

Tone Notching and AGC



Problem

Air Traffic Controllers have identified three significant problems with many current voice switches:

- High frequency tones accidentally induced into their headsets
- Improper balancing of the volume of incoming calls (i.e. inadequate or no Automatic Gain Control - AGC)
- High Idle Channel Headset Noise even when no call is in progress

The consequences of these problems are significant:

- The improper balancing of the volume causes controllers to constantly readjust volume settings for ground-to-ground (G/G) and air-to-ground (A/G) calls and increases the probability that a critical message could be missed. This increases the controller's workload and induces a significant safety hazard
- The high frequency tones are a health issue since they cause extreme pain, temporary loss of hearing and, in some cases, permanent hearing damage. These can result in both short-term absences from work (one day to several weeks) and long-term disabilities
- High Idle Channel Headset Noise results in unnecessary controller fatigue and could become a safety issue during peak busy times

Solution

Digital Signal Products (DSP), Inc. has developed an Audio Signal Processor (ASP) that simultaneously solves all of these problems. The ASP uses a digital signal processor to perform Analog to Digital conversion of all incoming signals. The digital signal processor analyzes the signal and removes up to two extraneous tones simultaneously within 70 milliseconds. This operation is performed without reducing the quality of normal voice signals.

The ASP also measures the strength of all incoming voice signals and adjusts the volume of all calls to the same level. A controller can select one volume that is comfortable and all incoming voice calls are adjusted to this volume. For the 400D switch application, the ASP chassis is installed in the equipment rack and the position cable re-routed through it. Each card has 4 audio channels to accommodate headset and loudspeaker paths of a regular or a split position. To prevent any ground noise or hum interference all input/output connections are done through transformers or opto-couplers.

The Tone Notching and AGC ASP has been successfully tested at the Oklahoma City FAA facility. After extensive testing this ASP unit has been successfully installed and operational at a number of FAA sites, such as Dallas Ft. Worth, Chicago O'Hare, etc.

Tone Notching and Automatic Gain Control

Configuration and Specifications

The Tone Notching/AGC ASP for the 400D voice switch is housed in a 5.25-inch high, 19-inch rack mountable chassis. The chassis has 12 card slots, each card servicing one position. Each card works in an independent manner. The chassis is powered by the existing system power supplies. All connections to the ASP chassis are made through I/O connectors located in the backplane. The I/Os are designed for an easy transition using existing cables. One small additional 12-pair cable is required for each position interconnect.

Input Impedance: 600 Ohms, Balanced

Output Impedance: 600 Ohms, Balanced

Frequency Response: +/- 1.0 dB (300-3000 Hz) with respect to 1 KHz

Gain: 0 dB (no gain, no loss)

Input Signal Range: +3.0 dBm to -50 dBm (no adjustment required)

Output Signal Range: +3.0 dBm to -50 dBm (no adjustment required)

Fail Safe Operation: Automatic bypass in case of DSP or power failure within 3-5 seconds or when a card is removed from the chassis

Relay contact closure and a red LED are provided to announce a card failure

Operating Voltage: +24 VDC

Power Consumption: Typical: 5 watts Maximum: 7 watts

DSP Speed: 160 MIPS

Encoding Scheme: u-Law encoding, with 8 KHz sampling rate

Inter-channel Crosstalk Attenuation: 65 dB minimum

Total Harmonic Distortion: Less than 2%

4-Wire Echo Return Loss: 20 dB minimum @ 600 Ohms'

Idle Channel Noise: 25 dBnc0

Number of channels per card: 4 channels (One operator position, normal or split)

AGC Attack Time: 5-10 msec, AGC Release Time: 400-800 msec, AGC Range: +/- 8 dB

Tone Notching: 45 dB minimum

Detection and recognition time: First Tone: Typ. 75 msec, max. 125 msec, Second Tone: Typ. 100 msec, max. 150 msec

Throughput delay: Typically less than 1 msec (including round trip delay through the codec)

Valid Tone Duration (Non-varying Tone Frequency Duration): 70 msec

Valid Tone Detect Level: > -16 dBm (Equal to -36 dBm output at the Headset Jack)

Card Size: 5.25" x 8.66"

Connections: 24 pin Amp-Champ for position or rack, and 2-Pin Power.

Other DSP Products

Voice Clipping – In some communication switches, there are call types where a caller will start speaking before the connection to the receiving position is complete. The Audio Clipping ASP prevents the loss of the initial portions of an incoming call when the connection times within the switch are too slow and up to 1 second of the message is lost.

Best Signal Selection (BSS) – In some radio communication systems, there are more than one receiver for a given frequency. This occurs for reasons such as too great a distance or terrain interference with only one receiver. Under some circumstances, multiple receivers will have a signal that exceeds an audible threshold, but the strength and quality may be significantly different. The Best Signal Selection ASP monitors all receivers and within 70 msec routes the call using the highest quality signal.

Radio Control Equipment (RCE) – DSP has developed an RCE that provides full duplex voice and data communications between a control site and a remote site over unconditioned telephone lines and satellite links. The control end modem trains the remote end modem to achieve the highest possible data transmission rate. The operator voice bandwidth is 300-3000 Hz end-to-end. The design employs speech encoding at 8 Kbits/s.

Digital Signal Products, Inc.

Digital Signal Products, Inc. provides both high quality products for communication systems as well as services for developing solutions for specific customer problems. DSP can help establish requirements, provide both a high level design and a detailed design that satisfy a set of requirements and, if desired, actually build and test products that conform to the design.

Digital Signal Products, Inc.

21400 Ridgetop Circle, Suite 240, Dulles, VA 20166

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POC: Ramesh Bakshi (703) 654-7581 x100 Fax: (703)654-7583 E-Mail: rbakshi@dsp-usa.com