

## Evaluates: MAX98361 (WLP)

## MAX98361 Evaluation System

### General Description

The MAX98361 evaluation system (EV system) is a fully assembled and tested system that evaluates the MAX98361A/B/C/D mono Class-D audio amplifiers. The EV system consists of a MAX98361 Development Board (DEV board), Maxim's Audio Interface Board III (AUDINT3), and a USB cable.

It is recommended that the DEV board be evaluated with the AUDINT3 board, as an EV system. MAX98361A and MAX98361C support the standard I<sup>2</sup>S interface, and MAX98361B and MAX98361D support standard left-justified mode. All MAX98361 variants support an 8-channel TDM digital audio interface.

The AUDINT3 board provides the USB-to-PCM interface in addition to the 1.8V V<sub>DDIO</sub> supply needed to evaluate the DEV board. The MAX98361 DEV board requires one additional supply input, 2.5V to 5.5V (V<sub>DD</sub>) when evaluating using the AUDINT3 board. [Figure 1](#) details the DEV board and the AUDINT3 board.

### Features

- 2.5V to 5.5V Single-Supply Operation
- I<sup>2</sup>S, Left-Justified, or TDM Input
- Five Selectable Gains (-3dB, 3dB, 6dB, 9dB, and 12dB)
- Audio Channel Select (Left, Right, and Mono Mix)
- Filterless Operation
- Low EMI
- Complete Hardware System with Easy Setup, No Tools or Special Software Required

### EV System Contents

- MAX98361 Development Board
- Audio Interface Board III
- Micro-USB Cable

[Ordering Information](#) appears at end of data sheet.

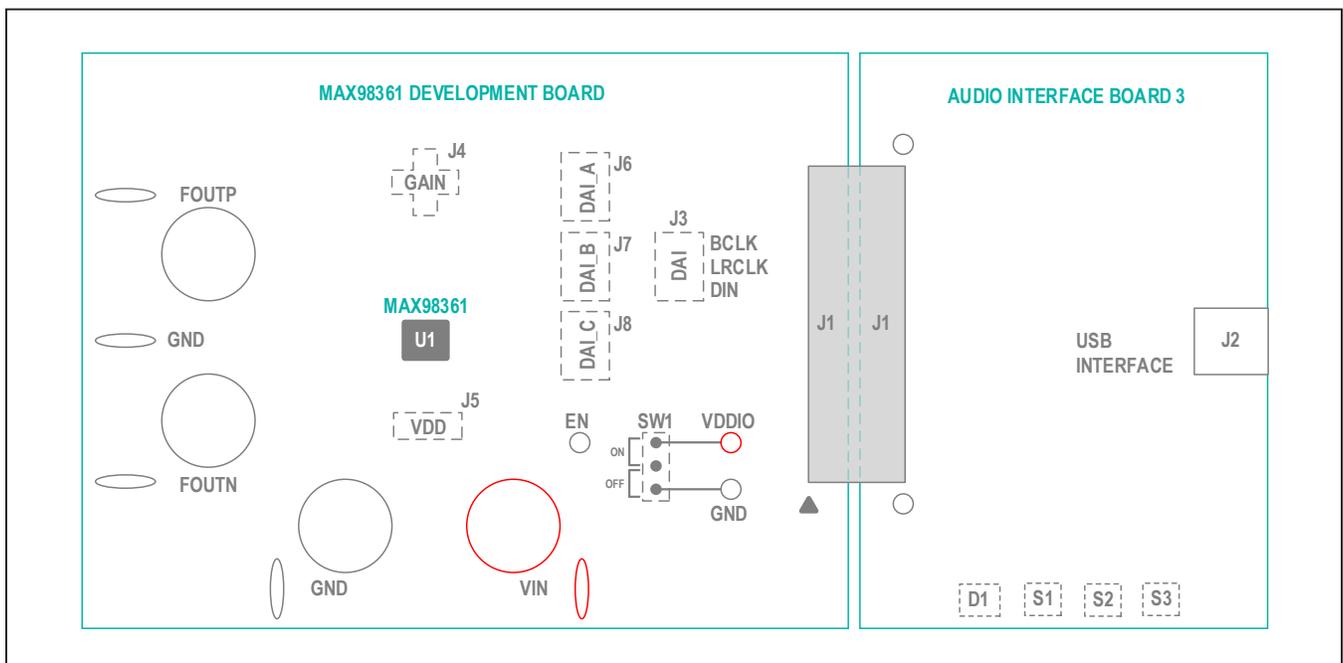


Figure 1. Simplified EV System Block Diagram

## Quick Start Guide

### Required Equipment

- MAX98361 EV System
  - Audio Interface Board III
  - 2.5V to 5.5V, 3A DC power supply
  - Micro-USB cable
- 4Ω to 8Ω speaker
- USB audio source (e.g., Windows Media Player® or iTunes®)
- PC with Windows® 7 or Windows 10 with available USB port

### Reference Material

- MAX98361 IC data sheet

### Procedure

The MAX98361 and AUDINT3 boards are fully assembled and tested. Follow the steps below to set up the EV system for device evaluation.

**Note:** In the following sections, software-related items are identified by bolding. Text in **bold** refers to items directly from the evaluation software. Text in **bold and underlined** refers to items from the Windows operating system.

### AUDINT3 Board Setup:

- 1) Connect the MAX98361 DEV board (2 row J1 connector) to the AUDINT3 board (3 row J1 connector). The bottom row of both J1 connectors should be lined up so the standoffs on the corners of the AUDINT3 and DEV board are level.
- 2) With the audio source disabled, connect the USB cable from your computer to the USB port (J2) on the AUDINT3 board. The AUDINT3 board provides

the BCLK and LRCLK signals as well as the power for  $V_{DDIO}$ , sourcing 1.8V to the DEV board through the J1 connector.

- 3) The multi-color LED D1 blinks white. When the computer registers the AUDINT3 as a USB device D1 changes to magenta and blink slowly.

### DEV Board Setup:

- 1) With all supplies unpowered, connect the 2.5V to 5.5V power supply across the  $V_{IN}$  and GND binding posts.
- 2) Connect the micro speaker leads across the FOUTP and FOUTN binding posts.
- 3) Place the shunt on jumper J5 across pins  $V_{DD}$  and  $V_{IN}$ .
- 4) Set the switch SW1 to the on position.

### Test:

- 1) Enable the supply voltages across each of the supply pins.
- 2) Open the Windows' **Sound** dialog and select the **Playback** tab. A **Speakers** item similar to [Figure 2](#) should be listed as an available playback device.
- 3) Verify that the **Speakers** item is set as the default device. Once this is done, the AUDINT3 board outputs PCM data to the DIN pin on the DEV board.
- 4) Adjust the audio source volume to a low level.
- 5) Enable the audio source and verify that audio is heard through the connected speaker. Adjust the audio source volume as needed.
- 6) Quick Start of the Evaluation software is now complete.



Figure 2. Playback Device

*iTunes is a registered trademark of Apple Inc.*

*Windows is a registered trademark and registered service mark of Microsoft Corporation.*

*Windows Media is a registered trademark and registered service mark of Microsoft Corporation.*

## Detailed Description of Hardware

The MAX98361 EV system is designed to allow for a thorough evaluation of the MAX98361 digital input Class-D audio amplifier IC. The EV system includes the MAX98361 development board (DEV board), Maxim’s Audio Interface Board III (AUDINT3), and a Micro-USB cable.

The MAX98361 DEV board can be evaluated as a stand-alone board that is driven directly by audio test equipment. To simplify the evaluation, the DEV board can be evaluated with the AUDINT3 board, which allows any computer to become a digital audio source. The AUDINT3 board provides on-board LDO regulators and a USB-to-PCM interface to provide an easy-to-use method for exercising the capabilities of the device with no additional audio equipment.

The AUDINT3 LDO regulators power the MAX98361 DEV board’s  $V_{DDIO}$  pin through connector J1. The USB-to-PCM converter accepts a USB audio stream from a USB connected computer and converts that into an I<sup>2</sup>S (MAX98361A/C) or left-justified (MAX98361B/MAX98361D) data stream, allowing for USB audio playback through the MAX98361 device. Do not use the AUDINT3 board while directly driving the DEV board’s PCM interface with external audio test equipment since the Digital Audio Interface (DAI) pins for the DEV board and AUDINT3 are connected through the J1 header.

### Power Supplies

The MAX98361 DEV board requires two external power supplies when evaluated as a stand-alone board. The  $V_{DD}$  supply provides system power to the MAX98361 IC. This voltage can be applied externally at the  $V_{IN}$  and GND PCB pads, or 5V can be provided from the AUDINT3 board. See [Table 2](#) for the J5 jumper selection. The 5V supply from the AUDINT3 board should be used only for functionality tests and should not be used when driving a speaker load due to the low current limit of the on-board 5V supply.

The voltage applied to the  $V_{DDIO}$  test point determines the logic level of the EN pin when SW1 is in the on position. The power supplies and their ranges are listed in [Table 1](#). The external supply voltages can be connected at the respective supply test-points and/or binding posts.

When using the AUDINT3 board, the AUDINT3’s on-board LDO regulator independently powers  $V_{DDIO}$  on the DEV board. This power is routed to the DEV board through the J1 connector. See the [Digital Audio Interface](#) section.

### Jumper Selection

#### Shutdown Mode

The DEV board includes switch SW1 to facilitate a device enable. The device features a low-power shutdown mode that is activated by setting SW1 in the “OFF” position. To exit shutdown mode, set SW1 to the “ON” position. When the PCM master is disabled and SW1 is in the “ON” position, the device is in standby mode. Enabling the PCM interface while SW1 is in the “ON” position puts the device in active playback mode, and the device output begins switching.

**Table 1. Power Supplies**

POWER SUPPLY	RANGE (V)
$V_{DD}$	2.5 to 5.5
$V_{DDIO}$	1.2 to $V_{DD}$

**Table 2. J5 Jumper Selection ( $V_{DD}$ ) Supplies**

SHUNT POSITION	INPUT VOLTAGE ( $V_{DD}$ )
1-2	$V_{DD}$ supplied by AUDINT3 board connected to J1 header
2-3	User-supplied external power supply applied at the $V_{IN}$ PCB pad

**Table 3. Jumper Configuration**

HEADER	SHUNT POSITION	DESCRIPTION
SW1	EN to DVDDIO	Normal operation
	EN to GND	Shutdown

## Gain and Channel Selection (I<sup>2</sup>S/Left-Justified Mode)

The MAX98361's GAIN\_SLOT pin is connected to the center pin (pin 1) of the J4 header. When operating the device in I<sup>2</sup>S or left-justified mode, shunting pin 1 to the adjacent pins of the J4 header controls the PCM gain. [Table 3](#) shows the available gain settings in I<sup>2</sup>S and left-justified modes.

In I<sup>2</sup>S and left-justified modes, channel selection is controlled by placing three shunts across the DAI configuration headers J6, J7, or J8. Each of the DAI configuration headers represent one valid mapping of the DAI pins to the PCM input signals. See [Table 4](#) for the valid jumper settings for the DAI configuration headers. Only one DAI configuration may be used at a time. [Figure 3](#) shows the shunt positions used for DAI Configuration A.

## Channel Selection (TDM Mode)

In TDM mode, the MAX98361 has a fixed gain of 12dB and the GAIN\_SLOT pin becomes repurposed for TDM channel selection. The MAX98361 accepts 8-channel TDM data with either 16-bit or 32-bit data. The GAIN\_SLOT pin and DAI configuration are used to select which of the 8 channels of TDM data the part responds to, as shown in [Table 6](#).

**Table 4. J4 Jumper Selection (GAIN\_SLOT)**

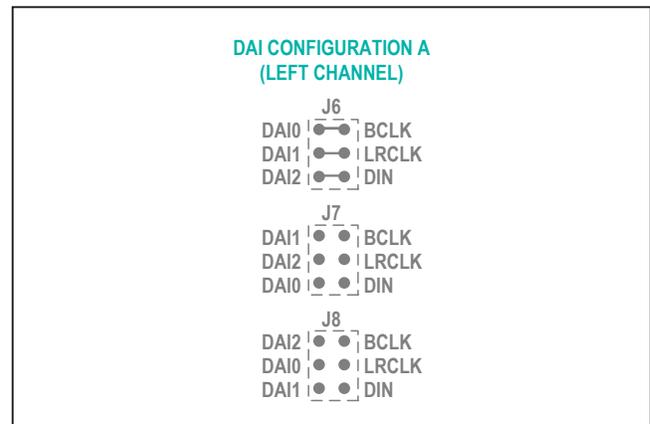
J4 SHUNT POSITION	GAIN_SLOT	GAIN
1-2	Connected to V <sub>DD</sub> through 100kΩ resistor R1	3dB
1-3	Connected to V <sub>DD</sub>	6dB
1-4	Connected to GND through 100kΩ resistor R2	-3dB
1-5	Connected to GND	12dB
Not Installed	Unconnected	9dB

**Table 5. J6-J8 Header Selection (DAI Configuration)**

DAI CONFIGURATION	SHUNT HEADER	I <sup>2</sup> S/LJ CHANNEL
A	J6	Left
B	J7	Right
C	J8	Monomix

## Digital Audio Interface

The MAX98361 Digital Audio Interface (DAI) is routed to interface header J3 as well as the AUDINT3 connector J1. The interface headers provide easy access to the device's PCM bus and the AUDINT3 connector allows for USB audio to be streamed onto the DEV board. See the [USB Audio Input](#) section for details on USB audio streaming and [Table 8](#) for the AUDINT3 connector J1 pinout.



*Figure 3. DAI Configuration A (Left-Channel for I<sup>2</sup>S/Left-Justified Operation)*

**Table 6. TDM Mode Channel Selection**

TDM CHANNEL	J4 SHUNT POSITION	DAI CONFIGURATION
0	1-5	A
1	1-3	A
2	Open	A
3	1-3	B
4	1-5	B
5	1-5	C
6	Open	C
7	1-3	C

**Table 7. DAI Header (J3)**

SIGNAL	PIN	PIN	SIGNAL
GND	1	2	BCLK
GND	3	4	LRCLK
GND	5	6	DIN

**DAI Header**

The DAI header (J3) provide access to MAX98361's PCM bus (BCLK, LRCLK, and DIN). This DAI headers facilitate evaluation with audio equipment I/O. See [Table 8](#) for the pinout of the DAI header and [Figure 4](#) for an illustration of how the MAX98361 DAI interface is routed through the DAI headers from the AUDINT3 connector.

**Speaker Output**

The MAX98361 audio output is routed to the FOUTP and FOUTN connections on the DEV board. The DEV board is, by default, assembled to allow the MAX98361 output to connect directly to a speaker load without the need for filtering.

**EMI Filter**

When long speaker cables are used with the MAX98361 output (exceeding approximately 12in), a ferrite bead plus capacitor filter can be installed to prevent excessive EMI radiation. Although it is best to choose filter components based on EMI test results, the combination of 100pF capacitors (C3, C4) and ferrite beads (FB1, FB2) generally work well. Before adding the filters to the design, first remove the small PCB traces shorting the pads of FB1 and FB2 (see the [MAX98361 EV Kit Development Board Schematic](#) and the [MAX98361 EV Kit Development Board PCB Layout Diagrams](#)).

**Table 8. AUDINT3 Connector (J1)**

SIGNAL*	PIN*	SIGNAL	PIN	SIGNAL	PIN
—	1	MCLK	2	GND	3
BCLK2	4	BCLK1	5	GPIO1	6
LRCLK2	7	LRCLK1	8	GPIO2	9
DAC2	10	DAC1	11	GPIO3	12
ADC2	13	ADC1	14	GPIO4	15
—	16	ID	17	3.3V	18
AVDD	19	DVDD	20	GND	21
HPVD	22	VDDIO	23	GND	24
GND	25	SDA	26	5V	27
—	28	SCL	29	5V	30
GND	31	IRQ	32	RST	33
—	34	—	35	—	36
GND	37	—	38	—	39

\*This row in the J1 header is present on the AUDINT3 J1 header, but not the Dev board J1 header.

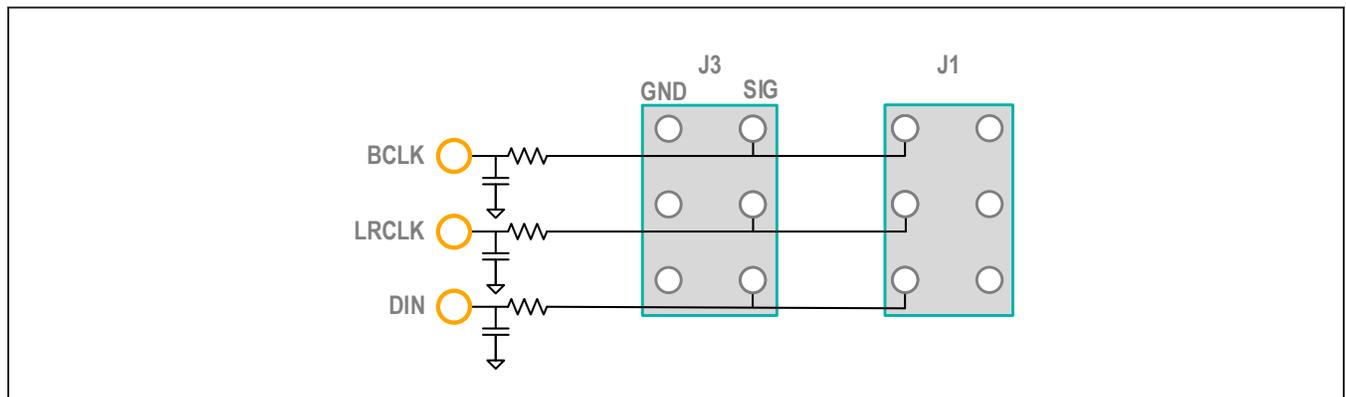


Figure 4. MAX98361 DAI Interface Headers (PCM)

## Audio Interface Board III

Maxim's Audio Interface board III (AUDINT3 board) facilitates the evaluation of the DEV board by providing a set of features that can be used to exercise the capabilities of the DEV board without the need for additional audio equipment. The main components of the AUDINT3 board are its LDO supply voltages and its USB-to-PCM interfaces. The supply voltages allow the DEV board to be evaluated with minimal amount of external supplies. The USB-to-PCM converter allows any computer to be used as an audio source for the DEV board's digital audio PCM interface.

The MAX98361 DEV board connects to the AUDINT3 board through connector J1. The physical connections made between the DEV board and AUDINT3 board are listed in [Table 8](#).

### USB Audio Input

To utilize the USB streaming feature of the AUDINT3 board, connect the USB cables from your computer to the USB connector J2 on the AUDINT3 board and ensure that the AUDINT3 board is connected to the DEV board.

## Ordering Information

PART	TYPE
MAX98361AEVSYS#WLP	Complete Evaluation System
MAX98361BEVSYS#WLP	Complete Evaluation System
MAX98361CEVSYS#WLP	Complete Evaluation System
MAX98361DEVSYS#WLP	Complete Evaluation System

#Denotes RoHS compliant.

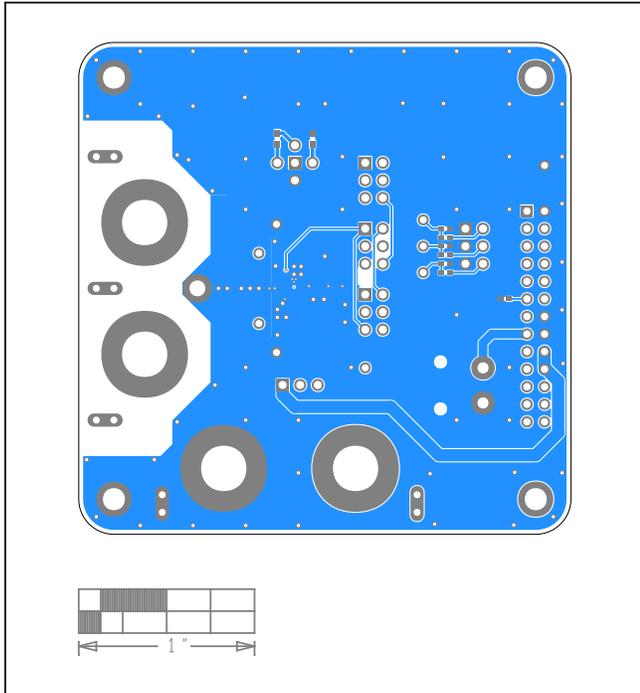
MAX98361 EV System DEV Board Bill of Materials

ITEM	REF_DES	DNI/DNP	QTY	MFG PART #	MANUFACTURER	VALUE	DESCRIPTION	COMMENTS
1	BCLK, DIN, EN, LRCLK	-	4	5003	KEYSTONE	N/A	TEST POINT; PIN DIA=0.1IN; TOTAL LENGTH=0.3IN; BOARD HOLE=0.04IN; ORANGE; PHOSPHOR BRONZE WIRE SILVER PLATE FINISH;	
2	C1	-	1	GRM155R61A106ME44; GRM155R61A106ME11; 0402ZD106MAT2A; CLO5A106MP5NUNC	MURATA;MURATA; AVX;SAMSUNG	10UF	CAPACITOR; SMT (0402); CERAMIC CHIP; 10UF; 10V; TOL=20%; TG=-55 DEGC TO +85 DEGC; TC=X5R	
3	C2	-	1	GRM033R61C104K; C0603X5R1C104K030BC	MURATA;TDK	0.1UF	CAPACITOR; SMT (0201); CERAMIC CHIP; 0.1UF; 16V; TOL=10%; MODEL=GRM SERIES; TG=-55 DEGC TO +85 DEGC; TC=X5R	
4	FOUTN, FOUTP, GND_VIN	-	4	111-2223-001	EMERSON NETWORK POWER	111-2223-001	MACHINE SCREW; THUMBSCREW; BANANA; 1/4-32IN; 11/32IN; NICKEL PLATED BRASS	
5	FOUTN_PAD, FOUTP_PAD, GND_PAD1, GND_PAD2, VIN_PAD	-	5	9020 BUSS	WEICO WIRE	MAXIMPAD	EVK KIT PARTS; MAXIM PAD; WIRE; NATURAL; SOLID; WEICO WIRE; SOFT DRAWN BUS TYPE-S; 20AWG	
6	GND_TP1	-	1	5011	KEYSTONE	N/A	TEST POINT; PIN DIA=0.125IN; TOTAL LENGTH=0.445IN; BOARD HOLE=0.063IN; BLACK; PHOSPHOR BRONZE WIRE SILVER PLATE FINISH;	
7	GND_TP2-GND_TP4	-	3	5001	KEYSTONE	N/A	TEST POINT; PIN DIA=0.1IN; TOTAL LENGTH=0.3IN; BOARD HOLE=0.04IN; BLACK; PHOSPHOR BRONZE WIRE SILVER PLATE FINISH;	
8	J1	-	1	TSW-113-08-S-D-RA	SAMTEC	TSW-113-08-S-D-RA	CONNECTOR; THROUGH HOLE; DOUBLE ROW; RIGHT ANGLE; 26PINS	
9	J3, J6-J8	-	4	PEC03DAAN	SULLINS ELECTRONICS CORP.	PEC03DAAN	CONNECTOR; MALE; THROUGH HOLE; BREAKAWAY; STRAIGHT THROUGH; 6PINS; -65 DEGC TO +125 DEGC	
10	J4	-	1	TSW-105-07-L-S	SAMTEC	TSW-105-07-L-S	EVKIT PART-CONNECTOR; THROUGH HOLE; TSW SERIES; SINGLE ROW; STRAIGHT; 5PINS	
11	J5	-	1	PEC03SAAN	SULLINS	PEC03SAAN	CONNECTOR; MALE; THROUGH HOLE; BREAKAWAY; STRAIGHT; 3PINS	
12	J9-J12	-	4	91772A108; PHILLIPS-PAN_4-40X3/8IN; PMSSS4400038PH; 9901	GENERIC PART	N/A	MACHINE SCREW; PHILLIPS; PAN; 4-40; 3/8IN; 18-8 STAINLESS STEEL	
13	J9-J12	-	4	MCH_SO_F_HEX_4-40X1/2	GENERIC PART	N/A	STANDOFF; FEMALE-THREADED; HEX; 4-40; 1/2IN; ALUMINUM	
14	R1, R2	-	2	RC0603JR-07100KL	YAGEO	100K	RESISTOR; 0603; 100K OHM; 5%; 100PPM; 0.1W; THICK FILM	
15	R3	-	1	CRCW06032K0FK; ERJ-3EKF2001	VISHAY DALE; PANASONIC	2K	RESISTOR; 0603; 2K OHM; 1%; 100PPM; 0.10W; THICK FILM	
16	R7-R9	-	3	ERJ-2GE0R00	PANASONIC	0	RESISTOR; 0402; 0 OHM; 0%; JUMPER; 0.10W; THICK FILM	
17	R18	-	1	ERJ-2RKF1782	PANASONIC	17.8K	RESISTOR; 0402; 17.8K OHM; 1%; 100PPM; 0.1W; THICK FILM	
18	SU1	-	1	C33-GAG1-2X3-G	VALCON	C33-GAG1-2X3-G	CONNECTOR; FEMALE; 2.54MM MULTI-POSITION JUMPER LINK; WIREMOUNT; 6PINS	
19	SU2, SU3	-	2	S1100-B;SX1100-B; STC02SYAN	KYCON;KYCON; SULLINS ELECTRONICS CORP.	SX1100-B	TEST POINT; JUMPER; STR; TOTAL LENGTH=0.24IN; BLACK; INSULATION=PBT;PHOSPHOR BRONZE CONTACT=GOLD PLATED	
20	SW1	-	1	CL-SB-12B-01T; CL-SB-12B-01	NIDEC COPAL ELECTRONICS CORP	CL-SB-12B-01T; CL-SB-12B-01	SWITCH; SPDT; SMT; 12V; 0.2A; CL-SB SERIES; SLIDE SWITCH; RCOIL=0.07 OHM; RINSULATION=100M OHM	
21	U1	-	1	MAX98361	MAXIM	MAX98361	EVKIT PART - IC; MAX98361; TINY; LOW-COST; PCM INPUT CLASS-D AMPLIFIER WITH CLASS-AB PERFORMANCE; WLP9; PACKAGE CODE: N91E1+1; PACKAGE OUTLINE: 21-100371	
22	VDDIO	-	1	5010	KEYSTONE	N/A	TEST POINT; PIN DIA=0.125IN; TOTAL LENGTH=0.445IN; BOARD HOLE=0.063IN; RED; PHOSPHOR BRONZE WIRE SIL;	
23	PCB	-	1	MAX98361_WLP_APPS_A	MAXIM	PCB	PCB:MAX98361_WLP_APPS_A	-
24	C3, C4, C8-C12	DNP	0	N/A	N/A	OPEN	PACKAGE OUTLINE 0402 NON-POLAR CAPACITOR	
25	FB1, FB2	DNP	0	RC1608J000CS	SAMSUNG ELECTRONICS	0	RESISTOR; 0603; 0 OHM; 5%; JUMPER; 0.10W; THICK FILM	
26	OUTN, OUTP	DNP	0	5002	KEYSTONE	N/A	TEST POINT; PIN DIA=0.1IN; TOTAL LENGTH=0.3IN; BOARD HOLE=0.04IN; WHITE; PHOSPHOR BRONZE WIRE SILVER;	
TOTAL			48					

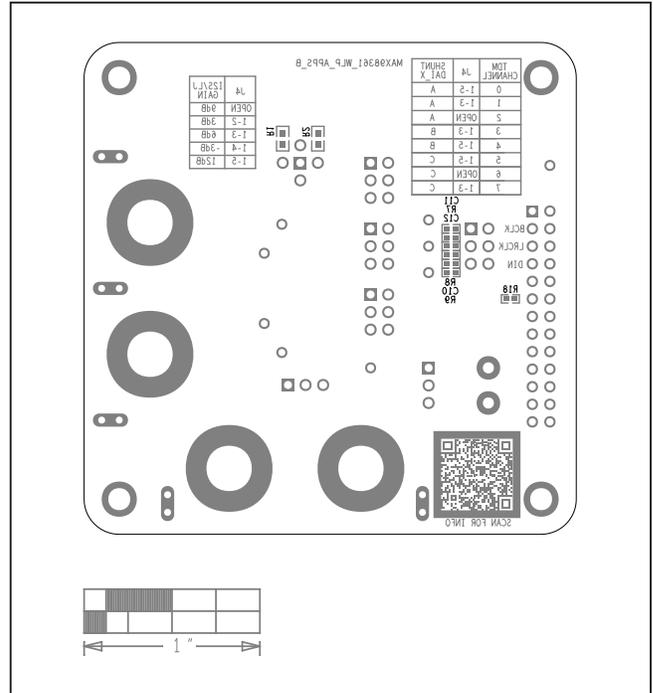




MAX98361 EV System PCB Layout Diagrams (continued)



MAX98361 EV System—Bottom



MAX98361 EV System—Bottom Silkscreen

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	2/22	Initial release	—
1	11/23	Updated Figure 1, <i>MAX98361 EV System PCB Schematic</i> and <i>MAX98361 EV System PCB Layout Diagrams</i> sections	1, 8–10
2	12/23	Updated <i>MAX98361 EV System PCB Layout Diagrams</i> section	9



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