IPSIA "R. FRAU" A.S. 2019/2020	**LABORATORIO DI FISICA CON ARDUINO** *Prof. Lorenzo Morresi*	Classe 3EMT-MAT San Ginesio

Titolo progetto	**Misura della rumorosità di un ambiente**	Scheda progetto n_**22**

Descrizione

Utilizziamo un microfono low-cost (Sound Sensor v1.6 del Grove Starter Kit) per implementare un semplice strumento di misura della rumorosità di un ambiente. Attraverso un processo di calibrazione, il tester è in grado di rappresentare i valori misurati in Decibel (dB) sia sul monitor seriale che sul display lcd collegato alla base shield di Arduino mediante la porta I2C. Il progetto include anche una BarGraph e un segnale visivo RGB proporzionale al rumore misurato.

Materiale necessario (qui trovi i link)

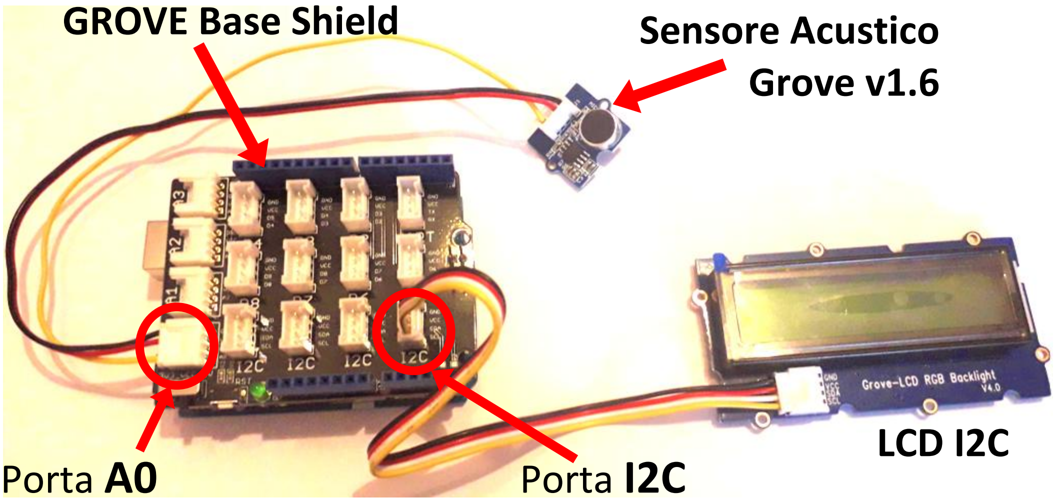
1 ARDUINO UNO board
1 Sensore di Suono – Sound Sensor v1.6
1 Display LCD – I2C
1 Grove Starter Kit per Arduino
1 Grove Base Shield

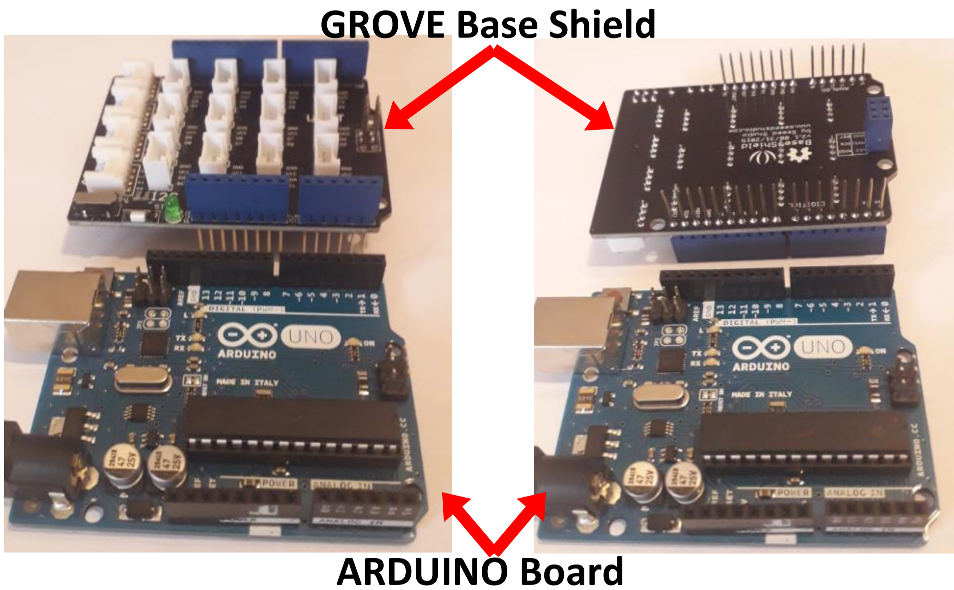
Sketch

```
#include <Wire.h>
#include <rgb_lcd.h>
rgb_lcd lcd;
byte p5[8] = {B11111,B11111,B11111,B11111,B11111,B11111,B11111,B11111};
#define MicSamples (1024)
const int MIC = 0;
int dB=0, bar=0;
long adc, avg_adc;

void setup() {
  lcd.begin(16,2);
  lcd.createChar(5,p5);
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("LORENZO MORRESI");
  lcd.setCursor(0, 1);
  lcd.print("Acoustic Tester");
  delay (500);
Serial.begin(9600);
  }

void loop(){
  for (int i = 0; i < MicSamples; i++) {
  adc= analogRead(MIC);
  avg_adc += adc;
  }
  avg_adc /= MicSamples;
  dB = (avg_adc+74.976) / 2.7691; // vedi procedura di calibrazione
  bar =dB*16/100;
```

```
 Serial.print (" dB = ");
 Serial.println (dB);
 Serial.print (" bar = ");
 Serial.println(bar);
 lcd.clear();
 lcd.setCursor(0,0);
 lcd.print("Noise lev.:");
 cd.setCursor(11,0);
 lcd.print(dB);
 lcd.setCursor(14,0);
 lcd.print("dB");
 lcd.setCursor(0,1);
  if (dB<=40)
  lcd.setRGB(255,255,255);
  if ((dB>40)&&(dB<=70))
  lcd.setRGB(250,233,6);
  if (dB>70)
  lcd.setRGB(252,4,4);
 for (int i = 0; i<bar; i++){
 lcd.write(byte(5));
 }
delay(100);
}
```

<u>Schema dei collegamenti</u>





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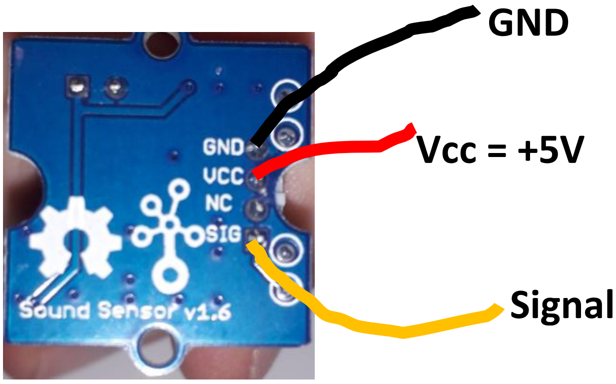
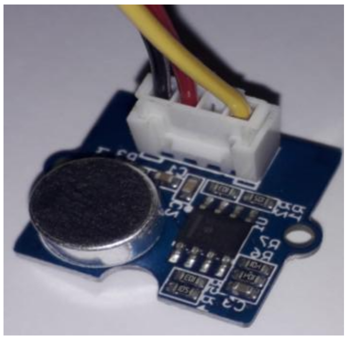
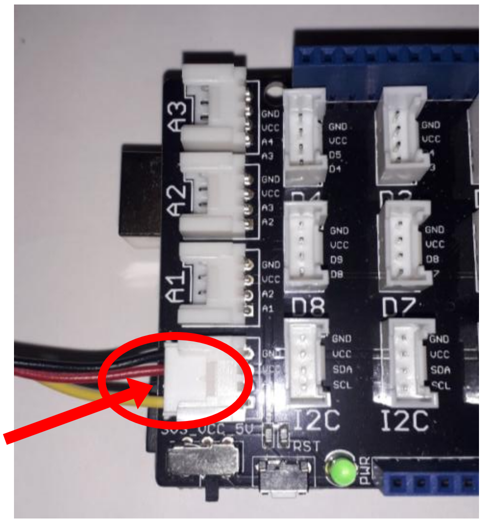
<tr><td></td><td></td></tr>
<tr><td><u>Dettaglio connessioni sensore acustico</u></td><td>




Signal collegato a A0 di ARDUINO

Se si usa la Grove Base Shield il connettore proveniente dal Sound Sensor v1.6 deve essere collegato alla sua porta A0.



Porta A0
della Grove Base Shield
</td></tr>
<tr><td><u>Dettaglio connessioni display LCD I2C</u></td><td>


Vcc collegato a +5V di ARDUINO

SDA collegato a A4 di ARDUINO

SCL collegato a A5 di ARDUINO

Se si usa la Grove Base Shield il connettore proveniente dal display LCD deve essere collegato ad una delle sue porte I2C.
</td></tr>
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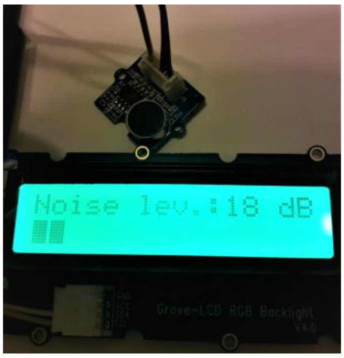
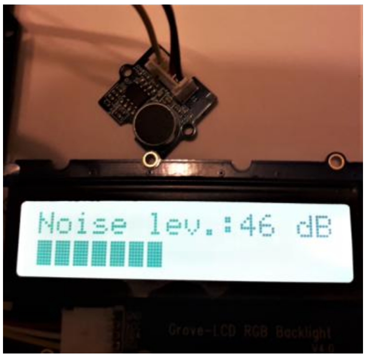
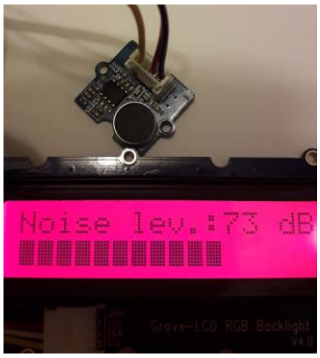
Risultato atteso (esempio)



Rumore fino a 40dB
Sfondo lcd bianco

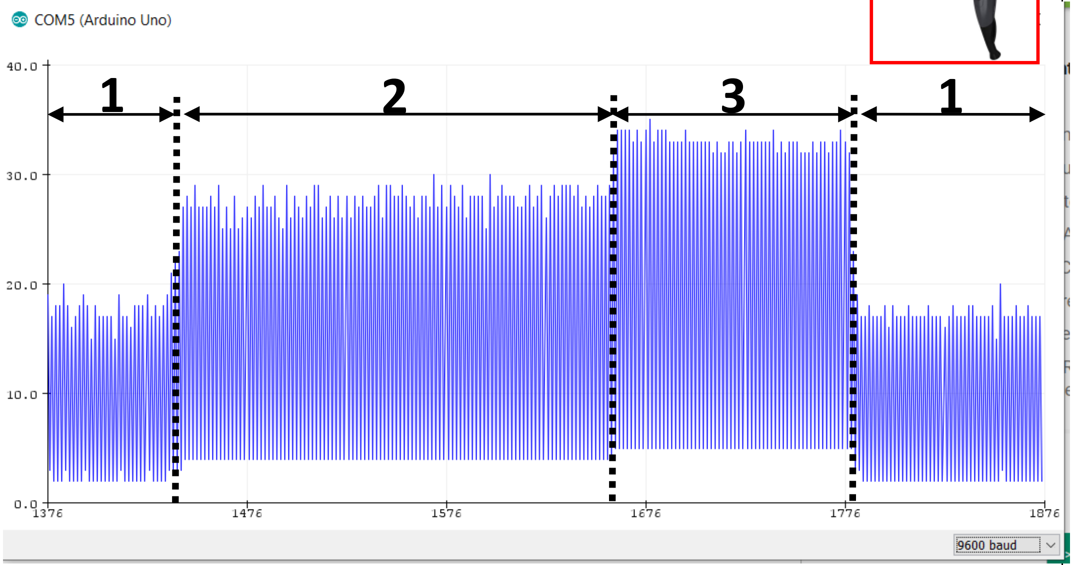


Rumore da 40dB fino a 70dB
Sfondo lcd giallo



Rumore oltre 70dB
Sfondo lcd rosso

Asciugacapelli Imetec K5 - 2200 W



1 – **Asciugacapelli spento** / Rumore di fondo della stanza
2 – **Asciugacapelli acceso alla potenza intermedia**
3 – **Asciugacapelli acceso alla massima potenza**

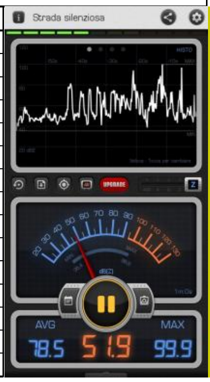
Calibrazione del Sensore con App

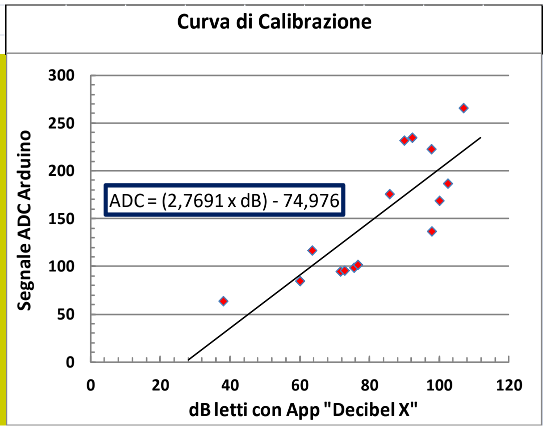
Il Sensore Acustico v1.6 della Grove utilizzato in questo progetto viene calibrato con l'App Android "Decibel X". La calibrazione permette di ottenere dei valori espressi in dB (Decibel) a partire dai valori analogici forniti dal sensore.
Il processo di calibrazione descritto è puramente indicativo in quanto la stessa App "Decibel X" non permette di ottenere valori certificati.
Tuttavia, la metodologia usata e sotto descritta può essere applicata sostituendo l'App con uno strumento calibrato e certificato quale un Fonometro professionale.

Procedura di calibrazione:
1 – Avviare l'App "Decibel X" precedentemente installata sul proprio cellulare.
2 – Avviare il presente sistema di misura del rumore, avendo modificato precedentemente lo sketch in modo tale da visualizzare sul display lcd il valore "avg_adc".
3 – Utilizzando diverse sorgenti di rumore (asciugacapelli, trapano, lavatrice, toni musicale a diversi volumi,….) leggere i valori di dB letti sulla App e i corrispondenti valori avg_adc letti sul display lcd.
4 – Riportare i valori letti su una tabella excel come nell'esempio sottostante.
5 – Rappresentare i valori letti come nel grafico sottostante.

App Decibel X

dB App	ADC Sensore Suono v1.6
38	64
60	85
63,5	117
71,6	95
72,8	96
75,5	99
76,6	102
85,7	176
89,9	232
92,2	235
97,7	223
97,8	137
100	169
102,4	187
106,9	266





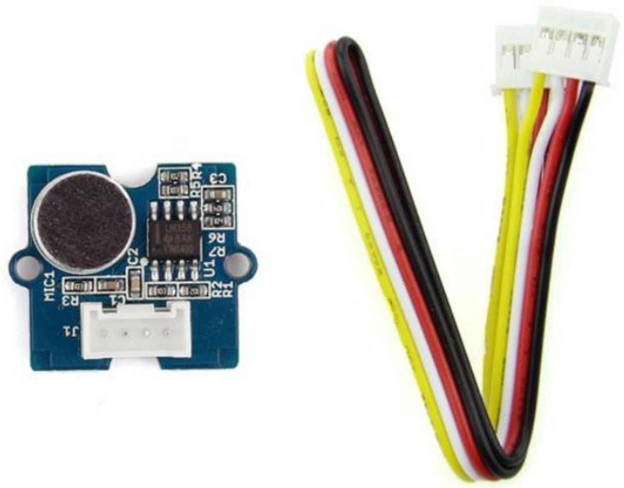
6 – Eseguire un fit lineare dei dati ottenuti, con rappresentazione sul grafico della equazione della retta ottenuta. PS: **excel utilizza il metodo della regressione lineare per il fit lineare dei dati**.
7 – Rappresentare l'equazione ottenuta in funzione di avg_adc.
8 – Inserire l'equazione ottenuta nello sketch:

```
:
:
dB = (avg_adc+74.976) / 2.7691; // vedi procedura di calibrazione
:
:
```

9 – I valori che ora vengono riportati sul display lcd sono confrontabili con quelli rappresentati dalla App "Decibel X".
10 – Se i dati ottenuti non hanno una distribuzione lineare, utilizzare la linea di tendenza che meglio li rappresenta, avendo cura di mostrare sul grafico l'equazione ottenuta.
11 – Ripeti i punti 7 e 8.
12 – Se si è in possesso di un fonometro professionale con calibrazione certificata, utilizzarlo per la calibrazione del presente sistema ripetendo i punti dall'1 all'8.

Improve your English

Grove - Sound Sensor Based on LM386 amplifier



Key Features

- Easy project operation: Grove compatible interface
- Analog output signal
- Wide supply voltage range: 4V-12V
- Low quiescent current drain: 4mA
- Tiny size: 2.0cm x 2.0cm twig module
- Minimum external parts
- Based on the power amplifier LM386

Description

The Sound sensor module is a simple microphone compatible with many microcontrollers and SBCs like Arduino and Raspberry Pi. Based on the power amplifier LM386 and the electret microphone, it can be used to detect whether there's sound (like the sound of clapping, noise, etc) surround or not and output the sound strength of the environment. This module can easily integrate with logic modules on the input side of Grove circuits and its output is analog. With its tiny size and high performance, it is perfect for your Raspberry Pi audio detection project and interactive project.

Typical Application

- Simple microphone
- Sound/noise detector
- Smart home: Sound control lamp
- Sound interactive device

Technical details

Dimensions	24mm x20mm x9.8mm
Weight	G.W 9g
Battery	Exclude
Operating Voltage Range	3.3/5 V
Operating Current(Vcc=5V)	4~5 mA
Voltage Gain(V=6V, f=1kHz)	26 dB
Microphone sensitivity(1kHz)	52-48 dB
Microphone Impedance	2.2k Ohm
Microphone Frequency	16-20 kHz
Microphone S/N Radio	54 dB

Nome e Cognome		VOTO:

National Semiconductor

August 2000

LM386
Low Voltage Audio Power Amplifier

General Description

The LM386 is a power amplifier designed for use in low voltage consumer applications. The gain is internally set to 20 to keep external part count low, but the addition of an external resistor and capacitor between pins 1 and 8 will increase the gain to any value from 20 to 200.

The inputs are ground referenced while the output automatically biases to one-half the supply voltage. The quiescent power drain is only 24 milliwatts when operating from a 6 volt supply, making the LM386 ideal for battery operation.

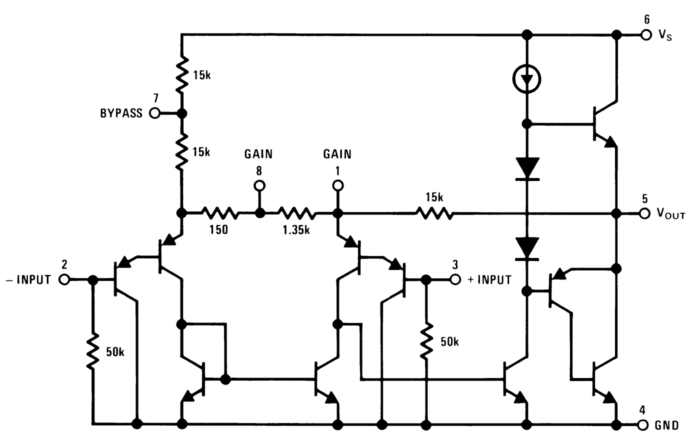
Features

- Battery operation
- Minimum external parts
- Wide supply voltage range: 4V–12V or 5V–18V
- Low quiescent current drain: 4mA
- Voltage gains from 20 to 200
- Ground referenced input
- Self-centering output quiescent voltage
- Low distortion: 0.2% (A_V = 20, V_S = 6V, R_L = 8Ω, P_O = 125mW, f = 1kHz)
- Available in 8 pin MSOP package

Applications

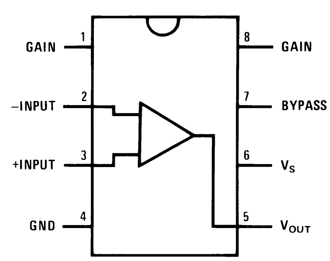
- AM-FM radio amplifiers
- Portable tape player amplifiers
- Intercoms
- TV sound systems
- Line drivers
- Ultrasonic drivers
- Small servo drivers
- Power converters

Equivalent Schematic and Connection Diagrams



DS006976-1

Small Outline, Molded Mini Small Outline, and Dual-In-Line Packages



DS006976-2

Top View
Order Number LM386M-1, LM386MM-1, LM386N-1, LM386N-3 or LM386N-4
See NS Package Number M08A, MUA08A or N08E

 DS006976 www.national.com

Absolute Maximum Ratings (Note 2)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/ Distributors for availability and specifications.

Supply Voltage	
(LM386N-1, -3, LM386M-1)	15V
Supply Voltage (LM386N-4)	22V
Package Dissipation (Note 3)	
(LM386N)	1.25W
(LM386M)	0.73W
(LM386MM-1)	0.595W
Input Voltage	±0.4V
Storage Temperature	−65˚C to +150˚C
Operating Temperature	0˚C to +70˚C
Junction Temperature	+150˚C
Soldering Information	
Dual-In-Line Package	
Soldering (10 sec)	+260˚C
Small Outline Package	
(SOIC and MSOP)	
Vapor Phase (60 sec)	+215˚C
Infrared (15 sec)	+220˚C

See AN-450 “Surface Mounting Methods and Their Effect on Product Reliability” for other methods of soldering surface mount devices.

Thermal Resistance	
θ_{JC} (DIP)	37˚C/W
θ_{JA} (DIP)	107˚C/W
θ_{JC} (SO Package)	35˚C/W
θ_{JA} (SO Package)	172˚C/W
θ_{JA} (MSOP)	210˚C/W
θ_{JC} (MSOP)	56˚C/W

Electrical Characteristics (Notes 1, 2)

T_A = 25˚C

Parameter	Conditions	Min	Typ	Max	Units
Operating Supply Voltage (V_S)					
LM386N-1, -3, LM386M-1, LM386MM-1		4		12	V
LM386N-4		5		18	V
Quiescent Current (I_Q)	V_S = 6V, V_{IN} = 0		4	8	mA
Output Power (P_{OUT})					
LM386N-1, LM386M-1, LM386MM-1	V_S = 6V, R_L = 8Ω, THD = 10%	250	325		mW
LM386N-3	V_S = 9V, R_L = 8Ω, THD = 10%	500	700		mW
LM386N-4	V_S = 16V, R_L = 32Ω, THD = 10%	700	1000		mW
Voltage Gain (A_V)	V_S = 6V, f = 1 kHz		26		dB
	10 µF from Pin 1 to 8		46		dB
Bandwidth (BW)	V_S = 6V, Pins 1 and 8 Open		300		kHz
Total Harmonic Distortion (THD)	V_S = 6V, R_L = 8Ω, P_{OUT} = 125 mW f = 1 kHz, Pins 1 and 8 Open		0.2		%
Power Supply Rejection Ratio (PSRR)	V_S = 6V, f = 1 kHz, C_{BYPASS} = 10 µF Pins 1 and 8 Open, Referred to Output		50		dB
Input Resistance (R_{IN})			50		kΩ
Input Bias Current (I_{BIAS})	V_S = 6V, Pins 2 and 3 Open		250		nA

Note 1: All voltages are measured with respect to the ground pin, unless otherwise specified.

Note 2: Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is functional, but do not guarantee specific performance limits. Electrical Characteristics state DC and AC electrical specifications under particular test conditions which guarantee specific performance limits. This assumes that the device is within the Operating Ratings. Specifications are not guaranteed for parameters where no limit is given, however, the typical value is a good indication of device performance.

Note 3: For operation in ambient temperatures above 25˚C, the device must be derated based on a 150˚C maximum junction temperature and 1) a thermal resistance of 107˚C/W junction to ambient for the dual-in-line package and 2) a thermal resistance of 170˚C/W for the small outline package.

Application Hints

GAIN CONTROL

To make the LM386 a more versatile amplifier, two pins (1 and 8) are provided for gain control. With pins 1 and 8 open the 1.35 kΩ resistor sets the gain at 20 (26 dB). If a capacitor is put from pin 1 to 8, bypassing the 1.35 kΩ resistor, the gain will go up to 200 (46 dB). If a resistor is placed in series with the capacitor, the gain can be set to any value from 20 to 200. Gain control can also be done by capacitively coupling a resistor (or FET) from pin 1 to ground.

Additional external components can be placed in parallel with the internal feedback resistors to tailor the gain and frequency response for individual applications. For example, we can compensate poor speaker bass response by frequency shaping the feedback path. This is done with a series RC from pin 1 to 5 (paralleling the internal 15 kΩ resistor). For 6 dB effective bass boost: $R \simeq 15$ kΩ, the lowest value for good stable operation is $R = 10$ kΩ if pin 8 is open. If pins 1 and 8 are bypassed then R as low as 2 kΩ can be used. This restriction is because the amplifier is only compensated for closed-loop gains greater than 9.

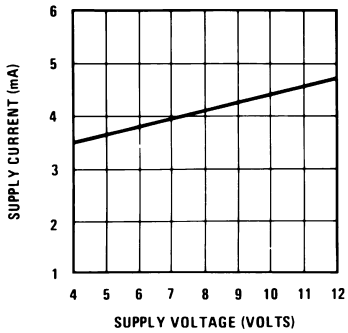
INPUT BIASING

The schematic shows that both inputs are biased to ground with a 50 kΩ resistor. The base current of the input transistors is about 250 nA, so the inputs are at about 12.5 mV when left open. If the dc source resistance driving the LM386 is higher than 250 kΩ it will contribute very little additional offset (about 2.5 mV at the input, 50 mV at the output). If the dc source resistance is less than 10 kΩ, then shorting the unused input to ground will keep the offset low (about 2.5 mV at the input, 50 mV at the output). For dc source resistances between these values we can eliminate excess offset by putting a resistor from the unused input to ground, equal in value to the dc source resistance. Of course all offset problems are eliminated if the input is capacitively coupled.

When using the LM386 with higher gains (bypassing the 1.35 kΩ resistor between pins 1 and 8) it is necessary to bypass the unused input, preventing degradation of gain and possible instabilities. This is done with a 0.1 µF capacitor or a short to ground depending on the dc source resistance on the driven input.

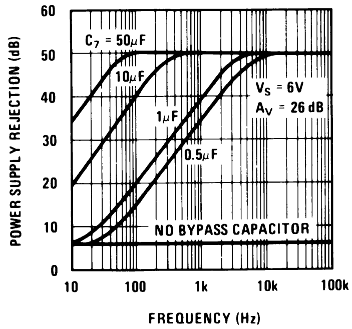
Typical Performance Characteristics

Quiescent Supply Current vs Supply Voltage



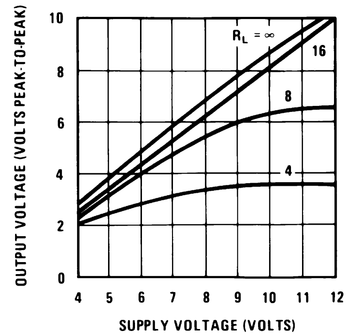
DS006976-5

Power Supply Rejection Ratio (Referred to the Output) vs Frequency



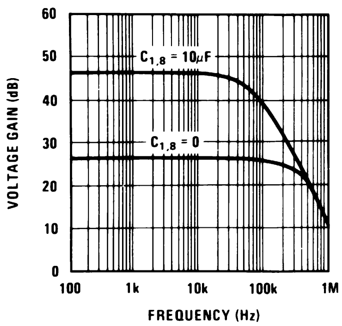
DS006976-12

Peak-to-Peak Output Voltage Swing vs Supply Voltage



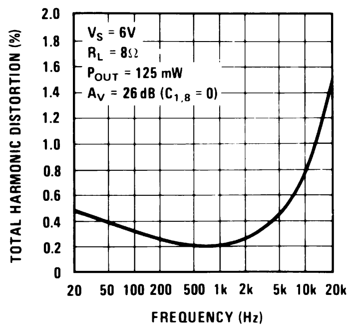
DS006976-13

Voltage Gain vs Frequency



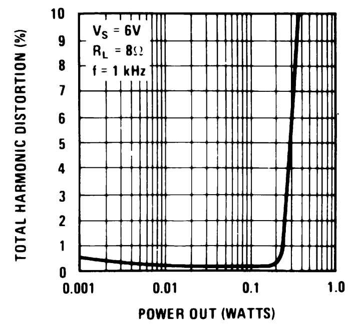
DS006976-14

Distortion vs Frequency



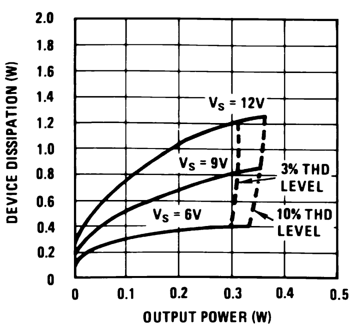
DS006976-15

Distortion vs Output Power



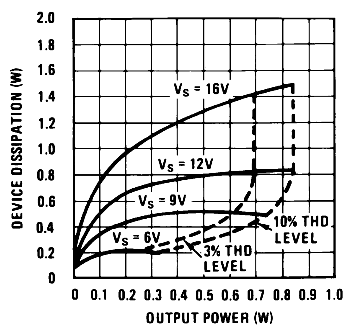
DS006976-16

Device Dissipation vs Output Power—4Ω Load



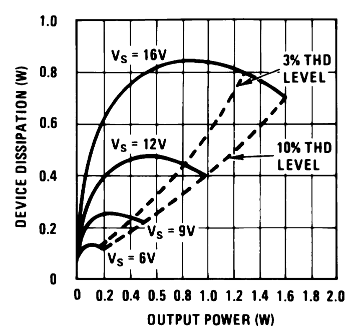
DS006976-17

Device Dissipation vs Output Power—8Ω Load



DS006976-18

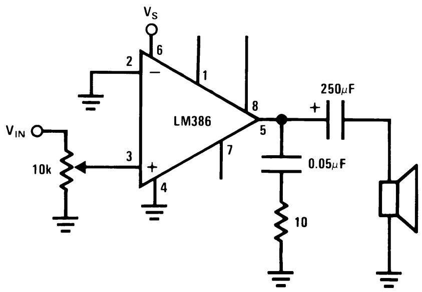
Device Dissipation vs Output Power—16Ω Load



DS006976-19

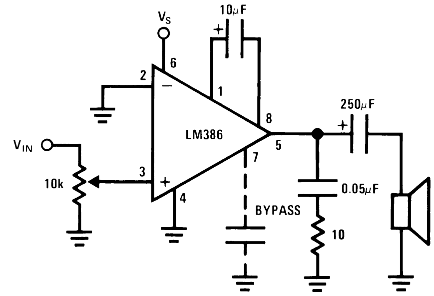
Typical Applications

Amplifier with Gain = 20 Minimum Parts



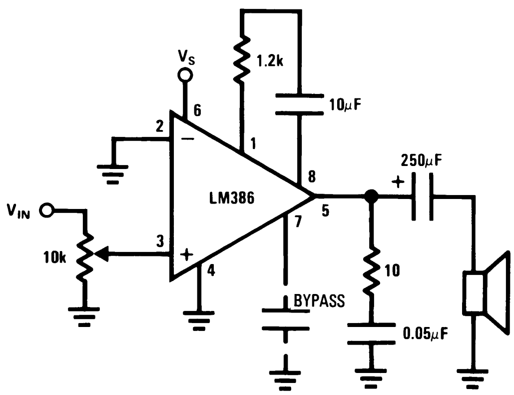
DS006976-3

Amplifier with Gain = 200



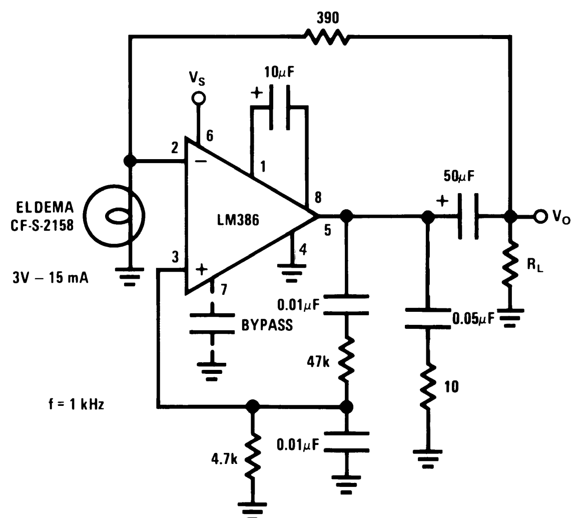
DS006976-4

Amplifier with Gain = 50



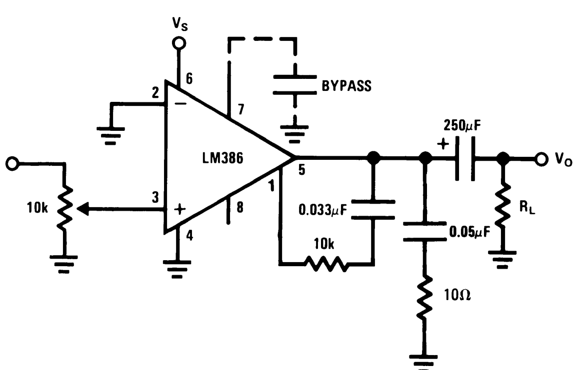
DS006976-6

Low Distortion Power Wienbridge Oscillator



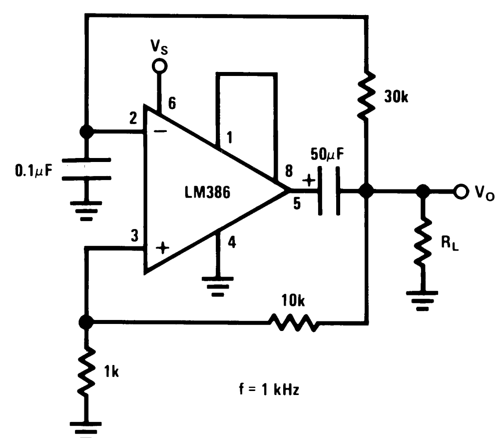
DS006976-7

Amplifier with Bass Boost



DS006976-8

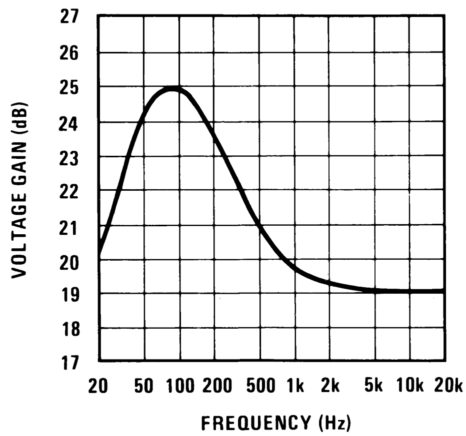
Square Wave Oscillator



DS006976-9

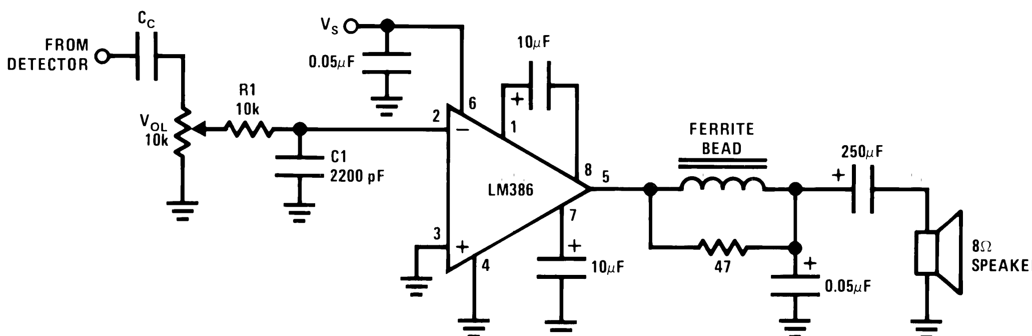
Typical Applications (Continued)

Frequency Response with Bass Boost



DS006976-10

AM Radio Power Amplifier



DS006976-11

Note 4: Twist Supply lead and supply ground very tightly.

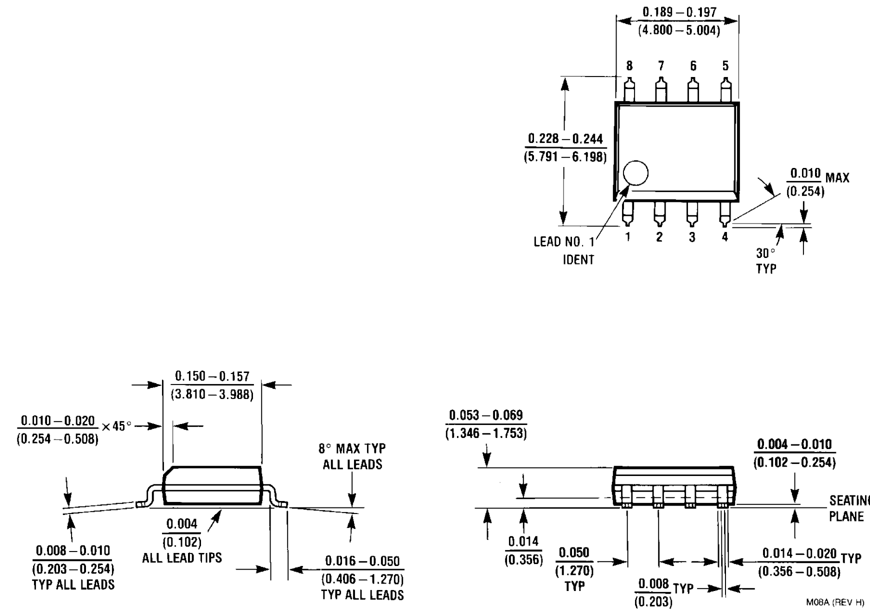
Note 5: Twist speaker lead and ground very tightly.

Note 6: Ferrite bead in Ferroxcube K5-001-001/3B with 3 turns of wire.

Note 7: R1C1 band limits input signals.

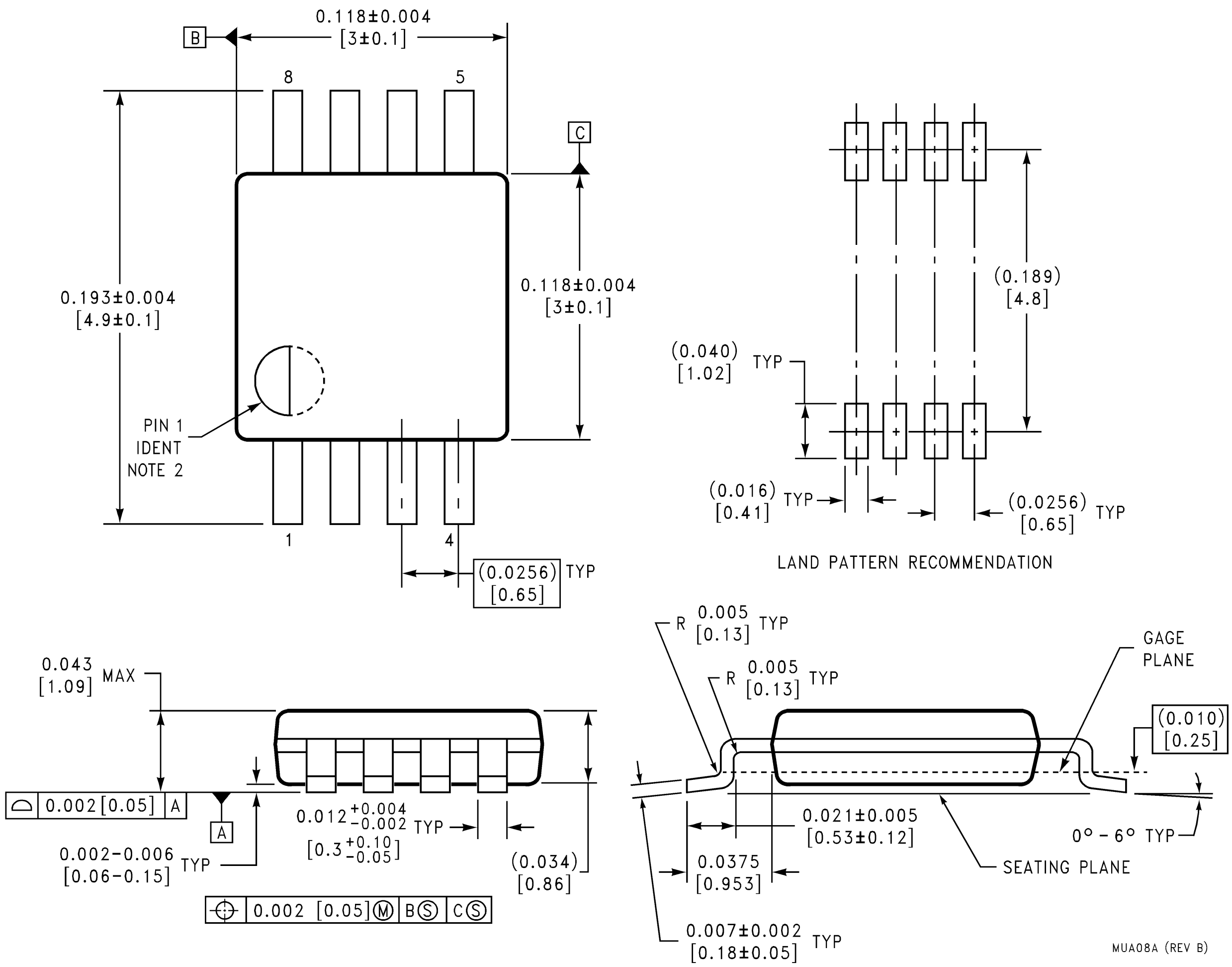
Note 8: All components must be spaced very closely to IC.

Physical Dimensions inches (millimeters) unless otherwise noted



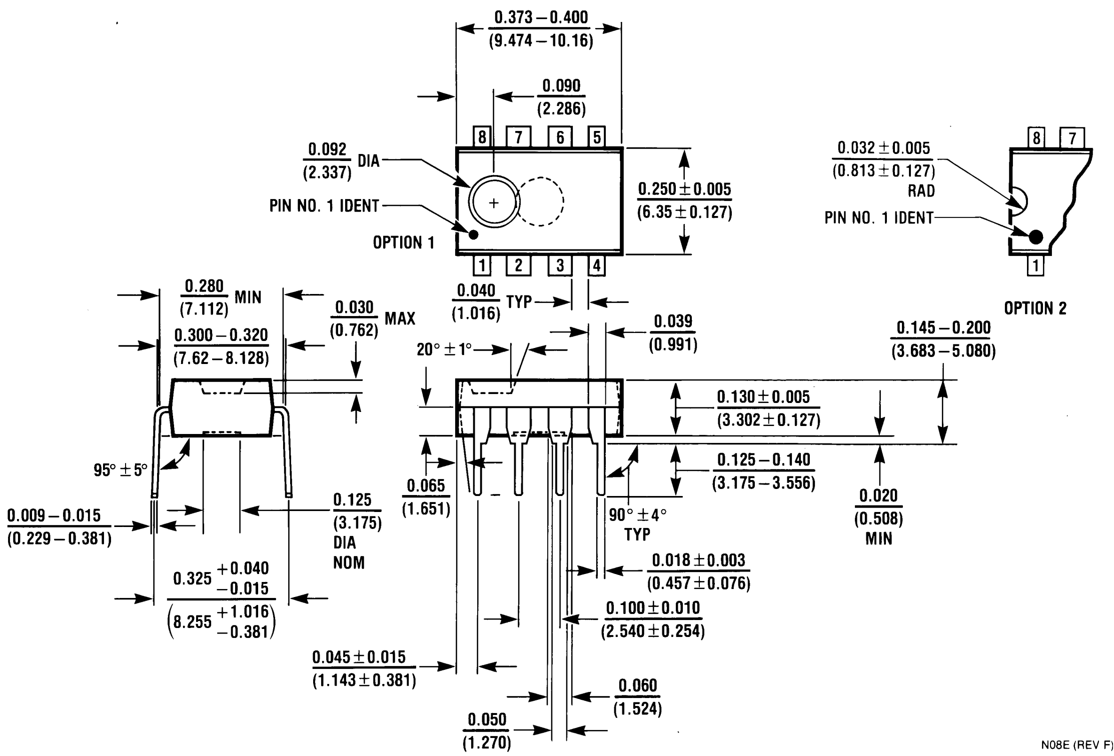
SO Package (M)
Order Number LM386M-1
NS Package Number M08A

Physical Dimensions inches (millimeters) unless otherwise noted (Continued)



8-Lead (0.118" Wide) Molded Mini Small Outline Package
Order Number LM386MM-1
NS Package Number MUA08A

Physical Dimensions inches (millimeters) unless otherwise noted (Continued)



Dual-In-Line Package (N)
Order Number LM386N-1, LM386N-3 or LM386N-4
NS Package Number N08E

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2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

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