CLC110

CLC110 Wideband, Closed-Loop Monolithic Buffer

TEXAS INSTRUMENTS

National Semiconductor

CLC110
Wideband, Closed-Loop Monolithic Buffer Amplifier

General Description

Using a unique closed-loop design, the CLC110 buffer offers a high-fidelity, high-performance alternative to conventional open-loop buffers. For example, the $-3dB$ bandwidth is 730MHz ($0.5V_{pp}$) and the settling time to 0.2% is typically only 5ns. Yet all this is achieved while maintaining excellent signal fidelity as demonstrated by the $-65dBc$ harmonic distortion at 20MHz – a value unmatched by any high-speed buffer.

The CLC110 is an ideal choice for a wide variety of applications. With its speed and accuracy, the CLC110 offers designers the benefit of buffering signals which might otherwise go unbuffered due to performance penalties imposed by conventional buffers. For example, the CLC110 is well suited for use within closed-loop systems such as amplifier or phase locked loop systems; with its 400ps rise time, its effect on loop dynamics is usually negligible.

Ultra-fast flash A/D converter systems can also benefit from the speed of the CLC110. And, since most flash A/D's have capacitive inputs, the CLC110's dynamic performance has been characterized for various loads. In addition, the amplifier specifications are for a 100Ω load.

The CLC110 is available in several versions to meet a variety of requirements. A three-letter suffix determines the version:

CLC110AJP   -40°C to +85°C   8-pin plastic DIP
CLC110AJE   -40°C to +85°C   8-pin plastic SOIC
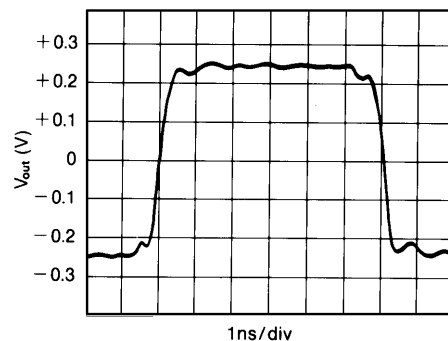DESC SMD number: 5962-89975

Features

- Closed-loop, unity-gain operation
- -3dB bandwidths of 730MHz ($0.5V_{pp}$)
- 0.2% settling in 5ns
- Low power, 150mW
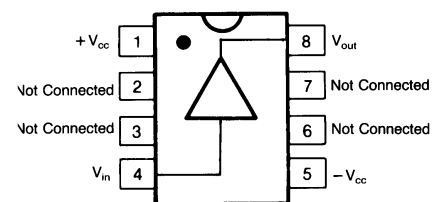- Low distortion, -65dBc at 20MHz

Applications

- Ultra-fast flash A/D conversion
- Line driving
- High-speed communications
- Impedance transformation
- Power buffers
- IF processors

Small Signal Pulse Response

1ns/div

Pinout
DIP & SOIC

CLC110 Electrical Characteristics (V$_{cc}$ = ±5V, R$_L$ = 100Ω, R$_S$ = 50Ω; unless specified)

PARAMETERS	CONDITIONS	TYP	MIN AND MAX RATINGS			UNITS	SYMBOL
Ambient Temperature	CLC110AJ	+25°C	−40°C	+25°C	+85°C		
FREQUENCY DOMAIN PERFORMANCE[1]							
−3dB bandwidth	V$_{out}$ < 0.5V$_{pp}$	730	>400	>400	>300	MHz	SSBW
	V$_{out}$ < 5V$_{pp}$	90	>50	>55	>50	MHz	LSBW
gain flatness	V$_{out}$ < 0.5V$_{pp}$						
peaking	DC to 200MHz	0	<0.8	<0.5	<0.6	dB	GFPH
rolloff	DC to 200MHz	0	<1.0	<0.8	<1.2	dB	GFRH
group delay	DC to 200MHz	0.75	<1.0	<1.0	<1.2	ns	GD
linear phase deviation	DC to 200MHz	0.7	<1.5	<1.5	<2.0	°	LPD
TIME DOMAIN PERFORMANCE[1]							
rise and fall time	0.5V step	0.4	<1.0	<1.0	<1.4	ns	TRS
(input signal rise/fall = 300ps)							
overshoot	0.5V step	0	<15	<10	<15	%	OS
(input signal rise/fall = 300ps)							
rise and fall time	5V step	4.5	<8.5	<7.5	<8.5	ns	TRL
(input signal rise/fall ≤ 1ns)							
settling time to ±0.2%	2V step	5	<10	<10	<10	ns	TSP
slew rate		800	>450	>500	>450	V/μs	SR
DISTORTION AND NOISE PERFORMANCE							
2nd harmonic distortion							
	2V$_{pp}$, 20MHz	−65	<−48	<−55	<−55	dBc	HD2
	2V$_{pp}$, 50MHz	−60	<−48	<−55	<−55	dBc	HHD2
3rd harmonic distortion							
	2V$_{pp}$, 20MHz	−65	<−55	<−55	<−55	dBc	HD3
	2V$_{pp}$, 50MHz	−60	<−50	<−50	<−45	dBc	HHD3
equivalent input noise							
noise floor	> 1MHz	−158	<−155	<−155	<−154	dBm(1Hz)	SNF
integrated noise	1MHz to 200MHz	40	<57	<57	<63	μV	INV
STATIC, DC PERFORMANCE							
small signal gain into 100Ω load		0.97	>0.95	>0.96	>0.95	V/V	GA
integral endpoint linearity	±2V full scale	0.2	<0.8	<0.4	<0.3	%FS	ILIN
* output offset voltage		2	<16	<8.0	<13	mV	VIO
average temperature coefficient		20	<100	—	<50	μV/°C	DVIO
* input bias current		20	<100	<50	<50	μA	IBN
average temperature coefficient		200	<700	—	<300	nA/°C	DIBN
power supply rejection ratio		50	>45	>45	>45	dB	PSRR
* supply current	no load	15	<20	<20	<20	mA	ICC
MISCELLANEOUS PERFORMANCE							
input resistance		160	>50	>100	>200	kΩ	RIN
capacitance		1.6	<2.5	<2.2	<2.5	pF	CIN
output impedance	at DC	2	<3.5	<3.0	<3.5	Ω	RO
output voltage range	100Ω load	±4	>±3.0	>±3.2	>±3.2	V	VO
output current		±70	>±45	>±50	>±50	mA	IO

Min/max ratings are based on product characterization and simulation. Individual parameters are tested as noted. Outgoing quality levels are determined from tested parameters.

Absolute Maximum Ratings

V$_{cc}$		±7V
I$_{out}$	output is short circuit protected to ground, but, maximum reliability will be obtained if I$_{out}$ does not exceed...	70mA
input voltage		±V$_{cc}$
junction temperature		+150°C
operating temperature range		
AI:		− 40°C to +85°C
storage temperature range		− 65°C to +150°C
lead solder duration (+300°C)		10 sec

Reliability Information

Transistor Count	21

Miscellaneous Ratings

Notes:

* AJ 100% tested at +25°C.

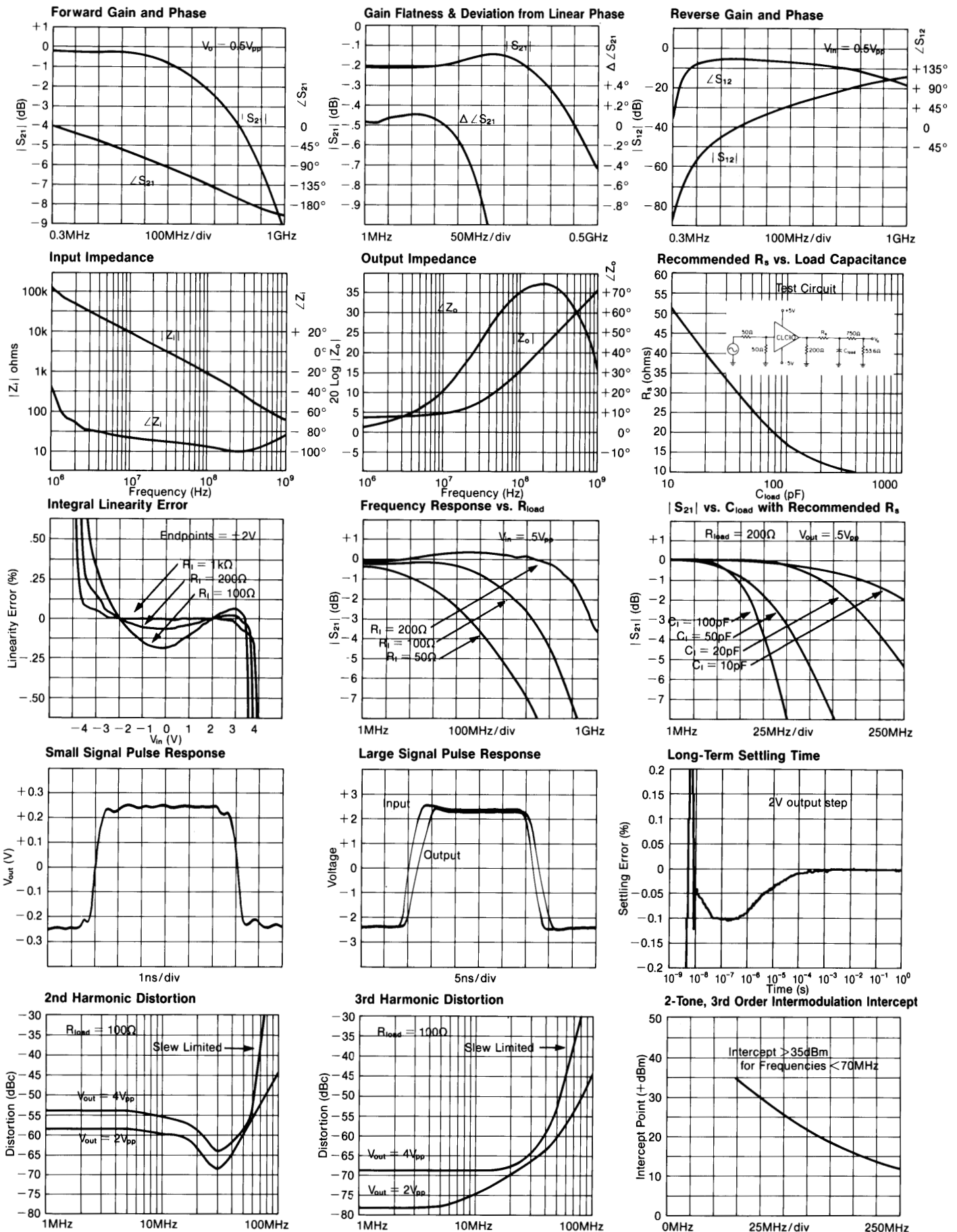note 1: AC performance is very dependent on layout. Specifications apply only in a 50Ω microstrip environment.

Package Thermal Resistance

Package	θ$_{JC}$	θ$_{JA}$
Plastic (AJP)	65°C/W	115°C/W
Surface Mount (AJE)	55°C/W	125°C/W

Forward Gain and Phase

Gain Flatness & Deviation from Linear Phase

Reverse Gain and Phase

Input Impedance

Output Impedance

Recommended R_s vs. Load Capacitance

Integral Linearity Error

Frequency Response vs. R_{load}

$|S_{21}|$ vs. C_{load} with Recommended R_s

Small Signal Pulse Response

Large Signal Pulse Response

Long-Term Settling Time

2nd Harmonic Distortion

3rd Harmonic Distortion

2-Tone, 3rd Order Intermodulation Intercept

R_{in} is chosen for desired input impedance.

R_{out} is chosen for desired output impedance. (CLC110 R_{out} = 2Ω)

Figure 1: recommended circuit and evaluation board schematic

Operation

The CLC110 is based upon a unique, patented closed-loop design, which provides the accuracy characteristics of a closed-loop amplifier, yet also has unmatched dynamic performance.

Printed Circuit Layout and Supply Bypassing

As with any high-frequency device, a good PCB layout is required for optimum performance. This is especially important for a device as fast as the CLC110, which has a typical bandwidth of 730MHz.

To minimize capacitive feedthrough, the pins not connected internally (pins 2, 3, 6, and 7) should be connected to the ground plane. Input and output traces should be laid out as transmission lines with the appropriate termination resistors very near the CLC110. On a 0.065 inch epoxy PCB material, a 50Ω transmission line (commonly called stripline) can be constructed by using a trace width of 0.1" over a complete ground plane.

Figure 1 shows recommended power supply bypassing. The ferrite beads are optional and are recommended only where additional isolation is needed from high-frequency (>400MHz) resonances of the power supply.

Parasitic or load capacitance directly on the output of the CLC110 will introduce additional phase shift in the device, which can lead to decreased phase margin and frequency response peaking. A small series resistor before the capacitance effectively decouples this effect. The graphs on the preceding page illustrate the required resistor value and the resulting performance vs. capacitance.

Precision buffed resistors (PRP8351 series from Precision Resistive Products), which have low parasitic reactances, were used to develop the data sheet specifications. Precision carbon composition resistors or standard spirally-trimmed RN55D metal film resistors will work, though they will cause a degradation of AC performance due to their reactive nature at high frequencies.

Evaluation Board

An evaluation board (part CLC730012) is available for the CLC110 to assist in the evaluation of the CLC110. It may also be used as a guide in developing a printed circuit layout. Figure 1 shows the board's schematic; Figures 2 through 4 show the board layout.

Evaluation Board Parts List:
R_{in} select for desired input impedance
R_{out} select for desired output impedance
C_1, C_2 0.1µF ceramic radial lead
C_3, C_4 6.8µF (Sprague 150D series)
L_1, L_2 ferrite beads (optional) (Ferroxcube #VK 200 19/4B)

Hardware (optional)
Sockets Cambion flush-mount connector jacks
        (#450-2598-01-06-00)
SMA Connectors (female)
        Amphenol 901-144 (straight)
        Amphenol 901-143 (angled)
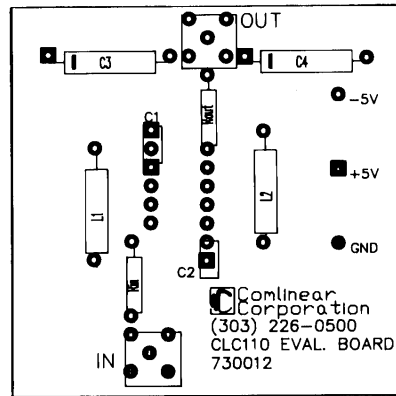
Figure 2: component placement guide
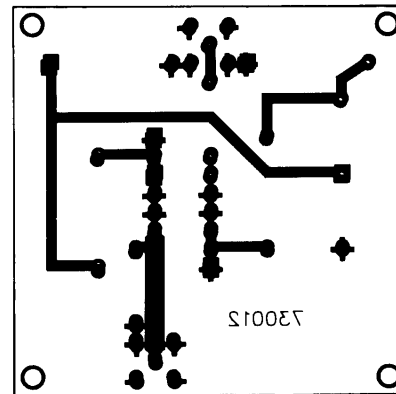
Figure 3: solder side (bottom) as viewed from component side (top)
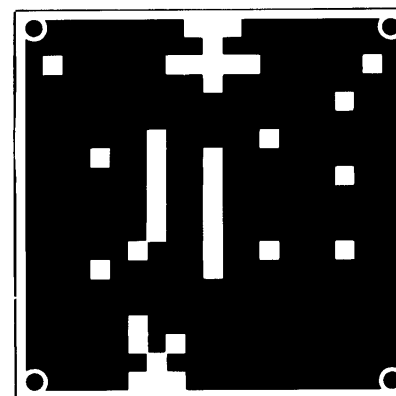
Figure 4: component side (top) showing extensive ground plane

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