AN-1567 LM4949 Demonstration Board

1 General Description

The LM4949TL demo board is a fully assembled circuit board for use evaluating the LM4949 stereo Class D subsystem with OCL headphone amplifiers. The LM4949 operates from a 2.7V to 5.5V power supply. The filterless class D amplifiers deliver 1.19W/channel into an 8Ω load with < 1% THD+N. The headphone amplifiers feature TI's Output Capacitor-less (OCL) architecture that eliminates the output coupling capacitors required by traditional headphone amplifiers. The LM4949 demo board allows the device to be configured with capacitively coupled loads.

The LM4949 features a 32-step volume control, multiple input mixing/multiplexing modes, and independent channel shutdown modes, all controlled through an I2C compatible digital interface.

2 Bill of Materials

Designator	Quantity	Description
C1– C6	6	0.33µF ± 10% 25V X7R
		Ceramic Capacitors (1206)
		Murata GRM319R71E334KA01D
C7	1	2.2µF ±10% 10V X7R
		Ceramic Capacitor (805)
		Murata GRM21BR71A225KA01L
C8–C11, C15	5	1µF ±10% 16V X7R
		Ceramic Capacitors (805)
		Murata GRM21BR71C105KA01L
C12	1	10µF ±10% 16V 500/mΩ
		Tantalum Capacitor (B Case)
		AVX TPSB106K016R0500
C13–C14	2	100µF ±10% 10V 75/mΩ
		Tantalum Capacitor (C Case)
		AVX TPSC107K010R0075
JP1–JP2	2	4 Pin Headers
JP3–JP13	11	2 Pin Headers
I^2C Connector	1	6 Pin Header
LM4949	1	LM4949 (25-bump DSBGA)

3 Quick Start

1. Connect a shunt across the ADR and GND pins of jumper JP11 (I^2C address bit = 0).
2. Connect a shunt across jumper JP8 (VOC = GND, Capacitor Coupled (CC) headphone mode).
3. Connect an 8Ω speaker across the + and – pins of jumper JP4 (left speaker output).
4. Connect an 8Ω speaker across the + and – pins of jumper JP5 (right speaker output).
5. Connect a headphone to jack J1 (headphone jack).

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6. Connect the 3.3V power supply to the VDD pin of jumper JP10 and the HPVDD pin of jumper JP9, and the power supply ground terminal to the GND pin of jumper JP10.
7. Connect the audio source to the + and – pins of JP3 (left input) and JP1 (right input).
8. Connect I^2C from PC to I^2C Interface jumper.
9. Open LM4949 I^2C control software.
10. Turn on power supply and audio source.
11. In the LM4949 I^2C control panel, select LS/HP predefined output mode 2, and select CHIP POWER-ON mode “ON” to enable the device.
12. Adjust the left and right input volume controls to change the speaker and headphone volumes.

4 Board Connections

4.1 Power Connections

The LM4949 demo board offers separate connections for the speaker amplifier and headphone amplifier power supplies. This allows the device to be evaluated with different supply configuration, a higher voltage for the speakers for more power, and a lower voltage for the headphones for better power dissipation.

- Connect the speaker amplifier power supply to the VDD pin and the power supply ground to the GND pin of jumper JP10
- Connect the headphone amplifier power supply to the HPVDD pin and the power supply ground to the GND pin of jumper JP9.

Although JP9 and JP10 have separate ground connections, the two GND pins are shorted together on the board.

4.2 Audio Input Connections

The left and right channel inputs of the LM4949 demo board can be configured for differential or single-ended sources. The mono input channel accepts only a differential input.

- Connect a differential input source between the “+” and “-“ pins of the jumpers JP1 and JP3.
- Connect a single-ended input source between either the “+” or “-“ pin and the ground pins of the jumpers JP1 and JP3.

Each stereo input can accept up to two single-ended inputs. The device input configuration is controlled through the I^2C interface.

4.3 Audio Output Connections

Jumpers JP4 and JP5 are the connections for the left and right channel speaker outputs respectively. The jack, J1 is the 3.5mm stereo headphone jack. Jumpers JP6 and JP7 are the output connections for the left and right headphone outputs, respectively, and are provided for scope probes and other connections. Jumper JP8 is the connection for the VOC output. In external amplifier mode, connect the VOC pin of JP8 to the shutdown input of the external amplifier.

5 Jumper Selection

Jumper JP11 sets the bit A1 of the LM4949 I^2C address (see the LM4949TL datasheet). Connect a shunt between the VDD and ADR pins of JP11 to set A1 = 1, connect a shunt between the ADR and GND pins of JP11 to set A1 = 0.

In CC mode, install a shunt across jumper JP8 and remove shunts across JP12 and JP13. With the shunt installed, JP8 shorts the VOC pin and the headphone jack return to GND. When evaluating the LM4949 is OCL mode, remove the shunt across jumper JP8, and install shunts across jumpers JP12 and JP13. Shunts across JP12 and JP13 remove the output coupling capacitors, C13 and C14, from the headphone signal path.

In external headphone amplifier mode, remove the shunt across jumper JP8 and install shunts across jumpers JP12 and JP13. Connect the VOC pin of JP8 to the shutdown input of the external amplifier.

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6 I²C Interface

The LM4949 is controlled through an I²C compatible serial interface. The LM4949 evaluation software provides an easy to use graphical user interface (Figure 1). Each button corresponds to bits in an I²C command byte. See the LM4949 data sheet for detailed I²C information.

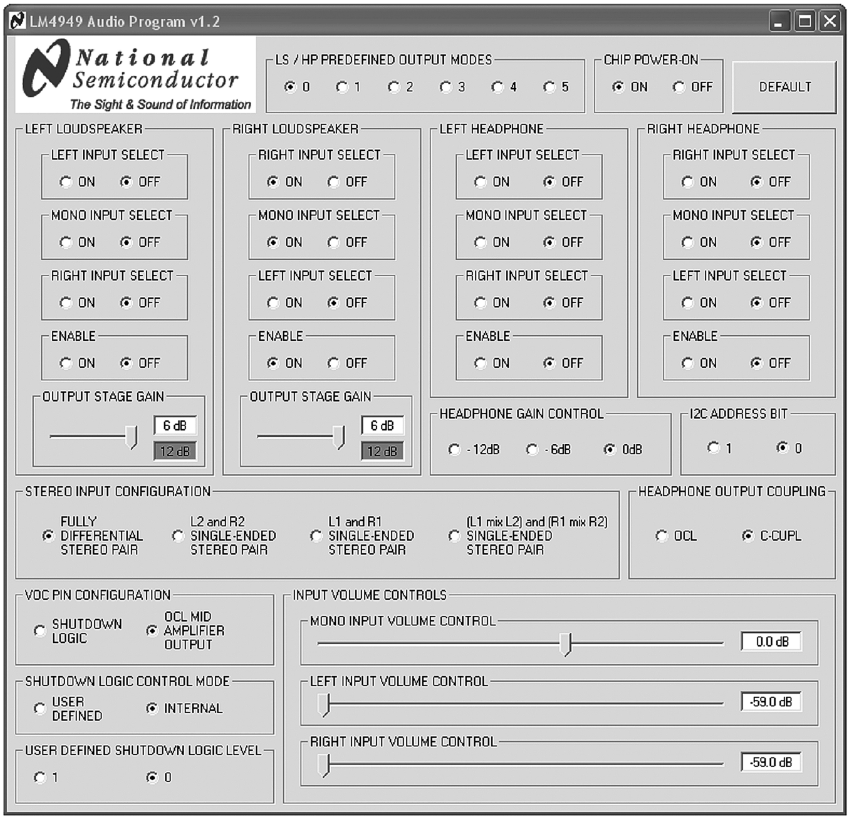


Figure 1. Evaluation Software Interface

7 Default

The DEFAULT button sets the LM4949 and the interface software to its default state. The default state is all amplifiers disabled, no inputs selected, all volume levels set to -59dB (mute). Each time power is cycled on the device, the interface must be reset to its default state.

8 Chip Power-On

The Chip Power-On button enables or disables the entire device. Even with the individual amplifier channels enabled, the device will not output any audio if Chip Power-On is set to “OFF.”

9 LS/HP Predefined Output Modes

The LM4949 demo board software features six preset output modes.

- **Mode 0:** All amplifier channels enabled, all inputs disabled.
- **Mode 1:** All amplifier channels enabled, all mono inputs enabled. All other inputs disabled.
- **Mode 2:** All amplifier channels enabled, individual stereo input channel enabled (left input enabled for left speaker amplifier output and right input enabled for right speaker amplifier output). All other inputs disabled.
- **Mode 3:** All amplifier channels enabled, individual stereo input channel and all mono channels enabled. All other inputs disabled.
- **Mode 4:** All amplifier channels enabled, individual stereo input channel and mixed stereo input (left

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input enabled for right speaker amplifier output, and right input enabled for left speaker amplifier output) enabled. All other inputs disabled.

- **Mode 5:** All amplifier channels enabled, all input channels enabled.

10 Individual Output Channel Controls

Each output channel of the LM4949 can be configured independently. The corresponding stereo input and mono input can be selected for each output channel independently. The mixed stereo input is enabled for both left and right channels simultaneously. Each output channel also features an independent shutdown.

11 Input Selection

The left and right stereo inputs can accept either differential or single-ended input sources. Select “FULLY DIFFERENTIAL STEREO PAIR” to configure the left and right inputs for differential operation. Select “L2 and R2 SINGLE-ENDED STEREO PAIR” to configure the LM4949 to accept single ended sources connected to LIN- and RIN-. Select “L1 and R1 SINGLE-ENDED STEREO PAIR” to configure the LM4949 to accept single-ended sources connected to LIN+ and RIN+. Select “(L1mix L2) and (R1 mix R2) SINGLE-ENDED STEREO PAIR” to configure the device to accept two single-ended stereo sources, connected to both input pairs.

12 Volume Control and Gain Setting

The LM4949 headphone and speaker channels feature separate gain controls. Three gain options are available in headphone mode, -12dB, -6dB, and 0dB. Four gain options are available in speaker mode, 6dB, 4dB, 2dB, and 0dB (differential mode and mixed single-ended mode) and 12dB, 10dB, 8dB, and 6dB (single-ended mode). Speaker gain for the left and right channels are set independently, while the headphone gain is the same for both left and right channels.

The LM4949 input channels feature independent volume controls. The mono, left and right input channels feature a 32 step volume control that extends from -57dB to 18dB.

13 VOC Output Configuration

The VOC output of the LM4949 can be configured to drive the shutdown input of an external amplifier. Select “OCL MID AMPLIFIER OUTPUT” to configure VOC as the midrail output voltage for OCL mode. Select “SHUDOWN LOGIC” to configure VOC as a logic level output. Select “USER DEFINED” to control the VOC output with “USER DEFINED SHUTDOWN LOGIC LEVEL.” In internal control mode, the shutdown signal comes from the internal start-up circuitry, allowing the external device to be turned on and off simultaneously with the LM4949.

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14 Schematic and Layout Pictures

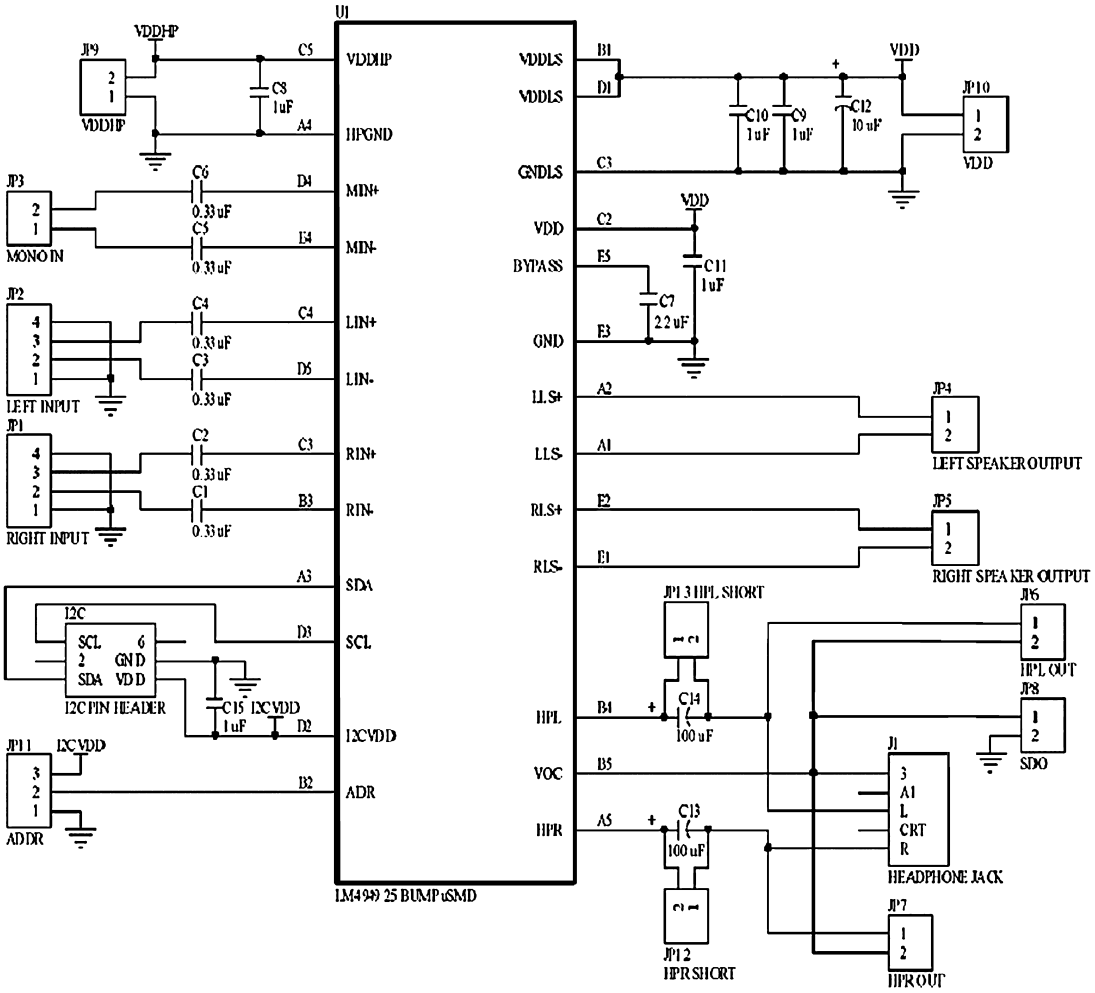


Figure 2. LM4949 Demoboard Schematic

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15 Demonstration Board PCB Layout

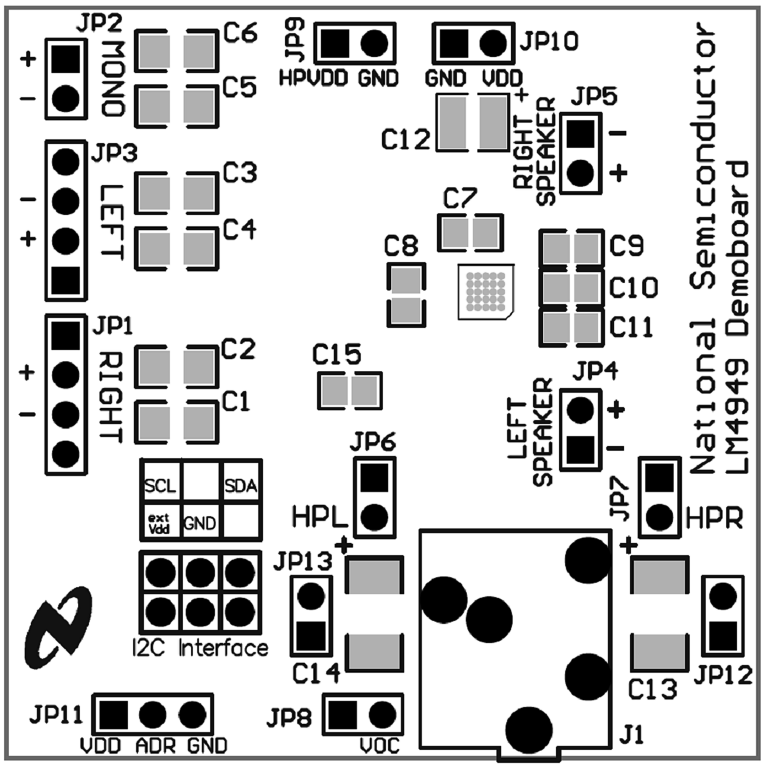


Figure 3. Solder Layer

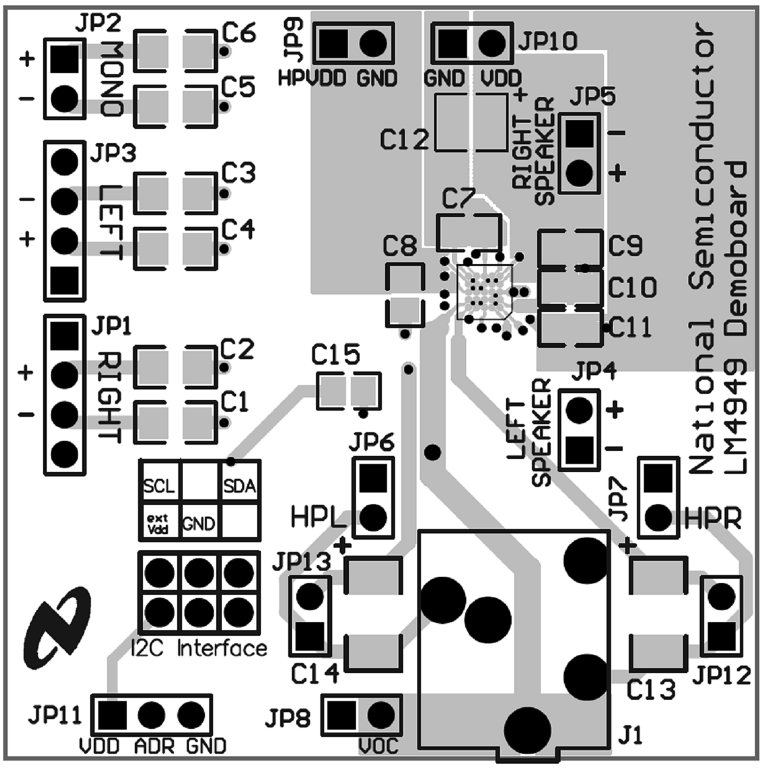


Figure 4. Top Layer

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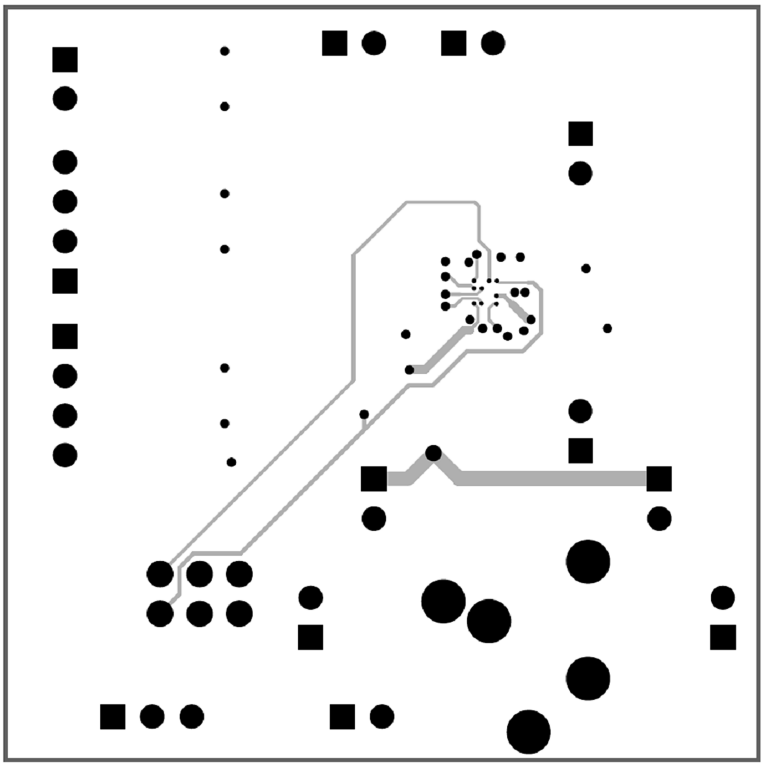


Figure 5. Mid Layer 1

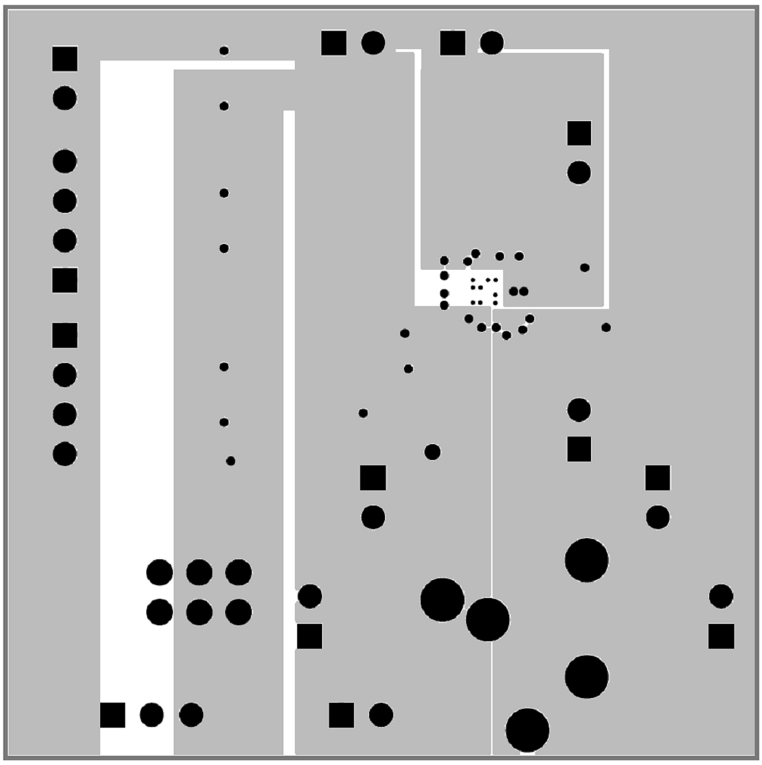


Figure 6. Mid Layer 2

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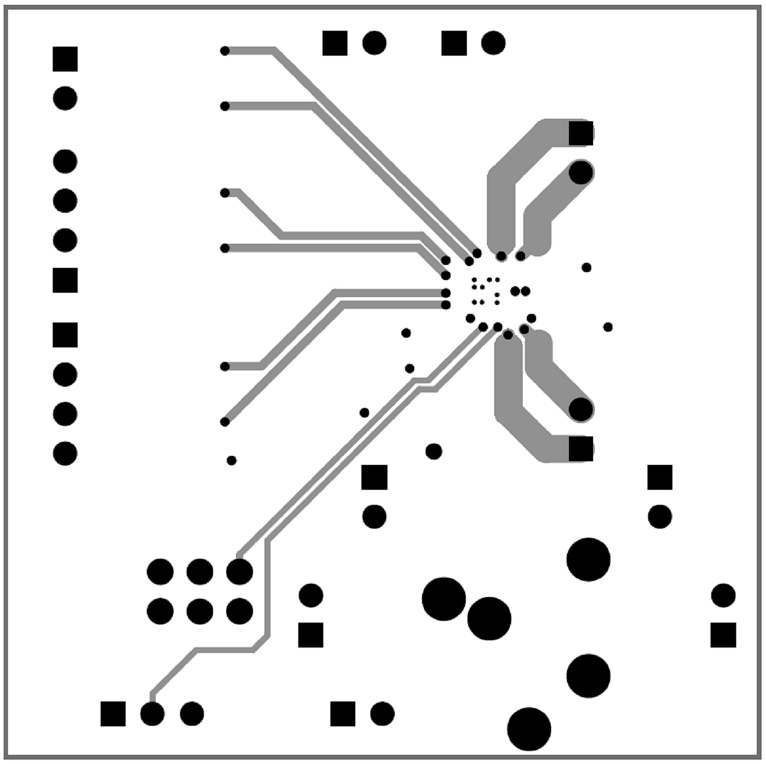


Figure 7. Bottom Layer

16 Revision History

Rev	Date	Description
1.0	07/17/07	Initial release.

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