

2Vrms Audio Line Driver

1 General Description

The NAU8220 is a high quality 2Vrms analog input and output line driver. This device includes an integrated charge pump enabling true ground referenced inputs and outputs and full 5.6Vpp output levels, while operating from only a single 3.3V positive supply voltage.

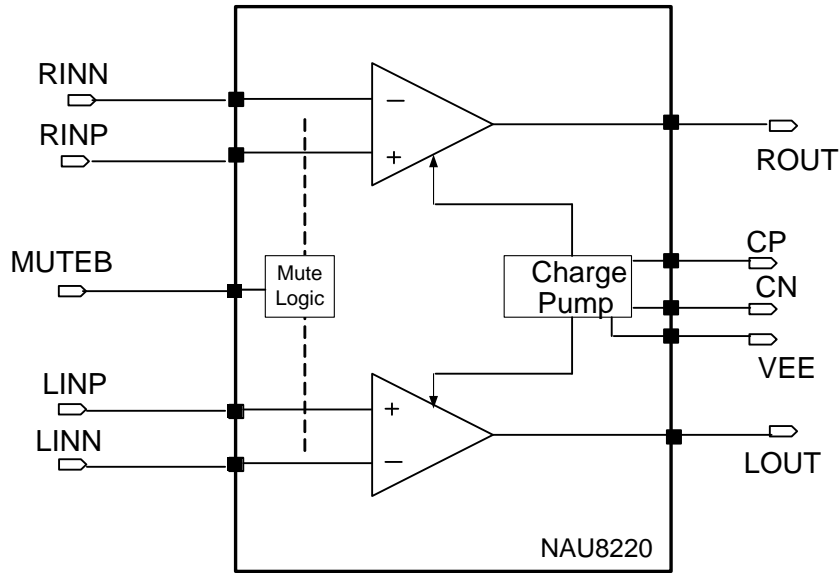
Additionally, the NAU8220 includes pop/click elimination features and high immunity to power supply and other system noise. This enables fast and efficient system integration while minimizing external component costs.

The NAU8220 is specified for operation from -40°C to +85°C, It is packaged in a cost-effective and space-saving 14-lead SOP and TSSOP packages.

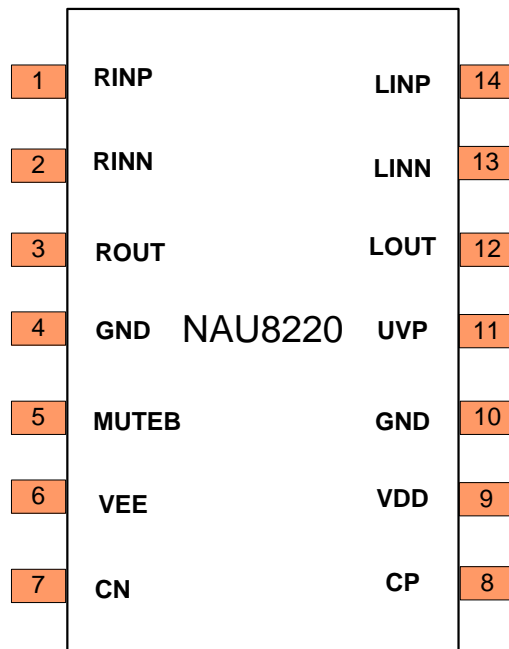
2 Features

- Operating voltage: 3.0-3.6V
- Full 2Vrms output using only 3.3Vdc supply
- True Ground Referenced analog outputs
- Low cost, small footprint package
- Automatic pop/click elimination and output muting for power-on
- 108dB SNR A-weighted performance
- >90dB THD+N
- 114dB Mute Attenuation
- < 1mV Output Offset
- 110dB channel separation at 1kHz
- Low external parts count
- High system noise immunity
- Packages: Pb free 14-pin SOP and TSSOP
- Operating temperature range: -40 to +85°C
- ±8 kV HBM protection on line outputs

3 Block diagram



4 Pin Configuration



5 Pin Description

Pin No.	Pin Name	Type	Description
1	RINP	AI	Right Channel Positive Input
2	RINN	AI	Right Channel Negative Input
3	ROUT	O	Right Channel Line Output
4	GND	P	Ground
5	MUTEB	I	Mute Bar
6	VEE	IO	Charge Pump Decoupling Output (Negative Voltage)
7	CN	IO	Charge Pump Capacitor Negative Node
8	CP	IO	Charge Pump Capacitor Positive Node
9	VDD	P	Positive Voltage Supply
10	GND	P	Ground
11	UVP	I	Under Voltage Protection
12	LOUT	O	Left Channel Line Output
13	LINN	AI	Left Channel Negative Input
14	LINP	AI	Left Channel Positive Input

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7 Absolute Maximum Ratings

DESCRIPTION	SYMBOL	CONDITION	MINIMUM	MAXIMUM	UNIT
VDD supply voltage	VDD	VDD–GND	-0.3	+4.0	V
Digital Input Voltage range	DV _{IN}	DV _{IN} – GND	GND – 0.3	VDD + 0.30	V
Analog Input Voltage	AV _{IN}	AV _{IN} – VEE	VEE – 0.3	VDD + 0.30	V
Operating Temperature	TA		-40	+85	°C
Storage Temperature	Tst		-65	+150	°C

CAUTION: Do not operate at or near the maximum ratings listed for extended periods of time. Exposure to such Conditions may adversely influence product reliability and result in failures not covered by warranty. Follow IC handling procedures to avoid ESD damage.

8 Recommended Operating Conditions

DESCRIPTION	SYMBOL	MINIMUM	TYPICAL	MAXIMUM	UNIT
Supply voltage	VDD	3.0	3.3	3.6	V
Ground	GND		0		V

9 Electrical Characteristics

Test Conditions VDD = 3.3V, TA = +25°C, 1 V rms 1 kHz signal, R1 (IN) = 15kΩ, R2 (FB) = 30kΩ, CP = 1μF, RL = 10kΩ unless otherwise stated.

Parameter	Sym	Test Conditions	Min	Typ	Max	Unit
Full Scale Output Voltage	Vout		2.0		-	Vrms
Signal to Noise Ratio	SNR	A-weighted	90	108	-	dB
Dynamic Range	DNR	A-weighted	90	108	-	dB
Total Harmonic Distortion + Noise	THD+N	20 kHz LPF	90	102	-	dB
Power Supply Rejection Ratio	PSRR	VDD = 3.0 V to 3.6 V		100		dB
Power Supply Rejection Ratio ¹	AC	100Hz	-	90	-	dB
	PSRR	1kHz		75	-	dB
		20kHz	-	60	-	dB
Channel Separation		1kHz	-	-110	-	dB
Noise Voltage	VN	A-weighted	-	8	-	μV
Mute Noise Voltage	VN	A-weighted MUTEB=GND	-	4	-	μV
Output Offset			-1	0.5	+1	mV
Output Impedance when muted	ZM	MUTEB = GND		0.6		Ω
Input to output attenuation when muted	MdB	MUTEB = GND		114		dB
UVP detect voltage	VUVP			1.2		Volts
UVP feedback current	IUVP			5		μA
Current Limit	ILIMIT	Output = GND		30		mA AC
Supply Current	IDD	VDD = 3.3 Volts		15		mA
Charge pump switching frequency	FCP	Pin CP		300		kHz
Low input level	VIL	MUTEB		40		% VDD
High input level	VIH	MUTEB		60		% VDD
Input current	IIN	MUTEB GND or VDD	-1		+1	μA

Notes

- The performance of AC PSRR depends upon the board layout.

10 Functional Description

The NAU8220 uses charge pump mechanism to get the full output signal swing. The charge pump uses the charge pump capacitor to put a negative voltage onto VEE, the charge pump decoupling node. An additional capacitor is needed from VDD to GND, pin 10. A low resistance one micro-farad capacitor is recommended for each of these capacitors. All of these connections need to be short. The negative voltage developed on pin 6 VEE enables the outputs to swing both positive and negative from GND.

Signal gain is set by the ratio of external resistors. The input signal can be either single ended or differential. The typical single ended application diagram is shown in figure 1 and differential in figure 2. For single ended inputs, the signal polarity of the output is inverted. A gain of two using R1 = 15 K Ohms and R2 = 30 K Ohms is recommended for good performance. R3 of 10 K Ohms helps to reject unwanted signals by balancing the inputs. For larger gains, R2 can be increased. R1 can also be decreased, but 10 K Ohms is the minimum recommended. For example, a gain of three could use R1 = 10 K Ohms, R2 = 30 K Ohms, and R3 = 7.5 K Ohms. For better performance R3 and R6 should be approximately equal to R1||R2 and R4||R5. Gains larger than ten are not recommended. Large gains will have more noise and distortion than the nominal gain of two. The following table shows the R1 and R2 resistance values for different gain settings.

Gain	Input Resistance, R1	Feedback Resistance, R2
-1	10k Ohms	10k Ohms
-2	15k Ohms	30k Ohms
-3	10k Ohms	30k Ohms
-10	10k Ohms	100k Ohms

Load of the line driver outputs is from 600 Ohms minimum to 10 K Ohms nominal. With VDD at 3.3 Volts, the maximum output signal is 2 Volts RMS. Capacitive loads up to 200 pF can be driven. If larger capacitive loads such as 2.2 nF (C_{PC}) need to be driven, then a resistance of at least 33 Ohms (R_{PC}) should be added in series to provide both stability and protection. If this resistor and capacitor are added for protection, then the components need to be properly rated. For example, 100 volts rating for the capacitor may be needed to survive an output surge.

For best output offset voltages, the inputs can be AC coupled.

Upon the application of power to the VDD pin, the part will enter into a pop reduction mode which applies a resistive loading to the two outputs. After the VEE pin reaches more than about 1.5 Volts, a power up sequence begins that places the outputs into the Mute condition. This condition is held until both the MUTE pin is held high and the UVP pin exceeds about 1.25 Volts. When the MUTE pin rises, the outputs will follow the input signals. This pin should not be raised until a valid signal is available. The MUTE pin is driven by a logic signal to GND or VDD.

The MUTE condition can be entered from normal operation by pulling MUTE low. If power is interrupted, the UVP pin can be used to force the part into the MUTE condition.

The UVP pin can force the part into the Mute condition when the power supply voltage drops below the desired voltage. If this function is not needed, the UVP pin should be connected to VDD. Feed back is provided by a nominal 5 μ A current developed across the external resistors applied. The turn on voltage sets the ratio of R11 and R12 compared to the internal 1.22 Volt reference. The formula for turn ON

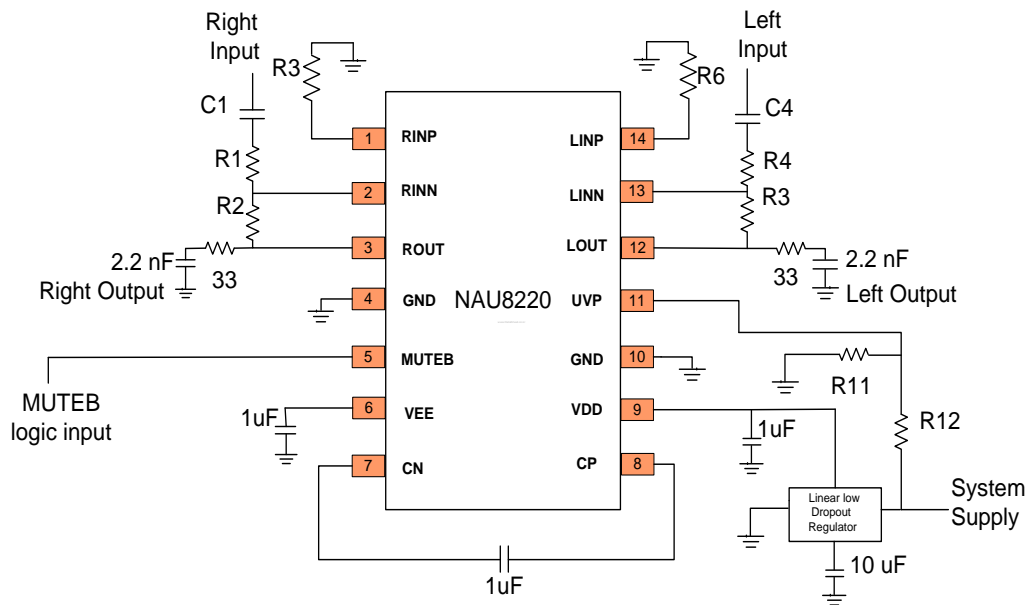
voltage is $V_{ON} = 1.22V * (R11 + R12)/R11$ and the formula for the turn off voltage is $V_{OFF} = V_{ON} - (5\mu A * R12)$.

For example, for a turn on voltage of 3.0 Volts and a turn off voltage of 2.5 volts, the calculated resistors are $R11 = 68.5k\Omega$ and $R12 = 100k\Omega$, or using standard values, $R11 = 68k\Omega$ and $R12 = 100k\Omega$.

Important note: When using a LDO, the turn-on and turn-off voltages for the UVP should be set higher than the sum of 3.3V and the minimum required voltage drop across the LDO, to ensure proper operation.

11 Typical Application Diagram

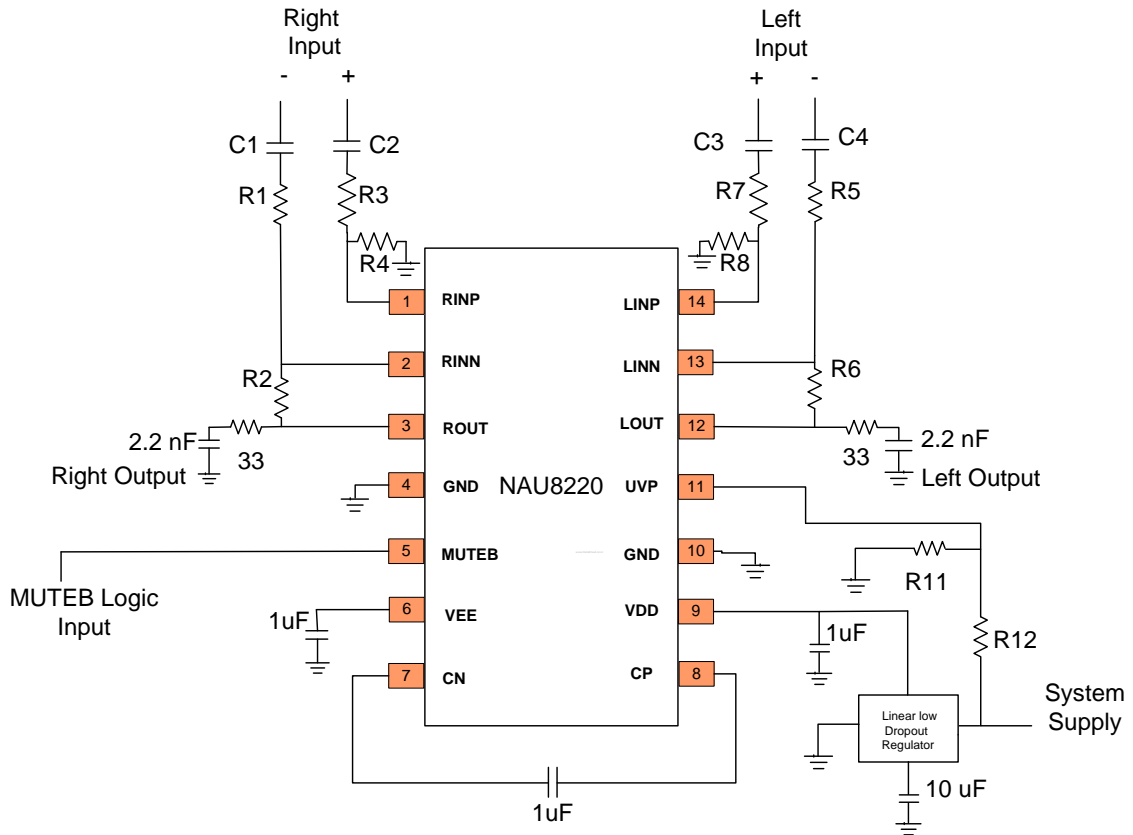
Single Input Configuration:



R1 = R4 = 15 KOhms
 R2 = R5 = 30 KOhms
 R3 = R6 = 10 Kohms
 C1 = C4 = 2.2 uF

Figure 1

Differential Input Configuration:



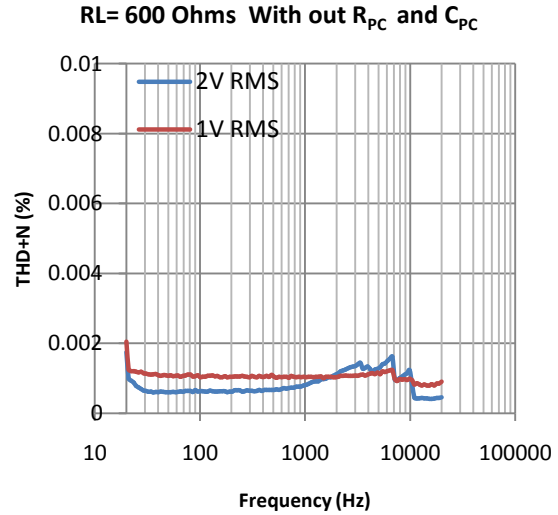
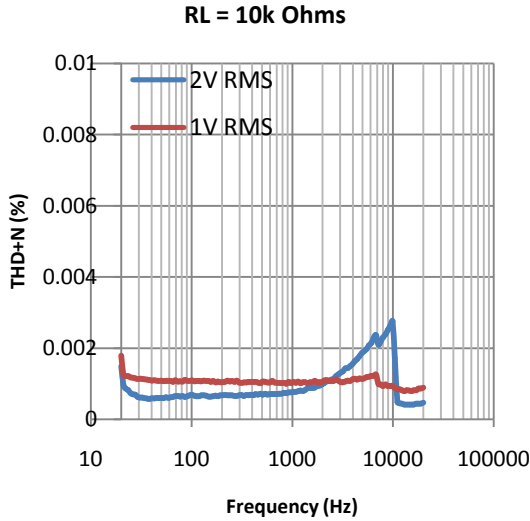
R1 = R3 = R5 = R7 = 15 KOhms
 R2 = R4 = R6 = R8 = 30 KOhms
 C1 = C2 = C3 = C4 = 2.2 uF

Figure 2

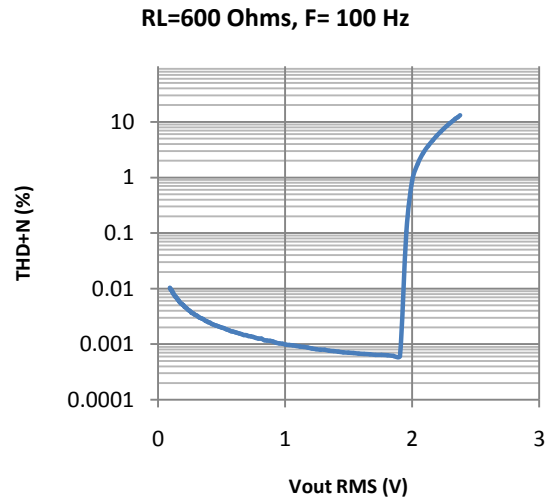
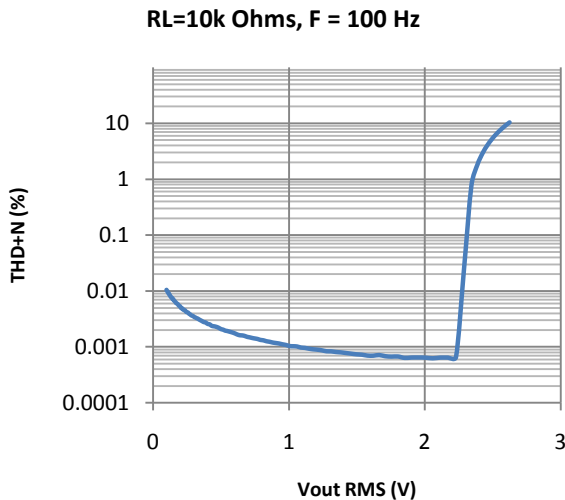
12 Typical Characteristics

Test Conditions VDD = 3.3V, TA = +25°C, 1kHz signal, R1 (IN) = 15kΩ, R2 (FB) = 30kΩ, CP = 1μF, RL = 10kΩ, C_{PC} = 2200pF, R_{PC} = 33 Ohms unless otherwise stated.

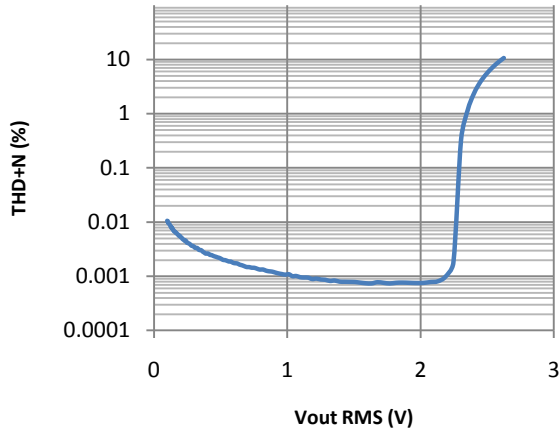
Total Harmonic Distortion + Noise Vs Frequency



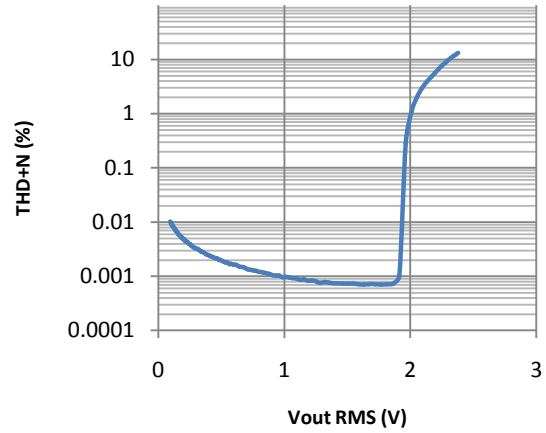
Total Harmonic Distortion + Noise Vs Output Voltage



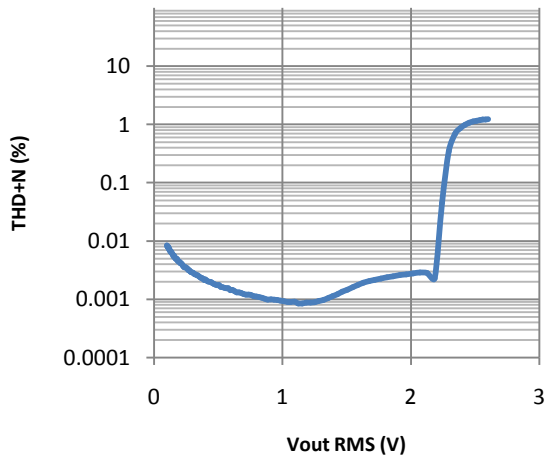
RL=10k Ohms, F = 1kHz



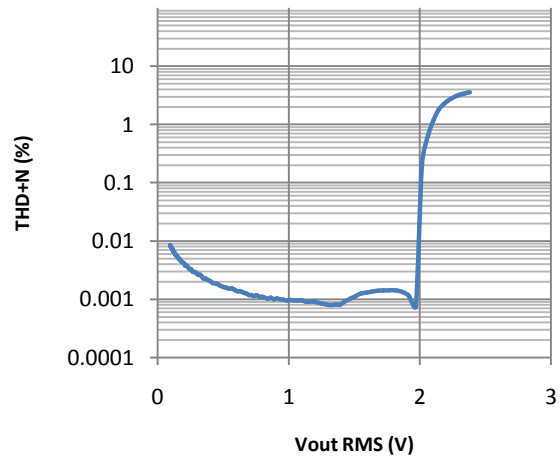
RL=600 Ohms, F = 1kHz



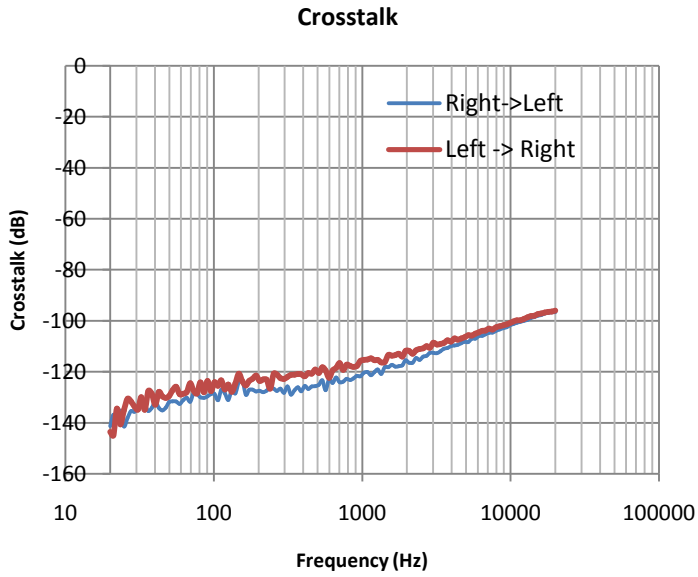
RL=10k Ohms, F = 10kHz



RL=600 Ohms, F = 10kHz

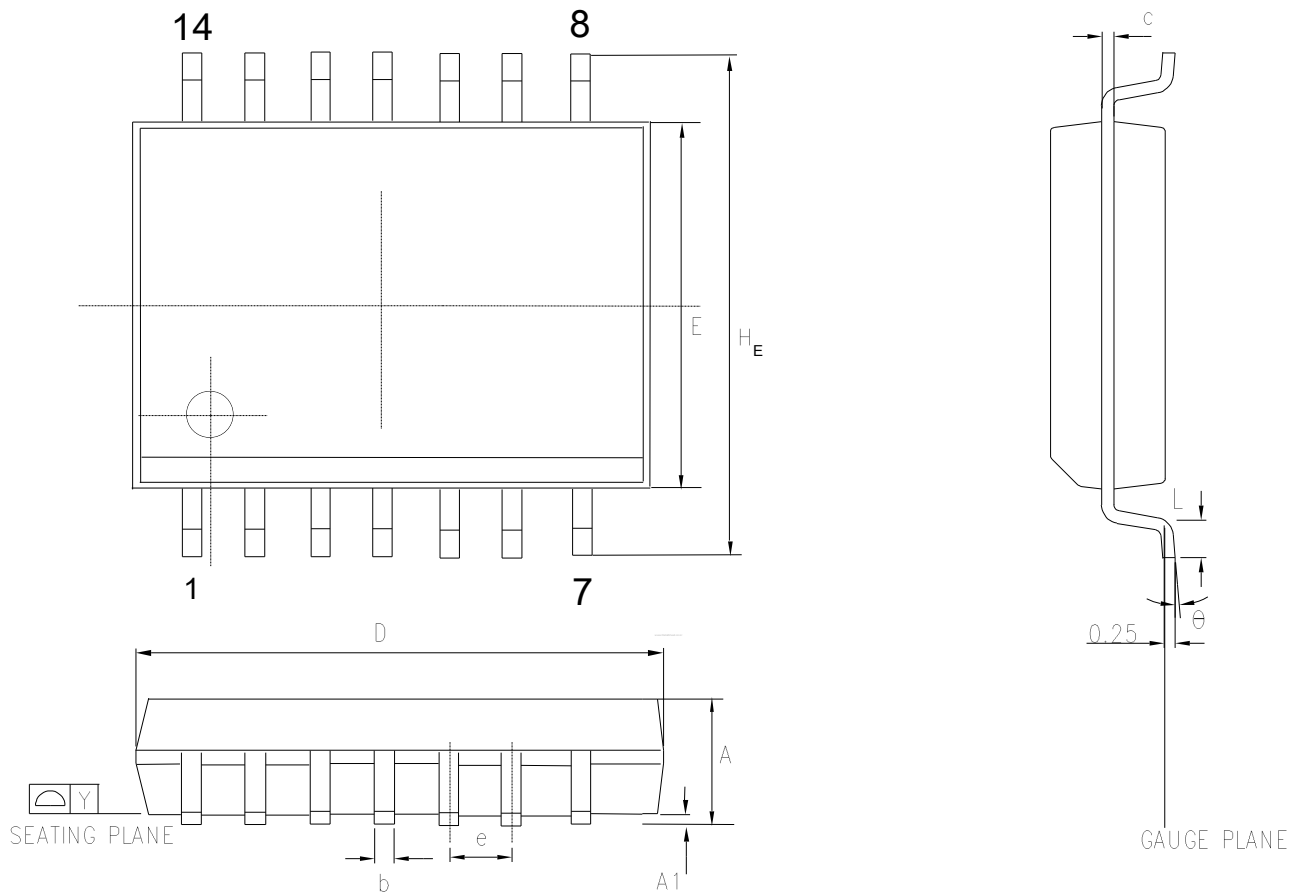


Cross talk Vs Frequency



13 Package Specification

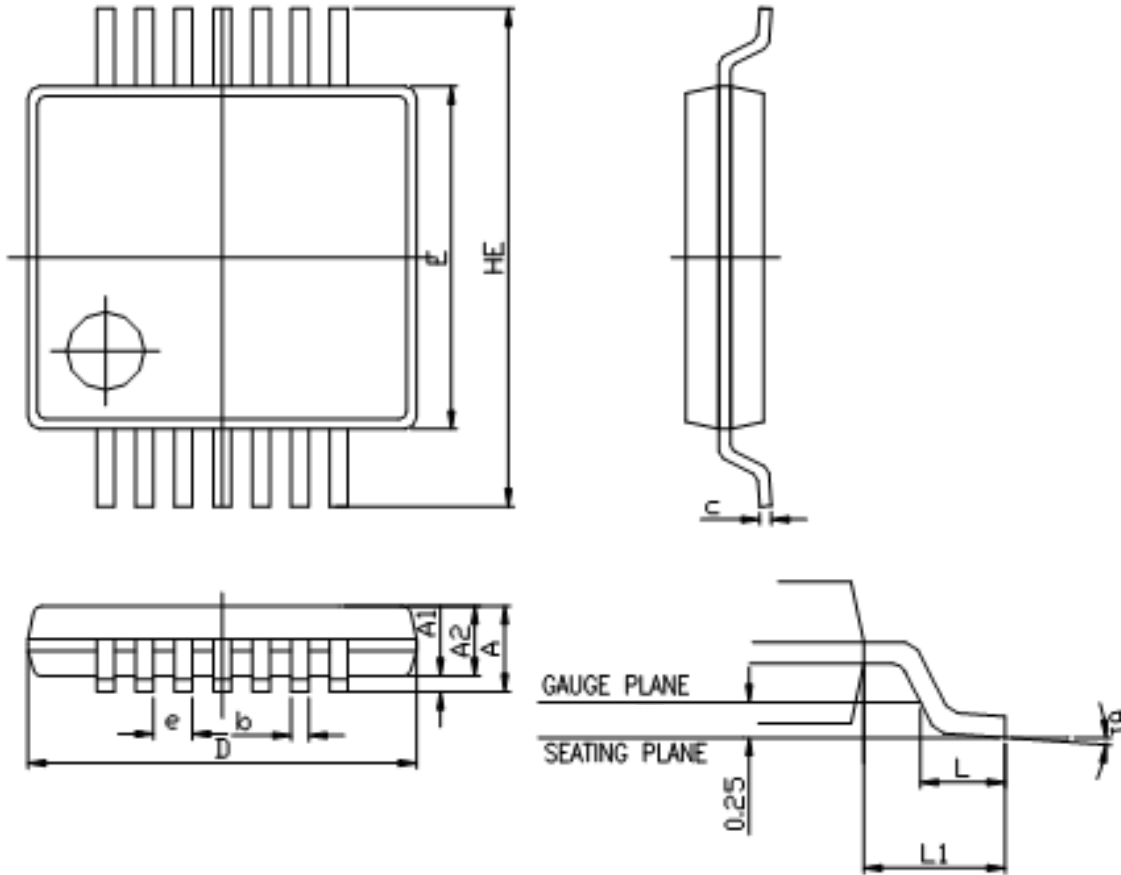
13.1 SOP-14 PACKAGE



Control dimensions are in millimeters .

SYMBOL	DIMENSION IN MM		DIMENSION IN INCH	
	MIN.	MAX.	MIN.	MAX.
A	1.35	1.75	0.053	0.069
A1	0.10	0.25	0.004	0.010
b	0.33	0.51	0.013	0.020
c	0.19	0.25	0.008	0.010
E	3.80	4.00	0.150	0.157
D	8.55	8.75	0.337	0.344
e	1.27 BSC		0.050 BSC	
H _E	5.80	6.20	0.228	0.244
Y	0.10		0.004	
L	0.40	1.27	0.016	0.050
θ	0	8	0	8

13.2 TSSOP-14 PACKAGE (14L 4.4X5.0 MM²)



CONTROLLING DIMENSION: MILLIMETERS

SYMBOL	DIMENSION IN MM			DIMENSION IN INCH		
	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.
A	---	---	1.20	---	---	0.043
A1	0.05	---	0.15	0.002	---	0.006
A2	0.80	0.90	1.05	0.031	0.035	0.041
L	0.50	0.60	0.75	0.020	0.024	0.030
EH	6.40 BSC.			0.252 BSC.		
E	4.30	4.40	4.50	0.169	0.173	0.177
D	4.90	5.00	5.10	0.193	0.197	0.201
b	0.19	---	0.30	0.007	---	0.012
c	0.09	---	0.20	0.004	---	0.008
L1	1.0 REF.			0.039 REF.		
e	0.65 BSC.			0.026 BSC.		
θ1	0	---	8	0	---	8

14 Ordering Information

Nuvoton Part Number Description

NAU8220_ _

┌	┌	Package Material:
		G = Pb-free Package / Green
└	└	Package Type:
		S = 14-Pin SOP Package
		W = 14-Pin TSSOP Package

Important Notice

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