

## Ultra Low Power CODEC for Portable Audio Applications

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### DESCRIPTION

The WM8904 is a high performance ultra-low power stereo CODEC optimised for portable audio applications.

The device features stereo ground-referenced headphone amplifiers using the Wolfson 'Class-W' amplifier techniques - incorporating an innovative dual-mode charge pump architecture - to optimise efficiency and power consumption during playback. The ground-referenced headphone and line outputs eliminate AC coupling capacitors, and both outputs include common mode feedback paths to reject ground noise.

Control sequences for audio path setup can be pre-loaded and executed by an integrated control write sequencer to reduce software driver development and minimise pops and clicks via Wolfson's SilentSwitch™ technology.

The analogue input stage can be configured for single ended, or differential inputs. Up to 3 stereo microphone or line inputs may be connected. The input impedance is constant with PGA gain setting.

A stereo digital microphone interface is provided, with a choice of two inputs.

A dynamic range controller provides compression and level control to support a wide range of portable recording applications. Anti-clip and quick release features offer excellent performance in the presence of loud impulsive noises.

ReTune™ Mobile 5-band parametric equaliser with fully programmable coefficients is integrated for optimization of speaker characteristics. Programmable dynamic range control is also available for maximizing loudness, protecting speakers from clipping and preventing premature shutdown due to battery droop.

Common audio sampling frequencies are supported from a wide range of external clocks, either directly or generated via the FLL.

The WM8904 can operate directly from a single 1.8V switched supply. For optimal power consumption, the digital core can be operated from a 1.0V supply.

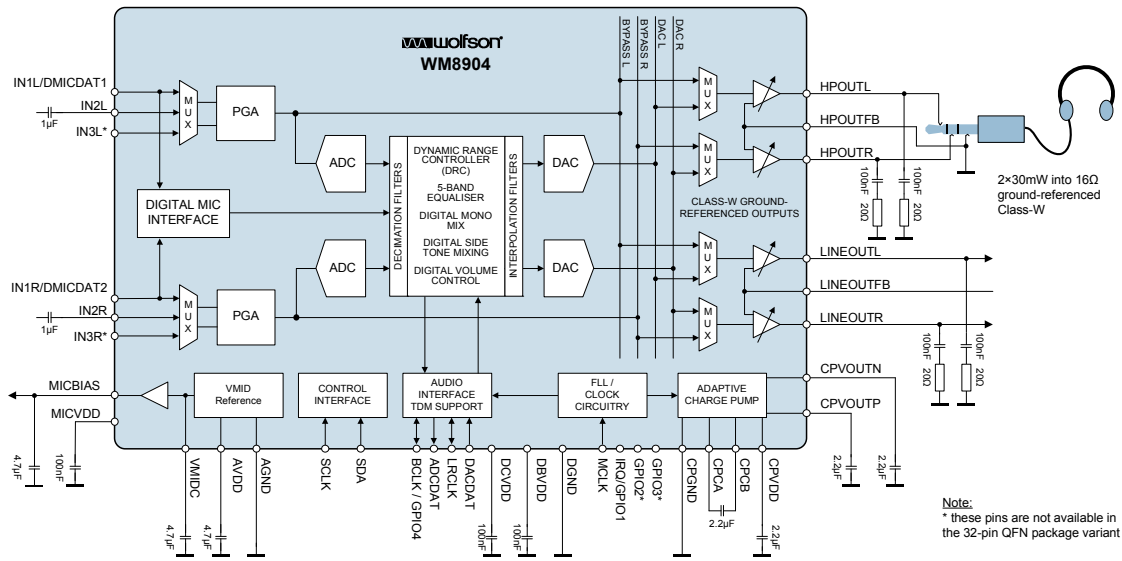
### FEATURES

- 4mW quiescent power consumption for DAC to headphone playback
- 2.4mW quiescent power consumption for analogue bypass playback
- DAC SNR 96dB typical, THD -86dB typical
- ADC SNR 91dB typical, THD -80dB typical
- Control write sequencer for pop minimised start-up and shutdown
- Single register write for default start-up sequence
- Integrated FLL provides all necessary clocks
  - Self-clocking modes allow processor to sleep
  - All standard sample rates from 8kHz to 96kHz
- Stereo digital microphone input
- 3 single ended inputs per stereo channel
- 1 fully differential mic / line input per stereo channel
- Digital Dynamic Range Controller (compressor / limiter)
- Digital sidetone mixing
- Ground-referenced headphone driver
- Ground-referenced line outputs
- 32-pin QFN package (4x4mm, 0.4mm pitch)
- 36-ball W-CSP package (6x6 ball grid, 0.4mm pitch)

### APPLICATIONS

- Portable multimedia players
- Multimedia handsets
- Handheld gaming
- Wireless headsets
- Mobile internet devices
- Netbooks

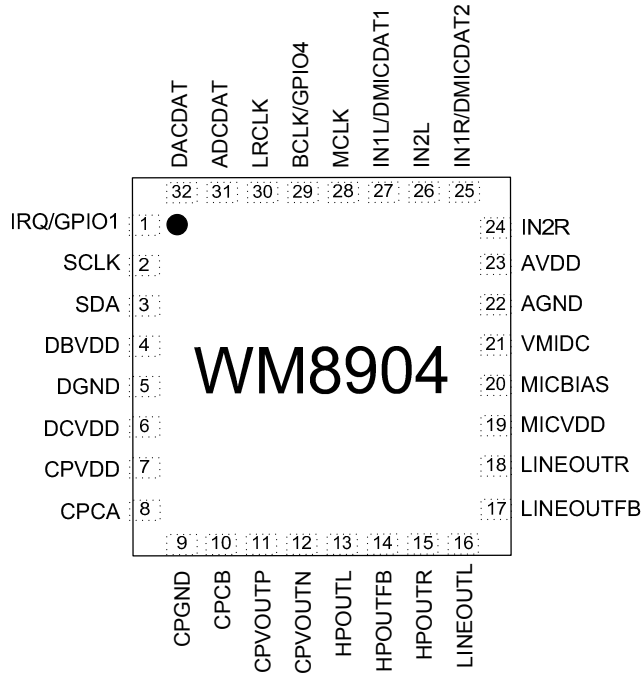
BLOCK DIAGRAM



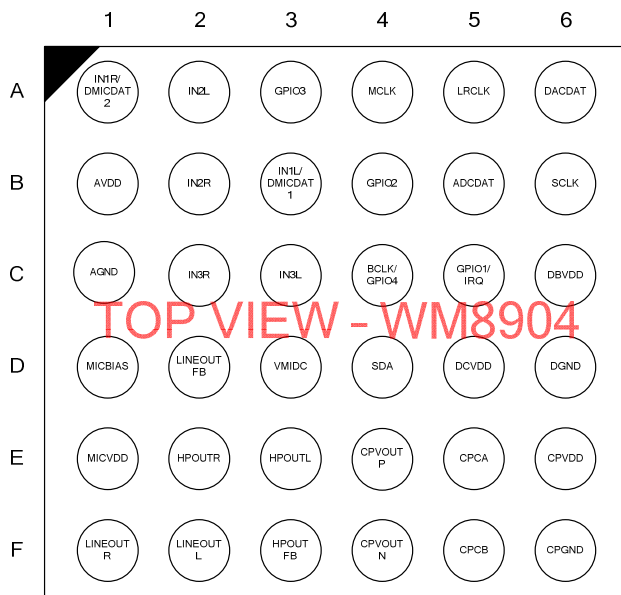
### PIN CONFIGURATION

The WM8904 is supplied in a 32-pin QFN package or in a 36-ball CSP format.

The diagram below shows the 32-pin QFN configuration.



The following diagram shows the 36-ball CSP configuration.



**ORDERING INFORMATION**

DEVICE	TEMPERATURE RANGE	PACKAGE	MOISTURE SENSITIVITY LEVEL	PEAK SOLDERING TEMPERATURE
WM8904GEFL/V	-40°C to +85°C	32-lead QFN (4x4x0.4mm, lead-free)	MSL3	260°C
WM8904GEFL/RV	-40°C to +85°C	32-lead QFN (4x4x0.4mm, lead-free, tape and reel)	MSL3	260°C
WM8904ECS/R	-40°C to +85°C	36-ball W-CSP (6x6 ball grid, 0.4mm, lead-free, tape and reel)	MSL1	260°C

**Note:**

Reel quantity = 3,500

## PIN DESCRIPTION

NAME	W-CSP 6x6	QFN-32	TYPE	DESCRIPTION
IN1L / DMICDAT1	B3	27	Analogue / Digital Input	Left channel input 1 / Digital microphone data input 1
IN2L	A2	26	Analogue Input	Left channel input 2
IN3L	C3	n/a	Analogue Input	Left channel input 3
IN1R / DMICDAT2	A1	25	Analogue / Digital Input	Right channel input 1 / Digital microphone data input 2
IN2R	B2	24	Analogue Input	Right channel input 2
IN3R	C2	n/a	Analogue Input	Right channel input 3
MICBIAS	D1	20	Analogue Output	Microphone bias
MICVDD	E1	19	Supply	Microphone bias amp supply
HPOUTL	E3	13	Analogue Output	Left headphone output (line or headphone output)
HPOUTR	E2	15	Analogue Output	Right headphone output (line or headphone output)
HPOUTFB	F3	14	Analogue Output	Headphone output ground loop noise rejection feedback
LINEOUTL	F2	16	Analogue Output	Left line output 1 (line output)
LINEOUTR	F1	18	Analogue Output	Right line output 1 (line output)
LINEOUTFB	D2	17	Analogue Output	Line output ground loop noise rejection feedback
CPVDD	E6	7	Supply	Charge pump power supply
CPGND	F6	9	Supply	Charge pump ground
CPCA	E5	8	Analogue Input	Charge pump flyback capacitor pin
CPCB	F5	10	Analogue Input	Charge pump flyback capacitor pin
CPVOUPT	E4	11	Analogue Output	Charge pump positive supply decoupling (powers HPOUTL/R, LINEOUTL/R)
CPVOUTN	F4	12	Analogue Output	Charge pump negative supply decoupling (powers HPOUTL/R, LINEOUTL/R)
AVDD	B1	23	Supply	Analogue power supply (powers analogue inputs, reference, ADC, DAC)
AGND	C1	22	Supply	Analogue power return
VMIDC	D3	21		Midrail voltage decoupling capacitor
DCVDD	D5	6	Supply	Digital core supply
DBVDD	C6	4	Supply	Digital buffer supply (powers audio interface and control interface)
DGND	D6	5	Supply	Digital ground (return path for DCVDD and DBVDD)
MCLK	A4	28	Digital Input	Master clock for CODEC
BCLK / GPIO4	C4	29	Digital Input / Output	Audio interface bit clock / GPIO4
LRCLK	A5	30	Digital Input / Output	Audio interface left / right clock (common for ADC and DAC)
DACDAT	A6	32	Digital Input	DAC digital audio data
ADCDAT	B5	31	Digital Output	ADC digital audio data
SCLK	B6	2	Digital Input	Control interface clock input
SDA	D4	3	Digital Input / Output	Control interface data input / output
GPIO1 / IRQ	C5	1	Digital Input / Output	GPIO1 / Interrupt
GPIO2	B4	n/a	Digital Input / Output	GPIO2
GPIO3	A3	n/a	Digital Input / Output	GPIO3
GND_PADDLE	n/a	33		Die Paddle

## Note:

1. It is recommended that the QFN ground paddle is connected to analogue ground on the application PCB.

## ABSOLUTE MAXIMUM RATINGS

Absolute Maximum Ratings are stress ratings only. Permanent damage to the device may be caused by continuously operating at or beyond these limits. Device functional operating limits and guaranteed performance specifications are given under Electrical Characteristics at the test conditions specified.



ESD Sensitive Device. This device is manufactured on a CMOS process. It is therefore generically susceptible to damage from excessive static voltages. Proper ESD precautions must be taken during handling and storage of this device.

Wolfson tests its package types according to IPC/JEDEC J-STD-020B for Moisture Sensitivity to determine acceptable storage conditions prior to surface mount assembly. These levels are:

MSL1 = unlimited floor life at <30°C / 85% Relative Humidity. Not normally stored in moisture barrier bag.

MSL2 = out of bag storage for 1 year at <30°C / 60% Relative Humidity. Supplied in moisture barrier bag.

MSL3 = out of bag storage for 168 hours at <30°C / 60% Relative Humidity. Supplied in moisture barrier bag.

The Moisture Sensitivity Level for each package type is specified in Ordering Information.

CONDITION	MIN	MAX
AVDD, DCVDD	-0.3V	+2.5V
DBVDD,	-0.3V	+4.5V
MICVDD	-0.3V	+4.5V
CPVDD	-0.3V	+2.2V
HPOUTL, HPOUTR, LINEOUTL, LINEOUTR	(CPVDD + 0.3V) * -1	CPVDD + 0.3V
Voltage range digital inputs	DGND -0.3V	DBVDD +0.3V
Voltage range analogue inputs	AGND -0.3V	AVDD +0.3V
Temperature range, T <sub>A</sub>	-40°C	+85°C
Storage temperature after soldering	-65°C	+150°C

### Notes:

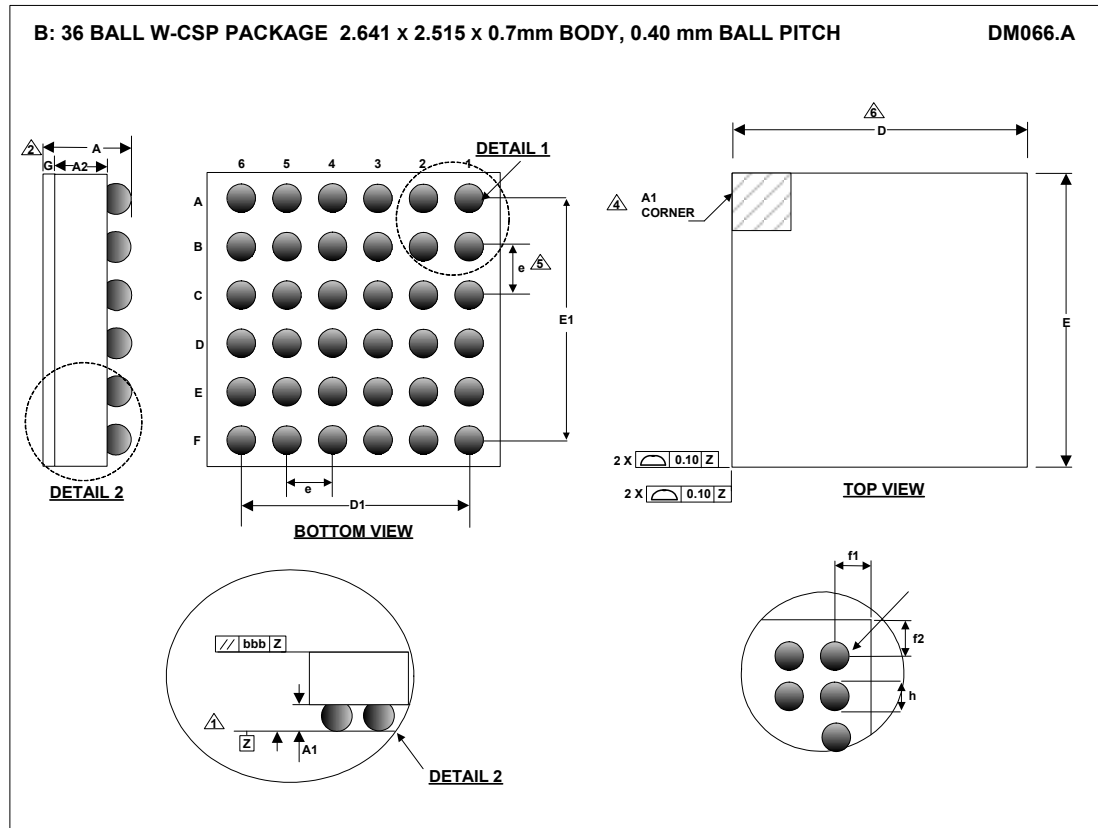
1. Analogue and digital grounds must always be within 0.3V of each other.
2. All digital and analogue supplies are completely independent from each other; there is no restriction on power supply sequencing.
3. HPOUTL, HPOUTR, LINEOUTL, LINEOUTR are outputs, and should not normally become connected to DC levels. However, if the limits above are exceeded, then damage to the WM8904 may occur.

## RECOMMENDED OPERATING CONDITIONS

PARAMETER	SYMBOL	MIN	TYP	MAX	UNIT
Digital supply range (Core)	DCVDD	0.95	1.0	1.98	V
Digital supply range (Buffer)	DBVDD	1.42	1.8	3.6	V
Analogue supplies range	AVDD	1.71	1.8	2.0	V
Charge pump supply range	CPVDD	1.71	1.8	2.0	V
Microphone bias	MICVDD	1.71	2.5	3.6	V
Ground	DGND, AGND, CPGND		0		V
Operating Temperature (ambient)	T <sub>A</sub>	-40	+25	+85	°C

## PACKAGE DIMENSIONS

The 36-ball W-CSP package drawing is shown below.

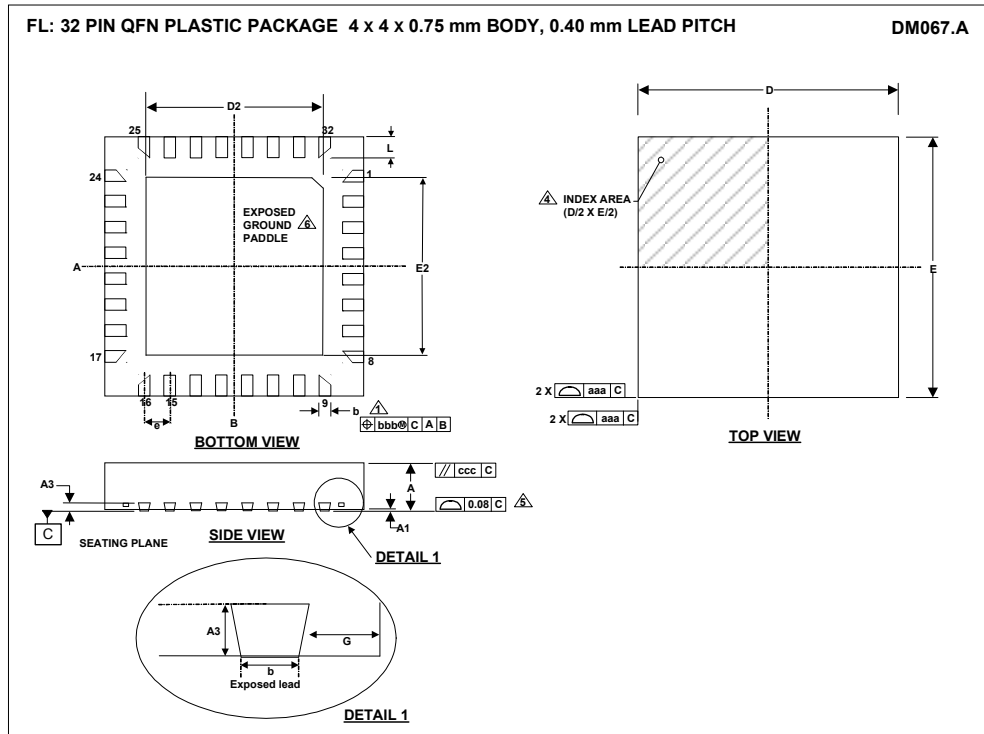


Symbols	Dimensions (mm)			NOTE
	MIN	NOM	MAX	
<b>A</b>	0.615	0.7	0.785	
<b>A1</b>	0.185	0.210	0.235	
<b>A2</b>	0.395	0.420	0.445	
<b>D</b>		2.641 BSC		
<b>D1</b>		2.000 BSC		
<b>E</b>		2.515 BSC		
<b>E1</b>		2.000 BSC		
<b>e</b>		0.400 BSC		5
<b>f1</b>	0.311			
<b>f2</b>	0.248			
<b>g</b>	0.035	0.070	0.105	
<b>h</b>		0.258 BSC		

### NOTES:

1. PRIMARY DATUM -Z- AND SEATING PLANE ARE DEFINED BY THE SPHERICAL CROWNS OF THE SOLDER BALLS.
2. THIS DIMENSION INCLUDES STAND-OFF HEIGHT 'A1' AND BACKSIDE COATING.
3. A1 CORNER IS IDENTIFIED BY INK/LASER MARK ON TOP PACKAGE.
4. BILATERAL TOLERANCE ZONE IS APPLIED TO EACH SIDE OF THE PACKAGE BODY.
5. 'e' REPRESENTS THE BASIC SOLDER BALL GRID PITCH.
6. THIS DRAWING IS SUBJECT TO CHANGE WITHOUT NOTICE.
7. FOLLOWS JEDEC DESIGN GUIDE MO-211-C.

The 32-pin QFN package drawing is shown below.



Symbols	Dimensions (mm)			
	MIN	NOM	MAX	NOTE
A	0.70	0.75	0.8	
A1	0	0.035	0.05	
A3		0.203 REF		
b	0.15	0.2	0.25	1
D		4.00 BSC		
D2	2.65	2.7	2.75	2
E		4.00 BSC		
E2	2.65	2.7	2.75	2
e		0.40 BSC		
G		0.5		
L	0.35	0.40	0.45	
<b>Tolerances of Form and Position</b>				
aaa	0.05			
bbb	0.10			
ccc	0.10			
REF:				

- NOTES:
1. DIMENSION b APPLIES TO METALLIZED TERMINAL AND IS MEASURED BETWEEN 0.15 mm AND 0.25 mm FROM TERMINAL TIP.
  2. ALL DIMENSIONS ARE IN MILLIMETRES.
  3. THE TERMINAL #1 IDENTIFIER AND TERMINAL NUMBERING CONVENTION SHALL CONFORM TO JEDEC 95-1 SPP-002.
  4. COPLANARITY APPLIES TO THE EXPOSED HEAT SINK SLUG AS WELL AS THE TERMINALS.
  5. REFER TO APPLICATION NOTE WAN\_0118 FOR FURTHER INFORMATION REGARDING PCB FOOTPRINTS AND QFN PACKAGE SOLDERING.
  6. THIS DRAWING IS SUBJECT TO CHANGE WITHOUT NOTICE.



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