

AN1991

Audio decibel level detector with meter driver

Rev. 2.1 — 20 March 2015

Application note

Document information

Info	Content
Keywords	SA604A, LM358, RSSI, cellular radio
Abstract	The SA604A can provide a logarithmic response proportional to the input signal level over an 80 dB range up to a 15 MHz operating frequency. This application note describes a technique that optimizes this useful function within the audio band.



Revision history

Rev	Date	Description
v.2.1	20150320	Updated Figure 1
v.2	20121029	application note; second release <ul style="list-style-type: none">• The format of this application note has been redesigned to comply with the new identity guidelines of NXP Semiconductors.• Legal texts have been adapted to the new company name where appropriate.• All references to “SA604” are replaced with “SA604A”• All references to “SA532” are replaced with “LM358”
v.1	19970820	first release

Contact information

For more information, please visit: <http://www.nxp.com>

For sales office addresses, please send an email to: salesaddresses@nxp.com

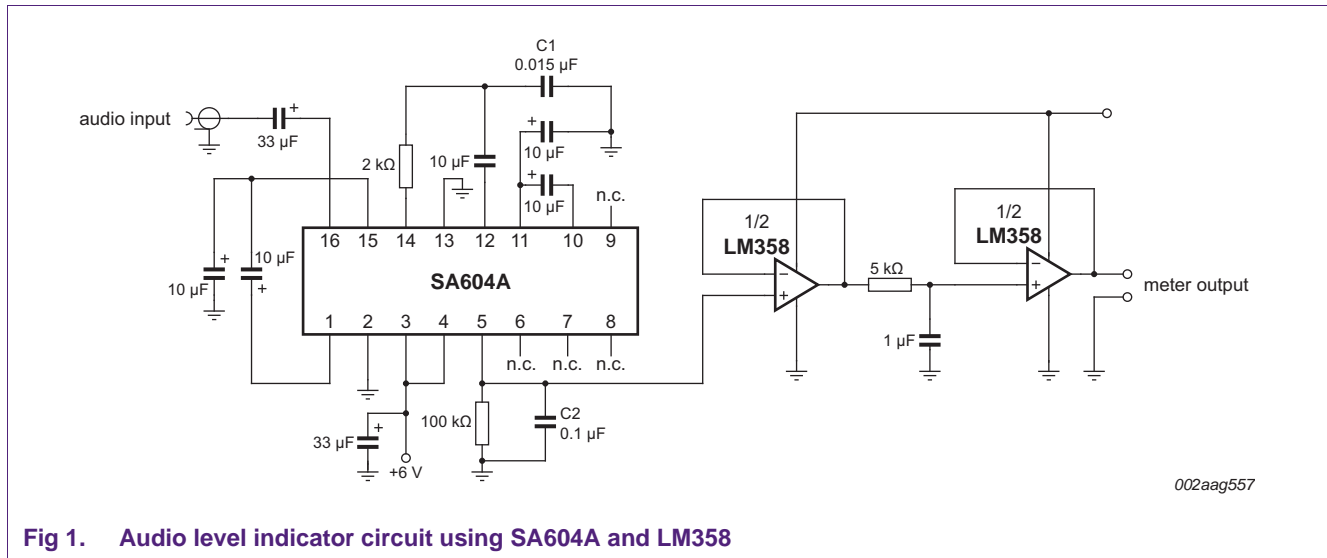
1. Introduction

Although the SA604A was designed as an RF device intended for the cellular radio market, it has features that permit other design configurations. One of these features is the Received Signal Strength Indicator (RSSI). In a cellular radio, this function is necessary for continuous monitoring of the received signal strength by the radio's microcomputer. This circuit provides a logarithmic response proportional to the input signal level. The SA604A can provide this logarithmic response over an 80 dB range up to a 15 MHz operating frequency. This application note describes a technique that optimizes this useful function within the audio band.

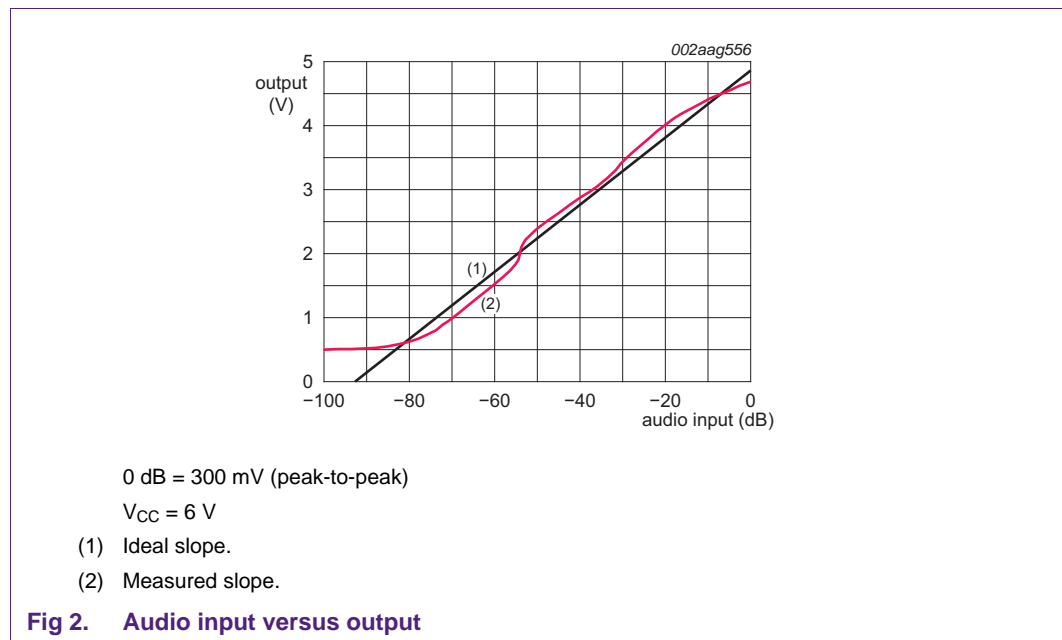
2. Audio level indicator circuit

A sensitive audio level indicator circuit can be constructed using two integrated circuits, the SA604A and LM358. This circuit draws very little power (less than 5 mA with a single 6 V power supply), making it ideal for portable battery operated equipment. The small size and low power consumption belie the 80 dB dynamic range and 10.5 μV sensitivity.

The RSSI function requires a DC output voltage that is proportional to the \log_{10} of the input signal level, thus a standard 0 V to 5 V voltmeter can be linearly calibrated in decibels over a single 80 dB range. The entire circuit is composed of nine capacitors and two resistors along with the two ICs. No tuning or calibration is required in a manufacturing setting.



[Figure 2](#) shows that the circuit is within 1.5 dB tolerance over the 80 dB range for audio frequencies from 100 Hz to 10 kHz. Higher audio levels can be measured by placing an attenuator ahead of the input capacitor. The input impedance is high (about 50 k Ω), so lower impedance terminations (50 Ω or 600 Ω) will not be affected by the input impedance. If very accurate tracking is required (<0.5 dB accuracy), a 40 dB or 50 dB segment can be 'selected'. A range switch can then be added with appropriate attenuators if more than 40 dB or 50 dB dynamic range is required.



There are two amplifier sections in the SA604A with two and three stages in the first and second sections, respectively. Each stage outputs a sample current to a summing circuit. The summing circuit has a current mirror, which appears at pin 5. This current is proportional to the \log_{10} of the input audio signal. A voltage is dropped across the 100 k Ω resistor by the current, and a 0.1 μ F capacitor is used to bypass and filter the output signal. The LM358 op amp is used as a buffer and meter driver, although a digital voltmeter could replace both the op amp and the meter shown. The rest of the capacitors are used for power supply and amplifier input bypassing.

The RC circuit between pin 14 and pin 12 forms a low-pass filter which can be adjusted by changing the value of C1. Raising the capacitance will lower the cut-off frequency and also lower the zero signal output resting voltage (about 0.6 V). Lowering the capacitance value will have the opposite effect with some reduction in dynamic range, but will raise the frequency response. The 2 k Ω resistor value provides the near-ideal interstage loss for maximum RSSI linearity. C2 can also be changed. The trade-offs here are between output damping and ripple. Most analog and digital metering methods will tend to cancel the effects of small or moderate ripple voltages through integration, but high ripple voltages should be avoided.

A second op amp is used with an optional second filter. This filter has the advantage of low impedance signal source by virtue of the first op amp. Again, a trade-off exists between meter damping and ripple attenuation. If very low ripple and low damping are both required, a more complex active low-pass filter should be constructed.

Some applications of this circuit include:

- Portable acoustic analyzer
- Microphone tester
- Audio spectrum analyzer
- VU meters
- S-meter for direct conversion radio receiver
- Audio dynamic range testers
- Audio analyzers (THD, noise, separation, response, etc.)

3. Abbreviations

Table 1. Abbreviations

Acronym	Description
IC	Integrated Circuit
RC	Resistor-Capacitor
RSSI	Received Signal Strength Indicator
THD	Total Harmonic Distortion
VU	Volume Units

4. Legal information

4.1 Definitions

Draft — The document is a draft version only. The content is still under internal review and subject to formal approval, which may result in modifications or additions. NXP Semiconductors does not give any representations or warranties as to the accuracy or completeness of information included herein and shall have no liability for the consequences of use of such information.

4.2 Disclaimers

Limited warranty and liability — Information in this document is believed to be accurate and reliable. However, NXP Semiconductors does not give any representations or warranties, expressed or implied, as to the accuracy or completeness of such information and shall have no liability for the consequences of use of such information. NXP Semiconductors takes no responsibility for the content in this document if provided by an information source outside of NXP Semiconductors.

In no event shall NXP Semiconductors be liable for any indirect, incidental, punitive, special or consequential damages (including - without limitation - lost profits, lost savings, business interruption, costs related to the removal or replacement of any products or rework charges) whether or not such damages are based on tort (including negligence), warranty, breach of contract or any other legal theory.

Notwithstanding any damages that customer might incur for any reason whatsoever, NXP Semiconductors' aggregate and cumulative liability towards customer for the products described herein shall be limited in accordance with the *Terms and conditions of commercial sale* of NXP Semiconductors.

Right to make changes — NXP Semiconductors reserves the right to make changes to information published in this document, including without limitation specifications and product descriptions, at any time and without notice. This document supersedes and replaces all information supplied prior to the publication hereof.

Suitability for use — NXP Semiconductors products are not designed, authorized or warranted to be suitable for use in life support, life-critical or safety-critical systems or equipment, nor in applications where failure or malfunction of an NXP Semiconductors product can reasonably be expected to result in personal injury, death or severe property or environmental damage. NXP Semiconductors and its suppliers accept no liability for inclusion and/or use of NXP Semiconductors products in such equipment or applications and therefore such inclusion and/or use is at the customer's own risk.

Applications — Applications that are described herein for any of these products are for illustrative purposes only. NXP Semiconductors makes no representation or warranty that such applications will be suitable for the specified use without further testing or modification.

Customers are responsible for the design and operation of their applications and products using NXP Semiconductors products, and NXP Semiconductors accepts no liability for any assistance with applications or customer product

design. It is customer's sole responsibility to determine whether the NXP Semiconductors product is suitable and fit for the customer's applications and products planned, as well as for the planned application and use of customer's third party customer(s). Customers should provide appropriate design and operating safeguards to minimize the risks associated with their applications and products.

NXP Semiconductors does not accept any liability related to any default, damage, costs or problem which is based on any weakness or default in the customer's applications or products, or the application or use by customer's third party customer(s). Customer is responsible for doing all necessary testing for the customer's applications and products using NXP Semiconductors products in order to avoid a default of the applications and the products or of the application or use by customer's third party customer(s). NXP does not accept any liability in this respect.

Export control — This document as well as the item(s) described herein may be subject to export control regulations. Export might require a prior authorization from competent authorities.

Evaluation products — This product is provided on an "as is" and "with all faults" basis for evaluation purposes only. NXP Semiconductors, its affiliates and their suppliers expressly disclaim all warranties, whether express, implied or statutory, including but not limited to the implied warranties of non-infringement, merchantability and fitness for a particular purpose. The entire risk as to the quality, or arising out of the use or performance, of this product remains with customer.

In no event shall NXP Semiconductors, its affiliates or their suppliers be liable to customer for any special, indirect, consequential, punitive or incidental damages (including without limitation damages for loss of business, business interruption, loss of use, loss of data or information, and the like) arising out of the use of or inability to use the product, whether or not based on tort (including negligence), strict liability, breach of contract, breach of warranty or any other theory, even if advised of the possibility of such damages.

Notwithstanding any damages that customer might incur for any reason whatsoever (including without limitation, all damages referenced above and all direct or general damages), the entire liability of NXP Semiconductors, its affiliates and their suppliers and customer's exclusive remedy for all of the foregoing shall be limited to actual damages incurred by customer based on reasonable reliance up to the greater of the amount actually paid by customer for the product or five dollars (US\$5.00). The foregoing limitations, exclusions and disclaimers shall apply to the maximum extent permitted by applicable law, even if any remedy fails of its essential purpose.

Translations — A non-English (translated) version of a document is for reference only. The English version shall prevail in case of any discrepancy between the translated and English versions.

4.3 Trademarks

Notice: All referenced brands, product names, service names and trademarks are the property of their respective owners.

5. Contents

1	Introduction	3
2	Audio level indicator circuit	3
3	Abbreviations	5
4	Legal information	6
4.1	Definitions	6
4.2	Disclaimers	6
4.3	Trademarks	6
5	Contents	7

Please be aware that important notices concerning this document and the product(s) described herein, have been included in section 'Legal information'.

© NXP Semiconductors N.V. 2015.

All rights reserved.

For more information, please visit: <http://www.nxp.com>

For sales office addresses, please send an email to: salesaddresses@nxp.com

Date of release: 20 March 2015

Document identifier: AN1991