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**OSCILLATORE A 8 MHZ E SISTEMA
DI DISTRIBUZIONE CLOCK**

IRA 231/96

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1. INTRODUZIONE

L'intenzione di realizzare un correlatore digitale per il radiotelescopio " Croce del Nord " ha portato alla necessita' di realizzare un sistema che permetta di distribuire un clock a 8 MHz necessario per il campionamento dei segnali radioastronomici da convertire in banda base (0-4 Mhz) e per la correlazione dei segnali.

L'oggetto di questo rapporto interno consiste nella descrizione di un oscillatore locale a 8 MHz e di un sistema di distribuzione su circuito stampato da noi appositamente realizzato al fine di avere segnali di clock coerenti fra loro e privi di ritardo che avrebbero potuto creare problemi di temporizzazione.

2. DESCRIZIONE

Il sistema da noi realizzato e' diviso in due parti come si puo' vedere dallo schema a blocchi di fig. 1:

- L'oscillatore a 8 Mhz vero e proprio;
- Un sistema di distribuzione su circuito stampato da noi realizzato composto da 5 schede aventi ciascuna 8 uscite terminate a 50Ω per un totale di 40 canali.

L' elevato numero di canali si e` reso necessario data la necessita` di distribuire il clock singolarmente ad ogni unita` di correlazione, senza introdurre sfasamenti fra gli stessi.

Il tutto e` stato posto in un contenitore da rack a 3 unita` della Rack-Peruzzi.

Sul frontale sono disponibili le 40 uscite con connettore SMB e 3 led per evidenziare le alimentazioni.

Sul posteriore e` presente, oltre all'interruttore di accensione completo di fusibili, una ventola di raffreddamento dato l' elevato calore sviluppato dagli integrati utilizzati.

3. OSCILLATORE

Lo schema elettrico del circuito da noi realizzato e rappresentato in figura 2 ed è montato su scheda bulinata.

Come si può notare il circuito è estremamente semplice e concepito per non introdurre ritardi tra i vari canali.

Si fa uso di un quarzo per calibrazione con stabilità di 5ppm nel range di temperatura che va da -20 a +70°C ad 8 MHz; le sue caratteristiche sono indubbiamente buone anche se, dato l' utilizzo, non sarebbe necessaria una stabilità del genere.

Il quarzo ed un integrato 74S04 permettono di ottenere il segnale (8 Mhz TTL) da distribuire che viene inviato a 2 integrati 74128 (driver a 50 Ω) per pilotare le schede con i buffer (vedi capitolo successivo).

I collegamenti fra le schede avvengono mediante cavo coassiale con connettori SMB.

Durante la realizzazione del circuito si è posta molta attenzione all' equalizzazione dei tragitti dei singoli canali nell' intento di limitare i ritardi dovuti alla lunghezza differenziale dei collegamenti.

4. DISTRIBUTORE A 8Mhz

Il distributore e' stato realizzato su circuito stampato (doppia faccia fori metallizzati serigrafia e solder) da noi progettato con **ORCAD** e successivamente realizzato dalla ditta Selema.

In figura 3 e' rappresentato lo schema elettrico del circuito. Come si puo' vedere su ogni scheda sono utlizzati 8 integrati HA2-5002 della Harris Semiconductor di cui si allegano le caratteristiche in appendice.

Questi buffer a guadagno unitario vengono utilizzati come driver di segnali a 50Ω e distribuiscono il segnale di clock a tutti gli "utilizzatori esterni". I livelli in uscita sono TTL/ 50Ω .

Nelle figure 4, 5, e 6 sono rappresentate rispettivamente la serigrafia, il circuito stampato lato componenti ed il circuito stampato lato saldature.

In fig.7 sono mostrate le forme d'onda ottenute con l'oscilloscopio; si noti come il ritardo fra quattro qualunque (dei quaranta possibili) differenti canali visualizzati non sia rilevabile.

Al fine di evidenziare la criticita` dei ritardi dovuti alla lunghezza dei tragitti compiuti dal segnale, in fig.8 sono visualizzate le forme d' onda di 4 canali ottenute con l' oscilloscopio; CH2 e CH3 erano collegati con cavi da 1 metro, CH1 e CH4 erano collegati con cavi da 5,50 metri di lunghezza.

5. CONCLUSIONI

L' oscillatore utilizzato in un correlatore deve avere come requisito fondamentale la coerenza del segnale per tutti i canali; non e` quindi necessaria una stabilita` come quella da noi utilizzata per la sorgente (5ppm nel range -20:+70°C); e` solo sufficiente che tutti i cavi utilizzati per la distribuzione del clock abbiano tutti la stessa lunghezza .

In ogni caso lo sfasamento fra i vari canali deve essere inferiore ad un periodo di clock (nel nostro caso 125ns).

Particolarmente importante e` risultato l' utilizzo dei buffer-driver della Harris HA-5002 che grazie ad una insignificante dispersione delle caratteristiche ed alla elevata potenza in uscita in grado di erogare, ci hanno permesso di realizzare 40 canali con differenze fra loro del tutto irrilevanti.

Monolithic, Wideband, High Slew Rate, High Output Current Buffer

August 1991

Features

- Voltage Gain 0.995
- High Input Impedance 3000k Ω
- Low Output Impedance 3 Ω
- Very High Slew Rate 1300V/ μ sec
- Very Wide Bandwidth 110MHz
- High Output Current \pm 200mA
- Pulsed Output Current 400mA
- Monolithic Construction

Description

The HA-5002 is a monolithic, wideband, high slew rate, high output current, buffer amplifier.

Utilizing the advantages of the Harris D.I. technologies, the HA-5002 current buffer offers 1300V/ μ sec slew rate with 110MHz of bandwidth. The \pm 200mA output current capability is enhanced by a 3 Ω output impedance.

The monolithic HA-5002 will replace the hybrid LH0002 with corresponding performance increases. These characteristics range from the 3000k Ω input impedance to the increased output voltage swing. Monolithic design technologies have

Applications

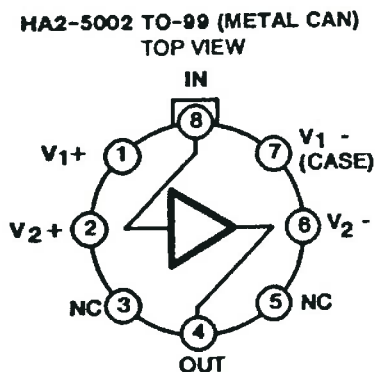
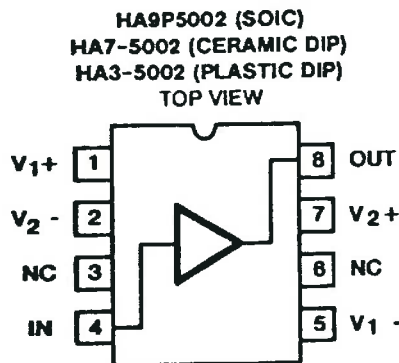
- Line Driver
- Data Acquisition
- 110MHz Buffer
- High Power Current Booster
- High Power Current Source
- Sample and Holds
- Radar Cable Driver
- Video Products

allowed a more precise buffer to be developed with more than an order of magnitude smaller gain error.

The HA-5002 will provide many present hybrid users with a higher degree of reliability and at the same time increase overall circuit performance.

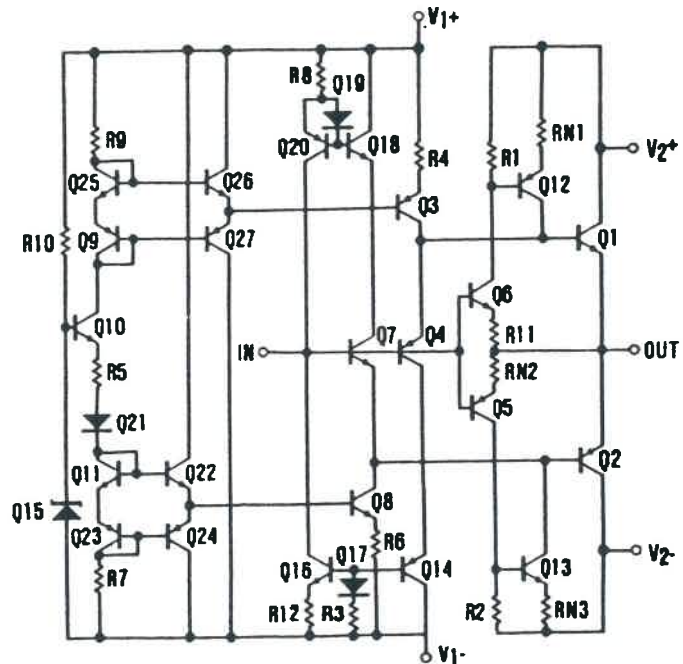
The HA-5002 is available in an 8 pin SOIC package, an 8 pin Metal Can, and 8 pin Ceramic and Plastic Mini-DIPs. For the military grade product, refer to the HA-5002/883 Data Sheet.

Pinouts



LCC Package Available for HA-5002/883.
See HA-5002/883 Data Sheet

Schematic



Specifications HA-5002

Absolute Maximum Ratings (Note 1)

Voltage Between V+ and V- pins	44V
Input Voltage	Equal to Supplies
Output Current	Continuous $\pm 200\text{mA}$
Output Current	(50ms On, 1s Off) $\pm 400\text{mA}$
Internal Power Dissipation (Note 2)	
TO-99 (+25°C)	1.13W
Mini-DIP (+25°C)	1.22W
Plastic DIP (+25°C)	1.88W

Operating Temperature Range

Maximum Junction Temperature (Plastic Packages)	+150°C
Maximum Junction Temperature	+175°C
HA-5002-2	$-55^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$
HA-5002-5	$0^\circ\text{C} \leq T_A \leq +75^\circ\text{C}$
HA-5002-9	$-40^\circ\text{C} \leq T_A \leq +85^\circ\text{C}$
Storage Temperature Range	$-65^\circ\text{C} \leq T_A \leq +150^\circ\text{C}$

Electrical Specifications $V_{\text{SUPPLY}} = \pm 12\text{V}$ to $\pm 15\text{V}$, $R_S = 50\Omega$, $R_L = 1\text{k}\Omega$, $C_L = 10\text{pF}$, Unless Otherwise Specified.

PARAMETER	TEMP	HA-5002-2			HA-5002-5, -9			UNITS
		MIN	TYP	MAX	MIN	TYP	MAX	
INPUT CHARACTERISTICS								
Offset Voltage	+25°C	-	5	20	-	5	20	mV
	Full	-	10	30	-	10	30	mV
Average Offset Voltage Drift	Full	-	30	-	-	30	-	$\mu\text{V}/^\circ\text{C}$
Bias Current	+25°C	-	2	7	-	2	7	μA
	Full	-	3.4	10	-	2.4	10	μA
Input Resistance	Full	1.5	3	-	1.5	3	-	M Ω
Input Noise Voltage (10Hz-1MHz)	+25°C	-	4	-	-	4	-	$\mu\text{Vp-p}$
TRANSFER CHARACTERISTICS								
Voltage Gain (Note 7)	$R_L = 100\Omega$	+25°C	-	0.971	-	-	0.971	V/V
	$R_L = 1\text{k}\Omega$	+25°C	-	0.995	-	-	0.995	V/V
	$R_L = 1\text{k}\Omega$	Full	0.990	-	-	0.980	-	V/V
-3dB Bandwidth (Note 4)	+25°C	-	110	-	-	110	-	MHz
AC Current Gain	+25°C	-	40	-	-	40	-	A/mA
OUTPUT CHARACTERISTICS								
Output Voltage Swing	$R_L = 100\Omega$	+25°C	± 10	± 10.7	-	± 10	± 11.2	V
	$R_L = 1\text{k}\Omega$ (Note 3)	Full	± 10	± 13.5	-	± 10	± 13.9	V
	$R_L = 1\text{k}\Omega$ (Note 5)	Full	± 10	± 10.5	-	± 10	± 10.5	V
Output Resistance	Full	-	3	10	-	3	10	Ω
Harmonic Distortion (Note 6)	+25°C	-	<0.005	-	-	<0.005	-	%
TRANSIENT RESPONSE								
Full Power Bandwidth (Note 8)	+25°C	-	41	-	-	41	-	MHz
Rise Time	+25°C	-	3.6	-	-	3.6	-	ns
Propagation Delay	+25°C	-	2	-	-	2	-	ns
Overshoot	+25°C	-	30	-	-	30	-	%
Slew Rate	+25°C	1.0	1.3	-	1.0	1.3	-	V/ns
Settling Time to 0.1%	+25°C	-	50	-	-	50	-	ns
POWER REQUIREMENTS								
Supply Current	+25°C	-	8.3	-	-	8.3	-	mA
	Full	-	-	10	-	-	10	mA
Power Supply Rejection Ratio (Note 9)	Full	54	64	-	54	64	-	dB

NOTES:

1. Absolute maximum ratings are limiting values, applied individually beyond which the serviceability of the circuit may be impaired. Functional operability under any of these conditions is not necessarily implied.
2. See thermal constants data in Die Characteristics section.
3. $V_{\text{SUPPLY}} = \pm 15\text{V}$
4. $V_{\text{IN}} = 1\text{Vp-p}$
5. $V_{\text{SUPPLY}} = \pm 12\text{V}$
6. $V_{\text{IN}} = 1\text{V}_{\text{RMS}}$; $f = 10\text{kHz}$.
7. $V_{\text{OUT}} = \pm 10\text{V}$
8. $\text{FPBW} = \frac{\text{Slew Rate}}{2\pi V_p} = \frac{5\text{V}(10\text{Vp-p})}{2\pi V_p}$
9. $\Delta V_{\text{SUPPLY}} = 10\text{V}$

HA-5002

Operating Instructions

Layout Considerations

The wide bandwidth of the HA-5002 necessitates that high frequency circuit layout procedures be followed. Failure to follow these guidelines can result in marginal performance.

Probably the most crucial of the RF/video layout rules is the use of a ground plane. A ground plane provides isolation and minimizes distributed circuit capacitance and inductance which will degrade high frequency performance.

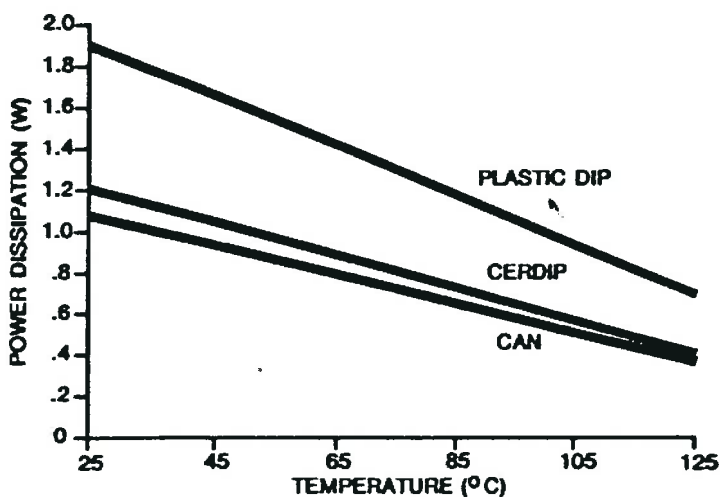
Other considerations are proper power supply bypassing and keeping the input and output connections as short as possible which minimizes distributed capacitance and reduces board space.

Power Supply Decoupling

For optimal device performance, it is recommended that the positive and negative power supplies be bypassed with capacitors to ground. Ceramic capacitors ranging in value from 0.01 to 0.1 μ F will minimize high frequency variations in supply voltage, while low frequency bypassing requires larger valued capacitors since the impedance of the capacitor is dependent on frequency.

It is also recommended that the bypass capacitors be connected close to the HA-5002 (preferably directly to the supply pins).

FREE AIR POWER DISSIPATION



$$P_{dmax} = \frac{T_{jmax} - T_A}{\theta_{j-c} + \theta_{c-s} + \theta_{s-a}}$$

Where: T_{jmax} = Maximum Junction Temperature of the Device

T_A = Ambient

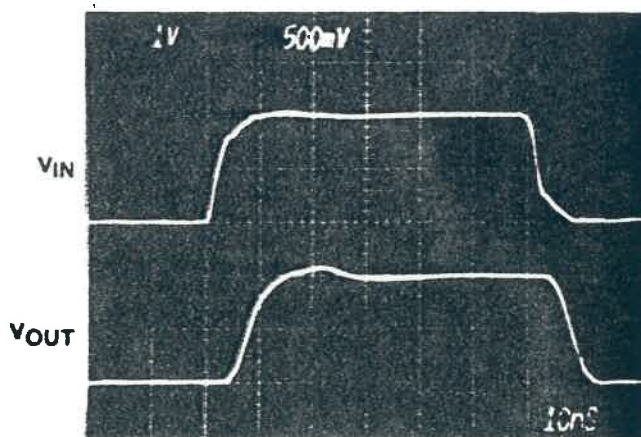
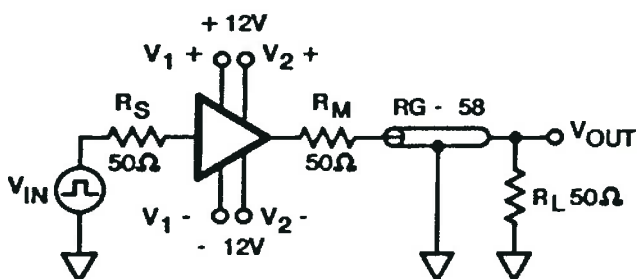
θ_{j-c} = Junction to Case Thermal Resistance

θ_{c-s} = Case to Heat Sink Thermal Resistance

θ_{s-a} = Heat Sink to Ambient Thermal Resistance

Test Circuits

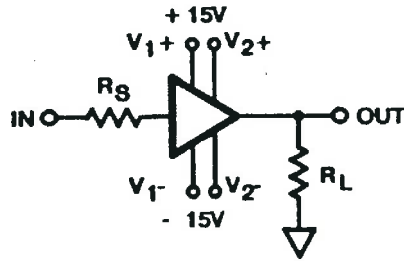
COAXIAL CABLE DRIVER - 50 Ω SYSTEM



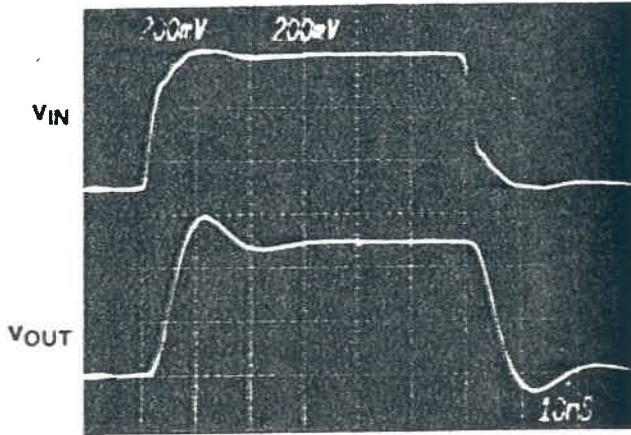
HA-5002

Test Circuits

LARGE AND SMALL SIGNAL RESPONSE

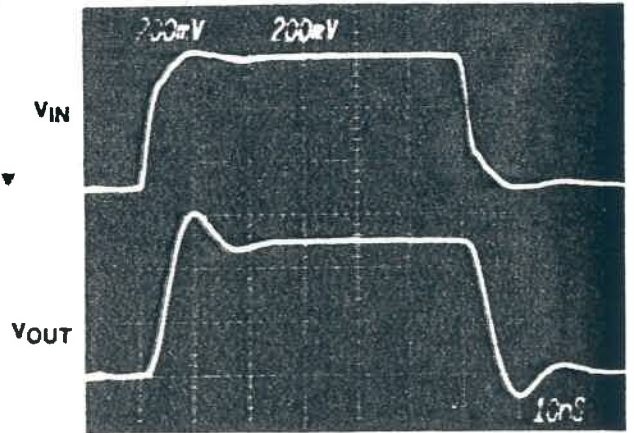


SMALL SIGNAL WAVEFORMS



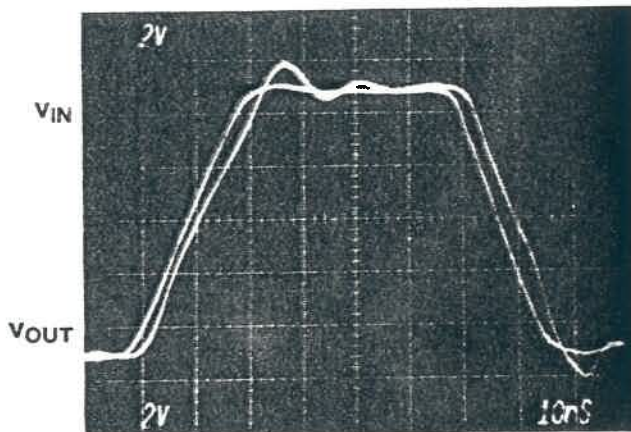
$R_S = 50\Omega$
 $R_L = 100\Omega$

SMALL SIGNAL WAVEFORMS



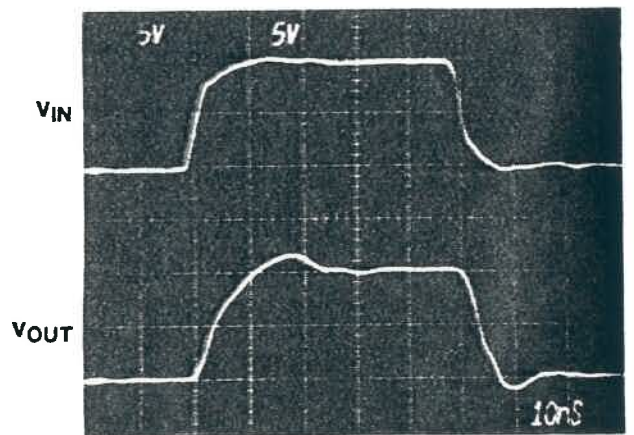
$R_S = 50\Omega$
 $R_L = 1k\Omega$

LARGE SIGNAL WAVEFORMS



$R_S = 50\Omega$
 $R_L = 1k\Omega$

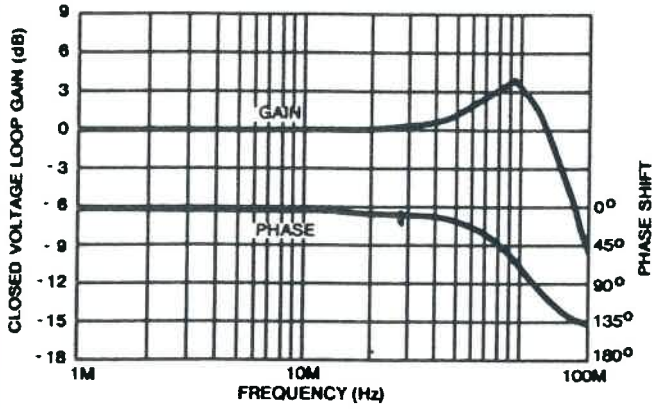
LARGE SIGNAL WAVEFORMS



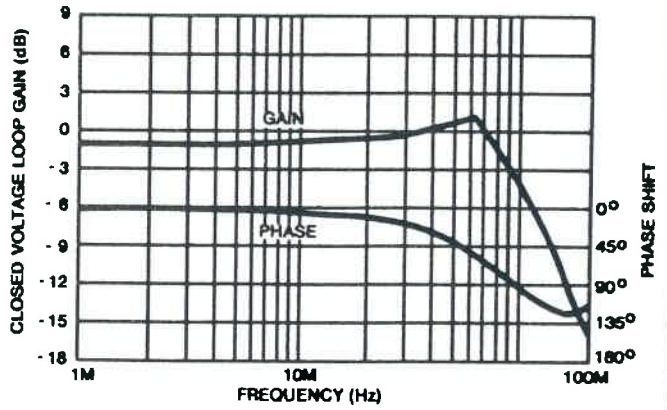
$R_S = 50\Omega$
 $R_L = 1k\Omega$

Typical Performance Curves

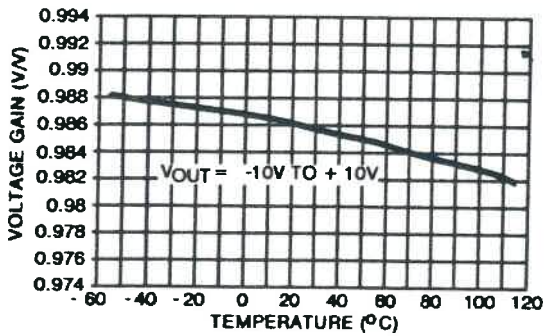
GAIN/PHASE vs. FREQUENCY
 $V_{CC} = \pm 15V, R_L = 1K, R_S = 50\Omega$



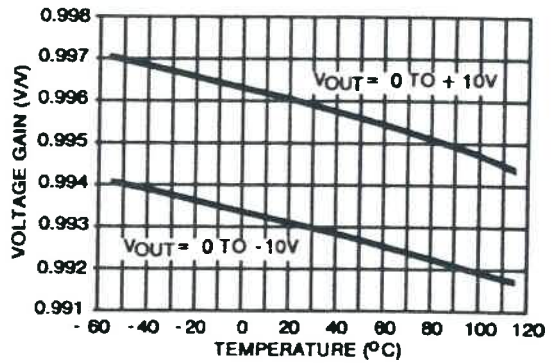
GAIN/PHASE vs. FREQUENCY
 $V_{CC} = \pm 15V, R_L = 50\Omega, R_S = 50\Omega$



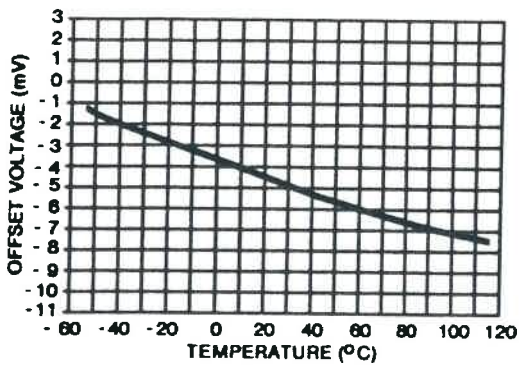
VOLTAGE GAIN vs. TEMPERATURE
 $V_{CC} = \pm 15V, R_{LOAD} = 100\Omega$



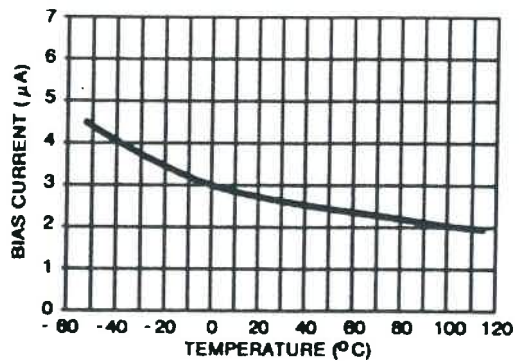
VOLTAGE GAIN vs. TEMPERATURE
 $V_{CC} = \pm 15V, R_{LOAD} = 1k\Omega$



OFFSET VOLTAGE vs. TEMPERATURE
 $V_{CC} = \pm 15V$

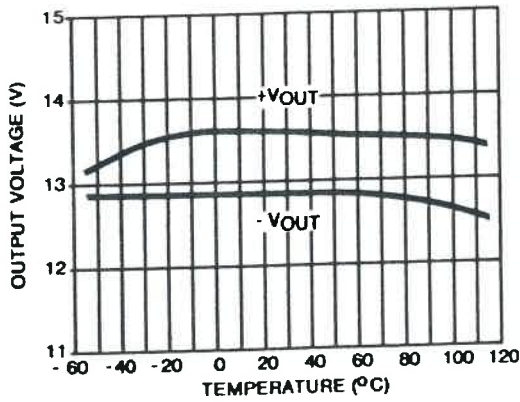


BIAS CURRENT vs. TEMPERATURE
 $V_{CC} = \pm 15V$

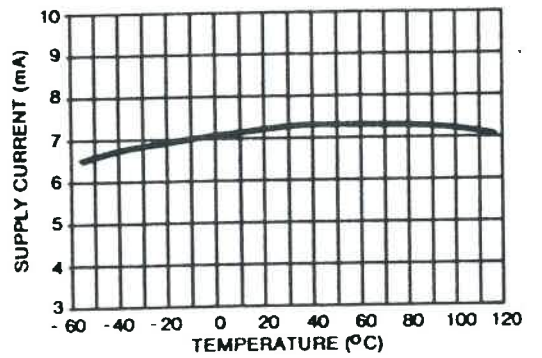


Typical Performance Curves (Continued)

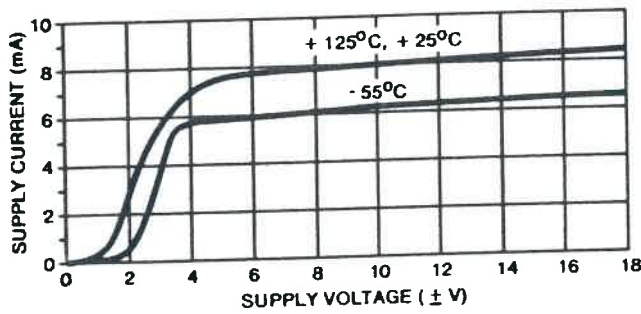
MAXIMUM OUTPUT VOLTAGE vs. TEMPERATURE
 $V_{CC} = \pm 15V, R_{LOAD} = 100\Omega$



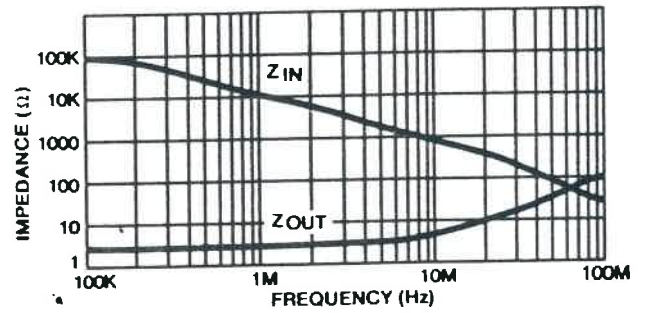
SUPPLY CURRENT vs. TEMPERATURE
 $V_{CC} = \pm 15V, I_{OUT} = 0mA$



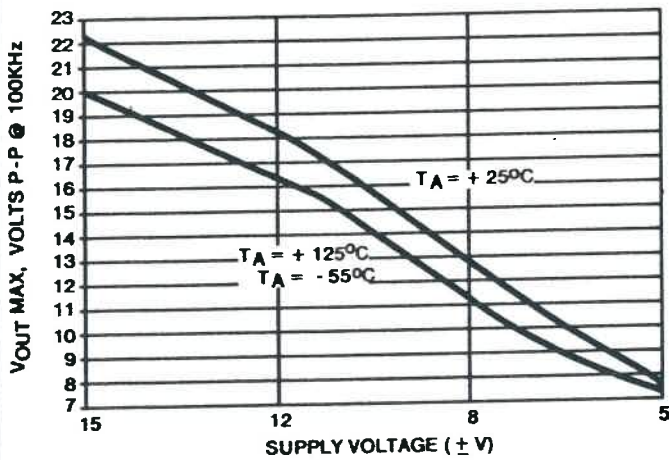
SUPPLY CURRENT vs. SUPPLY VOLTAGE
 $I_{OUT} = 0mA$



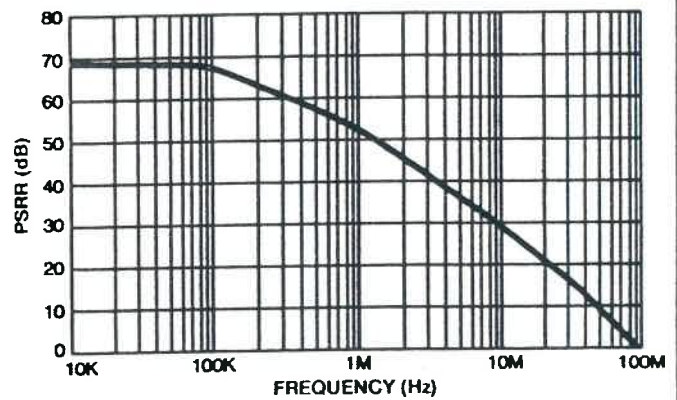
INPUT/OUTPUT IMPEDANCE vs. FREQUENCY
 $V_{CC} = \pm 15V$



V_{OUT} MAXIMUM vs. V_{SUPPLY}
 $R_{LOAD} = 100\Omega$



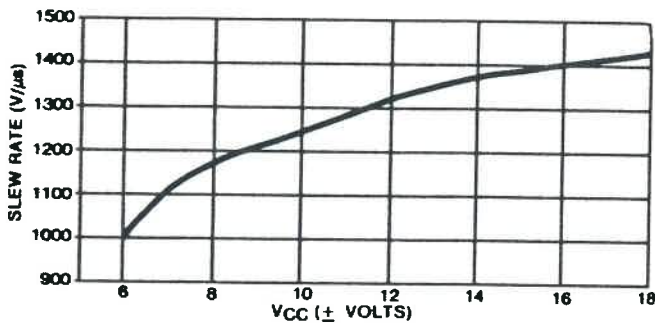
PSRR vs. FREQUENCY



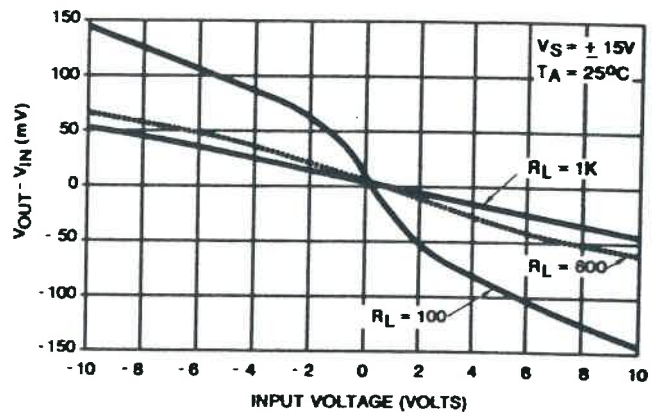
HA-5002

Typical Performance Curves (Continued)

SLEW RATE vs. SUPPLY VOLTAGE



GAIN ERROR vs. INPUT VOLTAGE



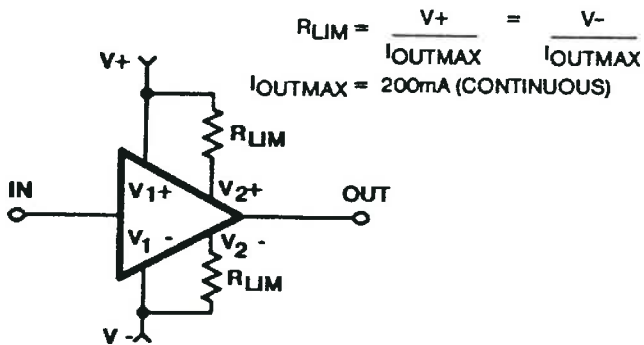
Typical Applications

OPERATION AT REDUCED SUPPLY LEVELS

The HA-5002 can operate at supply voltage levels as low as $\pm 5V$ and lower. Output swing is directly affected as well as slight reductions in slew rate and bandwidth.

SHORT CIRCUIT PROTECTION

The Output current can be limited by using the following circuit:



CAPACITIVE LOADING

The HA-5002 will drive large capacitive loads without oscillation but peak current limits should not be exceeded. Following the formula $I = Cdv/dt$ implies that the slew rate or the capacitive load must be controlled to keep peak current below the maximum or use the current limiting approach as shown. The HA-5002 can become unstable with small capacitive loads (50pF) if certain precautions are not taken. Stability is enhanced by any one of the following: a source resistance in series with the input of 50Ω to $1K$; increasing capacitive load to 150pF or greater; decreasing C_{LOAD} to 20pF or less; adding an output resistor of 10Ω to 50Ω ; or adding feedback capacitance of 50pF or greater. Adding source resistance generally yields the best results.

Die Characteristics

Transistor Count	27	
Die Dimensions	80 x 81 x 19 mils (2030 μ m x 2050 μ m x 480 μ m)	
Substrate Potential*	V1-	
Process	Bipolar-DI	
Thermal Constants ($^{\circ}C/W$)	θ_{ja}	θ_{jc}
HA7-5002 Ceramic Mini-DIP	122	39
HA3-5002 Plastic DIP	80	20
HA2-5002 Metal Can	103	31
HA9P5002 SOIC	160	42

*The substrate may be left floating (Insulating Die Mount) or it may be mounted on a conductor at V- potential.

Schema a blocchi oscillatore 8mhz

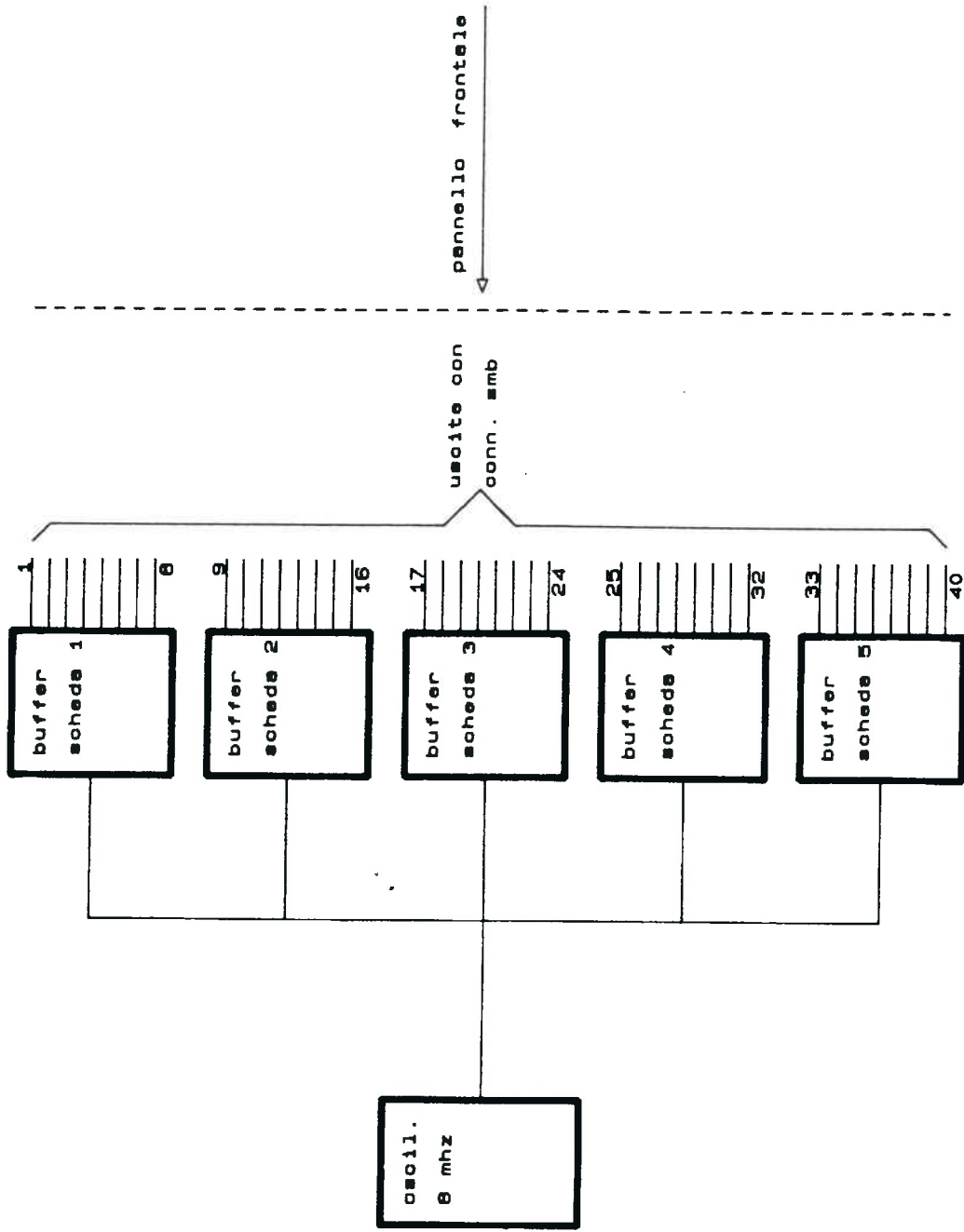


fig. 1

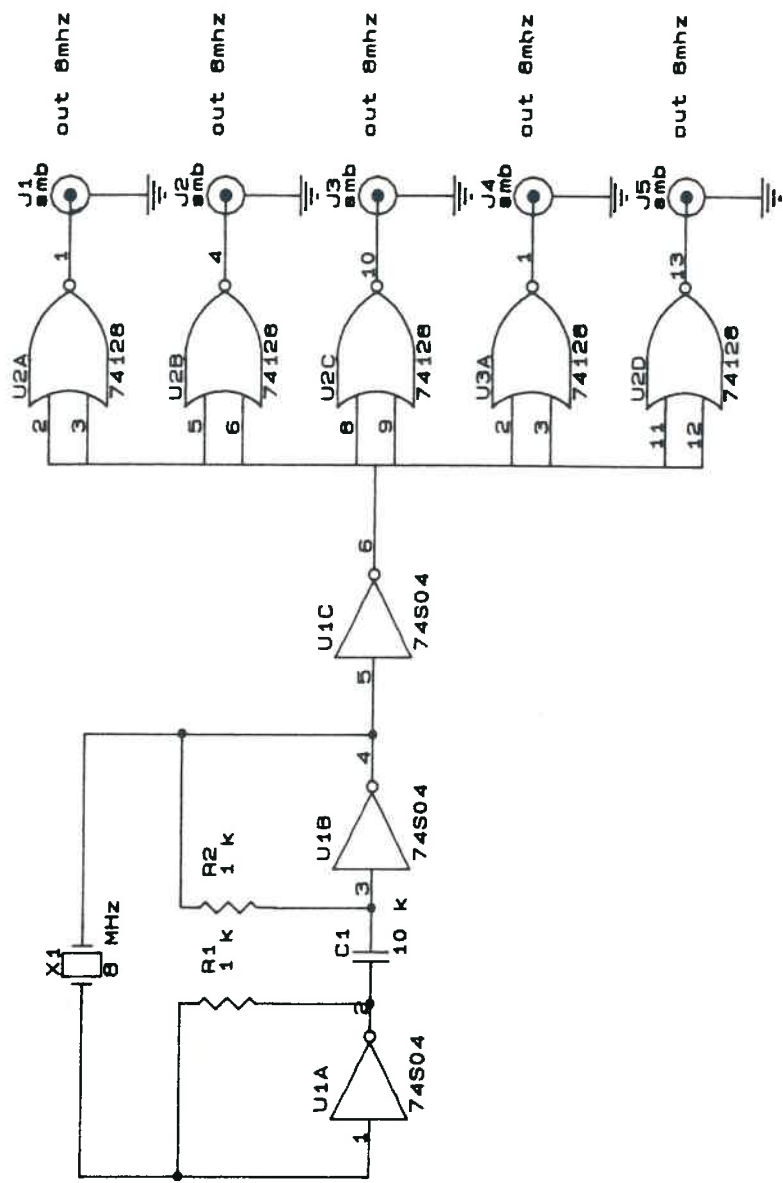


FIG. 2

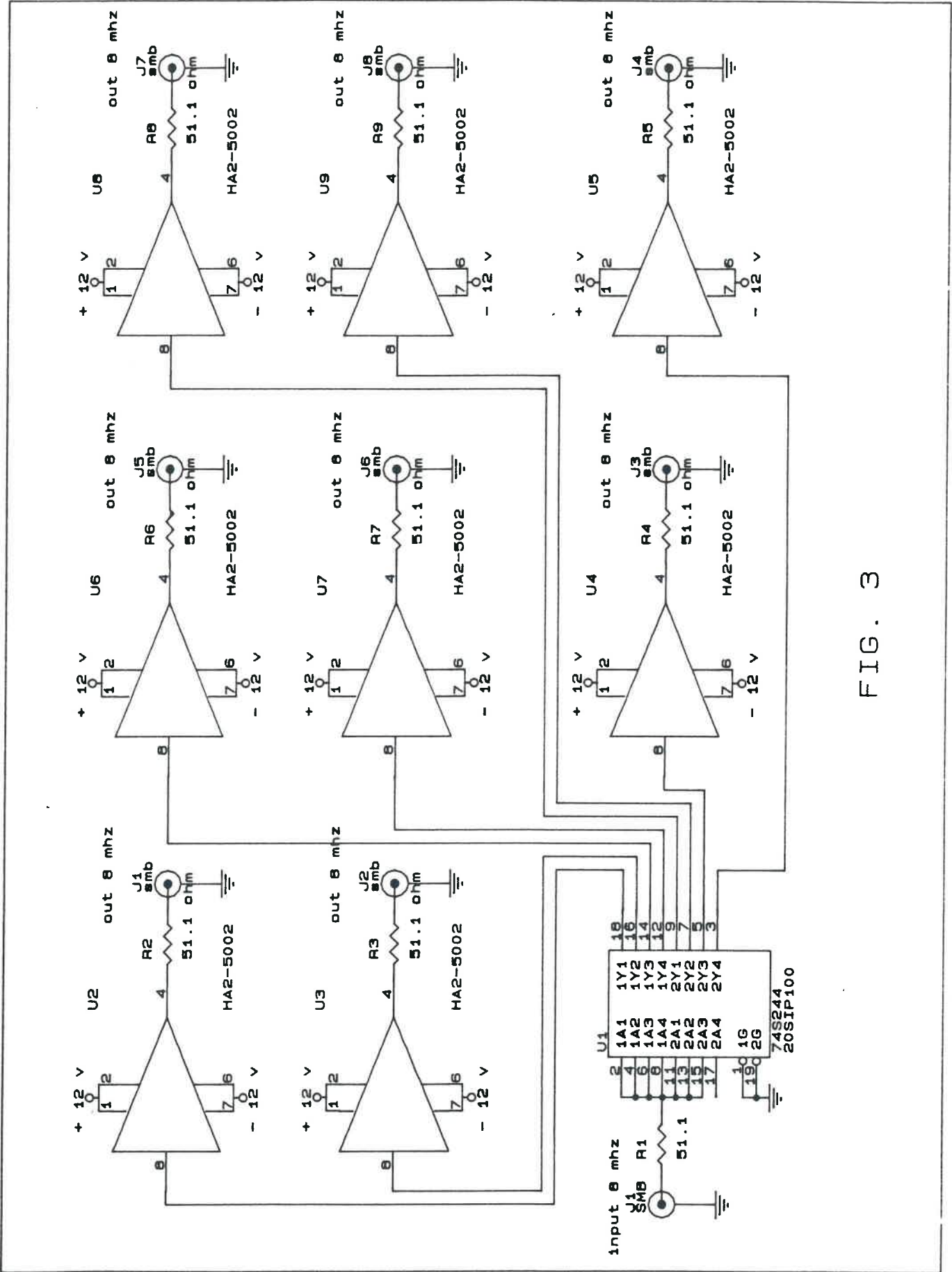


FIG. 3

Serigrafia buffer lato comp.

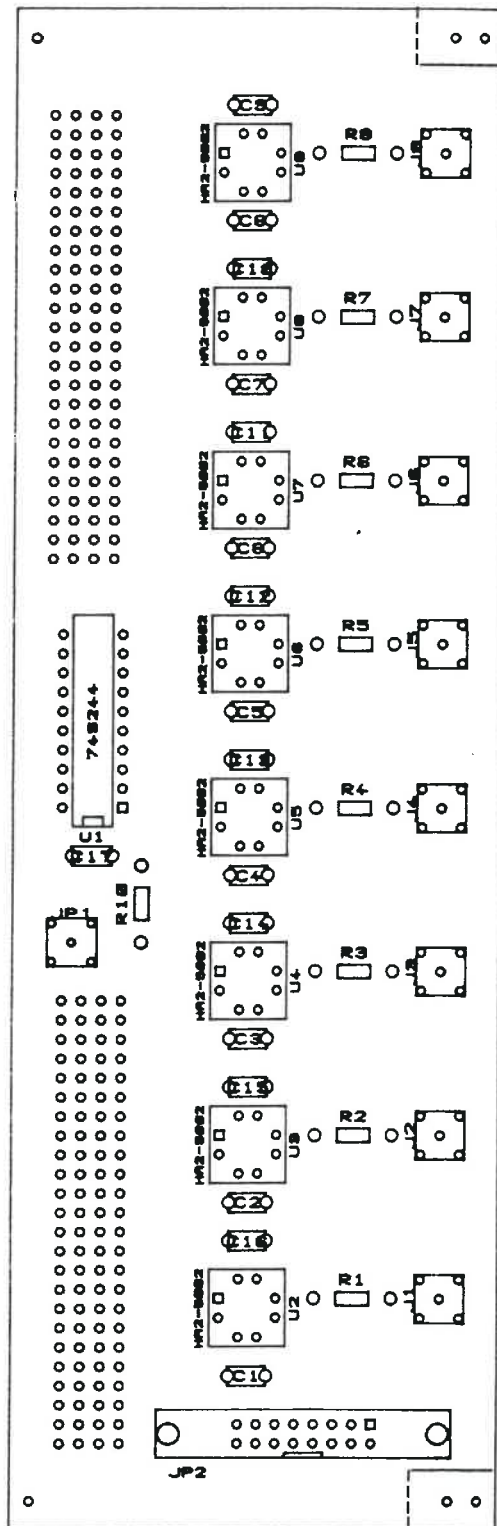


Fig. 4

circuito stampato del buffer lato componenti

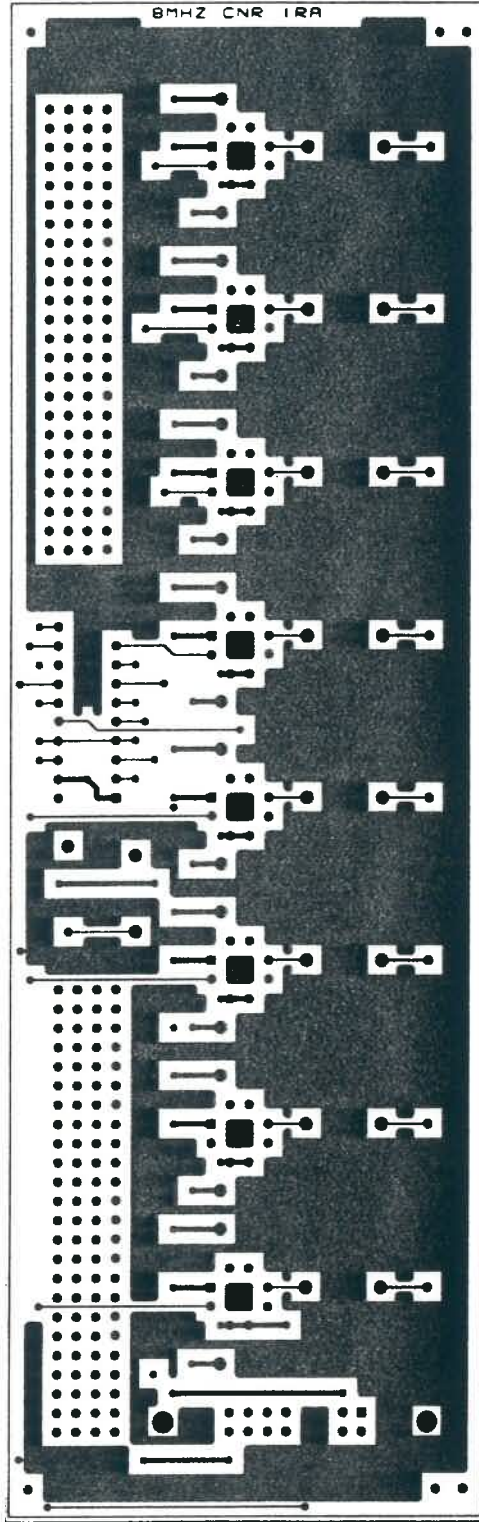


Fig. 5

ciruito stampato del buffer lato saldature

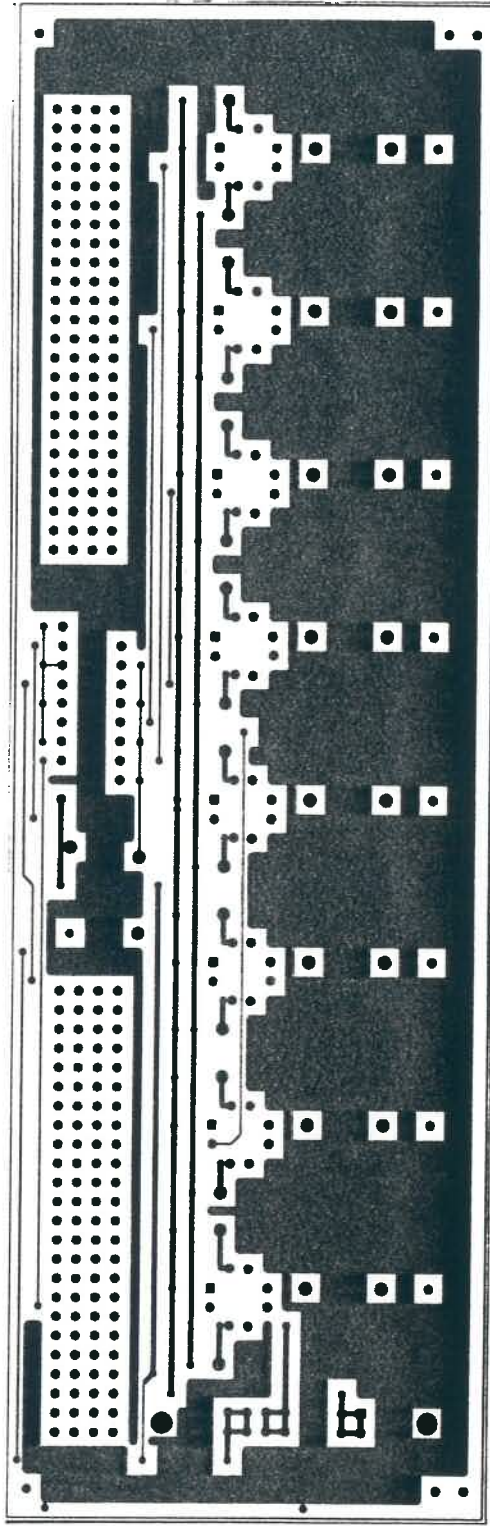


Fig. 6

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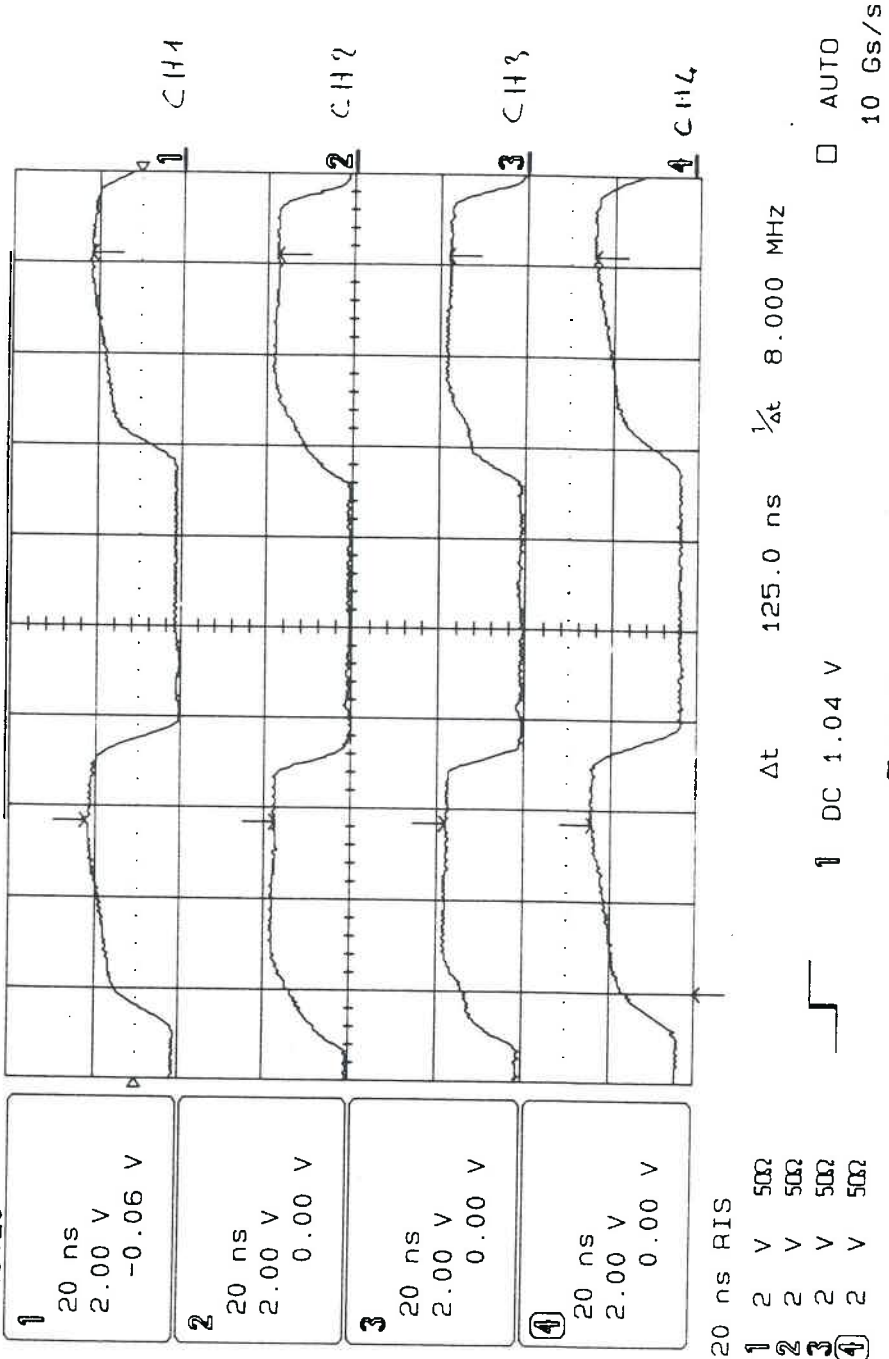
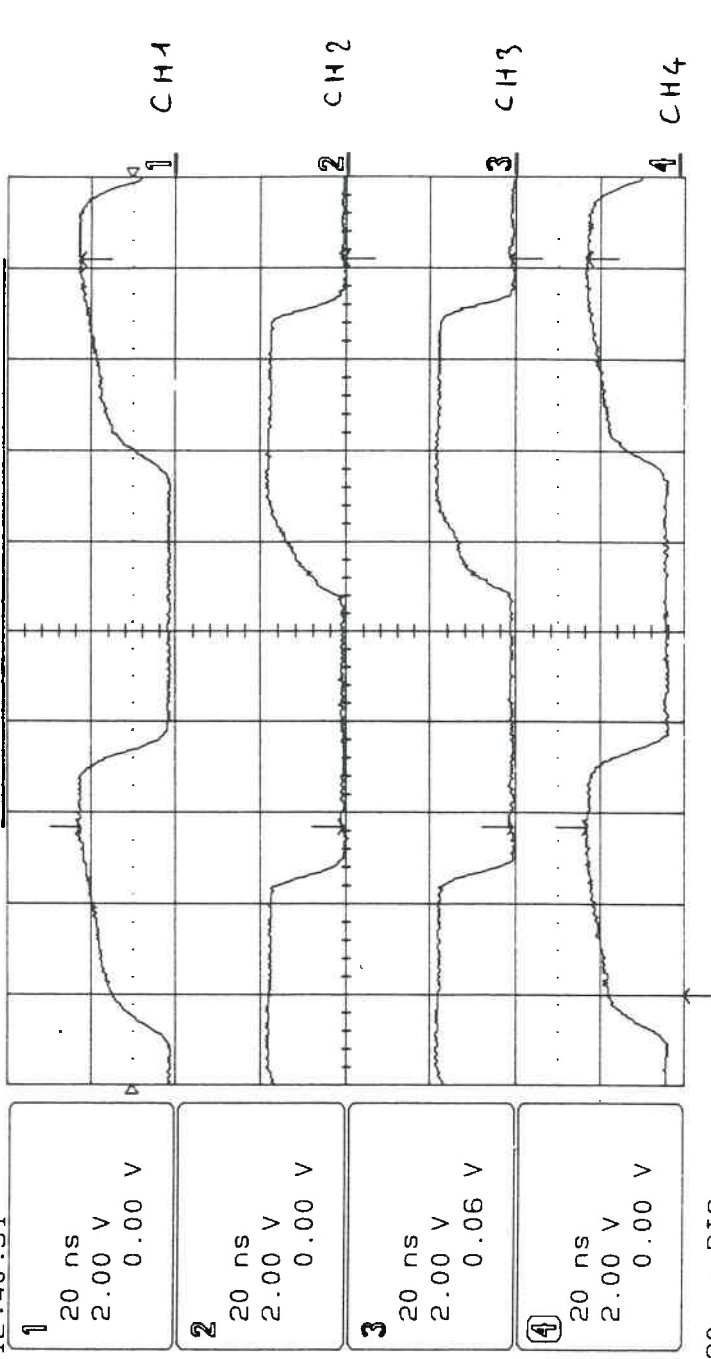


FIG. 7

CAVI TUTTI UGUALI DA 1 mE

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20 ns RIS
 1 2 V 50Ω
 2 2 V 50Ω
 3 2 V 50Ω
 4 2 V 50Ω

Δt 125.0 ns 1/Δt 8.000 MHz

1 DC 1.04 V AUTO
 10 GS/s

FIG. 8

IL COLLEGAMENTO ALL'OSCILLOSCOPIO PER CH1 e CH4 è FATTO CON 3 CAVI da 1,5 m e 1 da 1 m con 3 ABATTITORI BNC F/F, MENTRE CH2 e CH4 CON CAVI da 1 m