



ZEGER-ABRAMS INCORPORATED

CAPABILITIES BROCHURE

MITIGATING COSITE RADIO INTERFERENCE FOR GOVERNMENT AND INDUSTRY



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LEADERSHIP STATEMENT

Zeger-Abrams Incorporated (**ZA**) is dedicated to designing and implementing unique and affordable solutions to extremely difficult radio frequency interference (**RFI**) problems. RFI severely degrades the performance of modern communications, electronic warfare, radar, and navigation receivers. The effects of RFI can jeopardize personnel and platform safety, prevent successful completion of missions and increase risks to network centric command and control. ZA's innovative designs and products provide a practical means to mitigate cosite RFI and jamming without incurring high cost penalties in dollars, size and weight. We develop our innovative products and license them to manufacturers and system integrators who are capable of exploiting this unique technology to capture significant segments of military or commercial RFI mitigation markets.

Founded in 1977, ZA has become a recognized U.S. leader in developing and applying advanced signal processing techniques for suppression of RFI from Very Low Frequency (**VLF**) to Super High Frequency (**SHF**).

CORE COMPETENCIES

ZA has capabilities, direct experience, and prototypes or products in the RF and IF technologies represented by the following products and systems:

- » Cosite Interference Cancellers;
- » Frequency Agile, Ultra Narrowband Notch Filters;
- » Anti-Jammer Adaptive Nulling Antenna Arrays;
- » RF Power Amplifier Linearizers.

ZA has maintained its competitive advantage since its founding by a combination of the following actions:

- » Upgrade its products to meet electromagnetic compatibility (EMC) requirements of current and future systems. Example – upgrade our interference cancellers for the wideband JTRS waveforms.
- » Extend products to new frequency bands to capture emerging markets at microwave frequencies.
- » Partner with other companies to meet requirements for full scale, low cost production of products. Example – VHF Cancellation Unit (VCU) for the new USMC Expeditionary Fighting Vehicle (EFV).
- » Devise and test new RFI mitigation techniques. Example – presently developing a frequency agile narrowband notch filter to stop RFI at the output of high power airborne transmitters to protect both cosite and multiple off board VHF, UHF and L-band comms receivers.

The ZA staff is experienced in the research, design, simulation, development, production, testing, and installation phases of electronic engineering for military and commercial applications. These include:

- » **Equipment development:** experimental models; prototype design and improvement; MIL SPEC requirements; RF, IF, analog and digital circuits; microprocessors.
- » **System studies:** analysis, simulation, synthesis, and evaluation (VLF through Ku band).
- » **System test and evaluation:** laboratory, field, shipboard, and flight-testing.
- » **Consulting services,** presentation of special courses (e.g. adaptive arrays, interference cancellation, random processes), and preparation of technical proposals.
- » **Investigation and characterization** of RFI, Electromagnetic Interference (**EMI**) problems and synthesis of interference mitigation systems for military and commercial platforms.

PRODUCTS / SERVICES

DEVELOPMENT OF ELECTRONICS TO REDUCE RFI

ZA's development of advanced signal processing equipment is typified by the following proprietary RFI suppression equipment for simultaneous operation of colocated TXs and receivers (**RXs**). The following RF hardware systems are customizable for platform, housing, number of RFIs, prime power source, etc.

- » **Dual Band Interference Cancellation System**, cancels high power RFI in the VHF/UHF (30-400 MHz) band to prevent desensitization of single channel or frequency agile RXs.
- » Single Channel Ground-to-Air Radio System (**SINGARS**) 30-88 MHz **Cosite RFI Canceller**, permits operation of multiple colocated FH radio sets on USMC AAV, EFV and other vehicles.
- » **Cosite Interference Canceller** protects SHF shipborne ELINT RXs from RFI coming from AN/WSC-6 SATCOM TXs.
- » **HF Adaptive Interference Canceller**, reduces high-level interference from colocated frequency agile transmitters to maintain receiver sensitivity on P-3C Navy aircraft.
- » **Antenna Coupler Discriminator/TX System**, permits an HF antenna coupler to self-tune during transmission by another high power inband TX on the same platform/location.
- » VHF Canceller is being developed to suppress RFI at front end of RX but originating from SINGARS TXs on nearby platforms without needing an RFI reference cable between the platforms.
- » **Intermodulation Product (IMP) Canceller**, suppresses IMPs in the UHF band originating from nonlinearities in the vicinity of nearby HF and VHF transmitters and allows reception at IMP frequencies.

RF TRANSMITTER NOTCH FILTER TECHNOLOGY

Zeger-Abrams Incorporated (**ZA**), a Small Business in its 33rd year of reducing both deliberate and unintentional RFI in military systems, is continuing to develop its RF Cancellation Notch Filter (**CNF**) technology to mitigate RFI to cosited and off-board receivers. ZA achieved a notch depth of > 40 dB at any selected frequency in the 225-400 MHz band with its advanced development hardware model CNF. Its passband loss is a small fraction of a dB. A network analyzer plot of the notch formed at 325 MHz is shown in Figure 1. The notch center frequency is electronically tunable to be compatible with frequency hop (**FH**) rates of legacy Ultra High Frequency (**UHF**) HAVE QUICK radios.

The CNF has two RF interfaces with the transmitter's (**TX's**) Power Amplifier (**PA**) as shown in the simplified block diagram in Figure 2. A coupler is inserted at the RF input to the PA and another at the PA's RF output. A digital input representing each of the cosited receive frequencies f_R to be notched from the PA output spectrum is provided and updated for each FH.

Powerful wideband TXs are employed on Navy aircraft to disrupt enemy RF and microwave RXs and on Army ground vehicles to defeat enemy radio con-

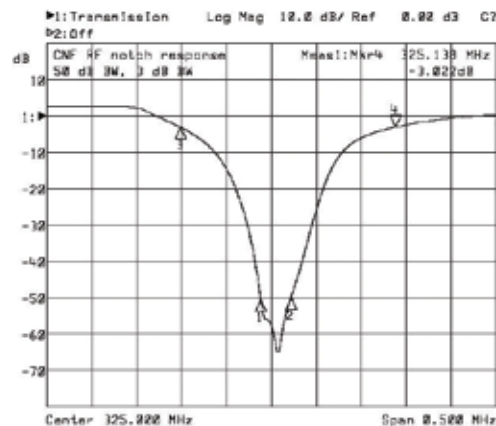


Figure 1: CNF Response at RF = 325 MHz, BW (-50 dB) = 32 kHz

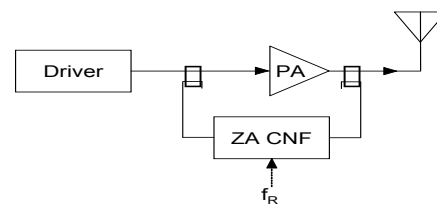


Figure 2: CNF Block Diagram

trolled IEDs. These jammer's TXs interfere with legacy blue force cosited and nearby communications RXs at VHF, UHF and L-band, and with GPS Navigation and other cosited RF RXs. A **CNF**, which forms extremely narrow frequency agile notches in the output spectrum of a radio transmitter's PA is being developed. Combined with an adaptive interference-canceller, this technology enables simultaneous operation of cosited/noncosited receivers and powerful transmitters.

The CNF notches are rapidly tunable to VHF, UHF, and SHF receive frequencies of blue force radios and permits simultaneous operation of powerful radio TXs without compromising the effective radio range of nearby protected RXs. Interference cancellers alone do not provide sufficient mitigation to cosite RFI to restore useful radio communications range. Resonator notch filters located at a jammer PA output reduce RFI, but they have much wider notch width, high insertion loss, are not frequency agile to protect legacy FH RXs, and could damage the PA. Applications include powerful TXs on aircraft and counter radio controlled IED jammers.

COCHANNEL SIGNAL SORTER

Separates multiple spectrally and temporally overlapping signals at RF or in the IF passband of a radio receiver using only one RX antenna. Allows multiple mutually interfering cochannel signals to be demodulated.

HIGH POWER AMPLIFIER (PA) LINEARIZER

High Power Amplifier Linearizer system cancels intermodulation distortion products to provide an ultra-linear 1 kW PA output at HF.

This prevents intermodulation products generated in the PA from interfering with and desensitizing on board and nearby off board receivers operating in the same frequency band.

DUAL BAND COSITE EMI MITIGATION SYSTEM

Under a Navy SBIR effort, ZA developed a system to operate VHF/UHF frequency-hopped (**FH**) radio RXs simultaneously with four active cosited TXs at VHF and UHF.

The system cancels up to four strong RFIs in the 30-400 MHz frequency range from one combined VHF-UHF receive antenna. Cosite EMI mitigation is provided by the HAIC shown in Figure 3. The HAIC typically reduces RFI by 45 dB to prevent saturation of the front end of cosited RXs, thereby restoring their radio's entire broad receive range. SINCGARS and HAVE QUICK compatible.



- » Modular
- » Dual Band – VHF/UHF
- » Fully Automatic Operation
- » Size: 5.7" H x 8.5" W x 6.5" D
- » Weight: 8.5 lbs for 4 Module Version

Figure 3: Figure ZA's Frequency Hopping Adaptive Interference Canceller (HAIC™)

ADAPTIVE ANTENNA ARRAY PROTECTS GPS RECEIVERS FROM MULTIPLE JAMMERS

ZA's experience with Global Positioning System (**GPS**) has focused on the analysis and development of techniques for improving the resistance of GPS navigation receivers to deliberate jammers and incidental interferences. We have been active in the application of adaptive antenna array technology to develop a product to improve simultaneously the jammer and multipath resistance and signal enhancement of GPS receiver systems.

ZA developed for the USN a unique compact, low cost antijam (**AJ**) antenna array (Figure 4) with extraordinary capabilities. ZA's Low Elevation Angle Nuller (**LEAN™**) antenna has a Fixed Radiation Pattern Antenna (**FRPA**) footprint but forms 360° azimuthal ring nulls at L1 and L2 to suppress an arbitrarily large number of independent jammers at or close to the horizon. LEAN's adaptive RF electronics unit uses a digital algorithm to automatically form nulls on incident waveforms that would interfere with GPS signal reception. In a non-jammed environment, LEAN provides full hemispheric coverage for RHCP P and C/A code GPS signals. Its performance can be optimized for L1, L2, P, and C/A code operation.

ANTIMULTIPATH ANTENNA MEASUREMENT SYSTEM

ZA combined adaptive interference cancellation with narrowband spread spectrum signal processing techniques to develop and integrate into antenna test range equipment the new capability to significantly reduce antenna range multipath. This system enables the accurate measurement of microwave antenna/array patterns having extremely low sidelobe levels.



Figure 4: LEAN™ Adaptive Antenna Nulling Array

PARTNERS

ZA has licensed several electronics manufacturers to produce and market ZA's RFI cancellation products. We are developing additional RFI mitigation technology that we will offer to license to interested organizations that are capable of exploiting these products to capture a significant portion of the RFI reduction market at VHF through SHF.

PROFILE

Zeger-Abrams Incorporated was organized 33 years ago by Andrew Zeger and Burton Abrams to innovate, develop and apply advanced Radio Frequency signal processing techniques and systems to mitigate RFI that could devastate the performance of radio receivers. ZA has continued to the present to specialize in suppression of RFI for DoD and commercial markets.

ZA has facilities comprising engineering offices, modern R&D laboratory, and model shop, occupying approximately 2,800 square feet in Glenside, PA. The ZA laboratory is in the Philadelphia area and is well equipped with company-owned instruments and computers for the development, fabrication, and test of analog and digital electronic circuits and systems at Microwave, RF, IF, and baseband.

MANAGEMENT PROFILES

Andrew E. Zeger, the President of ZA, has forty-five years experience in the analysis, design, and development of adaptive interference suppression techniques for communications, radar, navigation, sonar, and ultrasonics. Mr. Zeger has an SB from MIT (Physics) and an MS from Brooklyn Polytechnic (Mathematics), where he has completed all but the dissertation for a Ph.D in electrical engineering. He has taught mathematics at Queens College/CUNY and served as Adjunct Professor of Electrical Engineering at the Graduate School of the University of Pennsylvania. Mr. Zeger has four patents and 27 publications. Mr. Zeger is a Life Member of the IEEE, a member of the AOC, and AMTA.

Prior to founding Zeger-Abrams Inc. with Burton Abrams in 1977, Mr. Zeger was at Magnavox/General Atronics Corp. from 1965 to 1977 where he organized and headed the Adaptive Systems Department.

Burton S. Abrams is the Executive Vice President of ZA. Mr. Abrams has more than forty years experience in the analysis, development, and testing of communication systems and adaptive signal processing systems. He has served as Principal Investigator at ZA on numerous Adaptive Interference Cancellation (**AIC**) and CNF hardware development programs from VLF through SHF including frequency-hopping AIC (**HAIC™**) development programs.

Mr. Abrams holds a BS from Drexel University and an MS from Polytechnic University, and he has completed all course requirements for a Ph.D at the University of Pennsylvania, all in electrical engineering. He has been awarded four patents and has 15 publications to his credit.

MARKETS / CUSTOMERS

ZA has satisfactorily completed numerous contracts for a variety of customers since 1977.

U.S. GOVERNMENT AGENCIES

- » Naval Air Warfare Center-WD, China Lake, CA
- » Army LABCOM and CECOM, Fort Monmouth, NJ
- » DARPA, Arlington, VA
- » USAF Rome Laboratory, Griffiss AFB, NY, and Hanscom AFB, MA
- » USMC Systems Center, Quantico, VA
- » Naval Research Laboratory, Washington, DC
- » Naval Air Warfare Center-Aircraft Div., Patuxent River, MD and Point Mugu NAS, CA
- » Army Research Laboratory, Adelphi, MD
- » National Science Foundation, Washington, DC
- » Navy SPAWAR Systems Center Pacific, San Diego, CA
- » Naval Sea Systems Command, Crane, IN Division

INDUSTRIAL AND INSTITUTIONAL

- » Argon ST, Fairfax, VA
- » BAE, Greenlawn, NY
- » Ball Aerospace & Technologies Corp., Westminster, CO
- » Checkpoint Systems Inc., Thorofare, NJ
- » Rockwell Collins International Corp., Cedar Rapids, IA
- » Electric Power Research Institute, Palo Alto, CA
- » DRS, Wyndmoor, PA
- » Harris Corporation, Melbourne, FL and Rochester, NY
- » Interstate Electronics Corp., Anaheim, CA
- » ITT Avionics, Nutley, NJ
- » Lockheed Martin Management, Data, Reconnaissance Systems, Litchfield Park, AZ
- » ORBIT/FR, Horsham, PA
- » Raytheon, Falls Church, VA and Fort Wayne, IN
- » Westinghouse Electric Corp., Baltimore, MD

CORE ADVANTAGE

- » Corporate leaders with more than four decades of experience creating solutions to extremely difficult RF interference problems
- » RFI mitigation systems developed and successfully tested on military aircraft (P-3C) in flight, ships (LHD-5) at sea and on modern amphibious vehicles (USMC EFV)
- » Technology designed for next generation systems and compatible with legacy systems



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