

MAX9814

Microphone Amplifier with AGC and Low-Noise Microphone Bias

General Description

The MAX9814 is a low-cost, high-quality microphone amplifier with automatic gain control (AGC) and low-noise microphone bias. The device features a low-noise preamplifier, variable gain amplifier (VGA), output amplifier, microphone-bias-voltage generator and AGC control circuitry.

The low-noise preamplifier has a fixed 12dB gain, while the VGA gain automatically adjusts from 20dB to 0dB, depending on the output voltage and the AGC threshold. The output amplifier offers selectable gains of 8dB, 18dB, and 28dB. With no compression, the cascade of the amplifiers results in an overall gain of 40dB, 50dB, or 60dB. A trilevel digital input programs the output amplifier gain. An external resistive divider controls the AGC threshold and a single capacitor programs the attack/release times. A trilevel digital input programs the ratio of attack-to-release time. The hold time of the AGC is fixed at 30ms. The low-noise microphone-bias-voltage generator can bias most electret microphones.

The MAX9814 is available in the space-saving, 14-pin TDFN package. This device is specified over the -40°C to +85°C extended temperature range.

Applications

Digital Still Cameras
 Digital Video Cameras
 PDAs
 Bluetooth Headsets
 Entertainment Systems
 (e.g., Karaoke)

Two-Way Communicators
 High-Quality Portable
 Recorders
 IP Phones/Telephone
 Conferencing

Features

- ◆ Automatic Gain Control (AGC)
- ◆ Three Gain Settings (40dB, 50dB, 60dB)
- ◆ Programmable Attack Time
- ◆ Programmable Attack and Release Ratio
- ◆ 2.7V to 5.5V Supply Voltage Range
- ◆ Low Input-Referred Noise Density of $30\text{nV}/\sqrt{\text{Hz}}$
- ◆ Low THD: 0.04% (typ)
- ◆ Low-Power Shutdown Mode
- ◆ Internal Low-Noise Microphone Bias, 2V
- ◆ Available in the Space-Saving, 14-Pin TDFN (3mm x 3mm) Package
- ◆ -40°C to +85°C Extended Temperature Range

Ordering Information

PART	TEMP RANGE	PIN-PACKAGE
MAX9814ETD+T	-40°C to +85°C	14 TDFN-EP*

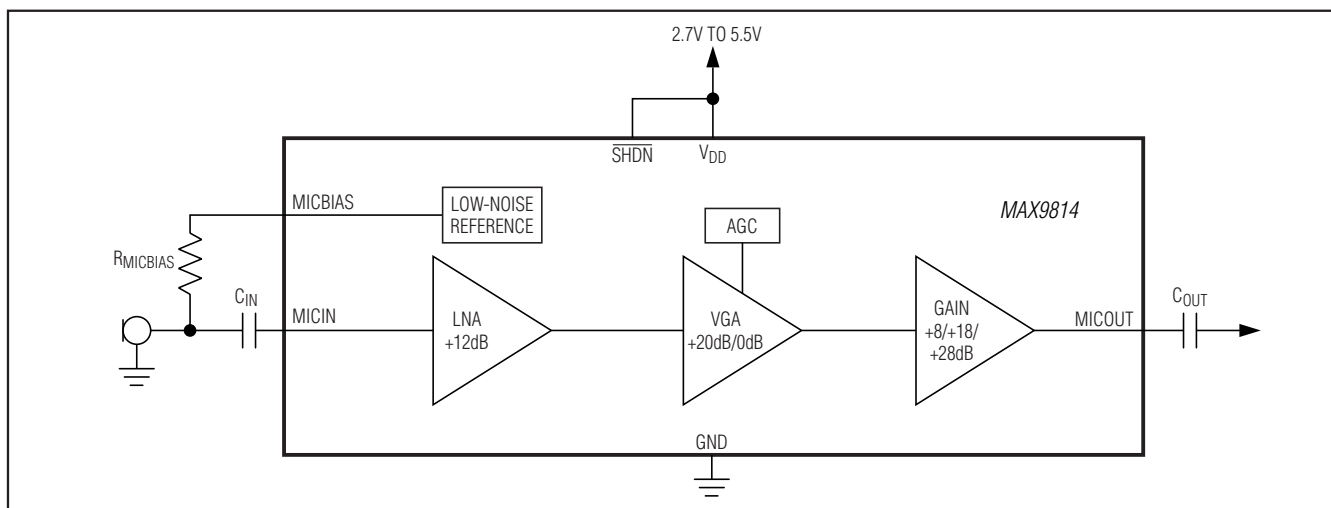
+ Denotes a lead(Pb)-free/RoHS-compliant package.

T = Tape and reel.

*EP = Exposed pad.

Pin Configurations appear at end of data sheet.

Simplified Block Diagram



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ABSOLUTE MAXIMUM RATINGS

V_{DD} to GND-0.3V to +6V
 All Other Pins to GND.....-0.3V to (V_{DD} + 0.3V)
 Output Short-Circuit Duration.....Continuous
 Continuous Current (MICOUT, MICBIAS).....±100mA
 All Other Pins±20mA

Continuous Power Dissipation (T_A = +70°C)
 14-Pin TDFN-EP
 (derate 16.7mW/°C above +70°C).....1481.5mW
 Operating Temperature Range-40°C to +85°C
 Junction Temperature.....+150°C
 Lead Temperature (soldering, 10s).....+300°C
 Bump Temperature (soldering) Reflow.....+235°C

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS

(V_{DD} = 3.3V, $\overline{\text{SHDN}}$ = V_{DD}, C_{CT} = 470nF, C_{CG} = 2μF, GAIN = V_{DD}, T_A = T_{MIN} to T_{MAX}, unless otherwise specified. Typical values are at T_A = +25°C.) (Note 1)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
GENERAL						
Operating Voltage	V _{DD}	Guaranteed by PSRR test	2.7		5.5	V
Supply Current	I _{DD}			3.1	6	mA
Shutdown Supply Current	I _{SHDN}			0.01	1	μA
Input-Referred Noise Density	e _n	BW = 20kHz, all gain settings		30		nV/√Hz
Output Noise		BW = 20kHz		430		μVRMS
Signal-to-Noise Ratio	SNR	BW = 22Hz to 22kHz (500mVRMS output signal)		61		dB
		A-weighted		64		
Dynamic Range	DR	(Note 2)		60		dB
Total Harmonic Distortion Plus Noise	THD+N	f _{IN} = 1kHz, BW = 20Hz to 20kHz, R _L = 10kΩ, V _{TH} = 1V (threshold = 2V _{P-P}), V _{IN} = 0.5mVRMS, V _{CT} = 0V		0.04		%
		f _{IN} = 1kHz, BW = 20Hz to 20kHz, R _L = 10kΩ, V _{TH} = 0.1V (threshold = 200mV _{P-P}), V _{IN} = 30mVRMS, V _{CT} = 2V		0.2		
Amplifier Input BIAS	V _{IN}		1.14	1.23	1.32	V
Maximum Input Voltage	V _{IN_MAX}	1% THD		100		mV _{P-P}
Input Impedance	Z _{IN}			100		kΩ
Maximum Gain	A	GAIN = V _{DD}	39.5	40	40.5	dB
		GAIN = GND	49.5	50	50.6	
		GAIN = unconnected	59.5	60	60.5	
Minimum Gain		GAIN = V _{DD}	18.7	20	20.5	dB
		GAIN = GND	29.0	30	30.8	
		GAIN = unconnected	38.7	40	40.5	
Maximum Output Level	V _{OUT_RMS}	1% THD+N, V _{TH} = MICBIAS		0.707		V _{RMS}
Regulated Output Level		AGC enabled, V _{TH} = 0.7V	1.26	1.40	1.54	V _{P-P}
AGC Attack Time	t _{ATTACK}	C _{CT} = 470nF (Note 3)		1.1		ms
Attack/Release Ratio	A/R	A/R = GND		1:500		ms/ms
		A/R = V _{DD}		1:2000		
		A/R = unconnected		1:4000		

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ELECTRICAL CHARACTERISTICS (continued)

($V_{DD} = 3.3V$, $\overline{SHDN} = V_{DD}$, $C_{CT} = 470nF$, $C_{CG} = 2\mu F$, $GAIN = V_{DD}$, $T_A = T_{MIN}$ to T_{MAX} , unless otherwise specified. Typical values are at $T_A = +25^\circ C$.) (Note 1)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
MICOUT High Output Voltage	V _{OH}	I _{OUT} sourcing 1mA		2.45		V
MICOUT Low Output Voltage	V _{OL}	I _{OUT} sinking 1mA		3		mV
MICOUT Bias		MICOUT unconnected	1.14	1.23	1.32	V
Output Impedance	Z _{OUT}			50		Ω
Minimum Resistive Load	R _{LOAD_MIN}			5		kΩ
Maximum Capacitive Drive	C _{LOAD_MAX}			200		pF
Maximum Output Current	I _{OUT_MAX}	1% THD, R _L = 500Ω		1	2	mA
Output Short-Circuit Current	I _{SC}		3	8		mA
Power-Supply Rejection Ratio	PSRR	AGC mode; V _{DD} = 2.7V to 5.5V (Note 4)	35	50		dB
		f = 217Hz, V _{RIPPLE} = 100mV _{P-P} (Note 5)		55		
		f = 1kHz, V _{RIPPLE} = 100mV _{P-P} (Note 5)		52.5		
		f = 10kHz, V _{RIPPLE} = 100mV _{P-P} (Note 5)		43		
MICROPHONE BIAS						
Microphone Bias Voltage	V _{MICBIAS}	I _{MICBIAS} = 0.5mA	1.84	2.0	2.18	V
Output Resistance	R _{MICBIAS}	I _{MICBIAS} = 1mA		1		Ω
Output Noise Voltage	V _{MICBIAS_NOISE}	I _{MICBIAS} = 0.5mA, BW = 22Hz to 22kHz		5.5		μV _{RMS}
Power-Supply Rejection Ratio	PSRR	DC, V _{DD} = 2.7V to 5.5V	70	80		dB
		I _{MICBIAS} = 0.5mA, V _{RIPPLE} = 100mV _{P-P} , f _{IN} = 1kHz		71		
TRILEVEL INPUTS (A/R, GAIN)						
Tri-Level Input Leakage Current		A/R or GAIN = V _{DD}	0.5V _{DD} / 180kΩ	0.5V _{DD} / 100kΩ	0.5V _{DD} / 50kΩ	mA
		A/R or GAIN = GND	0.5V _{DD} / 180kΩ	0.5V _{DD} / 100kΩ	0.5V _{DD} / 50kΩ	
Input High Voltage	V _{IH}		V _{DD} × 0.7			V
Input Low Voltage	V _{IL}		V _{DD} × 0.3			V
Shutdown Enable Time	t _{ON}		60			ms
Shutdown Disable Time	t _{OFF}		40			ms
DIGITAL INPUT (SHDN)						
SHDN Input Leakage Current			-1		+1	μA
Input High Voltage	V _{IH}		1.3			V
Input Low Voltage	V _{IL}		0.5			V
AGC THRESHOLD INPUT (TH)						
TH Input Leakage Current			-1		+1	μA

Note 1: Devices are production tested at $T_A = +25^\circ C$. Limits over temperature are guaranteed by design.

Note 2: Dynamic range is calculated using the EIAJ method. The input is applied at -60dBFS ($0.707\mu V_{RMS}$), $f_{IN} = 1kHz$.

Note 3: Attack time measured as time from AGC trigger to gain reaching 90% of its final value.

Note 4: CG is connected to an external DC voltage source, and adjusted until $V_{MICOUT} = 1.23V$.

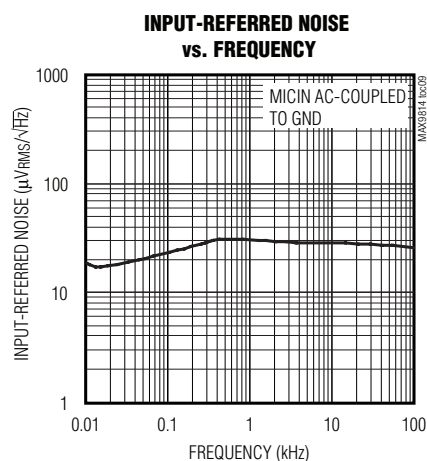
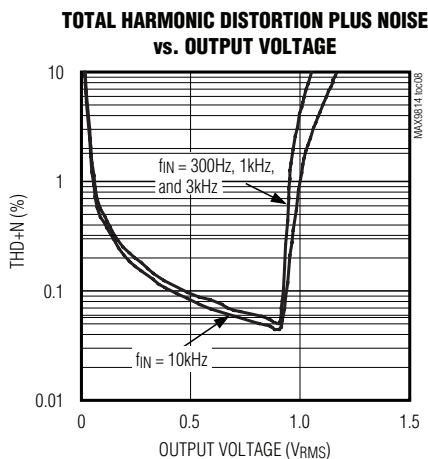
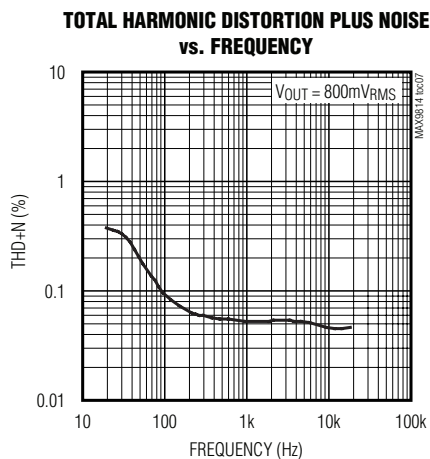
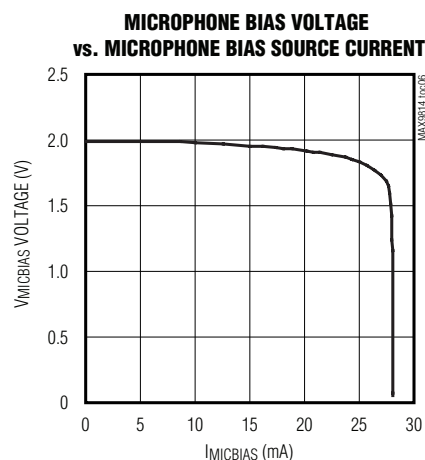
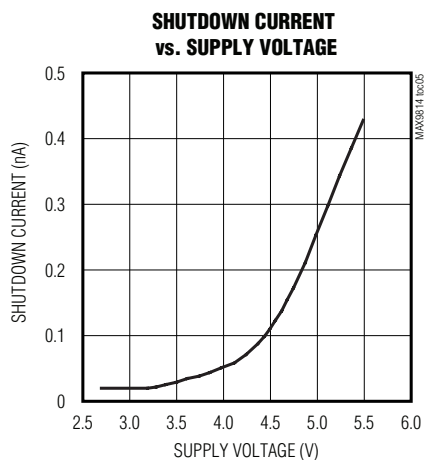
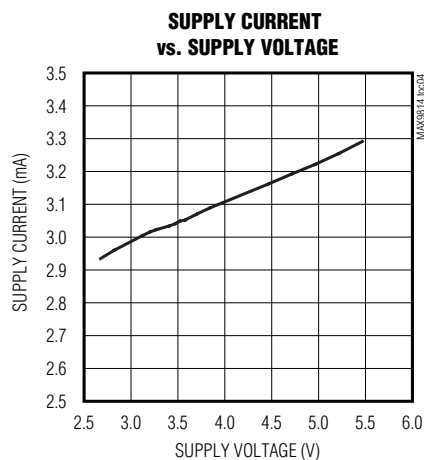
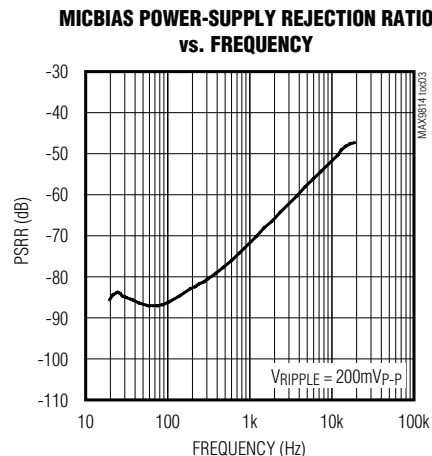
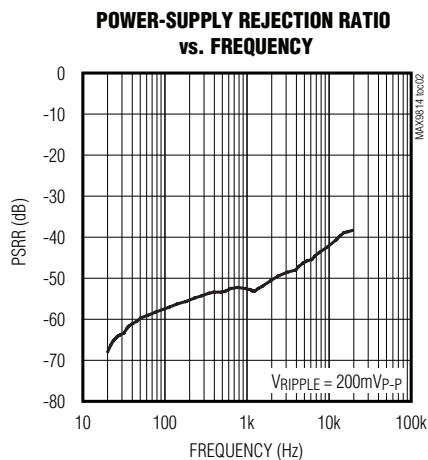
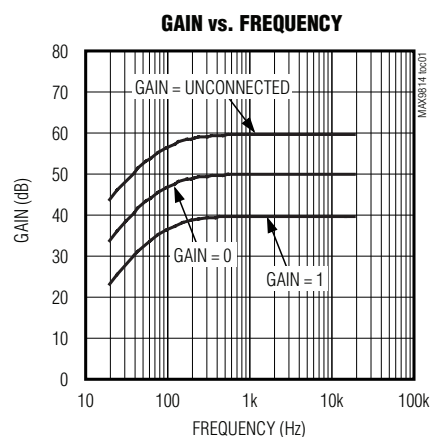
Note 5: CG connected to GND with $2.2\mu F$.

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Microphone Amplifier with AGC and Low-Noise Microphone Bias

Typical Operating Characteristics

($V_{DD} = 5V$, $C_{CT} = 470nF$, $C_{CG} = 2.2\mu F$, $V_{TH} = V_{MICBIAS} \times 0.4$, $GAIN = V_{DD}$ (40dB), AGC disabled, no load, $R_L = 10k\Omega$, $C_{OUT} = 1\mu F$, $T_A = +25^\circ C$, unless otherwise noted.)

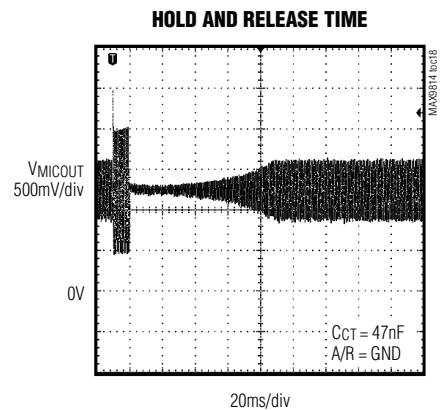
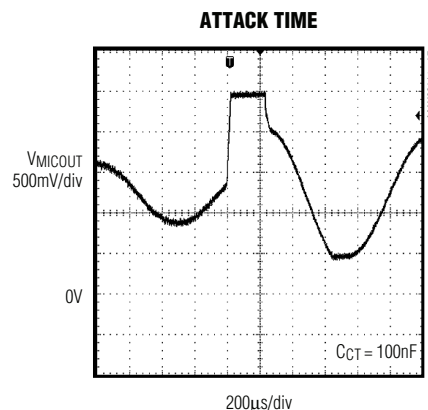
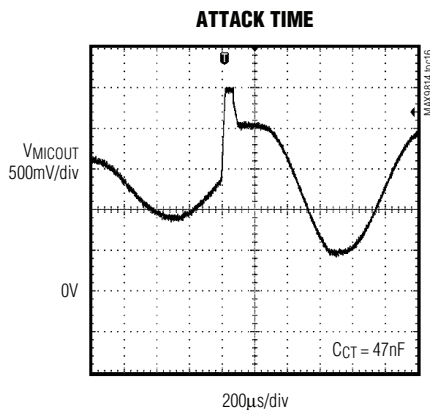
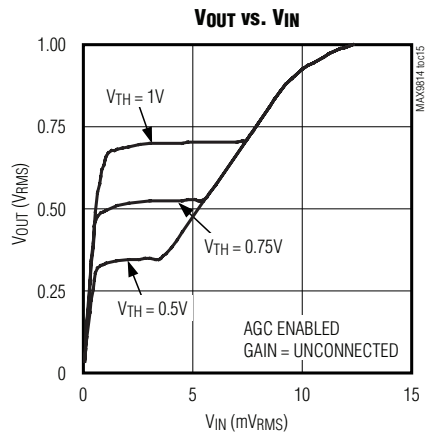
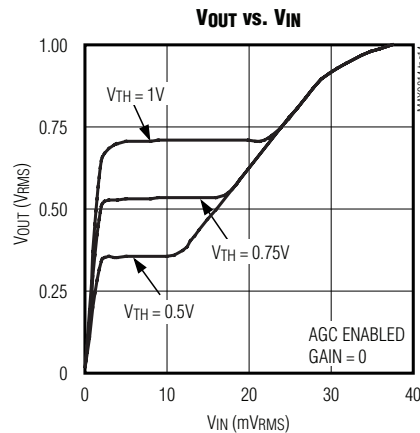
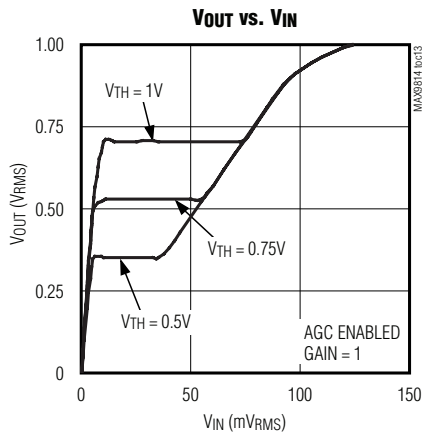
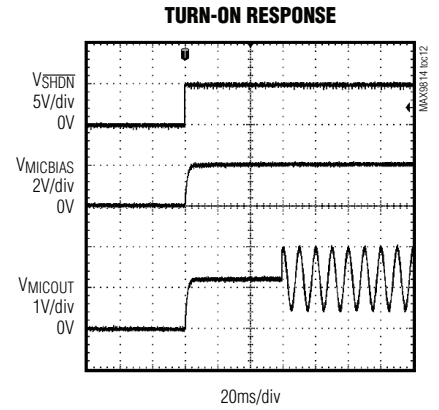
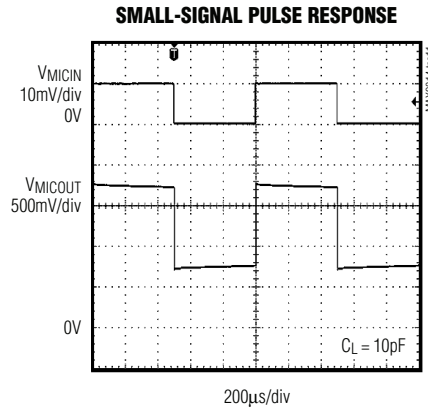
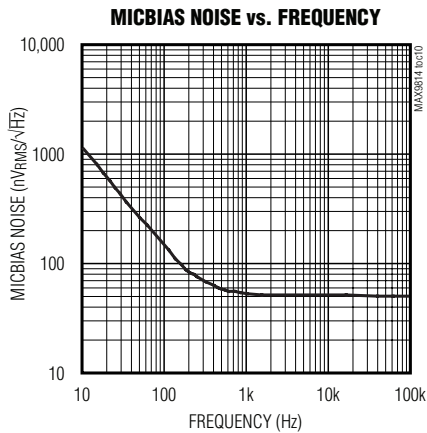


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Microphone Amplifier with AGC and Low-Noise Microphone Bias

Typical Operating Characteristics (continued)

($V_{DD} = 5V$, $C_{CT} = 470nF$, $C_{CG} = 2.2\mu F$, $V_{TH} = V_{MICBIAS} \times 0.4$, $GAIN = V_{DD}$ (40dB), AGC disabled, no load, $R_L = 10k\Omega$, $C_{OUT} = 1\mu F$, $T_A = +25^\circ C$, unless otherwise noted.)

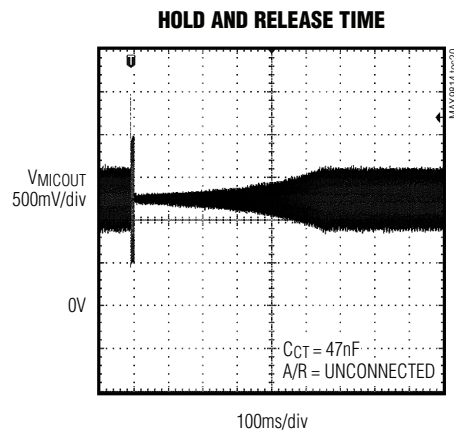
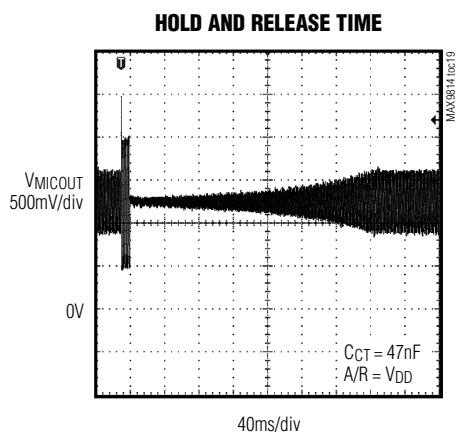


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Microphone Amplifier with AGC and Low-Noise Microphone Bias

Typical Operating Characteristics (continued)

($V_{DD} = 5V$, $C_{CT} = 470nF$, $C_{CG} = 2.2\mu F$, $V_{TH} = V_{MICBIAS} \times 0.4$, $GAIN = V_{DD}$ (40dB), AGC disabled, no load, $R_L = 10k\Omega$, $C_{OUT} = 1\mu F$, $T_A = +25^\circ C$, unless otherwise noted.)



Pin Description

PIN	NAME	FUNCTION
TDFN		
1	CT	Timing Capacitor Connection. Connect a capacitor to CT to control the Attack and Release times of the AGC.
2	SHDN	Active-Low Shutdown Control
3	CG	Amplifier DC Offset Adjust. Connect a $2.2\mu F$ capacitor to GND to ensure zero offset at the output.
4, 11	N.C.	No Connection. Connect to GND.
5	V_{DD}	Power Supply. Bypass to GND with a $1\mu F$ capacitor.
6	MICOUT	Amplifier Output
7	GND	Ground
8	MICIN	Microphone Noninverting Input
9	A/R	Tri-Level Attack and Release Ratio Select. Controls the ratio of attack time to release time for the AGC circuit. A/R = GND: Attack/Release Ratio is 1:500 A/R = V_{DD} : Attack/Release Ratio is 1:2000 A/R = Unconnected: Attack/Release Ratio is 1:4000
10	GAIN	Tri-Level Amplifier Gain Control. GAIN = V_{DD} , gain set to 40dB. GAIN = GND, gain set to 50dB. GAIN = Unconnected, uncompressed gain set to 60dB.
12	BIAS	Amplifier Bias. Bypass to GND with a $0.47\mu F$ capacitor.
13	MICBIAS	Microphone Bias Output
14	TH	AGC Threshold Control. TH voltage sets gain control threshold. Connect TH to MICBIAS to disable the AGC.
—	EP	Exposed Pad. Connect the TDFN EP to GND.

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Microphone Amplifier with AGC and Low-Noise Microphone Bias

Detailed Description

The MAX9814 is a low-cost, high-quality microphone amplifier with automatic gain control (AGC) and a low-noise microphone bias. The MAX9814 consists of several distinct circuits: a low-noise preamplifier, a variable gain amplifier (VGA), an output amplifier, a microphone-bias-voltage generator, and AGC control circuitry.

An internal microphone bias voltage generator provides a 2V bias that is suitable for most electret condenser microphones. The MAX9814 amplifies the input in three distinct stages. In the first stage, the input is buffered and amplified through the low-noise preamplifier with a gain of 12dB. The second stage consists of the VGA controlled by the AGC. The VGA/AGC combination is capable of varying the gain from 20dB to 0dB. The output amplifier is the final stage in which a fixed gain of 8dB, 18dB, 20dB is programmed through a single tri-level logic input. With no compression from the AGC, the MAX9814 is capable of providing 40dB, 50dB, or 60dB gain.

Automatic Gain Control (AGC)

A device without AGC experiences clipping at the output when too much gain is applied to the input. AGC prevents clipping at the output when too much gain is applied to the input, eliminating output clipping. Figure 1 shows a comparison of an over-gained microphone input with and without AGC.

The MAX9814's AGC controls the gain by first detecting that the output voltage has exceeded a preset limit. The microphone amplifier gain is then reduced with a selectable time constant to correct for the excessive output-voltage amplitude. This process is known as the attack time. When the output signal subsequently lowers in amplitude, the gain is held at the reduced state for a short period before slowly increasing to the normal value. This process is known as the hold and release time. The speed at which the amplifiers adjust to changing input signals is set by the external timing capacitor C_{CT} and the voltage applied to A/R. The AGC threshold can be set by adjusting V_{TH} . Gain reduction is a function of input signal amplitude with a maximum AGC attenuation of 20dB. Figure 2 shows the effect of an input burst exceeding the preset limit, output attack, hold and release times.

If the attack and release times are configured to respond too fast, audible artifacts often described as "pumping" or "breathing" can occur as the gain is rapidly adjusted to follow the dynamics of the signal. For best results, adjust the time constant of the AGC to accommodate the source material. For applications in which music CDs are the main audio source, a 160 μ s attack time with an 80ms release time is recommended. Music applications typically require a shorter release time than voice or movie content.

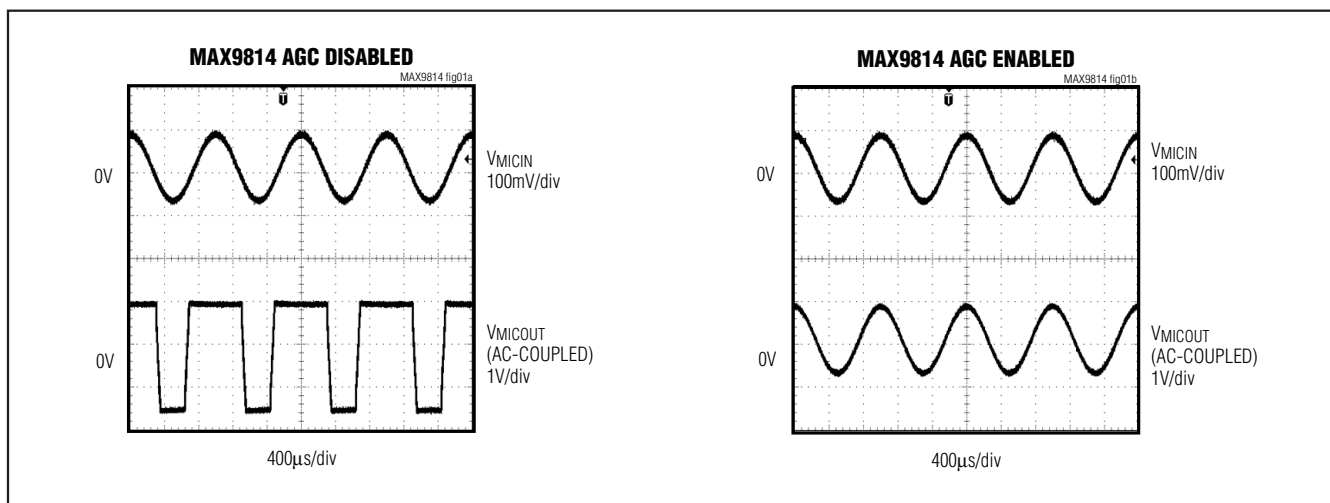


Figure 1. Microphone Input with and Without AGC

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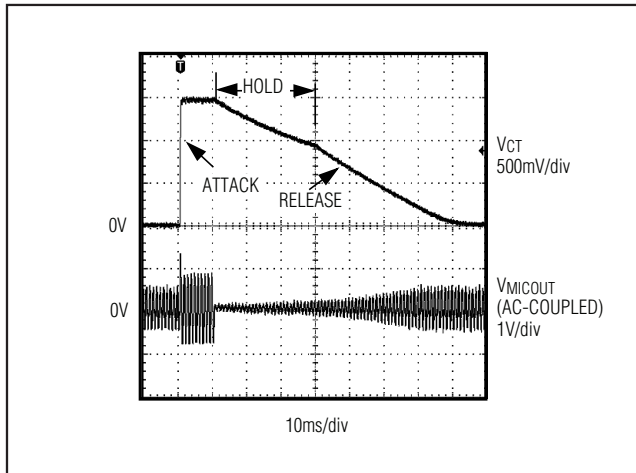


Figure 2. Input Burst Exceeding AGC Limit

Attack Time

The attack time is the time it takes for the AGC to reduce the gain after the input signal has exceeded the threshold level. The gain attenuation during the attack time is exponential, and defined as one-time constant. The time constant of the attack is given by $2400 \times C_{CT}$ seconds (where C_{CT} is the external timing capacitor):

- Use a short attack time for the AGC to react quickly to transient signals, such as snare drum beats (music) or gun shots (DVD).
- Use a longer attack time to allow the AGC to ignore short-duration peaks and only reduce the gain when a noticeable increase in loudness occurs. Short-duration peaks are not reduced, but louder passages are. This allows the louder passages to be reduced in volume, thereby maximizing output dynamic range.

Hold Time

Hold time is the delay after the signal falls below the threshold level before the release phase is initiated. Hold time is internally set to 30ms and nonadjustable. The hold time is cancelled by any signal exceeding the set threshold level, and the attack time is reinitiated.

Release Time

The release time is how long it takes for the gain to return to its normal level after the output signal has fallen below the threshold level and 30ms hold time has expired. Release time is defined as release from a 20dB gain compression to 10% of the nominal gain setting after the input signal has fallen below the TH threshold and the 30ms hold time has expired. Release time is adjustable and has a minimum of 25ms. The release time is set by picking an attack time using C_{CT}

and setting the attack-to-release time ratio by configuring A/R as shown in Table 1:

- Use a small ratio to maximize the speed of the AGC.
- Use a large ratio to maximize the sound quality and prevent repeated excursions above the threshold from being independently adjusted by the AGC.

AGC Output Threshold

The output threshold that activates AGC is adjustable through the use of an external resistive divider. Once the divider is set, AGC reduces the gain to match the output voltage to the voltage set at the TH input.

Microphone Bias

The MAX9814 features an internal low-noise microphone bias voltage capable of driving most electret condenser microphones. The microphone bias is regulated at 2V to provide that the input signal to the low-noise preamplifier does not clip to ground.

Applications Information

Programming Attack and Release Times

Attack and release times are set by selecting the capacitance value between CT and GND, and by setting the logic state of A/R (Table 1). A/R is a tri-level logic input that sets the attack-to-release time ratio.

Table 1. Attack-and-Release Ratios

A/R	ATTACK/RELEASE RATIO
GND	1:500
V _{DD}	1:2000
Unconnected	1:4000

The attack and release times can be selected by utilizing the corresponding capacitances listed in Table 2.

Table 2. Attack-and-Release Time

C _{CT}	t _{ATTACK} (ms)	t _{RELEASE} (ms)		
		A/R = GND	A/R = V _{DD}	A/R = UNCONNECTED
22nF	0.05	25	100	200
47nF	0.11	55	220	440
68nF	0.16	80	320	640
100nF	0.24	120	480	960
220nF	0.53	265	1060	2120
470nF	1.1	550	2200	4400
680nF	1.63	815	3260	6520
1μF	2.4	1200	4800	9600

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Microphone Amplifier with AGC and Low-Noise Microphone Bias

Setting the AGC Threshold

To set the output-voltage threshold at which the microphone output is clamped, an external resistor-divider must be connected from MICBIAS to ground with the output of the resistor-divider applied to TH. The voltage V_{TH} determines the peak output-voltage threshold at which the output becomes clamped. The maximum signal swing at the output is then limited to two times V_{TH} and remains at that level until the amplitude of the input signal is reduced. To disable AGC, connect TH to MICBIAS.

Microphone Bias Resistor

MICBIAS is capable of sourcing 20mA. Select a value for $R_{MICBIAS}$ that provides the desired bias current for the electret microphone. A value of 2.2k Ω is usually sufficient for a microphone of typical sensitivity. Consult the microphone data sheet for the recommended bias resistor.

Bias Capacitor

The BIAS output of the MAX9814 is internally buffered and provides a low-noise bias. Bypass BIAS with a 470nF capacitor to ground.

Input Capacitor

The input AC-coupling capacitor (C_{IN}) and the input resistance (R_{IN}) to the microphone amplifier form a highpass filter that removes any DC bias from an input signal (see the *Typical Application Circuit/Functional Diagram*). C_{IN} prevents any DC components from the input-signal source from appearing at the amplifier outputs. The -3dB point of the highpass filter, assuming zero source impedance due to the input signal source, is given by:

$$f_{-3dB_IN} = \frac{1}{2\pi \times R_{IN} \times C_{IN}}$$

Choose C_{IN} such that f_{-3dB_IN} is well below the lowest frequency of interest. Setting f_{-3dB_IN} too high affects the amplifier's low-frequency response. Use capacitors with low-voltage coefficient dielectrics. Aluminum electrolytic, tantalum, or film dielectric capacitors are good choices for AC-coupling capacitors. Capacitors with high-voltage coefficients, such as ceramics (non-C0G dielectrics), can result in increased distortion at low frequencies.

Output Capacitor

The output of the MAX9814 is biased at 1.23V. To eliminate the DC offset, an AC-coupling capacitor (C_{OUT}) must be used. Depending on the input resistance (R_L) of the following stage, C_{OUT} and R_L effectively form a highpass filter. The -3dB point of the highpass filter, assuming zero output impedance, is given by:

$$f_{-3dB_OUT} = \frac{1}{2\pi \times R_L \times C_{OUT}}$$

Shutdown

The MAX9814 features a low-power shutdown mode. When $\overline{SHDN}$ goes low, the supply current drops to 0.01 μ A, the output enters a high-impedance state, and the bias current to the microphone is switched off. Driving $\overline{SHDN}$ high enables the amplifier. Do not leave $\overline{SHDN}$ unconnected.

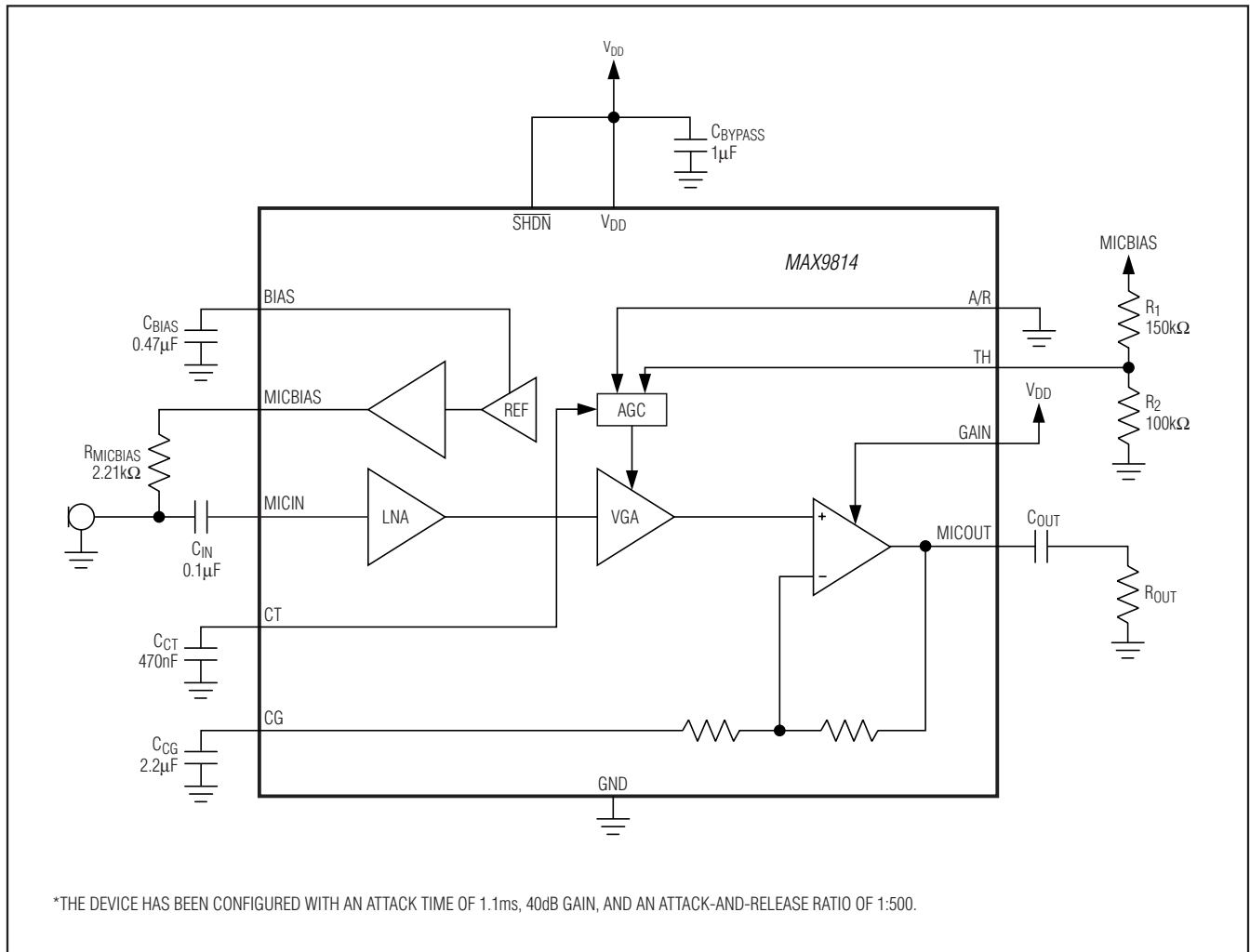
Power-Supply Bypassing and PCB Layout

Bypass the power supply with a 0.1 μ F capacitor to ground. Reduce stray capacitance by minimizing trace lengths and place external components as close to the device as possible. Surface-mount components are recommended. In systems where analog and digital grounds are available, connect the MAX9814 to analog ground.

MAX9814

Microphone Amplifier with AGC and Low-Noise Microphone Bias

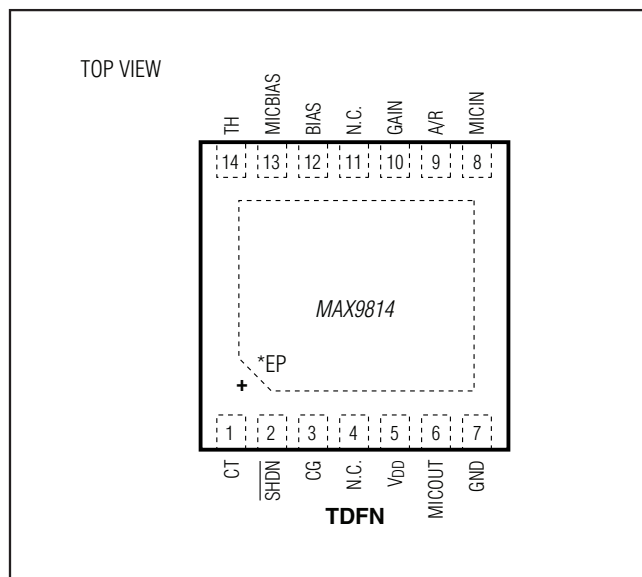
Typical Application Circuit/Functional Diagram



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Pin Configuration

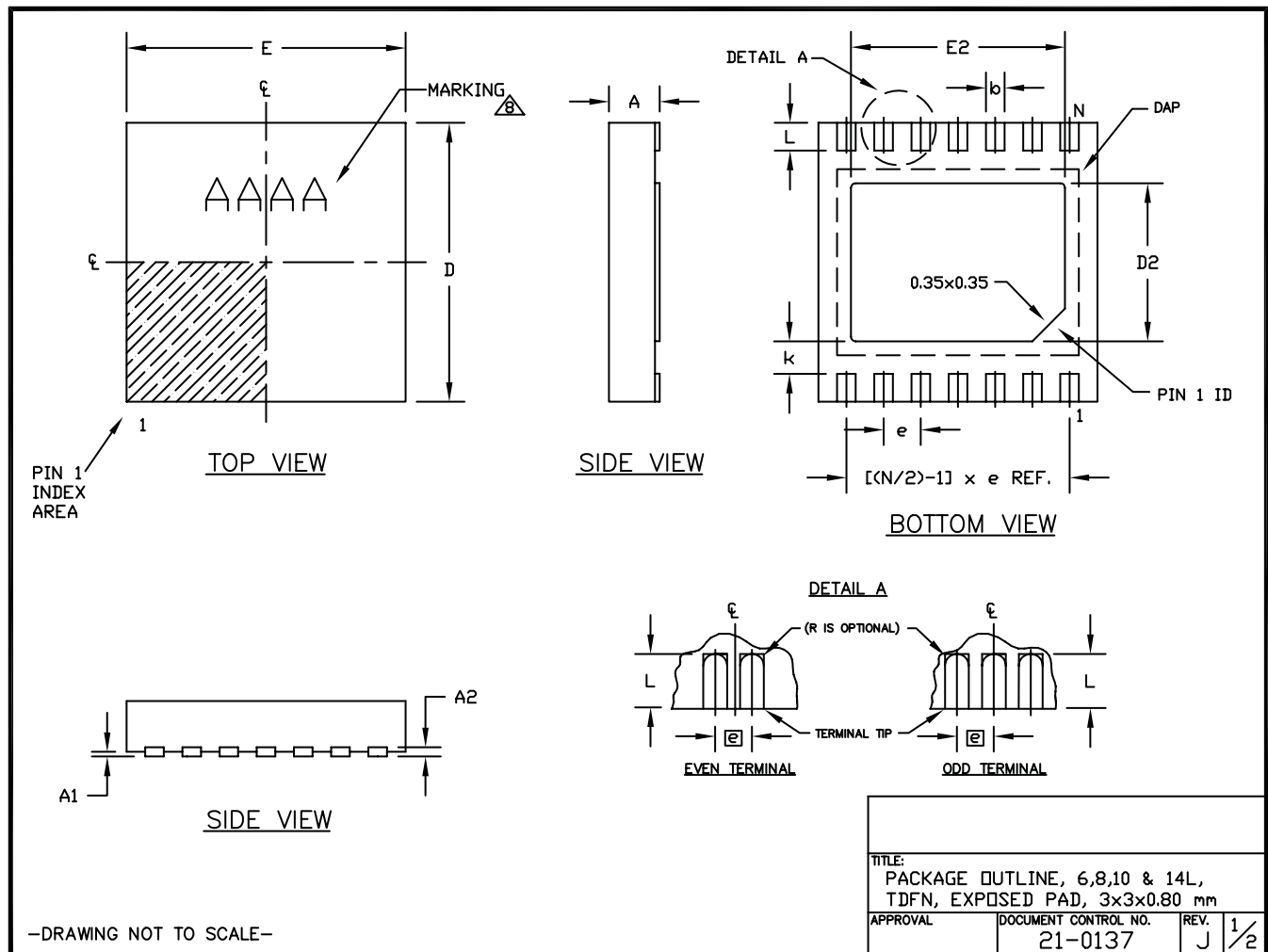


Chip Information

PROCESS: BiCMOS

Microphone Amplifier with AGC and Low-Noise Microphone Bias

For the latest package outline information and land patterns, go to www.maxim-ic.com/packages.



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Package Information (continued)

For the latest package outline information and land patterns, go to www.maxim-ic.com/packages.

COMMON DIMENSIONS		
SYMBOL	MIN.	MAX.
A	0.70	0.80
D	2.90	3.10
E	2.90	3.10
A1	0.00	0.05
L	0.20	0.40
k	0.25 MIN.	
A2	0.20 REF.	

PACKAGE VARIATIONS							
PKG. CODE	N	D2	E2	e	JEDEC SPEC	b	[(N/2)-1] x e
T633-2	6	1.50±0.10	2.30±0.10	0.95 BSC	MO229 / WEEA	0.40±0.05	1.90 REF
T833-2	8	1.50±0.10	2.30±0.10	0.65 BSC	MO229 / WEEC	0.30±0.05	1.95 REF
T833-3	8	1.50±0.10	2.30±0.10	0.65 BSC	MO229 / WEEC	0.30±0.05	1.95 REF
T1033-1	10	1.50±0.10	2.30±0.10	0.50 BSC	MO229 / WEED-3	0.25±0.05	2.00 REF
T1033MK-1	10	1.50±0.10	2.30±0.10	0.50 BSC	MO229 / WEED-3	0.25±0.05	2.00 REF
T1033-2	10	1.50±0.10	2.30±0.10	0.50 BSC	MO229 / WEED-3	0.25±0.05	2.00 REF
T1433-1	14	1.70±0.10	2.30±0.10	0.40 BSC	----	0.20±0.05	2.40 REF
T1433-2	14	1.70±0.10	2.30±0.10	0.40 BSC	----	0.20±0.05	2.40 REF
T1433-3F	14	1.70±0.10	2.30±0.10	0.40 BSC	----	0.20±0.05	2.40 REF

NOTES:

1. ALL DIMENSIONS ARE IN mm. ANGLES IN DEGREES.
2. COPLANARITY SHALL NOT EXCEED 0.08 mm.
3. WARPAGE SHALL NOT EXCEED 0.10 mm.
4. PACKAGE LENGTH/PACKAGE WIDTH ARE CONSIDERED AS SPECIAL CHARACTERISTIC(S).
5. DRAWING CONFORMS TO JEDEC MO229, EXCEPT DIMENSIONS "D2" AND "E2", AND T1433-1 & T1433-2.
6. "N" IS THE TOTAL NUMBER OF LEADS.
7. NUMBER OF LEADS SHOWN ARE FOR REFERENCE ONLY.
8. MARKING IS FOR PACKAGE ORIENTATION REFERENCE ONLY.
9. ALL DIMENSIONS APPLY TO BOTH LEADED (-) AND PbFREE (+) PKG. CODES.

—DRAWING NOT TO SCALE—

TITLE:		
PACKAGE OUTLINE, 6,8,10 & 14L, TDFN, EXPOSED PAD, 3×3×0.80 mm		
APPROVAL	DOCUMENT CONTROL NO.	REV.
	21-0137	J 2/2

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Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	3/07	Initial release	—
1	2/09	Updated <i>Ordering Information</i> , <i>Absolute Maximum Ratings</i> , <i>Pin Description</i> , and <i>Pin Configuration</i> sections to include EP for TDFN package	1, 2, 6, 11
2	6/09	Removed UCSP package	1, 2, 6, 11, 12



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PART NUMBER: CMA-4544PF-W

DESCRIPTION: electret condenser microphone

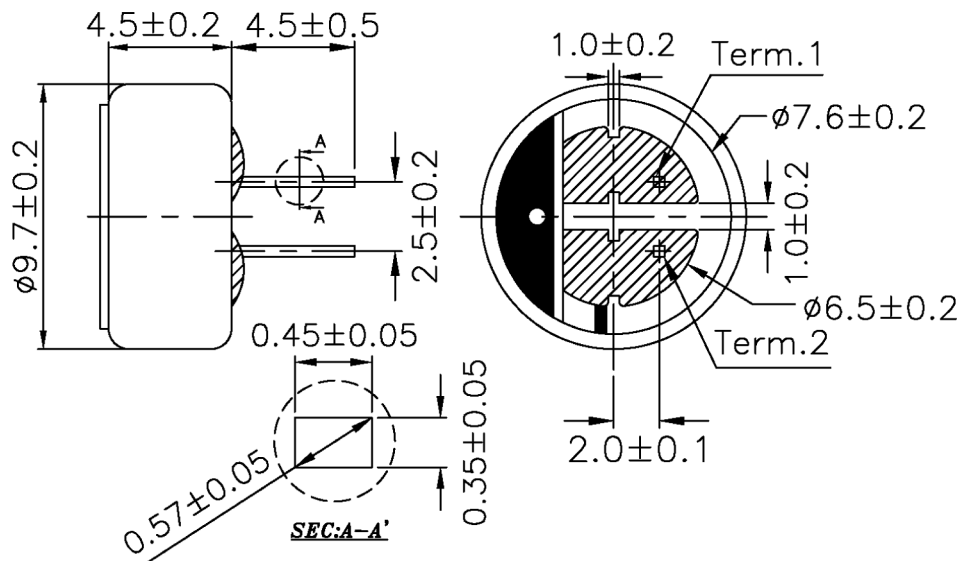
SPECIFICATIONS

directivity	omnidirectional	
sensitivity (S)	-44 ±2 dB	f = 1KHz, 1Pa 0dB = 1V/Pa
sensitivity reduction (ΔS-Vs)	-3 dB	f = 1KHz, 1Pa Vs = 3.0 ~ 2.0 V dc
operating voltage	3 V dc (standard), 10 V dc (max.)	
output impedance (Zout)	2.2 KΩ	f = 1KHz, 1Pa
operating frequency (f)	20 ~ 20,000 Hz	
current consumption (IDSS)	0.5 mA max.	Vs = 3.0 V dc RL = 2.2KΩ
signal to noise ratio (S/N)	60 dBA	f = 1KHz, 1Pa A-weighted
operating temperature	-20 ~ +70° C	
storage temperature	-20 ~ +70° C	
dimensions	ø9.7 x 4.5 mm	
weight	0.80 g max.	
material	Al	
terminal	pin type (hand soldering only)	
RoHS	yes	

note:

We use the "Pascal (Pa)" indication of sensitivity as per the recommendation of I.E.C. (International Electrotechnical Commission). The sensitivity of "Pa" will increase 20dB compared to the "ubar" indication. Example: -60dB (0dB = 1V/ubar) = -40dB (1V/Pa)

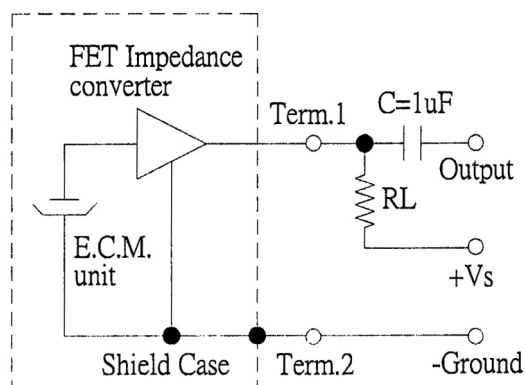
APPEARANCE DRAWING



PART NUMBER: CMA-4544PF-W

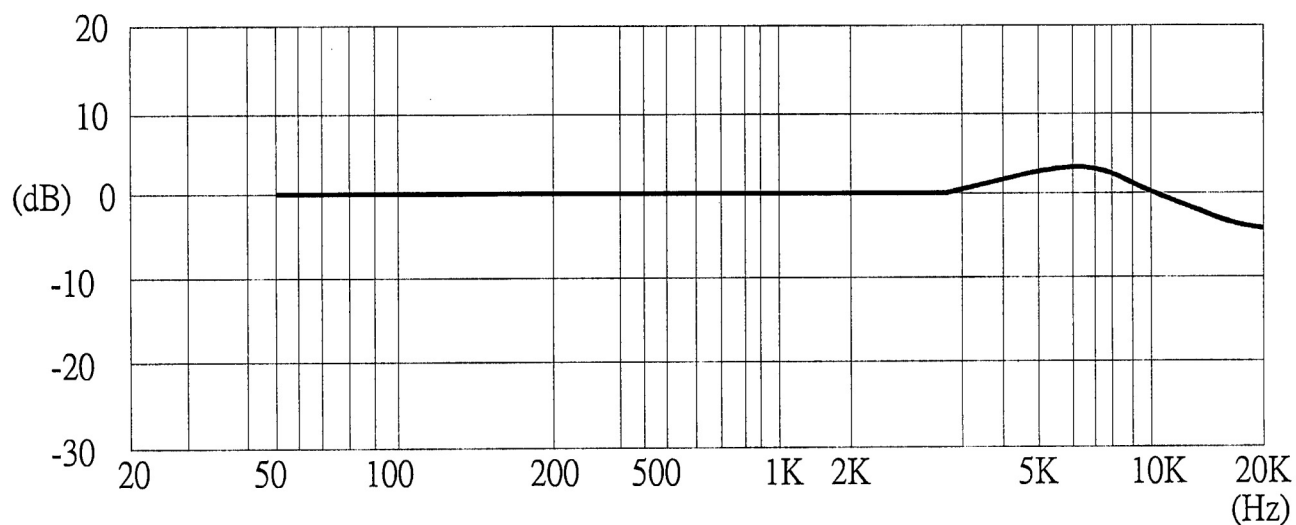
DESCRIPTION: electret condenser microphone

MEASUREMENT CIRCUIT



Schematic Diagram **RL=2.2K Ω**

FREQUENCY RESPONSE CURVE



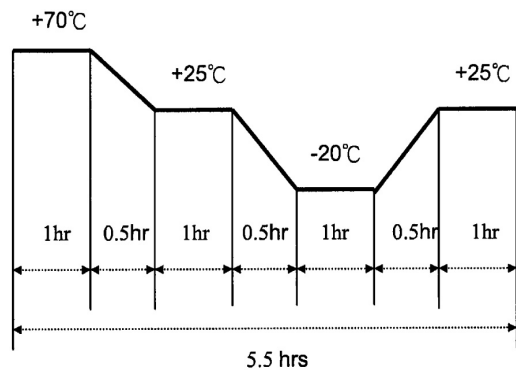
PART NUMBER: CMA-4544PF-W

DESCRIPTION: electret condenser microphone

MECHANICAL CHARACTERISTICS

item	test condition	evaluation standard
soldering heat resistance	Lead terminals are immersed in solder bath of $270 \pm 5^{\circ}\text{C}$ for 2 ± 0.5 seconds.	No interference in operation.
PCB wire pull strength	The pull force will be applied to double lead wire: Horizontal 4.9N (0.5kg) for 30 seconds	No damage or cutting off.
vibration	The part will be measured after applying a vibration amplitude of 1.5 mm with 10 to 55 Hz band of vibration frequency to each of the 3 perpendicular directions for 2 hours.	After any tests, the sensitivity should be within $\pm 3\text{dB}$ compared to the initial measurement.
drop test	The part will be dropped from a height of 1 m onto a 20 mm thick wooden board 3 times in 3 axes (X, Y, Z) for a total of 9 drops.	

ENVIRONMENT TEST

item	test condition	evaluation standard
high temp. test	After being placed in a chamber at $+70^{\circ}\text{C}$ for 72 hours.	The part will be measured after being placed at $+25^{\circ}\text{C}$ for 6 hours. After any tests, the sensitivity should be within $\pm 3\text{dB}$ compared to the initial measurement.
low temp. test	After being placed in a chamber at -20°C for 72 hours.	
humidity test	After being placed in a chamber at $+40^{\circ}\text{C}$ and $90 \pm 5\%$ relative humidity for 240 hours.	
temp. cycle test	The part shall be subjected to 10 cycles. One cycle will consist of: 	

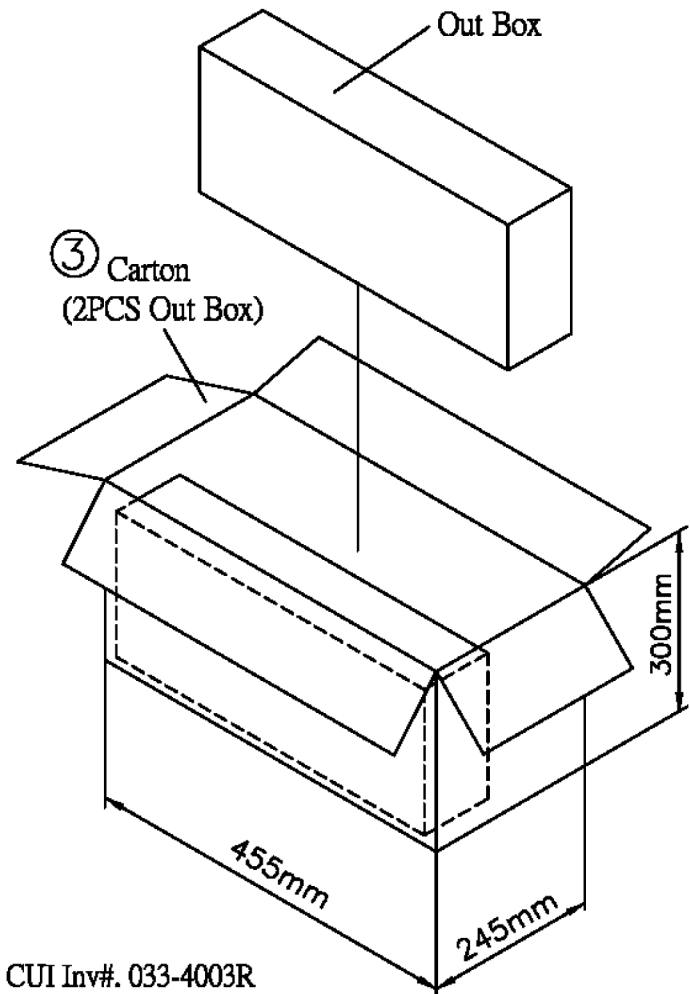
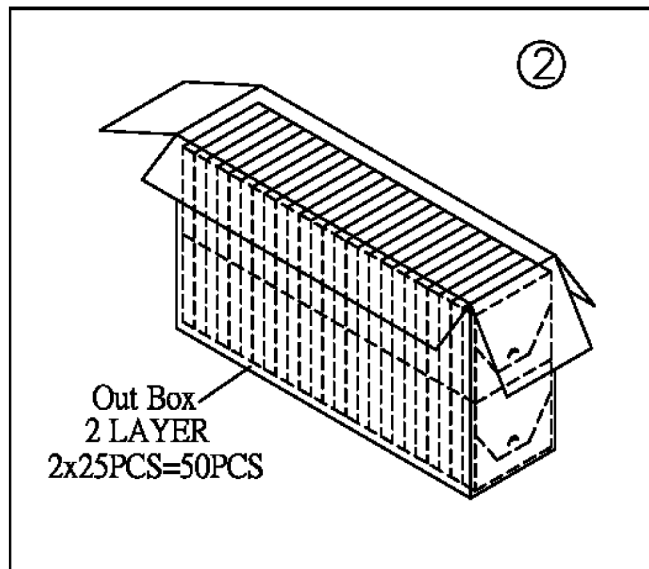
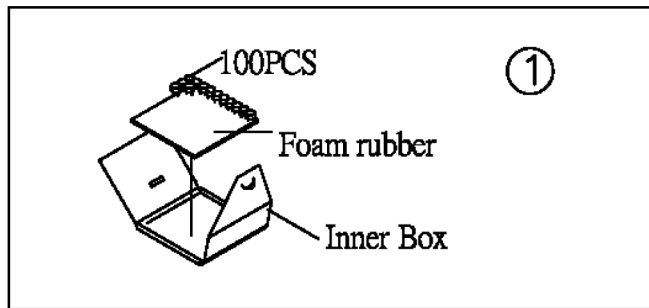
TEST CONDITIONS

standard test condition	a) temperature: $+5 \sim +35^{\circ}\text{C}$	b) humidity: 45 - 85%	c) pressure: 860-1060 mbar
judgement test condition	a) temperature: $+25 \pm 2^{\circ}\text{C}$	b) humidity: 60 - 70%	c) pressure: 860-1060 mbar

PART NUMBER: CMA-4544PF-W

DESCRIPTION: electret condenser microphone

PACKAGING



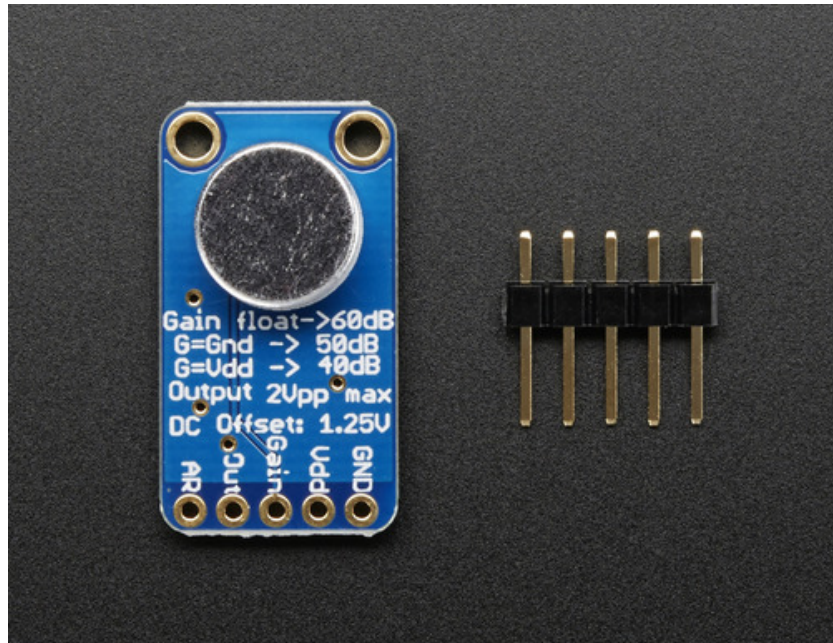
1. CUI Inv#. 033-4003R
CUI Part#. CMA-4544PF-W
2. RoHS Compliant

Inner Box	100mmx100mmx15mm	100PCSx1=100PCS
Out Box	435mmx120mmx280mm	100PCSx50=5,000PCS
Carton Box	455mmx245mmx300mm	5,000PCSx2=10,000PCS



Adafruit AGC Electret Microphone Amplifier - MAX9814

Created by lady ada

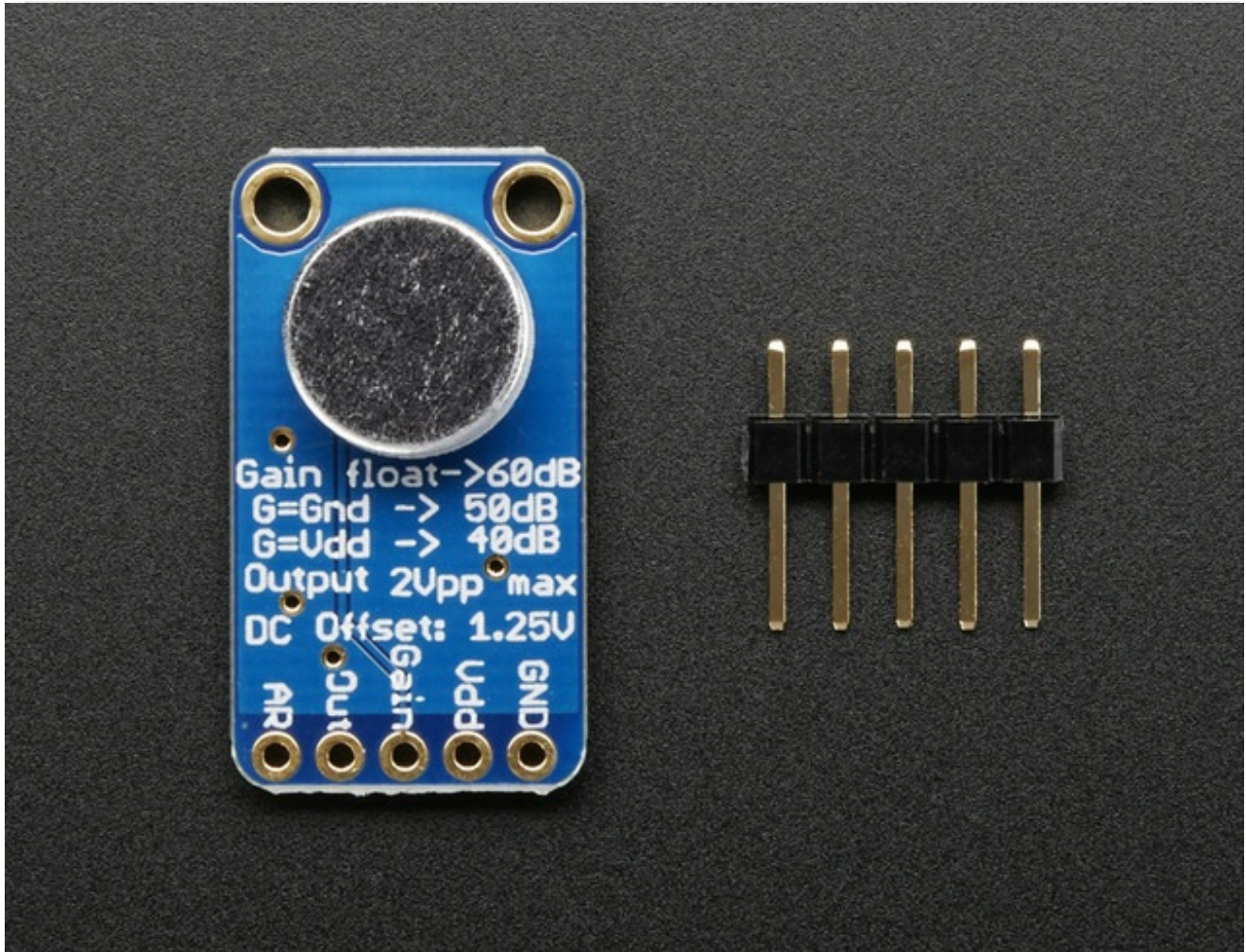


Last updated on 2015-06-22 11:30:12 AM EDT

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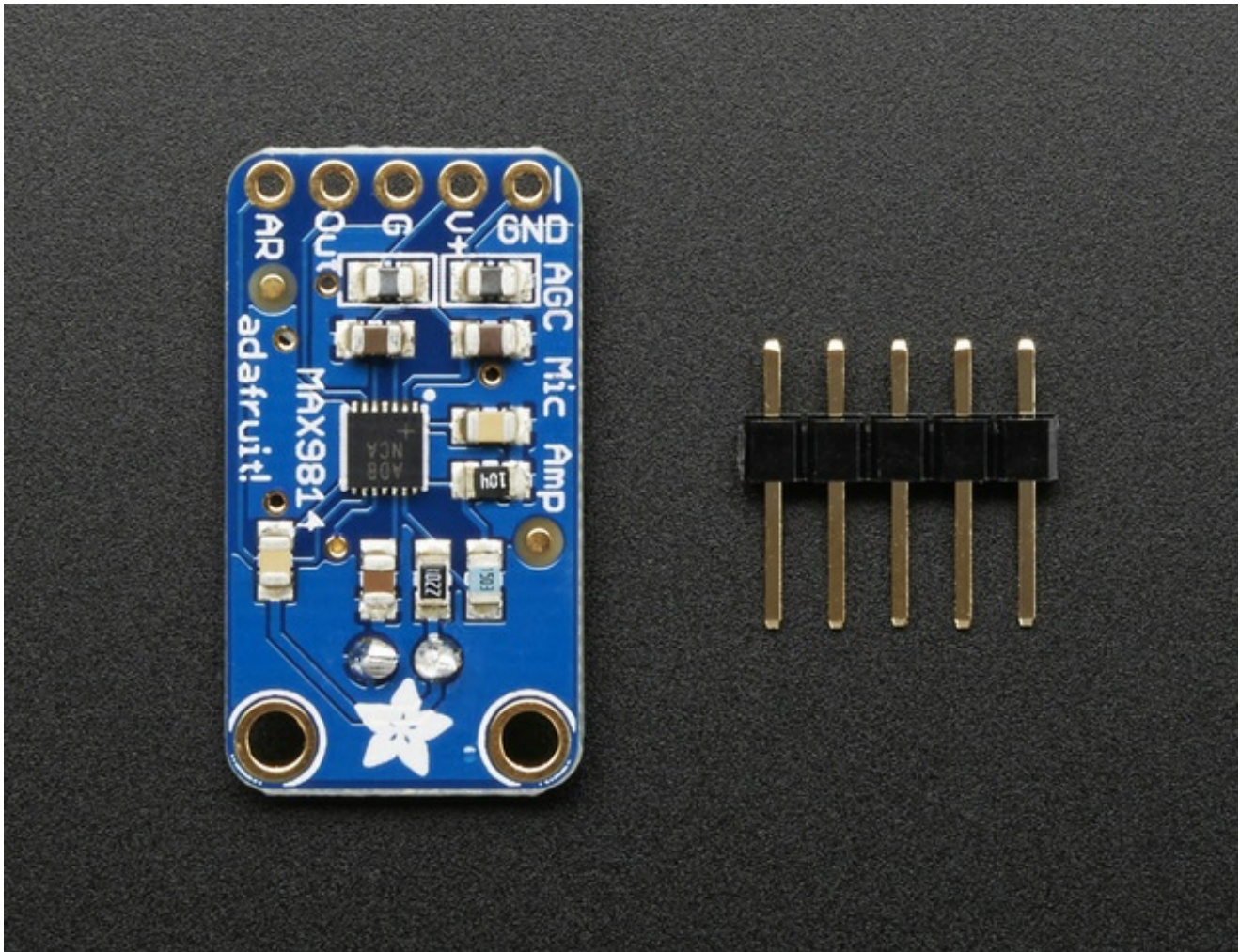
Overview



This fancy microphone amplifier module is a step above the rest, with built in automatic gain control. The AGC in the amplifier means that nearby 'loud' sounds will be quieted so they don't overwhelm & 'clip' the amplifier, and even quiet, far-away sounds will be amplified. This amplifier is great for when you want to record or detect audio in a setting where levels change and you don't want to have to tweak the amplifier gain all the time.

The chip at the heart of this amp is the [MAX9814 \(http://adafru.it/d9r\)](http://adafru.it/d9r), and has a few options you can configure with the breakout. The default 'max gain' is 60dB, but can be set to 40dB or 50dB by jumpering the **Gain** pin to VCC or ground. You can also change the Attack/Release ratio, from the default 1:4000 to 1:2000 or 1:500. The output from the amp is about 2Vpp max on a 1.25V DC bias, so it can be easily used with any Analog/Digital converter that is up to 3.3V input. If you want to pipe it into a Line Input, just use a 1uF blocking capacitor in series.

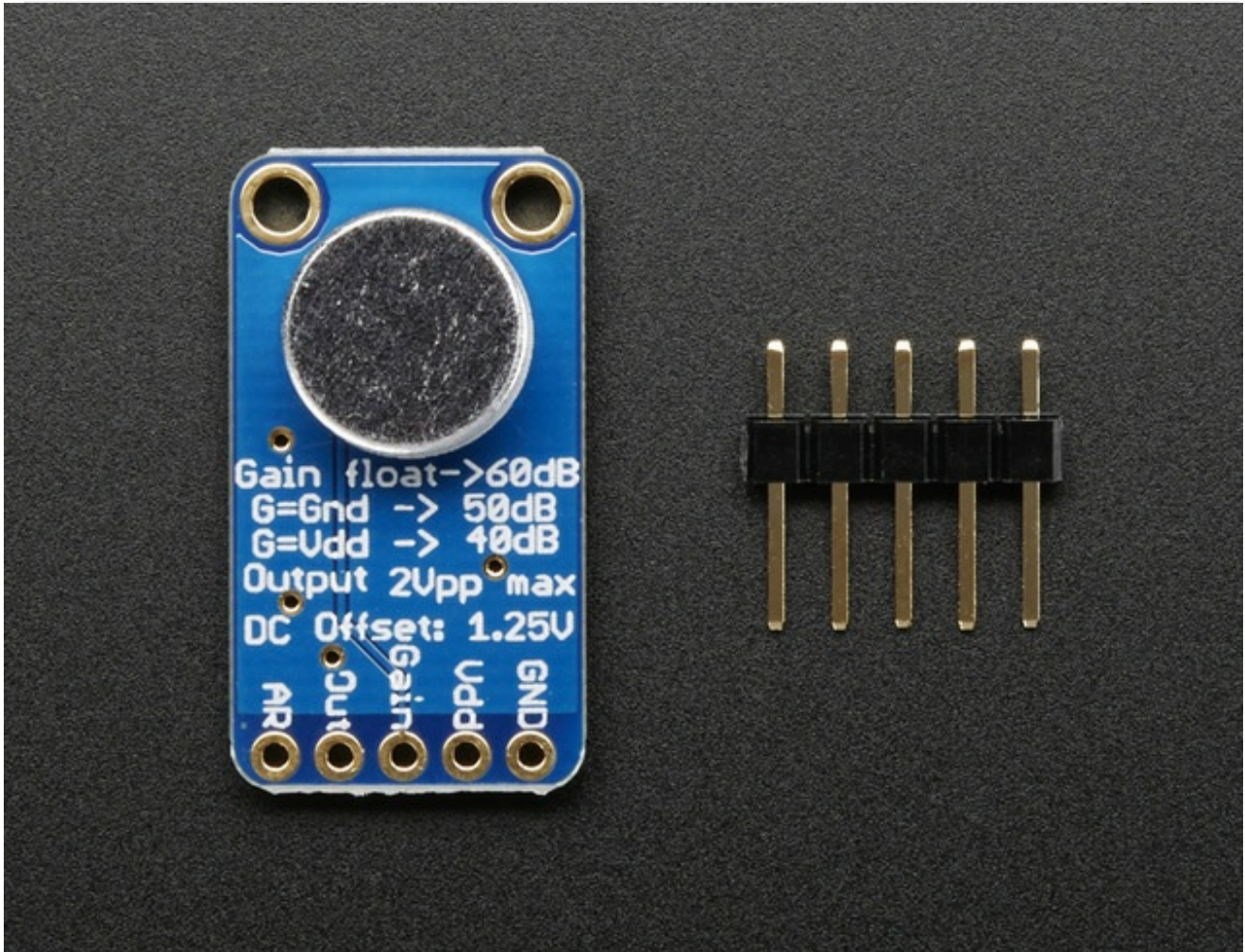
Each order comes with one assembled and tested board, with electret mic pre-soldered on, and a small piece of header.



Specifications:

- Supply Voltage: 2.7v-5.5v @ 3mA current
- Output: 2Vpp on 1.25V bias
- Frequency Response: 20Hz - 20 KHz
- Programmable Attack and Release Ratio
- Automatic gain, selectable max from 40dB, 50dB or 60dB
- Low Input-Referred Noise Density of $30\text{nV}/\sqrt{\text{Hz}}$
- Low THD: 0.04% (typ)

Assembly

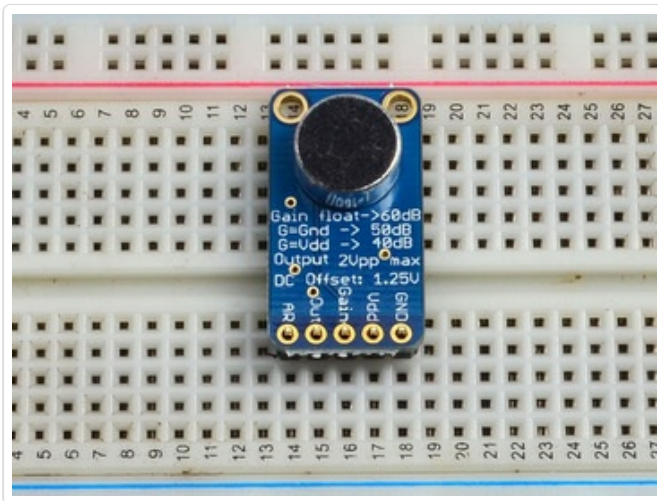
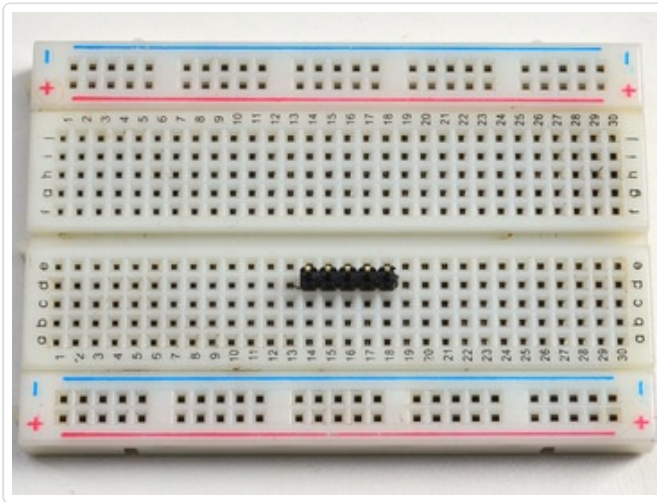


Assembly is really easy, you can use straight or 'right-angle' style headers to attach to the PCB. We'll be using the plain straight headers included

The board comes with all surface-mount components pre-soldered. The included header strip can be soldered on for convenient use on a breadboard or with 0.1" connectors. You can also skip this step and solder on wires.

Prepare the header strip:

Cut the strip to length if necessary. It will be easier to solder if you insert it into a breadboard - **long pins down**.



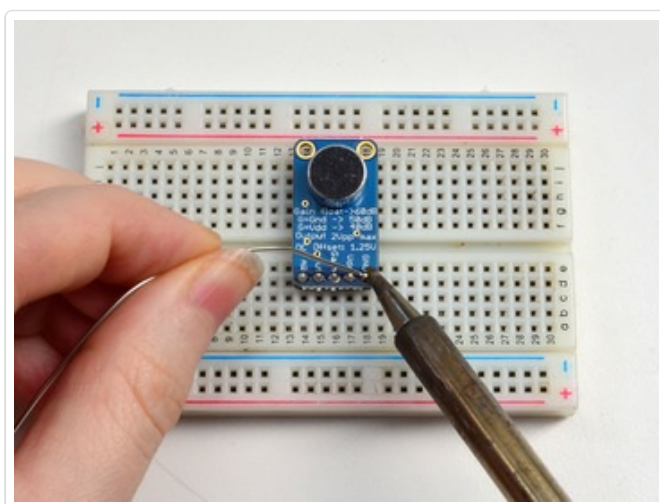
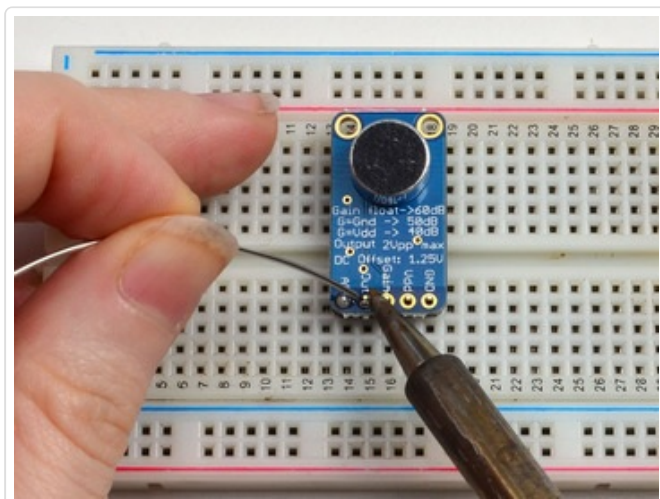
Add the breakout board:

Place the breakout board over the pins so that the short pins poke through the breakout pads

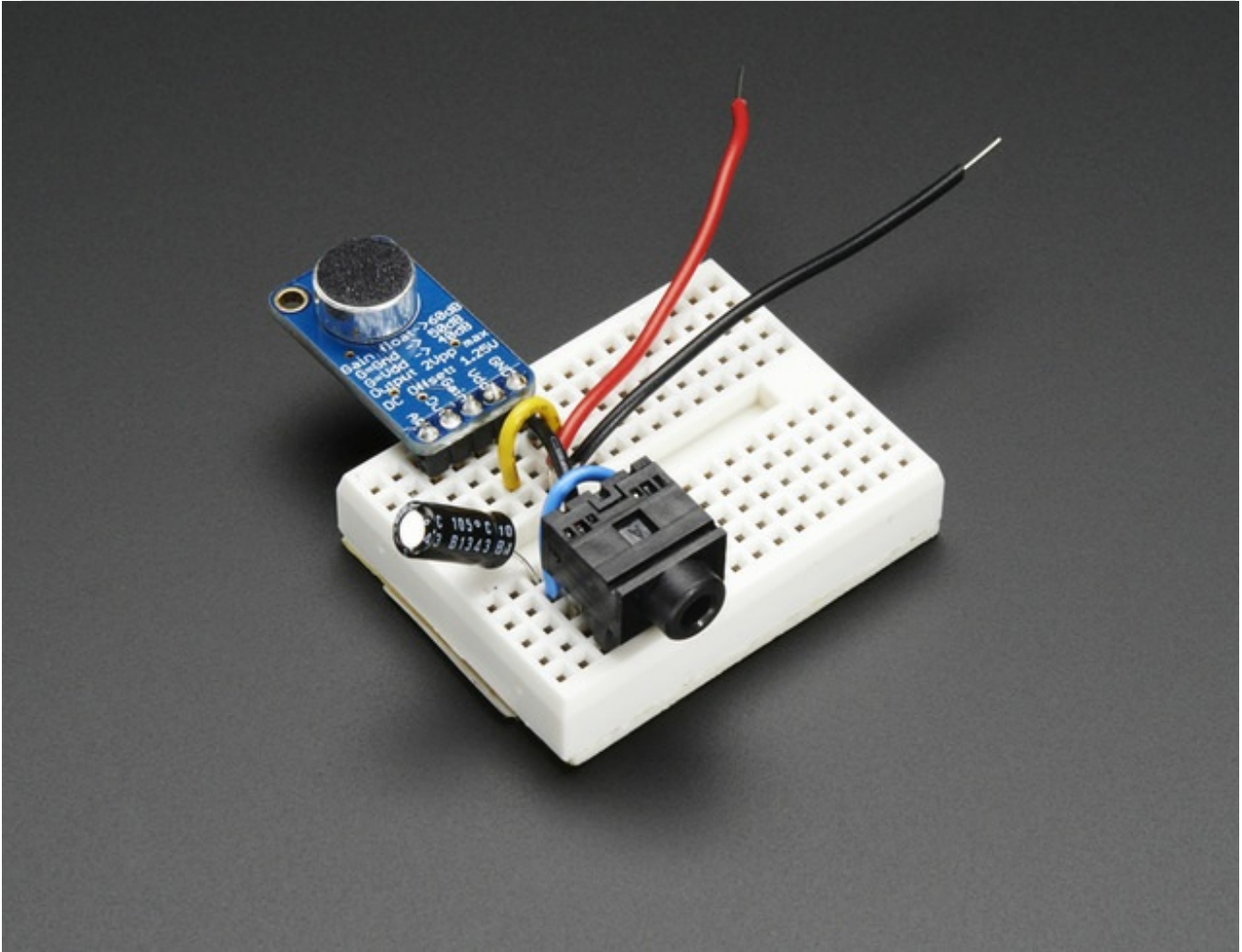
And Solder!

Be sure to solder all 5 pins for reliable electrical contact.

(For tips on soldering, be sure to check out our [Guide to Excellent Soldering](http://adafruit.it/aTk) (<http://adafruit.it/aTk>)).



Wiring and Test



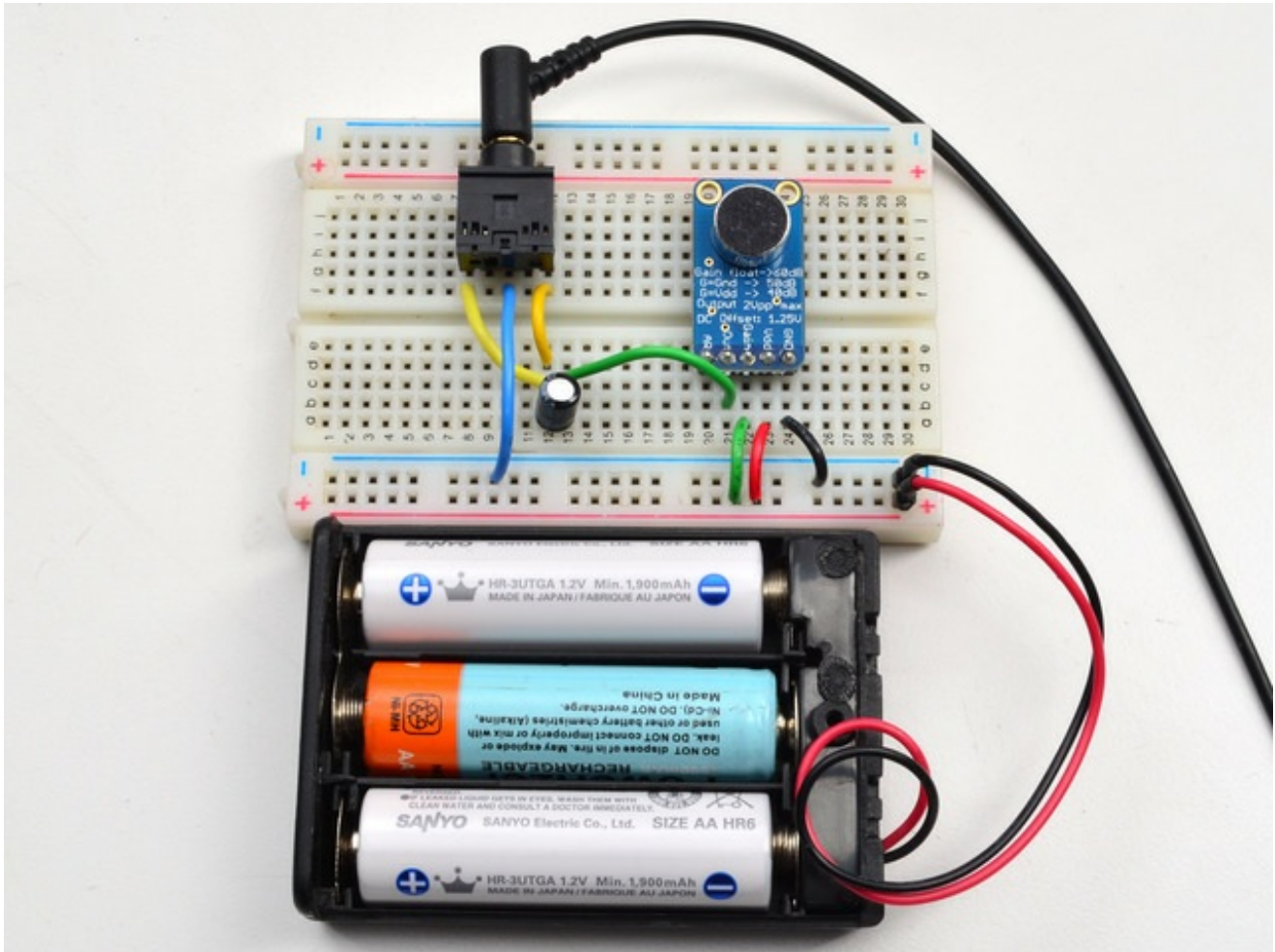
The microphone amp is thankfully quite simple to get started. No microcontroller or programming required. We suggest wiring it up directly with a battery pack and headphones to start while you get a hang of how the AGC acts and responds.

You'll need a [3 or 4 AA/AAA battery pack \(http://adafruit.it/727\)](http://adafruit.it/727) (or some external source of 3-5VDC) - we suggest batteries since they are very electrically-quiet compared to USB or wall power adapters.

You'll also need a [headphone jack, this breadboard-friendly one \(http://adafruit.it/1699\)](http://adafruit.it/1699) works great, and a 1 to 100uF electrolytic capacitor. This is just to protect your headphones from the DC bias voltage. Just about any capacitor will work.

Find the 'cheapest' headphones you have, or use earbuds, they won't load down the microphone amp as much! This is not a good time to use your huge Sennheiser cans. Don't connect to speakers or you will get really horrible feedback effects

Wiring



Connect the amplifier, battery pack and headphone jack as shown above.

For the Microphone amp:

- **GND** connects to the battery pack ground - black wire
- **VDD** connects to the battery pack positive - red wire
- Connect the **Gain** pin to VDD for now - green wire
- Connect the **OUT** pin to a 1uF-100uF capacitor (really any value will do). If the capacitor is polarized, connect the OUT pin to the positive side - green wire

For the headphone jack

- Connect the **Left** and **Right** pins together (the microphone is mono out) to the negative side of the capacitor - yellow wires.
- Connect the center ground pin to the battery ground - blue wire

Test!

Now try listening to sounds on the headphones, you should notice a strange 'effect' where you can hear people from further away than your hearing is used to! Try setting the **Gain** pin to the GND pin to get 10dB more gain. You can also remove the Gain wire, to set the gain to 60dB but you may find the gain is way too high, and it sounds 'too noisy', so we suggest sticking to 40 or 50dB for most purposes.

You can also try adjusting the A/R (attack/response) ratio by connecting the A/R pin to VDD or GND but we found that the default no-wire works pretty well for most purposes.

Do more!

Now that you have the amplifier tested, you can use this microphone amp just like our non-AGC board.

Check out <http://learn.adafruit.com/adafruit-microphone-amplifier-breakout/measuring-sound-levels> (<http://adafru.it/d9p>) and <http://learn.adafruit.com/adafruit-microphone-amplifier-breakout/more-cool-projects> (<http://adafru.it/d9q>) for other projects that can be adapted to use this amplifier.

Downloads

Datasheets

[Datasheet for the MAX9814 \(http://adafru.it/d9o\)](http://adafru.it/d9o)

[Datasheet for the electret mic capsule \(http://adafru.it/aW6\)](http://adafru.it/aW6)

3D models

Thanks to Aron Rubin!

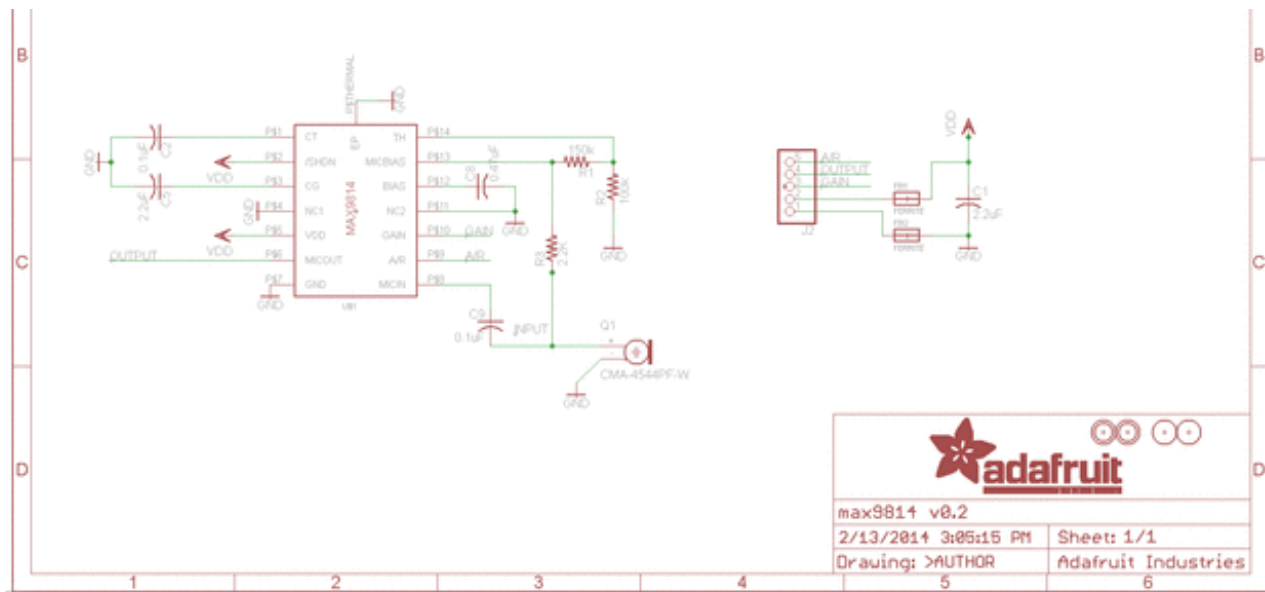
adafruit_mic_agc.pdf

<http://adafru.it/frD>

adafruit_mic_agc.skp

<http://adafru.it/frE>

Schematics



PCB Dimensional Diagram

