# CX20787

## Ultra Low-Power I²S Audio Codec with Integrated Digital Signal Processing Features NEW

### Features

- Cap-less Stereo class G Headphone driver
- Two Stereo Differential 10 kΩ Line (or Single Ended)
- Stereo Differential Speaker - Class D Amplifier 2 Wrms 4Ω @ 5 V.0 or 1 Wrms 4 Ω @3.2 V
- No pops, clicks, or zipper noise during any change of state
- Single-ended External Mono Mic (Headset Jack)
- Three Differential Mic / Line - shared with digital mic ports
- 2 Mic Bias
- Nokia / Apple headset type detection & mic/Gnd switch control
- Inline command sensing
- Stereo 24-b ADCs, & 1 digital ADC
- Stereo 24-b DACs
- HW Audio Signal Processing
  - 5-band bi-quad EQ on stereo output
  - 2-knee stereo DRC
- Digital Mic support, clk support: 1.5,3 MHz,
- Two 4-wire bi-directional I²S/PCM, 1 Aux (pass-thru)
- SPI (5 MHz)/I²C (100/400 kHz)
- 4 GPIO
- Writer Sequencer to minimize setup
- MCLK clock input (10-48 MHz) for reference to 2 PLLs
- 1.8 V +/- 0.5 V, 3.3 V
- 4x3.9x1mm 72-p WLCSP, 0.4mm ball pitch
- -40 to +85 deg C ambient, -40 to +125 C junction

### Applications

- Smartphones
- Tablets
- Ultrabooks
- Portable Media Player

### Overview

The CX20787 is an ultra low-power, I²S stereo audio codec with integrated Class-D speaker amplifiers and power-efficient Class G headphone amplifiers with in- line DSP features. Combined with our software driver and design support, this is an ideal turnkey solution for Tablets, Ultrabooks, Smartphones etc.

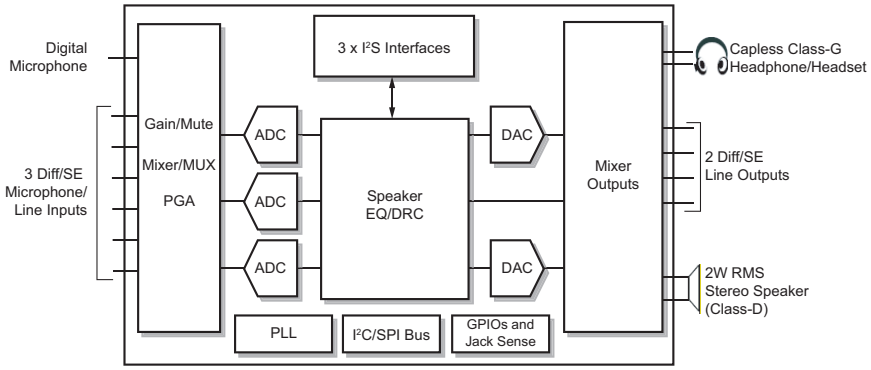
The device features a pair of ProCousticTM headphone drivers. The high-performance headphone drivers eliminate the need for an external headphone amplifier and DC blocking capacitors. The capless architecture outputs a full-range frequency response at 97 dB dynamic range. CX20787 supports both Apple and Nokia style headset jacks with fully integrated auto detect and switch and inline command button sensing. All output ports feature PopShield circuitry that eliminates pops or clicks.

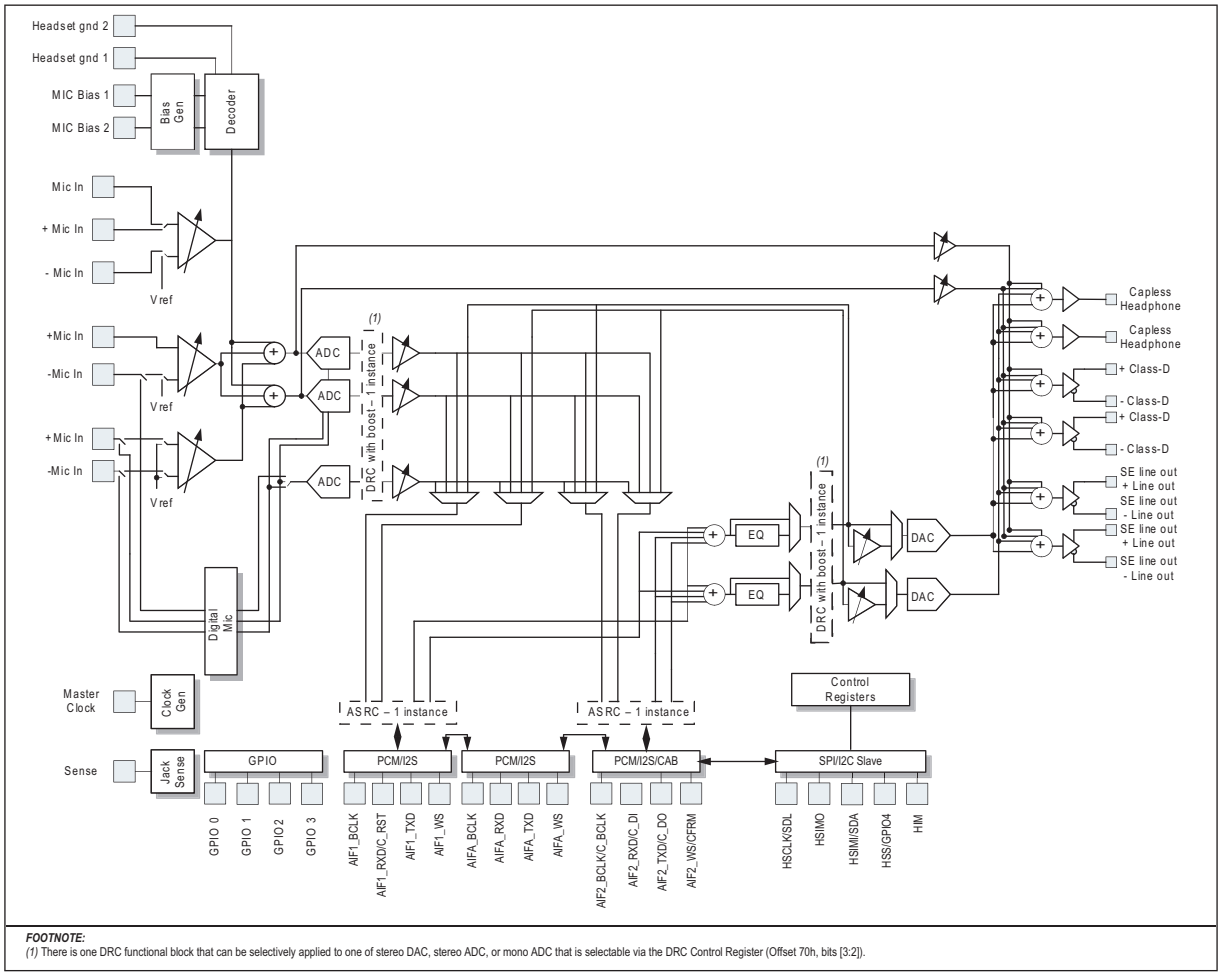
The integrated stereo filter-less Class-D amplifier with Spread Spectrum EMI dispersion technology is capable of outputting 2W-rms into a 4 Ω speaker with 5 V supply rail. The device can be completely powered by a 3.3 V supply rail with reduced Class-D output power. All other internal supply rails are generated by the integrated LDOs.

The digital I/Os, such as I²S ports, Conexant Audio Bus, etc., support a wide range of topologies for connections to both the application processor and baseband processor simultaneously. Additional salient features of CX20787 include Write Sequencer for ease of use.

CX20787 features Hardware Digital Volume Control, similar to an infinite volume control knob commonly found in high-end AV equipment. There is also a single-bit stream digital microphone interface that connects up to 3 digital microphones for dual microphone array implementations. The Digital Microphone Interface (DMI) is optimized with a hardware DC-level filter, which compliments and improves the compatibility with more digital microphones. A fully configurable hardware EQ and dual knee Dynamic Range Control with reconfigurable inputs is integrated to improve frequency response, maximize output volume, and protect speakers from over driving.

### Functional Block Diagram






***FOOTNOTE:***
*(1)* There is one DRC functional block that can be selectively applied to one of stereo DAC, stereo ADC, or mono ADC that is selectable via the DRC Control Register (Offset 70h, bits [3:2]).

## System Block Diagram



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**Distributor/Representative Information**

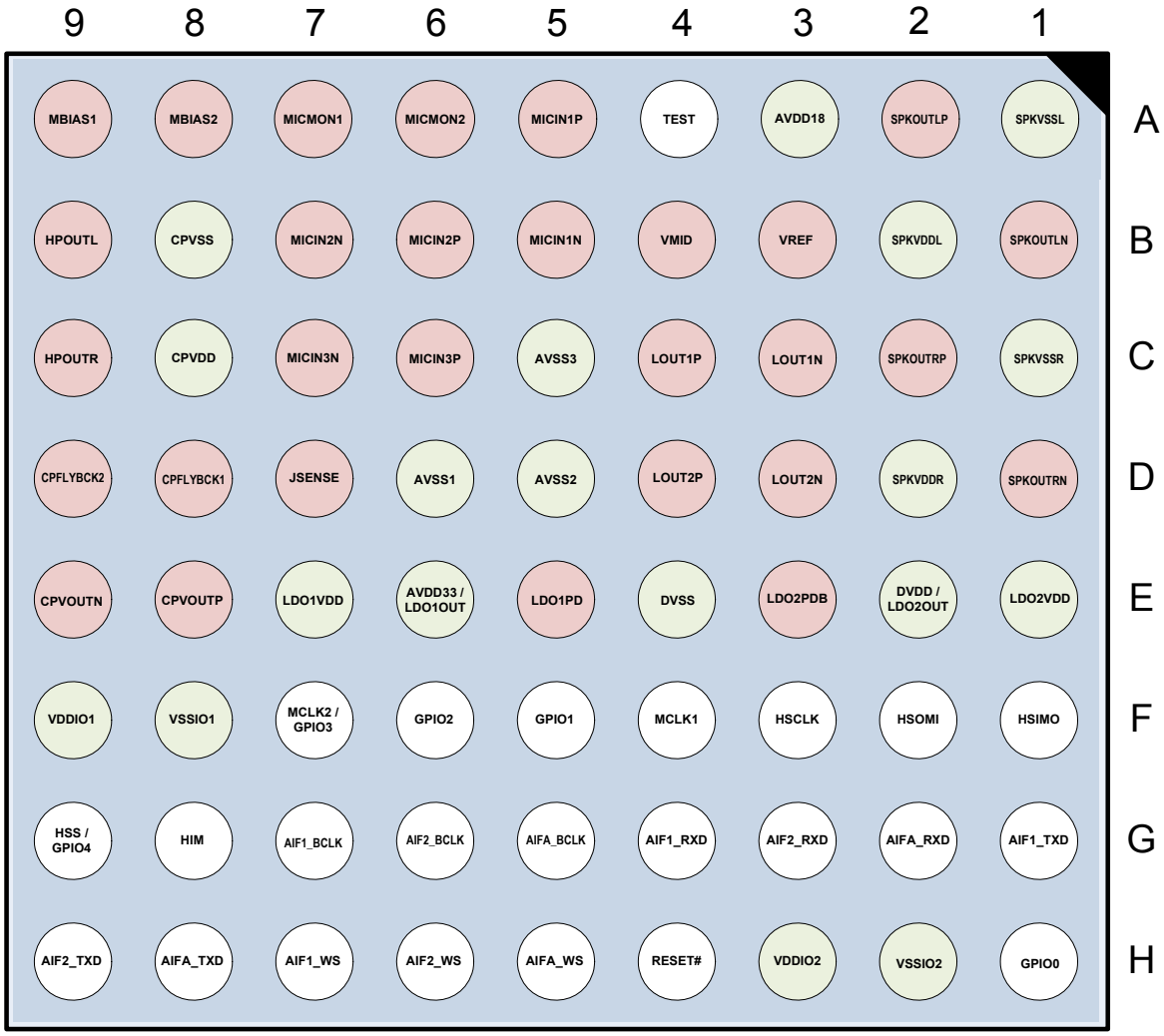
| TERMINAL | | | INPUT/ OUTPUT/ POWER (I/O/P) | DESCRIPTION |
|---|---|---|---|---|
| NAME | BALL WLP | TYPE | | |
| MBIAS1 | A9 | analog | O | Microphone Bias |
| MBIAS2 | A8 | analog | O | Microphone Bias |
| MICMON1 | A7 | analog | I | Microphone monitor input. Muxed – Headset Gnds/Mic |
| MICMON2 | A6 | analog | I | Microphone monitor input. Muxed – Headset Gnds/Mic |
| MICIN1P | A5 | analog | I | Differential microphone & digital mic inputs. (MICIN2N =DMIC1D, MICIN3P=DMIC2D, MICIN3N=DMICCLK) |
| MICIN1N | B5 | analog | I | Differential microphone & digital mic inputs. (MICIN2N =DMIC1D, MICIN3P=DMIC2D, MICIN3N=DMICCLK) |
| MICIN2P | B6 | analog | I | Differential microphone & digital mic inputs. (MICIN2N =DMIC1D, MICIN3P=DMIC2D, MICIN3N=DMICCLK) |
| MICIN2N | B7 | analog | I | Differential microphone & digital mic inputs. (MICIN2N =DMIC1D, MICIN3P=DMIC2D, MICIN3N=DMICCLK) |
| MICIN3P | C6 | analog | I | Differential microphone & digital mic inputs. (MICIN2N =DMIC1D, MICIN3P=DMIC2D, MICIN3N=DMICCLK) |
| MICIN3N | C7 | analog | I | Differential microphone & digital mic inputs. (MICIN2N =DMIC1D, MICIN3P=DMIC2D, MICIN3N=DMICCLK) |
| JSENSE | D7 | analog | I | Jack Sense input. |
| HPOUTL | B9 | analog | O | Capless Stereo Headphone Output. |
| HPOUTR | B8 | analog | O | Capless Stereo Headphone Output. |
| SPKOUTLN | B1 | analog | O | Stereo Differential Class D Speaker Output. |
| SPKOUTLP | A2 | analog | O | Stereo Differential Class D Speaker Output. |
| SPKOUTRN | C2 | analog | O | Stereo Differential Class D Speaker Output. |
| SPKOUTRP | D1 | analog | O | Stereo Differential Class D Speaker Output. |
| SPKVDDL | B2 | power | P | Speaker power |
| SPKVDDR | D2 | power | P | Speaker power |
| SPKVSSL | A1 | power | P | Speaker Ground |
| SPKVSSR | C1 | power | P | Speaker Ground |
| LOUT1N | C3 | analog | O | Differential Line outputs. |
| LOUT1P | C4 | analog | O | Differential Line outputs. |
| LOUT2N | D3 | analog | O | Differential Line outputs. |
| LOUT2P | D4 | analog | O | Differential Line outputs. |
| LDO1VDD | E7 | power | I | LDO input power |

| TERMINAL | | | INPUT/ OUTPUT/ POWER (I/O/P) | DESCRIPTION |
|---|---|---|---|---|
| NAME | BALL WLP | PIN QFN | | |
| LDO2VDD | E1 | power | I | LDO input power |
| LDO1PD | E5 | analog | I | Power-dn. LDO1PD active high power down. |
| LDO2PDB | E3 | analog | I | Power-dn. LDO2PDB is active low power down. |
| LDO1OUT | E6 | power | I | 3.0V, 0.95V power supplies. LDO1OUT = AVDD33, |
| LDO2OUT | E2 | power | I | 3.0V, 0.95V power supplies. LDO2OUT=DVDD |
| AVSS1 | D6 | power | I | Analog Ground. |
| AVSS2 | D5 | power | I | Analog Ground. |
| AVSS3 | C5 | power | I | Analog Ground. |
| DVSS | E4 | power | I | Digital Ground. (route to VSS ball) |
| VMID | B4 | analog | I/O | 3.3V / 2 reference. (ext decouple) |
| VREF | B3 | analog | I/O | Bandgap reference (ext decouple) |

| | | | | |
|---|---|---|---|---|
| CPVDD | C8 | analog | I/O | Charge-pump Supply |
| CPVSS | B8 | analog | I/O | Charge-pump Supply |
| CPFLYBCK1 | D8 | analog | I/O | Flyback capacitor |
| CPFLYBCK2 | D9 | analog | I/O | Flyback capacitor |
| CPVOUTP | E8 | analog | I/O | Charge-pump DC-DC supply. |
| CPVOUTN | E9 | analog | I/O | Charge-pump DC-DC supply. |
| VDDIO1 | F9 | power | I | Pad Ring Pwr. GPIO/I2S/I2S-pass-thru, & I2S/CAB/Host/Ctrl |
| VDDIO2 | H3 | power | I | Pad Ring Pwr. GPIO/I2S/I2S-pass-thru, & I2S/CAB/Host/Ctrl |
| VSSIO1 | F8 | power | I | Pad Ring Gnd. 3.3V nominal. 3 sets for VSSIO. |
| VSSIO2 | H2 | power | I | Pad Ring Gnd. 3.3V nominal. 3 sets for VSSIO. |
| MCLK1 | F4 | pd_gpio | I | Master Reference Clocks for PLLs. (MCLK2 = GPIO[3]) |
| MCLK2/GPIO3 | F7 | pd_gpio | I | Master Reference Clocks for PLLs. (MCLK2 = GPIO[3]) |
| GPIO2 | F6 | pd_gpio | I/O | 5-b General purpose I/O port. |
| GPIO1 | F5 | pd_gpio | I/O | 5-b General purpose I/O port. MCLK2 and HSS are alternative general purpose I/O ports. |
| GPIO0 | H1 | pd_gpio | I/O | 5-b General purpose I/O port. MCLK2 and HSS are alternative general purpose I/O ports. |
| HSCLK | F3 | pd_gpio | I | Serial Clock (or SCL) |
| HSIMO | F1 | pd_gpin | I | Serial Data input (alt_slave_id) |
| HSOMI | F2 | pd_gpio | I/O | Slave Output (or SDA) |

| TERMINAL | | | INPUT/ OUTPUT/ POWER (I/O/P) | DESCRIPTION |
|---|---|---|---|---|
| NAME | BALL WCSP | TYPE | | |
| LDO2VDD | E1 | power | P | LDO input power |
| HSS/GPIO4 | G9 | pd_gpio | I/O | Slave select (or GPIO[4]) |
| HIM | G8 | pd_gpio | I | Host Interface Mode, 1 = SPI, 0 = I2C |
| AIF{1,2,A}_BCLK | G{8,6,5} | pd_gpio | I/O | I2S/PCM Bit Clock (AIF2_BCLK = C_CLK) |
| AIF{1,2,A}_RXD | G{4,3,2} | pd_gpin | I | Receive Data (AIF2_RXD = C_DI,AIF1_RXD=C_RST) |
| AIF{1,2,A}_TXD | G{1}, H{9,8} | pd_gpio | O | Transmit Data (AIF2_TXD = C_DO) |
| AIF{1,2,A}_WS | H{7,6,5] | pd_gpio | I/O | Receive/Transmit Word Select (AIF2_WS = C_FRM |

# BOTTOM VIEW


9 8 7 6 5 4 3 2 1
A: MBIAS1 MBIAS2 MICMON1 MICMON2 MICIN1P TEST AVDD18 SPKOUTLP SPKVSSL
B: HPOUTL CPVSS MICIN2N MICIN2P MICIN1N VMID VREF SPKVDDL SPKOUTLN
C: HPOUTR CPVDD MICIN3N MICIN3P AVSS3 LOUT1P LOUT1N SPKOUTRP SPKVSSR
D: CPFLYBCK2 CPFLYBCK1 JSENSE AVSS1 AVSS2 LOUT2P LOUT2N SPKVDDR SPKOUTRN
E: CPVOUTN CPVOUTP LDO1VDD AVDD33 / LDO1OUT LDO1PD DVSS LDO2PDB DVDD / LDO2OUT LDO2VDD
F: VDDIO1 VSSIO1 MCLK2 / GPIO3 GPIO2 GPIO1 MCLK1 HSCLK HSOMI HSIMO
G: HSS / GPIO4 HIM AIF1_BCLK AIF2_BCLK AIFA_BCLK AIF1_RXD AIF2_RXD AIFA_RXD AIF1_TXD
H: AIF2_TXD AIFA_TXD AIF1_WS AIF2_WS AIFA_WS RESET# VDDIO2 VSSIO2 GPIO0

## ABSOLUTE MAXIMUM RATINGS(1)

over operating free–air temperature range, $T_A$ = 25°C (unless otherwise noted)

| | | VALUE / UNIT |
|---|---|---|
| | Supply voltage, AVDD, PVDD | - 0.3 V to 6.0 V |
| $V_I$ | Input Voltage | -0.3 V to $V_{DD}$ + 0.3 V |
| $T_A$ | Operating free-air temperature range | -40 ? C to 85 ? C |
| $T_J$ | Operating junction temperature range | -40 ? C to 150 ? C |
| $T_{stg}$ | Storage temperature range | -65 ? C to 85 ? C |
| | Lead temperature 1.6 mm (1/16 inch) from case for 10 seconds | 260 ? C |

## ORDERING GUIDE

| $T_A$ | PACKAGED DEVICES | PART NUMBER | SYMBOL |
|---|---|---|---|
| -40°C to 85°C | 72-ball, 4.0 mm × 3.9 mm WSCP | CX20787<br>xxx | TBD |
| | 88-pin, TBD LGA | CX20787<br>xxx | TBD |

## Device Power Supplies

| Parameter | Ball Name | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|
| Digital Core Supply | LDO2OUT (DVDD) | 0.95 | 1.0 | 1.98 | V |
| 3V Analog Supply | LDO1OUT (AVDD33) | 2.24 | 3.0 | 3.3 | V |
| Digital I/O Supply 1 | VDDIO1 | 1.62 | 1.8 | 3.6 | V |
| Digital I/O Supply 2 | VDDIO2 | 1.62 | 1.8 | 3.6 | V |
| 1.8V Analog Supply | AVDD18 | 1.71 | 1.8 | 1.98 | V |
| Charge Pump Supply | CPVDD | 1.71 | 1.8 | 1.98 | V |
| Left Speaker Supply | SPKVDDL | 2.7 | 5.0 | 5.5 | V |
| Right Speaker Supply | SPKVDDR | 2.7 | 5.0 | 5.5 | V |
| LDO1 Supply | LDO1VDD | 2.7 | 5.0 | 5.5 | V |
| LDO2 Supply | LDO2VDD | 1.71 | 1.8 | 1.98 | V |

## ELECTRICAL CHARACTERISTICS

$T_A$ = 25°C (unless otherwise noted); AVDD18 = 1.8 V; AVDD33 = 3.3 V; SPKVDD = 5 V; DVDD = 1.0 V

| PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|
| I2S to Headphone Out | All Supplies at Min Value | | 4.7 | | mW |
| | All Supplies at Typical | | 7.5 | | mW |
| Standby Power | All Supplies at Min Value | | 70 | | μW |
| | All Supplies at Typical | | 106 | | μW |
| Record Power | All Supplies at Min Value | | 15.5 | | mW |
| | All Supplies at Typical | | 23 | | mW |
| Digital Bypass Power | All Supplies at Min Value | | 9.3 | | mW |
| | All Supplies at Typical | | 17.2 | | mW |
| Handset Voice Power (analog MIC) | All Supplies at Min Value | | 6.4 | | mW |
| Handset Voice Power (digital MIC) | All Supplies at Min Value | | 4.1 | | mW |
| Speaker Leakage Power | All Supplies at Min Value | | 1 | | μW |
| | All Supplies at Typical | | 3 | | μW |
| I2S to Class-D Out | All Supplies at Min Value | | 7.6 | | mW |
| | All Supplies at Typical | | 15.2 | | mW |

## OPERATING CHARACTERISTICS

$T_A$ = 25°C (unless otherwise noted); AVDD18 = 1.8 V; AVDD33 = 3.3 V; SPKVDD = 5 V; DVDD = 1.0 V

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| **MIC – HEADPHONE** | | | | | | |
| SNR | Signal-to-noise ratio(1) | | | 97 | | dB |
| THD+N | Total harmonic distortion plus noise | $P_O$ = 20 mW, f = 1 kHz | | 83 | | dB |
| | | $P_O$ = 5 mW, f = 1 kHz | | 83 | | dB |
| **MIC – CLASS-D** | | | | | | |
| SNR | Signal-to-noise ratio(1) | | | 85 | | dB |
| THD+N | Total harmonic distortion plus noise | $P_O$ = 1.0 W, f = 1 kHz | | 65 | | dB |
| | | $P_O$ = 500 mW, f = 1 kHz | | 63 | | dB |
| **LINE IN – HEADPHONE** | | | | | | |
| SNR | Signal-to-noise ratio(1) | | | 97 | | dB |
| THD+N | Total harmonic distortion plus noise | $P_O$ = 20 mW, f = 1 kHz | | 85 | | dB |
| | | $P_O$ = 5 mW, f = 1 kHz | | 83 | | dB |
| | Crosstalk | (-20 dB, 10 kHz) | | 90 | | dB |
| **LINE IN – CLASS-D** | | | | | | |
| SNR | Signal-to-noise ratio(1) | | | 91 | | dB |
| THD+N | Total harmonic distortion plus noise | $P_O$ = 1.0 W, f = 1 kHz | | 65 | | dB |
| | | $P_O$ = 500 mW, f = 1 kHz | | 63 | | dB |
| **LINE IN – ADC** | | | | | | |
| SNR | Signal-to-noise ratio(1) | | | 92 | | dB |
| THD+N | Total harmonic distortion plus noise | -1 dBFS input | | 85 | | dB |
| | | -1 dBFS input | | 83 | | dB |
| | Crosstalk | | | 90 | | dB |
| **DAC – ADC** | | | | | | |
| SNR | Signal-to-noise ratio(1) | | | 92 | | dB |
| THD+N | Total harmonic distortion plus noise | -1 dBFS input | | 85 | | dB |
| | | -1 dBFS input | | 90 | | dB |
| **DAC – SE LINEOUT** | | | | | | |
| SNR | Signal-to-noise ratio(1) | | | 97 | | dB |
| THD+N | Total harmonic distortion plus noise | -1 dBFS input | | 75 | | dB |
| | Crosstalk | | | 85 | | dB |
| **DAC – DIFF LINEOUT** | | | | | | |
| SNR | Signal-to-noise ratio(1) | | | 97 | | dB |
| THD+N | Total harmonic distortion plus noise | -1 dBFS input | | 85 | | dB |
| | Crosstalk | | | 90 | | dB |
| **DAC – HEADPHONE** | | | | | | |
| SNR | Signal-to-noise ratio(1) | | | 97 | | dB |
| THD+N | Total harmonic distortion plus noise | $R_{hp}$ = 16 Ω $P_O$ = 20 mW, f = 1 kHz | | 85 | | dB |
| | | $R_{hp}$ = 16 Ω $P_O$ = 5 mW, f = 1 kHz | | 83 | | dB |
| | | $R_{hp}$ = 32 Ω $P_O$ = 20 mW, f = 1 kHz | | 83 | | dB |
| | | $R_{hp}$ = 32 Ω $P_O$ = 5 mW, f = 1 kHz | | 81 | | dB |
| | Crosstalk | | | 90 | | dB |
| **DAC – CLASS-D** | | | | | | |
| SNR | Signal-to-noise ratio(1) | | | 94 | | dB |
| THD+N | Total harmonic distortion plus noise | $P_O$ = 1.0 W, f = 1 kHz | | 68 | | dB |
| | | $P_O$ = 500 mW, f = 1 kHz | | 63 | | dB |
| | Crosstalk | | | 80 | | dB |
| | | | | | | |

(1) A-weighted