TS4974

1W Differential Audio Power Amplifier
with Up/Down Digital Volume Control Pins

- ■ **Operating from V_{CC} = 2.5V to 5.5V**
- ■ **Zero pop&clickless circuit**
- ■ **1.W output power @ Vcc=5V, THD=1%, F=1kHz, with 8Ω Load**
- ■ **Ultra low consumption in standby mode (2µA max.)**
- ■ **85dB PSRR @ 217Hz**
- ■ **16 digital volume control steps**
- ■ **Two up and down volume control discrete pins**
- ■ **Gain range from -33dB to + 12dB**
- ■ **Integrated debouncing system**
- ■ **Ultra fast start up time: 15ms typ.**
- ■ **DFN10 3X3 mm pitch 0.5**

Description

At 3.3v, the TS4974 is a dual power audio amplifier capable of delivering 380mW of continuous RMS ouput power into a 8Ω bridged-tied loads with 1% THD+N. An external standby mode control reduces the supply current to less than 2µA. An internal over-temperature shutdown protection is provided.

The TS4974 has been designed for high quality audio applications such as mobile phones and for minimizing the number of external components.

The TS4974 features a 16 step digital volume control through two discrete control Up and Down pins. The start-up gain is internally fixed to -12dB. An integrated debounce system prevents voltage pikes on UP/DOWN pins during volume control mode to be taken into account during a debounce time of 10ms (typ.).

Pin Connections (top view)

TS4974IQ DFN Package

TS4974IQ - Pinout

Pin	Signal	Pin	Signal
1	VIN-	10	VCC
2	VIN+	9	VOUT-
3	BYPASS	8	VOUT+
4	STANDBY	7	UP / DVC
5	GND	6	DOWN / DVC

Applications

- ■ **Mobile phones (cellular / cordless)**
- ■ **PDAs**
- ■ **Laptop/notebook computers**
- ■ **Portable audio devices**

Order Codes

Part Number	Temperature Range	Package	Packaging	Marking
TS4974IQT	-40, +85°C	QFN	Tape & Reel	TBA
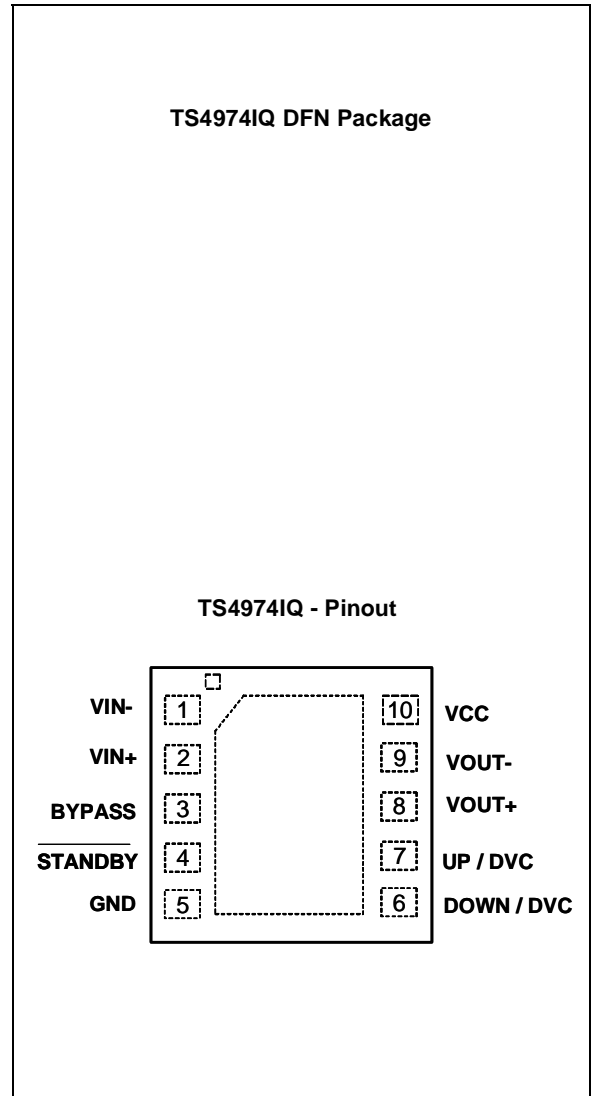
1   Absolute Maximum Ratings

Table 1: Key parameters and their absolute maximum ratings

Symbol	Parameter	Value	Unit
Vcc	Supply voltage [1]	6	V
V_i	Input Voltage [2]	G_{ND} to V_{CC}	V
T_{oper}	Operating Free Air Temperature Range	-40 to + 85	°C
T_{stg}	Storage Temperature	-65 to +150	°C
T_j	Maximum Junction Temperature	150	°C
R_{thja}	Thermal Resistance Junction to Ambient [3]	200	°C/W
Pd	Power Dissipation	Internally Limited[4]	
ESD	Human Body Model[5]	2	kV
ESD	Machine Model (min Value)	200	V
Latch-up	Latch-up Immunity	200	mA
	Lead Temperature (soldering, 10sec)	260	°C

1)   All voltages values are measured with respect to the ground pin.

2)   The magnitude of input signal must never exceed V_{CC} + 0.3V / G_{ND} - 0.3V.

3)   Device is protected in case of over temperature by a thermal shutdown active @ 150°C.

4)   Exceeding the power derating curves during a long period, may involve abnormal operating condition.

5)   Human body model, 100pF discharged through a 1.5kOhm resistor, into pin to Vcc device.

Table 2: Operating Conditions

Symbol	Parameter	Value	Unit
Vcc	Supply Voltage	2.5 to 5.5	V
VSTB	Standby Voltage Input : Device ON Device OFF	$1.5 \leq V_{STB} \leq V_{CC}$ $GND \leq V_{STB} \leq 0.4$	V
VU/D	Volume control UP/DOWN voltage input: UP/DOWN mode ON UP/DOWN mode OFF	$0 \leq V_{U/D} \leq$ 30% of V_{CC} 40% of $V_{CC} \leq V_{U/D} \leq V_{CC}$	V
RL	Load Resistor	≥ 8	Ω
TSD	Thermal Shutdown Temperature	150	°C
R_{thja}	Thermal Resistance Junction to Ambient [1]	80	°C/W

1)   With Heat Sink Surface = 125mm^2.

1 Application Information

Figure 1: Typical application schematics
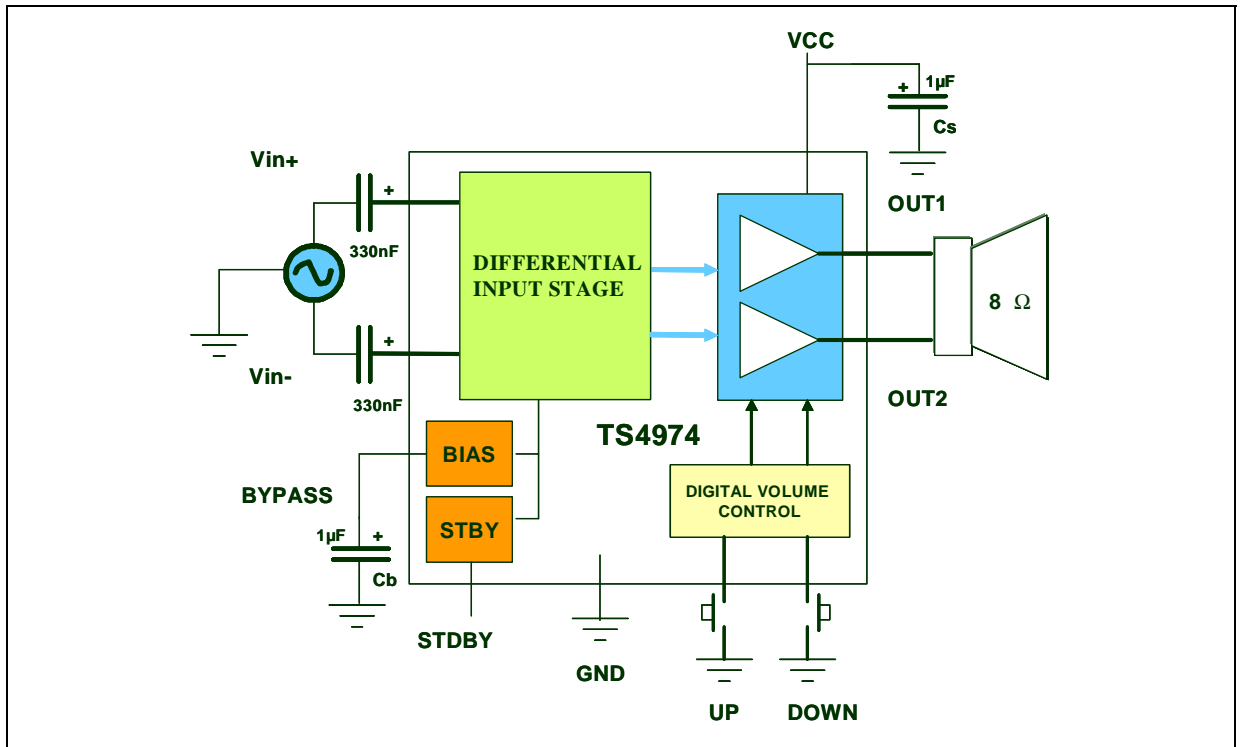
Operation Mode

The TS4974 is a fully differential power amplifier which enables better performances in terms of noise immunity and PSRR.

The TS4974 features a digital volume control with an internal gain range from -33dB up to +12dB, by steps of 3dB. When the device is firstly biased, an initial gain of -12dB is internally fixed. When standby mode is activated, the gain value is memorized and held until standby is released.

The volume is controlled by means of two pins UP and DOWN on which the application of a VIL voltage will activate the increase or decrease in gain. The TS4974 integrates a debouncing system which does not allow to take into account UP or DOWN pulse shorter than $T_{debounce}$ time. Moreover an autorepeat function is implemented. When a continuous voltage is applied on UP or DOWN pin, the gain is continuously increased or decreased after a certain time called $T_{autorepeat}$. The first period of each autorepeat sequence is longer ($x1.5T_{auto}$) to avoid any parasitic activation. In this operational mode, T_{range} time is necessary to cover the whole gain range of the device.

2   Electrical Characteristics

Table 3: V_{CC} = +5V, GND = 0V, T_{amb} = 25°C (unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Unit
I_{CC}	Supply Current No input signal, no load		3.2		mA
$I_{STANDBY}$	Standby Current No input signal, Vstdby = Gnd, RL = 8Ω		300	2000	nA
Voo	Output Offset Voltage No input signal, RL = 8Ω, Floating inputs		5	20	mV
Po	Output Power THD = 1% Max, f = 1kHz, RL = 8Ω	0.8	1		W
THD + N	Total Harmonic Distortion + Noise Po = 500mW rms, 20Hz < F < 20kHz, RL = 8Ω, 0dB gain, Cb=1µF, Cin=330nF		0.5		%
PSRR	Power Supply Rejection Ratio[1] F = 217Hz, RL = 8Ω,) Vripple = 200mVpp, Input Grounded, Cb=1µF, Cin=330nF	75	85		dB
CMRR	Common Mode Rejection Ratio[2] F = 217Hz, RL = 8Ω, Vincm = 200mVpp, Cb = 1µF, Cin=330nF	45	61		dB
SNR	Signal-to-Noise Ratio (Weighted A, 6dB gain) (RL = 8Ω, THD + N ≤ 0.5%, 20Hz < F < 20kHz)		100		dB
Gs	Start up Gain		-12		dB
G	Digital Gain Range	-33		+12	dB
Gain Step size			3		dB
Gain accuracy		-1		+1	dB
Twu	Wake-up Time		15		ms
V_N	Output Voltage Noise F = 20Hz to 20kHz, RL = 8Ω Unweighted Weighted A		21 17		$µV_{RMS}$
Zin	Differential input impedance	48	60	75	kΩ
$T_{debounce}$	Debouncing time		10		ms
$T_{autorepeat}$	Time between volume changes		160		ms
T_{range}	During autorepeat mode, necessary time to cover the whole gain range		2500		ms

1) Dynamic measurements - 20*log(rms(Vout)/rms(Vripple)). Vripple is an added sinus signal to Vcc @ F = 217Hz.

2) Dynamic measurements - 20*log(rms(Vout)/rms(Vincm)).

Table 4: V_{CC} = +3.3V, GND = 0V, T_{amb} = 25°C (unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Unit
I_{CC}	Supply Current No input signal, no load		3.0		mA
$I_{STANDBY}$	Standby Current No input signal, Vstdby = Gnd, RL = 8Ω		230	2000	nA
Voo	Output Offset Voltage No input signal, RL = 8Ω, Floating inputs		5	20	mV
Po	Output Power THD = 1% Max, f = 1kHz, RL = 8Ω	300	380		mW
THD + N	Total Harmonic Distortion + Noise Po = 250mW rms, 20Hz < F < 20kHz, RL = 8Ω, 0dB gain, Cb=1µF, Cin=330nF		0.5		%
PSRR	Power Supply Rejection Ratio[1] F = 217Hz, RL = 8Ω,) Vripple = 200mVpp, Input Grounded, Cb=1µF, Cin=330nF	75	85		dB
CMRR	Common Mode Rejection Ratio[2] F = 217Hz, RL = 8Ω, Vincm = 200mVpp, Cb = 1µF, Cin=330nF	45	61		dB
SNR	Signal-to-Noise Ratio (Weighted A, 6dB gain) (RL = 8Ω, THD + N ≤ 0.5%, 20Hz < F < 20kHz)		100		dB
Gs	Start up Gain		-12		dB
G	Digital Gain Range	-33		+12	dB
Gain Step size			3		dB
Gain accuracy		-1		+1	dB
Twu	Wake-up Time		15		ms
V_N	Output Voltage Noise F = 20Hz to 20kHz, RL = 8Ω Unweighted Weighted A		21 17		µV$_{RMS}$
Zin	Differential input impedance	48	60	75	kΩ
$T_{debounce}$	Debouncing time		10		ms
$T_{autorepeat}$	time between volume change		160		ms
T_{range}	During autorepeat mode, necessary time to cover the whole gain range		2500		ms

1) Dynamic measurements - 20*log(rms(Vout)/rms(Vripple)). Vripple is an added sinus signal to Vcc @ F = 217Hz.

2) Dynamic measurements - 20*log(rms(Vout)/rms(Vincm)).

Table 5: V_{CC} = +2.6V, GND = 0V, T_{amb} = 25°C (unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Unit
I_{CC}	Supply Current No input signal, no load		2.8		mA
$I_{STANDBY}$	Standby Current No input signal, Vstdby = Gnd, RL = 8Ω		265	2000	nA
Voo	Output Offset Voltage No input signal, RL = 8Ω, Floating inputs		5	20	mV
Po	Output Power THD = 1% Max, f = 1kHz, RL = 8Ω	200	250		mW
THD + N	Total Harmonic Distortion + Noise Po = 150mW rms, 20Hz < F < 20kHz, RL = 8Ω, 0dB gain, Cb=1µF, Cin=330nF		0.5		%
PSRR	Power Supply Rejection Ratio[1] F = 217Hz, RL = 8Ω,) Vripple = 200mVpp, Input Grounded, Cb=1µF, Cin=330nF	75	85		dB
CMRR	Common Mode Rejection Ratio[2] F = 217Hz, RL = 8Ω, Vincm = 200mVpp, Cb = 1µF, Cin=330nF	45	61		dB
SNR	Signal-to-Noise Ratio (Weighted A, 6dB gain) (RL = 8Ω, THD + N ≤ 0.5%, 20Hz < F < 20kHz)		100		dB
Gs	Start up Gain		-12		dB
G	Digital Gain Range	-33		+12	dB
Gain Step size			3		dB
Gain accuracy		-1		+1	dB
Twu	Wake-up Time		15		ms
V_N	Output Voltage Noise F = 20Hz to 20kHz, RL = 8Ω Unweighted Weighted A		21 17		μV_{RMS}
Zin	Differential input impedance	48	60	75	kΩ
$T_{debounce}$	Debouncing time		10		ms
$T_{autorepeat}$	time between volume change		160		ms
T_{range}	During autorepeat mode, necessary time to cover the whole gain range		2500		ms

1) Dynamic measurements - 20*log(rms(Vout)/rms(Vripple)). Vripple is an added sinus signal to Vcc @ F = 217Hz.

2) Dynamic measurements - 20*log(rms(Vout)/rms(Vincm)).

3 Package Mechanical Data

3.1 Pinout (top view)

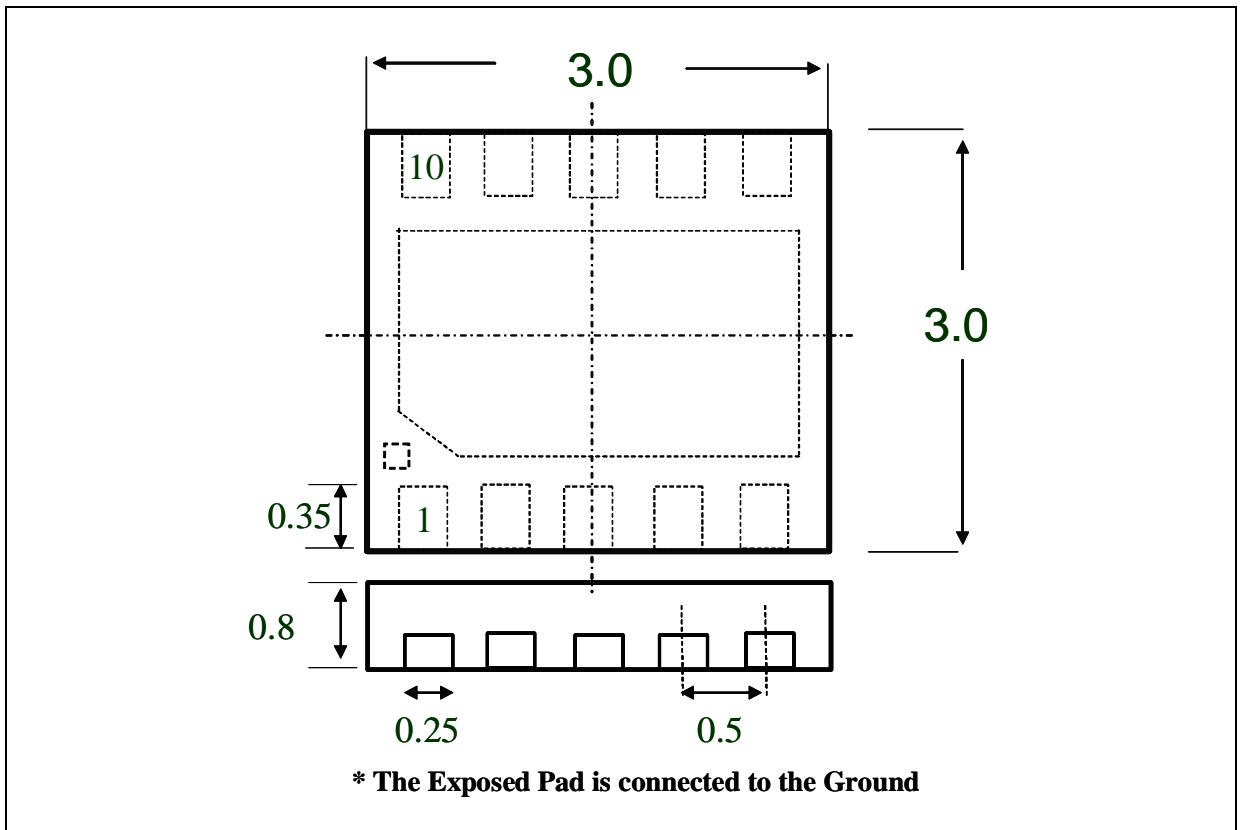VIN-   [1]   [10] VCC

VIN+   [2]   [9]   VOUT-

BYPASS   [3]   [8]   VOUT+

$\overline{\text{STANDBY}}$ [4]   [7]   UP / DVC

GND   [5]   [6]   DOWN / DVC
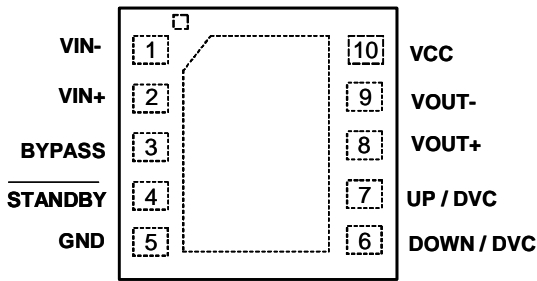
3.2 Marking (top view)

■ Logo : **ST**
■ Part Number : **A74**
■ Date Code : YWW
■ The Dot is for marking pin **1**

3.3 DFN10 3X3 Package (all dimensions in mm)

3.0

3.0

0.35

0.8

0.25

0.5

* The Exposed Pad is connected to the Ground

4   Revision History

Date	Revision	Description of Changes
01 Nov 2004	1	First Release