIAS CURRENT vs TEMPERATURE



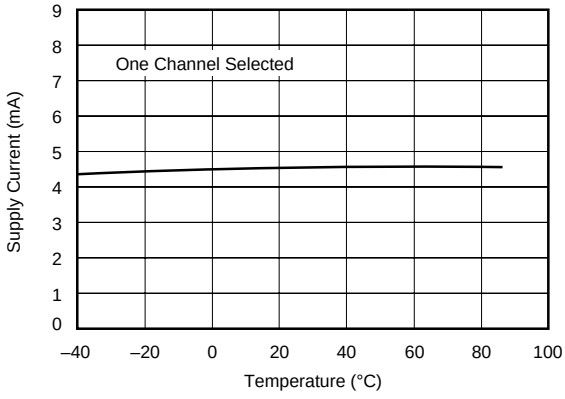
INPUT IMPEDANCE vs FREQUENCY



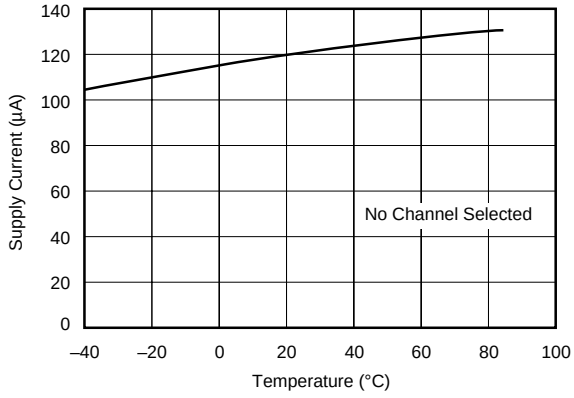
OUTPUT IMPEDANCE vs FREQUENCY



TOTAL POSITIVE QUIESCENT CURRENT vs TEMPERATURE



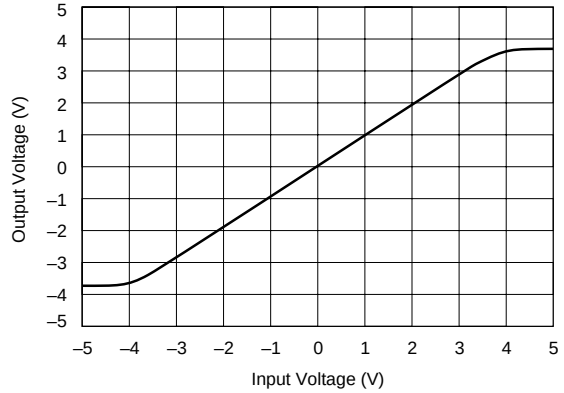
TOTAL POSITIVE QUIESCENT CURRENT vs TEMPERATURE



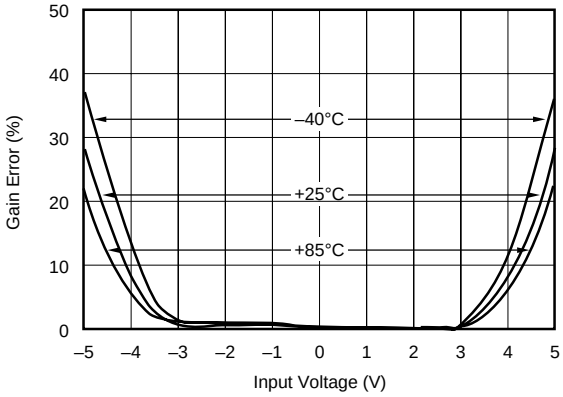
TYPICAL PERFORMANCE CURVES (CONT)

At V_{CC} = ±5VDC, R_L = 10kΩ, R_{IN} = 100Ω, R_{SOURCE} = 50Ω, and T_A = +25°C, unless otherwise noted.

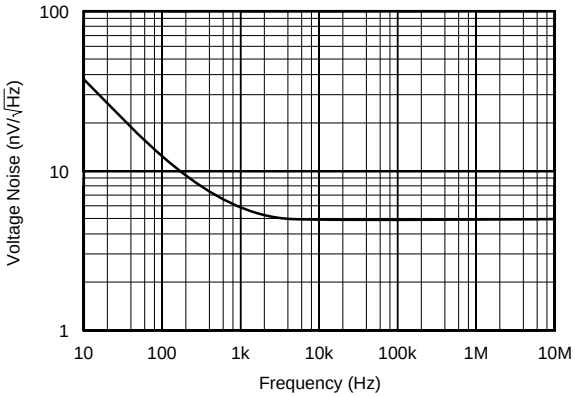
TRANSFER FUNCTION



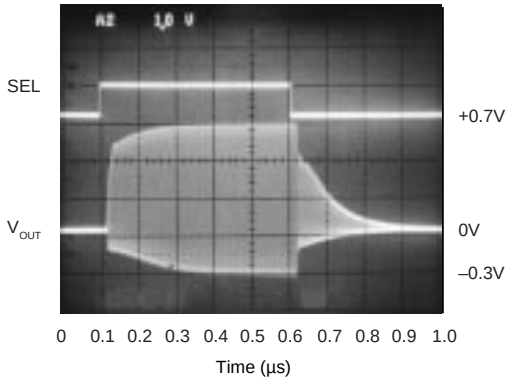
GAIN ERROR vs INPUT VOLTAGE

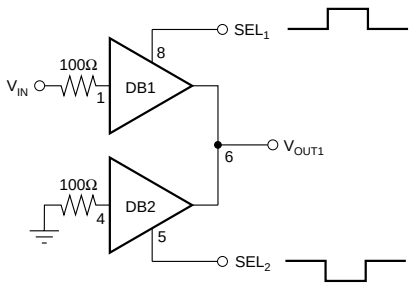


INPUT VOLTAGE NOISE SPECTRAL DENSITY

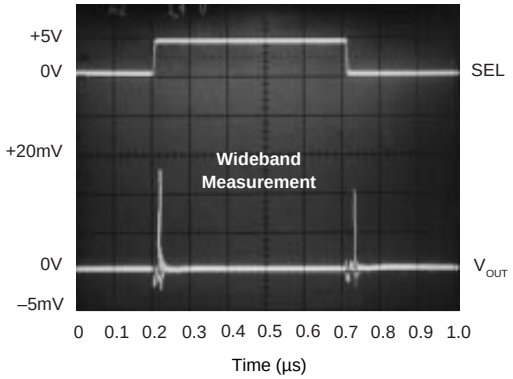


SWITCHING ENVELOPE
(Channel-to-Channel Switching)

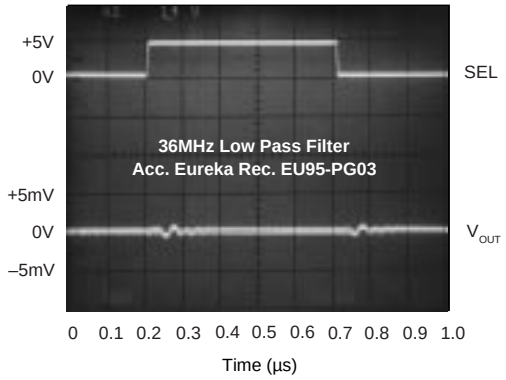




SWITCHING TRANSIENTS



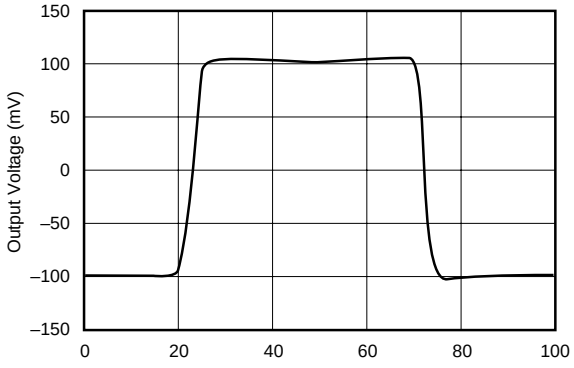
SWITCHING TRANSIENTS



TYPICAL PERFORMANCE CURVES (CONT)

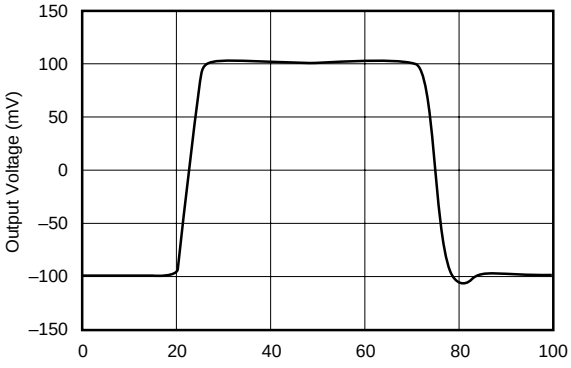
At V_{CC} = ±5VDC, R_L = 10kΩ, R_{IN} = 100Ω, R_{SOURCE} = 50Ω, and T_A = +25°C, unless otherwise noted.

SMALL SIGNAL PULSE RESPONSE



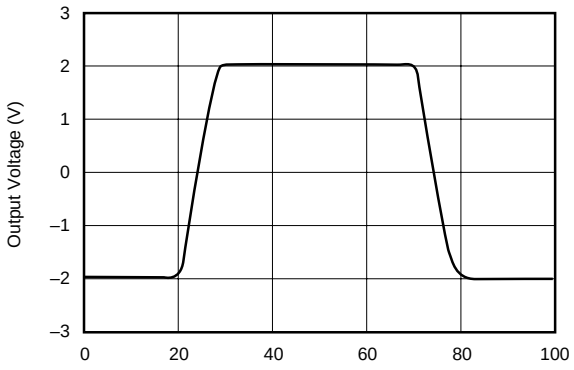
V_{IN} = 0.2Vp-p, C_{OUT} = 1pF
t_{RISE} = t_{FALL} = 2ns (Generator)

SMALL SIGNAL PULSE RESPONSE



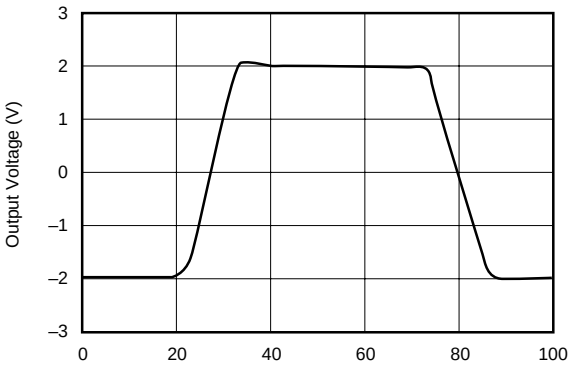
V_{IN} = 0.2Vp-p, C_{OUT} = 47pF
t_{RISE} = t_{FALL} = 2ns (Generator)

LARGE SIGNAL PULSE RESPONSE



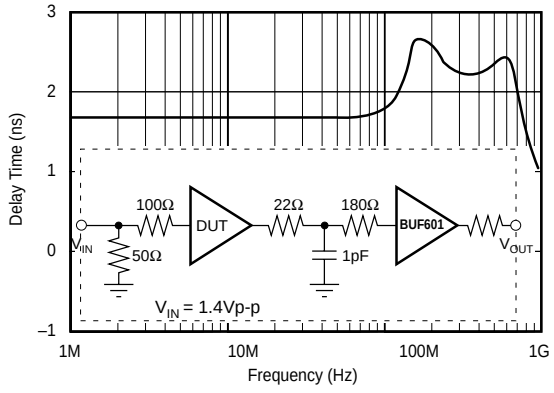
V_{IN} = 4Vp-p, C_{OUT} = 1pF
t_{RISE} = t_{FALL} = 2ns (Generator)

LARGE SIGNAL PULSE RESPONSE

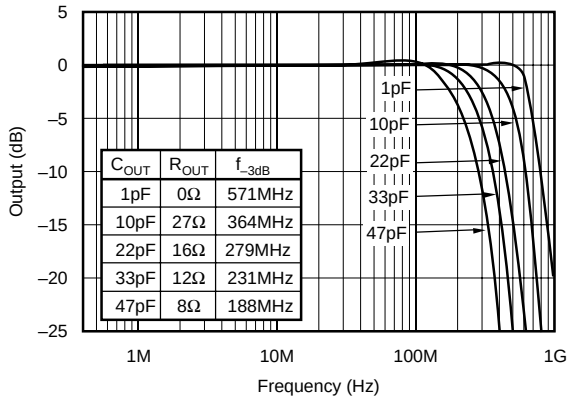


V_{IN} = 4Vp-p, C_{OUT} = 47pF
t_{RISE} = t_{FALL} = 2ns (Generator)

GROUP DELAY TIME vs FREQUENCY



BANDWIDTH vs C_{OUT} WITH RECOMMENDED R_{OUT}

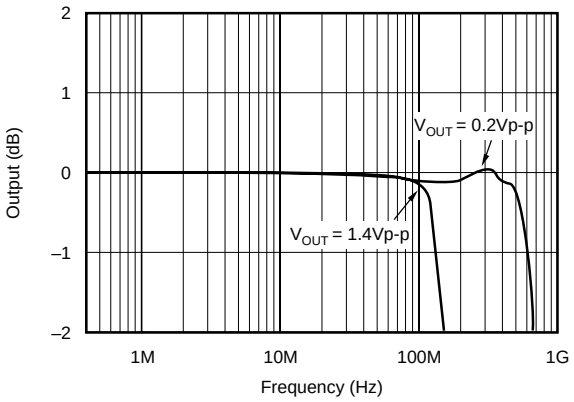


C_{OUT}	R_{OUT}	f_{-3dB}
1pF	0Ω	571MHz
10pF	27Ω	364MHz
22pF	16Ω	279MHz
33pF	12Ω	231MHz
47pF	8Ω	188MHz

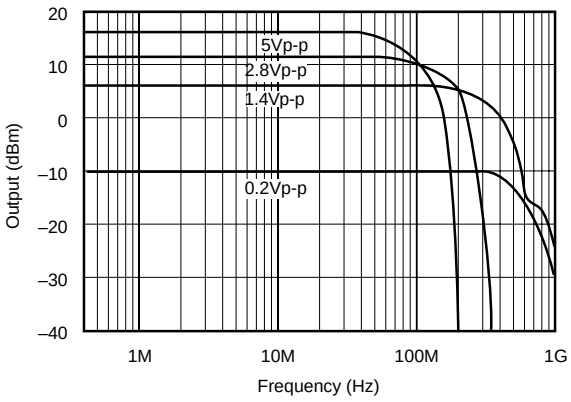
TYPICAL PERFORMANCE CURVES (CONT)

At V_{CC} = ±5VDC, R_L = 10kΩ, R_{IN} = 100Ω, R_{SOURCE} = 50Ω, and T_A = +25°C, unless otherwise noted.

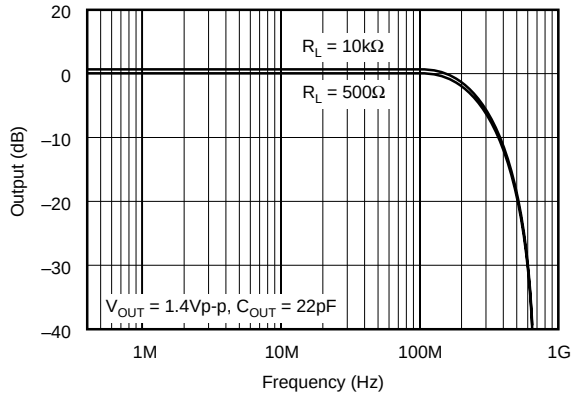
GAIN FLATNESS



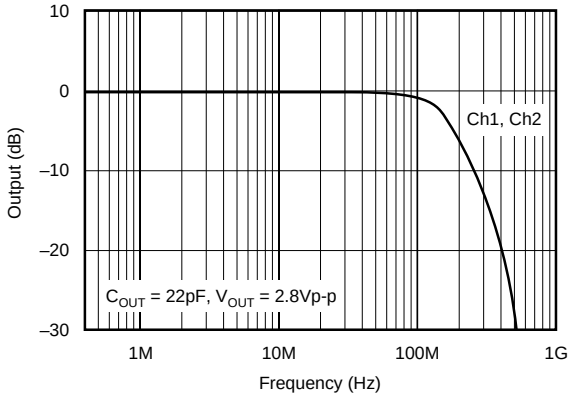
BANDWIDTH vs OUTPUT VOLTAGE



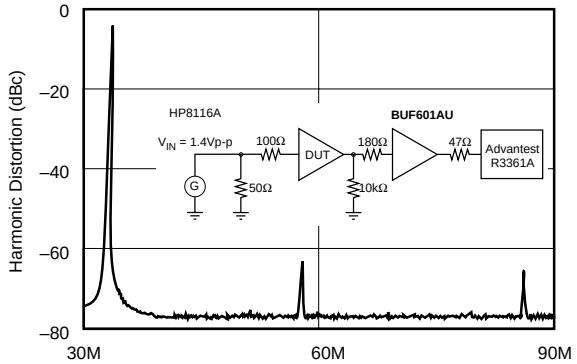
BANDWIDTH vs R_{LOAD}



BANDWIDTH MATCHING

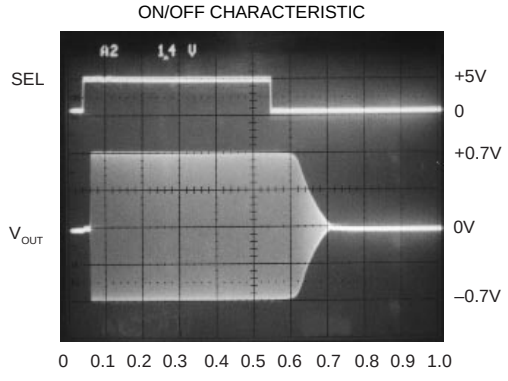


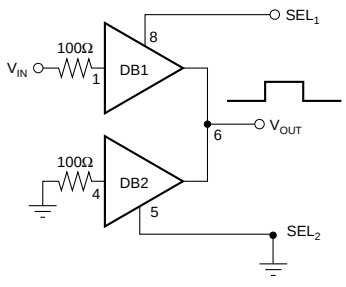
30MHz HARMONIC DISTORITION



V_{OUT} = 1.4Vp-p, R_L = 10kΩ, C_{OUT} = 1pF

ON/OFF CHARACTERISTIC





APPLICATIONS INFORMATION

The MPC104 operates from ±5V power supplies (±6V maximum). Do not attempt to operate with larger power supply voltages or permanent damage may occur. The buffer outputs are not current-limited or protected. If the output is shorted to ground, currents up to 18mA could flow. Momentary shorts to ground (a few seconds) should be avoided, but are unlikely to cause permanent damage.

INPUT PROTECTION

As shown below, all pins on the MPC104 are internally protected from ESD by a pair of back-to-back reverse-biased diodes to either power supply. These diodes will begin to conduct when the input voltage exceeds either power supply by about 0.7V. This situation can occur with loss of the amplifier's power supplies while a signal source is still present. The diodes can typically withstand a continuous current of 30mA without destruction. To insure long term reliability, however, diode current should be externally limited to 10mA whenever possible.

The internal protection diodes are designed to withstand 2.5kV (using Human Body Model) and will provide adequate ESD protection for most normal handling procedures. However, static damage can cause subtle changes in the characteristics of the buffer amplifier input without necessarily destroying the device. In precision buffer amplifiers, such damage may cause a noticeable degradation of offset voltage and drift. Therefore, static protection is strongly recommended when handling the MPC104.

Static damage has been well-recognized as a problem for MOSFET devices, but any semiconductor device deserves protection from this potentially damaging source. The MPC104 incorporates on-chip ESD protection diodes as shown in Figure 1. Thus the user does not need to add external protection diodes, which can add capacitance and degrade AC performance.

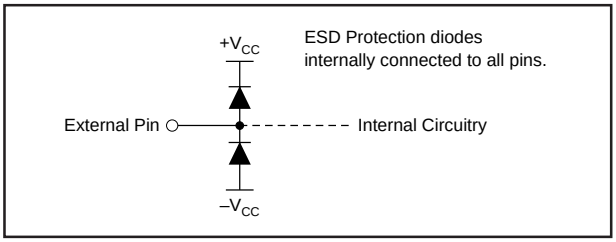


FIGURE 1. Internal ESD Protection.

DISCUSSION OF PERFORMANCE

The MPC104 is a 2 x 1, wide-band analog signal multiplexer. It allows the user to connect one of the two inputs (IN_1/IN_2) to the output. The switching speed between two input channels is typically less than 300ns.

However, in contrast to signal switches using CMOS or DMOS transistors, the switching transients were kept very low at +13mV and –4mV. The MPC104 consists of two identical unity-gain buffer amplifiers, respectively connected together internally at the output. The open-loop buffer amps, which consist of complementary emitter followers, apply no feedback so their low-frequency gain is slightly less than unity and somewhat dependent on loading. Unlike devices using MOS bilateral switching elements, the bipolar complementary buffers form a unidirectional transmission path, thus providing high output-to-input isolation. Switching stages compatible to TTL-level digital signals are provided for each buffer to select the input channel. When no channel is selected, the outputs of the device are high-impedance and allow the user to wire several MPC104s together to create multichannel switch matrices.

Chip select logic is not integrated. The selected design increases the flexibility of address decoding in complex distribution fields, eases BUS-controlled channel selection, simplifies channel selection monitoring for the user, and lowers transient peaks. All of these characteristics make the multiplexer, in effect, a quad switchable high-speed buffer. The buffers require DC coupling and termination resistors when driven directly from a low-impedance cable. High-current output amplifiers are recommended when driving low-impedance transmission lines or inputs.

An advanced complementary bipolar process, consisting of pn-junction isolated, high-frequency NPN and PNP transistors, provides wide bandwidth while maintaining low crosstalk and harmonic distortion. The single chip bandwidth of over 210MHz at an output voltage of 1.4Vp-p allows the design of multi-channel crosspoint or distribution fields in HDTV-quality with an overall system bandwidth of 36MHz, or in quality for high resolution graphic and imaging systems with 200MHz system bandwidth. The buffer amplifiers also offer low differential gain (0.03%) and phase (0.01°) errors. These parameters are essential for video applications and demonstrate how well the signal path maintains a constant small-signal gain and phase for the low-level color subcarrier at 4.43MHz (PAL) or 3.58MHz (NSTC) as the luminance signal is ramped through its specified range. The bipolar construction also ensures that the input impedance remains high and constant between ON and OFF states. The ON/OFF input capacitance ratio is near unity, and does not vary with power supply voltage variations. The low output capacitance of 1.2pF when no channel is selected is a very important parameter for large distribution fields. Each parallel output capacitance is an additional load and reduces the overall system bandwidth.

Bipolar video crosspoint switches are virtually glitch-free when compared to signal switches using CMOS or DMOS devices. The MPC104 operates with a fast make-before-break switching action to keep the output switching transients small and short. Switching from one channel to another causes the signal to mix at the output for a short time, but it hardly interferes with the input signals. The transient peaks remain less than +13mV and –4mV. The generated output transients are extremely small, so DC clamping during switching between channels is unnecessary. DC clamping during the switching dead time is re-

quired to avoid synchronization by large negative output glitches in subsequent equipment.

The SEL-to-channel-ON time is typically 25ns and always shorter than the typical SEL-to-channel-OFF time of 250ns. In the worst case, an ON/OFF margin of 150ns ensures safe switching even for timing spreads in the digital control latches. The short interchannel switching time of 300ns allows channel change during the vertical blanking time, even in high-resolution graphic or broadcast systems. As shown in the typical performance curves, the signal envelope during transition from one channel to another rises and falls symmetrically and shows less overshooting and DC settling effects.

Power consumption is a serious problem when designing large crosspoint fields with high component density. Most of the buffer amplifiers are in the off-state. One important design goal was to attain low off-state quiescent current when no channel is selected. The low supply current of ±120µA when no channel is selected and ±4.6mA when one channel is selected, as well as the reduced ±5V supply voltage, conserves power, simplifies the power supply design, and results in cooler, more reliable operation.

CIRCUIT LAYOUT

The high-frequency performance of the MPC104 can be greatly affected by the physical layout of the circuit. The following tips are offered as suggestions, not as absolutes. Oscillations, ringing, poor bandwidth and settling, higher crosstalk, and peaking are all typical problems which plague high-speed components when they are used incorrectly.

- Bypass power supplies very close to the device pins. Use tantalum chip capacitors (approximately 2.2µF), a parallel 470pF ceramic chip capacitor may be added if desired. Surface-mount types are recommended due to their low lead inductance.
- PC board traces for signal and power lines should be wide to reduce impedance or inductance.
- Make short and low inductance traces. The entire physical circuit should be as small as possible.
- Use a low-impedance ground plane on the component side to ensure that low-impedance ground is available throughout the layout. Grounded traces between the input traces are essential to achieve high interchannel crosstalk rejection.
- Do not extend the ground plane under high-impedance nodes sensitive to stray capacitances, such as the buffer's input terminals.
- Sockets are not recommended, because they add significant inductance and parasitic capacitance. If sockets must be used, consider using zero-profile solderless sockets.
- Use low-inductance and surface-mounted components. Circuits using all surface mount components with the MPC104 will offer the best AC-performance.
- A resistor (100Ω to 150Ω) in series with the input of the buffers may help to reduce peaking. Place the resistor as close as possible to the pin.
- Plug-in prototype boards and wire-wrap boards will not function well. A clean layout using RF techniques is essential—there are no shortcuts.

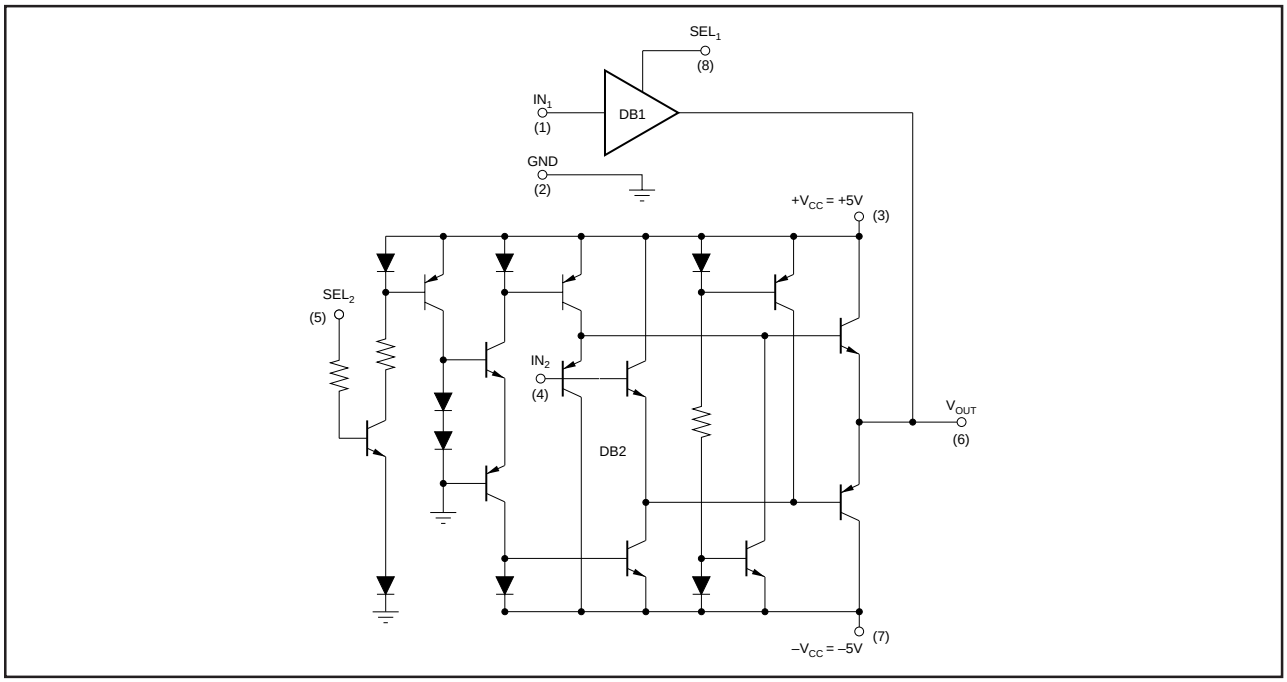
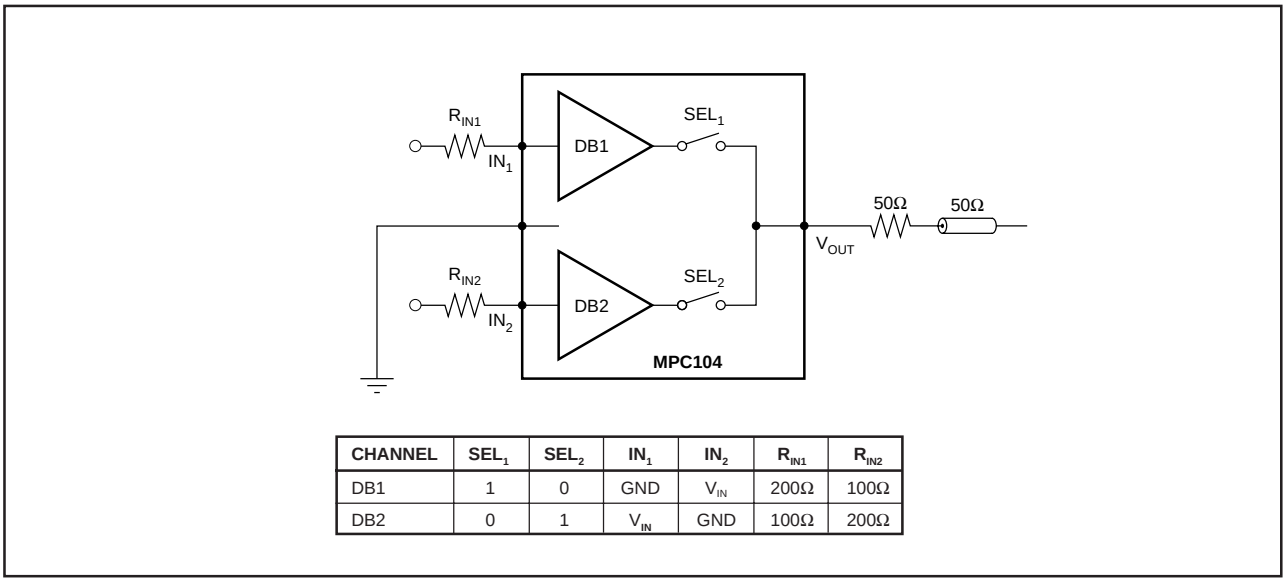
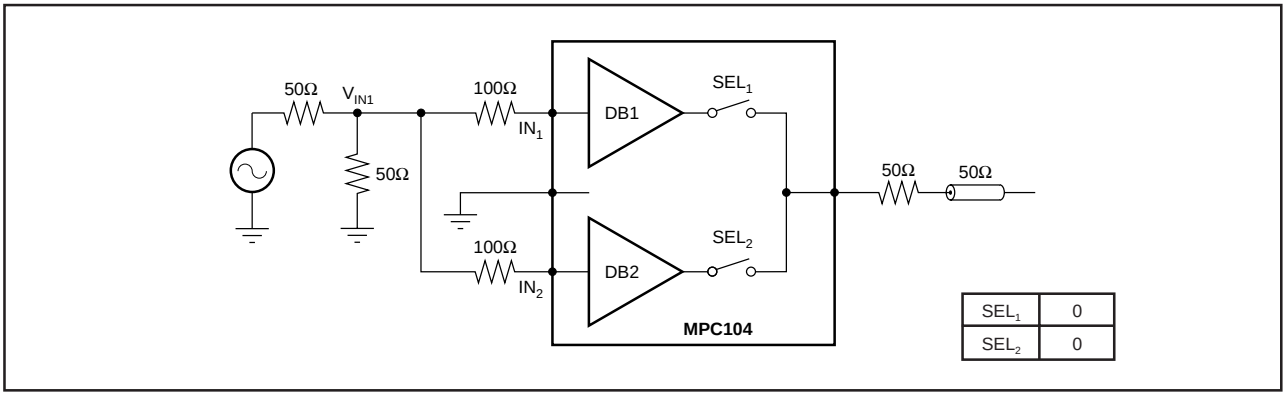


FIGURE 2. Simplified Circuit Diagram.



CHANNEL	SEL_1	SEL_2	IN_1	IN_2	R_{IN1}	R_{IN2}
DB1	1	0	GND	V_{IN}	200Ω	100Ω
DB2	0	1	V_{IN}	GND	100Ω	200Ω

FIGURE 3. Crosstalk Test Circuit 1.



SEL_1	0
SEL_2	0

FIGURE 4. Off Isolation Test Circuit 2.

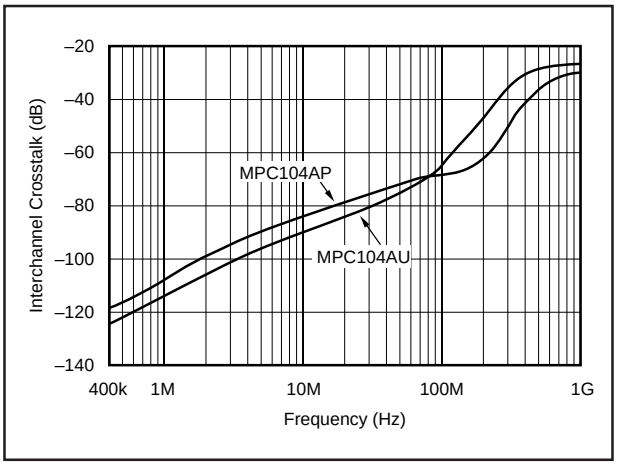


FIGURE 5. Interchannel Crosstalk.

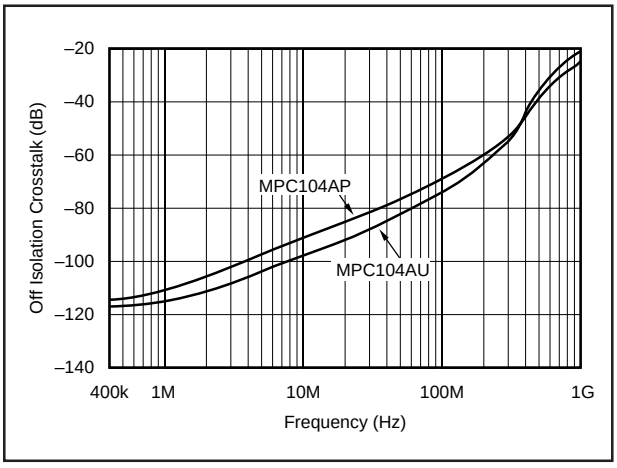


FIGURE 6. Off Isolation.

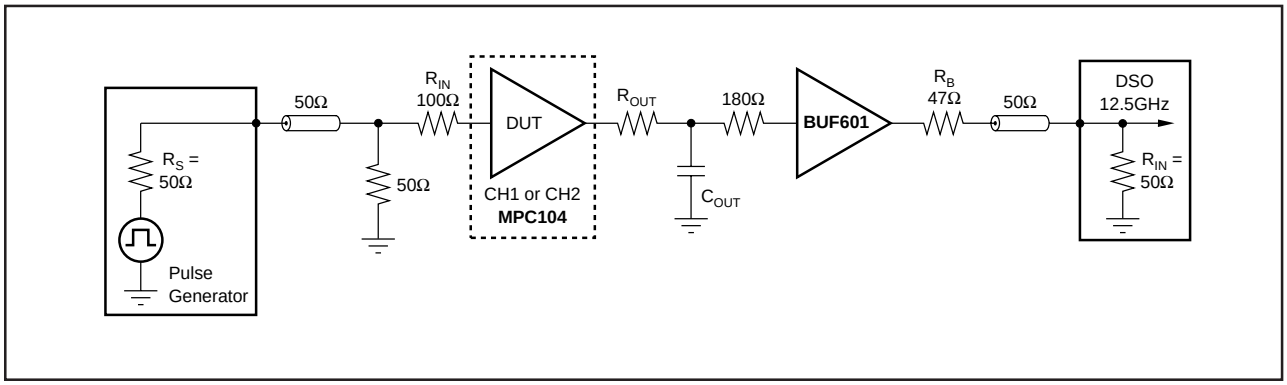


FIGURE 7. Test Circuit Pulse Response.

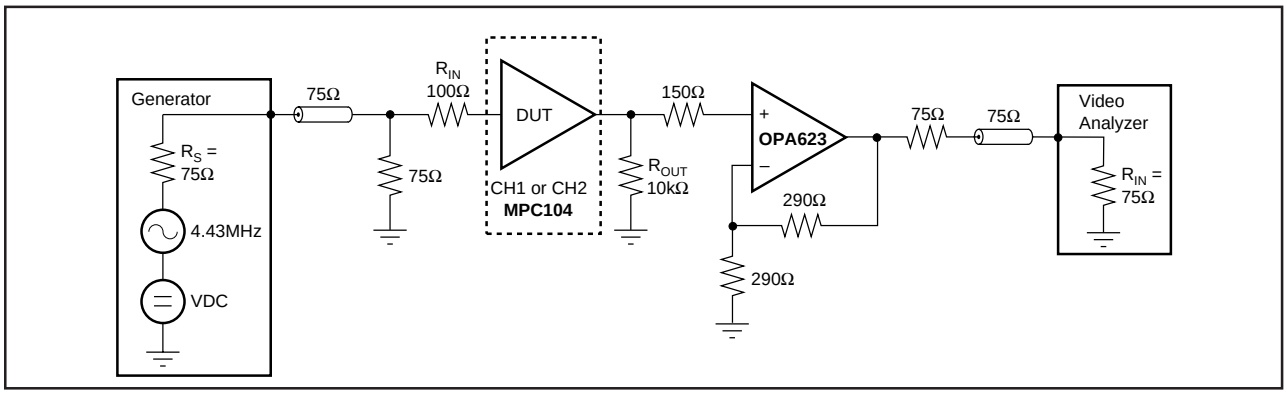


FIGURE 8. Test Circuit Differential Gain and Phase.

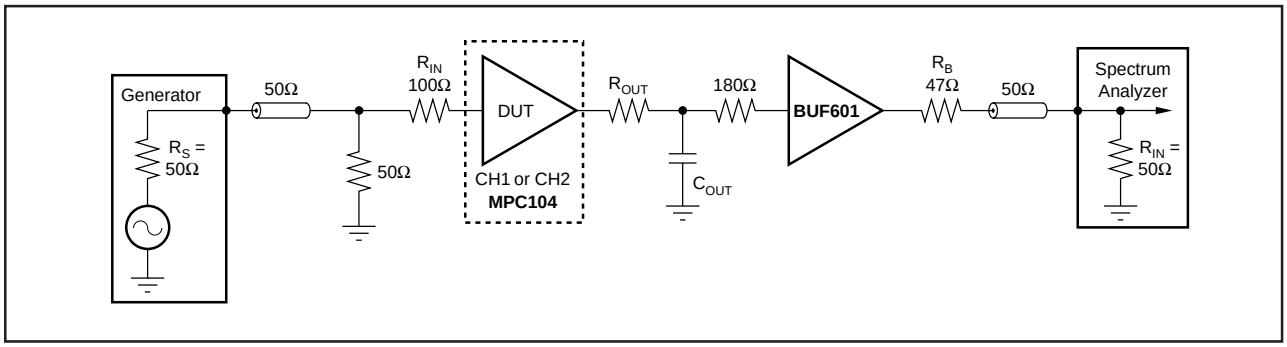


FIGURE 9. Test Circuit Frequency Response.

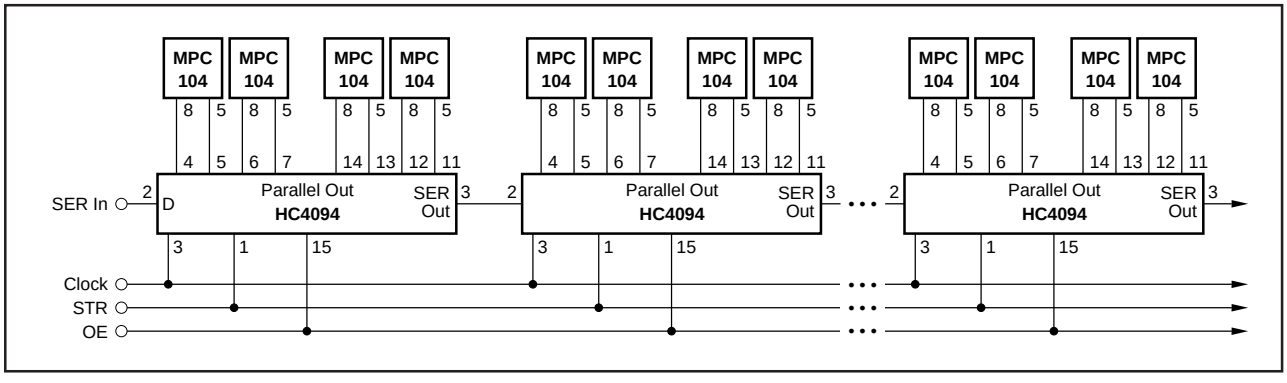


FIGURE 10. Serial Bus-Controlled Distribution Field.

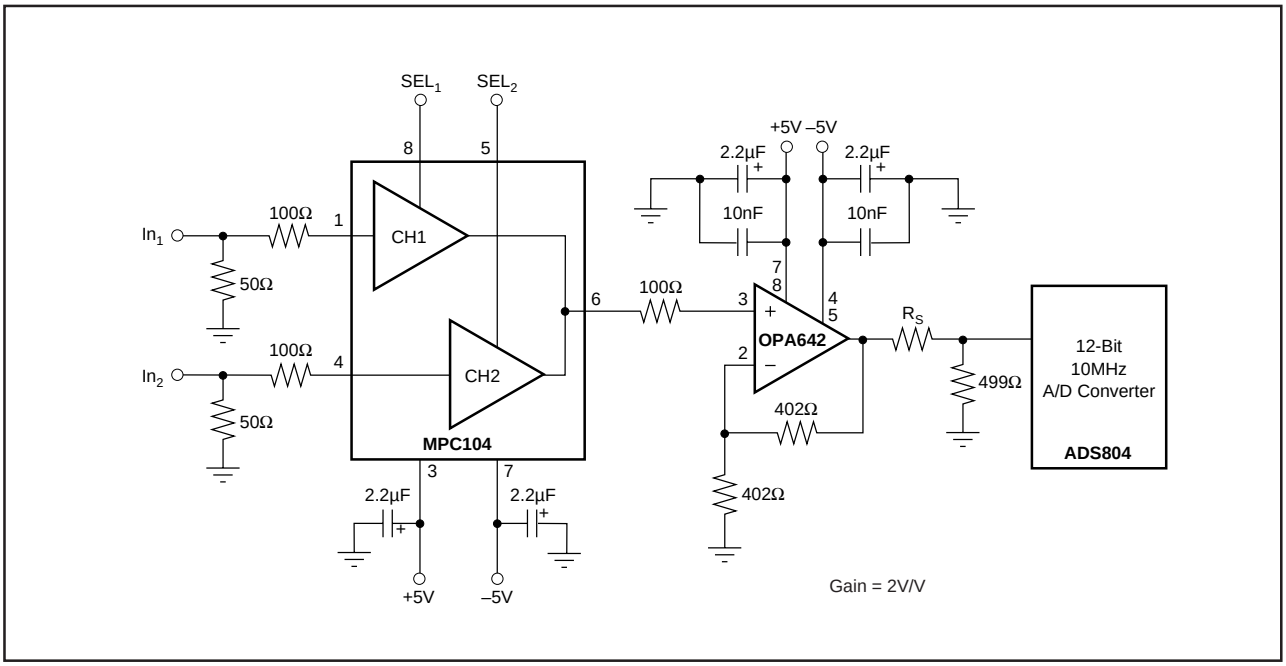


FIGURE 11. High-Speed Data Acquisition System.

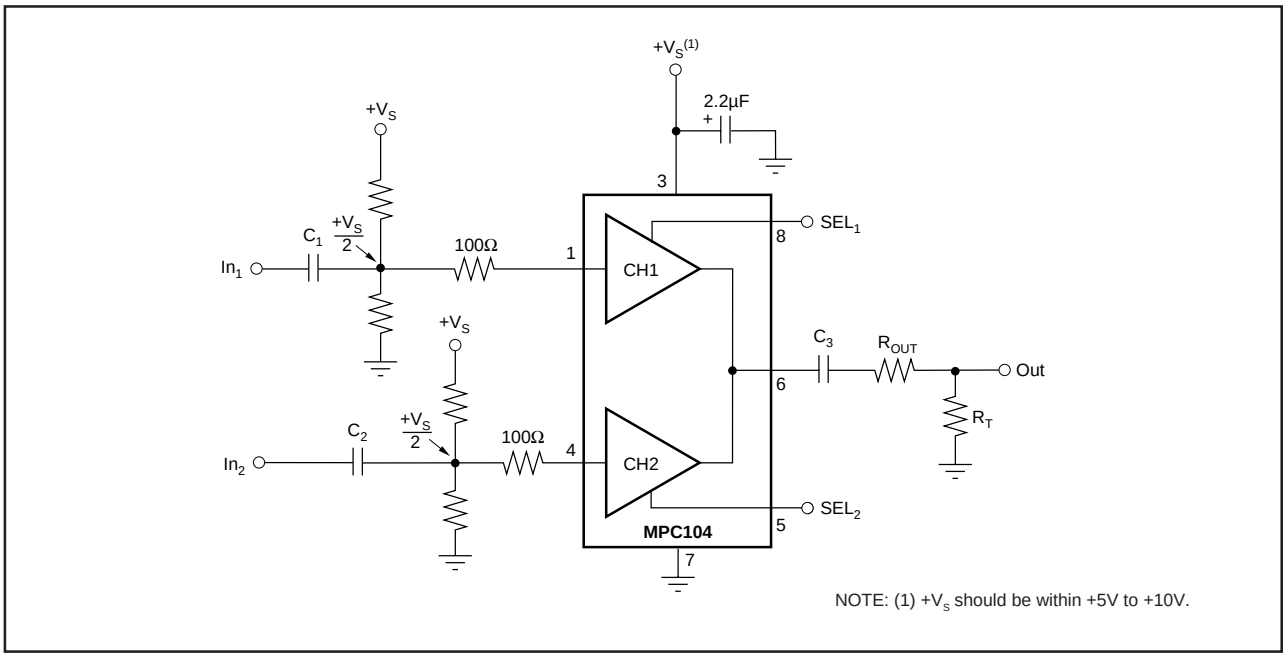


FIGURE 12. Single Supply Operation.

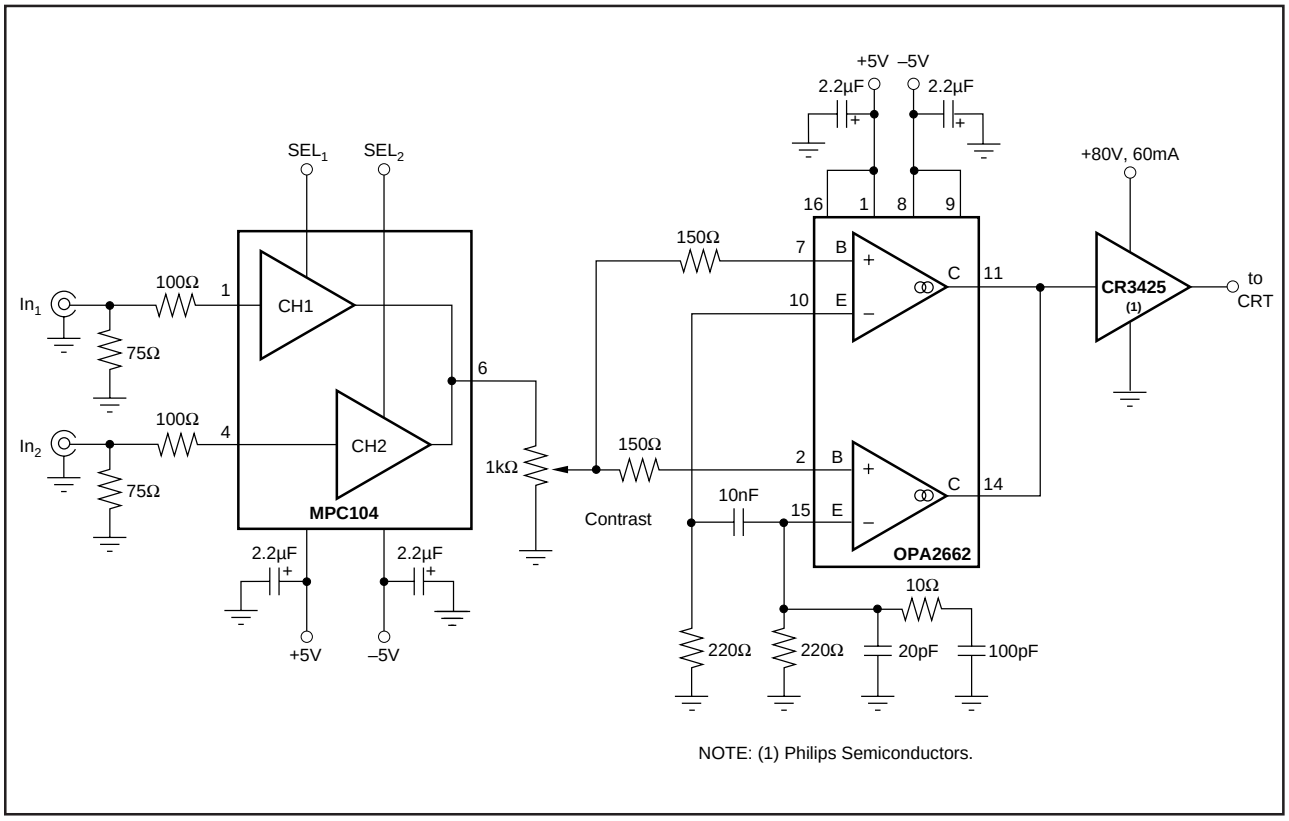


FIGURE 13. Input Multiplexer for a CRT Output Stage.

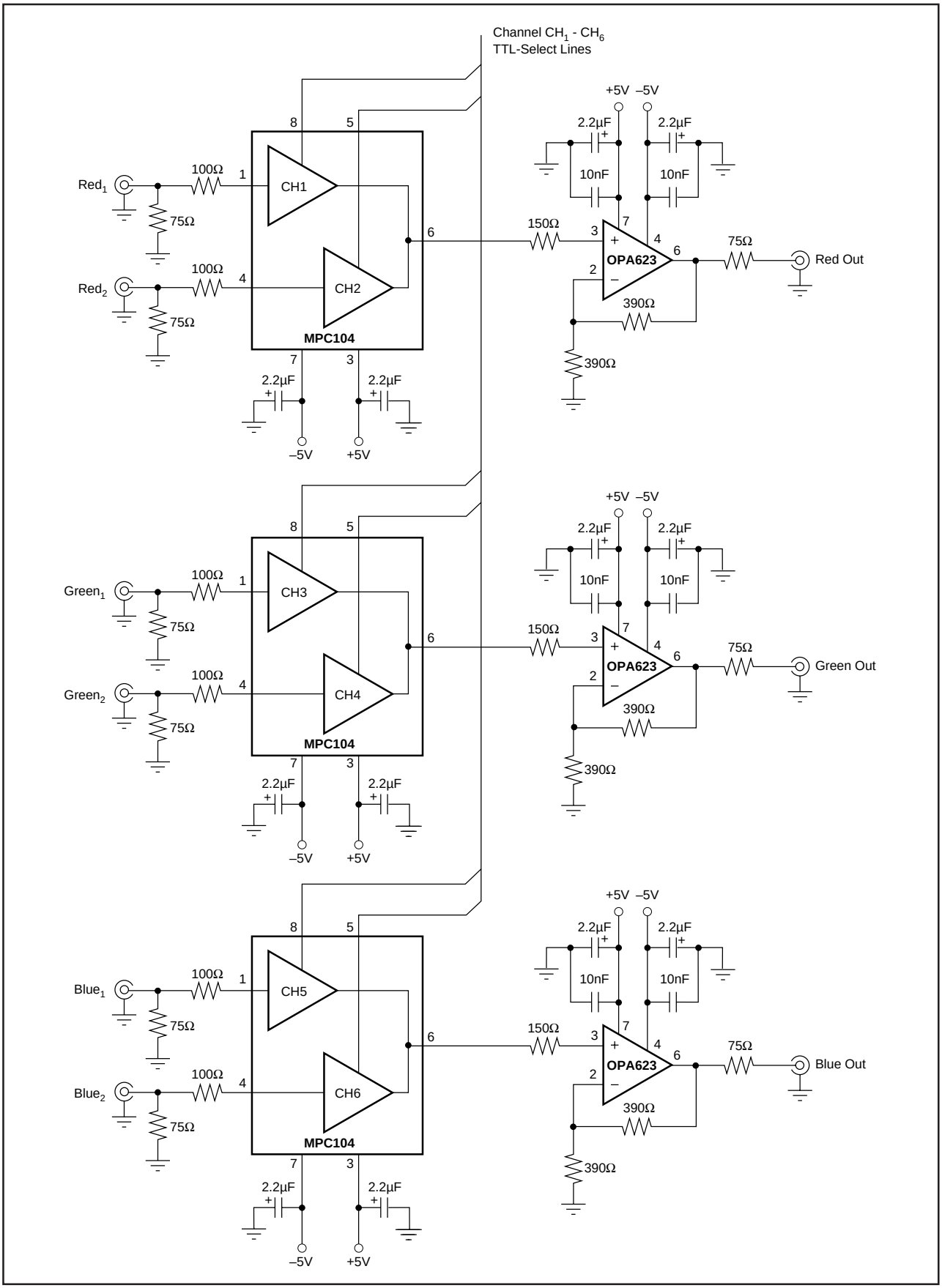


FIGURE 14. Input Multiplexer for RGB Video Signals.