VOCAL

Voice Over IP Audio Center (VAC)

VOCAL's Voice over IP Audio Center (VAC) is a versatile platform designed to support many IP-based communications applications. The original application met NASA's requirements for the communications monitoring and testing of the Orion space capsule as part of the Artemis return to the moon program*. The platform was designed to support additional roles with interfaces for human operators (loud speakers, headset/mic and PTT) as well as for E&M (supporting all types as carrier or exchange), telephone lines as an FXO endpoint, serial interfaces for external device control (UART and I2C), and line level audio in/out. VoCAL's highly optimized On-One™ DSP technology is used to reduce system cost by controlling all VoIP operations for its audio ports and performing advanced signal processing on a single state-of-the-art DSP.

* - VOCAL as a subcontractor provided its VoIP software for use on a specialized radiation hardened DSP used in flight hardware within the Orion space capsule facilitating astronaut communications.

The VOCAL VAC supports two independent audio channels and provides the following from left to right on the front panel (LCD panel items listed separately):

AG1 Speaker (8 ohms)
AG1 Speaker Volume Knob (counterclockwise detent for off)
AG1 Disabled Red LED/Speaker On Green LED
AG1 PJ7 Headset Jack
AG1 Rx/Tx Green/Red Bicolor LED
AG1 Headset Volume Knob

Power On/Off Rocker Switch
AC/DC Power Module A Standby Yellow LED
Power on Green LED
AC/DC Power Module B Standby Yellow LED
AG2 Enable Rocker Switch

AG2 Headset Volume Knob
AG2 Rx/Tx Green/Red Bicolor LED
AG2 PJ7 Headset Jack
AG2 Disabled Red LED/Speaker On Green LED
AG2 Speaker Volume Knob (counterclockwise detent for off)
AG2 Speaker (8 ohms)

Note: The PJ-7 headset jacks may also be used with a stereo headset (as mono) in the top ¼" TRS jack and a microphone (on tip) and PTT (as ring) on the lower ¼" TRS jack. (3.5mm jacks are available with special order.)

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The Display Panel has the following:

4 Line x 20 Character Liquid Crystal Display (high contrast White on Blue with backlighting)
5 Button Menu Navigation (Up, Down, Previous/Left, Next/Right and Select)
4 Rectangular LED's (function unassigned)
1 Escape Button
1 Extra Button (function unassigned)

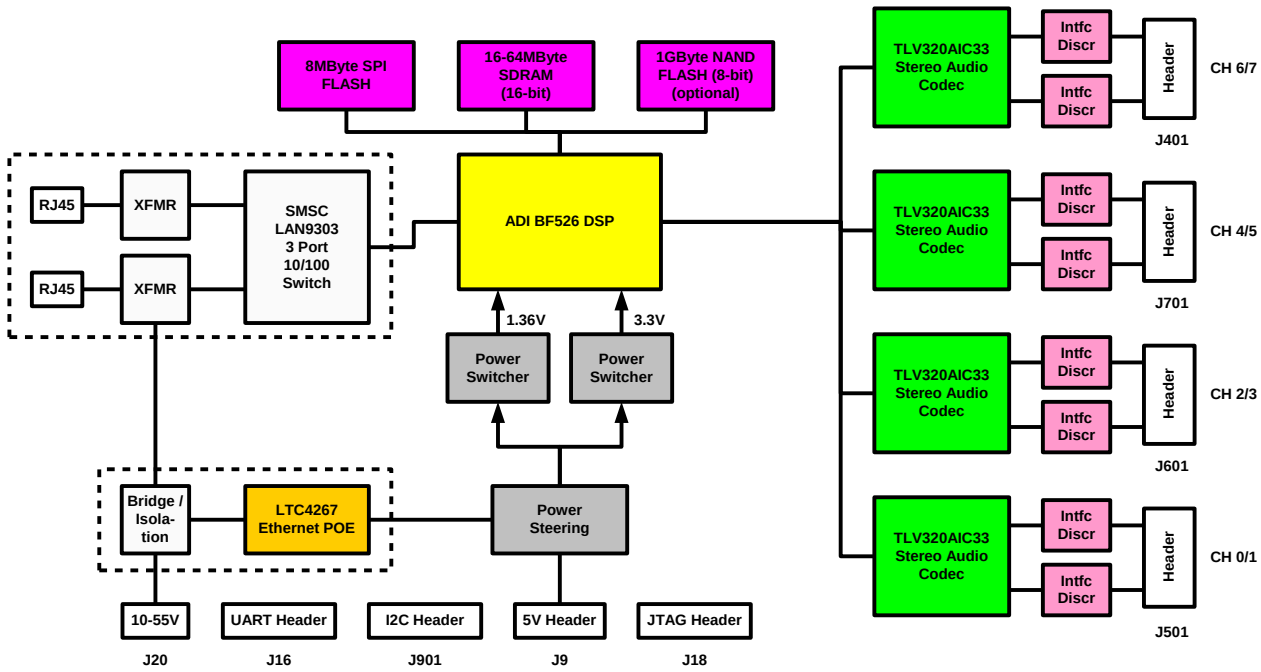
It should be noted that a hidden reset button is accessible when AG2 volume knob is removed. This can be used to reset the DSP processor without powering down the VoIP Audio Center with a momentary depression with a paper clip. If pushed and held as described in the software operating instructions, this can be used to revert the last changed configuration and if held longer to revert to a factory default configuration. (This same reset function is available on the rear panel.)

The rear panel of the VAC presents from left to right the following:

AC Power Module B
Recessed Reset Button
Console USB Mini B Jack
(top) ETH1 Audio Data Ethernet RJ45
(bottom) Serial 2 EIA-561 RJ45
(top) ETH0 Management Ethernet RJ45
(bottom) Serial 1 EIA-561 RJ45
600 Ohm Line In 3.5mm Connector
600 Ohm Line Out 3.5mm Connector
E&M 2 RJ45 Connector
E&M 1 RJ45 Connector
Monitor 2 BNC Female Jack
Monitor 1 BNC Female Jack
Ground Stud
AC Power Module A

The processing core of this unit uses VOCAL's AoIP (Analog over IP) processor card. An Analog Devices Blackfin BF526 DSP runs VOCAL's bare-metal network system, LANsEND, or an embedded Linux for the Blackfin. It also performs all the signal processing and speech coding as required for the VoIP aspects of customer applications. Its Ethernet ports may be separated and used as two independent networks (as supported by the Microchip/SMSC LAN 9303) or as a simple three port Ethernet switch. (Its POE is not used in this configuration.)

The VOCAL RAC is designed for operation across the standard commercial temperature range 0 °C (32 °F) to + 70 °C (158 °F). Industrial temperature range may be available as an ordering option.

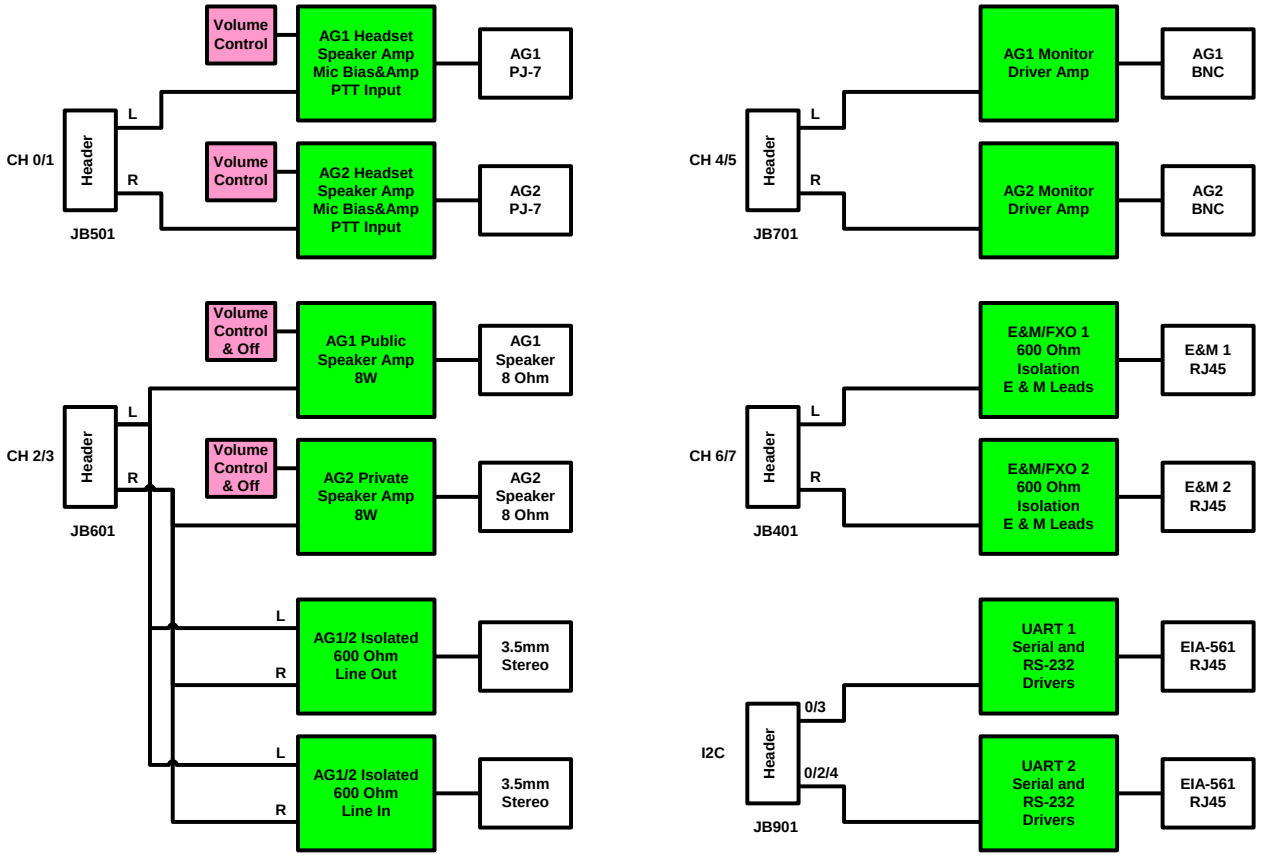


The four stereo audio codecs regarded as 8 audio channels are assigned to various analog inputs/outputs of the VAC as follows:

Channel 0 (left) – AG1 Headset Input and Output
Channel 1 (right) – AG2 Headset Input and Output
Channel 2 (left) – AG1 Speaker Driver/Line In/Line Out Left
Channel 3 (right) – AG2 Speaker Driver/Line In/Line Out Right
Channel 4 (left) – AG1 BNC Monitor/ E&M 1 Primary Input and Output
Channel 5 (right) – AG2 BNC Monitor/ E&M 1/2 Primary/Secondary Input and Output
Channel 6 (left) – E&M 2 Primary Input and Output
Channel 7 (right) – E&M 1/2 Primary/Secondary Input and Output

It should be noted that many of the interface circuits may be assigned to alternate channels by population resistors when the unit is built.

The following diagram shows the analog interfaces of the VAC as per the default assignments (secondary E&M connections are not shown).



VOCAL RFTS Main Board

The VAC's supports a wide range of VoIP applications supported by VOCAL's extensive voice processing, speech coding and protocol support applications. As an example, the NASA RFTS application used nailed-up (preconfigured multicast IP/static UDP ports) for each talk group (AG1/AG2) coded using G.729. Applications for monitoring or communicating with UAV's using NET IOP would use SIP/RTP with MELPe speech coding. ED-137 ATC systems could use this unit as a gateway or an Air Traffic Controller Terminal with either standard or pre-standards based remote radios. Pre-standards based radios may not use SIP but rather be directly accessed at specific UDP ports with receiver demultiplexing requirements. Other applications can be developed by VOCAL for purposes unique to each customer or subject specifications.

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Software Support

VOCAL's VoIP software libraries offer the following capabilities:

Technical Specifications

Voice-over-IP (VoIP) protocols
- SIPv2 - Session Initiation Protocol (RFC 3261, 3262, 3263, 3264)
- SDP - Session Description Protocol (RFC 4566)
- RTP - Real-Time Protocol (RFC 3550, 3551)
- RTCP - Real-Time Control Protocol (RFC 3550)
- RFC 4733 X-NSE Tone Events for SIP/RTP
- RFC 4733 AVT Tone Events for SIP/RTP
- STUN - Simple Traversal of UDP over NATs (RFC 3789)

Network Protocols
- IPv4 - Internet Protocol Version 4 (RFC 791)
- TCP - Transmission Control Protocol (RFC 793)
- UDP - User Datagram Protocol (RFC 768)
- ICMP - Internet Control Message Protocol (RFC 792)
- RARP - Reverse Address Resolution Protocol (RFC 903)
- ARP - Address Resolution Protocol (RFC 826)
- DNS- Domain Name Server
- DHCP Client - Dynamic Host Control Protocol (RFC 2131)
- NTP - Network Time Protocol (RFC 1305)
- SNTP - Simple Network Time Protocol (RFC 2030)
- HTTP - HyperText Transfer Protocol
- TFTP - Trivial File Transfer Protocol (RFC 1350)
- PPPoE - Point to Point Protocol over Ethernet (RFC 2516)

Voice Codecs
- G.711 - Pulse Code Modulation
- G.722 - Wideband ADPCM
- G.723.1 - 6.4 and 5.3 kbps ACELP/MP-MLQ
- G.726 - 16, 24, 32 and 40 kbps ADPCM
- G.728 - 16 kbps LD-CELP
- G.729A - 8 kbps CS-ACELP
- G.729B - Silence Detection/Comfort Noise Generation
- GSM, GSM HR, GSM FR, GSM AMR, GSM AMR-WB
- iLBC - Internet Low Bitrate Codec
- Speex/Opus – Nonproprietary VDR Codec
- MELPe - 2400/1200/600 bps Codec
- TSVCIS - Wideband VDR MELPe extension

Telephony
- Q.24 DTMF Generation with Zero Crossing Cutoff
- Q.24 DTMF Detection exceeding Bellcore Specifications
- Configurable Tone Generation for 4 Sets of Frequencies and 4 Sets of On/Off Cadence
- Caller ID Type I Detection
- Caller ID Type II Detection

Line-echo cancellation
- G.168 Line Echo Cancellation
- 16 to 64 ms Echo Length
- Nonlinear Echo Suppression (ERL greater than 28 dB for f = 300 to 3400 Hz)
- Double-Talk Detection

Quality of Service
- Layer 2 Class-of-Service (CoS) Tagging (802.1P)
- Layer 2 (802.1Q VLAN)
- Layer 3 Type-of-Service (ToS) Tagging (RFC 791/1349)
- Layer 3 DIFFServ (RFC 2475)

Hardware Features

Data Network
- Ethernet - 10baseT/100baseT RJ-45
- Ethernet WAN Port RJ-45
- Ethernet LAN Port RJ-45
- Configurable MAC Address (IEEE 802.3)

Analog Ports
- Narrow (8KHz), wide (16KHz), or full (48KHz) band operation

PSTN Port
- FXO Analog RJ-11 Port
- Dial Plan Accessible

Indicators
- POWER LED (Power, Registration, Use)
- LAN LED (Activity and Link Fail)
- LINE LEDS (Line Status)

Reset Button
- System Reset
- Reset Configuration to Factory Defaults when Held

Feature List

Voice-over-IP (VoIP) protocols
- Power-on Auto Registration
- Re-registration with SIP Proxy Server
- SIP over UDP
- SIP Authentication (HHP Digest with MD5)

Quality of Service
- Port Priority for VoIP Packets from Application
- High and Low Priority Transmit Queues for Interface

NAT/Firewall Support
- Built-in Router
- Automated NAT Traversal Without Manual Manipulation of Firewall/NAT
- NAT Traversal for Private Networks with STUN (RFC3489)
- NAT Firewall
- Gateway and DMZ Port Forwarding
- LAN Pass Through
- Voice Priority
- PPPoE – Point-to-Point Protocol over Ethernet (RFC2516)

Security
- Provisioning/Configuration/Authentications
- Password Protected Web based Administration
- RC4 Encryption for TFTP Configuration Profiles
- Authentication (DIGEST using MD5)
- Secure SIP (SIPS)
- Secure RTP (SRTP)
- TLS 1.1 or later

Remote Configuration/Maintenance
- Web Configuration via Built-in Web Server
- Configuration Update via TFTP or HTTP
- Firmware Upgrade via TFTP or HTTP
- SYSLOG Update/Upgrade Processing Notifications

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