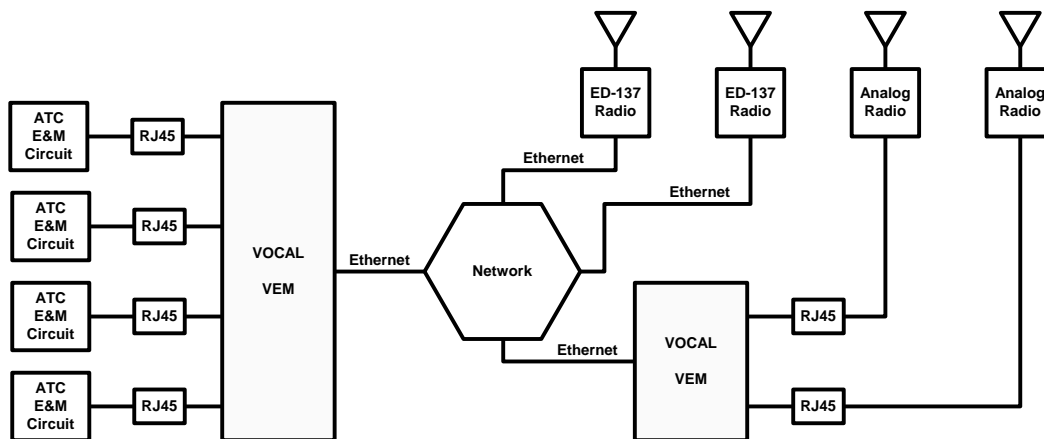


# VOCAL

## Voice Over IP on E&M (VEM) for Radio Circuits

VOCAL's Voice over IP on E&M replacement (VEM) is an optimized platform designed to replace legacy E&M telco circuits with IP-based communications. E&M circuits have been used for many applications such as conveying two-way isolated audio with remote circuit controls (commonly used for PTT). Air Traffic Controller (ATC) systems for commercial and military flight operations have many such legacy circuits in operation. Over time, these are being replaced by EUROCAE ED-137 capable devices in their transition to VoIP ATM. VOCAL's VEM implements services and features according to the ED-137 standards and hence can be used as a gateway between legacy E&M based ATC and newer technology Voice over IP Communications Enterprise (VoICE).



The VOCAL VEM supports a wide range of VoIP applications supported by VOCAL's extensive voice processing, speech coding and protocol support applications. As an example, an Air Force demonstration application used nailed-up (preconfigured multicast IP/static UDP ports) for each E&M port to connect with a different Rockwell-Collins 721s ED-137 radio. Applications for monitoring or communicating with UAV's using NET IOP would use SIP/RTP with MELPe speech coding. Other 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.

The VOCAL AoIP Reference Design Kits enable licensees to develop a variety of standards-based next generation product configurations with extensive features and world-wide configurability. VoCAL's highly optimized On-One™ DSP technology is used to reduce system cost by controlling all AoIP operations for E&M audio ports and performing advanced signal processing on a single state-of-the-art DSP. Supports PTT and COS/COR signals for interfacing E&M ports to radio audio. These designs far surpass the competition in terms of cost advantage and time-to-market potential, and VoCAL's extensive customization support allows quick and easy implementation of value-added features.



The front panel of the VEM has the following from left to right:

- Power LED
- System LED
- Port 1 Active LED
- Port 2 Active LED
- Port 3 Active LED
- Port 4 Active LED
- Console Port (connects via FTDI USB 3.3v serial cable)

It should be noted that a recessed reset button is through the front panel. This can be used to reset the DSP processor without powering down the VEM 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.

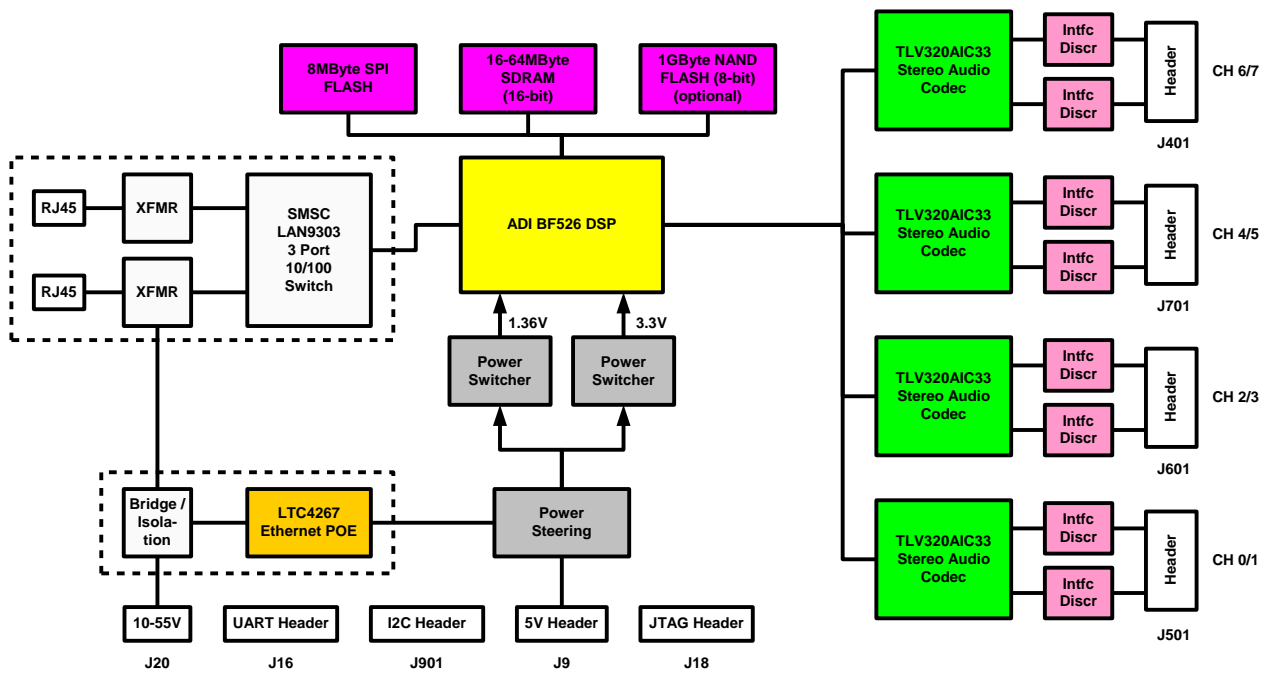


The rear panel of the VEM presents from left to right the following:

- 5.5/2.1mm barrel connector for 5VDC or optional 10-50V isolated power+
- RJ45 Ethernet with optional POE
- RJ45 Ethernet (optional)
- RJ45 E&M Port 4
- RJ45 E&M Port 3
- RJ45 E&M Port 2
- RJ45 E&M Port 1

+ - Optional isolated power supply also supports locking barrel connector. Requires resistor straps and eliminates Ethernet POE.

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 if the application requires, 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.



An internal daughterboard for E&M attaches internally to the AoIP processor card and supports four isolated E&M ports. GPIO signals are protected and configurable for driving PTT (push to talk) and receiving COS/COR (carrier on squelch/receive) signals.

- Pin 1 – SB (M Lead return) #
- Pin 2 – M Lead (COR) with configurable polarity and ground/return#
- Pin 3 – RX Audio+ (protected and 600ohm isolated)
- Pin 4 – TX Audio+ (protected and 600ohm isolated)
- Pin 5 – TX Audio-
- Pin 6 – RX Audio-
- Pin 7 – E Lead (PTT) with configurable polarity and ground/return#
- Pin 8 – SG (E Lead return) #

# - Supports E&M Types I to V as trunk or terminal sides by configuration jumpers or optional soldered 0 ohm resistors. (No ground when on-hook for trunk side Type III.) Configurable SB of +5, -5, -24 or -36v or externally supplied.

The VOCAL VEM 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.

# 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-CELP  
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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