élantec
HIGH PERFORMANCE ANALOG INTEGRATED CIRCUITS

EL4095C
Video Gain Control/Fader/Multiplexer

Features
- Full function video fader
- 0.02%/0.02° differential gain/phase @ 100% gain
- 25 ns multiplexer included
- Output amplifier included
- Calibrated linear gain control
- ±5V to ±15V operation
- 60 MHz bandwidth
- Low thermal errors

Applications
- Video faders/wipers
- Gain control
- Graphics overlay
- Video text insertion
- Level adjust
- Modulation

Ordering Information

Part No.	Temp. Range	Package	Outline#
EL4095CN	$-40°$C to $+85°$C	14 Pin P-DIP	MDP0031
EL4095CS	$-40°$C to $+85°$C	SO-14	MDP0027

General Description

The EL4095C is a versatile variable-gain building block. At its core is a fader which can variably blend two inputs together and an output amplifier that can drive heavy loads. Each input appears as the input of a current-feedback amplifier and with external resistors can separately provide any gain desired. The output is defined as:

$$V_{OUT} = A^*V_{INA} (0.5V + V_{GAIN}) + B^*V_{INB} (0.5V - V_{GAIN}),$$

where A and B are the fed-back gains of each channel.

Additionally, two logic inputs are provided which each override the analog V_{GAIN} control and force 100% gain for one input and 0% for the other. The logic inputs switch in only 25 ns and provide high attenuation to the off channel, while generating very small glitches.

Signal bandwidth is 60 MHz, and gain-control bandwidth 20 MHz. The gain control recovers from overdrive in only 70 ns.

The EL4095C operates from ±5V to ±15V power supplies, and is available in both 14-pin DIP and narrow surface mount packages.

Connection Diagram

14-Pin DIP, SO

Top View
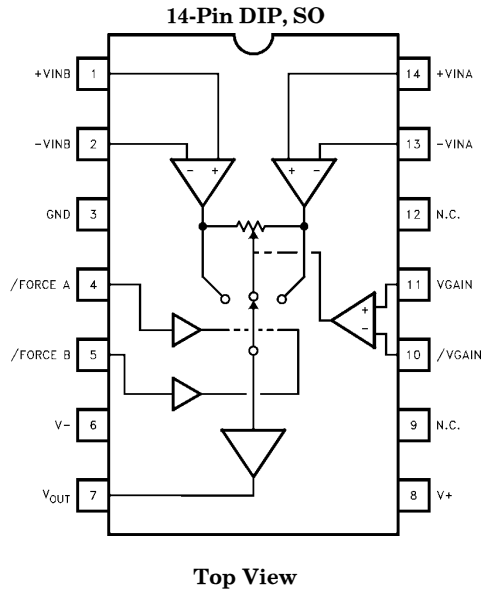
Manufactured under U.S. Patent No. 5,321,371, 5,374,898

Note: All information contained in this data sheet has been carefully checked and is believed to be accurate as of the date of publication; however, this data sheet cannot be a "controlled document". Current revisions, if any, to these specifications are maintained at the factory and are available upon your request. We recommend checking the revision level before finalization of your design documentation.

© 1992 Elantec, Inc.

EL4095C
Video Gain Control/Fader/Multiplexer

Absolute Maximum Ratings $(T_A = 25°C)$

V_{S+}	Supply Voltage	$+18V$
V_S	Voltage between $V_S{}^+$ and $V_S{}^-$	$+33V$
$+V_{INA}$,	Input Voltage	$(V_S-) -0.3V$
$+V_{INB}$		to $(V_S{}^+) +0.3V$
I_{IN}	Current Into $-V_{INA}$, $-V_{INB}$	5 mA
V_{GAIN}	Input Voltage	$V_{\overline{GAIN}} \pm 5V$
$V_{\overline{GAIN}}$	Input Voltage	$V_S- \text{ to } V_S+$
V_{FORCE}	Input Voltage	$-1V \text{ to } +6V$
I_{OUT}	Output Current	$\pm 35\text{ mA}$
T_A	Operating Temperature Range	$-40°C \text{ to } +85°C$
T_J	Operating Junction Temperature	$0°C \text{ to } +150°C$
T_{ST}	Storage Temperature Range	$-65°C \text{ to } +150°C$
Internal Power Dissipation		See Curves

Important Note:

All parameters having Min/Max specifications are guaranteed. The Test Level column indicates the specific device testing actually performed during production and Quality inspection. Elantec performs most electrical tests using modern high-speed automatic test equipment, specifically the LTX77 Series system. Unless otherwise noted, all tests are pulsed tests, therefore $T_J = T_C = T_A$.

Test Level	Test Procedure
I	100% production tested and QA sample tested per QA test plan QCX0002.
II	100% production tested at $T_A = 25°C$ and QA sample tested at $T_A = 25°C$, T_{MAX} and T_{MIN} per QA test plan QCX0002.
III	QA sample tested per QA test plan QCX0002.
IV	Parameter is guaranteed (but not tested) by Design and Characterization Data.
V	Parameter is typical value at $T_A = 25°C$ for information purposes only.

Open Loop DC Electrical Characteristics

$V_S = \pm15V$, $T_A = 25°C$, $V_{\overline{GAIN}}$ ground unless otherwise specified

Parameter	Description	Limits			Test Level	Units
		Min	Typ	Max		
V_{OS}	Input Offset Voltage		1.5	5	I	mV
I_{B+}	$+V_{IN}$ Input Bias Current		5	10	I	μA
I_{B-}	$-V_{IN}$ Input Bias Current		10	50	I	μA
CMRR	Common Mode Rejection	65	80		I	dB
$-$CMRR	$-V_{IN}$ Input Bias Current Common Mode Rejection		0.5	1.5	I	$\mu A/V$
PSRR	Power Supply Rejection Ratio	65	95		I	dB
$-$IPSR	$-V_{IN}$ Input Current Power Supply Rejection Ratio		0.2	2	I	$\mu A/V$
R_{OL}	Transimpedance	0.2	0.4		I	$M\Omega$
R_{IN-}	$-V_{IN}$ Input Resistance		80		V	Ω
V_{IN}	$+V_{IN}$ Range	$(V-) + 3.5$		$(V+) -3.5$	I	V
V_O	Output Voltage Swing	$(V-) +2$		$(V+) -2$	I	V
I_{SC}	Output Short-Circuit Current	80	125	160	I	mA
V_{IH}	Input High Threshold at Force A or Force B Inputs			2.0	I	V
V_{IL}	Input Low Threshold at Force A or Force B Inputs	0.8			I	V
I_{FORCE}, High	Input Current of Force A or Force B, $V_{FORCE} = 5V$			-50	I	μA
I_{FORCE}, Low	Input Current of Force A or Force B, $V_{FORCE} = 0V$		-440	-650	I	μA

2

TD is 0.7in

TD is 4.0in

Open Loop DC Electrical Characteristics — Contd.

$V_S = \pm 15V$, $T_A = 25°C$, unless otherwise specified

Parameter	Description	Limits			Test Level	Units
		Min	Typ	Max		
Feedthrough, Forced	Feedthrough of Deselected Input to Output, Deselected Input at 100% Gain Control	60	75		I	dB
V_{GAIN}, 100%	Minimum Voltage at V_{GAIN} for 100% Gain	0.45	0.5	0.55	I	V
V_{GAIN}, 0%	Maximum Voltage at V_{GAIN} for 0% Gain	-0.55	-0.5	-0.45	I	V
NL, Gain	Gain Control Non-linearity, $V_{IN} = \pm 0.5V$		2	4	I	%
R_{IN}, VG	Impedance between V_{GAIN} and $\overline{V_{GAIN}}$	4.5	5.5	6.5	I	kΩ
NL, $A_V = 1$	Signal Non-linearity, $V_{IN} = \pm 1V$, $V_{GAIN} = 0.55V$		<0.01		V	%
$A_V = 0.5$	Signal Non-linearity, $V_{IN} = \pm 1V$, $V_{GAIN} = 0V$		0.03		V	%
$A_V = 0.25$	Signal Non-linearity, $V_{IN} = \pm 1V$, $V_{GAIN} = -0.25V$		0.07	0.4	I	%
I_S	Supply Current		17	21	I	mA

Closed Loop AC Electrical Characteristics

$V_S = \pm 15V$, $A_V = +1$, $R_F = R_{IN} = 1\,k\Omega$, $R_L = 500\Omega$, $C_L = 15\,pF$, $C_{IN}- = 2\,pF$, $T_A = 25°C$, $A_V = 100\%$ unless otherwise noted

Parameter	Description	Limits			Test Level	Units
		Min	Typ	Max		
SR	Slew Rate; V_{OUT} from $-3V$ to $+3V$ Measured at $-2V$ and $+2V$		330		V	V/µs
BW	Bandwidth -3 dB		60			MHz
	-1 dB		30		V	MHz
	-0.1 dB		6			MHz
dG	Differential Gain; AC Amplitude of 286 mV$_{p-p}$ at 3.58 MHz on DC Offset of $-0.7V$, 0V and $+0.7V$					
	$A_V = 100\%$		0.02		V	%
	$A_V = 50\%$		0.07			%
	$A_V = 25\%$		0.07			%
dθ	Differential Phase; AC Amplitude of 286 mV$_{p-p}$ at 3.58 MHz on DC Offset of $-0.7V$, 0V and $+0.7V$					
	$A_V = 100\%$		0.02		V	°
	$A_V = 50\%$		0.05			°
	$A_V = 25\%$		0.15			°
T_S	Settling Time to 0.2%; V_{OUT} from $-2V$ to $+2V$					
	$A_V = 100\%$		100		V	ns
	$A_V = 25\%$		100			ns
T_{FORCE}	Propagation Delay from $V_{FORCE} = 1.4V$ to 50% Output Signal Enabled or Disabled Amplitude		25		V	ns
BW, Gain	-3 dB Gain Control Bandwidth, V_{GAIN} Amplitude 0.5 V$_{P-P}$		20		V	MHz
T_{REC}, Gain	Gain Control Recovery from Overload; V_{GAIN} from $-0.7V$ to 0V		70		V	ns

TD is 2.4in

TD is 3.8in

EL4095C
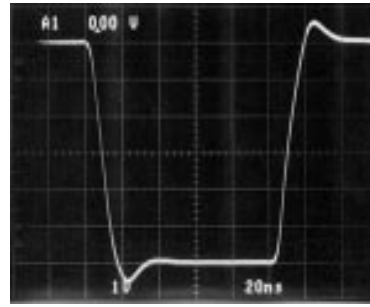## Video Gain Control/Fader/Multiplexer

Typical Performance Curves

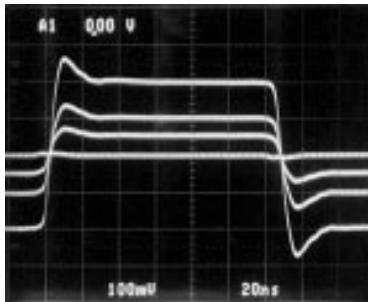**Large-Signal Pulse Response Gain = +1**
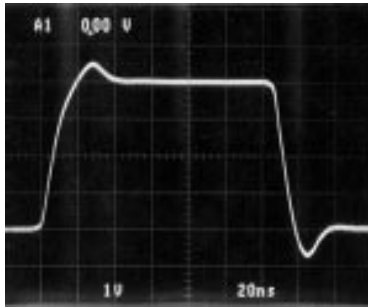
4095–6
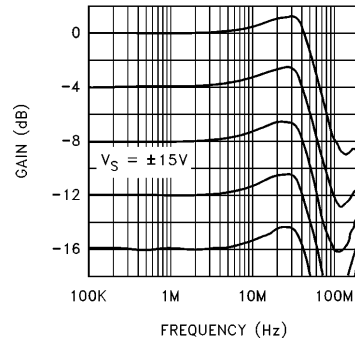
Large-Signal Pulse Response Gain = −1

4095–7

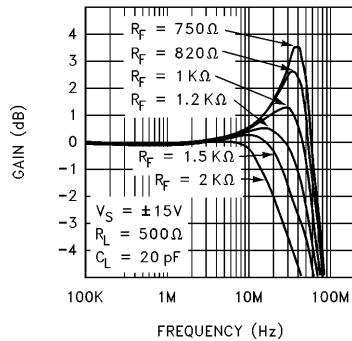**Small-Signal Pulse Response for Various Gains**

4095–8

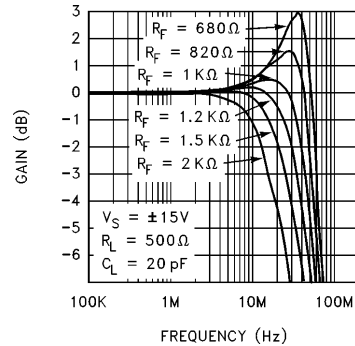**Frequency Response for Different Gains-A_V = +1**

$V_S = \pm 15V$

4095–9

Frequency Response with Different Values of R_F − Gain = +1

$R_F = 750\,\Omega$
$R_F = 820\,\Omega$
$R_F = 1\,K\Omega$
$R_F = 1.2\,K\Omega$
$R_F = 1.5\,K\Omega$
$R_F = 2\,K\Omega$
$V_S = \pm 15V$
$R_L = 500\,\Omega$
$C_L = 20\,pF$

4095–10

Frequency Response with Different Values of R_F − Gain = −1

$R_F = 680\,\Omega$
$R_F = 820\,\Omega$
$R_F = 1\,K\Omega$
$R_F = 1.2\,K\Omega$
$R_F = 1.5\,K\Omega$
$R_F = 2\,K\Omega$
$V_S = \pm 15V$
$R_L = 500\,\Omega$
$C_L = 20\,pF$

4095–11

4

Typical Performance Curves — Contd.

Frequency Response with Different Gains

A_V = +1
A_V = +2
A_V = +5
A_V = +10

GAIN (dB)

$V_S = \pm 15V$
$R_F = 1 K\Omega$
$R_L = 500 \Omega$
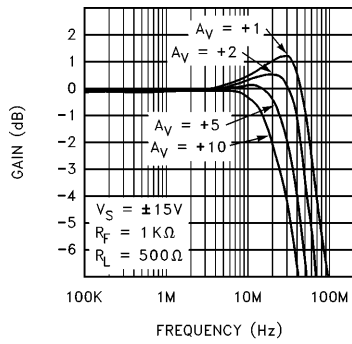
FREQUENCY (Hz)

Frequency Response with Various Load Capacitances and Resistances
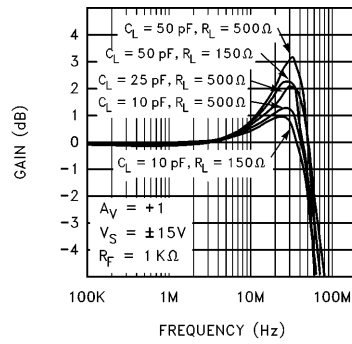
$C_L = 50$ pF, $R_L = 500 \Omega$
$C_L = 50$ pF, $R_L = 150 \Omega$
$C_L = 25$ pF, $R_L = 500 \Omega$
$C_L = 10$ pF, $R_L = 500 \Omega$
$C_L = 10$ pF, $R_L = 150 \Omega$

GAIN (dB)

$A_V = +1$
$V_S = \pm 15V$
$R_F = 1 K\Omega$

FREQUENCY (Hz)

Frequency Response with Various Values of Parasitic C_{IN-}
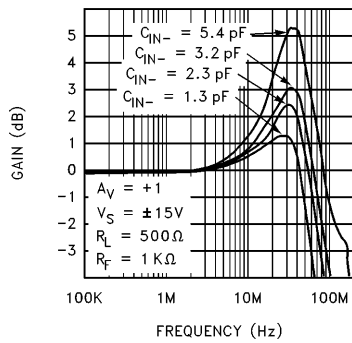
$C_{IN-} = 5.4$ pF
$C_{IN-} = 3.2$ pF
$C_{IN-} = 2.3$ pF
$C_{IN-} = 1.3$ pF

GAIN (dB)

$A_V = +1$
$V_S = \pm 15V$
$R_L = 500 \Omega$
$R_F = 1 K\Omega$

FREQUENCY (Hz)

Input Noise Voltage and Current vs Frequency
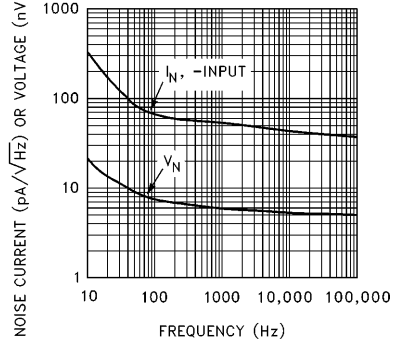
NOISE CURRENT $(pA/\sqrt{Hz})$ OR VOLTAGE $(nV/\sqrt{Hz})$

I_N, −INPUT

V_N

FREQUENCY (Hz)

Change in Bandwidth and Slewrate with Supply Voltage − Gain = +1

CHANGE IN BANDWIDTH OR SLEWRATE (%)

BANDWIDTH

SLEWRATE ($4V_{PP}$)

V_{SUPPLY} (±V)

Change in Bandwidth and Slewrate with Supply Voltage − Gain = −1

CHANGE IN BANDWIDTH OR SLEWRATE (%)
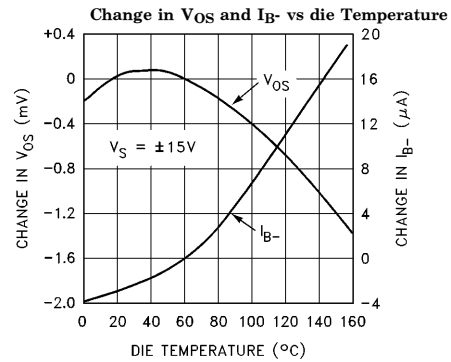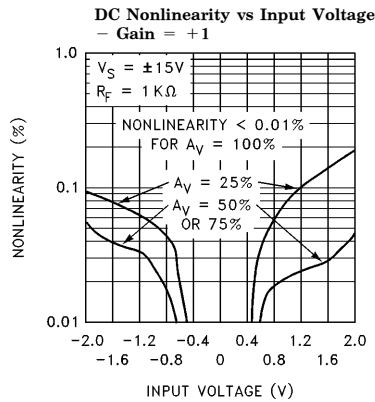
BANDWIDTH
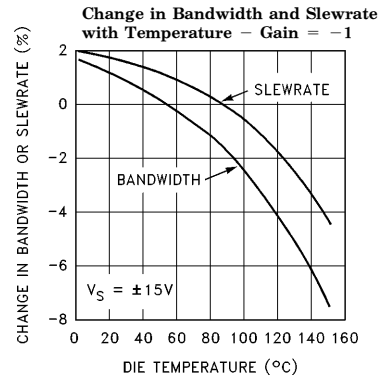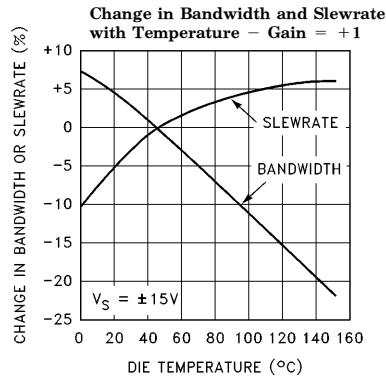
SLEWRATE ($5.5V_{P-P}$)
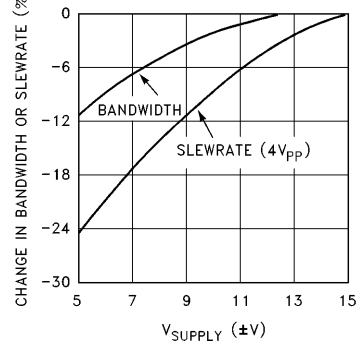
V_{SUPPLY} (±V)
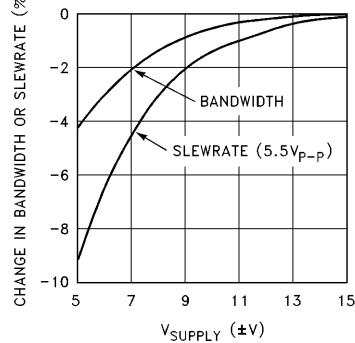
4095−12

EL4095C
Video Gain Control/Fader/Multiplexer

Typical Performance Curves — Contd.

Change in Bandwidth and Slewrate with Temperature − Gain = +1
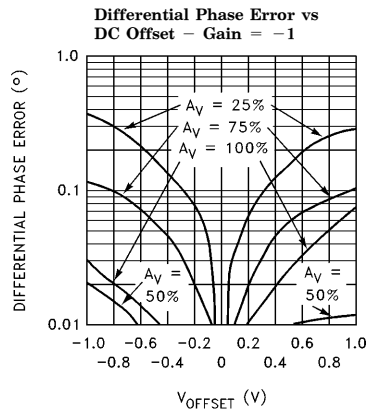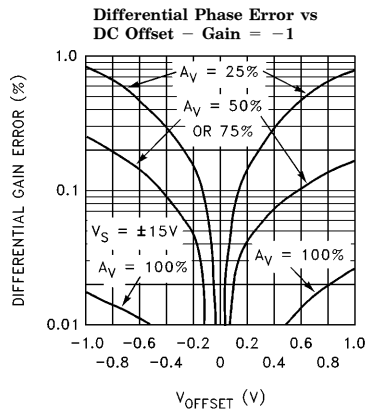
CHANGE IN BANDWIDTH OR SLEWRATE (%)

+10 +5 0 −5 −10 −15 −20 −25

SLEWRATE
BANDWIDTH
$V_S = \pm 15V$

DIE TEMPERATURE (°C)
0 20 40 60 80 100 120 140 160

Change in Bandwidth and Slewrate with Temperature − Gain = −1

CHANGE IN BANDWIDTH OR SLEWRATE (%)

2 0 −2 −4 −6 −8

SLEWRATE
BANDWIDTH
$V_S = \pm 15V$

DIE TEMPERATURE (°C)
0 20 40 60 80 100 120 140 160

DC Nonlinearity vs Input Voltage − Gain = +1

NONLINEARITY (%)

1.0 0.1 0.01

$V_S = \pm 15V$
$R_F = 1K\Omega$

NONLINEARITY < 0.01%
FOR $A_V = 100\%$

$A_V = 25\%$
$A_V = 50\%$ OR 75%

INPUT VOLTAGE (V)
−2.0 −1.6 −1.2 −0.8 −0.4 0 0.4 0.8 1.2 1.6 2.0

Change in V_{OS} and I_{B-} vs die Temperature

CHANGE IN V_{OS} (mV)

+0.4 0 −0.4 −0.8 −1.2 −1.6 −2.0

CHANGE IN I_{B-} (μA)

20 16 12 8 4 0 −4

V_{OS}
I_{B-}
$V_S = \pm 15V$

DIE TEMPERATURE (°C)
0 20 40 60 80 100 120 140 160

Differential Gain and Phase Errors vs Gain Control Setting − Gain = +1

DIFFERENTIAL GAIN OR PHASE ERROR (% or °)

0.5 0.4 0.3 0.2 0.1 0

$V_S = \pm 15V$
$V_{OFFSET} = 0\ TO\ 0.714V$

dG
dθ

GAIN (%)
0 20 40 60 80 100

Differential Gain and Phase Errors vs Gain Control Setting − Gain = −1

DIFFERENTIAL GAIN OR PHASE ERROR (% or °)

0.5 0.4 0.3 0.2 0.1 0

$V_S = \pm 15V$
$V_{OFFSET} = 0\ TO\ 0.714V$

dθ
dG

GAIN (%)
0 20 40 60 80 100

4095−13

6

Typical Performance Curves — Contd.

Differential Phase Error vs
DC Offset — Gain = +1

DIFFERENTIAL GAIN ERROR (%)

$A_V = 25\%$

$A_V = 50\%$
AND 75%

$V_S = \pm 15V$

dG < 0.01% FOR
$A_V = 100\%$

V_{OFFSET} (V)

Differential Phase Error vs
DC Offset — Gain = +1

DIFFERENTIAL PHASE ERROR (°)

$V_S = \pm 15V$

$A_V = 25\%$ AND 75%

$A_V = 50\%$

$A_V = 100\%$

$A_V = 100\%$

V_{OFFSET} (V)

Differential Phase Error vs
DC Offset — Gain = −1

DIFFERENTIAL GAIN ERROR (%)

$A_V = 25\%$

$A_V = 50\%$
OR 75%

$V_S = \pm 15V$

$A_V = 100\%$

$A_V = 100\%$

V_{OFFSET} (V)

Differential Phase Error vs
DC Offset — Gain = −1

DIFFERENTIAL PHASE ERROR (°)

$A_V = 25\%$
$A_V = 75\%$
$A_V = 100\%$

$A_V = 50\%$

$A_V = 50\%$

V_{OFFSET} (V)

Attenuation over
Frequency — Gain = +1

GAIN (dB)

$V_G = +0.6V$

$V_G = -0.6V$

FREQUENCY (Hz)

Attenuation over
Frequency — Gain = −1

GAIN (dB)

$V_G = +0.6V$

$V_G = -0.6V$

FREQUENCY (Hz)

4095−14

7

EL4095C
Video Gain Control/Fader/Multiplexer

Typical Performance Curves — Contd.

Gain vs V_G (1 V_{DC} at V_{INA})

4095–15

Gain Control Gain vs Frequency

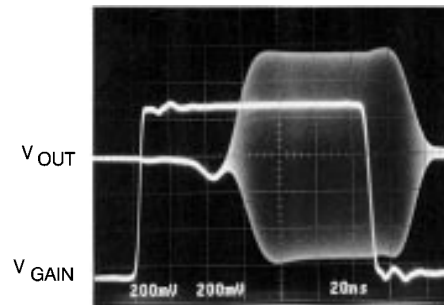V_{INA} = 1V
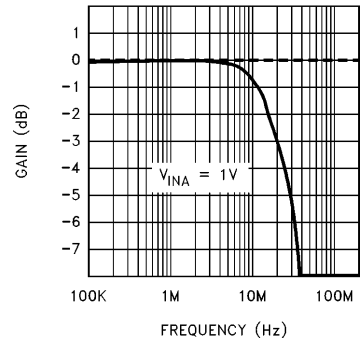
4095–16

Gain Control Response to a Non-Overloading Step, Constant Sinewave at V_{INA}
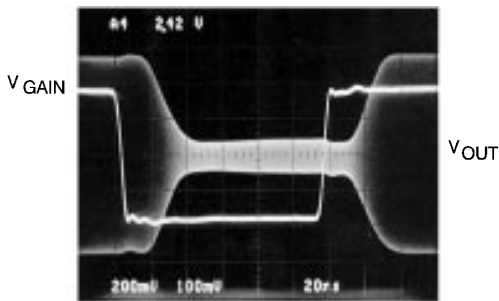
4095–17
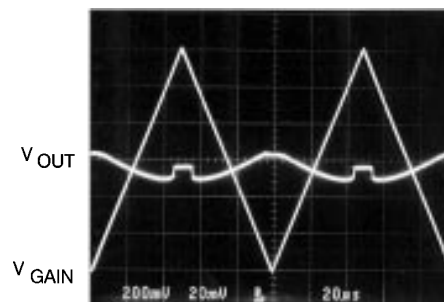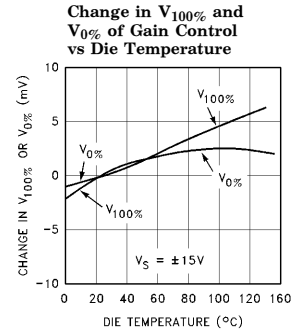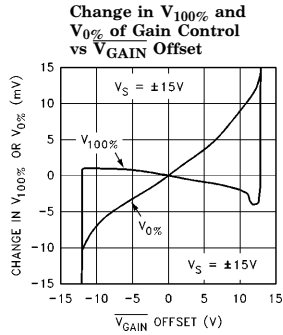
V_{GAIN} Overload Recovery Delay

4095–18

V_{GAIN} Overload Recovery Response—No AC Input

4095–19

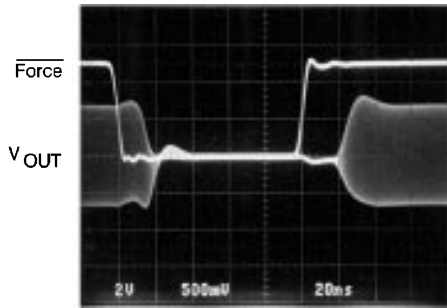**Cross-Fade Balance −0V on A_{IN} and B_{IN}; Gain = +1**

4095–20

8

Typical Performance Curves — Contd.

Change in $V_{100\%}$ and $V_{0\%}$ of Gain Control vs Supply Voltage

Change in $V_{100\%}$ and $V_{0\%}$ of Gain Control vs $\overline{V_{GAIN}}$ Offset

Change in $V_{100\%}$ and $V_{0\%}$ of Gain Control vs Die Temperature
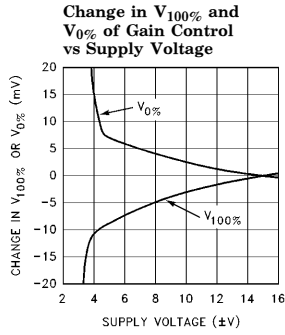
4095–21

$\overline{\text{Force}}$ Response

4095–22

$\overline{\text{Force}}$-Induced Output Transient

4095–23

Supply Current vs Supply Voltage

4095–24

Package Power Dissipation vs Ambient Temperature

4095–25

9
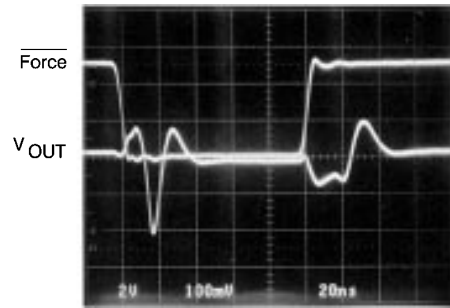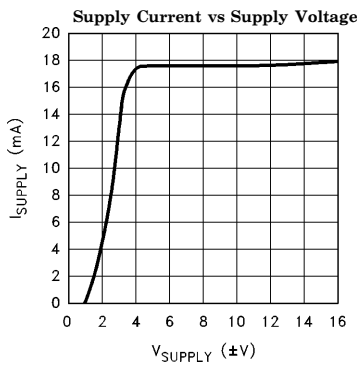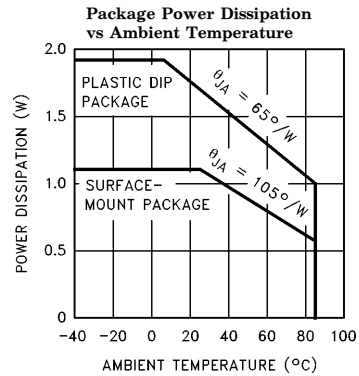
EL4095C
Video Gain Control/Fader/Multiplexer

Test Circuit, A$_V$ = +1

B$_{INPUT}$

A$_{INPUT}$

R$_{FB}$
1 KΩ

R$_{FA}$
1 KΩ
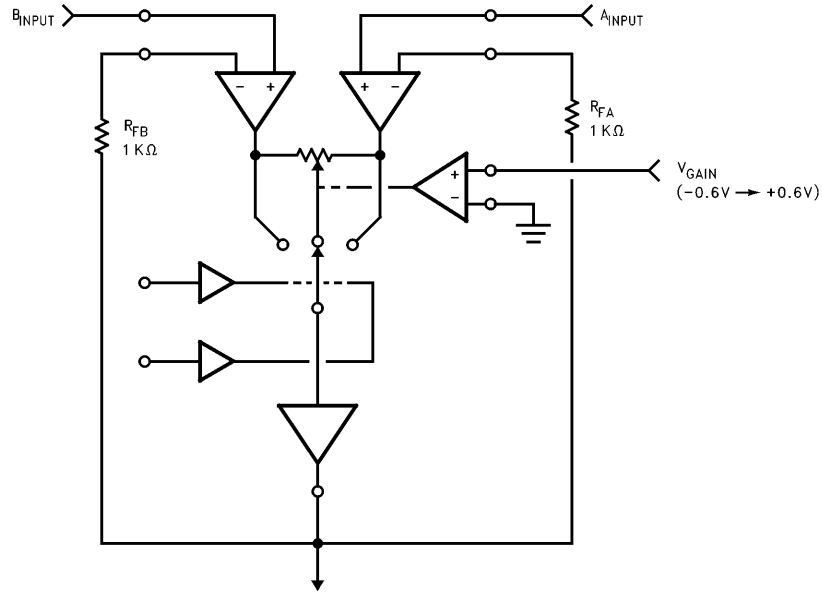
V$_{GAIN}$
(−0.6V ⟶ +0.6V)

OUTPUT
$$= A_{IN}\ (0.5 + V_{GAIN}) + B_{IN}\ (0.5 - V_{GAIN})$$
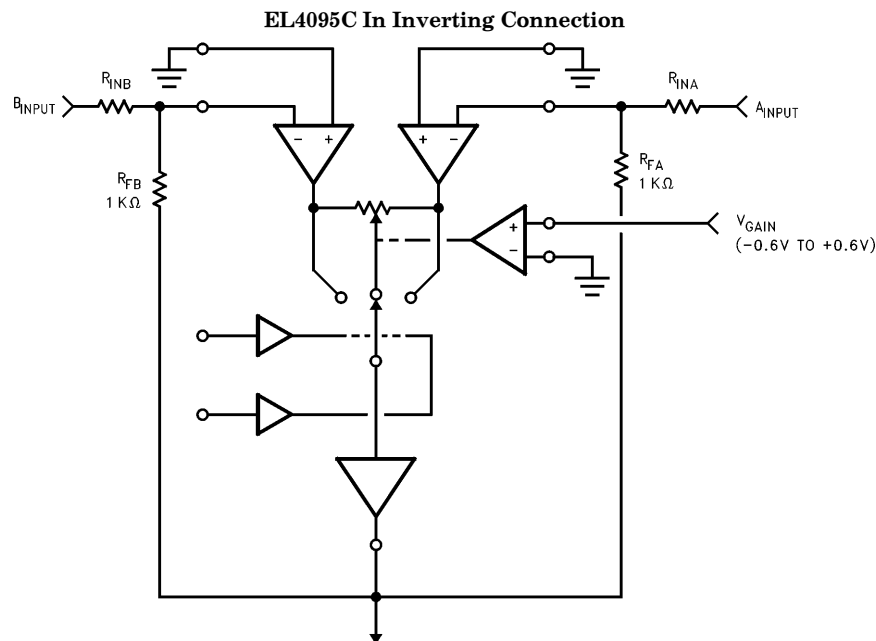FOR −0.5V ≤ V$_{GAIN}$ ≤ +0.5V

4095−26

10

Applications Information

The EL4095 is a general-purpose two-channel fader whose input channels each act as a current-feedback amplifier (CFA) input. Each input can have its own gain factor as established by external resistors. For instance, the Test Circuit shows two channels each arranged as $+1$ gain, with the traditional single feedback resistor R_F connected from V_{OUT} to the $-V_{IN}$ of each channel.

The EL4095 can be connected as an inverting amplifier in the same manner as any CFA:

Frequency Response

Like other CFA's, there is a recommended feedback resistor, which for this circuit is 1 KΩ. The value of RF sets the closed-loop -3 dB bandwidth, and has only a small range of practical variation. The user should consult the typical performance curves to find the optional value of R_F for a given circuit gain. In general, the bandwidth will decrease slightly as closed-loop gain is increased; R_F can be reduced to make up for bandwidth loss. Too small a value of R_F will cause frequency response peaking and ringing during transients. On the other hand, increasing R_F will reduce bandwidth but improve stability.

EL4095C In Inverting Connection

$$\text{OUTPUT} = - A_{IN} \left(\frac{R_{FA}}{R_{INA}} \right) (0.5 + V_{GAIN})$$

$$- B_{IN} \left(\frac{R_{FB}}{R_{INB}} \right) (0.5 - V_{GAIN})$$

$$\text{FOR } -0.5V \leq V_{GAIN} \leq +0.5V$$

4095–27

11

EL4095C
Video Gain Control/Fader/Multiplexer

Applications Information — Contd.

Stray capacitance at each $-V_{IN}$ terminal should absolutely be minimized, especially in a positive-gain mode, or peaking will occur. Similarly, the load capacitance should be minimized. If more than 25 pF of load capacitance must be driven, a load resistor from 100Ω to 400Ω can be added in parallel with the output to reduce peaking, but some bandwidth degradation may occur. A "snubber" load can alternatively be used. This is a resistor in series with a capacitor to ground, 150Ω and 100 pF being typical values. The advantage of a snubber is that it does not draw DC load current. A small series resistor, low tens of ohms, can also be used to isolate reactive loads.

Distortion

The signal voltage range of the $+V_{IN}$ terminals is within 3.5V of either supply rail.

One must also consider the range of error currents that will be handled by the $-V_{IN}$ terminals. Since the $-V_{IN}$ of a CFA is the output of a buffer which replicates the voltage at $+V_{IN}$, error currents will flow into the $-V_{IN}$ terminal. When an input channel has 100% gain assigned to it, only a small error current flows into its negative input; when low gain is assigned to the channel the output does not respond to the channel's signal and large error currents flow.

Here are a few idealized examples, based on a gain of $+1$ for channels A and B and $R_F = 1$ kΩ for different gain settings:

Gain	V_{INA}	V_{INB}	$I(-V_{INA})$	$I(-V_{INB})$	V_{OUT}
100%	1V	0	0	1 mA	1V
75%	1V	0	$-250\ \mu A$	750 μA	0.75V
50%	1V	0	$-500\ \mu A$	500 μA	0.5V
25%	1V	0	$-750\ \mu A$	250 μA	0.25V
0%	1V	0	-1 mA	0	0V

Thus, either $-V_{IN}$ can receive up to 1 mA error current for 1V of input signal and 1 kΩ feedback resistors. The maximum error current is 3 mA for the EL4095, but 2 mA is more realistic. The major contributor of distortion is the magnitude of error currents, even more important than loading effects. The performance curves show distortion versus input amplitude for different gains.

If maximum bandwidth is not required, distortion can be reduced greatly (and signal voltage range enlarged) by increasing the value of R_F and any associated gain-setting resistor.

100% Accuracies

When a channel gain is set to 100%, static and gain errors are similar to those of a simple CFA. The DC output error is expressed by

$$V_{OUT},\ Offset = V_{OS}{}^* A_V + (I_B-)^* R_F.$$

The input offset voltage scales with fed-back gain, but the bias current into the negative input, I_B-, adds an error not dependent on gain. Generally, I_B- dominates up to gains of about seven.

The fractional gain error is given by

$$E_{GAIN} = (R_F + A_V{}^* R_{IN} -)\ R_F$$
$$+ A_V\ R_{IN})/R_{OL}$$

The gain error is about 0.3% for a gain of one, and increases only slowly for increasing gain. $R_{IN}-$ is the input impedance of the input stage buffer, and R_{OL} is the transimpedance of the amplifier, 80 kΩ and 350 kΩ respectively.

Gain Control Inputs

The gain control inputs are differential and may be biased at any voltage as long as $\overline{V_{GAIN}}$ is less than 2.5V below $V+$ and 3V above $V-$. The differential input impedance is 5.5 kΩ, and a common-mode impedance is more than 500 kΩ. With zero differential voltage on the gain inputs, both signal inputs have a 50% gain factor. Nominal calibration sets the 100% gain of V_{INA} input at $+0.5V$ of gain control voltage, and 0% at $-0.5V$ of gain control. V_{INB}'s gain is complementary to that of V_{INA}; $+0.5V$ of gain control sets 0% gain at V_{INB} and $-0.5V$ gain control sets 100% V_{INB} gain. The gain control does not have a completely abrupt transition at the 0% and 100% points. There is about 10 mV of "soft" transfer at the gain endpoints. To obtain the most accurate 100% gain factor or best attenuation of 0% gain, it is necessary to overdrive the gain control input by about 30 mV. This would set the gain control voltage range as -0.565 mV to $+0.565V$, or 30 mV beyond the maximum guaranteed 0% to 100% range.

12

Applications Information — Contd.

In fact, the gain control internal circuitry is very complex. Here is a representation of the terminals:

Representation of Gain Control Inputs V_G and $\overline{V_G}$
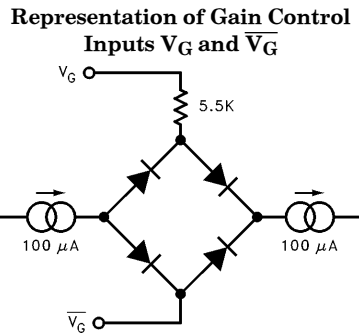
4095–28

For gain control inputs between ± 0.5V ($\pm 90\ \mu$A), the diode bridge is a low impedance and all of the current into V_G flows back out through $\overline{V_G}$. When gain control inputs exceed this amount, the bridge becomes a high impedance as some of the diodes shut off, and the V_G impedance rises sharply from the nominal 5.5 KΩ to over 500 KΩ. This is the condition of gain control overdrive. The actual circuit produces a much sharper overdrive characteristics than does the simple diode bridge of this representation.

The gain input has a 20 MHz -3 dB bandwidth and 17 ns risetime for inputs to ± 0.45V. When the gain control voltage exceeds the 0% or 100% values, a 70 ns overdrive recovery transient will occur when it is brought back to linear range. If quicker gain overdrive response is required, the Force control inputs of the EL4095 can be used.

Force Inputs

The Force inputs completely override the V_{GAIN} setting and establish maximum attainable 0% and 100% gains for the two input channels. They are activated by a TTL logic low on either of the $\overline{FORCE}$ pins, and perform the analog switching very quickly and cleanly. $\overline{FORCEA}$ causes 100% gain on the A channel and 0% on the B channel. $\overline{FORCEB}$ does the reverse, but there is no defined output state when $\overline{FORCEA}$ and $\overline{FORCEB}$ are simultaneously asserted.

The Force inputs do not incur recovery time penalties, and make ideal multiplexing controls. A typical use would be text overlay, where the A channel is a video input and the B channel is digitally created text data. The $\overline{FORCEA}$ input is set low normally to pass the video signal, but released to display overlay data. The gain control can be used to set the intensity of the digital overlay.

Other Applications Circuits

The EL4095 can also be used as a variable-gain single input amplifier. If a 0% lower gain extreme is required, one channel's input should simply be grounded. Feedback resistors must be connected to both $-V_{IN}$ terminals; the EL4095 will not give the expected gain range when a channel is left unconnected.
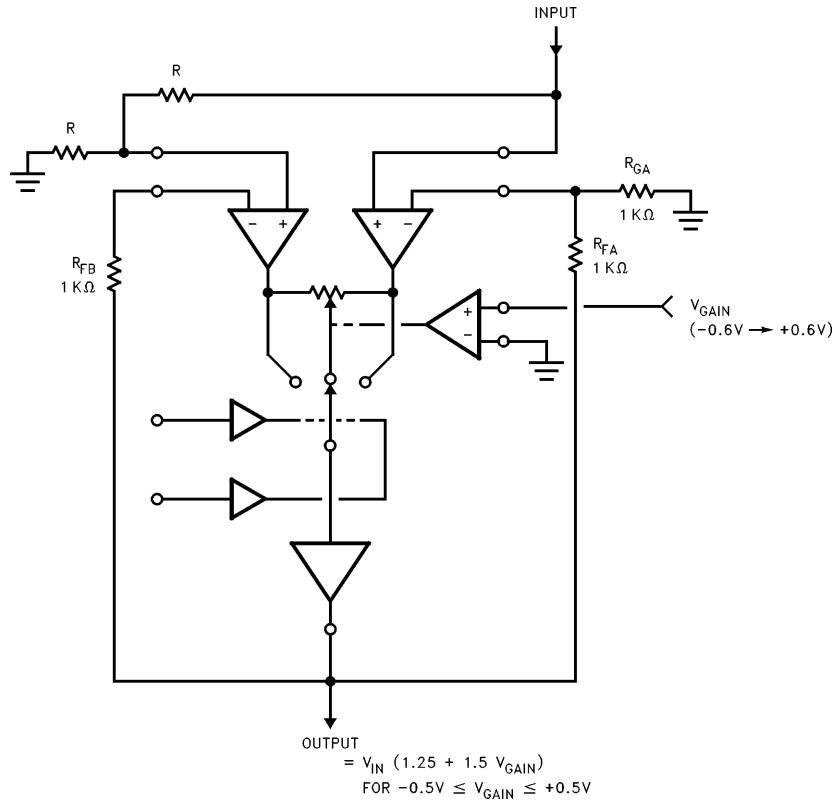
This circuit gives $+0.5$ to $+2.0$ gain range, and is useful as a signal leveller, where a constant output level is regulated from a range of input amplitudes:

Application Information — Contd.

Leveling Circuit with $0.5 \leq A_V \leq 2$

OUTPUT
$$= V_{IN} (1.25 + 1.5\ V_{GAIN})$$
$$\text{FOR } -0.5V \leq V_{GAIN} \leq +0.5V$$

4095-29

Here the A input channel is configured for a gain of $+2$ and the B channel for a gain of $+1$ with its input attenuated by $\frac{1}{2}$. The connection is virtuous because the distortions do not increase monotonically with reducing gain as would the simple single-input connecton.

For video levels, however, these constants can give fairly high differential gain error. The problem occurs for large inputs. Assume that a "twice-size" video input occurs. The A-side stage sees the full amplitude, but the gain would be set to 100% B-input gain to yield an overall gain of
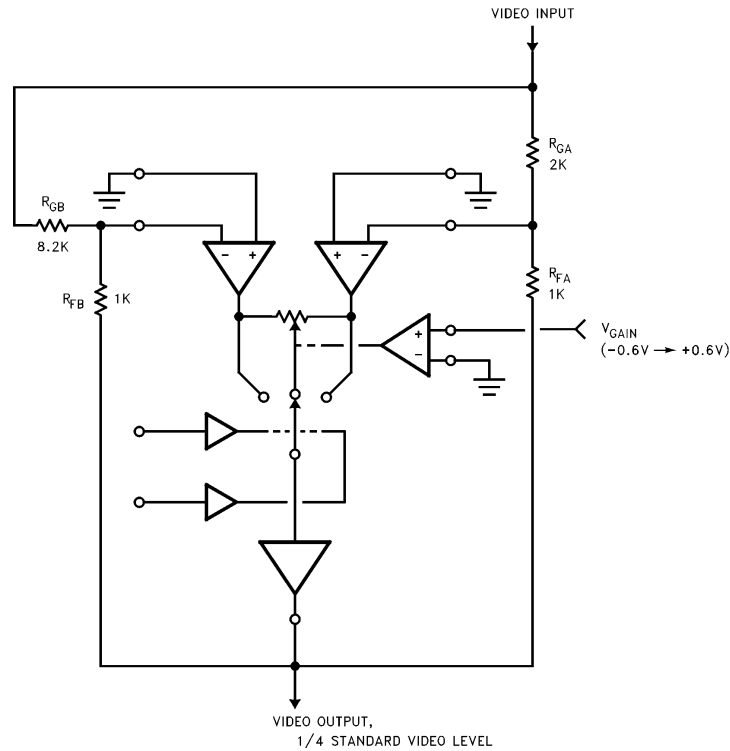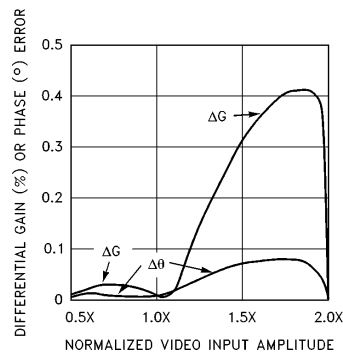
14

Application Information — Contd.

$\frac{1}{2}$ to produce a standard video output. The $-V_{IN}$ of the A side is a buffer output that reproduces the input signal, and drives R_{GA} and R_{FA}. Into the two resistors 2.1 mA of error current flows for a typical 1.4V of input DC offset, creating distortion in a A-side input stage. R_{GA} and R_{FA} could be increased together in value to reduce the error current and distortions, but increasing R_{FA} would lower bandwidth. A solution would be to simply attenuate the input signal magnitude and restore the EL4095 output level to standard level with another amplifier so:

Reduced-Gain Leveler for Video Inputs and Differential Gain and Phase Performance (see text)

VIDEO INPUT

R_{GA} 2K

R_{GB} 8.2K

R_{FB} 1K

R_{FA} 1K

V_{GAIN} (−0.6V → +0.6V)

VIDEO OUTPUT, 1/4 STANDARD VIDEO LEVEL

4095−30

4095−31

15

Application Information — Contd.

Although another amplifier is needed to gain the output back to standard level, the reduced error currents bring the differential phase error to less than 0.1′ over the entire input range.

A useful technique to reduce video distortion is to DC-restore the video level going into the EL4095, and offsetting black level to $-0.35V$ so that the entire video span encompasses $\pm 0.35V$ rather than the unrestored possible span of $\pm 0.7V$ (for standard-sized signals). For the preceding leveler circuit, the black level should be set more toward $-0.7V$ to accommodate the largest input, or made to vary with the gain control itself (large gain, small offset; small gain, larger offset).

The EL4095 can be wired as a four quadrant multiplier:

**EL4095 Connected as a Four-Quadrant Multiplier**
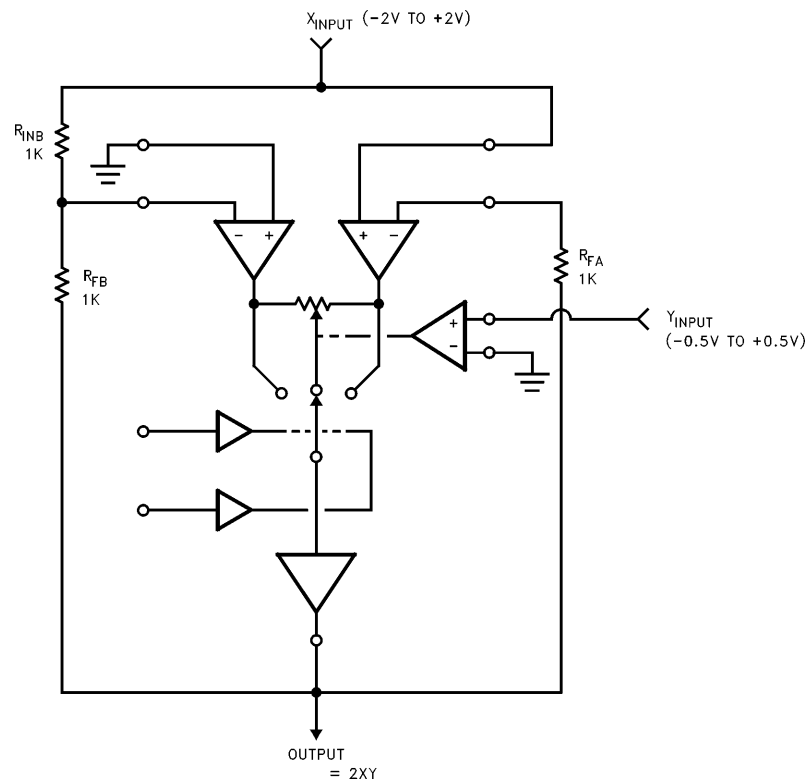
4095–32

Application Information — Contd.

The A channel gains the input by $+1$ and the B channel by -1. Feedthrough suppression of the Y input can be optimized by introducing an offset between channel A and B. This is easily done by injecting an adjustable current into the summing junction ($-V_{IN}$ terminal) of the B input channel.

The two input channels can be connected to a common input through two dissimilar filters to create a DC-controlled variable filter. This circuit provides a controlled range of peaking through rolloff characteristics:
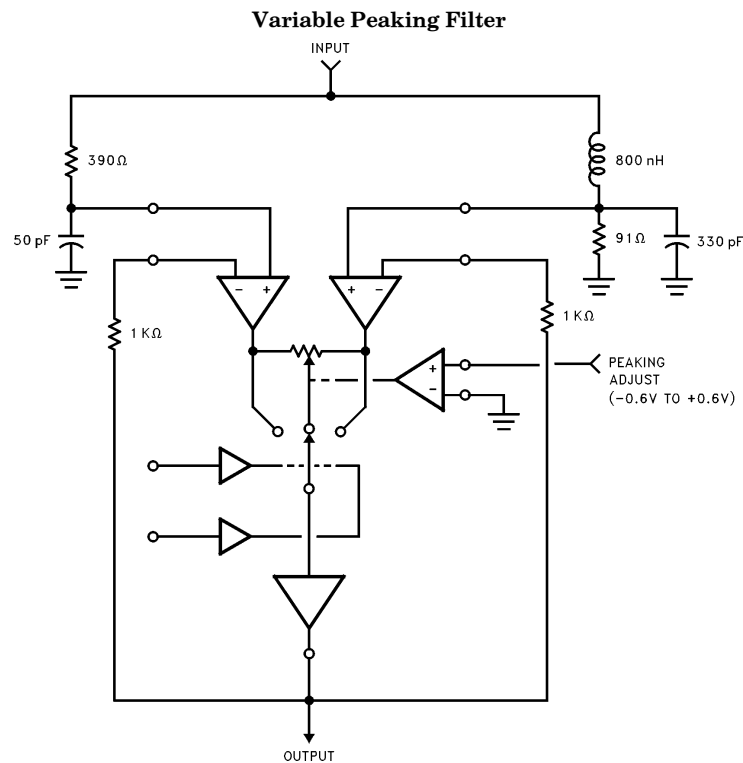
Variable Peaking Filter

4095–33

4095–34
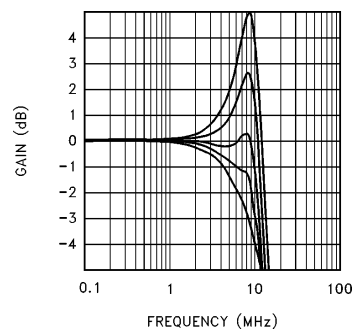
EL4095C
Video Gain Control/Fader/Multiplexer

Applications Information — Contd.

The EL4095 is connected as a unity-gain fader, with an LRC peaking network connected to the A-input and an RC rolloff network connected to the B-input. The plot shows the range of peaking controlled by the V_{GAIN} input. This circuit would be useful for flattening the frequency response of a system, or for providing equalization ahead of a lossy transmission line.

Noise

The electrical noise of the EL4095 has two components: the voltage noise in series with $+V_{IN}$ is $5 \, nV \sqrt{Hz}$ wideband, and there is a current noise injected into $-V_{IN}$ of $35 \, pA\sqrt{Hz}$. The output noise will be
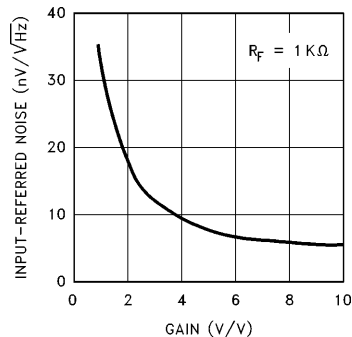
$$\overline{V_{n, \, out}} = \sqrt{(A_V \bullet \overline{V_{n, \, input}})^2 + (\overline{I_{n, \, input}} \bullet R_F)^2},$$

and the input-referred noise is

$$\overline{V_{n, \, input\text{-}referred}} = \sqrt{(\overline{V_{n, \, input}})^2 + (\overline{I_{n, \, input}} \bullet R_F/A_V)^2}$$

where A_V is the fed-back gain of the EL4095. Here is a plot of input-referred noise vs A_V:

Input-Referred Noise vs Closed-Loop Gain

4095–35

Thus, for a gain of three or more the fader has a noise as good as an op-amp. The only trade-off is that the dynamic range of the input is reduced by the gain due to the nonlinearity caused by gained-up output signals.

Power Dissipation

Peak die temperature must not exceed 150°C. This allows 75°C internal temperature rise for a 75°C ambient. The EL4095 in the 14-pin PDIP package has a thermal resistance of 65°C/W, and can thus dissipate 1.15W at a 75°C ambient temperature. The device draws 20 mA maximum supply current, only 600 mW at ±15V supplies, and the circuit has no dissipation problems in this package.

The SO-14 surface-mount package has a 105°C/W thermal resistance with the EL4095, and only 714 mW can be dissipated at 75°C ambient temperature. The EL4095 thus can be operated with ±15V supplies at 75°C, but additional dissipation caused by heavy loads must be considered. If this is a problem, the supplies should be reduced to ±5V to ±12V levels.

The output will survive momentary short-circuits to ground, but the large available current will overheat the die and also potentially destroy the circuit's metal traces. The EL4095 is reliable within its maximum average output currents and operating temperatures.

EL4095C Macromodel

This macromodel is offered to allow simulation of general EL4095 behavior. We have included these characteristics:

Small-signal frequency response	Signal path DC distoritons
Output loading effects	V_{GAIN} I-V characteristics
Input impedance	V_{GAIN} overdrive recovery delay
Off-channel feedthrough	
Output impedance over frequency	100% gain error
$-V_{IN}$ characteristics and sensitivity to parasitic capacitance	$\overline{FORCE}$ operation

These will give a good range of results of various operating conditions, but the macromodel does not behave identically as the circuit in these areas:

Temperature effects	Manufacturing tolerances
Signal overload effects	Supply voltage effects
Signal and $\overline{V_G}$ operating range	Slewrate limitations
Current-limit	Noise
Video and high-frequency distortions	Power supply interactions
Glitch and delay from $\overline{FORCE}$ inputs	

18

EL4095C Macromodel — Contd.

```
*** EL4095 macromodel ***
******
******
*                      +VinB
*                        |    -VinB
*                        |    |    /ForceA
*                        |    |    |    /ForceB
*                        |    |    |    |    Vout
*                        |    |    |    |    |    /Vgain
*                        |    |    |    |    |    |    Vgain
*                        |    |    |    |    |    |    |    -VinA
*                        |    |    |    |    |    |    |    |    +VinA
*                        |    |    |    |    |    |    |    |    |
.SUBCKT 4095macromodel ( 1    2    4    5    7    10   11   13   14 )
***
Rol 810 0 290k
Ccomp 810 0 4.3p
G1 110 0 810 0 -10
Rout 110 0 0.1
Lout 110 7 350n
RLout 110 7 80
***
Rina+ 14 0 5E6
Rinb+ 1 0 5E6
Rvg 11 0 2E6
Rvgg 10 0 2E6
Rforcea 4 0 1E9
Rforceb 5 0 1E9
******
*** Input channel A
***
Rina 22 313 79
Ra 111 0 1k
Rfeedthrougha 13 313 1.0
Cfeedthrougha 23 13 2500p
Ccompa 111 0 2p
E1a 23 313 302 25 -1
E2a 22 0 14 0 0.9999
Rspice3 23 313 1E12
G1a 111 0 POLY(1) (22,313) 0.0 0.0125 -150E-6
G2a 810 0 POLY(2) (111,0) (113,0) 0.0 0.0 0.0 0.0 0.001
***
***Input channel B
***
Rinb 25 302 79
Rb 120 0 1k
Rfeedthroughb 2 302 1.0
Cfeedthroughb 24 2 2500p
Ccompb 120 0 2p
E1b 24 302 22 313 -1
E2b 25 0 1 0 0.9999
Rspice4 24 302 1E12
G1b 120 0 POLY(1) (25,302) 0.0 0.0125 -150E-6
G2b 810 0 POLY(2) (120,0) (119,0) 0.0 0.0 0.0 0.0 0.001
***
***Gain control
***
Rspice1 113 0 1E12
Rspice2 119 0 1E12
R10 114 0 1E7
R11 204 206 2.5E6
R12 205 206 2.5E6
C10 201 0 9.5E-16
D1 114 115 Dclamp
D2 116 114 Dclamp
D3 204 4 Dclamp
```

4095-36

19

EL4095C Macromodel — Contd.

```
D4 205 5 Dclamp
.model Dclamp D(TT=200n)
Vttl 206 0 2.4
V1 115 0 4999.3
V2 0 116 4999.3
V3 113 117 0.5
V4 119 118 0.5
V5 203 115 0.7
V6 116 202 0.7
G10 114 0 11 10 -0.001
G11 11 10 114 0 -2E-8
E10 117 0 201 0 1E-4
E11 118 0 201 0 -1E-4
S1 114 200 5 0 Nopen
S2 200 201 4 0 Nopen
S3 203 201 4 0 Nclosed
S4 202 201 5 0 Nclosed
.model Nopen VSWITCH(Ron=100 Roff=1E12 Von=1.6 Voff=1.2)
.model Nclosed VSWITCH( Ron=100 Roff=1E12 Von=1.2 Voff=1.6)
***
.ENDS
******
```
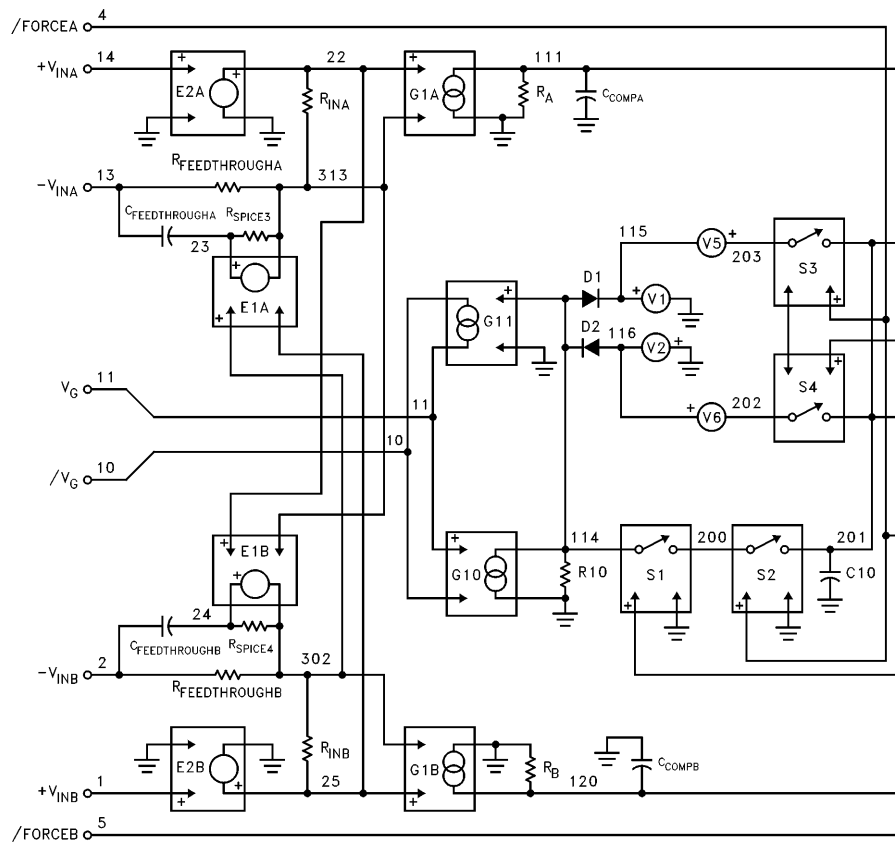
4095–37

20

EL4095C Macromodel — Contd.

The EL4095 Macromodel Schematic

4095−38

21

EL4095C
Video Gain Control/Fader/Multiplexer

EL4095C Macromodel — Contd.

4095–39

22

BLANK

23
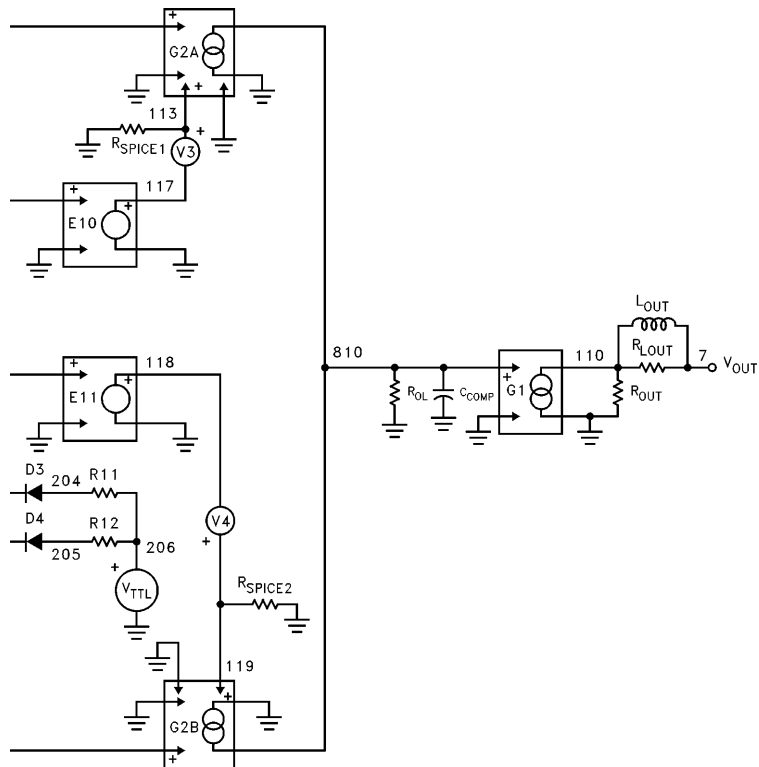
General Disclaimer

Specifications contained in this data sheet are in effect as of the publication date shown. Elantec, Inc. reserves the right to make changes in the circuitry or specifications contained herein at any time without notice. Elantec, Inc. assumes no responsibility for the use of any circuits described herein and makes no representations that they are free from patent infringement.

élantec
HIGH PERFORMANCE ANALOG INTEGRATED CIRCUITS

August 1996 Rev D

Elantec, Inc.
1996 Tarob Court
Milpitas, CA 95035
Telephone: (408) 945-1323
(800) 333-6314
Fax: (408) 945-9305
European Office: 44-71-482-4596

WARNING — Life Support Policy

Elantec, Inc. products are not authorized for and should not be used within Life Support Systems without the specific written consent of Elantec, Inc. Life Support systems are equipment intended to support or sustain life and whose failure to perform when properly used in accordance with instructions provided can be reasonably expected to result in significant personal injury or death. Users contemplating application of Elantec, Inc. products in Life Support Systems are requested to contact Elantec, Inc. factory headquarters to establish suitable terms & conditions for these applications. Elantec, Inc.'s warranty is limited to replacement of defective components and does not cover injury to persons or property or other consequential damages.

Printed in U.S.A.