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8-CHANNEL HIGH DEFINITION AUDIO CODEC
STAC9227/9228/9228D
Description

The STAC9227/9228/9228D are a family of Theater Quality 8-channel audio CODECs that enable systems with 7.1 audio or 5.1 audio playing simultaneously with VoIP or another stereo audio stream. SigmaTel's proprietary $\Sigma\Delta$ technology provides high fidelity with an estimated DAC SNR up to 105dB. Up to four digital microphones are supported enabling high quality voice input for increased usability of voice applications.

Features

- **High performance HD Audio CODEC provides Theater Quality Audio**
- **High performance $\Sigma\Delta$ technology**
 - 105dB DAC SNR
 - 90dB ADC SNR
- **Four Stereo DACs and three stereo ADCs**
 - Supports 7.1 audio or 5.1 audio with simultaneous Real Time Communication (RTC) channel such as VoIP or separate stereo audio stream
- **24-bit resolution with up to 192 KHz sample rates**
- **Digital Microphone Interface (STAC9228X/D only)**
 - Direct interface up to four Digital Microphones
- **Analog Stereo Microphone**
 - Microphone Boost 0, 10, 20, 30, 40dB
 - Six adjustable Vref outputs for microphone bias
- **Integrated Headphone Amps (3).**
- **S/PDIF In and Out**
- **Volume Up/Down Control**
- **Jack Insertion Detect and Impedance Sensing Supports Jack Retasking and Universal Jacks**
- **Digital PC BEEP to all outputs**
- **+3.3 V to +5 V analog power supply options**
- **Environmental 48-pin LQFP package option**

Software Support

- **SKPI (Kernel Processing Interface)**
 - Enables plug-ins that can operate globally on all audio streams of the system
- **12 band parametric equalizer SKPI plug-in**
 - Constant, system-level effects tuned to optimize a particular platform can be combined with user-mode "presets" tailored for specific acoustical environments and applications
 - System-level effects automatically disabled when external connections made
- **Dynamics Processing SKPI plug-in**
 - Enables improved voice articulation
 - Compressor/limiter allows higher average noise level without resonances
- **Dolby Home Theatre (STAC9228D)**
- **Dolby Technologies**
 - Dolby Headphone™, Dolby Virtual Speaker™
 - Dolby ProLogic II™, Dolby ProLogic IIx™
 - Dolby Digital Live™
- **Intel Audio Studio™ from Sonic Focus**
- **Maxx Player™ from Waves**
- **Microphone Beam Forming, Acoustic Echo Cancellation, & Noise Suppression from Knowles™**

TABLE OF CONTENTS

| | |
|--|-----------|
| 1. DESCRIPTION | 14 |
| 2. CHARACTERISTICS | 15 |
| 2.1. Audio Fidelity | 15 |
| 2.2. Electrical Specifications | 15 |
| 2.2.1. Absolute Maximum Ratings | 15 |
| 2.2.2. Recommended Operation Conditions | 15 |
| 2.3. STAC9227/9228/9228D 5V, 4.5V, 4.0V, and 3.3V Analog Performance Characteristics | 17 |
| 3. DETAILED DESCRIPTION | 22 |
| 3.1. Universal Jacks™ | 22 |
| 3.1.1. Audio Jack Presence Detect | 22 |
| 3.2. Impedance Sense | 23 |
| 3.3. SPDIF Input | 23 |
| 3.4. SPDIF Output | 23 |
| 3.5. Digital Microphone Support (STAC9228X/D) | 23 |
| 3.6. Analog PC-Beep | 27 |
| 3.7. Headphone Drivers (Restrictions) | 27 |
| 3.8. Device IDs | 27 |
| 4. FUNCTIONAL BLOCK DIAGRAMS | 28 |
| 5. WIDGET DIAGRAM | 29 |
| 5.1. Pin Configuration Default Register Settings | 30 |
| 6. WIDGET INFORMATION FOR THE STAC9227/9228/9228D | 31 |
| 6.1. Root Node (NID = 0x00) | 33 |
| 6.1.1. Root ID | 33 |
| 6.1.2. Root RevID | 33 |
| 6.1.3. Root NodeInfo | 34 |
| 6.2. AFG Node (NID = 0x01) | 34 |
| 6.2.1. AFG Reset | 34 |
| 6.2.2. AFG NodeInfo | 35 |
| 6.2.3. AFG Type | 35 |
| 6.2.4. AFG Cap | 36 |
| 6.2.5. AFG PCMCap | 37 |
| 6.2.6. AFG Stream | 38 |
| 6.2.7. AFG InAmpCap | 38 |
| 6.2.8. AFG SupPwrState | 39 |
| 6.2.9. AFG GPIOCnt | 39 |
| 6.2.10. AFG OutAmpCap | 40 |
| 6.2.11. AFG PwrState | 41 |
| 6.2.12. AFG UnsolResp | 41 |
| 6.2.13. AFG GPIO | 42 |
| 6.2.14. AFG GPIOEn | 43 |
| 6.2.15. AFG GPIODir | 44 |
| 6.2.16. AFG GPIOWakeEn | 45 |
| 6.2.17. AFG GPIOUnsol | 46 |
| 6.2.18. AFG GPIOSticky | 47 |
| 6.2.19. AFG SubID | 48 |
| 6.2.20. AFG TCKT | 49 |
| 6.2.21. AFG Sply | 49 |
| 6.2.22. AFG DACMode | 50 |

| | |
|-----------------------------------|----|
| 6.2.23. AFG GPIOIrty | 50 |
| 6.2.24. AFG GPIODrive | 52 |
| 6.2.25. AFG DMic | 53 |
| 6.3. DAC0 Node (NID = 0x02) | 54 |
| 6.3.1. DAC0 Cnvtr | 54 |
| 6.3.2. DAC0 OutAmpRight | 55 |
| 6.3.3. DAC0 OutAmpLeft | 55 |
| 6.3.4. DAC0 WCap | 56 |
| 6.3.5. DAC0 PwrState | 57 |
| 6.3.6. DAC0 CnvtrID | 58 |
| 6.3.7. DAC0 LR | 58 |
| 6.4. DAC1 Node (NID = 0x03) | 59 |
| 6.4.1. DAC1 Cnvtr | 59 |
| 6.4.2. DAC1 OutAmpRight | 60 |
| 6.4.3. DAC1 OutAmpLeft | 60 |
| 6.4.4. DAC1 WCap | 61 |
| 6.4.5. DAC1 PwrState | 62 |
| 6.4.6. DAC1 CnvtrID | 63 |
| 6.4.7. DAC1 LR | 63 |
| 6.5. DAC2 Node (NID = 0x04) | 64 |
| 6.5.1. DAC2 Cnvtr | 64 |
| 6.5.2. DAC2 OutAmpRight | 65 |
| 6.5.3. DAC2 OutAmpLeft | 65 |
| 6.5.4. DAC2 WCap | 66 |
| 6.5.5. DAC2 PwrState | 67 |
| 6.5.6. DAC2 CnvtrID | 68 |
| 6.5.7. DAC2 LR | 68 |
| 6.6. DAC3 Node (NID = 0x05) | 69 |
| 6.6.1. DAC3 Cnvtr | 69 |
| 6.6.2. DAC3 OutAmpRight | 70 |
| 6.6.3. DAC3 OutAmpLeft | 70 |
| 6.6.4. DAC3 WCap | 71 |
| 6.6.5. DAC3 PwrState | 72 |
| 6.6.6. DAC3 CnvtrID | 73 |
| 6.6.7. DAC3 LR | 73 |
| 6.7. DAC4 Node (NID = 0x06) | 74 |
| 6.7.1. DAC4 Cnvtr | 74 |
| 6.7.2. DAC4 OutAmpRight | 75 |
| 6.7.3. DAC4 OutAmpLeft | 75 |
| 6.7.4. DAC4 WCap | 76 |
| 6.7.5. DAC4 PwrState | 77 |
| 6.7.6. DAC4 CnvtrID | 78 |
| 6.7.7. DAC4 LR | 78 |
| 6.8. ADC0 Node (NID = 0x07) | 79 |
| 6.8.1. ADC0 Cnvtr | 79 |
| 6.8.2. ADC0 WCap | 80 |
| 6.8.3. ADC0 ConLst | 81 |
| 6.8.4. ADC0 ConLstEntry | 81 |
| 6.8.5. ADC0 ProcState | 82 |
| 6.8.6. ADC0 PwrState | 82 |

| | |
|----------------------------------|-----|
| 6.8.7. | 83 |
| 6.9. ADC1 Node (NID = 0x08) | 84 |
| 6.9.1. ADC1 Cnvtr | 84 |
| 6.9.2. ADC1 WCap | 85 |
| 6.9.3. ADC1 ConLst | 86 |
| 6.9.4. ADC1 ConLstEntry | 86 |
| 6.9.5. ADC1 ProcState | 87 |
| 6.9.6. ADC1 PwrState | 87 |
| 6.9.7. ADC1 CnvtrID | 88 |
| 6.10. ADC2 Node (NID = 0x09) | 89 |
| 6.10.1. ADC2 Cnvtr | 89 |
| 6.10.2. ADC2 WCap | 90 |
| 6.10.3. ADC2 ConLst | 91 |
| 6.10.4. ADC2 ConLstEntry | 91 |
| 6.10.5. ADC2 ProcState | 92 |
| 6.10.6. ADC2 PwrState | 92 |
| 6.10.7. ADC2 CnvtrID | 93 |
| 6.11. SPDIFOut Node (NID = 0x1E) | 94 |
| 6.11.1. SPDIFOut Cnvtr | 94 |
| 6.11.2. SPDIFOut WCap | 95 |
| 6.11.3. SPDIFOut PCM | 96 |
| 6.11.4. SPDIFOut Stream | 97 |
| 6.11.5. SPDIFOut CnvtrID | 98 |
| 6.11.6. SPDIFOut DigCnvtr | 98 |
| 6.12. SPDIFIn Node (NID = 0x20) | 99 |
| 6.12.1. SPDIFIn Cnvtr | 99 |
| 6.12.2. SPDIFIn WCap | 100 |
| 6.12.3. SPDIFIn PCMCap | 101 |
| 6.12.4. SPDIFIn Stream | 102 |
| 6.12.5. SPDIFIn ConLst | 103 |
| 6.12.6. SPDIFIn ConLstEntry | 103 |
| 6.12.7. SPDIFIn CnvtrID | 104 |
| 6.12.8. SPDIFIn DigCnvtr | 104 |
| 6.12.9. SPDIFIn VCSR0 | 105 |
| 6.13. PortA Node (NID = 0x0A) | 107 |
| 6.13.1. PortA WCap | 107 |
| 6.13.2. PortA PinCap | 108 |
| 6.13.3. PortA ConLst | 109 |
| 6.13.4. PortA ConLstEntry | 110 |
| 6.13.5. PortA ConSelectCtrl | 110 |
| 6.13.6. PortA PinWCntrl | 110 |
| 6.13.7. PortA UnsolResp | 111 |
| 6.13.8. PortA ChSense | 112 |
| 6.13.9. PortA ConfigDefault | 112 |
| 6.14. PortB Node (NID = 0x0B) | 113 |
| 6.14.1. PortB WCap | 113 |
| 6.14.2. PortB PinCap | 114 |
| 6.14.3. PortB ConLst | 115 |
| 6.14.4. PortB ConLstEntry | 115 |
| 6.14.5. PortB ConSelectCtrl | 116 |

| | |
|-------------------------------------|-----|
| 6.14.6. PortB PinWCntrl | 116 |
| 6.14.7. PortB UnsolResp | 117 |
| 6.14.8. PortB ChSense | 118 |
| 6.14.9. PortB ConfigDefault | 118 |
| 6.15. PortC Node (NID = 0x0C) | 119 |
| 6.15.1. PortC WCap | 119 |
| 6.15.2. PortC PinCap | 120 |
| 6.15.3. PortC ConLst | 121 |
| 6.15.4. PortC ConLstEntry | 121 |
| 6.15.5. PortC PinWCntrl | 122 |
| 6.15.6. PortC UnsolResp | 122 |
| 6.15.7. PortC ChSense | 123 |
| 6.15.8. PortC ConfigDefault | 124 |
| 6.16. PortD Node (NID = 0x0D) | 124 |
| 6.16.1. PortD WCap | 124 |
| 6.16.2. PortD PinCap | 125 |
| 6.16.3. PortD ConLst | 126 |
| 6.16.4. PortD ConLstEntry | 127 |
| 6.16.5. PortD PinWCntrl | 127 |
| 6.16.6. PortD UnsolResp | 128 |
| 6.16.7. PortD ChSense | 128 |
| 6.16.8. PortD ConfigDefault | 129 |
| 6.17. PortE Node (NID = 0x0E) | 130 |
| 6.17.1. PortE WCap | 130 |
| 6.17.2. PortE PinCap | 131 |
| 6.17.3. PortE ConLst | 132 |
| 6.17.4. PortE ConLstEntry | 132 |
| 6.17.5. PortE PinWCntrl | 133 |
| 6.17.6. PortE UnsolResp | 133 |
| 6.17.7. PortE ChSense | 134 |
| 6.17.8. PortE ConfigDefault | 135 |
| 6.18. PortF Node (NID = 0x0F) | 135 |
| 6.18.1. PortF WCap | 135 |
| 6.18.2. PortF PinCap | 136 |
| 6.18.3. PortF ConLst | 137 |
| 6.18.4. PortF ConLstEntry | 138 |
| 6.18.5. PortF PinWCntrl | 138 |
| 6.18.6. PortF UnsolResp | 139 |
| 6.18.7. PortF ChSense | 140 |
| 6.18.8. PortF ConfigDefault | 140 |
| 6.19. PortG Node (NID = 0x10) | 141 |
| 6.19.1. PortG WCap | 141 |
| 6.19.2. PortG PinCap | 142 |
| 6.19.3. PortG ConLst | 143 |
| 6.19.4. PortG ConLstEntry | 143 |
| 6.19.5. PortG PinWCntrl | 144 |
| 6.19.6. PortG UnsolResp | 144 |
| 6.19.7. PortG ChSense | 145 |
| 6.19.8. PortG ConfigDefault | 146 |
| 6.20. PortH Node (NID = 0x11) | 146 |

| | |
|--|-----|
| 6.20.1. PortH WCap | 146 |
| 6.20.2. PortH PinCap | 147 |
| 6.20.3. PortH ConLst | 148 |
| 6.20.4. PortH ConLstEntry | 149 |
| 6.20.5. PortH PinWCntrl | 149 |
| 6.20.6. PortH UnsolResp | 150 |
| 6.20.7. PortH ChSense | 150 |
| 6.20.8. PortH ConfigDefault | 151 |
| 6.21. DMic0 Node (NID = 0x13) | 152 |
| 6.21.1. DMic0 WCap | 152 |
| 6.21.2. DMic0 PinCap | 153 |
| 6.21.3. DMic0 PinWCntrl | 154 |
| 6.21.4. DMic0 ConfigDefault | 154 |
| 6.22. DMic1 Node (NID = 0x14) | 155 |
| 6.22.1. DMic1 WCap | 155 |
| 6.22.2. DMic1 PinCap | 156 |
| 6.22.3. DMic1 PinWCntrl | 157 |
| 6.22.4. DMic1 ConfigDefault | 157 |
| 6.23. DigOut0 Node (NID = 0x21) | 158 |
| 6.23.1. DigOut0 WCap | 158 |
| 6.23.2. DigOut0 PinCap | 159 |
| 6.23.3. DigOut0 ConLst | 160 |
| 6.23.4. DigOut0 ConLstEntry0 | 160 |
| 6.23.5. DigOut0 ConLstEntry4 | 161 |
| 6.23.6. DigOut0 ConSelectCtrl | 161 |
| 6.23.7. DigOut0 PinWCntrl | 162 |
| 6.23.8. DigOut0 ConfigDefault | 162 |
| 6.24. DigIn Node (NID = 0x22) | 163 |
| 6.24.1. DigIn WCap | 163 |
| 6.24.2. DigIn PinCap | 164 |
| 6.24.3. DigIn PwrState | 165 |
| 6.24.4. DigIn PinWCntrl | 165 |
| 6.24.5. DigIn UnsolResp | 166 |
| 6.24.6. DigIn ChSense | 166 |
| 6.24.7. DigIn EAPD | 167 |
| 6.24.8. DigIn ConfigDefault | 168 |
| 6.25. InPort0Mux Node (NID = 0x15) | 168 |
| 6.25.1. InPort0Mux WCap | 168 |
| 6.25.2. InPort0Mux ConLst | 169 |
| 6.25.3. InPort0Mux OutAmpCap | 170 |
| 6.25.4. InPort0Mux OutAmpRight | 170 |
| 6.25.5. InPort0Mux OutAmpLeft | 171 |
| 6.25.6. InPort0Mux ConSelectCtrl | 171 |
| 6.25.7. InPort0Mux ConLstEntry0 | 172 |
| 6.25.8. InPort0Mux ConLstEntry4 | 172 |
| 6.25.9. InPort0Mux ConLstEntry8 | 173 |
| 6.26. InPort1Mux Node (NID = 0x16) | 173 |
| 6.26.1. InPort1Mux WCap | 173 |
| 6.26.2. InPort1Mux ConLst | 174 |
| 6.26.3. InPort1Mux OutAmpCap | 175 |

| | |
|--|-----|
| 6.26.4. InPort1Mux OutAmpRight | 175 |
| 6.26.5. InPort1Mux OutAmpLeft | 176 |
| 6.26.6. InPort1Mux ConSelectCtrl | 176 |
| 6.26.7. InPort1Mux ConLstEntry0 | 177 |
| 6.26.8. InPort1Mux ConLstEntry4 | 177 |
| 6.26.9. InPort1Mux ConLstEntry8 | 178 |
| 6.27. InPort2Mux Node (NID = 0x17) | 178 |
| 6.27.1. InPort2Mux WCap | 178 |
| 6.27.2. InPort2Mux ConLst | 179 |
| 6.27.3. InPort2Mux OutAmpCap | 180 |
| 6.27.4. InPort2Mux OutAmpRight | 180 |
| 6.27.5. InPort2Mux OutAmpLeft | 181 |
| 6.27.6. InPort2Mux ConSelectCtrl | 181 |
| 6.27.7. InPort2Mux ConLstEntry0 | 182 |
| 6.27.8. InPort2Mux ConLstEntry4 | 182 |
| 6.27.9. InPort2Mux ConLstEntry8 | 183 |
| 6.28. PCBEEP Node (NID = 0x23) | 183 |
| 6.28.1. PCBEEP OutAmpLeft | 183 |
| 6.28.2. PCBEEP WCap | 184 |
| 6.28.3. PCBEEP OutAmpCap | 184 |
| 6.28.4. PCBEEP Gen | 185 |
| 6.29. CD Node (NID = 0x12) | 186 |
| 6.29.1. CD WCap | 186 |
| 6.29.2. CD PinCap | 187 |
| 6.29.3. CD PinWCntrl | 188 |
| 6.29.4. CD ConfigDefault | 189 |
| 6.30. Reserved Node (NID = 0x1F) | 189 |
| 6.31. VolumeKnob Node (NID = 0x24) | 189 |
| 6.31.1. VolumeKnob WCap | 189 |
| 6.31.2. VolumeKnob VolKnobCap | 190 |
| 6.31.3. VolumeKnob ConLst | 190 |
| 6.31.4. VolumeKnob ConLstEntry0 | 191 |
| 6.31.5. VolumeKnob ConLstEntry4 | 191 |
| 6.31.6. VolumeKnob UnsolResp | 192 |
| 6.31.7. VolumeKnob Cntrl | 192 |
| 6.31.8. VolumeKnob VCSR0 | 193 |
| 6.32. InPort0Vol Node (NID = 0x18) | 193 |
| 6.32.1. InPort0Vol WCap | 193 |
| 6.32.2. InPort0Vol ConLst | 194 |
| 6.32.3. InPort0Vol InAmpRight | 195 |
| 6.32.4. InPort0Vol InAmpLeft | 195 |
| 6.32.5. InPort0Vol ConLstEntry | 196 |
| 6.33. InPort1Vol Node (NID = 0x19) | 196 |
| 6.33.1. InPort1Vol WCap | 196 |
| 6.33.2. InPort1Vol ConLst | 197 |
| 6.33.3. InPort1Vol InAmpRight | 198 |
| 6.33.4. InPort1Vol InAmpLeft | 198 |
| 6.33.5. InPort1Vol ConLstEntry | 198 |
| 6.34. InPort2Vol Node (NID = 0x1A) | 199 |
| 6.34.1. InPort2Vol WCap | 199 |

| | |
|--|------------|
| 6.34.2. InPort2Vol ConLst | 200 |
| 6.34.3. InPort2Vol InAmpRight | 200 |
| 6.34.4. InPort2Vol InAmpLeft | 201 |
| 6.34.5. InPort2Vol ConLstEntry | 201 |
| 6.35. ADC0Mux Node (NID = 0x1B) | 202 |
| 6.35.1. ADC0Mux WCap | 202 |
| 6.35.2. ADC0Mux ConLst | 203 |
| 6.35.3. ADC0Mux ConSelectCtrl | 203 |
| 6.35.4. ADC0Mux ConLstEntry | 203 |
| 6.35.5. ADC0Mux LR | 204 |
| 6.35.6. ADC0Mux OutAmpCap | 204 |
| 6.35.7. ADC0Mux OutAmpRight | 205 |
| 6.35.8. ADC0Mux OutAmpLeft | 205 |
| 6.36. ADC1Mux Node (NID = 0x1C) | 206 |
| 6.36.1. ADC1Mux WCap | 206 |
| 6.36.2. ADC1Mux ConLst | 207 |
| 6.36.3. ADC1Mux ConSelectCtrl | 207 |
| 6.36.4. ADC1Mux ConLstEntry | 208 |
| 6.36.5. ADC1Mux LR | 208 |
| 6.36.6. ADC1Mux OutAmpCap | 209 |
| 6.36.7. ADC1Mux OutAmpRight | 209 |
| 6.36.8. ADC1Mux OutAmpLeft | 210 |
| 6.37. ADC2Mux Node (NID = 0x1D) | 210 |
| 6.37.1. ADC2Mux WCap | 210 |
| 6.37.2. ADC2Mux ConLst | 211 |
| 6.37.3. ADC2Mux ConSelectCtrl | 212 |
| 6.37.4. ADC2Mux ConLstEntry | 212 |
| 6.37.5. ADC2Mux LR | 213 |
| 6.37.6. ADC2Mux OutAmpCap | 213 |
| 6.37.7. ADC2Mux OutAmpRight | 214 |
| 6.37.8. ADC2Mux OutAmpLeft | 214 |
| 7. ORDERING INFORMATION | 216 |
| 7.1. STAC9227/9228/9228D Options and Part Order Numbers | 216 |
| 8. PIN INFORMATION | 217 |
| 8.1. STAC9227/28/29/30 48-Pin LQFP Diagram | 217 |
| 8.2. Pin Table | 218 |
| 9. PACKAGE OUTLINE AND PACKAGE DIMENSIONS | 220 |
| 9.1. 48-Pin LQFP | 220 |
| 10. SOLDER REFLOW PROFILE | 221 |
| 10.1. Standard Reflow Profile Data | 221 |
| 10.2. Pb Free Process - Package Classification Reflow Temperatures | 222 |
| 11. REVISION HISTORY | 223 |

List of Figures

| | |
|--|-----|
| Figure 1. Single Digital Microphone (data is ported to both left and right channels) | 26 |
| Figure 2. Stereo Digital Microphone Configuration | 27 |
| Figure 3. Quad Digital Microphone Configuration | 28 |
| Figure 4. 48-Pin LQFP Pinout | 248 |
| Figure 5. 48-Pin LQFP Package Outline and Package Dimensions | 255 |
| Figure 6. Solder Reflow Profile | 256 |

List of Tables

| | |
|--|----|
| Table 2. Valid Digital Microphone Configurations | 30 |
| Table 3. DMIC_CLK, DMIC_0 and DMIC_1 Operation During Power States | 30 |
| Table 4. Device IDs | 33 |
| Table 5. Pin Configuration Default Settings | 37 |
| Table 6. High Definition Audio Widget List | 38 |
| Table 7. Root ID Command Verb Format | 40 |
| Table 8. Root ID Command Response Format | 40 |
| Table 9. Root RevID Command Verb Format | 40 |
| Table 10. Root RevID Command Response Format | 40 |
| Table 11. Root NodeInfo Command Verb Format | 41 |
| Table 12. Root NodeInfo Command Response Format | 41 |
| Table 13. AFG Reset Command Verb Format | 41 |
| Table 14. AFG Reset Command Response Format | 42 |
| Table 15. AFG NodeInfo Command Verb Format | 42 |
| Table 16. AFG NodeInfo Command Response Format | 42 |
| Table 17. AFG Type Command Verb Format | 42 |
| Table 18. AFG Type Command Response Format | 43 |
| Table 19. AFG Cap Command Verb Format | 43 |
| Table 20. AFG Cap Command Response Format | 43 |
| Table 21. AFG PCMCap Command Verb Format | 44 |
| Table 22. AFG PCMCap Command Response Format | 44 |
| Table 23. AFG Stream Command Verb Format | 45 |
| Table 24. AFG Stream Command Response Format | 45 |
| Table 25. AFG InAmpCap Command Verb Format | 45 |
| Table 26. AFG InAmpCap Command Response Format | 45 |
| Table 27. AFG SupPwrState Command Verb Format | 46 |
| Table 28. AFG SupPwrState Command Response Format | 46 |
| Table 29. AFG GPIOCnt Command Verb Format | 46 |
| Table 30. AFG GPIOCnt Command Response Format | 47 |
| Table 31. AFG OutAmpCap Command Verb Format | 47 |
| Table 32. AFG OutAmpCap Command Response Format | 47 |
| Table 33. AFG PwrState Command Verb Format | 48 |
| Table 34. AFG PwrState Command Response Format | 48 |
| Table 35. AFG UnsolResp Command Verb Format | 48 |
| Table 36. AFG UnsolResp Command Response Format | 49 |
| Table 37. AFG GPIO Command Verb Format | 49 |
| Table 38. AFG GPIO Command Response Format | 49 |
| Table 39. AFG GPIOEn Command Verb Format | 50 |
| Table 40. AFG GPIOEn Command Response Format | 50 |
| Table 41. AFG GPIODir Command Verb Format | 51 |
| Table 42. AFG GPIODir Command Response Format | 51 |
| Table 43. AFG GPIOWakeEn Command Verb Format | 52 |
| Table 44. AFG GPIOWakeEn Command Response Format | 52 |
| Table 45. AFG GPIOUnsol Command Verb Format | 53 |
| Table 46. AFG GPIOUnsol Command Response Format | 53 |
| Table 47. AFG GPIOSticky Command Verb Format | 54 |
| Table 48. AFG GPIOSticky Command Response Format | 54 |
| Table 49. AFG SubID Command Verb Format | 55 |
| Table 50. AFG SubID Command Response Format | 55 |
| Table 51. AFG TCKT Command Verb Format | 56 |
| Table 52. AFG TCKT Command Response Format | 56 |
| Table 53. AFG Sply Command Verb Format | 56 |

| | |
|---|----|
| Table 54. AFG Sply Command Response Format | 56 |
| Table 55. AFG DACMode Command Verb Format | 57 |
| Table 56. AFG DACMode Command Response Format | 57 |
| Table 57. AFG GPIOIrty Command Verb Format | 57 |
| Table 58. AFG GPIOIrty Command Response Format | 58 |
| Table 59. AFG GPIODrive Command Verb Format | 59 |
| Table 60. AFG GPIODrive Command Response Format | 59 |
| Table 61. AFG DMic Command Verb Format | 60 |
| Table 62. AFG DMic Command Response Format | 60 |
| Table 63. DAC0 Cnvtr Command Verb Format | 61 |
| Table 64. DAC0 Cnvtr Command Response Format | 61 |
| Table 65. DAC0 OutAmpRight Command Verb Format | 62 |
| Table 66. DAC0 OutAmpRight Command Response Format | 62 |
| Table 67. DAC0 OutAmpLeft Command Verb Format | 62 |
| Table 68. DAC0 OutAmpLeft Command Response Format | 63 |
| Table 69. DAC0 WCap Command Verb Format | 63 |
| Table 70. DAC0 WCap Command Response Format | 63 |
| Table 71. DAC0 PwrState Command Verb Format | 64 |
| Table 72. DAC0 PwrState Command Response Format | 64 |
| Table 73. DAC0 CnvtrID Command Verb Format | 65 |
| Table 74. DAC0 CnvtrID Command Response Format | 65 |
| Table 75. DAC0 LR Command Verb Format | 65 |
| Table 76. DAC0 LR Command Response Format | 65 |
| Table 77. DAC1 Cnvtr Command Verb Format | 66 |
| Table 78. DAC1 Cnvtr Command Response Format | 66 |
| Table 79. DAC1 OutAmpRight Command Verb Format | 67 |
| Table 80. DAC1 OutAmpRight Command Response Format | 67 |
| Table 81. DAC1 OutAmpLeft Command Verb Format | 67 |
| Table 82. DAC1 OutAmpLeft Command Response Format | 68 |
| Table 83. DAC1 WCap Command Verb Format | 68 |
| Table 84. DAC1 WCap Command Response Format | 68 |
| Table 85. DAC1 PwrState Command Verb Format | 69 |
| Table 86. DAC1 PwrState Command Response Format | 69 |
| Table 87. DAC1 CnvtrID Command Verb Format | 70 |
| Table 88. DAC1 CnvtrID Command Response Format | 70 |
| Table 89. DAC1 LR Command Verb Format | 70 |
| Table 90. DAC1 LR Command Response Format | 70 |
| Table 91. DAC2 Cnvtr Command Verb Format | 71 |
| Table 92. DAC2 Cnvtr Command Response Format | 71 |
| Table 93. DAC2 OutAmpRight Command Verb Format | 72 |
| Table 94. DAC2 OutAmpRight Command Response Format | 72 |
| Table 95. DAC2 OutAmpLeft Command Verb Format | 72 |
| Table 96. DAC2 OutAmpLeft Command Response Format | 73 |
| Table 97. DAC2 WCap Command Verb Format | 73 |
| Table 98. DAC2 WCap Command Response Format | 73 |
| Table 99. DAC2 PwrState Command Verb Format | 74 |
| Table 100. DAC2 PwrState Command Response Format | 74 |
| Table 101. DAC2 CnvtrID Command Verb Format | 75 |
| Table 102. DAC2 CnvtrID Command Response Format | 75 |
| Table 103. DAC2 LR Command Verb Format | 75 |
| Table 104. DAC2 LR Command Response Format | 75 |
| Table 105. DAC3 Cnvtr Command Verb Format | 76 |
| Table 106. DAC3 Cnvtr Command Response Format | 76 |
| Table 107. DAC3 OutAmpRight Command Verb Format | 77 |
| Table 108. DAC3 OutAmpRight Command Response Format | 77 |
| Table 109. DAC3 OutAmpLeft Command Verb Format | 77 |

| | |
|---|----|
| Table 110. DAC3 OutAmpLeft Command Response Format | 78 |
| Table 111. DAC3 WCap Command Verb Format | 78 |
| Table 112. DAC3 WCap Command Response Format | 78 |
| Table 113. DAC3 PwrState Command Verb Format | 79 |
| Table 114. DAC3 PwrState Command Response Format | 79 |
| Table 115. DAC3 CnvtrID Command Verb Format | 80 |
| Table 116. DAC3 CnvtrID Command Response Format | 80 |
| Table 117. DAC3 LR Command Verb Format | 80 |
| Table 118. DAC3 LR Command Response Format | 80 |
| Table 119. DAC4 Cnvtr Command Verb Format | 81 |
| Table 120. DAC4 Cnvtr Command Response Format | 81 |
| Table 121. DAC4 OutAmpRight Command Verb Format | 82 |
| Table 122. DAC4 OutAmpRight Command Response Format | 82 |
| Table 123. DAC4 OutAmpLeft Command Verb Format | 82 |
| Table 124. DAC4 OutAmpLeft Command Response Format | 83 |
| Table 125. DAC4 WCap Command Verb Format | 83 |
| Table 126. DAC4 WCap Command Response Format | 83 |
| Table 127. DAC4 PwrState Command Verb Format | 84 |
| Table 128. DAC4 PwrState Command Response Format | 84 |
| Table 129. DAC4 CnvtrID Command Verb Format | 85 |
| Table 130. DAC4 CnvtrID Command Response Format | 85 |
| Table 131. DAC4 LR Command Verb Format | 85 |
| Table 132. DAC4 LR Command Response Format | 85 |
| Table 133. ADC0 Cnvtr Command Verb Format | 86 |
| Table 134. ADC0 Cnvtr Command Response Format | 86 |
| Table 135. ADC0 WCap Command Verb Format | 87 |
| Table 136. ADC0 WCap Command Response Format | 87 |
| Table 137. ADC0 ConLst Command Verb Format | 88 |
| Table 138. ADC0 ConLst Command Response Format | 88 |
| Table 139. ADC0 ConLstEntry Command Verb Format | 88 |
| Table 140. ADC0 ConLstEntry Command Response Format | 89 |
| Table 141. ADC0 ProcState Command Verb Format | 89 |
| Table 142. ADC0 ProcState Command Response Format | 89 |
| Table 143. ADC0 PwrState Command Verb Format | 89 |
| Table 144. ADC0 PwrState Command Response Format | 90 |
| Table 145. ADC0 CnvtrID Command Verb Format | 90 |
| Table 146. ADC0 CnvtrID Command Response Format | 90 |
| Table 147. ADC1 Cnvtr Command Verb Format | 91 |
| Table 148. ADC1 Cnvtr Command Response Format | 91 |
| Table 149. ADC1 WCap Command Verb Format | 92 |
| Table 150. ADC1 WCap Command Response Format | 92 |
| Table 151. ADC1 ConLst Command Verb Format | 93 |
| Table 152. ADC1 ConLst Command Response Format | 93 |
| Table 153. ADC1 ConLstEntry Command Verb Format | 93 |
| Table 154. ADC1 ConLstEntry Command Response Format | 94 |
| Table 155. ADC1 ProcState Command Verb Format | 94 |
| Table 156. ADC1 ProcState Command Response Format | 94 |
| Table 157. ADC1 PwrState Command Verb Format | 94 |
| Table 158. ADC1 PwrState Command Response Format | 95 |
| Table 159. ADC1 CnvtrID Command Verb Format | 95 |
| Table 160. ADC1 CnvtrID Command Response Format | 95 |
| Table 161. ADC2 Cnvtr Command Verb Format | 96 |
| Table 162. ADC2 Cnvtr Command Response Format | 96 |
| Table 163. ADC2 WCap Command Verb Format | 97 |
| Table 164. ADC2 WCap Command Response Format | 97 |

| | |
|--|-----|
| Table 165. ADC2 ConLst Command Verb Format | 98 |
| Table 166. ADC2 ConLst Command Response Format | 98 |
| Table 167. ADC2 ConLstEntry Command Verb Format | 98 |
| Table 168. ADC2 ConLstEntry Command Response Format | 99 |
| Table 169. ADC2 ProcState Command Verb Format | 99 |
| Table 170. ADC2 ProcState Command Response Format | 99 |
| Table 171. ADC2 PwrState Command Verb Format | 99 |
| Table 172. ADC2 PwrState Command Response Format | 100 |
| Table 173. ADC2 CnvtrID Command Verb Format | 100 |
| Table 174. ADC2 CnvtrID Command Response Format | 100 |
| Table 175. SPDIFOut Cnvtr Command Verb Format | 101 |
| Table 176. SPDIFOut Cnvtr Command Response Format | 101 |
| Table 177. SPDIFOut WCap Command Verb Format | 102 |
| Table 178. SPDIFOut WCap Command Response Format | 102 |
| Table 179. SPDIFOut PCM Command Verb Format | 103 |
| Table 180. SPDIFOut PCM Command Response Format | 103 |
| Table 181. SPDIFOut Stream Command Verb Format | 104 |
| Table 182. SPDIFOut Stream Command Response Format | 104 |
| Table 183. SPDIFOut CnvtrID Command Verb Format | 105 |
| Table 184. SPDIFOut CnvtrID Command Response Format | 105 |
| Table 185. SPDIFOut DigCnvtr Command Verb Format | 105 |
| Table 186. SPDIFOut DigCnvtr Command Response Format | 105 |
| Table 187. SPDIFIn Cnvtr Command Verb Format | 106 |
| Table 188. SPDIFIn Cnvtr Command Response Format | 106 |
| Table 189. SPDIFIn WCap Command Verb Format | 107 |
| Table 190. SPDIFIn WCap Command Response Format | 108 |
| Table 191. SPDIFIn PCMCap Command Verb Format | 108 |
| Table 192. SPDIFIn PCMCap Command Response Format | 109 |
| Table 193. SPDIFIn Stream Command Verb Format | 109 |
| Table 194. SPDIFIn Stream Command Response Format | 110 |
| Table 195. SPDIFIn ConLst Command Verb Format | 110 |
| Table 196. SPDIFIn ConLst Command Response Format | 110 |
| Table 197. SPDIFIn ConLstEntry Command Verb Format | 110 |
| Table 198. SPDIFIn ConLstEntry Command Response Format | 110 |
| Table 199. SPDIFIn CnvtrID Command Verb Format | 111 |
| Table 200. SPDIFIn CnvtrID Command Response Format | 111 |
| Table 201. SPDIFIn DigCnvtr Command Verb Format | 111 |
| Table 202. SPDIFIn DigCnvtr Command Response Format | 112 |
| Table 203. SPDIFIn VCSR0 Command Verb Format | 112 |
| Table 204. SPDIFIn VCSR0 Command Response Format | 112 |
| Table 205. PortA WCap Command Verb Format | 114 |
| Table 206. PortA WCap Command Response Format | 114 |
| Table 207. PortA PinCap Command Verb Format | 115 |
| Table 208. PortA PinCap Command Response Format | 115 |
| Table 209. PortA ConLst Command Verb Format | 116 |
| Table 210. PortA ConLst Command Response Format | 116 |
| Table 211. PortA ConLstEntry Command Verb Format | 117 |
| Table 212. PortA ConLstEntry Command Response Format | 117 |
| Table 213. PortA ConSelectCtrl Command Verb Format | 117 |
| Table 214. PortA ConSelectCtrl Command Response Format | 117 |
| Table 215. PortA PinWCntrl Command Verb Format | 117 |
| Table 216. PortA PinWCntrl Command Response Format | 118 |
| Table 217. PortA UnsolResp Command Verb Format | 118 |
| Table 218. PortA UnsolResp Command Response Format | 118 |
| Table 219. PortA ChSense Command Verb Format | 119 |

| | |
|--|-----|
| Table 220. PortA ChSense Command Response Format | 119 |
| Table 221. PortA ConfigDefault Command Verb Format | 119 |
| Table 222. PortA ConfigDefault Command Response Format | 120 |
| Table 223. PortB WCap Command Verb Format | 120 |
| Table 224. PortB WCap Command Response Format | 120 |
| Table 225. PortB PinCap Command Verb Format | 121 |
| Table 226. PortB PinCap Command Response Format | 121 |
| Table 227. PortB ConLst Command Verb Format | 122 |
| Table 228. PortB ConLst Command Response Format | 122 |
| Table 229. PortB ConLstEntry Command Verb Format | 122 |
| Table 230. PortB ConLstEntry Command Response Format | 123 |
| Table 231. PortB ConSelectCtrl Command Verb Format | 123 |
| Table 232. PortB ConSelectCtrl Command Response Format | 123 |
| Table 233. PortB PinWCntrl Command Verb Format | 123 |
| Table 234. PortB PinWCntrl Command Response Format | 124 |
| Table 235. PortB UnsolResp Command Verb Format | 124 |
| Table 236. PortB UnsolResp Command Response Format | 124 |
| Table 237. PortB ChSense Command Verb Format | 125 |
| Table 238. PortB ChSense Command Response Format | 125 |
| Table 239. PortB ConfigDefault Command Verb Format | 125 |
| Table 240. PortB ConfigDefault Command Response Format | 126 |
| Table 241. PortC WCap Command Verb Format | 126 |
| Table 242. PortC WCap Command Response Format | 126 |
| Table 243. PortC PinCap Command Verb Format | 127 |
| Table 244. PortC PinCap Command Response Format | 127 |
| Table 245. PortC ConLst Command Verb Format | 128 |
| Table 246. PortC ConLst Command Response Format | 128 |
| Table 247. PortC ConLstEntry Command Verb Format | 128 |
| Table 248. PortC ConLstEntry Command Response Format | 128 |
| Table 249. PortC PinWCntrl Command Verb Format | 129 |
| Table 250. PortC PinWCntrl Command Response Format | 129 |
| Table 251. PortC UnsolResp Command Verb Format | 129 |
| Table 252. PortC UnsolResp Command Response Format | 130 |
| Table 253. PortC ChSense Command Verb Format | 130 |
| Table 254. PortC ChSense Command Response Format | 130 |
| Table 255. PortC ConfigDefault Command Verb Format | 131 |
| Table 256. PortC ConfigDefault Command Response Format | 131 |
| Table 257. PortD WCap Command Verb Format | 131 |
| Table 258. PortD WCap Command Response Format | 132 |
| Table 259. PortD PinCap Command Verb Format | 132 |
| Table 260. PortD PinCap Command Response Format | 133 |
| Table 261. PortD ConLst Command Verb Format | 133 |
| Table 262. PortD ConLst Command Response Format | 133 |
| Table 263. PortD ConLstEntry Command Verb Format | 134 |
| Table 264. PortD ConLstEntry Command Response Format | 134 |
| Table 265. PortD PinWCntrl Command Verb Format | 134 |
| Table 266. PortD PinWCntrl Command Response Format | 134 |
| Table 267. PortD UnsolResp Command Verb Format | 135 |
| Table 268. PortD UnsolResp Command Response Format | 135 |
| Table 269. PortD ChSense Command Verb Format | 135 |
| Table 270. PortD ChSense Command Response Format | 136 |
| Table 271. PortD ConfigDefault Command Verb Format | 136 |
| Table 272. PortD ConfigDefault Command Response Format | 137 |
| Table 273. PortE WCap Command Verb Format | 137 |
| Table 274. PortE WCap Command Response Format | 137 |

| | |
|--|-----|
| Table 275. PortE PinCap Command Verb Format | 138 |
| Table 276. PortE PinCap Command Response Format | 138 |
| Table 277. PortE ConLst Command Verb Format | 139 |
| Table 278. PortE ConLst Command Response Format | 139 |
| Table 279. PortE ConLstEntry Command Verb Format | 139 |
| Table 280. PortE ConLstEntry Command Response Format | 139 |
| Table 281. PortE PinWCntrl Command Verb Format | 140 |
| Table 282. PortE PinWCntrl Command Response Format | 140 |
| Table 283. PortE UnsolResp Command Verb Format | 140 |
| Table 284. PortE UnsolResp Command Response Format | 141 |
| Table 285. PortE ChSense Command Verb Format | 141 |
| Table 286. PortE ChSense Command Response Format | 141 |
| Table 287. PortE ConfigDefault Command Verb Format | 142 |
| Table 288. PortE ConfigDefault Command Response Format | 142 |
| Table 289. PortF WCap Command Verb Format | 142 |
| Table 290. PortF WCap Command Response Format | 143 |
| Table 291. PortF PinCap Command Verb Format | 143 |
| Table 292. PortF PinCap Command Response Format | 144 |
| Table 293. PortF ConLst Command Verb Format | 144 |
| Table 294. PortF ConLst Command Response Format | 144 |
| Table 295. PortF ConLstEntry Command Verb Format | 145 |
| Table 296. PortF ConLstEntry Command Response Format | 145 |
| Table 297. PortF PinWCntrl Command Verb Format | 145 |
| Table 298. PortF PinWCntrl Command Response Format | 145 |
| Table 299. PortF UnsolResp Command Verb Format | 146 |
| Table 300. PortF UnsolResp Command Response Format | 146 |
| Table 301. PortF ChSense Command Verb Format | 147 |
| Table 302. PortF ChSense Command Response Format | 147 |
| Table 303. PortF ConfigDefault Command Verb Format | 147 |
| Table 304. PortF ConfigDefault Command Response Format | 148 |
| Table 305. PortG WCap Command Verb Format | 148 |
| Table 306. PortG WCap Command Response Format | 148 |
| Table 307. PortG PinCap Command Verb Format | 149 |
| Table 308. PortG PinCap Command Response Format | 149 |
| Table 309. PortG ConLst Command Verb Format | 150 |
| Table 310. PortG ConLst Command Response Format | 150 |
| Table 311. PortG ConLstEntry Command Verb Format | 150 |
| Table 312. PortG ConLstEntry Command Response Format | 150 |
| Table 313. PortG PinWCntrl Command Verb Format | 151 |
| Table 314. PortG PinWCntrl Command Response Format | 151 |
| Table 315. PortG UnsolResp Command Verb Format | 151 |
| Table 316. PortG UnsolResp Command Response Format | 152 |
| Table 317. PortG ChSense Command Verb Format | 152 |
| Table 318. PortG ChSense Command Response Format | 152 |
| Table 319. PortG ConfigDefault Command Verb Format | 153 |
| Table 320. PortG ConfigDefault Command Response Format | 153 |
| Table 321. PortH WCap Command Verb Format | 153 |
| Table 322. PortH WCap Command Response Format | 154 |
| Table 323. PortH PinCap Command Verb Format | 154 |
| Table 324. PortH PinCap Command Response Format | 155 |
| Table 325. PortH ConLst Command Verb Format | 155 |
| Table 326. PortH ConLst Command Response Format | 155 |
| Table 327. PortH ConLstEntry Command Verb Format | 156 |
| Table 328. PortH ConLstEntry Command Response Format | 156 |
| Table 329. PortH PinWCntrl Command Verb Format | 156 |

| | |
|--|-----|
| Table 330. PortH PinWCntrl Command Response Format | 156 |
| Table 331. PortH UnsolResp Command Verb Format | 157 |
| Table 332. PortH UnsolResp Command Response Format | 157 |
| Table 333. PortH ChSense Command Verb Format | 157 |
| Table 334. PortH ChSense Command Response Format | 158 |
| Table 335. PortH ConfigDefault Command Verb Format | 158 |
| Table 336. PortH ConfigDefault Command Response Format | 158 |
| Table 337. DMic0 WCap Command Verb Format | 159 |
| Table 338. DMic0 WCap Command Response Format | 159 |
| Table 339. DMic0 PinCap Command Verb Format | 160 |
| Table 340. DMic0 PinCap Command Response Format | 160 |
| Table 341. DMic0 PinWCntrl Command Verb Format | 161 |
| Table 342. DMic0 PinWCntrl Command Response Format | 161 |
| Table 343. DMic0 ConfigDefault Command Verb Format | 161 |
| Table 344. DMic0 ConfigDefault Command Response Format | 161 |
| Table 345. DMic1 WCap Command Verb Format | 162 |
| Table 346. DMic1 WCap Command Response Format | 162 |
| Table 347. DMic1 PinCap Command Verb Format | 163 |
| Table 348. DMic1 PinCap Command Response Format | 163 |
| Table 349. DMic1 PinWCntrl Command Verb Format | 164 |
| Table 350. DMic1 PinWCntrl Command Response Format | 164 |
| Table 351. DMic1 ConfigDefault Command Verb Format | 164 |
| Table 352. DMic1 ConfigDefault Command Response Format | 165 |
| Table 353. DigOut0 WCap Command Verb Format | 165 |
| Table 354. DigOut0 WCap Command Response Format | 165 |
| Table 355. DigOut0 PinCap Command Verb Format | 166 |
| Table 356. DigOut0 PinCap Command Response Format | 166 |
| Table 357. DigOut0 ConLst Command Verb Format | 167 |
| Table 358. DigOut0 ConLst Command Response Format | 167 |
| Table 359. DigOut0 ConLstEntry0 Command Verb Format | 167 |
| Table 360. DigOut0 ConLstEntry0 Command Response Format | 167 |
| Table 361. DigOut0 ConLstEntry4 Command Verb Format | 168 |
| Table 362. DigOut0 ConLstEntry4 Command Response Format | 168 |
| Table 363. DigOut0 ConSelectCtrl Command Verb Format | 168 |
| Table 364. DigOut0 ConSelectCtrl Command Response Format | 168 |
| Table 365. DigOut0 PinWCntrl Command Verb Format | 169 |
| Table 366. DigOut0 PinWCntrl Command Response Format | 169 |
| Table 367. DigOut0 ConfigDefault Command Verb Format | 169 |
| Table 368. DigOut0 ConfigDefault Command Response Format | 169 |
| Table 369. DigIn WCap Command Verb Format | 170 |
| Table 370. DigIn WCap Command Response Format | 170 |
| Table 371. DigIn PinCap Command Verb Format | 171 |
| Table 372. DigIn PinCap Command Response Format | 171 |
| Table 373. DigIn PwrState Command Verb Format | 172 |
| Table 374. DigIn PwrState Command Response Format | 172 |
| Table 375. DigIn PinWCntrl Command Verb Format | 172 |
| Table 376. DigIn PinWCntrl Command Response Format | 172 |
| Table 377. DigIn UnsolResp Command Verb Format | 173 |
| Table 378. DigIn UnsolResp Command Response Format | 173 |
| Table 379. DigIn ChSense Command Verb Format | 173 |
| Table 380. DigIn ChSense Command Response Format | 174 |
| Table 381. DigIn EAPD Command Verb Format | 174 |
| Table 382. DigIn EAPD Command Response Format | 174 |
| Table 383. DigIn ConfigDefault Command Verb Format | 175 |
| Table 384. DigIn ConfigDefault Command Response Format | 175 |

| | |
|---|-----|
| Table 385. InPort0Mux WCap Command Verb Format | 175 |
| Table 386. InPort0Mux WCap Command Response Format | 176 |
| Table 387. InPort0Mux ConLst Command Verb Format | 176 |
| Table 388. InPort0Mux ConLst Command Response Format | 177 |
| Table 389. InPort0Mux OutAmpCap Command Verb Format | 177 |
| Table 390. InPort0Mux OutAmpCap Command Response Format | 177 |
| Table 391. InPort0Mux OutAmpRight Command Verb Format | 177 |
| Table 392. InPort0Mux OutAmpRight Command Response Format | 178 |
| Table 393. InPort0Mux OutAmpLeft Command Verb Format | 178 |
| Table 394. InPort0Mux OutAmpLeft Command Response Format | 178 |
| Table 395. InPort0Mux ConSelectCtrl Command Verb Format | 178 |
| Table 396. InPort0Mux ConSelectCtrl Command Response Format | 179 |
| Table 397. InPort0Mux ConLstEntry0 Command Verb Format | 179 |
| Table 398. InPort0Mux ConLstEntry0 Command Response Format | 179 |
| Table 399. InPort0Mux ConLstEntry4 Command Verb Format | 179 |
| Table 400. InPort0Mux ConLstEntry4 Command Response Format | 179 |
| Table 401. InPort0Mux ConLstEntry8 Command Verb Format | 180 |
| Table 402. InPort0Mux ConLstEntry8 Command Response Format | 180 |
| Table 403. InPort1Mux WCap Command Verb Format | 180 |
| Table 404. InPort1Mux WCap Command Response Format | 180 |
| Table 405. InPort1Mux ConLst Command Verb Format | 181 |
| Table 406. InPort1Mux ConLst Command Response Format | 181 |
| Table 407. InPort1Mux OutAmpCap Command Verb Format | 182 |
| Table 408. InPort1Mux OutAmpCap Command Response Format | 182 |
| Table 409. InPort1Mux OutAmpRight Command Verb Format | 182 |
| Table 410. InPort1Mux OutAmpRight Command Response Format | 183 |
| Table 411. InPort1Mux OutAmpLeft Command Verb Format | 183 |
| Table 412. InPort1Mux OutAmpLeft Command Response Format | 183 |
| Table 413. InPort1Mux ConSelectCtrl Command Verb Format | 183 |
| Table 414. InPort1Mux ConSelectCtrl Command Response Format | 184 |
| Table 415. InPort1Mux ConLstEntry0 Command Verb Format | 184 |
| Table 416. InPort1Mux ConLstEntry0 Command Response Format | 184 |
| Table 417. InPort1Mux ConLstEntry4 Command Verb Format | 184 |
| Table 418. InPort1Mux ConLstEntry4 Command Response Format | 184 |
| Table 419. InPort1Mux ConLstEntry8 Command Verb Format | 185 |
| Table 420. InPort1Mux ConLstEntry8 Command Response Format | 185 |
| Table 421. InPort2Mux WCap Command Verb Format | 185 |
| Table 422. InPort2Mux WCap Command Response Format | 185 |
| Table 423. InPort2Mux ConLst Command Verb Format | 186 |
| Table 424. InPort2Mux ConLst Command Response Format | 186 |
| Table 425. InPort2Mux OutAmpCap Command Verb Format | 187 |
| Table 426. InPort2Mux OutAmpCap Command Response Format | 187 |
| Table 427. InPort2Mux OutAmpRight Command Verb Format | 187 |
| Table 428. InPort2Mux OutAmpRight Command Response Format | 188 |
| Table 429. InPort2Mux OutAmpLeft Command Verb Format | 188 |
| Table 430. InPort2Mux OutAmpLeft Command Response Format | 188 |
| Table 431. InPort2Mux ConSelectCtrl Command Verb Format | 188 |
| Table 432. InPort2Mux ConSelectCtrl Command Response Format | 189 |
| Table 433. InPort2Mux ConLstEntry0 Command Verb Format | 189 |
| Table 434. InPort2Mux ConLstEntry0 Command Response Format | 189 |
| Table 435. InPort2Mux ConLstEntry4 Command Verb Format | 189 |
| Table 436. InPort2Mux ConLstEntry4 Command Response Format | 189 |
| Table 437. InPort2Mux ConLstEntry8 Command Verb Format | 190 |
| Table 438. InPort2Mux ConLstEntry8 Command Response Format | 190 |
| Table 439. PCBEEP OutAmpLeft Command Verb Format | 190 |

| | |
|--|-----|
| Table 440. PCBEEP OutAmpLeft Command Response Format | 190 |
| Table 441. PCBEEP WCap Command Verb Format | 191 |
| Table 442. PCBEEP WCap Command Response Format | 191 |
| Table 443. PCBEEP OutAmpCap Command Verb Format | 191 |
| Table 444. PCBEEP OutAmpCap Command Response Format | 192 |
| Table 445. PCBEEP Gen Command Verb Format | 192 |
| Table 446. PCBEEP Gen Command Response Format | 193 |
| Table 447. CD WCap Command Verb Format | 193 |
| Table 448. CD WCap Command Response Format | 193 |
| Table 449. CD PinCap Command Verb Format | 194 |
| Table 450. CD PinCap Command Response Format | 194 |
| Table 451. CD PinWCntrl Command Verb Format | 195 |
| Table 452. CD PinWCntrl Command Response Format | 195 |
| Table 453. CD ConfigDefault Command Verb Format | 196 |
| Table 454. CD ConfigDefault Command Response Format | 196 |
| Table 455. VolumeKnob WCap Command Verb Format | 196 |
| Table 456. VolumeKnob WCap Command Response Format | 197 |
| Table 457. VolumeKnob VolKnobCap Command Verb Format | 197 |
| Table 458. VolumeKnob VolKnobCap Command Response Format | 197 |
| Table 459. VolumeKnob ConLst Command Verb Format | 197 |
| Table 460. VolumeKnob ConLst Command Response Format | 198 |
| Table 461. VolumeKnob ConLstEntry0 Command Verb Format | 198 |
| Table 462. VolumeKnob ConLstEntry0 Command Response Format | 198 |
| Table 463. VolumeKnob ConLstEntry4 Command Verb Format | 198 |
| Table 464. VolumeKnob ConLstEntry4 Command Response Format | 198 |
| Table 465. VolumeKnob UnsolResp Command Verb Format | 199 |
| Table 466. VolumeKnob UnsolResp Command Response Format | 199 |
| Table 467. VolumeKnob Cntrl Command Verb Format | 199 |
| Table 468. VolumeKnob Cntrl Command Response Format | 200 |
| Table 469. VolumeKnob VCSR0 Command Verb Format | 200 |
| Table 470. VolumeKnob VCSR0 Command Response Format | 200 |
| Table 471. InPort0Vol WCap Command Verb Format | 200 |
| Table 472. InPort0Vol WCap Command Response Format | 201 |
| Table 473. InPort0Vol ConLst Command Verb Format | 201 |
| Table 474. InPort0Vol ConLst Command Response Format | 202 |
| Table 475. InPort0Vol InAmpRight Command Verb Format | 202 |
| Table 476. InPort0Vol InAmpRight Command Response Format | 202 |
| Table 477. InPort0Vol InAmpLeft Command Verb Format | 202 |
| Table 478. InPort0Vol InAmpLeft Command Response Format | 202 |
| Table 479. InPort0Vol ConLstEntry Command Verb Format | 203 |
| Table 480. InPort0Vol ConLstEntry Command Response Format | 203 |
| Table 481. InPort1Vol WCap Command Verb Format | 203 |
| Table 482. InPort1Vol WCap Command Response Format | 203 |
| Table 483. InPort1Vol ConLst Command Verb Format | 204 |
| Table 484. InPort1Vol ConLst Command Response Format | 204 |
| Table 485. InPort1Vol InAmpRight Command Verb Format | 205 |
| Table 486. InPort1Vol InAmpRight Command Response Format | 205 |
| Table 487. InPort1Vol InAmpLeft Command Verb Format | 205 |
| Table 488. InPort1Vol InAmpLeft Command Response Format | 205 |
| Table 489. InPort1Vol ConLstEntry Command Verb Format | 205 |
| Table 490. InPort1Vol ConLstEntry Command Response Format | 206 |
| Table 491. InPort2Vol WCap Command Verb Format | 206 |
| Table 492. InPort2Vol WCap Command Response Format | 206 |
| Table 493. InPort2Vol ConLst Command Verb Format | 207 |
| Table 494. InPort2Vol ConLst Command Response Format | 207 |

| | |
|---|-----|
| Table 495. InPort2Vol InAmpRight Command Verb Format | 207 |
| Table 496. InPort2Vol InAmpRight Command Response Format | 208 |
| Table 497. InPort2Vol InAmpLeft Command Verb Format | 208 |
| Table 498. InPort2Vol InAmpLeft Command Response Format | 208 |
| Table 499. InPort2Vol ConLstEntry Command Verb Format | 208 |
| Table 500. InPort2Vol ConLstEntry Command Response Format | 208 |
| Table 501. ADC0Mux WCap Command Verb Format | 209 |
| Table 502. ADC0Mux WCap Command Response Format | 209 |
| Table 503. ADC0Mux ConLst Command Verb Format | 210 |
| Table 504. ADC0Mux ConLst Command Response Format | 210 |
| Table 505. ADC0Mux ConSelectCtrl Command Verb Format | 210 |
| Table 506. ADC0Mux ConSelectCtrl Command Response Format | 210 |
| Table 507. ADC0Mux ConLstEntry Command Verb Format | 210 |
| Table 508. ADC0Mux ConLstEntry Command Response Format | 211 |
| Table 509. ADC0Mux LR Command Verb Format | 211 |
| Table 510. ADC0Mux LR Command Response Format | 211 |
| Table 511. ADC0Mux OutAmpCap Command Verb Format | 211 |
| Table 512. ADC0Mux OutAmpCap Command Response Format | 212 |
| Table 513. ADC0Mux OutAmpRight Command Verb Format | 212 |
| Table 514. ADC0Mux OutAmpRight Command Response Format | 212 |
| Table 515. ADC0Mux OutAmpLeft Command Verb Format | 212 |
| Table 516. ADC0Mux OutAmpLeft Command Response Format | 213 |
| Table 517. ADC1Mux WCap Command Verb Format | 213 |
| Table 518. ADC1Mux WCap Command Response Format | 213 |
| Table 519. ADC1Mux ConLst Command Verb Format | 214 |
| Table 520. ADC1Mux ConLst Command Response Format | 214 |
| Table 521. ADC1Mux ConSelectCtrl Command Verb Format | 214 |
| Table 522. ADC1Mux ConSelectCtrl Command Response Format | 215 |
| Table 523. ADC1Mux ConLstEntry Command Verb Format | 215 |
| Table 524. ADC1Mux ConLstEntry Command Response Format | 215 |
| Table 525. ADC1Mux LR Command Verb Format | 215 |
| Table 526. ADC1Mux LR Command Response Format | 216 |
| Table 527. ADC1Mux OutAmpCap Command Verb Format | 216 |
| Table 528. ADC1Mux OutAmpCap Command Response Format | 216 |
| Table 529. ADC1Mux OutAmpRight Command Verb Format | 216 |
| Table 530. ADC1Mux OutAmpRight Command Response Format | 217 |
| Table 531. ADC1Mux OutAmpLeft Command Verb Format | 217 |
| Table 532. ADC1Mux OutAmpLeft Command Response Format | 217 |
| Table 533. ADC2Mux WCap Command Verb Format | 217 |
| Table 534. ADC2Mux WCap Command Response Format | 218 |
| Table 535. ADC2Mux ConLst Command Verb Format | 218 |
| Table 536. ADC2Mux ConLst Command Response Format | 219 |
| Table 537. ADC2Mux ConSelectCtrl Command Verb Format | 219 |
| Table 538. ADC2Mux ConSelectCtrl Command Response Format | 219 |
| Table 539. ADC2Mux ConLstEntry Command Verb Format | 219 |
| Table 540. ADC2Mux ConLstEntry Command Response Format | 219 |
| Table 541. ADC2Mux LR Command Verb Format | 220 |
| Table 542. ADC2Mux LR Command Response Format | 220 |
| Table 543. ADC2Mux OutAmpCap Command Verb Format | 220 |
| Table 544. ADC2Mux OutAmpCap Command Response Format | 220 |
| Table 545. ADC2Mux OutAmpRight Command Verb Format | 221 |
| Table 546. ADC2Mux OutAmpRight Command Response Format | 221 |
| Table 547. ADC2Mux OutAmpLeft Command Verb Format | 221 |
| Table 548. ADC2Mux OutAmpLeft Command Response Format | 222 |
| Table 549. STAC9227/9228/9229/9230 Options and Part Order Numbers | 223 |

Table 550. Pin Table 225

1. DESCRIPTION

The STAC9227/9228/9228D are high fidelity, 8-channel audio CODECs compatible with the Intel High Definition (HD) Audio Interface. The STAC9227/9228/9228D CODECs provide high quality, HD Audio capability to notebook and cost sensitive desktop PC applications.

The STAC9227/9228/9228D incorporate SigmaTel's proprietary technology to achieve a DAC SNR in excess of 100 dB. The higher performance and quality of SigmaTel's audio solutions brings consumer electronics level performance to the notebook, desktop and media center PC.

The STAC9227/9228/9228D provide stereo 24-bit, full duplex resolution supporting sample rates up to 192 KHz by the DAC and ADC. The STAC9227/9228/9228D SPDIF In/Out support sample rates of 96 KHz, 48 KHz and 44.1 KHz plus SPDIF OUT supports 88.2 KHz. Additional sample rates are supported by the driver software.

The STAC9227/9228/9228D support all desired eight channel configurations, including switchable Headphone Out, and Universal Jacks™ functionality for jack detection and re-tasking. The SPDIF interface provides connectivity to Consumer Electronic equipment like Dolby Digital decoders, powered speakers, mini disk drives or to a home entertainment system. All analog I/O pairs support LINE_IN, LINE_OUT and MIC.

MIC inputs can be programmed with 0/10/20/30/40dB boost. For more advanced configurations, the STAC9227/9228/9228D has up to four General Purpose I/O (GPIO) pin. The STAC9227/9228/9228D also provide a single ended CD input for compatibility with DRM solutions and to support legacy OS issues.

The STAC9227/9228/9228D integrate a headphone amplifier which is available on Ports A, B and D. The headphone amplifier is dedicated to these three outputs for increased flexibility, enhanced user experience, and reduced implementation costs.

The Universal Jack capabilities allow the CODECs to detect when audio devices are connected to the CODEC, and to allow the CODECs to be reconfigured to support these devices regardless of which port they are plugged into the system. SPDIF input sensing is also supported. The fully parametric SigmaTel SoftEQ can be initiated upon headphone jack insertion and removal for protection of notebook speakers. Note: The Jack Detect circuit and component selection are critical for accurate detection of audio jacks on individual ports. Please see the reference design for circuit implementation details.

The STAC9227/9228/9228D operate with a 3.3 V digital supply and a 3.3 V to 5 V analog supply.

The STAC9227/9228/9228D are available in a 48-pin LQFP Environmental (ROHS) package.

2. CHARACTERISTICS

2.1. Audio Fidelity

| | | | |
|----------|-------|------------|--------------|
| DAC SNR: | 105dB | A-Weighted | 5.0 V +/- 5% |
| ADC SNR: | 90dB | A-Weighted | 5.0 V +/- 5% |

2.2. Electrical Specifications

2.2.1. Absolute Maximum Ratings

Stresses above the ratings listed below can cause permanent damage to the STAC9227/9228/9228D. These ratings, which are standard values for IDT commercially rated parts, are stress ratings only. Functional operation of the device at these or any other conditions above those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods can affect product reliability. Electrical parameters are guaranteed only over the recommended operating temperature range.

| Item | Pin | Maximum Rating |
|---------------------------------------|------|---|
| Analog maximum supply voltage | AVdd | 6 Volts |
| Digital maximum supply voltage | DVdd | 5.5 Volts |
| VREFOUT output current | | 5 mA |
| Voltage on any pin relative to ground | | Vss - 0.3 V to Vdd + 0.3 V |
| Operating temperature | | 0°C to +70°C |
| Storage temperature | | -55 °C to +125 °C |
| Soldering temperature | | 260 °C for 10 seconds * Soldering temperature information for all available packages begins on page 228. |

2.2.2. Recommended Operation Conditions

| Parameter | | Min. | Typ. | Max. | Units |
|---|-----------------------------|-------|------|-------|-------|
| Power Supply Voltage | Digital - 3.3 V | 3.135 | 3.3 | 3.465 | V |
| | Analog - 3.3 V | 3.135 | 3.3 | 3.465 | V |
| (Note: With Supply Override Enable Bit set to force 5 V operation.) | Analog - 4 V | 3.8 | 4 | 4.2 | V |
| | Analog - 4.5 V | 4.275 | 4.5 | 4.725 | V |
| | Analog - 5 V | 4.75 | 5 | 5.25 | V |
| Ambient Operating Temperature | | 0 | | +70 | °C |
| Case Temperature | T _{case} (48-LQFP) | | | +90 | °C |

ESD: The STAC9227/9228/9228D is an ESD (electrostatic discharge) sensitive device. The human body and test equipment can accumulate and discharge electrostatic charges up to 4000 Volts without detection. Even though the STAC9227/9228/9228D implements internal ESD protection circuitry, proper ESD precautions should be followed to avoid damaging the functionality or performance.

2.3. STAC9227/9228/9228D 5V, 4.5V, 4.0V, and 3.3V Analog Performance Characteristics

($T_{\text{ambient}} = 25\text{ }^{\circ}\text{C}$, $AV_{\text{dd}} = \text{Supply} \pm 5\%$, $DV_{\text{dd}} = 3.3\text{ V} \pm 5\%$, $AV_{\text{ss}} = DV_{\text{ss}} = 0\text{ V}$; 1 KHz input sine wave; Sample Frequency = 48 KHz; 0 dB = 1 VRMS, 10 K Ω /50 pF load, Testbench Characterization BW: 20 Hz – 20 KHz, 0 dB settings on all gain stages)

| Parameter | Conditions | AVdd | Min | Typ | Max | Unit |
|--|--|--------------------------------|-----|-------------------------|-----|------|
| Digital to Analog Converters | | | | | | |
| Resolution | | All | | 24 | | Bits |
| SNR - DAC to All Line-Out Ports (Note 4) | Analog Mixer Disabled, PCM data | 5 V 4.5 V 4.0 V 3.3 V | | 105 101 100 98 | | dB |
| THD+N - DAC to All Line-Out Ports (Note 3) | Analog Mixer Disabled, -3dB Signal, PCM data | 5 V 4.5 V 4.0 V 3.3 V | | 90 88 86 84 | | dB |
| SNR - DAC to All Line-Out Ports (Note 4) | Analog Mixer Enabled, PCM data | 5 V 4.5 V 4.0 V 3.3 V | | 90 88 87 85 | | dB |
| THD+N - DAC to All Line-Out Ports (Note 3) | Analog Mixer Enabled, -3dB Signal, PCM data | 5 V 4.5 V 4.0 V 3.3 V | | 80 78 77 75 | | dB |
| Dynamic Range: DAC to All Line Out Ports (Note2) | -60dB signal level | 5 V 4.5 V 4.0 V 3.3 V | - | 95 93 92 90 | - | dB |
| SNR - DAC to All Headphone Ports (Note 4) | Analog Mixer Disabled, 10 K Ω load, PCM data | 5 V 4.5 V 4.0 V 3.3 V | | 105 101 100 98 | | dB |
| THD+N - DAC to All Headphone Ports (Note 3) | Analog Mixer Disabled, -3dB Signal, 10 K Ω load, PCM data | 5 V 4.5 V 4.0 V 3.3 V | | 85 83 82 80 | | dB |
| SNR - DAC to All Headphone Ports with 2 Headphone Outputs Operating (Note 4) | Analog Mixer Disabled, 32 Ω load, PCM data | 5 V 4.5 V 4.0 V 3.3 V | | 100 98 97 95 | | dB |
| THD+N - DAC to All Headphone Ports with 2 Headphone Outputs Operating (Note 3) | Analog Mixer Disabled, -3dB Signal, 32 Ω load, PCM data | 5 V 4.5 V 4.0 V 3.3 V | | 82 80 79 77 | | dB |
| SNR - DAC to All Headphone Ports (Note 4) | Analog Mixer Disabled, 32 Ω load, PCM data | 5 V 4.5 V 4.0 V 3.3 V | | 100 98 97 95 | | dB |

| Parameter | Conditions | AVdd | Min | Typ | Max | Unit |
|--|--|--------------------------------|--------|----------------------|--------|-------------------|
| THD+N - DAC to All Headphone Ports (Note 3) | Analog Mixer Disabled, -3dB Signal, 32 Ω load, PCM data | 5 V 4.5 V 4.0 V 3.3 V | | 85 83 82 80 | | dB |
| SNR - DAC to All Headphone Ports (Note 4) | Analog Mixer Enabled, 10 K Ω load, PCM data | 5 V 4.5 V 4.0 V 3.3 V | | 90 88 87 85 | | dB |
| THD+N - DAC to All Headphone Ports (Note 3) | Analog Mixer Enabled, -3dB Signal, 10k Ω load, PCM data | 5 V 4.5 V 4.0 V 3.3 V | | 79 77 76 74 | | dB |
| SNR - DAC to All Headphone Ports (Note 4) | Analog Mixer Enabled, 32 Ω load, PCM data | 5 V 4.5 V 4.0 V 3.3 V | | 87 85 84 82 | | dB |
| THD+N - DAC to All Headphone Ports (Note 3) | Analog Mixer Enabled, -3dB Signal, 32 Ω load, PCM data | 5 V 4.5 V 4.0 V 3.3 V | | 74 72 71 69 | | dB |
| Any Analog Input to DAC Crosstalk | 10 KHz Signal Frequency | All | - | -85 | - | dB |
| Any Analog Input to DAC Crosstalk | 1 KHz Signal Frequency | All | - | -80 | - | dB |
| Gain Error | Analog Mixer Disabled | All | | | 0.5 | dB |
| Interchannel Gain Mismatch | Analog Mixer Disabled | All | | | 0.5 | dB |
| D/A Digital Filter Pass Band (Note 5) | | All | 20 | - | 19,200 | Hz |
| D/A Digital Filter Transition Band | | All | 19,200 | - | 28,800 | Hz |
| D/A Digital Filter Stop Band | | All | 28,800 | - | - | Hz |
| D/A Digital Filter Stop Band Rejcn (Note 6) | | All | -100 | - | - | dB |
| D/A Out-of-Band Rejection (Note 7) | | All | -55 | - | - | dB |
| Group Delay (48 KHz sample rate) | | All | - | - | 1 | ms |
| Attenuation, Gain Step Size DIGITAL | | All | - | 0.75 | - | dB |
| Gain Drift | | All | - | 100 | - | ppm/ $^{\circ}$ C |
| DAC Offset Voltage | | All | - | 100 | 20 | mV |
| Deviation from Linear Phase | | All | - | 1 | 10 | degrees |
| Analog Outputs | | | | | | |

| Parameter | Conditions | AVdd | Min | Typ | Max | Unit |
|--|---|-------|--------|-----|--------|------------|
| Full Scale All Line-Outs | DAC PCM Data | 5 V | 1.00 | - | - | Vrms |
| | | 4.5 V | 1.00 | | | |
| | | 4.0 V | 1.00 | | | |
| | | 3.3 V | 0.70 | | | |
| Full Scale All Line-Outs | DAC PCM Data | All | 2.83 | - | - | Vp-p |
| All Headphone Capable Outputs | 32 Ω load | All | 31 | 50 | - | mW peak |
| Analog inputs | | | | | | |
| Full Scale Input Voltage | 0dB Boost @ 4.75 V | All | 1.00 | - | - | Vrms |
| All Analog Inputs with boost | 10dB Boost | All | 0.31 | - | - | Vrms |
| All Analog Inputs with boost | 20dB Boost | All | 0.10 | - | - | Vrms |
| All Analog Inputs with boost | 30dB Boost | All | 0.03 | - | - | Vrms |
| All Analog Inputs with boost | 40dB Boost | All | 0.01 | - | - | Vrms |
| Input Impedance | | All | - | 50 | - | K Ω |
| Input Capacitance | | All | - | 15 | - | pF |
| Analog Mixer | | | | | | |
| SNR - CD to Ports A,B, & D Line-Out (Note 4) | | All | | 90 | | dB |
| THD+N - CD to Ports A,B, & D Line-Out (Note 3) | -3dB Input | All | | 70 | | dB |
| SNR - All Line-In to A,B, & D Line-Out (Note 4) | | All | | 90 | | dB |
| THD+N - All Line-In to A,B, & D Line-Out (Note 3) | -3dB Input | All | | 70 | | dB |
| SNR - Analog PC Beep to Ports A,B, & D Line-Out (Note 4) | | All | | 85 | | dB |
| THD+N - Analog PC Beep to Ports A,B, & D Line-Out (Note 3) | -3dB Input | All | | 70 | | dB |
| Analog to Digital Converter | | | | | | |
| Resolution | | All | | 24 | | Bits |
| Dynamic Range, All Analog Inputs to A/D (Note 1) | High Pass Filer Enabled, 1 Vrms Input, No boost | All | 88 | 90 | | dB |
| SNR All Analog Inputs to A/D (Note 4) | High Pass Filter enabled | All | 88 | 90 | | dB |
| THD+N All Analog Inputs to A/D (Note 3) | High Pass Filter enabled, -3dBV input Level | All | | 85 | | dB |
| Analog Frequency Response (Note 2) | | All | 10 | - | 30,000 | Hz |
| A/D Digital Filter Pass Band (Note 5) | | All | 20 | - | 19,200 | Hz |
| A/D Digital Filter Transition Band | | All | 19,200 | - | 28,800 | Hz |