LMV1091 Noise Suppression Microphone Amplifier Evaluation Kit User's Guide

National Semiconductor
Application Note 1989
Gerardine Ly
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Overview

The LMV1091TL evaluation kit contains the following:

- LMV1091TL Demonstration Board, 551600341–001
- Microphone board
- Microphone cable

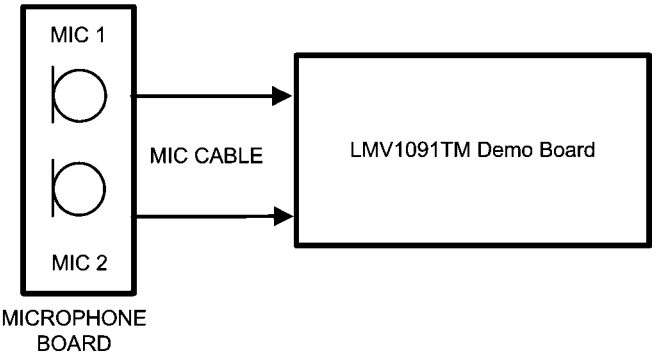

FIGURE 1. Basic Evaluation System

Introduction

The LMV1091 demo board offers the means for easy evaluation of the LMV1091 Dual input, Far Field Noise Suppression (FFNS) Microphone Amplifier with Differential Outputs.

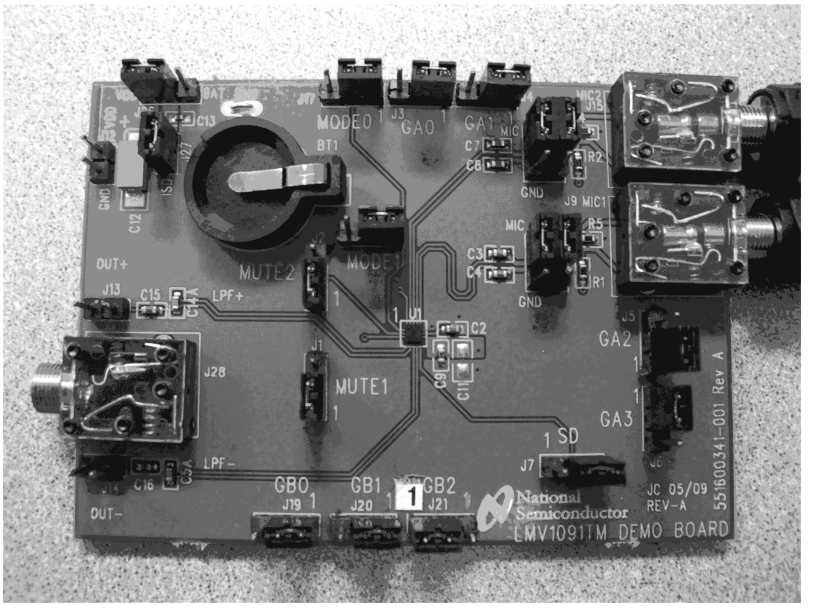

FIGURE 2. The LMV1091TL Demo Board

General Description

The LMV1091 is a fully analog dual input, differential output, microphone array amplifier designed to reduce background acoustic noise, while delivering superb speech clarity in voice communications applications. The LMV1091 has two differential input microphone amplifier channels plus far-field noise suppression (FFNS) circuitry. The LMV1091 preserves near-field wire signals within 4cm of the microphones. While rejecting far-field acoustic noise greater than 50cm from the microphones. Up to 20dB of far-field rejection is possible in a properly configured and using ±0.5dB matched microphones.

Operating Conditions

- Temperature Range $-40°C \leq T_A \leq 85°C$
- Power Supply Voltage $2.7V \leq V_{DD} \leq 5.5V$
- I^2C supply voltage $1.7V \leq I^2CV_{DD} \leq 5.5V$

LMV1091 Demo Board

The LMV1091TL Demonstration Board takes analog inputs from two microphones and performs the Far Field noise cancellation process. It outputs an analog differential signal. This output can be connected to a recording device, such as a personal computer sound card through its LINE IN/MIC IN input or mobile phone through its MIC IN input, for evaluation purposes.

Power Supply of the LMV1091 Demo Board

The LMV1091 demo board provides two (2) possible sources for the power supply. The first one is using the external supply via header J12 for V_{DD} and GND. Header J26 needs to be in the position shown in Figure 3.

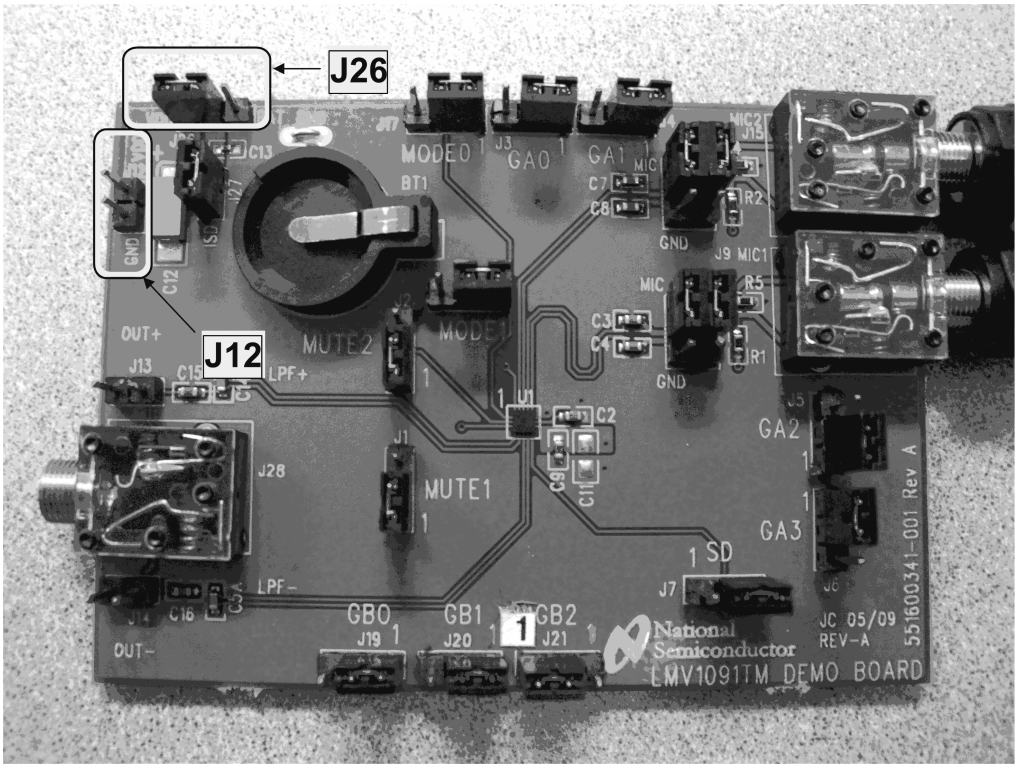

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FIGURE 3. Power Supply Connectors and Headers

The second source of power supply is a small battery placed in battery holder mounted on the PCB. See Figure 4. For a limited time, the demo board can be operated from the board battery (CR1220 placed in the battery holder BT1). To operate the board using a battery, J26 must be configured as shown in Figure 4.

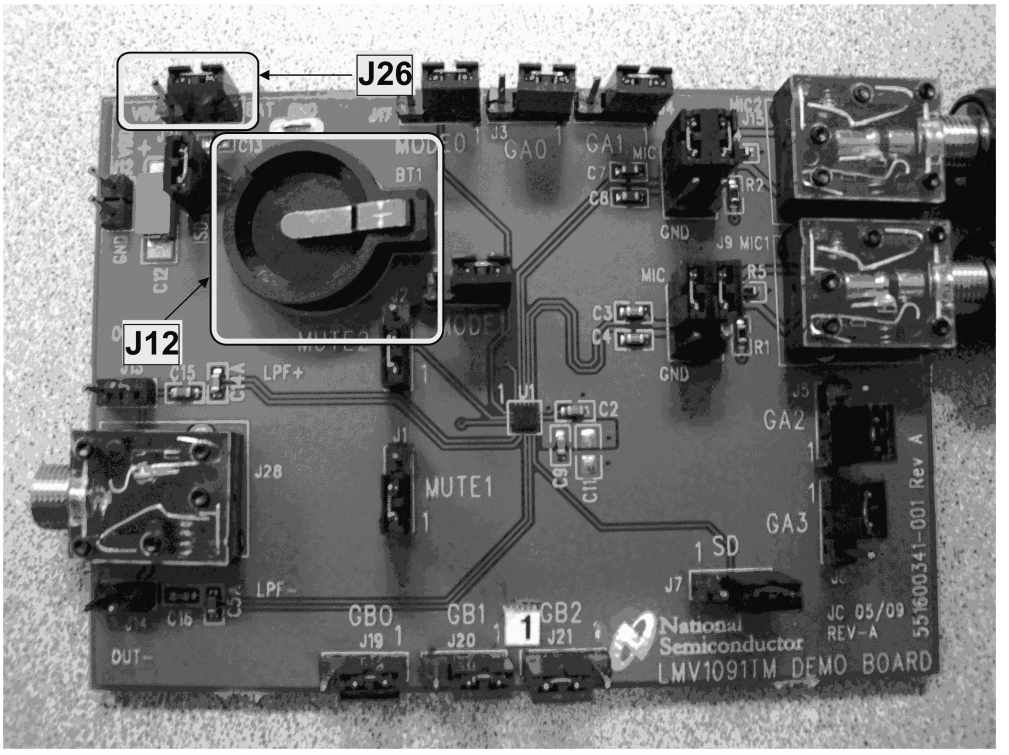

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FIGURE 4. Battery Power Supply

Connecting Microphones to the LMV1091 Demo Board

The demo board can be used to connect a set of two microphones to the LMV1091 to evaluate the performance of the LMV1091 in a customer application. To enable these microphone input connectors, the jumpers on header J11 and J16 must be placed between pin 3–5 and pin 4–6 of both headers. Microphones can also be connected to 3.5mm connectors J9 and J15 (see Figure 5).

For a optimal performance of the Far Field Noise Reduction system it is important to find the correct placement of the microphones. In many applications the microphones are placed next to each other with a distance of 1.5cm to 2.5cm between the microphones. The best noise canceling performance will occur in systems where the far field signals comes from a source orthogonal to the plane of the microphones and where the desired signal is close to the microphones and is located in line with the microphones as shown in Figure 6.

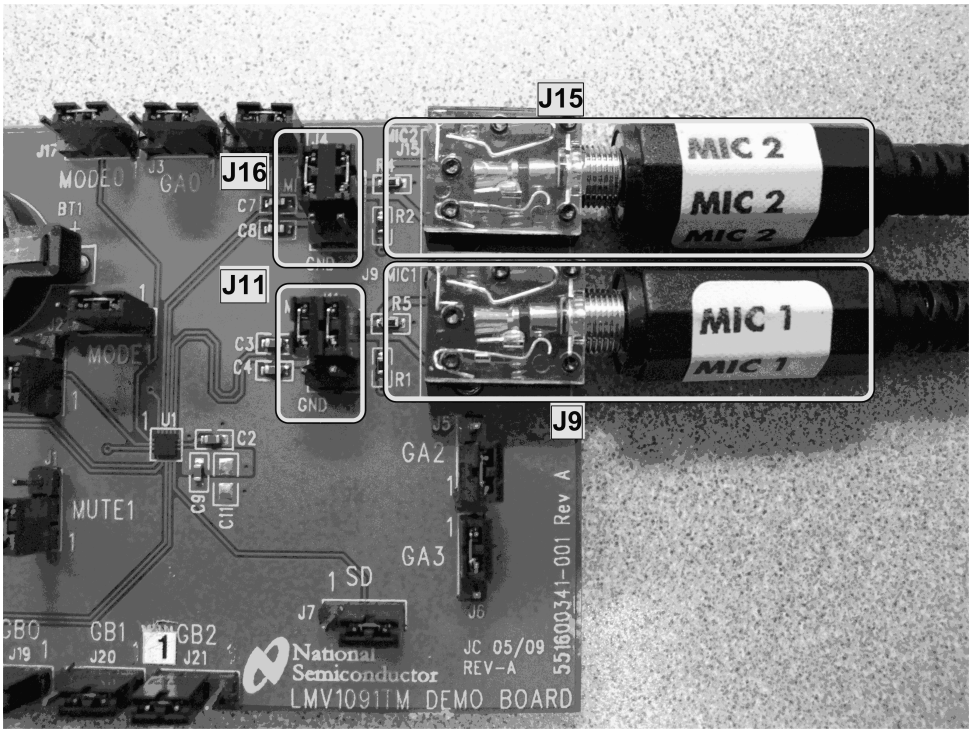

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FIGURE 5. Orientation of Microphones and Sound Sources

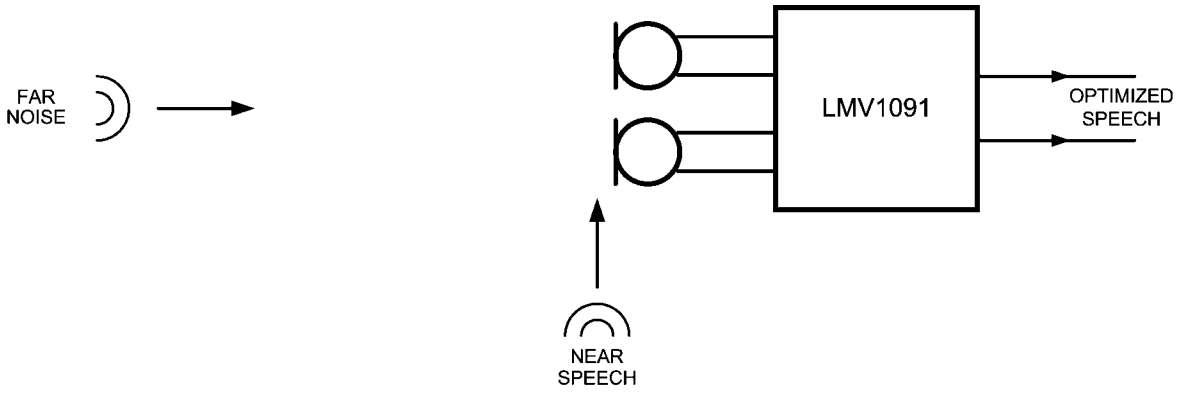

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FIGURE 6. Orientation of Microphones and Sound Sources

Microphone Placement in the Application

Because the LMV1091 is a microphone array Far Field Noise Reduction solution, proper microphone placement is critical for optimum performance. Two things need to be considered: The spacing between the two microphones and the position of the two microphones relative to near field source.

If the spacing between the two microphones is too small, near field speech will be canceled along with the far field noise. Conversely, if the spacing between the two microphones is large, the far field noise reduction performance will be degraded. The optimum spacing between Mic 1 and Mic 2 is 1.5-2.5cm. This range provides a balance of minimal near field speech loss and maximum far field noise reduction. The microphones should be in line with the desired sound source 'near speech' and configured in an endfire array orientation from the sound source (see *Figure 8*). If the 'near speech' (desired sound source) is equidistant to the source like a broadside array (see *Figure 7*) the result will be a great deal of near field speech loss.

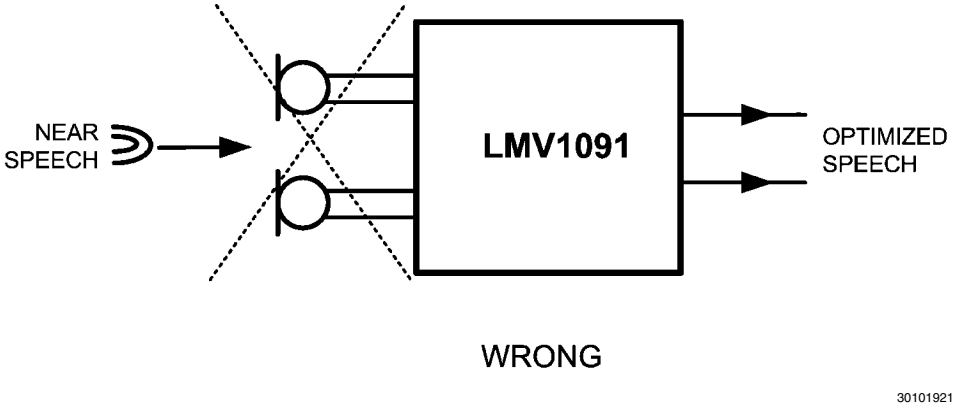


FIGURE 7. Broadside Array (WRONG)

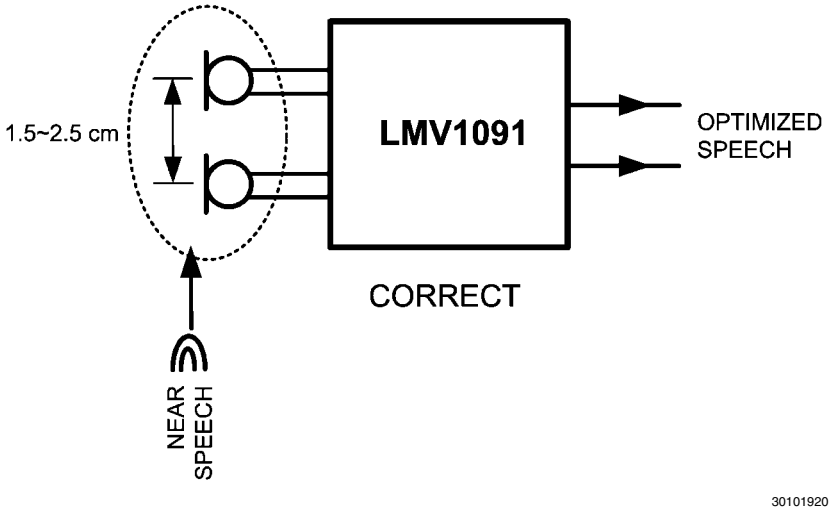


FIGURE 8. End fire Array (CORRECT)

Pre Amp and Post Amp Gain

The Pre-amplifier gain of the LMV1091TM can be controlled using the GA0-GA3 pins. See table 2 below for Pre-amplifier gain control. The Post-Amp gain can be controlled using the GB0-GB2 pins. See table 3 below for Post-amplifier gain control.

TABLE 1. Mic Pre-Amp Gain Settings

GA3	GA2	GA1	GA0	Pre-Amplifier Gain
0	0	0	0	6dB
0	0	0	1	8dB
0	0	1	0	10dB
0	0	1	1	12dB
0	1	0	0	14dB
0	1	0	1	16dB
0	1	1	0	18dB
0	1	1	1	20dB
1	0	0	0	22dB
1	0	0	1	24dB
1	0	1	0	26dB
1	0	1	1	28dB
1	1	0	0	30dB
1	1	0	1	32dB
1	1	1	0	34dB
1	1	1	1	36dB

TABLE 2. Post-Amp Gain Settings

GB2	GB1	GB0	Pre-Amplifier Gain
0	0	0	6dB
0	0	1	9dB
0	1	0	12dB
0	1	1	15dB
1	0	0	18dB
1	0	1	18dB
1	1	0	18dB
1	1	1	18dB

Note: The silkscreen on the LMV1091TM demoboard has a '1' on the header for GA0–GA3, GB0–GB2, MUTE1, MUTE2, MODE0, and MODE1. The '1' indicates GND pin.

Noise Reduction Mode Settings

The LMV1091TM has four mode settings. It can be placed in noise cancellation mode, mic 1 on with mic 2 off, mic 1 off with mic 2 on, and mic1 and mic2. See Table 3. for control settings.

TABLE 3. Noise Reduction Mode Settings

Mode 1	Mode 0	Noise Reduction Mode Selection
0	0	Noise Cancellation mode
0	1	Mic 1 On
1	0	Mic 2 On
1	1	Mic 1 + Mic 2

Mic 1 and Mic 2 can be muted independently, using the Mute 1 and Mute 2 pins. See Table 4 for control settings.

TABLE 4. Noise Reduction Nute Settings

Mute2	Mute1	Noise Reduction Mode Selection
0	0	Mic 1 and Mic 2 on
0	1	Mic 1 mute
1	0	Mic 2 mute
1	1	Mic 1 and Mic 2 mute

PCB Layout Guidelines

This section provides general practical guidelines for PCB layouts that use various power and ground traces. Designers should note that these are only "rule-of-thumb" recommendations and the actual results are predicated on the final layout.

DIFFERENTIAL SIGNALS

Keep both signals coupled by routing them closely together and keeping them of equal length. Keep all impedances in both traces of the signal equal.

POWER AND GROUND

Connect all ground pins together under the part forming a star point. Keep the current for the de-coupling capacitor of the REF pin C4 and the accompanying ground pin B5 separated from the other currents. Keep the location of the supply de-coupling capacitor close to V_{DD} pin D5 and ground.

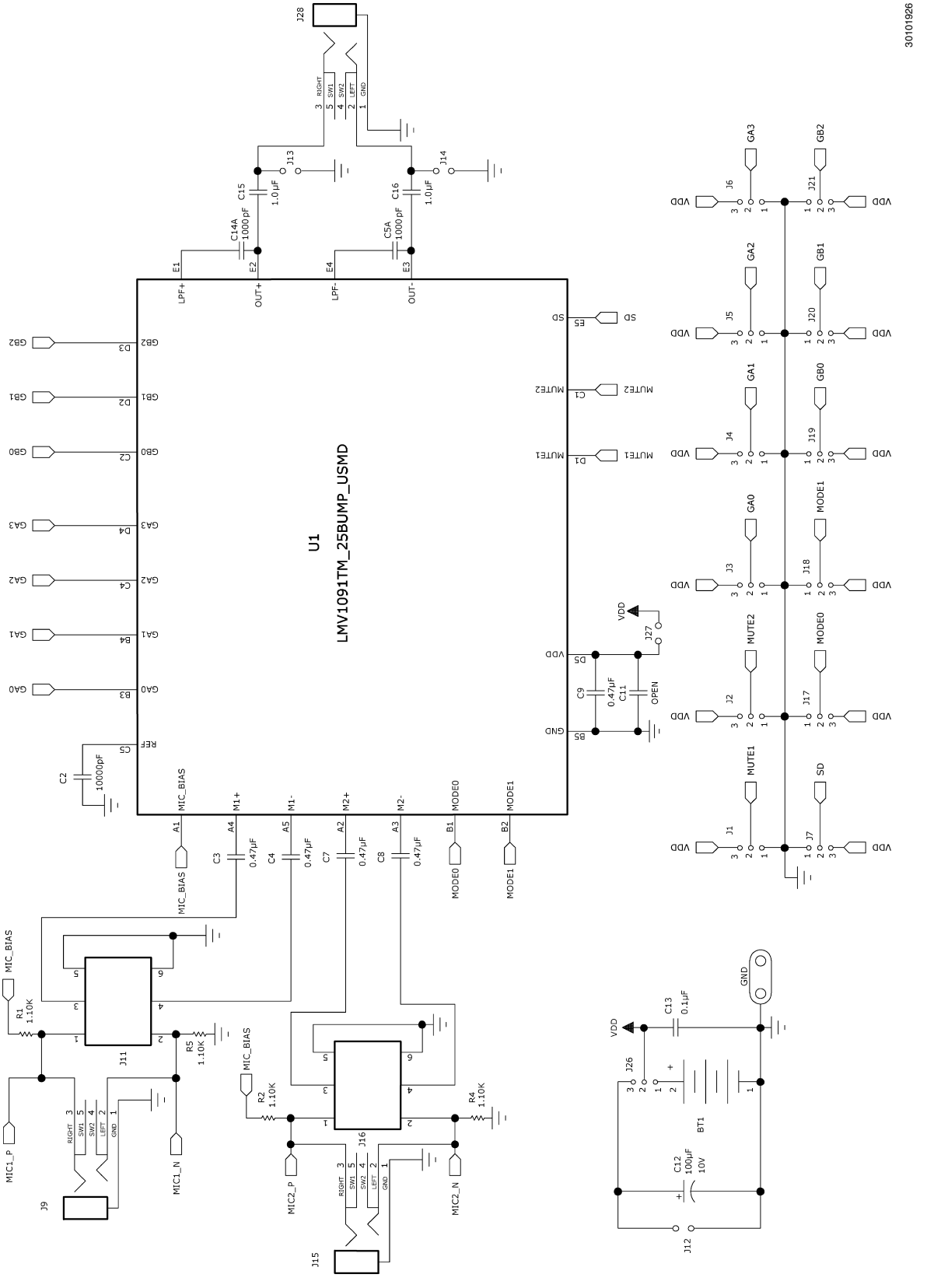
Description of Headers and Connectors of the LMV1091 Demo Board

The LMV1091 demo board provides many headers and connectors for connecting test equipment and controlling the settings of the part. The function that is controlled by the jumpers on the LMV1091 demo board is also indicated on the PCB in silk screen as shown in *Figure 9* (The name in parenthesis is as shown in the silk screen).

Connector and Header Functions

Designator	Function or Use	Comment
J12	Power supply connector for external supply	
J26	Supply select pin external (V_{DD}) or battery (BAT)	
J11, J16	Connection for input of electrical test signals at pin 4+5	Pin 3+4 differential input with ground at Pin 5+6
J8, J10	Low pass filter selection (LPF+, LPF-)	Pin 1+2 to connect to an external LPF capacitor. Pin 2+3 select the on board LPF capacitor C5, C14 (a minimum of 1nF is always mounted on the board).
J26	Supply select pin external (V_{DD}) or battery (BAT)	
J27	Connects Supply to V_{DD} pin	
J1	Select for MUTE1	
J2	Select for MUTE2	
J3	Select for GA0	
J4	Select for GA1	
J5	Select for GA2	
J6	Select for GA3	
J7	Select for SD	
J17	Select for MODE0	
J18	Select for MODE1	
J19	Select for GB0	
J20	Select for GB1	
J21	Select for GB2	
J13, J14	GND outputs (option to test for various parameters	

Schematic


U1
LMV1091TM_25BUMP_USMD
J28
J13
J14
C15
C16
C14A
C5A
1000pF
1.0µF
LPF+
OUT+
LPF-
OUT-
SD
MUTE2
MUTE1
GB2
GB1
GB0
GA3
GA2
GA1
GA0
REF
MIC_BIAS
M1+
M1-
M2+
M2-
MODE0
MODE1
VDD
GND
C2
C3
C4
C7
C8
C9
C11
C13
C12
0.47µF
OPEN
0.1µF
100µF
10V
R1
R2
R4
R5
1.10K
J11
J16
J15
J9
J12
J26
BT1
MIC1_P
MIC1_N
MIC2_P
MIC2_N
J1
J2
J3
J4
J5
J6
J7
J17
J18
J19
J20
J21
J27
RIGHT
SW1
SW2
LEFT
GND
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Layout

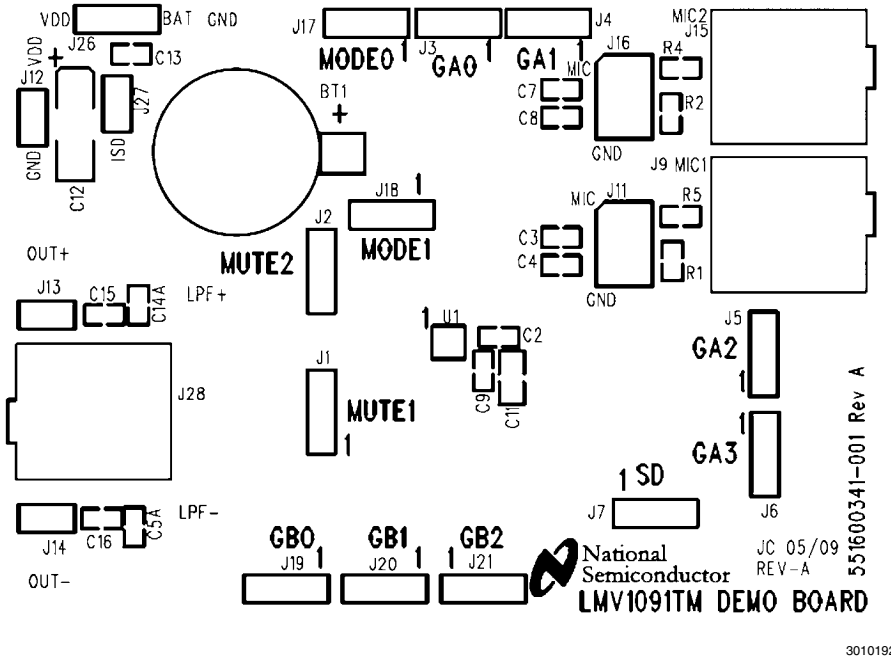

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FIGURE 9. Layout, Silk Screen

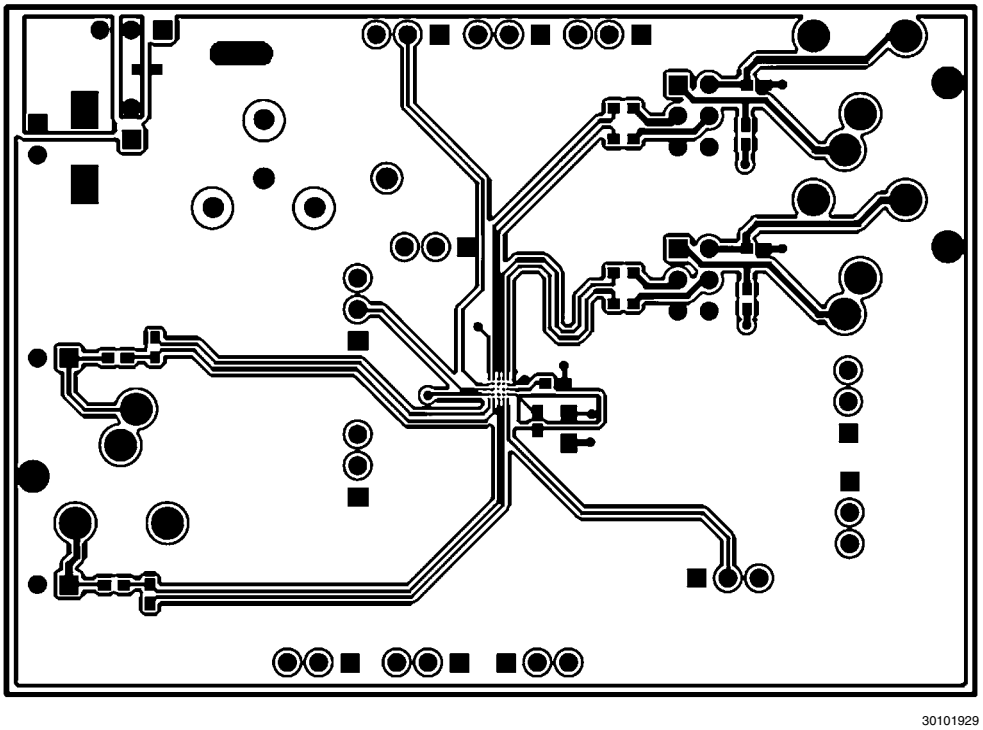

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FIGURE 10. Layout, Top Layer

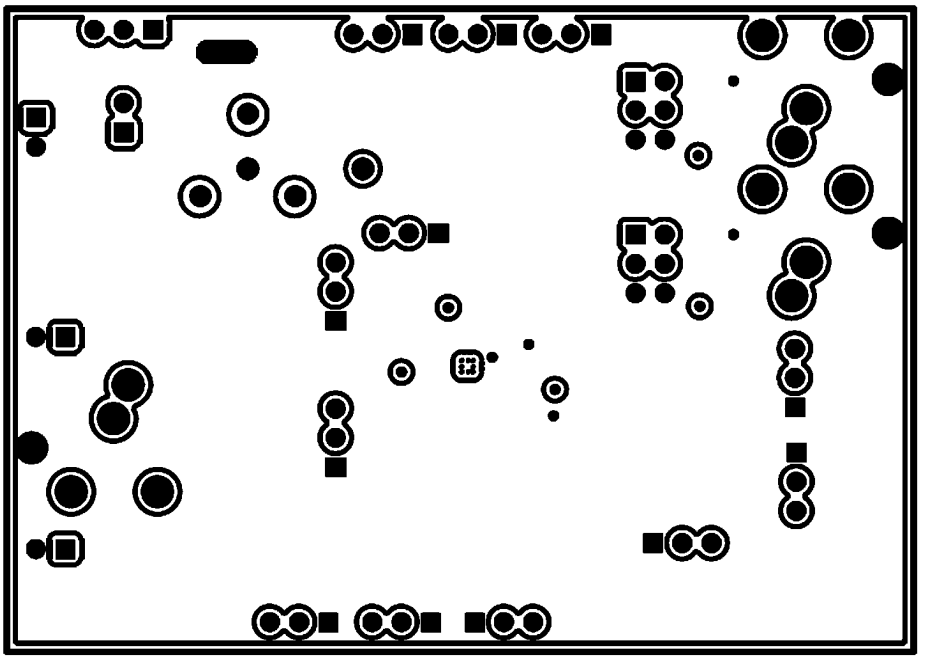

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FIGURE 11. Layout, Top Inner Layer

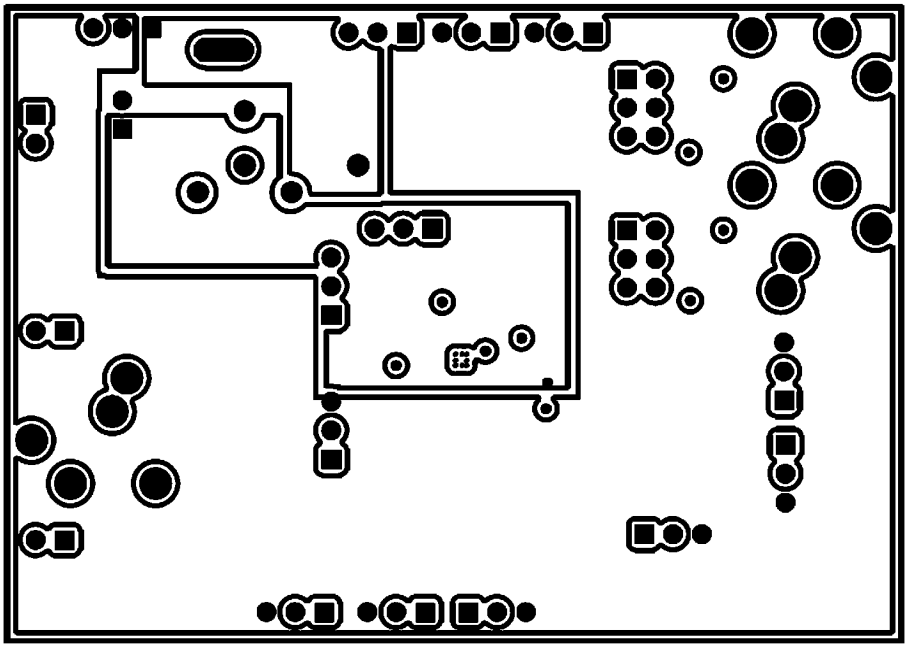

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FIGURE 12. Layout, Bottom Inner Layer

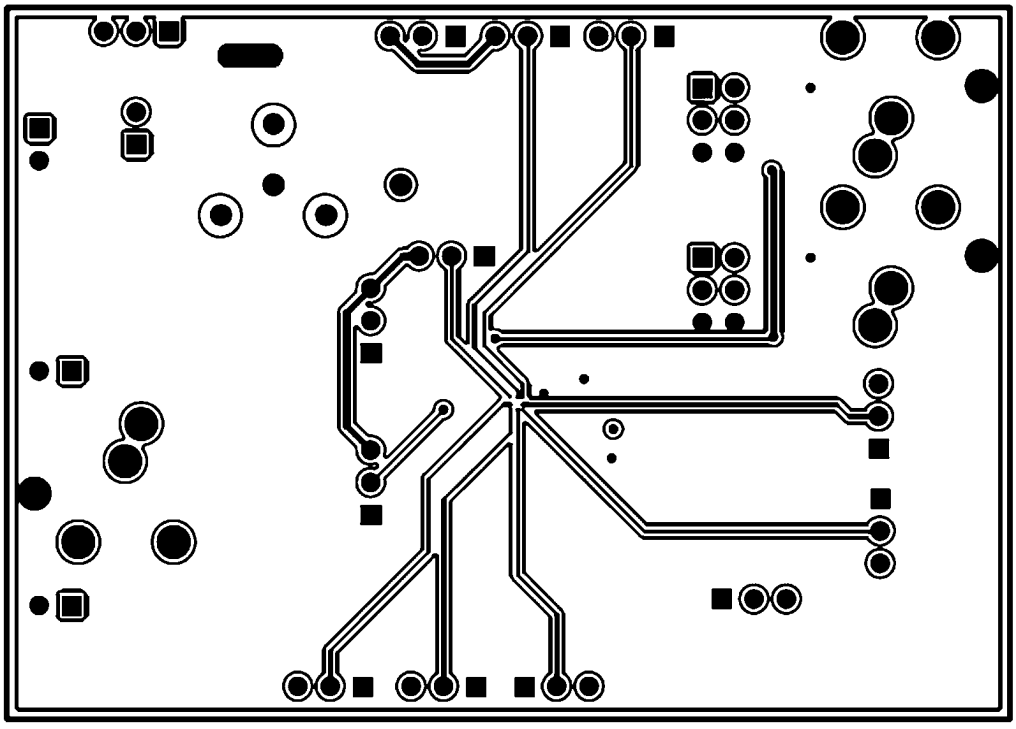

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FIGURE 13. Layout, Bottom Layer

Bill of Materials

Designator	Component	Value	Tolerance	Rating	Package Type
U1	LMV1091TL				
C15, C16	Capacitor Ceramic	1.0µF	10%	16V	0603
C2	Capacitor Ceramic	10000pF	10%	50V	0603
C3, C4, C7, C8, C9	Capacitor Ceramic	0.47pF	10%	16V	0603
C5A, C14A	Capacitor Ceramic	4.7nF	10%	100V	0603
C13	Capacitor Ceramic	0.1µF	10%	16V	0603
C11	No Load	No Load			
C12	Capacitor Tantalum	100µF	10%	10V	Case C
R1, R2, R4, R5	Resistor	1.1k	1%	1/10W	0603
J12, J13, J14, J27	Connector Header Brkway .100 02POS STR				
J11, J16	Connector Header Brkway .100 06POS VERT				
J9, J15, J28	5 Pole Headphone conn jack stereo 3.5mm horizontal				
GND	Ground hook jumper 5mm high mount				
BT1	Battery holder CR1220, 1 cell 12mm				
J1_SH, J2_SH, J3_SH, J4_SH, J5_SH, J6_SH, J7_SH, J11a_SH, J11b_SH, J16a_SH, J16b_SH, J17_SH, J18_SH, J19_SH, J20_SH, J21_SH, J26_SH	Jumper Shunt 0.100” 30µin Au (no handle)				
J1, J2, J3, J4, J5, J6, J7, J18, J19, J20, J21, J26	Connector Header Brkway .100 03POS STR				

Revision History

Rev	Date	Description
1.0	11/12/09	Initial release.

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Switching Regulators	www.national.com/switchers	Distributors	www.national.com/contacts
LDOs	www.national.com/ldo	Quality and Reliability	www.national.com/quality
LED Lighting	www.national.com/led	Feedback/Support	www.national.com/feedback
Voltage Reference	www.national.com/vref	Design Made Easy	www.national.com/easy
PowerWise® Solutions	www.national.com/powerwise	Solutions	www.national.com/solutions
Serial Digital Interface (SDI)	www.national.com/sdi	Mil/Aero	www.national.com/milaero
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