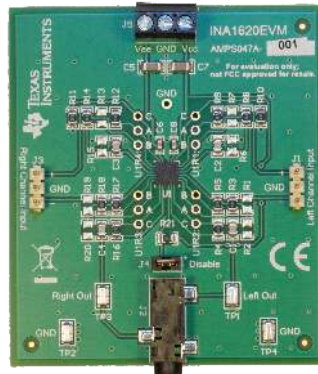


INA1620EVM Audio Amplifier Evaluation Module



This user's guide contains information for the INA1620 device as well as support documentation for the INA1620 evaluation module (EVM). Included are the performance specifications, set-up procedure, modifications, measured data, printed circuit board (PCB) layout, schematic, and bill of materials (BOM) of the INA1620EVM.

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1 Introduction

The INA1620 is a high-performance, bipolar-input audio operational amplifier with integrated thin-film resistors. For a full list of electrical characteristics of the INA1620, see the [INA1620 product data sheet](#).

2 Performance Specification Summary

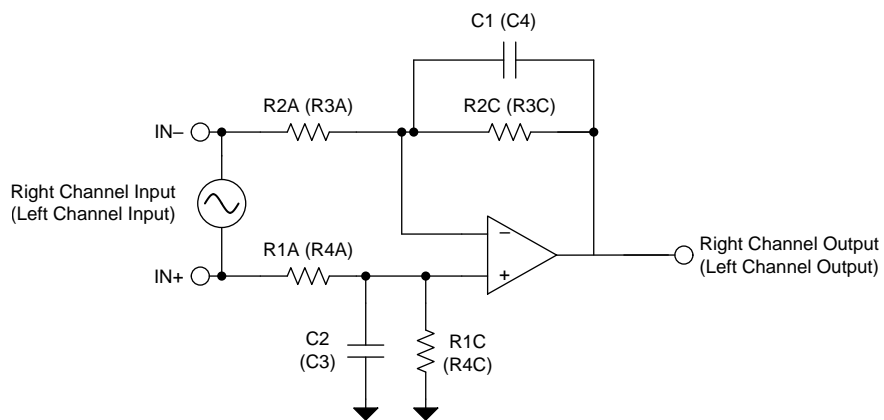
A summary of the INA1620EVM performance specifications is provided in [Table 1](#). Specifications are given for a supply voltage of $V_s = \pm 15\text{ V}$ and at an ambient temperature of 25°C , unless otherwise noted.

Table 1. INA1620EVM Measured Performance Summary

SPECIFICATION	TEST CONDITIONS	MEASURED PERFORMANCE
Total Harmonic Distortion Plus Noise (THD+N) at 1 kHz	$V_{IN} = 1\text{ V}_{RMS}$, Load = $32\ \Omega$, measurement bandwidth = 90 kHz	-107.8 dB
THD+N vs at 1 kHz	$V_{IN} = 1\text{ V}_{RMS}$, Load = $16\ \Omega$, measurement bandwidth = 90 kHz	-107.1 dB
Second Harmonic – Left Channel	$V_{IN} = 1\text{ V}_{RMS}$, Load = $32\ \Omega$, $F_{IN} = 1\text{ kHz}$	-129.62 dBV
Second Harmonic – Right Channel	$V_{IN} = 1\text{ V}_{RMS}$, Load = $32\ \Omega$, $F_{IN} = 1\text{ kHz}$	-125.53 dBV
Second Harmonic – Left Channel	$V_{IN} = 1\text{ V}_{RMS}$, Load = $16\ \Omega$, $F_{IN} = 1\text{ kHz}$	-122.91 dBV
Second Harmonic – Right Channel	$V_{IN} = 1\text{ V}_{RMS}$, Load = $16\ \Omega$, $F_{IN} = 1\text{ kHz}$	-121.36 dBV
CMRR - Left	$V_{IN} = 1\text{ V}_{RMS}$, $F_{IN} = 1\text{ kHz}$, no load	-83 dB
CMRR - Right	$V_{IN} = 1\text{ V}_{RMS}$, $F_{IN} = 1\text{ kHz}$, no load	-84 dB

3 Modifications

This EVM is designed to provide access to the features of and measure the performance of the INA1620. The phase shift and cutoff frequency of this EVM can be modified by changing external capacitors. The INA1620EVM allows external resistors to be used instead of the internal thin-film resistors INA1620. This may be useful for applications where the excellent matching of the INA162 resistors is desired for another use. The schematic of the INA1620EVM configured to use internal resistors is displayed in [Figure 1](#). For a full schematic of the INA1620EVM, see [Figure 15](#).



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Figure 1. INA1620EVM Schematic Using Internal Resistors

3.1 Gain

Equation 1 and Equation 2 display the transfer function of the circuit shown in Figure 1.

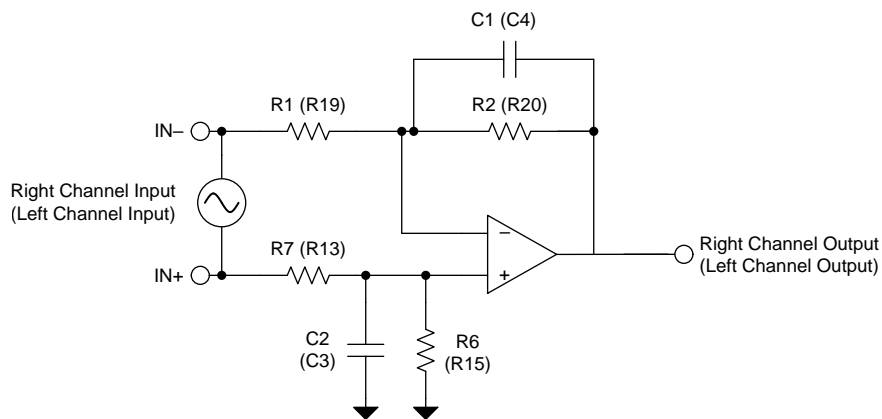
$$V_{\text{RightChannelOutput}} = \left(\frac{R_{1C}}{R_{1C} + R_{1A}} \right) \times \left(1 + \frac{R_{2C}}{R_{2A}} \right) \times IN_+ - \left(\frac{R_{2C}}{R_{2A}} \right) \times IN_- \quad (1)$$

$$V_{\text{LeftChannelOutput}} = \left(\frac{R_{4C}}{R_{4C} + R_{4A}} \right) \times \left(1 + \frac{R_{3C}}{R_{3A}} \right) \times IN_+ - \left(\frac{R_{3C}}{R_{3A}} \right) \times IN_- \quad (2)$$

When using the internal thin-film resistors, all resistance values in Equation 1 and Equation 2 are 1 kΩ. This simplifies Equation 1 and Equation 2 into Equation 3.

$$V_{\text{LeftChannelOutput}} = V_{\text{RightChannelOutput}} = IN_+ - IN_- \quad (3)$$

The INA1620EVM also allows the use of external resistors to set the amplifier gain. Note that external resistors must be used if the thin-film resistors in the INA1620 are to be used for other purposes. Equation 4 and Equation 5 display the transfer function for the circuit shown in Figure 2.



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Figure 2. INA1620EVM Schematic Using External Resistors

$$V_{\text{RightChannelOutput}} = \left(\frac{R_7}{R_6 + R_7} \right) \times \left(1 + \frac{R_2}{R_1} \right) \times IN_+ - \left(\frac{R_2}{R_1} \right) \times IN_- \quad (4)$$

$$V_{\text{LeftChannelOutput}} = \left(\frac{R_{15}}{R_{13} + R_{15}} \right) \times \left(1 + \frac{R_{20}}{R_{19}} \right) \times IN_+ - \left(\frac{R_{20}}{R_{19}} \right) \times IN_- \quad (5)$$

For best CMRR performance, it is desirable to balance the gain from the IN+ and IN- components by setting $R_1 = R_7$, $R_{13} = R_{19}$, $R_2 = R_6$, and $R_{20} = R_{15}$. For a typical headphone amplifier application, both the left and right channels will be identical, so $R_1 = R_7 = R_{13} = R_{19}$ and $R_2 = R_6 = R_{15} = R_{20}$. In this case, Equation 4 and Equation 5 simplify to Equation 6.

$$V_{\text{LeftChannelOutput}} = V_{\text{RightChannelOutput}} = \left(\frac{R_2}{R_1} \right) \times (IN_+ - IN_-) \quad (6)$$

3.2 Cutoff Frequency

This EVM provides the ability to filter the output of the INA1620. The cutoff frequency of the filter can be calculated using [Equation 7](#) and [Equation 8](#).

$$f_{c\text{-right}} = \frac{1}{2\pi \times R_2 \times C_1}$$

given

- $R_1 = R_7$, $R_2 = R_6$, and $C_1 = C_2$ (7)

$$f_{c\text{-left}} = \frac{1}{2\pi \times R_{15} \times C_3}$$

given

- $R_{13} = R_{19}$, $R_{15} = R_{20}$, and $C_3 = C_4$ (8)

If the internal resistors of the INA1620 are used instead, both R_2 and R_{15} above are 1-k Ω resistors.

3.3 Phase Shift

The phase shift, Θ , is calculated using [Equation 9](#).

$$\Theta = -\tan^{-1}\left(\frac{f}{f_c}\right)$$

where

- f is the maximum frequency of interest within the audio band
- f_c is the cutoff frequency discussed in [Section 3.2](#) (9)

3.4 Alternative Uses for Internal Resistors

For most headphone amplifier applications, the internal thin-film resistors in the INA1620 are used as shown in [Figure 1](#). However, these resistors may be used for other purposes, if desired. The INA1620EVM supports disconnecting each of the four matched resistor pairs for external use, as described below.

Table 2. Jumper and Resistor Substitutions for Internal Resistor Reuse

INA1620 INTERNAL RESISTOR PAIR	0- Ω RESISTORS TO REMOVE	1-k Ω RESISTORS TO INSTALL
R1 (terminals R1A, R1B, R1C)	R8, R9, R10	R6, R7
R2 (terminals R2A, R2B, R2C)	R3, R4, R5	R1, R2
R3 (terminals R3A, R3B, R3C)	R16, R17, R18	R19, R20
R4 (terminals R4A, R4B, R4C)	R11, R12, R14	R13, R15

[Table 2](#) shows the 0- Ω resistors that must be removed and 1-k Ω resistors that must be added in order to use each internal resistor pair in the INA1620 separately. When the appropriate changes have been made, the internal resistor pairs may be accessed on the corresponding connections on the EVM labelled U1R1 A, B, and C, U1R2 A, B, and C, etc, as shown in [Figure 13](#).

4 Test Setup and Results

This section describes how to properly connect, set up, and use the INA1620EVM. This section also includes measured data of the INA1620EVM to display typical performance of the INA1620EVM.

Measurements include:

- *THD+N vs Frequency* for a 32- and 16- Ω load
- *THD+N vs Amplitude* for a 32- and 16- Ω load
- *Fast-Fourier Transform (FFT)* for a 32- and 16- Ω load
- *CMRR vs. Frequency* with no output load

The *THD+N vs Frequency*, *THD+N vs Amplitude*, *FFT*, and *CMRR vs Frequency* measurements were taken using an *Audio Precision APx555*. All measurements were taken using ± 15 -V supplies at an ambient temperature of 25 °C, unless otherwise noted.

4.1 Power Supply Connections

Power-supply connections to the INA1620EVM are made through screw terminal connector J5 at the top of the EVM. The positive power supply connection is marked V_{CC1} , the negative supply connection V_{EE} , and the ground connection GND. To connect power to the EVM, insert wires into each terminal, then tighten the screws to make the connection. [Figure 3](#) shows the proper way to connect power to the INA1620EVM. For minimum and maximum supply voltages of the INA1620EVM, see the [INA1620 product data sheet](#).

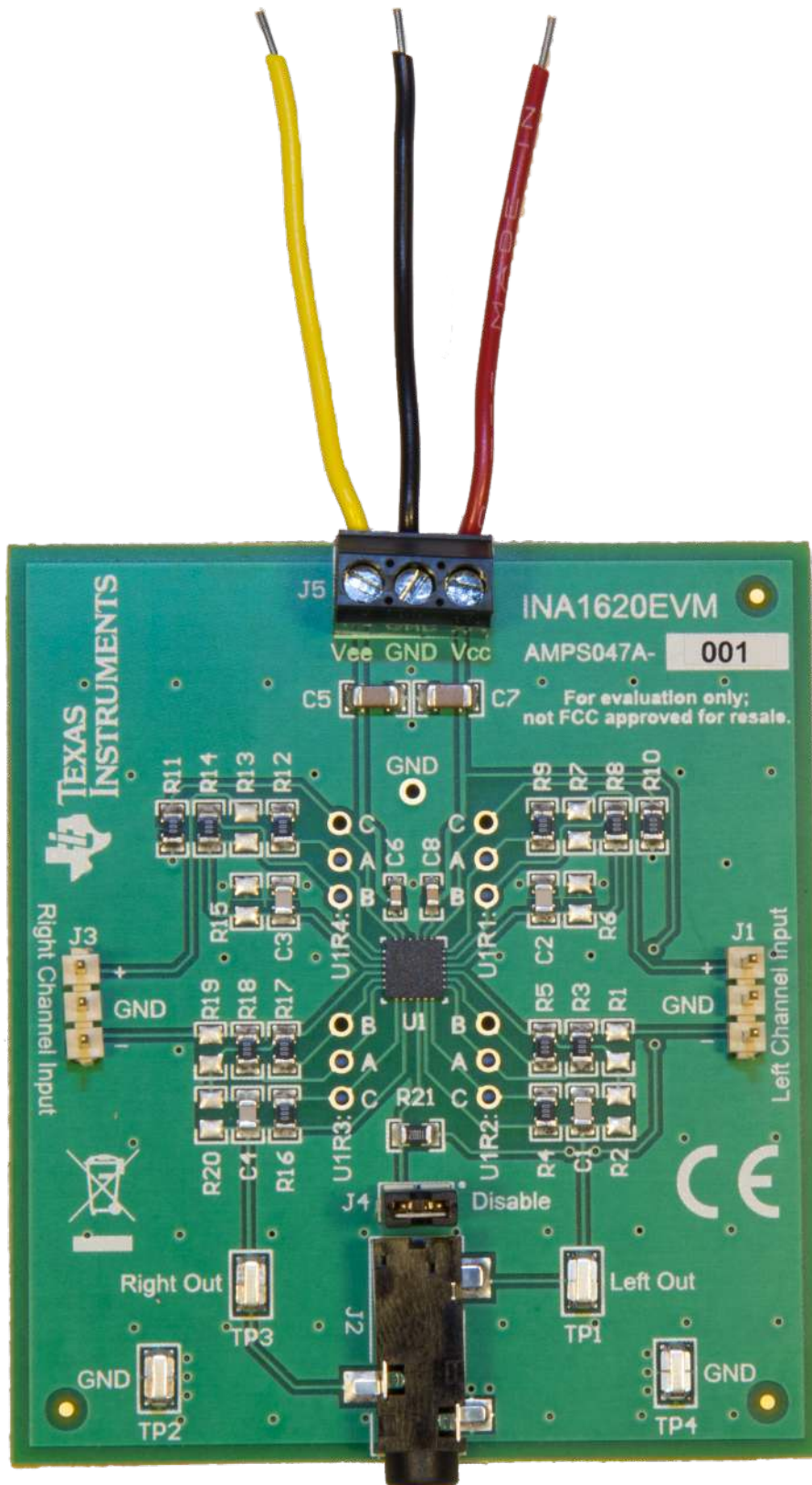


Figure 3. Power Supply Connections

4.2 Input Connections

Signals for the left channel and right channel inputs are applied through connectors J3 and J1, respectively. Connect wires to J1 and J3 to provide an input signal from an audio source such as an audio analyzer or audio digital-to-analog converter (DAC). The positive input connects to the pin labeled +, the negative input to the pin labeled –, and the ground connection connects to the center pin, marked GND.

4.3 Output Connections

Output connections are provided through the use of the audio jack, J2, and two test points labelled Left Out and Right Out. The audio jack provides a way to connect headphones or a resistive load to the output of the INA1620. The test points provide a connection to measure the performance of the two channels with an audio analyzer, distortion analyzer, or other test equipment.

4.4 Enable

Jumper J4 provides access to the EN pin on the INA1620. Placing a shunt across J4 disables the INA1620 by grounding the EN pin. When the EN pin is grounded, a current flows through R3 to ground that is larger than the shutdown current of the OPA1622. Removing the shunt across J5 enables the INA1620 by pulling the EN pin up to the positive supply through resistor R3. Voltages up to the positive supply can be applied to the EN pin. External sources can be applied to the enable pin by removing the shunt and resistor R3 and connecting an external source to J4.

4.5 THD+N vs. Frequency

For all *THD+N vs Frequency* measurements, the input signal frequency was swept from 20 Hz to 20 kHz and had an amplitude of 1 V_{RMS} on the output of the INA1620 with the measurement bandwidth of the *Audio Precision* set to 90 kHz. A small variation in the THD+N performance between amplifier channels is normal. Figure 4 shows the *THD+N vs Frequency* for a 32-Ω load.

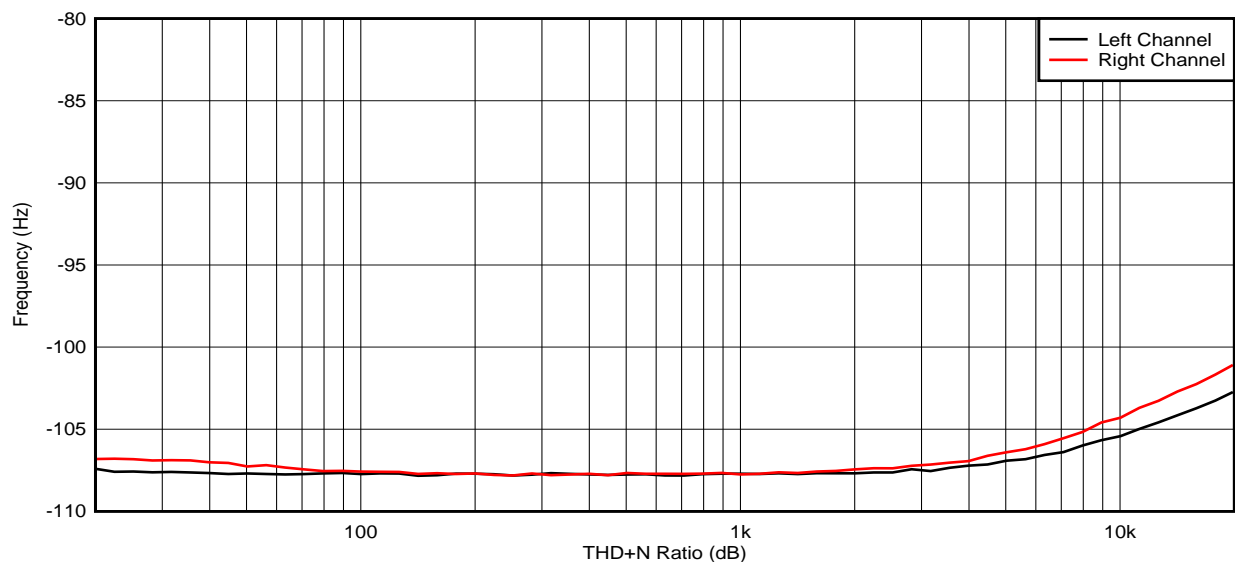


Figure 4. THD+N vs Frequency for a 32-Ω Load

Figure 5 shows the $THD+N$ vs Frequency for a 16- Ω load.

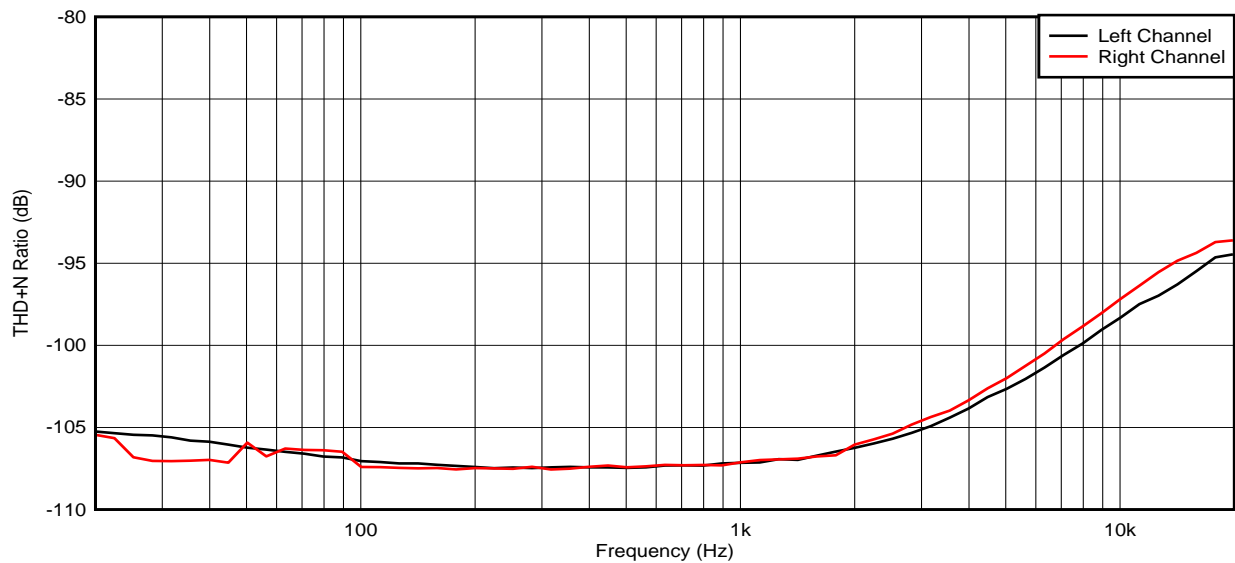


Figure 5. THD+N vs Frequency for a 16- Ω Load

4.6 THD+N vs. Amplitude

For all $THD+N$ vs Amplitude measurements, the output amplitude was swept from 10 mV_{RMS} to 3 V_{RMS} at a frequency of 1 kHz. The measurement bandwidth of the *Audio Precision* was set to 22 kHz. Note that driving low impedance loads from power supply voltages larger than ± 5 V may cause the output of the INA1620 to clip at a lower output amplitude than what is shown in the measurements because the increased power dissipation in the amplifier will trigger the thermal protection circuitry. See the [INA1620 product datasheet Application and Implementation](#) section for information on calculating power dissipation. Figure 6 shows the $THD+N$ vs Amplitude for a 32- Ω load.

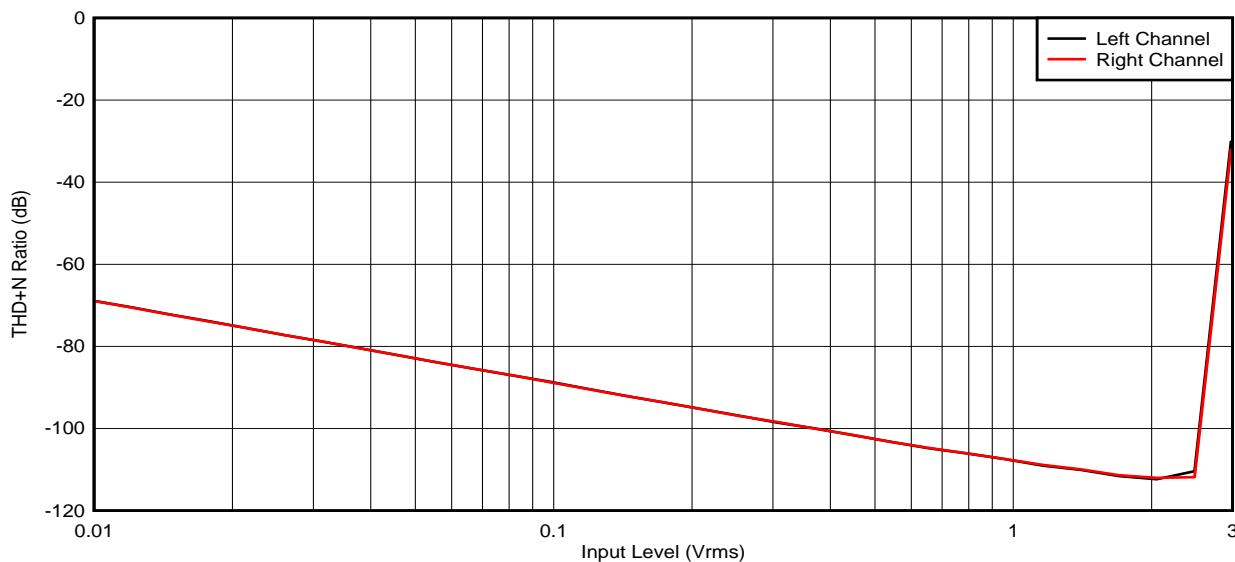


Figure 6. THD+N vs Amplitude for a 32- Ω Load

Figure 7 shows the THD+N vs Amplitude for a 16-Ω load.

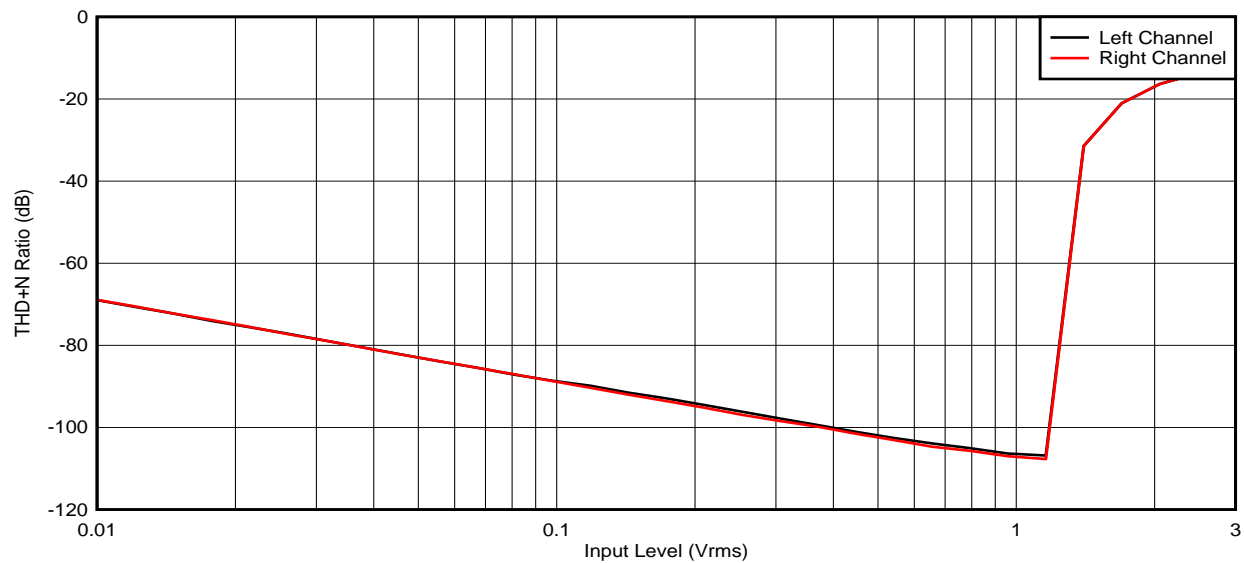


Figure 7. THD+N vs Amplitude for a 16-Ω Load

4.7 Fast Fourier Transforms

For all FFT measurements, a frequency of 1 kHz and amplitude of 1 V_{RMS} on the output was used. The 1-V_{RMS} fundamental corresponds to 0 dBV in all FFT measurements. Figure 8 shows an FFT of the left channel with a 32-Ω load. The second harmonic was measured to be -125.45 dBV.

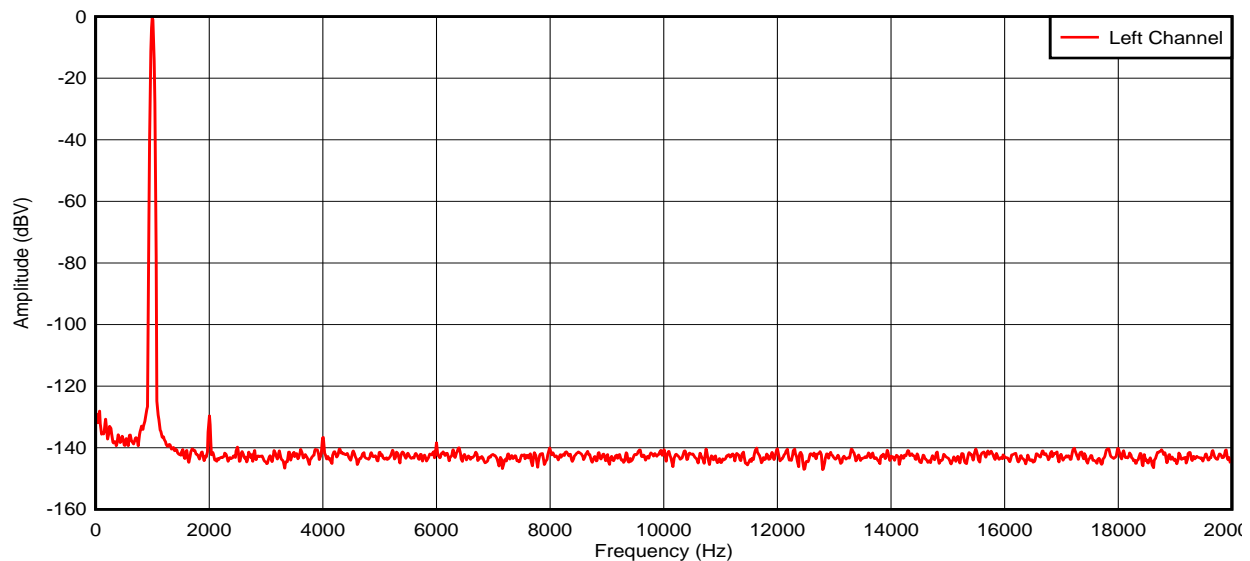


Figure 8. FFT of Left Channel With a 32-Ω Load

Figure 9 shows an FFT of the right channel with a 32-Ω load. The second harmonic was measured to be -126.90 dBV.

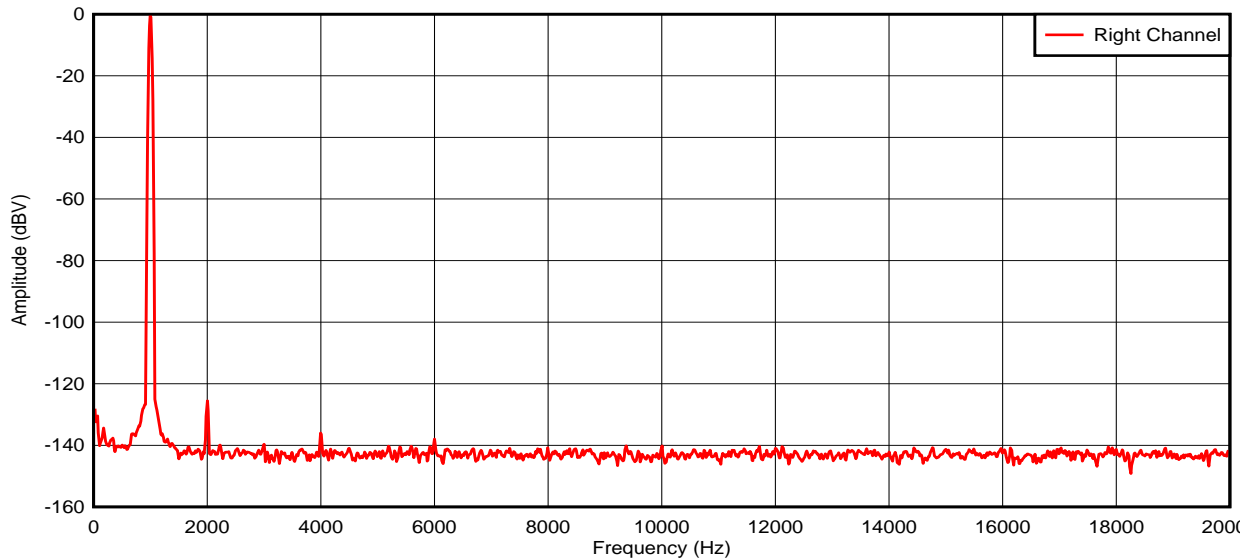


Figure 9. FFT of Right Channel With a 32-Ω Load

Figure 10 shows an FFT of the left channel with a 16-Ω load. The second harmonic was measured to be -120.25 dBV.

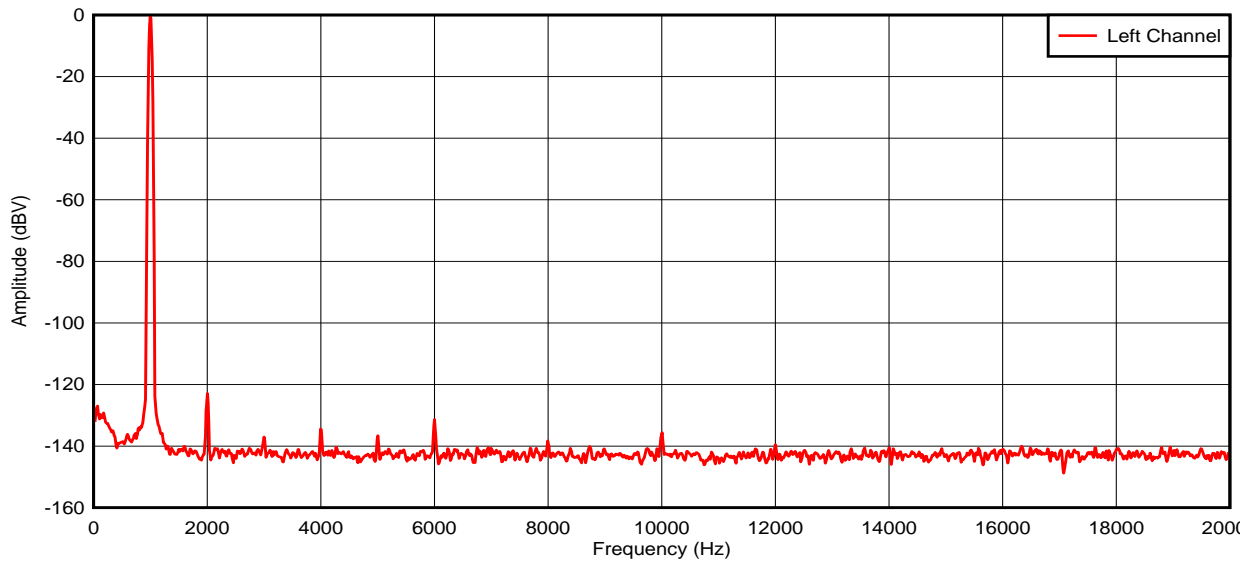


Figure 10. FFT of Left Channel With a 16-Ω Load

Figure 11 shows an FFT of the right channel with a 16-Ω load. The second harmonic was measured to be -120.68 dBV.

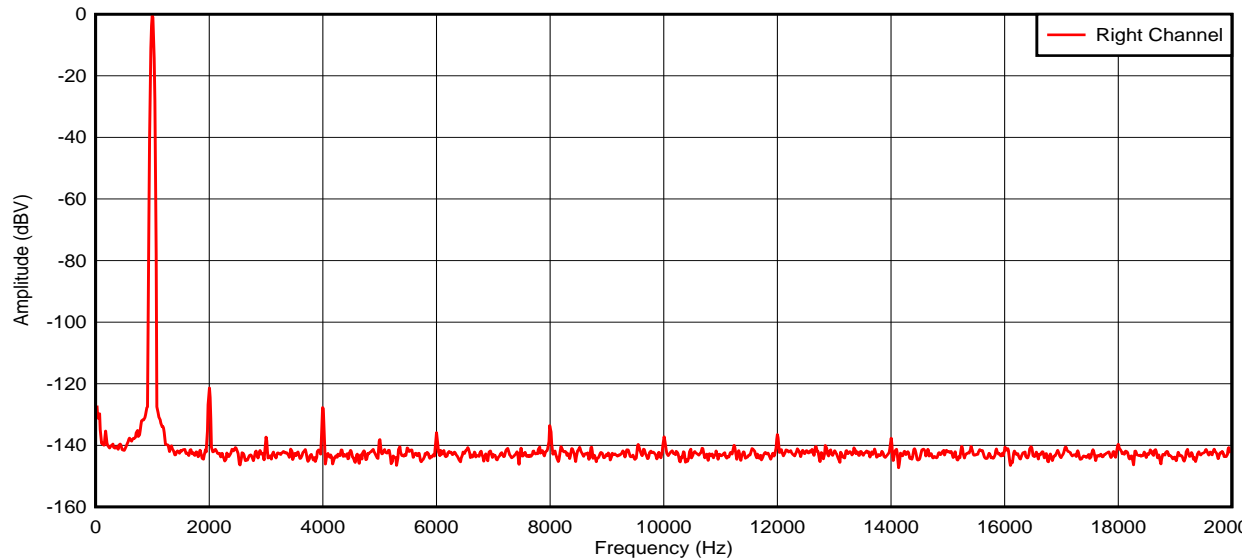


Figure 11. FFT of Right Channel With a 16-Ω Load

4.8 CMRR vs. Frequency

For all CMRR vs Frequency measurements, the *Audio Precision* was configured to provide a common-mode input signal into the INA1620EVM. This common-mode signal was configured to an amplitude of 1 V_{RMS} and swept from 20 Hz to 200 kHz. Figure 12 shows CMRR vs Frequency with no load on the INA1620 output.

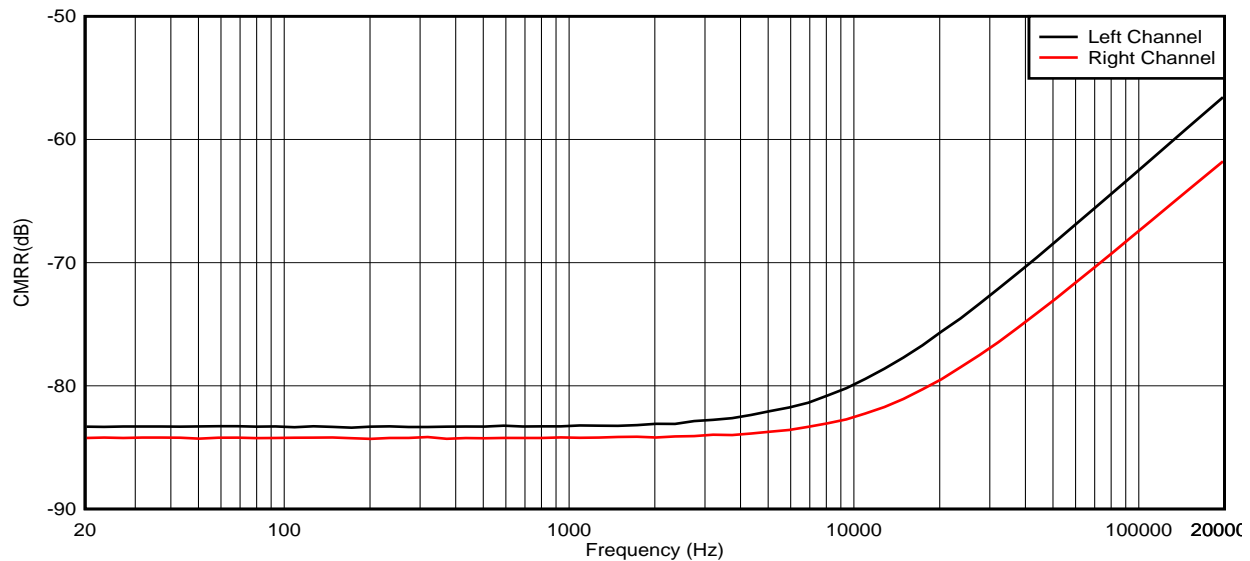


Figure 12. CMRR vs Frequency With No Load

5 Board Layout

This section provides a description of the INA1620EVM board layout and layer illustrations.

5.1 Layout

The board layout for the INA1620EVM is shown in [Figure 13](#) and [Figure 14](#). The top layer consists of all signal traces and is poured with a solid ground plane. Traces for both the left and right channel were kept as balanced as possible to eliminate any impedance mismatch due to trace impedance. Power supply decoupling capacitors C6 and C8 were placed as close as possible to the supply pins of the INA1620. The placement of the remaining passive components was kept as close and symmetrical as possible to minimize loop areas, which can couple noise and interference into the INA1620. This via stitching also helps shunt ground currents from the top ground pour, which is interrupted by traces and components, down to the bottom ground pour, which has much less interruption. The bottom layer was used to route only one signal, the V_{cc} connection to the EN pin pullup resistor. Note that due to the size of the copper pour for the thermal pad on the bottom layer, the thermal performance specified in the INA1620 datasheet may not be met on the INA1620EVM. Refer to the application report, [PowerPAD™ Thermally Enhanced Package](#) for more information.

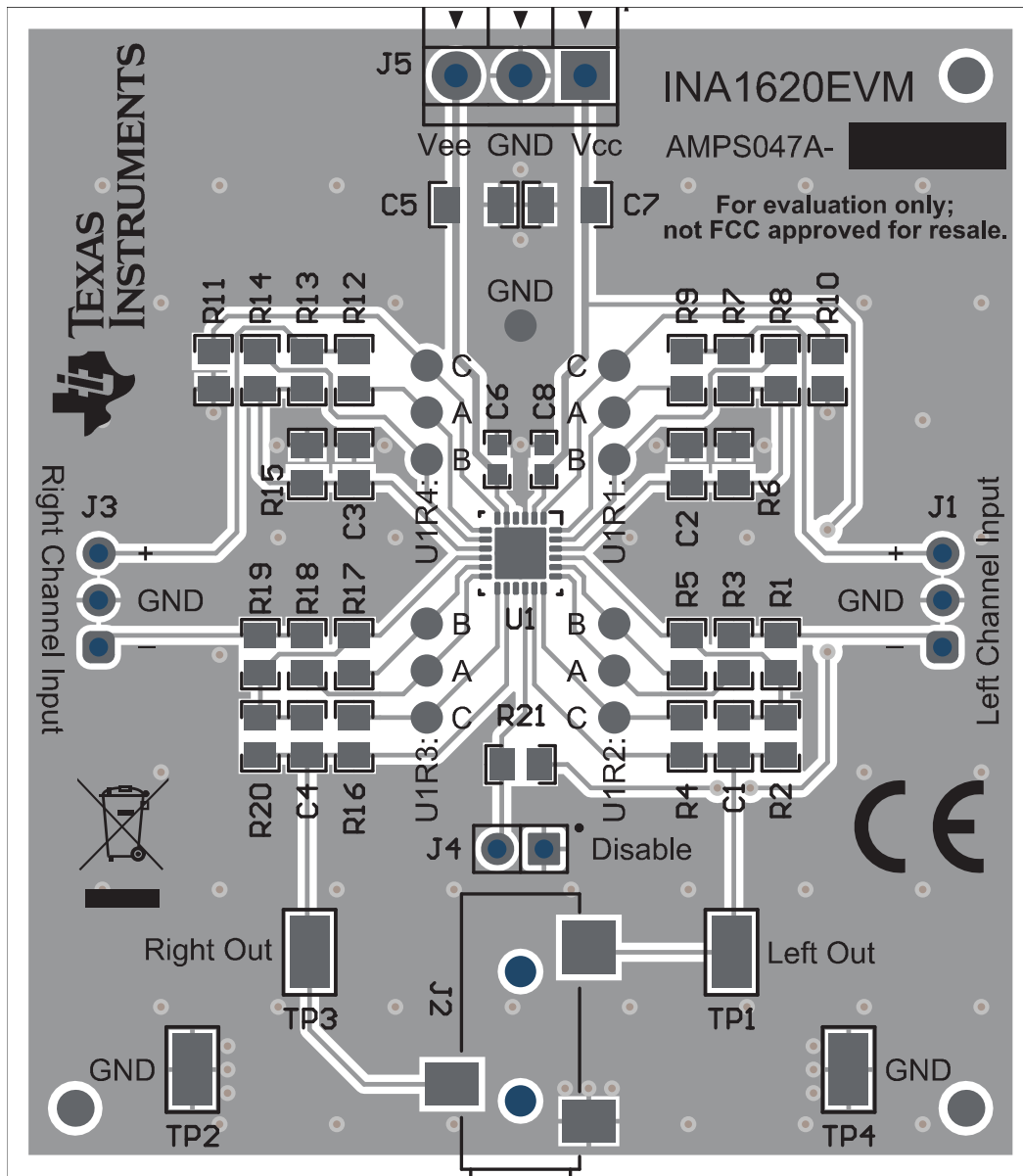


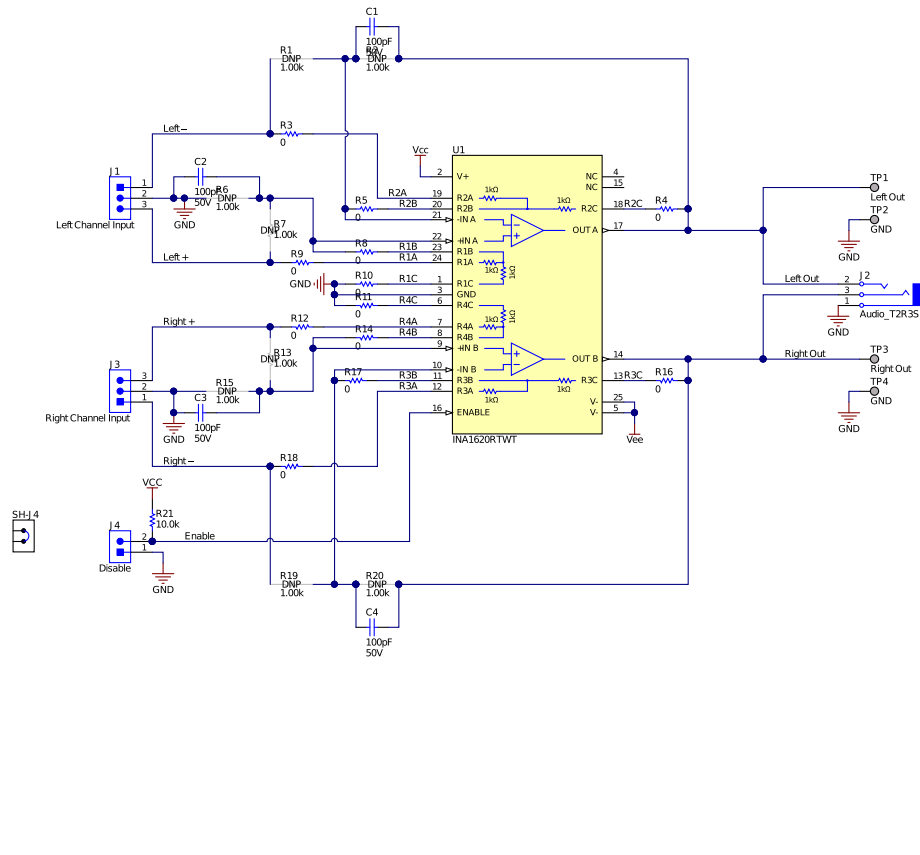
Figure 13. Top Layer PCB Layout

6 Schematic, Bill of Materials, and Reference

This section contains the schematics, the bill of materials, and a list of reference documents.

6.1 Schematic

[Figure 15](#) illustrates the EVM schematics.



EVM Hardware
 AMPS047A_EVM_Hardware.SchDoc

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Figure 15. INA1620EVM Schematic

6.2 Bill of Materials

Table 3 lists the EVM BOM.

Table 3. INA1620EVM Bill of Materials

Designator	QTY	Value	Description	Package Reference	Part Number	Manufacturer
!PCB1	1		Printed Circuit Board		AMPS047	Any
C1, C2, C3, C4	4	100pF	CAP, CERM, 100 pF, 50 V, +/- 5%, COG/NP0, 0805	0805	08055A101JAT2A	AVX
C5, C7	2	10uF	CAP, CERM, 10 uF, 35 V, +/- 10%, X7R, 1206	1206	GMK316AB7106KL	Taiyo Yuden
C6, C8	2	0.1uF	CAP, CERM, 0.1 uF, 25 V, +/- 5%, X7R, 0603	0603	C0603C104J3RACTU	Kemet
H1, H2, H3, H4	4		Bumpon, Cylindrical, 0.312 X 0.200, Black	Black Bumpon	SJ61A1	3M
J1, J3	2		Header, 100mil, 3x1, Gold, TH	3x1 Header	TSW-103-07-G-S	Samtec
J2	1		Audio Jack, 3.5mm, Stereo, R/A, SMT	Audio Jack SMD	SJ-3523-SMT	CUI Inc.
J4	1		Header, 100mil, 2x1, Gold, TH	Header, 100mil, 2x1, TH	HTSW-102-07-G-S	Samtec
J5	1		Terminal Block, 3.5mm Pitch, 3x1, TH	10.5x8.2x6.5mm	ED555/3DS	On-Shore Technology
R3, R4, R5, R8, R9, R10, R11, R12, R14, R16, R17, R18	12	0	RES, 0, 5%, 0.333 W, AEC-Q200 Grade 0, 0805	0805	CRCW08050000Z0EAHP	Vishay-Dale
R21	1	10.0k	RES, 10.0 k, 0.5%, 0.1 W, 0805	0805	RR1220P-103-D	Susumu Co Ltd
SH-J4	1		Shunt, 100mil, Gold plated, Black	Shunt 2 pos. 100 mil	881545-2	TE Connectivity
TP1, TP2, TP3, TP4	4		Test Point, Miniature, SMT	Test Point, Miniature, SMT	5019	Keystone
U1	1		High-Fidelity Audio Operational Amplifier With Integrated Thin-Film Resistors, RTW0024H (WQFN-24)	RTW0024H	INA1620RTWT	Texas Instruments

6.3 Reference

- [INA1620 Hi-Fidelity Audio Op Amplifier With Integrated Thin-Film Resistors](#)
- [PowerPAD™ Thermally Enhanced Package](#)

STANDARD TERMS FOR EVALUATION MODULES

1. *Delivery:* TI delivers TI evaluation boards, kits, or modules, including any accompanying demonstration software, components, and/or documentation which may be provided together or separately (collectively, an "EVM" or "EVMs") to the User ("User") in accordance with the terms set forth herein. User's acceptance of the EVM is expressly subject to the following terms.
 - 1.1 EVMs are intended solely for product or software developers for use in a research and development setting to facilitate feasibility evaluation, experimentation, or scientific analysis of TI semiconductor products. EVMs have no direct function and are not finished products. EVMs shall not be directly or indirectly assembled as a part or subassembly in any finished product. For clarification, any software or software tools provided with the EVM ("Software") shall not be subject to the terms and conditions set forth herein but rather shall be subject to the applicable terms that accompany such Software
 - 1.2 EVMs are not intended for consumer or household use. EVMs may not be sold, sublicensed, leased, rented, loaned, assigned, or otherwise distributed for commercial purposes by Users, in whole or in part, or used in any finished product or production system.
2. *Limited Warranty and Related Remedies/Disclaimers:*
 - 2.1 These terms do not apply to Software. The warranty, if any, for Software is covered in the applicable Software License Agreement.
 - 2.2 TI warrants that the TI EVM will conform to TI's published specifications for ninety (90) days after the date TI delivers such EVM to User. Notwithstanding the foregoing, TI shall not be liable for a nonconforming EVM if (a) the nonconformity was caused by neglect, misuse or mistreatment by an entity other than TI, including improper installation or testing, or for any EVMs that have been altered or modified in any way by an entity other than TI, (b) the nonconformity resulted from User's design, specifications or instructions for such EVMs or improper system design, or (c) User has not paid on time. Testing and other quality control techniques are used to the extent TI deems necessary. TI does not test all parameters of each EVM. User's claims against TI under this Section 2 are void if User fails to notify TI of any apparent defects in the EVMs within ten (10) business days after delivery, or of any hidden defects with ten (10) business days after the defect has been detected.
 - 2.3 TI's sole liability shall be at its option to repair or replace EVMs that fail to conform to the warranty set forth above, or credit User's account for such EVM. TI's liability under this warranty shall be limited to EVMs that are returned during the warranty period to the address designated by TI and that are determined by TI not to conform to such warranty. If TI elects to repair or replace such EVM, TI shall have a reasonable time to repair such EVM or provide replacements. Repaired EVMs shall be warranted for the remainder of the original warranty period. Replaced EVMs shall be warranted for a new full ninety (90) day warranty period.
3. *Regulatory Notices:*
 - 3.1 *United States*
 - 3.1.1 *Notice applicable to EVMs not FCC-Approved:*

FCC NOTICE: This kit is designed to allow product developers to evaluate electronic components, circuitry, or software associated with the kit to determine whether to incorporate such items in a finished product and software developers to write software applications for use with the end product. This kit is not a finished product and when assembled may not be resold or otherwise marketed unless all required FCC equipment authorizations are first obtained. Operation is subject to the condition that this product not cause harmful interference to licensed radio stations and that this product accept harmful interference. Unless the assembled kit is designed to operate under part 15, part 18 or part 95 of this chapter, the operator of the kit must operate under the authority of an FCC license holder or must secure an experimental authorization under part 5 of this chapter.
 - 3.1.2 *For EVMs annotated as FCC – FEDERAL COMMUNICATIONS COMMISSION Part 15 Compliant:*

CAUTION

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

FCC Interference Statement for Class A EVM devices

NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

FCC Interference Statement for Class B EVM devices

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

3.2 Canada

3.2.1 For EVMs issued with an Industry Canada Certificate of Conformance to RSS-210 or RSS-247

Concerning EVMs Including Radio Transmitters:

This device complies with Industry Canada license-exempt RSSs. Operation is subject to the following two conditions:

(1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Concernant les EVMs avec appareils radio:

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Concerning EVMs Including Detachable Antennas:

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication. This radio transmitter has been approved by Industry Canada to operate with the antenna types listed in the user guide with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Concernant les EVMs avec antennes détachables

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante. Le présent émetteur radio a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés dans le manuel d'usage et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur.

3.3 Japan

3.3.1 *Notice for EVMs delivered in Japan:* Please see http://www.tij.co.jp/lstds/ti_ja/general/eStore/notice_01.page 日本国内に輸入される評価用キット、ボードについては、次のところをご覧ください。
http://www.tij.co.jp/lstds/ti_ja/general/eStore/notice_01.page

3.3.2 *Notice for Users of EVMs Considered "Radio Frequency Products" in Japan:* EVMs entering Japan may not be certified by TI as conforming to Technical Regulations of Radio Law of Japan.

If User uses EVMs in Japan, not certified to Technical Regulations of Radio Law of Japan, User is required to follow the instructions set forth by Radio Law of Japan, which includes, but is not limited to, the instructions below with respect to EVMs (which for the avoidance of doubt are stated strictly for convenience and should be verified by User):

1. Use EVMs in a shielded room or any other test facility as defined in the notification #173 issued by Ministry of Internal Affairs and Communications on March 28, 2006, based on Sub-section 1.1 of Article 6 of the Ministry's Rule for Enforcement of Radio Law of Japan,
2. Use EVMs only after User obtains the license of Test Radio Station as provided in Radio Law of Japan with respect to EVMs, or
3. Use of EVMs only after User obtains the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to EVMs. Also, do not transfer EVMs, unless User gives the same notice above to the transferee. Please note that if User does not follow the instructions above, User will be subject to penalties of Radio Law of Japan.

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3.4 *European Union*

3.4.1 *For EVMs subject to EU Directive 2014/30/EU (Electromagnetic Compatibility Directive):*

This is a class A product intended for use in environments other than domestic environments that are connected to a low-voltage power-supply network that supplies buildings used for domestic purposes. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

4 *EVM Use Restrictions and Warnings:*

4.1 EVMS ARE NOT FOR USE IN FUNCTIONAL SAFETY AND/OR SAFETY CRITICAL EVALUATIONS, INCLUDING BUT NOT LIMITED TO EVALUATIONS OF LIFE SUPPORT APPLICATIONS.

4.2 User must read and apply the user guide and other available documentation provided by TI regarding the EVM prior to handling or using the EVM, including without limitation any warning or restriction notices. The notices contain important safety information related to, for example, temperatures and voltages.

4.3 *Safety-Related Warnings and Restrictions:*

4.3.1 User shall operate the EVM within TI's recommended specifications and environmental considerations stated in the user guide, other available documentation provided by TI, and any other applicable requirements and employ reasonable and customary safeguards. Exceeding the specified performance ratings and specifications (including but not limited to input and output voltage, current, power, and environmental ranges) for the EVM may cause personal injury or death, or property damage. If there are questions concerning performance ratings and specifications, User should contact a TI field representative prior to connecting interface electronics including input power and intended loads. Any loads applied outside of the specified output range may also result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the EVM user guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative. During normal operation, even with the inputs and outputs kept within the specified allowable ranges, some circuit components may have elevated case temperatures. These components include but are not limited to linear regulators, switching transistors, pass transistors, current sense resistors, and heat sinks, which can be identified using the information in the associated documentation. When working with the EVM, please be aware that the EVM may become very warm.

4.3.2 EVMs are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems. User assumes all responsibility and liability for proper and safe handling and use of the EVM by User or its employees, affiliates, contractors or designees. User assumes all responsibility and liability to ensure that any interfaces (electronic and/or mechanical) between the EVM and any human body are designed with suitable isolation and means to safely limit accessible leakage currents to minimize the risk of electrical shock hazard. User assumes all responsibility and liability for any improper or unsafe handling or use of the EVM by User or its employees, affiliates, contractors or designees.

4.4 User assumes all responsibility and liability to determine whether the EVM is subject to any applicable international, federal, state, or local laws and regulations related to User's handling and use of the EVM and, if applicable, User assumes all responsibility and liability for compliance in all respects with such laws and regulations. User assumes all responsibility and liability for proper disposal and recycling of the EVM consistent with all applicable international, federal, state, and local requirements.

5. *Accuracy of Information:* To the extent TI provides information on the availability and function of EVMs, TI attempts to be as accurate as possible. However, TI does not warrant the accuracy of EVM descriptions, EVM availability or other information on its websites as accurate, complete, reliable, current, or error-free.

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