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Advancing Electromagnetic Warfare TOGETHER
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December 2022 Vol. 45, No.12

JED

Journal of Electromagnetic Dominance

Protecting Large Aircraft

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- 2023 EW/SIGINT Resource Guide
- EW 101: EP Against Cross-Polarization Jamming
- News: UK Dragonfire HEL Tested at Dstl Range

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US Air Force SSgt. Jonathan Dillingham, 355th Component Maintenance Squadron electronic warfare technician, performs maintenance on an AN/ALQ-188 electronic warfare pod at Davis-Monthan Air Force Base, AZ, in August. The 355th CMS is the only shop that can service AN/ALQ-188 pods in the continental US and Europe. USAF PHOTO BY SRA KAITLYN ERGISH

Departments

COVER US AIR FORCE PHOTO BY STAFF SGT. GREG C. BIONDO

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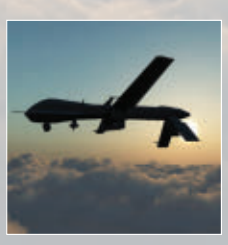

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HARD PROBLEMS

I remember a former USAF C-130 crewmember once telling me about how his aircraft handled IR MANPADS during the Vietnam War. They had no missile warning system and no flare dispenser installed on the aircraft. He said they would open the cargo ramp during flight and that he (or one of his crewmates) would stand at the top of it hanging onto a strap with one hand and holding a flare gun in the other. The idea was that he would act as the aircraft's missile warning system (scanning the ground below for missile launches) and the IR countermeasures dispenser (the flare gun – a single round hopefully fired at the right time and in the right direction to decoy the missile away from the aircraft). He may have been pulling my leg a bit, but it seemed quite plausible to me in the absence of any EW equipment on his C-130. We've come a long way since those early days, but as John Haystead writes in this month's *JED,* protecting large aircraft poses considerable challenges.

Transports, such as C-130s, C-17s and A-400Ms, are essential tools of regional and global power projection, and many western countries – and especially the US – depend on them to ferry troops and deliver supplies to forces in theater. Yet transports are among the most vulnerable aircraft types for the simple reasons that they are relatively slow, feature large radar cross sections and their engines present significant IR signatures. As a result, they face threats, such as IR MANPADs and small arms fire, during take-off and landing. And they increasingly are threatened by long-range RF-guided surface-to-air missiles (SAMs) from the moment they take-off until the moment they land. As countries such as China modernize their fighter fleets, transport aircraft are also more likely to face IR- and RF-guided air-to-air threats than in the past. With these challenges in mind, it's no exaggeration to say that protecting transports is one of EW's hardest problems.

As John's article points out, ensuring transport aircraft survivability today requires much more than fitting aircraft with self-protection EW suites. Onboard threat warning and countermeasures systems will certainly continue to be part of the equation, but additional resources are needed in the form of real-time offboard situational awareness (think JADC2), dynamic mission planning and re-routing, fighter escorts to handle air-to-air threats and support from airborne electronic attack platforms to help defeat long-range SAMs. Beyond these measures, aircrews will require more robust EMSO education and better EMSO training in Joint air exercises. In general, the strategic and tactical airlift mission will become more dependent on multiple resources across the battle network, and, as a result, transport aircraft and aircrews will need to become more tightly integrated into that network. Compared with the past, this is a much more complex approach to the air mobility mission. But the alternatives are worse: unacceptable attrition of aircraft, troops and supplies and, ultimately, lost combat power. Protecting large aircraft represents a hard EW problem, and it requires a robust, multi-layered survivability strategy. – *J. Knowles*

JED
Journal of Electromagnetic Dominance

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Calendar *Conferences & Trade Shows*

JANUARY

Surface Navy Association 35th Annual National Symposium
Jan. 10-12
Arlington, VA
www.navysna.org

FEBRUARY

Aero India 2023
Feb. 3-5
Bengaluru, India
www.aeroindia.gov.in

DIMDEX
Feb. 5-7
Doha, Qatar
www.dimdex.com

AFCEA West 2023
Feb. 14-16
San Diego, CA
www.westconference.org

IDEX
Feb. 20-24
Abu Dhabi, UAE
www.idexuae.ae

Avalon 2023
Feb. 28 – March 5
Geelong, Victoria, Australia
www.airshow.com.au

MARCH

AFA Air Warfare Symposium
March 6-8
Aurora, CO
www.afa.org

Satellite 2023
March 13-16
Washington, DC
www.satshow.com

Collaborative EW 2023
March 14-16
Point Mugu, CA
www.crows.org

DSEI Japan
March 15-17
Chiba, Japan
www.dsei-japan.com

Dixie Crow Symposium 46
March 20-23
Warner Robins, GA
www.dixiecrowsympsoium.com

APRIL

Annual Directed Energy S&T Symposium
April 3-5
Mobile, AL
www.deps.org

Navy League Sea-Air-Space
April 3-5
National Harbor, MD
www.seaairspace.org

Army Aviation Mission Solutions Summit
April 26-28
Nashville, TN
www.quad-a.org

MAY

Cyber Electromagnetic Activities (CEMA) Conference
May 2-4
Aberdeen Proving Ground, MD
www.crows.org

EW Capability Gaps and Enabling Technologies Conference
May 9-11
Crane, IN
www.crows.org

AOC Europe
May 16-18
Bonn, Germany
www.aoceurope.com

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D9816	8-Way	330-530	10,000	50,000	0.25	1.30:1	3 1/8" EIA, N-Female
D8454	8-Way	370-450	10,000	50,000	0.25	1.30:1	3 1/8" EIA, N-Female
D5320	12-Way	470-860	500	5,000	0.30	1.30:1	All N-Female
D10119	4-Way	700-4200	2,000	15,000	0.30	1.35:1	13-30 DIN-Female, N-F
D10603	32-Way	900-925	50,000	150,000	0.15	1.25:1	WR975, 7/16-Female
D10795	32-Way	900-930	25,000	150,000	0.25	1.20:1	WR975, 4.3-10-F
D9710	8-Way	1000-2500	2,000	10,000	0.30	1.40:1	1 5/8" EIA, N-Female
D8182	5-Way	1175-1375	1,500	25,000	0.40	1.35:1	1 5/8" EIA, N-Female
D6857	32-Way	1200-1400	4,000	16,000	0.50	1.35:1	1 5/8" EIA, N-Female
D11896	4-Way	2000-2120	4,000	40,000	0.25	1.40:1	WR430, 7/16-Female
D11828	4-Way	2400-2500	3,000	25,000	0.20	1.25:1	WR340, 7/16-Female
D10851	8-Way	2400-2500	8,000	50,000	0.20	1.25:1	WR340, 7/16-Female
D11433	16-Way	2700-3500	2,000	20,000	0.30	1.35:1	WR284, N-Female
D11815	16-Way	2700-3500	6,000	40,000	0.30	1.35:1	WR284, N-Female
D12101	6-Way	2750-3750	2,000	20,000	0.35	1.40:1	WR284, N-Female
D9582	16-Way	3100-3500	2,000	16,000	0.25	1.50:1	WR284, N-Female
D12102	6-Way	5100-6000	850	4,500	0.35	1.35:1	WR159, N-Female
D12484	6-Way	8200-8600	600	700	0.35	1.25:1	WR112, SMA-Female
D12485	6-Way	9000-11,000	500	700	0.40	1.35:1	WR90, SMA-Female

Specifications subject to change without notice.

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Calendar *Courses & Seminars*

DECEMBER

Electromagnetic Warfare Data Analysis
Dec. 6-7
Atlanta, GA
www.pe.gatech.edu

AOC Virtual Series Webinar: In the Flat Field: Did Russian Army EW Underperform in Ukraine
Dec. 15
2-3 p.m. EDT
www.crows.org

JANUARY

AOC Virtual Series Webinar: Regaining the Spectrum Offensive
Jan. 5
2-3 p.m. EDT
www.crows.org

AOC Virtual Series Webinar: 2023 GPS Spoofing – History and Prevention
Jan. 19
2-3 p.m. EDT
www.crows.org

AOC Virtual Series Webinar: Alternate Approaches for Enhanced Survivability of Missiles
Jan. 26
2-3 p.m. EDT
www.crows.org

FEBRUARY

AOC Virtual Series Webinar: Importance of Signal Generator Phase Noise in RF/mm-Wave Subsystem Measurements
Feb. 2
2-3 p.m. EDT
www.crows.org

AOC Virtual Series Webinar: Regaining the Spectrum Offensive
Jan. 5
2-3 p.m. EDT
www.crows.org

AOC Virtual Series Webinar: Joint All-Domain Command and Control (JADC2)
Feb. 23
2-3 p.m. EDT
www.crows.org

Advanced RF Electromagnetic Warfare Principles
Feb. 27 - March 3
Atlanta, GA
www.pe.gatech.edu

MARCH

AOC Virtual Series Webinar: Chinese Thinking on the Establishment of Information Dominance
March 2
2-3 p.m. EDT
www.crows.org

AOC Virtual Series Webinar: Countering UAS Using EW and DEW Attack Vectors
March 9
2-3 p.m. EDT
www.crows.org

AOC Virtual Series Webinar: SDR for Strategic COMINT Applications
March 23
2-3 p.m. EDT
www.crows.org

Principles of Millimeter-Wave Radar EW
March 28-29
Atlanta, GA
www.pe.gatech.edu

APRIL

AOC Virtual Series Webinar: 2023 GPS Spoofing – History and Prevention
Jan. 19
2-3 p.m. EDT
www.crows.org

Basic RF EW Concepts
April 11-13
Atlanta, GA
www.pe.gatech.edu

*AOC courses and webinars are noted in **red**. For more info or to register, visit crows.org.*

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OCTAVE BAND LOW NOISE AMPLIFIERS

Model No.	Freq (GHz)	Gain (dB) MIN	Noise Figure (dB)	Power-out @ P1-dB	3rd Order ICP	VSWR
CA01-2110	0.5-1.0	28	1.0 MAX, 0.7 TYP	+10 MIN	+20 dBm	2.0:1
CA12-2110	1.0-2.0	30	1.0 MAX, 0.7 TYP	+10 MIN	+20 dBm	2.0:1
CA24-2111	2.0-4.0	29	1.1 MAX, 0.95 TYP	+10 MIN	+20 dBm	2.0:1
CA48-2111	4.0-8.0	29	1.3 MAX, 1.0 TYP	+10 MIN	+20 dBm	2.0:1
CA812-3111	8.0-12.0	27	1.6 MAX, 1.4 TYP	+10 MIN	+20 dBm	2.0:1
CA1218-4111	12.0-18.0	25	1.9 MAX, 1.7 TYP	+10 MIN	+20 dBm	2.0:1
CA1826-2110	18.0-26.5	32	3.0 MAX, 2.5 TYP	+10 MIN	+20 dBm	2.0:1

NARROW BAND LOW NOISE AND MEDIUM POWER AMPLIFIERS

Model No.	Freq (GHz)	Gain (dB) MIN	Noise Figure (dB)	Power-out @ P1-dB	3rd Order ICP	VSWR
CA01-2111	0.4 - 0.5	28	0.6 MAX, 0.4 TYP	+10 MIN	+20 dBm	2.0:1
CA01-2113	0.8 - 1.0	28	0.6 MAX, 0.4 TYP	+10 MIN	+20 dBm	2.0:1
CA12-3117	1.2 - 1.6	25	0.6 MAX, 0.4 TYP	+10 MIN	+20 dBm	2.0:1
CA23-3111	2.2 - 2.4	30	0.6 MAX, 0.45 TYP	+10 MIN	+20 dBm	2.0:1
CA23-3116	2.7 - 2.9	29	0.7 MAX, 0.5 TYP	+10 MIN	+20 dBm	2.0:1
CA34-2110	3.7 - 4.2	28	1.0 MAX, 0.5 TYP	+10 MIN	+20 dBm	2.0:1
CA56-3110	5.4 - 5.9	40	1.0 MAX, 0.5 TYP	+10 MIN	+20 dBm	2.0:1
CA78-4110	7.25 - 7.75	32	1.2 MAX, 1.0 TYP	+10 MIN	+20 dBm	2.0:1
CA910-3110	9.0 - 10.6	25	1.4 MAX, 1.2 TYP	+10 MIN	+20 dBm	2.0:1
CA1315-3110	13.75 - 15.4	25	1.6 MAX, 1.4 TYP	+10 MIN	+20 dBm	2.0:1
CA12-3114	1.35 - 1.85	30	4.0 MAX, 3.0 TYP	+33 MIN	+41 dBm	2.0:1
CA34-6116	3.1 - 3.5	40	4.5 MAX, 3.5 TYP	+35 MIN	+43 dBm	2.0:1
CA56-5114	5.9 - 6.4	30	5.0 MAX, 4.0 TYP	+30 MIN	+40 dBm	2.0:1
CA812-6115	8.0 - 12.0	30	4.5 MAX, 3.5 TYP	+30 MIN	+40 dBm	2.0:1
CA812-6116	8.0 - 12.0	30	5.0 MAX, 4.0 TYP	+33 MIN	+41 dBm	2.0:1
CA1213-7110	12.2 - 13.25	28	6.0 MAX, 5.5 TYP	+33 MIN	+42 dBm	2.0:1
CA1415-7110	14.0 - 15.0	30	5.0 MAX, 4.0 TYP	+30 MIN	+40 dBm	2.0:1
CA1722-4110	17.0 - 22.0	25	3.5 MAX, 2.8 TYP	+21 MIN	+31 dBm	2.0:1

ULTRA-BROADBAND & MULTI-OCTAVE BAND AMPLIFIERS

Model No.	Freq (GHz)	Gain (dB) MIN	Noise Figure (dB)	Power-out @ P1-dB	3rd Order ICP	VSWR
CA0102-3111	0.1-2.0	28	1.6 Max, 1.2 TYP	+10 MIN	+20 dBm	2.0:1
CA0106-3111	0.1-6.0	28	1.9 Max, 1.5 TYP	+10 MIN	+20 dBm	2.0:1
CA0108-3110	0.1-8.0	26	2.2 Max, 1.8 TYP	+10 MIN	+20 dBm	2.0:1
CA0108-4112	0.1-8.0	32	3.0 MAX, 1.8 TYP	+22 MIN	+32 dBm	2.0:1
CA02-3112	0.5-2.0	36	4.5 MAX, 2.5 TYP	+30 MIN	+40 dBm	2.0:1
CA26-3110	2.0-6.0	26	2.0 MAX, 1.5 TYP	+10 MIN	+20 dBm	2.0:1
CA26-4114	2.0-6.0	22	5.0 MAX, 3.5 TYP	+30 MIN	+40 dBm	2.0:1
CA618-4112	6.0-18.0	25	5.0 MAX, 3.5 TYP	+23 MIN	+33 dBm	2.0:1
CA618-6114	6.0-18.0	35	5.0 MAX, 3.5 TYP	+30 MIN	+40 dBm	2.0:1
CA218-4116	2.0-18.0	30	3.5 MAX, 2.8 TYP	+10 MIN	+20 dBm	2.0:1
CA218-4110	2.0-18.0	30	5.0 MAX, 3.5 TYP	+20 MIN	+30 dBm	2.0:1
CA218-4112	2.0-18.0	29	5.0 MAX, 3.5 TYP	+24 MIN	+34 dBm	2.0:1

LIMITING AMPLIFIERS

Model No.	Freq (GHz)	Input Dynamic Range	Output Power Range Psat	Power Flatness dB	VSWR
CLA24-4001	2.0 - 4.0	-28 to +10 dBm	+7 to +11 dBm	+/- 1.5 MAX	2.0:1
CLA26-8001	2.0 - 6.0	-50 to +20 dBm	+14 to +18 dBm	+/- 1.5 MAX	2.0:1
CLA712-5001	7.0 - 12.4	-21 to +10 dBm	+14 to +19 dBm	+/- 1.5 MAX	2.0:1
CLA618-1201	6.0 - 18.0	-50 to +20 dBm	+14 to +19 dBm	+/- 1.5 MAX	2.0:1

AMPLIFIERS WITH INTEGRATED GAIN ATTENUATION

Model No.	Freq (GHz)	Gain (dB) MIN	Noise Figure (dB)	Power-out @ P1-dB	Gain Attenuation Range	VSWR
CA001-2511A	0.025-0.150	21	5.0 MAX, 3.5 TYP	+12 MIN	30 dB MIN	2.0:1
CA05-3110A	0.5-5.5	23	2.5 MAX, 1.5 TYP	+18 MIN	20 dB MIN	2.0:1
CA56-3110A	5.85-6.425	28	2.5 MAX, 1.5 TYP	+16 MIN	22 dB MIN	1.8:1
CA612-4110A	6.0-12.0	24	2.5 MAX, 1.5 TYP	+12 MIN	15 dB MIN	1.9:1
CA1315-4110A	13.75-15.4	25	2.2 MAX, 1.6 TYP	+16 MIN	20 dB MIN	1.8:1
CA1518-4110A	15.0-18.0	30	3.0 MAX, 2.0 TYP	+18 MIN	20 dB MIN	1.85:1

LOW FREQUENCY AMPLIFIERS

Model No.	Freq (GHz)	Gain (dB) MIN	Noise Figure dB	Power-out @ P1-dB	3rd Order ICP	VSWR
CA001-2110	0.01-0.10	18	4.0 MAX, 2.2 TYP	+10 MIN	+20 dBm	2.0:1
CA001-2211	0.04-0.15	24	3.5 MAX, 2.2 TYP	+13 MIN	+23 dBm	2.0:1
CA001-2215	0.04-0.15	23	4.0 MAX, 2.2 TYP	+23 MIN	+33 dBm	2.0:1
CA001-3113	0.01-1.0	28	4.0 MAX, 2.8 TYP	+17 MIN	+27 dBm	2.0:1
CA002-3114	0.01-2.0	27	4.0 MAX, 2.8 TYP	+20 MIN	+30 dBm	2.0:1
CA003-3116	0.01-3.0	18	4.0 MAX, 2.8 TYP	+25 MIN	+35 dBm	2.0:1
CA004-3112	0.01-4.0	32	4.0 MAX, 2.8 TYP	+15 MIN	+25 dBm	2.0:1

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THANK YOU

I'm almost 100 years behind Franklin Delano Roosevelt's famous fireside chats, but I am truly happy that *JED* allows me a similar opportunity to informally communicate some thoughts to our membership throughout my two-year tenure. My first message quite simply starts with a heartfelt "thank you" to my predecessor, Powder Carlson, and to the AOC staff, Board Members and past presidents for handing off a fully righted ship steaming full speed ahead. I plan to keep it between the navigational buoys, as they say, as we navigate the challenging waters ahead. Can you tell I'm Navy yet?

Navy yes, but I want to clarify that my proudest professional accomplishments have come directly from being first and foremost an EW officer. Although I loved carrier aviation, I personally was honored to be associated with great joint EW success in Iraq that began for me in 2006. As the first commander of Joint CREW Composite squadron ONE (JCCS-1), I witnessed the heroic efforts of hundreds of Navy Sailors – many pulled with minimum notice from their career paths and families to accomplish one mission: bring a robust EW focus to the fight in the land domain for the Army and the Marine Corps. The efforts by those young men and women, and the commitment to EW of Army and Marine leadership, proved once again that, when embraced and tactically employed, EW is an incredibly effective weapon that saves lives in combat.

At the unclassified level, within the first year of the establishment of JCCS-1, the number of US KIAs from Radio-Controlled Improvised Explosive Devices (RCIEDs) decreased by a factor of 100. The Center for Naval Analyses found that over a five-year period, the renewed focus from Army, Navy, Air Force and Marine forces on using EW as a weapon system was directly responsible for over 1,000 men and women – sons and daughters, mothers and fathers, sisters and brothers – returning safely home to their families. This success is just one example of many over our careers that explains why so many of us in the AOC continue to be incredibly passionate about EW.

Sharing this passion, I am humbled and very proud of being elected to serve our organization. The AOC is unequivocally the premier international professional association for our EW community, and we will perform as such. We will serve our members across the globe by making measurable progress in our Five-Year Strategy: 1) enhancing EW advocacy face-to-face with military, industry, academia and government leaders through an aggressive call plan; 2) growing our membership and building even greater return on investment for members and sponsors; 3) creating more networking opportunities for our members to allow you to take full advantage of the tremendous wealth of expertise and experience in our community; and 4) enhancing education programs and opportunities that accelerate the professional development, knowledge and expertise of the future of our association.

I thank you for the opportunity ahead. Together we are AOC – proud of our shared heritage, inspired by our common mission, and devoted to having a direct and positive impact on future readiness. – *Brian "Hinks" Hinkley*

Collaborative Electronic Warfare 2023

ASSOCIATION OF OLD CROWS

MARCH 14–16 Pt. Mugu, CA

CALL FOR PAPERS

ABSTRACTS DUE BY DECEMBER 14, 2022

THEME: US/AUS approaches to Collaborative EW: Stand-in/Stand-off/Self-Protect jammer collaboration, Sensor collaboration, Man/Machine Collaboration

Classification of Sessions: U.S. Secret, Releasable Australia

Conference Topics:

- Collaborative ES to support dynamic combat operations
- Cooperative electronic attack
- Collaborative electronic attack
- Emerging communications technologies
- Warfighter perspective

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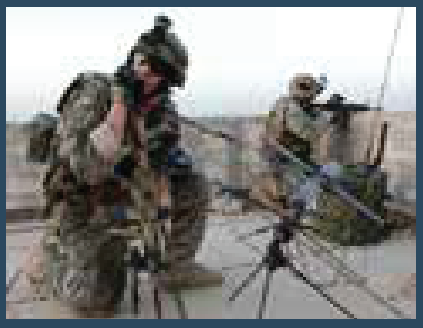

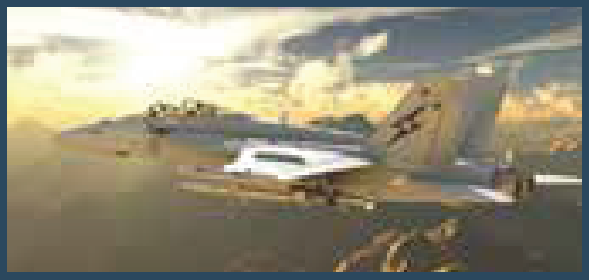

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UK DRAGONFIRE LDEW TESTBED COMPLETES HIGH-POWER DEMO

First high-power trials of the UK DragonFire Laser Directed Energy Weapon (LDEW) testbed have been successfully conducted at a Defence Science and Technology Laboratory (Dstl) range facility in southern England.

The UK DragonFire LDEW demonstrator has completed first high-power trials at Dstl Porton Down's Battery Hill range. RICHARD SCOTT

Developed by an industry consortium led by MBDA UK, the sovereign LDEW capability demonstrator program has been established to improve the UK Ministry of Defence's (MoD's) understanding of how high-energy lasers and their associated technologies can defeat representative air and surface targets at operationally relevant ranges, and in different operating environments.

The UK DragonFire LDEW demonstrator is a collaborative project jointly funded by the MoD (through the Chief Scientific Advisor's budget) and industry. Total funding amounts to approximately £100 million, with a roughly equal split between industry and the MoD.

As leader of the UK DragonFire consortium, MBDA UK has taken overall responsibility for the system, as well as developing its command and control and image processing capabilities. Leonardo has built the beam director, which enables the LDEW system to point and track on moving targets with high accuracy, while QinetiQ has developed novel coherent beam-combining technology to produce a scalable laser system that can achieve an enhanced power density and increased engagement range. The full system has been packaged into three containerized cabins.

First high-power static firings of the 50 kW-class capability demonstrator were conducted from the Dstl Porton Down's Battery Hill range site in mid-October, with several tens of firings were undertaken during the test campaign. While the range of the LDEW demonstrator is classified, the Battery Hill range has defined distances over which the trial serials were conducted to a maximum distance of 3.4 km from the system.

Previous US research into LDEW systems has been centered on spectral beam combining, a technique that spatially overlays the outputs of several laser emitters operating at specific wavelengths into a single beam. Dstl believes that coherent beam combining – where the outputs of multiple laser emitters are combined so that they form a single, spatially coherent aperture – offers a superior approach and is likely to be the optimum solution for long-range, high-power LDEW engagements.

Leonardo has delivered two prototype beam directors as part of the UK DragonFire program. The first – a fully articulated system – was integrated and tested in earlier trials at Aberporth in west Wales, where its pointing and tracking capability was fully exercised.

The recent live trials used the second beam director. This static system was fully integrated with the laser source in realistic conditions.

While the high-power firings marked the culmination of the initial capability demonstration, there is an expectation that the UK DragonFire system will be retained for use as a research tool. As well as delivering prototype hardware, the LDEW demonstrator has also sought to develop UK industrial capability and knowledge of laser weapon architectures, operation, performance and support in order to inform any follow-on acquisition programs. – *R. Scott*

USSOCOM SEEKS NEXT-GEN GROUND-BASED EW SYSTEM

US Special Operations Command (USSOCOM) is expected to release a solicitation in the coming weeks for its Next-Gen Multi-Mission Electromagnetic Countermeasures (NG-MM-ECM) program.

Currently, SOCOM relies on multiple configurations (manpack, vehicular and fixed-site) of RCIED jammers and counter-UAS systems. These include the EGON and Modi RCIED jammers from L3 Harris and Sierra Nevada Corp., respectively, as well as reconfigurable counter-UAS systems integrated by Anduril. The NG-MM-ECM program would replace these systems with a new generation of equipment in "body-worn, dismounted, mounted, and fixed-site configurations starting in FY25," according to a SOCOM Prototype Project Opportunity Notice (PPON).

Managed by Special Operations Forces Acquisition, Technology, & Logistics (SOF AT&L), Program Manager, Counterproliferation (PMCP), the NG-MM-ECM program is broken into four phases. Phase 1 calls for Whitepapers for proposed designs, with up to 10 contractors selected for Phase 2 site visits

and oral presentations. Phase 3 begins in Q3 FY2023 with selected contractors performing concept development (including preliminary and critical design reviews) under OTA agreements. Phase 4, which will start in Q2 FY2024, calls for a six-month operational prototype demonstration, followed by a follow-on production by the end of FY2024. The contracting point of contact is Jason Mayer, e-mail jason.a.mayer.civ@socom.mil. – *J. Knowles*

TEAM PROTECT SELECTED FOR UK'S PROJECT CRENIC

Team Protect, an industry group led by PA Consulting Services (London, UK), has been selected as system integrator (SI) for the recapitalization of UK land and littoral force protection electronic countermeasures (FP ECM) capability under Project Crenic.

Led by the UK's Strategic Command, Project Crenic is a £400 million program intended to protect personnel from the threat posed by radio controlled improvised explosive devices (RCIED). The program will provide next-generation FP ECM in the land and littoral domains for the British Army, and ground elements of the Royal Navy and Royal Air Force, and will include spiral delivery of capability for future platform mounted, dismounted, and static FP ECM solutions.

Team Protect, which also includes Leonardo UK, Leidos UK and Marshall Land Systems, has been awarded a five-year SI contract valued at £45 million by the Ministry of Defence (MoD). The contract additionally includes five one-year options.

Under its SI contract, PA Consulting and its partners will be responsible for setting up and managing an "ecosystem" of suppliers from which to identify innovative solutions and select best-in-class technology for project service taskings, with the majority equipment expected to be sourced from UK-based small/medium enterprises. First deliveries of the new FP ECM equipment for vehicle and soldier-carried systems for use on operations are due to take place in 2026.

An advanced integration laboratory facility will be established to support the development of the Project Crenic capability. The laboratory will promote "innovation and experimentation as the new capability evolves against emerging threats", said the MoD.

As part of Team Protect, Leonardo UK will perform as lead technology integrator for Crenic. The company has previously provided counter-RCIED systems to protect vehicle crews and dismounted patrols on operations in Iraq and Afghanistan

Project Crenic will be supported by the Defence Cyber and Electromagnetic Activities (CEMA) Architecture, which uses a common set of hardware and software open technology standards to allow for wider industry participation and support reconfiguration for other military uses. This Defence CEMA Architecture is "owned" by Dstl on behalf of the MoD. – *R. Scott*

ROKE WINS BRITISH ARMY'S PROJECT BESTLA

Roke (Romsey, UK) has been selected by the UK Ministry of Defence to provide remote observation, surveillance and radio frequency (RF) emission collection systems for the British Army's Land Warfare Centre (LWC) under Project Bestla.

Valued at £4.7 million, the contract lasts for an initial three years with options to extend for a further two years. According to Roke, the Project Bestla solution will leverage from the company's established "Electronic Warfare as a Service" (EWaaS) offering.

Project Bestla seeks to uplift the British Army's training assessment capability by creating a suite of three systems that will provide LWC observer mentors (OMs) – with greater objective data on the training troops' activities and behaviors. These will comprise an OM system (using a range of directional cameras and microphones installed into an HQ tent), a surveillance system (capturing visual and electro-optical/infrared (EO/IR) imagery to replicate what an adversary might see from a distance) and an RF system (capturing emissions from tactical communications systems used by troops in the military RF spectrum so that OMs can show troops what an adversary might be able to intercept/direction find).

EWaaS has been designed by Roke to provide a secure and highly skilled electronic warfare (EW)/passive electronic surveillance service that can monitor, analyze and provide dynamic feedback to commanders undergoing "live" collective training. The company will leverage technology from its Resolve and Perceive tactical EW product lines for the RF system being supplied for Project Bestla.

Soteria Defence and Security will partner with Roke to deliver Project Bestla. As well as providing EO/IR surveillance capabilities, Soteria will also provide ex-military personnel with experience of army training exercises to deliver specialized and dynamic consultancy services. – *R. Scott*

IN BRIEF

DARPA's **Strategic Technology Office** (STO) released an "office wide" Request for Information (RFI) seeking information from potential contractors that can "enable significant advances in finding difficult, elusive 'targets.' This includes new modalities, sensors, and signal processing techniques that create leap-ahead target detection, tracking, and recognition. STO also envisions a future of sensing and networking that, without any countermeasures, leaves 'nowhere left to hide.'" The RFI outlines five areas of interest: sensors and processing; battlefield effects; command, control and communications; systems of autonomous systems; and empowered human decision making. The sensors and processing area includes, "active and passive acoustic sensing and systems, electro-optic/infrared sensing and systems, high frequency sensors and systems, microwave and millimeter wave sensors and systems, radar and adaptive arrays, seekers and other expendable sensors and processing, advanced sensors and analytics, signal processing, space sensors." Battlefield effects cover "technologies and systems to achieve and counter kinetic and non-kinetic effects in all physical domains (air, space, sea, and land) and between all domains." This includes, "acoustic systems, combat identification, directed energy systems, effects chain functions (disaggregated find, fix, finish, target, engage, assess), novel kinetic effects, non-kinetic effects (electronic warfare, directed energy, cyber), photonics, strategy analysis with modeling and simulation technologies and systems to achieve and counter effects." The solicitation number is DARPA-SN-23-01. RFI responses are due by January 20, 2023. The solicitation coordinator can be contacted via e-mail at HR001123S0003@darpa.mil.

Centum Electronics Ltd. (Gandhinagar, India) and **Rafael Advanced Defense Systems** (Haifa, Israel) signed a Memorandum of Understanding (MoU) at India's DefExpo 2022 to "exclusively collaborate in the field of Electronic Warfare systems for the Indian Army, Indian Navy, Indian Air Force, Indian Coast Guards and other government agencies," according to a joint press release. "The MoU envisages development and indigenous production of the futuristic light weight Electronic Warfare systems in lower frequency bands and life cycle support of the existing Electronic Warfare systems."

The University of Dayton Research Institute (Dayton OH) received an $8 million contract from the Air Force Research Lab's Sensors Directorate, Aerospace Components & Subsystems Technology Division (AFRL/RYD) to perform R&D in support of its Proficient Research of Onboard Subsystems Technology (PROST) program. Managed by the Division's Radio Frequency/Electro-Optical Subsystems Branch (AFRL/RYDR), the PROST program will develop technologies for "electro-optical (EO), hyperspectral (HSI), radio frequency (RF), and electronic warfare (EW) subsystems, including both analog and digital components," according to an AFRL program description. "The research and development of on-board sensor subsystems combines heterogeneous devices, including (but not limited to) CPUs, GPUs, FPGAs, and AI accelerators, with open system architectures. This contract will include compression techniques for multiple sensor modalities including EO, RF, HSI, and EW onboard airborne and space based platforms."

Germany's **Rheinmetall Waffe Munition GmbH** and **MBDA Deutschland GmbH** disclosed last month that the German Navy frigate *Sachsen* conducted the German Armed Forces' first operational tests of a high-energy laser weapon against drones. The companies said that the weapon "successfully engaged drones at short and very short range" in the Baltic Sea near Putlos Major Training Area on August 30. MBDA Deutschland is responsible for the system's target detection and target tracking, operator console and linking the laser weapon demonstrator to the command-and-control system. Rheinmetall is responsible for the slewing system, the beam guidance, the demonstrator container, as well as mechanical and electrical integration of the demonstrator onto the deck of the *Sachsen*, and finally for the high-energy laser source. The joint integration and test phase of the naval demonstrator began in November 2021 and will continue through mid-2023.

Applied Signals Intelligence Inc. (Sterling, VA) received a $4 million contract from the Air Force Research Lab's Sensors Directorate, Multispectral Sensing and Detection Division (AFRL/RYM), for software and hardware development in support of its "Framework and Applications for Direction-finding at the Edge (FADE)" effort. The company will supply its Crosswinds ultrawideband precision DF system housed in a Stongback pod configuration. AFRL Awarded the contract under its Multi-Spectral Sensing Technologies Research and Development (MUSTER) umbrella program.

The Defense Advanced Research Projects Agency (DARPA) awarded a pair of contracts under its Modular Efficient Laser Technology (MELT) program. **Northrop Grumman** won a $21.6 million contract and **Lockheed Martin Aculight** (Bothell, WA) received a $28 million award to develop and demonstrate the next generation of scalable HEL sources. Overall, the MELT program aims to exploit technologies such as novel semiconductor fabrication techniques, coherent beam combining, photonic integration, and three-dimensional integration and packaging.

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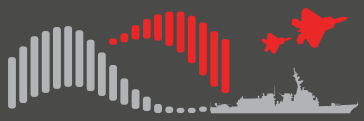

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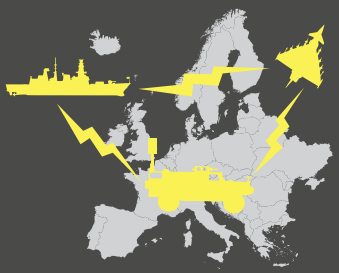

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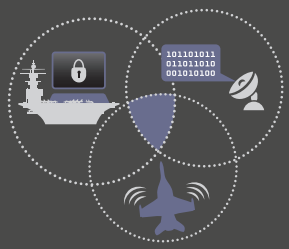

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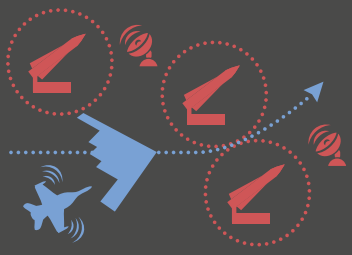

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Big-Picture Solutions for

By John Haystead

In February, just hours into Russia's invasion of Ukraine, Ukrainian forces shot down one, possibly two, Russian Il-76 (NATO name, CANDID) transport aircraft south of Kyiv. The aircraft were reportedly carrying paratroopers trained to take and secure airfields, and they were a critical piece of Russian plans to capture Kyiv in the early days of the conflict. Ukraine has claimed the aircraft (similar in size to US C-17) were brought down by its Air Defense Forces. The specific type of air-defense system responsible is unclear (from unclassified sources), with the possibility of it being a short-range defense weapon, but Ukraine is known to have brought down a number of other military aircraft with its Russian-made, long-range S-300 surface-to-air-missile systems. The provision of detailed US intelligence in advance of the raid is also reported to have played a significant role in the successful shoot-down. According to *Air Force Technology*, the Il-76 is equipped with a defensive aids suite, comprising radar warning, jammers, IR flare cartridges and chaff dispenser.

The dire significance of this event has not been lost on U. military planners. In fact, the emergence of longer-range, more sophisticated threats such as the Russian S-300 and S-400 air defense systems, together with changing mission requirements for large fixed-wing military aircraft to operate closer to, and even within, major threat environments has necessarily identified an immediate and pressing need to provide these aircraft (such as C-130, and C-17 transports, and KC-135 and KC-46 tankers), with improved and multi-spectral-threat electromagnetic protection systems. In its 2022 Command Strategy document, US Air Mobility Command's, Gen Michael Minihan, USAF, stated that, "We must focus our energy to aggressively and urgently close gaps across four mission imperatives of Global Command, Control, and Communications, Navigation, *Enroute under Attack* (emphasis added), and the Tempo needed to win."

Also, in a recent "From the Crows Nest" podcast, AOC's Ken Miller spoke with retired USAF Colonel Jeff Fischer, who observed from his research on large aircraft operating in the Ukraine battlespace, that it's a very different environment from what the US experienced in the Iraq and Afghanistan conflicts and, without EMS superiority as well as air superiority, the air defense systems of both Ukraine and Russia mean that air power (especially airlift) has not been much of a factor. "What you don't see in Ukraine is heavy-lift, like C-17s and C-130s, resupplying forward lines. The reason for this is that without the ability to do electromagnetic warfare (EW) and take out missile systems, such as the S-300 and S-400, and have air superiority in conjunction with EW, you have a contested airspace and you're not able to bring them in." He points out that, "this would be a big problem for the way that NATO (especially US) brings people and equipment into a war zone."

The point is further emphasized by Michael Baladjanian, Director of Self-Protect Systems at Raytheon Intelligence & Space (Arlington, VA). "The current threat environment we're seeing contains the most sophisticated mouse traps we've encountered due to adversaries' continued investments in science and technology. Detection abilities, density of sensor networks, communication resiliency, cyber sophistication, and weapon types and weapon speeds have complicated the mission for large aircraft. Ensuring uninterrupted supply to our Joint Services and allies is critical to the execution of domestic and international policies. The geopolitical landscape has shifted this century, and the US and its allies are now challenged in geographical locations and warfighting domains that were previously unopposed. We must continue to improve both our systems and tactics, techniques, and procedures (TTP), to prevail."

James Conroy, Northrop Grumman (Rolling Meadows, IL), Vice President Electronic Warfare and Targeting agrees. "The threat environments have really changed and have been advancing. Where we were in the past, was really a situation where aircrews could use and leverage tactics and maneuvers

Large-Aircraft Protection

USAF PHOTO

to ensure survivability, but today the threat environment has evolved to the point where maneuvers and tactics and pre-canned planning unto themselves can't ensure survivability. As a result, we're seeing a lot of our large-aircraft users moving EW into the forefront of mind, looking at how they can have the ability to do detection, identification, tracking and jamming on platform."

Mike Roske, BAE Systems' (Nashua, NH) Technology Director, Electronic Combat Solutions, emphasizes another emerging facet of the threat. "Something that has very much changed in recent times is that the fight has shifted from a fight against an individual air-defense system to a fight against an entire network of participants. In the current hostile environment that large aircraft will be operating in, the guy that sees you is probably not the guy that is shooting at you. Shots can be taken from an extremely long range these days, and large aircraft may not know which direction it's coming from. It may not even come from the same direction that you're getting a radar detection from and are protecting against. This is only going to get worse over the next five, 10, 20 years and it's critical to understand and address the implications."

COUNTERING THE IR THREAT

The types of threats facing large fixed-wing aircraft are many and varied, but ever since the emergence of Man-Portable Air Defense Systems (MANPADS), IR-guided missiles have posed a particularly dangerous and prolific threat. That threat remains today, and with new, sophisticated technology constantly being deployed, it continues to grow.

To deal with the IR threat, the Services have developed, and widely-deployed, IR detection and countermeasure systems on its large-aircraft fleets. In particular, Northrop Grumman's AN/AAQ-24 Large Aircraft IR Countermeasures (LAIRCM/DoN LAIRCM) system is currently deployed on C-17A, C-130H/J, C-5M, HC/MC-130J, KC-46A, KC-135, KC-130J, P-8A, and C-37B and C-40A/B/C fixed-wing aircraft, in addition to a large number of rotary-wing platforms. LAIRCM detects an incoming missile's IR seeker and automatically jams it with a directed laser beam.

In March, a pod-contained version of the LAIRCM system achieved milestone C for the USAF's KC-135 "Stratotanker" aircraft signaling the beginning of production and deployment. Says Neel, "The podded (LAIRCM G3) system is an easy way for us to put the capability on different aircraft without requiring a lot of A-kit modifications. It also allows for more flexibility with the platform depending on what environment it goes into." The system is now in its second round of Low-Rate Initial Production.

Dennis Neel, Northrup Grumman Director of Advanced Survivability Programs, says "We've seen a lot of change over the more than thirty years we've been involved with IRCM. Even as IR countermeasure systems are deployed on more and more large-aircraft platforms, we recognize that the IR threat environment is constantly evolving and expect that to continue into the future. As the threat evolves, there will likewise continue to be a need for improved detection and countermeasure technologies, such as new IR and UV sensors, and improved lasers to combat [IR missiles] as well as assisting in situational awareness for the aircraft." In May, the US Air Force Life Cycle Management Center (Wright-Patterson AFB, OH) awarded a $31.2 million contract to Northrop Grumman for new Advanced Threat Warning (ATW) sensors for the LAIRCM system.

RF WARNING SYSTEMS

While much attention has been focused on IR countermeasures for large aircraft over the past two decades, longer-range RF-guided threats have continued to evolve, as well. The danger has dramatically grown in recent years, as the range of these systems has expanded, and the requirement for transport, support, and special-mission large aircraft to operate near, or actually within, high threat environments has grown.

Says Northrop Grumman's Conroy, "During the Global War on Terrorism (GWOT), the threat to our larger transport aircraft operating in hostile areas was primarily driven by short-

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range, IR-guided missiles from man-portable weapons systems. But, as we've transitioned from the GWOT to the current need to prepare for near-peer and peer-to-peer conflicts, the threat to our large-aircraft fleets from RF-guided systems has increased dramatically. Our large aircraft must be able to operate in environments that are much more complex and integrated and which can detect and engage our them at much longer range."

This point is emphasized in the 2022 Air National Guard (ANG) Weapons Systems Modernization Priorities Book, which states that, "In accordance with National Defense Strategy defined competitors, mission modernizations must ensure overmatch including, but not limited to: radio frequency (RF), infrared (IR) self-protection systems, expendables, jammers, and signals intelligence/electronic intelligence detection capability and data." The Priorities Book notes, in particular, that even in the course of routine operations, the ANG's KC-135 tanker aircraft are increasingly subjected to hostile environments. "To survive, KC-135s require a digital radar warning receiver (RWR) capable of processing signals in a dense RF environment and automatically direct countermeasures to degrade or defeat RF threats."

Given the vast number of platforms, generations, missions and users of large aircraft such as the C-130, C-17, KC-135, KC-46 etc., there have also been, and still are, a large number of different radar warning receivers (RWRs) being employed, even within the US fleet.

Among these are the Raytheon ALR-69A all-digital RWR which has been installed on C-130H aircraft. In 2018, the US Air Force awarded Raytheon an IDIQ to outfit their fleet of tactical air and large body aircraft with the ALR-69A. Since that award, ALR-69A has gone through significant enhancements, including frequency extensions that detect and identify RF threats across the spectrum.

In September 2019, Raytheon announced that it was delivering the next batch of ALR-69A radar warning receivers for USAF KC-46A "Pegasus" aerial refueling and transport aircraft. Says Baladjanian, "After the Air Force Association Air Space Cyber conference in September, the AMC's KC-46A cross functional team lead, Brig Gen Ryan Samuelson stated, 'The KC-46 now officially joins the rest of the Air Force's refueling fleet in meeting combatant command requirements around the world.'" In total, Raytheon is providing 111 ALR-69A systems, including spares, to outfit its newest tanker. The contract calls for deliveries to be completed by 2025.

The Air Force's latest-generation C-130J "Super Hercules" aircraft are equipped with BAE Systems' AN/ALR-56M RWR. The digital RWR is a superheterodyne receiver operating in the 2GHz to 20GHz bands. It includes a low-band antenna and four high-band quadrant antennas. According to Roske, "We've had good success in the past with our ALR-56 series of programs, getting those involved in various places. The ALR-56 has a proven record on tactical aircraft and has been offered up for some of the large aircraft platforms, as well, as we look at modernization and bringing some of their EW suites up to date. Although integration is very different for different platforms, given the right suite of receive apertures and power amplifiers, the ALR-56M's core EW processing is highly effective in various places."

In March 2019, the US Army awarded Northrop Grumman a contract for the development of the latest iteration of its AN/APR-39 RWR system. In wide use on the Army's fleet of rotary-wing aircraft, as well as Marine Corps KC-130 tankers, the AN/APR-39E(V)2, was formerly known as the Modernized Radar Warning Receiver (MRWR). According to the company, "it is intended to provide high-precision detection, location and identification using a Digital Receiver Exciter (DRE) and innovative signal processing algorithms." The new warning system is expected to be able to see millimeter wave radars at longer ranges. Initial Operational Capability (IOC) is planned for 2025.

Also, on Air Force C130J aircraft is Northrop Grumman's AN/AAR-47 missile warning system intended to protect the aircraft against IR-guided missile threats, laser-guided/laser-aided threats, and unguided munitions. It uses electro-optic sensors to detect missile exhaust and advanced signal processing algorithms and spectral selection to analyze and prioritize threats. Sensors are mounted near the nose just below the second cockpit window and in the tail cone. Upon detection of a missile threat, the system will automatically cue the AN/ALE-47 countermeasure system, which is capable of dispensing chaff and flares, as well as expendable active decoys.

ACTIVE JAMMING RF COUNTERMEASURE (RFCM) SYSTEMS

Although many large fixed-wing aircraft have been, or soon will be, equipped with radar warning receivers, the same is not true for RF countermeasures systems. Those that do carry the capability are large non-stealthy bombers and special-mission aircraft that must enter and persist in high-threat environments. These aircraft have been equipped with RF jammers for some time. For example, the L3Harris AN/ALQ-172 self-protection integrated RF subsystem has been in service on USAF B-52H bombers for decades, but the system has also been installed on Special Operations Command (SOCOM) MC-130H "Combat Talon II" and AC-130U gunships. According to L3Harris, the system can simultaneously counter multiple pulse, continuous wave, pulse Doppler and monopulse threats. The ALQ-172(V)3 upgrade provides for extended frequency coverage, and the company is now in development of the next system upgrade. "The ALQ-172 'MARS' upgrade reduces system weight and power requirements while further improving system performance,

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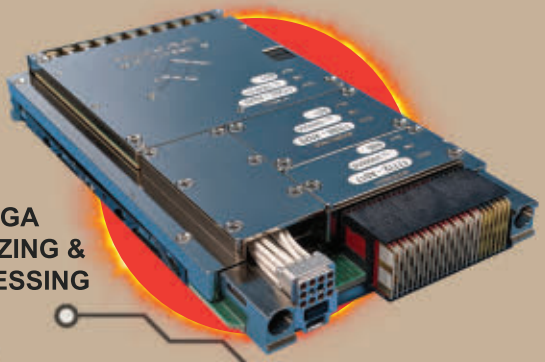

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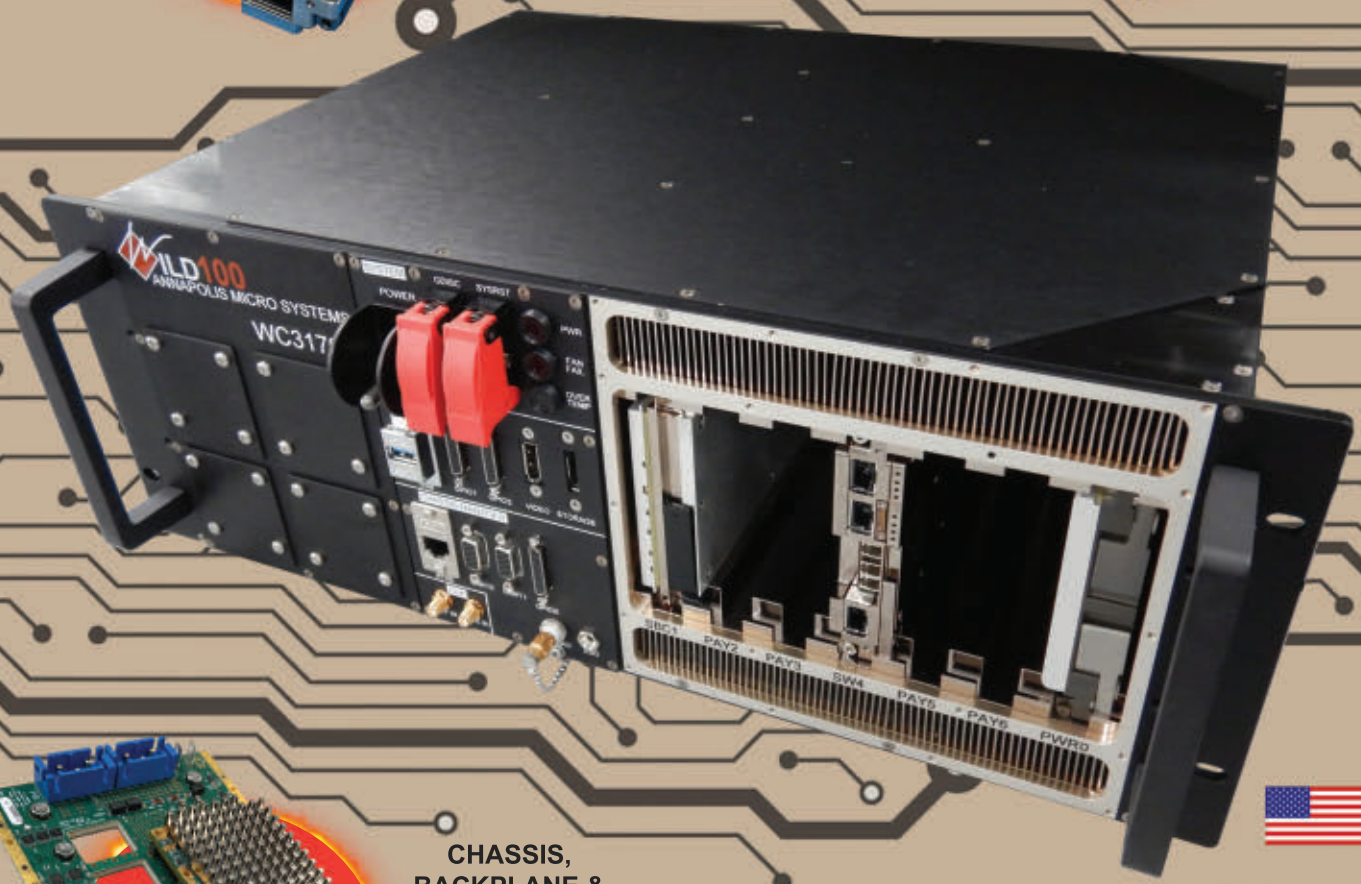

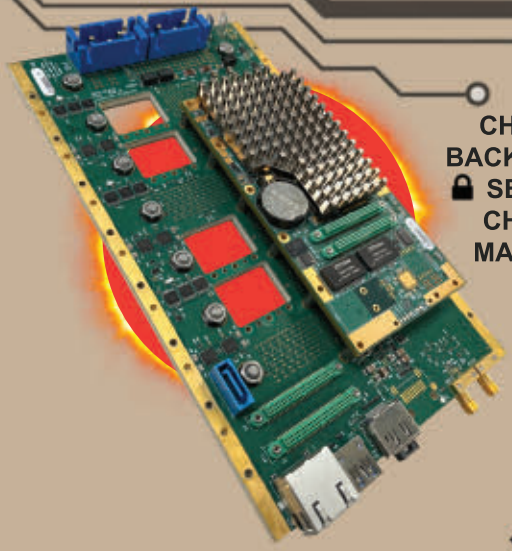

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maintainability, and reliability through the use of Field Programmable Gate Array (FPGA)-based technology."

Meanwhile, SOCOM is replacing its MC-130H aircraft with the MC-130J, and in March of this year, Northrop Grumman delivered its first AN/ALQ-251 RFCM system for the Command's AC-130J "Ghostrider" and MC-130J "Commando II" aircraft. According to the company, the ALQ-251 provides "situational awareness and 360-degree protection against EW systems and radar-guided weapons in contested and congested electromagnetic spectrum environments." Sierra Nevada Corporation (Sparks, NV) is the integrator for the program.

As described by Conroy, "the ALQ-251 architecture uses a modular, open systems approach and common building blocks shared across other EW programs of record. This allows for more rapid updates and affordability throughout the lifecycle." The ALQ-251 includes an integrated radar warning capability derived from the company's APR-39 RWR family, and Conroy says "it also has the ability to interface with another onboard RWR, if desired, for a particular mission application."

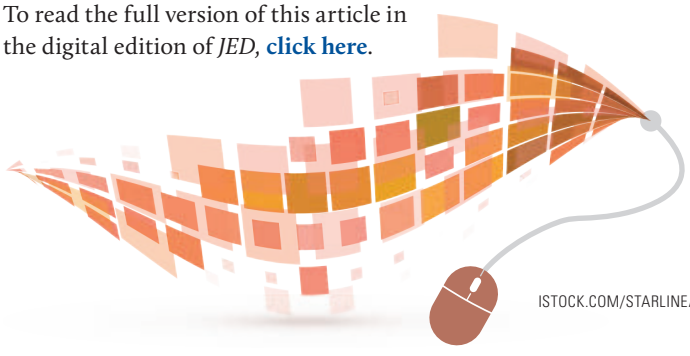
"RWR compatibility is a critical part on an RFCM system," says Conroy. "You want to be able to detect threats while you're also jamming them. Having an integrated RWR system really has a lot of benefits associated with it. With separate systems, there's a lot of interfacing work that has to be done which is inherent within an integrated system. And, it's not only compatibility associated with detection, identification and jamming, it's also compatibility with all of the other systems on the platform." For example, points out Conroy, "Although it's not something AC/MC is specifically doing right now, if there was an AESA (radar) system on the platform, then you would necessarily need more interfacing. We recently demonstrated our ability to do that with one of our other systems the ALQ-257 (for the F-16). Because we have the AESA there and trying to be lethal with it, having a compatible RF EW system that interfaces with it, allows you to be lethal and survivable simultaneously."

Conroy says SOCOM's first modified platform with the ALQ-251 system installed has gone through initial testing and is about to start Developmental Test and Evaluation (DT&E) activities. "Concurrent with this, we're also on contract for delivery of Low Rate Initial Production (LRIP) units this fall."

While special operations large aircraft have been, and continue to be, protected with RF jamming countermeasure systems, questions still remain regarding the much larger fleets of Air Mobility Command's (AMC's) C-130 and C-17 aircraft. In that regard, Conroy notes that, in addition to protecting the AC/MC-130Js, the -251 system is applicable to the broader C-130 fleet as well. "Obviously, we see this as our large aircraft architecture, and we built the system in a very modular fashion to allow it the maximum amount of adaptability and extensibility to different large platform types. There are a number of potential users interested in the system, and we are in conversations with them." Conroy says he can't comment at this time on AMC's specific plans, but does note, "They're still maintaining some decisions on how they want to proceed in addressing the RF threat environment, but when the need for this capability arises, we would see the -251 as being a very strong contender to support them."

Online Exclusive

To read the full version of this article in the digital edition of *JED*, **click here**.



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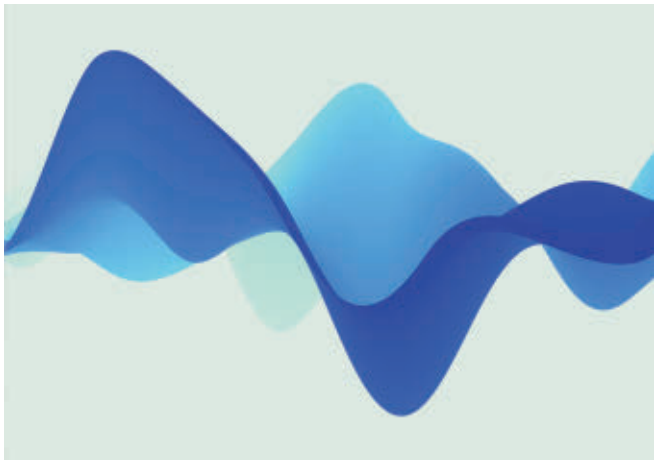
2023 EW/SIGINT Resource Guide

Welcome to the 2023 Electronic Warfare and Signals Intelligence Resource Guide. This guide is the print snapshot of the AOC's Defense Electronics Resource Guide, edited by *JED* staff. It is designed to list companies and organizations that manufacture products or provide services in the areas of electronic warfare and signals intelligence. This year, we added some new categories.



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ABOUT THIS GUIDE

This guide was assembled by *JED*'s editorial staff, based on our own research and from updated information provided to us by companies. Though we have attempted to produce a comprehensive listing, we expect this guide to continue to grow. If your company conducts business in the EW or SIGINT markets and it does not appear in this year's guide, please see the note below on how to have your company listed.

HOW TO USE THIS GUIDE

The guide's first section contains a "company listing," in which companies are featured in alphabetical order. The second section includes product and service categories, roughly organized by components/subsystems, software and services. The third section lists the companies in each category. Refer back to the company section for website and location data on listed companies.

GET LISTED

If your company is missing or your data requires additional updates, please provide your information to us via e-mail to JEDeditor@naylorcom so we may update our files. Please note that our next print guide will appear in November 2023, however, the online resource guide is live year-round at www.ewsigint.net.

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2023 EW/SIGINT Resource Guide

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www.oroliads.com
Overlook Systems Technologies, Inc.
www.overlooksys.com

P

Parker Aerospace
www.parker.com
Parry Labs
www.parrylabs.com
Parsec
www.parsec.co.za
Parsons
www.parsons.com
Pasternack Enterprises
www.pasterback.com
Patria
www.patriagroup.com
PCTEL
www.pctel.com
Pelican Cases
www.pelican.com
Pendar Technologies
www.pendartechnologies.com
Pentek, A Mercury Systems Company
www.pentek.com
Peralex
www.peralex.com
Per Vices Corp.
www.pervices.com
Petards Group
www.petards.com
Phase II Staffing and Contracting LLC
www.p2sc.net
Phase Matrix
www.phasematrix.net
Phasor Innovation PTY Ltd.
www.phasorinnovation.com
Phoenix Air
www.phoenixair.com
Photonis Defense, Inc.
www.photonisdefense.com
Pixus Technologies
www.pixustechnologies.com
PKI Electronic Intelligence
www.pki-electronic.com
PLATH AG
www.plath-ag.ch
PLATH GmbH & Co KG
www.plath.de
PLATH Signal Products
www.plath-signal products.com
Plexsa Manufacturing
www.plexsa.com
Plextek DTS
www.plextek-dts.com
Pole/Zero Corp.
www.polezero.com
Pranalytica
www.pranalytica.com
Precision Connector, Inc.
www.precisionconnector.com
Precision Display Technologies
www.pdt-usa.com
PROCITEC GmbH
www.procitec.de

Q

Q Microwave, Inc.
www.qmicrowave.com
Quantic PMI (Planar Monolithics)
www.pmi-rf.com
QinetiQ Ltd.
www.QinetiQ.com
Qnion Co., Ltd.
www.qnion.com
Qorvo
www.qorvo.vom

QRC Technologies
www.qrctech.com
Quarterwave Corp.
www.quarterwave.com
QuinStar Technology, Inc.
www.quinstar.com

R

R.A. Wood Associates
www.rawood.com
RADA USA
www.radausa.com
Radiall
www.radiall.com
Radio Reconnaissance Technologies
www.radiorecon.com
Radixon
www.radixon.com
RADX Technologies, Inc.
www.radxtech.com
Rafael – Advanced Defense Systems LTD
www.rafael.co.il
Rantelon
www.rantelon.ee
Raytheon
www.raytheon.com
Renaissance Electronics Corp.
www.rec-usa.com
Research Associates of Syracuse (RAS)
www.ras.com
Research Electronics International (REI)
www.reiusa.net
Reut Systems & Technologies (RST)
www.rst-tech.co.il
Revolution Aerospace
www.revn.aero
RF Engines Ltd.
www.rfel.com
RF Industries
www.rfindustries.com
RF Logic
www.rflogic.net
RFcore Co, Ltd.
www.rfcore.com
RFHIC USA
www.rfhic.com
RH Laboratories
www.rh-labs.com
Rheinmetall Defence
www.rheinmetall-defence.com
Rincon Research Corporation
www.rincon.com
Riverside Research Institute
www.riversideresearch.org
Rodale Electronics Inc.
www.rodaleelectronics.com
Rodelco Electronics Corp.
www.rodelco-usa.com
Rohde & Schwarz GmbH & Co. KG
www.rohde-schwarz.com
Rotating Precision Mechanisms, Inc.
www.rpm-psi.com
RUAG – Aerospace
www.ruag.com
Rubisoft
www.rubisoft.fr
RVJ Institute
www.rvjinstitute.org

S

S2 Corp.
www.s2corporation.com
Saab
www.saabgroup.com
Safran Electronics and Defense
www.safran-electronics-defense.com
Sagax Communications
www.sagax-communications.com
Sage Millimeter
www.sagemillimeter.com
SAIC
www.saic.com
Samel 90
www.samel90.com
Samtec
www.samtec.com
Santa Barbara Infrared Inc.
www.sbir.com
Schaefer Electronics
www.schaeferpower.com
Schoenhofer GmbH
www.schoenhofer.de
School of Information Operations
www.soio.com.au
Sciens Innovations LLC
www.sciensinnovations.com
Scientific Research Corp.
www.scires.com
SEA
www.sea.co.uk
Sechan Electronics Inc.
www.sechan.com
Select Fabricators
www.select-fabricators.com
Sensofusion
www.sensofusion.com
SensorCom Inc.
www.sensorcominc.com
Seqtor ApS
www.seqtor.com
Serpikom
www.serpikom.eu
SESP Group
www.sesp.com
Seven Technologies Group
www.7techgroup.com
Shadow Technologies
www.35technologiesgroup.wordpress.com
Shakespeare Military Products
www.shakespeare-military.com
Shield AI
www.shield.ai
Shoghi Communications Ltd.
www.shoghi.co.in
Sierra Nevada Corp.
www.sncorp.com
Signal Antenna Systems Inc.
www.signalantenna.com
Signal Hound
www.signalhound.com
SignalCore Inc.
www.signalcore.com
Silentium Defence
www.silentium-defence.com.au
Silver Palm Technologies
www.silverpalmtech.com
Simulation Technologies
www.simtechinc.com
SimVentions
www.simventions.com
SINTIS Technology Ltd.
www.sintistechnology.com
Sivers IMA AB
www.siversima.com
SkySafe
www.skysafe.io
Skyworks Solutions
www.skyworksinc.com
SMAG Mobile Antenna Masts GmbH
www.smam.de
Smiths Interconnect
www.smithsinterconnect.com
Solid State Devices, Inc.
www.ssdi-power.com
Southwest Antennas
www.southwestantennas.com
Southwest Microwave
www.southwest-microwave.com
Southwest Research Institute (SwRI)
www.swri.org
Spatial and Spectral Research
www.ssrllc.us
Spear Research
www.spear-research.com
Spectra Research
www.spectra-research.com
Spectranetix Inc.
www.spectranetix.com
Spherea GmbH
www.spherea.de
Spirent Communications
www.spirent.com
SRC, Inc.
www.srcinc.com
SRI International
www.sri.com
Steatite Antennas
www.steatite-antennas.co.uk
SteelRock Technologies
www.sruav.co.uk
Stellant Systems
www.stellantsystems.com
SunCastle Microwave, LLC
www.suncastlemicrowave.com
Sundance DSP
www.sundancedsp.com
SURVICE Engineering Co.
www.survice.com
Swisstoi2
www.swisstoi2.com
Syncopated
www.syncopatedproducts.com
Syncopated Engineering
www.syncopatedengr.com
Syntonics Corp.
www.syntonicscorp.com
Sypaq Systems
www.sypaq.com.au
Sypris Solutions
www.sypris.com
Systematic
www.systematic.com
Systems & Processes Engineering Corp. (SPEC)
www.spec.com

T

T2S Solutions
www.t2s-solutions.com
Tabor Electronics
www.taborelec.com
TACO Antenna
www.tacoantenna.com
Tampa Microwave
www.tampamicrowave.com
Tata Advanced Systems Limited (TASL)
www.tataadvanced-systems.com
Tata Power Strategic Electronics Division
www.tatapowersed.com
TCI International, Inc.
www.tcibr.com
TE Connectivity
www.te.com
TechComm
www.techcommdf.com
Tech Resources, Inc. (TRI)
www.trimilford.com
TEK Microsystems, Inc.
www.tekmicro.com
Tektronix, Inc.
www.tek.com
Teledyne Defense Electronics
www.teledynedefense-electronics.com
Teleplan Globe Defence
www.teleplanglobe.no/defence

COMPANY LISTINGS

TeleRadio Engineering Pte Ltd.
www.skydroner.com
Ten-Tec
www.tentec.com
Terma A/S
www.terma.com
Terra Hexen Group
www.terrahexen.com
TEVET
www.tevetllc.com
Texas Instruments
www.ti.com
Textron Systems Corporation
www.textronsystems.com
Textron Systems Electronic Systems LTD UK
www.textronsystems.com
Thales
www.thalesgroup.com
Thermacore
www.thermacore.com
Thermodyne Cases & Racks
www.thermodyne.com
ThinKom Solutions
www.thinkom.com
ThinkRF
www.thinkrf.com
Times Microwave Systems
www.timesmicrowave.com
TINEX AS
www.tinex.no
TJR Global
www.trjglobal.com
TMC Design Corp.
www.tmcdesign.com
Top Aces
www.topaces.com
Toyon Research Corp.
www.toyon.com
Transformational Security LLC
www.powerfulsecurity.com
Transhield Inc.
www.transhield-usa.com
TRD Consultancy Pte Ltd.
www.trd.com
Trenton Systems
www.trentonsystems.com
Tri Star Engineering, Inc.
www.star3.com
Triad RF Systems Inc.
www.triadrf.com
TriaSys Technologies Corp.
www.triasys.us
Trident Infosol
www.tridentinfosol.com
Trident Systems Inc.
www.tridsys.com
Trideum
www.trideum.com
Trival Antene
www.trivalantene.si
TrustComm
www.trustcomm.com
TSF5
www.tsf5.com
Tsunami Cases
www.tsunamicase.com
TTE Filters
www.tte.com
TTM Technologies
www.ttm.com
TUALCOM, Inc.
www.tualcom.com
TÜV SÜD
www.tuv-sud.com

U

U B Corp.
www.ubcorp.com
Ultra Electronics – Australia
www.ultra-electronics.com.au
Ultra Electronics – Herley
www.ultra-herley.com
Ultra Electronics Limited – EWST
www.ultra-cis.com
Ultraview Corp.
www.ultraviewcorp.com
Unival Group GmbH
www.unival-group.com
United Electronic Industries
www.ueidaq.com
United Monolithic Semiconductor
www.ums-gaas.com
Unseenlabs
www.unseenlabs.space
URC Systems
www.urc-systems.cz
US Dynamics Corp.
www.usdynamicscorp.com
US Technologies-Aldetec
www.ust-aldetec.com

V

VadaTech, Inc.
www.vadatech.com
Vadum Inc.
www.vaduminc.com
Valkyrie Enterprises LLC
www.valkyrie.com
Varilog Research, Inc.
www.varilog.com
Vecicma Networks
www.vecima.com
Vectrus Systems Corp.
www.vectrus.com
Verint
www.verint.com
ViaSat, Inc.
www.viasat.com
VIAVI Solutions, Inc.
www.viavisolutions.com
Vicor Corp.
www.vicorpower.com
Virtualabs srl
www.virtualabs.it

W

W.L. Gore and Associates, Inc. (Gore)
www.gore.com/cables
Wang Electro-Opto Corp.
www.weo.com
Warfare Solutions LLC
www.warfaresolutions.com
Warrior Support Solutions, LLC
www.warriorss.com
Wavepoint Research, Inc.
www.wavepointresearch.com
WDS Radar
www.wdsradar.com
Wenteq Microwave Corporation
www.wenteq.com
Werlatone, Inc.
www.werlatone.com
WGS Systems, Inc.
www.wgssystems.com
WhiteFox Defense Technologies, Inc.
www.whitefoxdefense.com
Wide Band Systems Inc.
www.widebandsystems.com
Wideband Systems, Inc.
www.wideband-sys.com
Winchester Interconnect
www.winconn.com
Windfreak Technologies, LLC
www.windfreaktech.com
Wolfspeed
www.wolfspeed.com
Work Microwave
www.work-microwave.com
Wright Technologies Inc.
www.wrighttec.com

Z

Zarges, Inc.
www.zargesusa.com
Zeta Associates
www.zai.com

2023 EW/SIGINT Resource Guide

CATEGORY LISTINGS

ISTOCK.COM/SALMAN ALFA

RF MICROWAVE COMPONENTS & SUBSYSTEMS

TEST EQUIPMENT

EO/IR COMPONENTS & SUBSYSTEMS

EW & SIGINT SYSTEMS

EW SIMULATORS

EW & SIGINT SERVICES

PRODUCT/SERVICE LISTINGS

ISTOCK.COM/SALMAN ALFA

RF MICROWAVE COMPONENTS & SUBSYSTEMS

Antennas/Arrays

Aero Telemetry
Alaris Antennas
AMT Microwave Corp.
Antenna Authority
Antenna Experts
Antenna Research Associates
APITech
Applied EM Inc.
ARA, Inc.
CAES
CAL-AV Labs Inc.
CEA Technologies
Chora A/S
COJOT
Communications & Power Industries, Inc (CPI)
Cubic Nuvotronics
Dayton-Granger
Defence Research and Development Canada
Electro-Metrics
Epirus
ET Industries
ETS-Lindgren
Eureka Aerospace
European Antennas
First RF Corp.
Flann Microwave
Fractal Antenna Systems
FS Antennentechnik GmbH
Hascall-Denke
HUBER+SUHNER AG
IFI – Instruments for Industry Inc.
JEM Engineering
Jenkins Engineering Defence Systems
Kratos
L3Harris – Randtron Antenna Systems
Leonardo
Link Microtek
MEDAV GmbH
Meggitt
Micronetixx, P.A.
Mercury Systems
Microwave Applications Group
Microwave Engineering Corp.
Microwave Specialty Company
Microwave Technologies Inc.
Montena Technology sa

mWave Industries, LLC
NovAtel
NSI-MI Technologies
Ocean Microwave Corp.
Octane Wireless
PCTEL Inc.
Phasor Innovation PTY Ltd.
Plath Signal Products
QuinStar Technology, Inc.
Radio Reconnaissance Technologies
Rantelon
Rincon Research Corporation
Rockwell Collins
Rohde & Schwarz GmbH & Co. KG
Rubisoft
Saab
SATIMO
Seqtor ApS
Shakespeare Military Antenna Products
Signal Antenna Systems Inc.
SMAG Mobile Antenna Masts GmbH
Southwest Antennas
Steatite Antennas
SunCastle Microwave LLC
Swisstoı2
TACO Antenna
Tech Resources, Inc.
TechComm
TECOM Industries, Inc.
ThinKom Solutions
Transformational Security LLC
Trival Antene
U B Corp.
Ultra Electronics – Herley
Wang Electro-Opto Corp.

Antenna Mounts/ Support Structures

CAES
Dayton-Granger
Hascall-Denke
IKHANA Aircraft Services
L3Harris – Randtron Antenna Systems
Rotating Precision Mechanisms, Inc.
SMAG Mobile Antenna Masts GmbH
Steatite Antennas
TECOM Industries, Inc.

Antenna Radomes

CAES
CEA Technologies
Dayton-Granger
HUBER+SUHNER AG
IKHANA Aircraft Services
L3Harris – Randtron Antenna Systems
Meggitt – Baltimore
Steatite Antennas
TECOM Industries, Inc.

Active RF Components

AKON, Inc.
Analog Devices Inc.
Anaren, Inc.
Applied Thin Film Products
CAES
Comtech PST
Crane Aerospace & Electronics
EM Research
ET Industries
I.F. Engineering Corp.
Jabil Defense and Aerospace Services
Jersey Microwave
MACOM
Mercury Systems
Micro Lambda Wireless, Inc.
Narda-Miteq
Phasor Innovation PTY Ltd.
Pole/Zero Corp.
Rodelco Electronics Corp.
Stellant Systems
Tektronix, Inc.
Teledyne Defense Electronics
TRAK Microwave
US Dynamics Corp.
Wolfspeed

Analog-to-Digital Converter Boards and RF Multifunction Boards

Alpha-Data Inc.
Ametek Abaco Systems
Analog Devices Inc.
Annapolis Micro Systems, Inc.
ApisSys
Bittware, Inc.
CAES
Curtiss-Wright Defense Solutions
Delphi Engineering Group
Dynamic Signals LLC
Elma Electronic
Innovative Integration
Intel Product Solutions Group
Interface Concept
Intersil
iVeia, LLC
Mercury Systems
New Wave Design & Verification
Parsec
Pentek
Reflex CES
Rincon Research Corporation
Sundance DSP
TEK Microsystems, Inc.
Tektronix, Inc.
Teledyne Defense Electronics
Ultraview Corp.
VadaTech, Inc.

Frequency Converters

AKON, Inc.
Analog Devices Inc.
Anaren, Inc.
Applied Radar Inc.
CAES
Crane Aerospace & Electronics
CTT, Inc.
EM Research
FEI-Elcom Tech
I.F. Engineering Corp.
iRF Solutions
Jersey Microwave
K&L Microwave, Inc.
KMIC Technology, Inc.
Kratos
L3Harris – Microwave West
Mercury Systems
Narda-Miteq
Norden Millimeter
NuWaves Engineering
Quantic PMI
Renaissance Electronics Corp.
SignalCore
TRAK Microwave
Ultra Electronics – Herley
Wright Technologies, Inc.

Frequency Synthesizers

AKON, Inc.
Analog Devices
Anritsu
Berkley Nucleonics
CAES
Crane Aerospace and Electronics
EM Research
FEI-Elcom Tech
iRF Solutions
Kratos
Luff Research
MagiQ Technologies Inc.
Mercury Systems
Micro Lambda Wireless, Inc.
Narda-Miteq
NEL Frequency Controls, Inc.
Novatech Instruments
Phase Matrix
Quantic PMI
Renaissance Electronics Corp.
RFcore Co, Ltd.
Rodelco Electronics Corp.
SignalCore
Sivers IMA AB
Tabor Electronics
Teledyne Technologies
TRAK Microwave
Ultra Electronics – Herley
Ultraview Corp.
Wide Band Systems Inc.
Work Microwave

Oscillators

Analog Devices Inc.
CAES
dB Control
EM Research
FEI-Elcom Tech
Jackson Labs Technologies Inc.
Jersey Microwave
Kratos
Luff Research
MACOM
Mercury Systems
Micro Lambda Wireless, Inc.
Microwave Dynamics
Narda-Miteq
NEL Frequency Controls, Inc.
Norden Millimeter
Pascall Electronics Limited
Phase Matrix
Qorvo
QuinStar Technology, Inc.
Renaissance Electronics Corp.
Sivers IMA AB
Skyworks Solutions
TRAK Microwave
Ultra Electronics – Herley
Vectron International
Work Microwave

Low Noise Amplifiers

AKON, Inc.
AMCOM Communications
Amplifier Solutions Corp.
AmpliTech
Analog Devices
APITech
ARS Products
Atlanta Micro
CAES
Ciao Wireless, Inc.
CTT, Inc.
Elite RF
Endwave Corp.
ERZIA Technologies SL
Herotek, Inc.
Hytem
Jersey Microwave
K&L Microwave, Inc.
Keragis
KMIC Technology, Inc.
MACOM
Mercury Systems
Microwave Communications Laboratories
Microwave Dynamics
Narda-Miteq
Norden Millimeter
NuWaves Engineering
Pascall Electronics Limited
Pasternak
Pole/Zero Corp.
Qorvo
Quantic PMI
QuinStar Technology, Inc.
Renaissance Electronics Corp.
RFHIC
Rodelco Electronics Corp.
Sage Millimeter
Smiths Interconnect
Teledyne Defense Electronics
TRAK Microwave
Triad RF Systems Inc.
Ultra Electronics – Herley
US Dynamics Corp.
US Technologies-Aldetec
Wenteq Microwave Corporation
Wolfspeed
Wright Technologies, Inc.

Passive RF Components

AMCOM Comunications
American Microwave Corp.
Analog Devices Inc.
Anaren, Inc.
Anritsu
APITech
Applied Thin Film Products
Bird Technologies
CAES
Coleman Microwave Company
Conductive Composites
Crane Aerospace & Electronics
Cubic Nuvotronics
Dayton-Granger
Dielectric Labs
Dow-Key Microwave
Ducommun Technologies
Emhiser Research, Inc.
Endwave Corp.
ET Industries
Herotek, Inc.
Honeywell Aerospace
HUBER+SUHNER AG
I.F. Engineering Corp.
Jabil Defense and Aerospace Services
JFW Industries
K&L Microwave, Inc.
Kratos
Krytar, Inc.
Lexatys
Link Microtek
Logus Microwave
Lorch Microwave
MACOM
MECA Electronics
Mercury Systems
Microphase Corp.
Microwave Applications Group
Microwave Communications Laboratories
Microwave Engineering Corp.
Microwave Products Group
Narda-Miteq
Pascall Electronics Limited
Picosecond Pulse Labs
Q Microwave, Inc.
Qorvo
Quantic PMI
QuinStar Technology, Inc.
Radiall
Renaissance Electronics Corp.
RH Laboratories
Rodelco Electronics Corp.
Skyworks Solutions
Smiths Interconnect
Solid State Devices, Inc.
Teledyne Defense Electronics
TRU Corp.
TTE Filters
Vishay Specialty Thin Film
Werlatone, Inc.

Converters and Mixers

Advanced Microwave Inc.
AKON, Inc.
Anaren, Inc.
Anritsu
CAES
EM Research
FEI-Elcom Tech
I.F. Engineering Corp.
Jersey Microwave
KMIC Technology, Inc.
Mercury Systems
Mu-Del Electronics
Narda-Miteq
QuinStar Technology, Inc.
RH Laboratories
Rodelco Electronics Corp.
Teledyne Defense Electronics
US Technologies-Aldetec

Couplers

Anaren, Inc.
ARS Products
Atlanta Micro
BJG Electronics
CAES
Cubic Nuvotronics
DynaWave Inc.
ET Industries
Ferrite Microwave Technologies
Honeywell Aerospace
HUBER+SUHNER AG
Hytem
I.F. Engineering Corp.
K&L Microwave, Inc.
Krytar Inc.
MECA Electronics
Mercury Systems
Microwave Communications Laboratories
Microwave Engineering Corp.
Narda-Miteq
Precision Connector
Qorvo
Quantic PMI
Radiall
RF Industries
Rohde & Schwarz GmbH & Co. KG
Southwest Microwave
TE Connectivity
Werlatone, Inc.
Winreak Technologies, LLC

Fiber-Optic Cable

Alker Optical Equipment
Assemblies, Inc.
HUBER+SUHNER AG
Meggitt Defense Systems
Samtec
Syntonics
W.L. Gore & Associates, Inc. (Gore)

Fiber-Optic Connectors

Assemblies, Inc.
BJG Electronics
HUBER+SUHNER AG
Meggitt Defense Systems

Filters and Diplexers

AKON, Inc.
Anatech Electronics
Atlanta Micro
BSC Filters
CAES
Coleman Microwave Company
Cubic Nuvotronics
Dayton-Granger
Endwave Corp.
ET Industries
Ferrite Microwave Technologies
Filters
Gowanda Components Group
Honeywell Aerospace
HUBER+SUHNER AG
KMIC Technology, Inc.
Lexatys
Link Microtek
Lorch Microwave
MECA Electronics
MEMtroncs Corp.
Mercury Systems
Metamagnetics
Micro Lambda Wireless, Inc.
Micronetixx, P.A.
Microphase Corp.
Microwave Communications Laboratories
Microwave Engineering Corp.
Microwave Filter Company
Microwave Products Group
Narda-Miteq
OEwaves
Physical Optics Corp.
Picosecond Pulse Labs
Plexsa Manufacturing
Pole/Zero Corp.
Q Microwave, Inc.
Werlatone, Inc.

Power Dividers/Combiners

American Microwave
Anaren, Inc.
Anatech Electronics
CAES
Comtech PST
Cubic Nuvotronics
EMS Technologies, Inc.
ET Industries
HUBER+SUHNER
Hytem
I.F. Engineering Corp.
JFW Industries
K&L Microwave, Inc.
Krytar, Inc.
L3Harris – Narda
MECA Electronics
Mercury Systems
Micronetixx, P.A.
Microwave Applications Group
Microwave Communications Laboratories
Microwave Engineering Corp.
Quantic PMI
QuinStar Technology, Inc.
Renaissance Electronics Corp.
Rodelco Electronics Corp.
Rohde & Schwarz GmbH & Co. KG
Teledyne Defense Electronics
TTE Filters
Werlatone, Inc.

RF Switches

Aethercomm, Inc.
AKON, Inc.
Alaris Antennas
American Microwave
Analog Devices
APITech
Atlanta Micro
CAES
Comtech PST
Dow-Key Microwave
Eureka Aerospace
Filtronic
iRF Solutions
JFW Industries
Kratos
MACOM
Menlo Microsystems
Microwave Applications Group
Microwave Products Group
Mini-Circuits
Mu-Del Electronics
Narda-Miteq
Pasternack Enterprises
Rohde & Schwarz GmbH & Co. KG
Skyworks Solutions

RF Absorptive Materials/Shielding

ARC Technologies
Boyd Corporation
Conductive Composites
Cuming Microwave Corp.
ETS-Lindgren
Select Fabricators
Transhield Inc.
Zarges, Inc.

RF Cables/ Cable Assemblies

Anatech Electronics
Assemblies Inc.
Cablex PTY Ltd.
CAES
Carlisle Interconnect Technologies
CDM Electronics
Custom Cable Assemblies, Inc.
Dayton-Granger
FLEXCO Microwave
Glenair
HUBER+SUHNER AG
Insulated Wire (IW)
MECA Electronics
MegaPhase
Micro-Coax, Inc.
Molex
Montena Technology sa
Radiall

RF Industries
RF Logic
Samtec
Shadow Technologies
TE Connectivity
Teledyne Defense Electronics
Times Microwave Systems
Transformational Security
TRU Corp.
W.L. Gore & Associates, Inc. (Gore)

RF Connectors and Adapters

Acewavetech
Amphenol RF
BJG Electronics
BTC Electronics
CAES
Cinch Connectivity Solutions
Custom Cable Assemblies
Delta Electronics Mfg. Corp.
Digi-Key
Dynawave Inc.
Fairview Microwave
Gigalane
Glenair
Hermetic Solutions
Huber + Suhner
Insulated Wire (IW)
JFW Industries
Krytar
Maury Microwave
Meca Electronics
Megaphase
Microwave Communications Laboratories Inc.
Molex
Pasternack
Radiall
Sage Millimeter
Samtec
Santron
Smiths Interconnect
Southwest Microwave
Spectrum Elektrotechnik GmbH
TE Connectivity
Times Microwave Systems

Waveguides

Anatech Electronics
CAES
Dow-Key Microwave
Ferrite Microwave Technologies
Honeywell Aerospace
K&L Microwave, Inc.
Keragis
Link Microtek
Micronetixx, P.A.
Microwave Applications Group
Microwave Communications Laboratories
Microwave Engineering Corp.
Montena Technology sa
Q Microwave, Inc.
Smiths Interconnect
Steatite Antennas
Teledyne Defense Electronics
Ultra Electronics – Herley

Digital Frequency Discriminators

AKON, Inc.
Anaren, Inc.
CSIR – DPSS
Mercury Systems
Narda-Miteq
Teledyne Defense Electronics
Triasys
TUALCOM, Inc.
Wide Band Systems Inc.

Digital RF Memories

Anaren, Inc.
Annapolis Micro Systems, Inc.
CSIR – DPSS
Curtiss-Wright Defense Solutions
L3Harris
Mercury Systems
Reut Systems and Technologies (RST)
Saab
Systems & Processes Engineering Corp. (SPEC)
TEK Microsystems, Inc.
Ultra Electronics – Herley

Integrated Microwave Assemblies

AKON, Inc.
American Microwave Corp.
Anaren, Inc.
APITech
ARS Products
CAES
Comtech PST
Crane Aerospace & Electronics
CTT Inc.
Dow-Key Microwave
ERZIA Technologies SL
FEI-Elcom Tech
Jabil Defense and Aerospace Services
Kratos
L3Harris
LaBarge, Inc.
Lexatys
Lorch Microwave
Mercury Systems
Microphase Corp.
Microwave Applications Group
Microwave Products Group
NEL Frequency Controls, Inc.
Quantic PMI
Quarterwave Corp.
Renaissance Electronics Corp.
RFcore Co, Ltd.
Rockwell Collins
Rodelco Electronics Corp.
Teledyne Defense Electronics
Ultra Electronics – Herley
US Dynamics Corp.

RF Receivers

AKON, Inc.
Anaren, Inc.
Argon ST
Avantix
BAE Systems
CAES
Chemring Technology Solutions
Clearbox Systems
Communications & Power Industries, Inc (CPI)
Communications Audit UK Ltd.
Curtiss-Wright Defense Solutions
D-TA Systems
Dayton-Granger
Digital Receiver Technology
ELDES S.r.l. – Radar Division
Emhiser Research Inc.
Epiq Solutions
FEI-Elcom Tech
iRF Solutions
IZT GmbH
Jersey Microwave
Kratos
L3Harris – Linkabit
Leonardo DRS
MEDAV GmbH
Mercury Systems
Mid-Atlantic RF Systems
National Instruments Corp. (NI)
Norden Millimeter
Plextek Consulting
Radio Reconnaissance Technologies
Raytheon
RFEL Ltd.
Rockwell Collins
Rohde & Schwarz GmbH & Co. KG
Signal Hound
Spectranetix, Inc.
Spectrum Signal Processing
Tampa Microwave
Teledyne Defense Electronics
Ten-Tec
Triasys
Trident Systems Inc.
Ultra Electronics – Herley

RF Tuners

AKON, Inc.
ASELSAN
Atlanta Micro
CAES
Chemring Technology Solutions
Communications Audit UK Ltd.
CyberRadio Solutions
D-TA Systems Inc.
Digital Receiver Technology
diminuSys
Elektrobit
Epiq Solutions
FEI-Elcom Tech
FS Antennentechnik GmbH
iRF Solutions
IZT GmbH
Leonardo DRS
Mercury Systems
Mid-Atlantic RF Systems
Midwest Microwave Solutions Inc.
Norden Millimeter, Inc.
NuWaves Engineering
Pentek
R.A. Wood Associates
Radixon
Rockwell Collins
Rohde & Schwarz GmbH & Co. KG
Saab Medav
Silver Palm Technologies
Systems & Processes Engineering Corp. (SPEC)
Teledyne Defense Electronics

Signal Conditioners

ARS Products
CAES
Pole/Zero Corp.
Rantelon
RFEL Ltd.
Teledyne Defense Electronics
Terma

Displays

Aeromaoz
Astronautics C.A. Ltd.
BARCO
Curtiss-Wright Defense Solutions
Ecrin Systems
L3Harris
Lockheed Martin
Meggitt Defense Systems
Precision Display Technologies
Terma
Z Microsystems, Inc.

Solid-State Power Amplifiers

Aero Telemetry
Aethercomm, Inc.
AMCOM Communications
Amplifier Solutions Corp.
Applied Systems Engineering Inc.
AR RF/Microwave Instrumentation
BC Systems
CAES
Communication Power Corporation
Communications & Power Industries, Inc (CPI)
Comtech PST
Crescend Technologies
CTT, Inc.
dB Control
Diamond Microwave
Elite RF

Emhiser Research, Inc.
Empower RF Systems
Epirus
ERZIA Technologies SL
ETL Systems
Exodus Advanced Communications
Filtronic
IFI – Instruments for Industry Inc.
Keragis
KMIC Technology, Inc.
Kratos
Linwave Technology
MACOM
Mercury Systems
Microwave Amplifiers Ltd.
Microwave Dynamics
Mid-Atlantic RF Systems
MILMEGA, a Teseq Company
Mission Microwave
Narda-Miteq
NEC Network and Sensor Systems, Ltd.
NuWaves Engineering
OPHIR RF
Protium Technologies, Inc.
Qorvo
Quarterwave Corp.
Rantelon
RFHIC
Rodelco Electronics Corp.
Rohde & Schwarz GmbH & Co. KG
Smiths Interconnect
Teledyne Defense Electronics
Thales Microwave and Imaging Systems
Triad RF Systems Inc.
Triton Services Inc.
US Technologies-Aldetec
WDS Radar

GaN/GaAs Transistors

Analog Devices Inc.
AMCOM Communications
Criteria Labs
MACOM
Mercury Systems
Northrop Grumman
NXP
Qorvo
United Monolithic Semiconductor
Wolfspeed

TWTs

Communications & Power Industries, Inc (CPI)
dB Control
NEC Network and Sensor Systems, Ltd.
Photonis Defense, Inc.
Stellant Systems
Teledyne Defense Electronics
Thales Microwave and Imaging Systems

TWT Assemblies

Applied Systems Engineering Inc.
CAES
Communications & Power Industries, Inc (CPI)
Comtech PST
dB Control
IFI – Instruments for Industry Inc.
Narda-Miteq
NEC Network and Sensor Systems, Ltd.
Photonis Defense, Inc.
Quarterwave Corp.
Stellant Systems
Teledyne Defense Electronics
Thales Microwave and Imaging Systems

Microwave Power Modules (MPMs)

Communications & Power Industries, Inc (CPI)
dB Control
L3Harris – Electron Devices Division
NEC Network and Sensor Systems, Ltd.
Photonis Defense, Inc.
Teledyne Defense Electronics
Thales Microwave and Imaging Systems
WDS Radar

Power Supplies and Converters

APITech
BC Systems
Behlman Electronics
Communications & Power Industries, Inc (CPI)
Crane Aerospace & Electronics
dB Control
Milpower Source Inc.
Schaefer Electronics
Vicor Corp.

Data Recorders

Ampex
Annapolis Micro Systems, Inc.
Avalon Electronics, Inc.
Conduant Corp.
Curtiss-Wright Defense Solutions
D-TA Systems Inc.
Daqscribe
Delphi Engineering Group
DSPCon, Inc.
Dynamic Signals LLC
Elma Electronics
Galleon Embedded Computing
IZT GmbH
Kratos
L3Harris – Communications Systems - East
Leonardo DRS
Mercury Systems
Novator Solutions AB
Pentek
PROCITEC GmbH
RADX Technologies, Inc.
Rincon Research Corporation
Rohde & Schwarz GmbH & Co. KG
Scientific Research Corp.
Serpikom
Shoghi Communications Ltd.
Signami-DCS – EW/Range
Sypris Solutions
TEK Microsystems
Tektronix, Inc.
Wideband Systems Inc.
X-COM Systems, LLC

Signal Analysis Systems

Annapolis Micro Systems, Inc.
Berkley Nucleonics
CAES
COMSEC LLC
Hensoldt South Africa
Innovative Signals Technology (ISigTech)
ITAS A/S
IZT GmbH
Keysight Technologies
Mercury Systems
Novator Solutions AB
Patria
Plath Signal Products
PROCITEC GmbH
RADX Technologies, Inc.
Rantelon
Rincon Research Corporation
Rockwell Collins
Rohde & Schwarz GmbH & Co. KG
Serpikom
Signal Hound
X-COM Systems, LLC

RF/Microwave Chassis and Enclosures

ADC Embedded Solutions
Aitech
Atrenne
Collins Aerospace
Extreme Engineering Solutions
LCR Embedded Systems
Mercury Systems
Nova Integration Solutions
Parker Aerospace
Pixus Technologies
Trident Infosol
United Electronic Industries

Transport Cases

ATS Cases
CP Cases
ECS Composites
Impact Cases
Pelican Cases
Thermodyne
Tsunami Cases
Zarges

TEST EQUIPMENT

Oscilloscopes

B&K Precision Corp.
Berkley Nucleonics
Dynamic Signals LLC
Keysight Technologies
National Instruments Corp. (NI)
Rohde & Schwarz GmbH & Co. KG
Tektronix, Inc.
Teledyne Defense Electronics

Signal Generators

Anritsu
B&K Precision Corp.
Berkley Nucleonics
CAES
Cyber Radio Solutions
Dynamic Signals LLC
FEI-Elcom Tech
ISPAS AS
IZT GmbH
Keysight Technologies
Mercury Systems
National Instruments Corp. (NI)
Novatech Instruments
Phase Matrix
RADX Technologies, Inc.
Rohde & Schwarz GmbH & Co. KG
Signal Hound
Tabor Electronics
Tektronix, Inc.
Textron Systems Corporation
Varilog Research, Inc.

Spectrum Analyzers

Aaronia AG
Anritsu
B&K Precision Corp.
Berkley Nucleonics
COMSEC LLC
Epiq Solutions
ESPY Corp.
Good Will Instrument Co., Ltd.
Keysight Technologies
National Instruments Corp. (NI)
RADX Technologies, Inc.
Research Electronics International (REI)
Rohde & Schwarz GmbH & Co. KG
Signal Hound
Tektronix, Inc.
ThinkRF
WhiteFox Defense Technologies, Inc.

Power Meters

Anritsu
Keysight Technologies
Krytar, Inc.
Mercury Systems

Rohde & Schwarz GmbH & Co. KG
Werlatone, Inc.

Network Analyzers

Anritsu
DaqScribe Solutions, LLC
Keysight Technologies
RADX Technologies, Inc.
Rohde & Schwarz GmbH & Co. KG
Tektronix, Inc.

Automatic Test Equipment

Advanced Testing Technologies Inc.
ARS Products
Berkley Nucleonics
CAES
COMSEC LLC
Dow Key Microwave Corp.
ELDES S.r.l. – Radar Division
Electronic Systems
INDRA
Keysight Technologies
L3Harris
Leonardo DRS
Meggitt Defense Systems
Mercer Engineering Research Center
MES S.p.A.
National Instruments Corp. (NI)
RADX Technologies, Inc.
Rodale Electronics Inc.
Rohde & Schwarz GmbH & Co. KG
RUAG – Aerospace
Signal Hound
Spirent Communications
Tabor Electronics
Tech Resources, Inc.
Tektronix, Inc.
Textron Systems Corporation
TRU Corp.
ViaSat, Inc.
VIAVI Solutions, Inc.

EO/IR COMPONENTS & SUBSYSTEMS

IR Detectors

Defense Research Associates, Inc.
Leonardo DRS
Textron Systems Electronic Systems LTD UK

Fine-Track Sensors

BAE Systems
L3Harris
Northrop Grumman
Teledyne Defense Electronics

EW & SIGINT SYSTEMS

Radar Warning Receivers (RWRs) and ESM Systems

Aeronix, Inc.
Argon ST
ASELSAN
BAE Systems
BEL – Bharat Electronics Ltd.
Elbit Systems
Elettronica SpA
ELTA Systems Ltd.
HawkEye 360
Hensoldt
INDRA
L3Harris
Leonardo
Lockheed Martin
Microwave Technologies Inc.
Northrop Grumman
Patria
RADA USA
Rafael – Advanced Defense Systems Ltd.
Raytheon
Saab
Sierra Nevada Corp.
Silentium Defence
Teledyne Defense Electronics
Telemus
Thales Airborne Systems
TINEX AS
Ultra Electronics – Australia
VIAVI Solutions, Inc.

RWR and ESM – Antennas

AMT Microwave Corp.
ASELSAN
BAE Systems
BEL – Bharat Electronics Ltd.
CAES
Elbit Systems
Electro-Metrics
First RF Corp.
Fractal Antenna Systems
IFI – Instruments for Industry Inc.
JEM Engineering
L3Harris – Randtron Antenna Systems
Link Microtek
Microwave Specialty Company
Rafael – Advanced Defense Systems Ltd.
Rohde & Schwarz GmbH & Co. KG
Saab – Electronic Defence Systems
Steatite Antennas

RWR and ESM – Receivers

Aeronix
Argon ST
Avantix
CAES
Elettronica SpA
ELTA Systems Ltd.
ESROE Limited
FEI-Elcom Tech
Leonardo
Lockheed Martin
Mercury Systems
Microwave Technologies Inc.
Northrop Grumman
Ocupoint Inc.
Plextek Consulting
Rafael – Advanced Defense Systems Ltd.
Saab
Sierra Nevada Corp.
Systems & Processes Engineering Corp. (SPEC)
Teledyne Defense Electronics
Telemus
Thales
Trident Systems Inc.
TUALCOM, Inc.

Radar Jammers

ASELSAN
BAE Systems
BEL – Bharat Electronics Ltd.
Elbit Systems
Elettronica SpA
ELTA Systems Ltd.
INDRA
L3Harris Technologies
Leonardo
MC Countermeasures Inc.
MyKonsult
Northrop Grumman
QinetiQ Ltd.
Rafael – Advanced Defense Systems Ltd.
Raytheon
Rodale Electronics Inc.
Saab
Southwest Research Institute
Thales Airborne Systems

Radar Jammers – Antennas

AMT Microwave Corp.
ASELSAN
BAE Systems
BEL – Bharat Electronics Ltd.
CAES
Elbit Systems
Electro-Metrics
First RF Corp.
Fractal Antenna Systems
IFI – Instruments for Industry Inc.
JEM Engineering
L3Harris – Randtron Antenna Systems
Link Microtek
Microwave Specialty Company
Rafael – Advanced Defense Systems Ltd.
Steatite Antennas
Times Microwave Systems

Radar Jammers – DRFMs

Anaren, Inc.
CSIR – DPSS
Curtiss-Wright Defense Solutions
L3Harris
Leonardo
MC Countermeasures Inc.
Mercury Systems
Military Optical RF Equipment Ltd.
Rafael – Advanced Defense Systems Ltd.
Saab
TEK Microsystems, Inc.
Ultra Electronics – Herley

Radar Jammers – Exciters

CAES
Elbit Systems
ELTA
FEI-Elcom Tech
L3Harris
Mercury Systems
Microwave Products Group
Northrop Grumman
Rafael – Advanced Defense Systems Ltd.

Radar Jammers – Power Amplifiers

Aethercomm, Inc.
Applied Systems Engineering Inc.
Communications & Power Industries, Inc (CPI)
Comtech PST
dB Control
Empower RF Systems
ERZIA Technologies SL
L3Harris – Electron Device Division
Leonardo
MACOM
Photonis Defense, Inc.
Qorvo
Teledyne Defense Electronics
Thales Microwave and Imaging Systems

Airborne Active RF Decoys

BAE Systems
Hensoldt
Leonardo
Rafael – Advanced Defense Systems Ltd.
Raytheon
Systems & Processes Engineering Corp. (SPEC)
Thales Airborne Systems

EW Suite Managers/ Controllers

BIRD Aerosystems
Leonardo
Northrop Grumman
Rafael – Advanced Defense Systems Ltd.
Terma

Passive Missile Warning Systems

BAE Systems
Elbit Systems
Hensoldt
Leonardo DRS
Lockheed Martin
MBDA
Northrop Grumman
Saab
Thales Airborne Systems

Active (Pulse Doppler) Missile Warning Systems

ELTA Systems Ltd.
Leonardo – Airborne and Space Systems Division
Thales

Laser Warning Systems

Collins Aerospace
ELTA Systems Ltd.
Leonardo
Saab

Directed IR Countermeasures (DIRCM) Systems

BAE Systems
BIRD Aerosystems
Elbit Systems
Elettronica SpA
INDRA
Leonardo
Northrop Grumman

DIRCM – Fine-Track Sensors

Defense Research Associates, Inc.
ElectroOptic Industries Ltd.
Leonardo DRS

DIRCM – Lasers

BAE Systems
CILAS
Coherent Inc.
DILAS
Elbit Systems
Leonardo
Leonardo Daylight Solutions
Lockheed Martin
Northrop Grumman
Pendar Technologies
Pranalytica

Airborne Decoy Dispensers

ASELSAN
BAE Systems
CAES
Extant Aerospace
Hensoldt
IMI Systems
Leonardo
MBDA
Meggitt Defense Systems
MES SpA
Petards Group
Rodale Electronics Inc.
Saab
Terma
Thales Airborne Systems

Airborne IR Decoys/ Countermeasures Flares

Armtec Defense Technologies
Chemring Countermeasures UK
Chemring Countermeasures USA
Esterline Defense Technologies
IMI Systems
Lacroix Defense and Security
MBDA
Rheinmetall Defence

Airborne Chaff Countermeasures

Armtec Defense Technologies
Chemring Countermeasures UK
Chemring Countermeasures USA
Esterline Defense Technologies
IMI Systems
Lacroix Defense and Security

Maneuvering Air-Launched Decoys

IMI Systems
Raytheon

Anti-Radiation Homing Missiles

Lockheed Martin
Northrop Grumman
Raytheon

Naval Decoy Launchers

Lacroix Defense and Security
Lockheed Martin
Rafael – Advanced Defense Systems Ltd.
Rheinmetall Defence
Safran Electronics and Defense
SEA
Sechan Electronics
Terma

Naval IR Decoys

Armtec Defense Technologies
Chemring Countermeasures UK
Chemring Countermeasures USA
Lacroix Defense and Security
Rafael – Advanced Defense Systems Ltd.
Rheinmetall Defence

Naval Chaff Countermeasures

Armtec Defense Technologies
Chemring Countermeasures UK
Chemring Countermeasures USA
Lacroix Defense and Security
Rafael – Advanced Defense Systems Ltd.
Rheinmetall Defence

Naval RF Reflector Decoys

Airborne Systems Limited
Elbit Systems EW and SIGINT – Elisra
Rafael – Advanced Defense Systems Ltd.

Active RF Naval Decoys

BAE SYSTEMS Australia
L3Harris
Leonardo
Lockheed Martin
Rafael – Advanced Defense Systems Ltd.
Thales

Multispectral Obscurants/Smoke

Armtec Defense Technologies
Chemring Countermeasures UK
Chemring Countermeasures USA
L3Harris
Lacroix Defense and Security
Rheinmetall Defense

Communications ESM Systems

Applied Signals Intelligence
ASELSAN
BAE Systems
Chemring Technology Solutions
CRFS
CTL SystemWare
Decodio AG
Defence Research and Development Canada
Digital Receiver Technology
Elettronica SpA
ELTA Systems Ltd.
Epiq Solutions
ESPY Corp.
EWA Government Systems, Inc.
General Dynamics Mission Systems
Hensoldt South Africa
INDRA
IZT GmbH
Kerberos International
Kratos
L3Harris
L3Harris Narda Safety Test Solutions
L3Harris TRL Technology
Leonardo DRS
Lockheed Martin
LS Telcom
Metis Aerospace Ltd.
Microwave Products Group
N-Ask Incorporated
Netline Communications Technologies
Northrop Grumman Corp.
Peralex
PLATH Signal Products
Professional Development TSCM Group
Radixon
Raytheon
Research Electronics International (REI)
Rincon Research Corporation
Rohde & Schwarz GmbH & Co. KG
Saab Medav
Seqtor ApS
Serpikom
Shoghi Communications Ltd.
Sierra Nevada Corp.
Southwest Research Institute
Spectranetix, Inc.
Tata Advanced Systems Limited (TASL)
Tata Power Strategic Electronics Division
TCI International, Inc.
Thales
ThinkRF
Transformational Security
URC Systems
VIAVI Solutions, Inc.

Comms ESM – Antennas

Alaris Antennas
AMT Microwave Corp.
Antenna Authority
Antenna Experts
Antenna Research Associates
Antenna Systems and Solutions
Applied EM Inc.
ARA, Inc.
CAES
CEA Technologies
COJOT
Defence Research and Development Canada
Electro-Metrics
ET Industries
ETS-Lindgren
European Antennas
First RF Corp.
Flann Microwave
Fractal Antenna Systems
FS Antennentechnik GmbH
JEM Engineering
L3Harris
Leonardo DRS
Link Microtek
Mercury Systems
Micronetixx, P.A.
Microwave Engineering Corp.
Microwave Specialty Company
Microwave Technologies Inc.

Ocean Microwave Corp.
Octane Wireless
PCTEL Inc.
PLATH GmbH
QuinStar Technology, Inc.
Radio Reconnaissance Technologies
Rantelon
Rockwell Collins
Rohde & Schwarz GmbH & Co. KG
Rubisoft
Saab
SATIMO
Steatite Antennas
TCI International, Inc.

Comms ESM – Receivers

Applied Signals Intelligence
Argon ST
Avantix
BAE Systems
Chemring Technology Solutions
Chora A/S
Communications Audit UK Ltd.
Cyber Radio Solutions
D-TA Systems
Deepwave Digital
Digital Receiver Technology
Emhiser Research Inc.
Enablia S.R.L.
Epiq Solutions
Ettus Research
FEI-Elcom Tech
Herrick Technologies
iRF Solutions
IZT GmbH
Jersey Microwave
Kratos
L3Harris
L3Harris Narda Safety Test Solutions
Leonardo DRS
LOG.IN Srl
Mercury Systems
Mid-Atlantic RF Systems
Norden Millimeter
Ocupoint Inc.
OEwaves
Orolia Defense & Security
PCTEL
Per Vices Corp.
PLATH Signal Products
Plextek Consulting
Radio Reconnaissance Technologies
Radixon
Raytheon
RFEL Ltd.
Rockwell Collins
Rohde & Schwarz GmbH & Co. KG
Saab Medav
Sagax Communications
SignalHound
Spectrum Signal Processing
Syncopated
Tampa Microwave
Teledyne Defense Electronics
Ten-Tec
Triasys
Wide Band Systems Inc.

Communications Jammers

Aegis Corea
Albrecht Telecommunications
Allen-Vanguard Corp.
ASELSAN
BAE Systems
CAES
Chesapeake Technology Intl (CTI)
DSE International
Elbit Systems
Elettronica SpA
ELTA Systems Ltd.
Enterprise Control Systems
Hensoldt
Hensoldt South Africa
Honeywell Aerospace
HP Marketing and Consulting
INDRA
Kerberos International
L3Harris
L3Harris TRL Technology
Leonardo
Lockheed Martin
Mitsubishi Electric Corp.
Motorola Solutions – Applied Technology
Netline Communications Technologies
PKI Electronic Intelligence
PLATH Signal Products
Radixon
Rantelon
Raytheon
Rockwell Collins
Rohde & Schwarz GmbH & Co. KG
Samel 90
Serpikom
SESP Group
Shoghi Communications Ltd.
Sierra Nevada Corp.
Southwest Research Institute
Spectranetix, Inc.
Tata Advanced Systems Limited
Tata Power
Thales
Unival Group
URC Systems

Comms Jammer – Antennas

Alaris Antennas
Applied EM Inc.
CAES
CEA Technologies
COJOT
Defence Research and Development Canada
Electro-Metrics
ET Industries
ETS-Lindgren
European Antennas
First RF Corp.
Flann Microwave
Fractal Antenna Systems
FS Antennentechnik GmbH
JEM Engineering
L3Harris
Leonardo DRS
Link Microtek
Micronetixx, P.A.
Microwave Engineering Corp.
Microwave Specialty Company
Microwave Technologies Inc.
Ocean Microwave Corp.
Octane Wireless
PCTEL Inc. – Antenna Products
QuinStar Technology, Inc.
Radio Reconnaissance Technologies
Rantelon
Rockwell Collins
Rohde & Schwarz GmbH & Co. KG
Rubisoft
Saab
SATIMO
Seqtor ApS
Shakespeare Antennas
Steatite Antennas

Comms Jammer – DRFMs

Anaren, Inc.
CSIR – DPSS
Curtiss-Wright Defense Solutions
Epiq Solutions
L3Harris
Mercury Systems
Saab
Systems & Processes Engineering Corp. (SPEC)
TEK Microsystems, Inc.
Ultra Electronics – Herley

Comms Jammer – Power Amplifiers

Aethercomm, Inc.
Amplifier Technology
Applied Systems Engineering Inc.
BC Systems
Comtech PST
Crescend Technologies
CTT, Inc.
dB Control
Emhiser Research, Inc.
Empower RF Systems
IFI – Instruments for Industry Inc.
Keragis
KMIC Technology, Inc.
L3Harris
Linwave Technology
Mercury Systems
Microwave Amplifiers Ltd.
Mid-Atlantic RF Systems
MILMEGA, a Teseq Company
NEC Network and Sensor Systems, Ltd.
OPHIR RF
Photonis Defense, Inc.
Qorvo
Quarterwave Corp.
Rantelon
RF Core Co, Ltd.
RFHIC
Rodelco Electronics Corp.
Smiths Interconnect

Counter-UAS Systems (EW)

Aaronia AG
Advanced Protection Systems
Allen-Vanguard
AntiDrone
ApolloShield
ArtSYS360
ASELSAN Inc.
Avantix
BATS
Blind Tiger
CACI
CerbAir
Citadel Defense
CRFS
CTS Technology Co. Ltd.
D-Fend Solutions A.D. Ltd.
DeDrone
Department 13
DeTect Inc.
Diehl Defence
Drone Defence
DroneShield
Elbit Systems
Elettronica SpA
Elta Systems Ltd.
Enterprise Control Systems
Epirus
HARP
Hensoldt
Hensoldt South Africa
High + Mighty International
HIK Vision
HP Marketing and Consulting
Hunan NovaSky Electronic Technology
IACIT
IMI Systems
Indra
Kirintec
L3 Technologies
Leonardo
Liteye Systems, Inc.
Lockheed Martin
LS Telcom
MCTech
Meritis Group
MyDefence Communication
Netline
Northrop Grumman
Orad
Phantom Technologies Ltd.
PKI Electronic Intelligence GmbH
Radio Hill Technologies

Rantelon
Rohde & Schwarz GmbH & Co. KG
Samel 90 PLC
Sensofusion
Serpikom
SESP Group
Sierra Nevada Corp.
Silentium Defence
SINTIS Technology Ltd.
Skysafe
SRC, Inc.
SteelRock Technologies
Teleradio Engineering
Terra Hexen
TCI International, Inc.
TRD Consultancy Pte Ltd.
Unival Group

GPS Jammers

Defence Research and Development Canada
Elbit Systems
Empower RF Systems
L3Harris
Scientific Research Corp.
Thales

ELINT Systems

Aeronix, Inc.
Avalon Electronics, Inc.
Azure Summit Technology
BAE Systems
BEL – Bharat Electronics Ltd.
DaqScribe Solutions, LLC
Elbit Systems
Elettronica SpA
ELTA Systems Ltd.
INDRA
iRF Solutions
Jordan Electronic Logistic Support – Electronic Warfare
L3Harris
Lockheed Martin
Microwave Technologies Inc.
Northrop Grumman
Patria
QinetiQ Ltd.
Rafael – Advanced Defense Systems Ltd.
Raytheon
Rockwell Collins
Rohde & Schwarz GmbH & Co. KG
Rubisoft
Saab
Sierra Nevada Corp.
Spectranetix, Inc.
Teledyne Defense Electronics
Telemus
Thales Airborne Systems
Ultra Electronics – Australia
VIAVI Solutions, Inc.

ELINT Systems – Antennas

Alaris Antennas
AMT Microwave Corp.
Antenna Authority
Antenna Research Associates
Antenna Systems and Solutions
Applied EM Inc.
CAES
CAL-AV Labs Inc.
CEA Technologies
Communications & Power Industries,Inc (CPI)
Comtech PST
Defence Research and Development Canada
Electro-Metrics
ET Industries
ETS-Lindgren
European Antennas
First RF Corp.
Flann Microwave
Fractal Antenna Systems
FS Antennentechnik GmbH
HUBER+SUHNER AG
IFI – Instruments for Industry Inc.
JEM Engineering
Jenkins Engineering Defence Systems
L3Harris
Leonardo DRS
Link Microtek
Micronetixx, P.A.
Mercury Systems
Microwave Engineering Corp.
Microwave Specialty Company
Microwave Technologies Inc.
Ocean Microwave Corp.
Octane Wireless
PCTEL Inc. – Antenna Products
QuinStar Technology, Inc.
Radio Reconnaissance Technologies
Rafael – Advanced Defense Systems Ltd.
Randtron Antenna Systems
Rohde & Schwarz GmbH & Co. KG
Steatite Antennas
Telemus

ELINT Systems – Tuners

AKON, Inc.
D-TA Systems Inc.
Epiq Solutions
FEI-Elcom Tech
iRF Solutions
Leonardo DRS
Mercury Systems
Midwest Microwave
NuWaves Engineering
R. A. Wood Associates
Rafael – Advanced Defense Systems Ltd.
Rockwell Collins
Rohde & Schwarz GmbH & Co. KG

ELINT Systems – Receivers

Aeronix, Inc..
Argon ST
Avalon Electronics
Avantix
Azure Summit Technology
CAES
Chemring Technology Solutions
Communications Audit UK Ltd.
D-TA Systems
Elbit Systems
Elettronica SpA
ELTA Systems Ltd.
Emhiser Research Inc.
FEI-Elcom Tech
iRF Solutions
IZT GmbH
Kratos
L3Harris
Leonardo DRS
Lockheed Martin
Mercury Systems
Mid-Atlantic RF Systems
Motorola Solutions – Applied Technology
Patria
Plextek Consulting
Rafael – Advanced Defense Systems Ltd.
Raytheon
Research Associates of Syracuse (RAS)
Rohde & Schwarz GmbH & Co. KG
Sierra Nevada Corp.
Teledyne Defense Electronics
Telemus
Thales
TUALCOM, Inc.
Wide Band Systems Inc.

COMINT Systems

Applied Signals Intelligence
Argon ST
Avalon Electronics, Inc.
BAE Systems
BATS
Chemring Technology Solutions
CRFS
CyberRadio Solutions
DaqScribe Solutions, LLC
Decodio AG
Digital Receiver Technology
Elbit Systems
ELTA Systems Ltd.
ESPY Corp.
General Dynamics
Hensoldt
Hensoldt South Africa
Jordan Electronic Logistic Support – Electronic Warfare
L3Harris
L3Harris Narda Safety Test Solutions
Leonardo DRS
Lockheed Martin
LS Telcom
N-Ask Incorporated
Northrop Grumman
PLATH GmbH
PROCITEC GmbH
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Electromagnetic Protection (Part 8)

EP Against Cross-Polarization Jamming

By Dave Adamy

When signals arrive at an antenna away from its boresight, their polarization can be changed by the shape of the antenna. Figure 1 shows a parabolic dish antenna that has a forward geometry at the edges. At some angles this forward geometry is about 45 degrees to the polarization of an arriving signal – for example a vertically polarized signal arriving from 45 degrees away from the top of the antenna. This can cause an antenna to have a cross polarized lobe in that direction. This is called a Condon lobe. As shown in Figure 2, these Condon lobes are significantly smaller than the antenna's co-polarized main beam. It should be noted that a flat phased array antenna does not have any Condon lobes. However, if the radar has a graduated gain profile (i.e., weaker gain at the beam edges to suppress side lobes) the antenna will have Condon lobes.

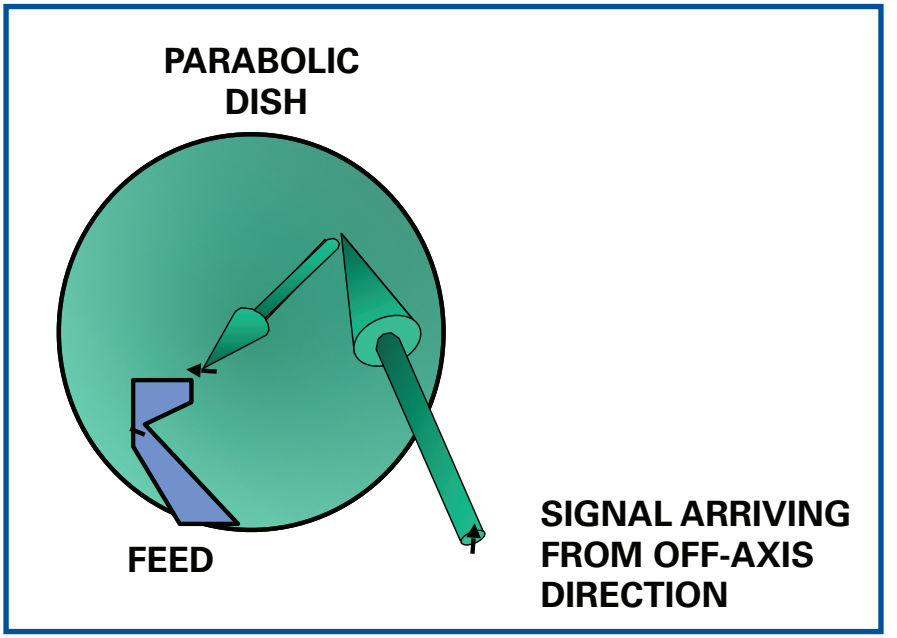

Fig. 1: *In a parabolic antenna, the forward geometry of the reflector will cause a cross polarized reflection from some directions of arrival. This causes the antenna response to have false lobes known as Condon lobes.*

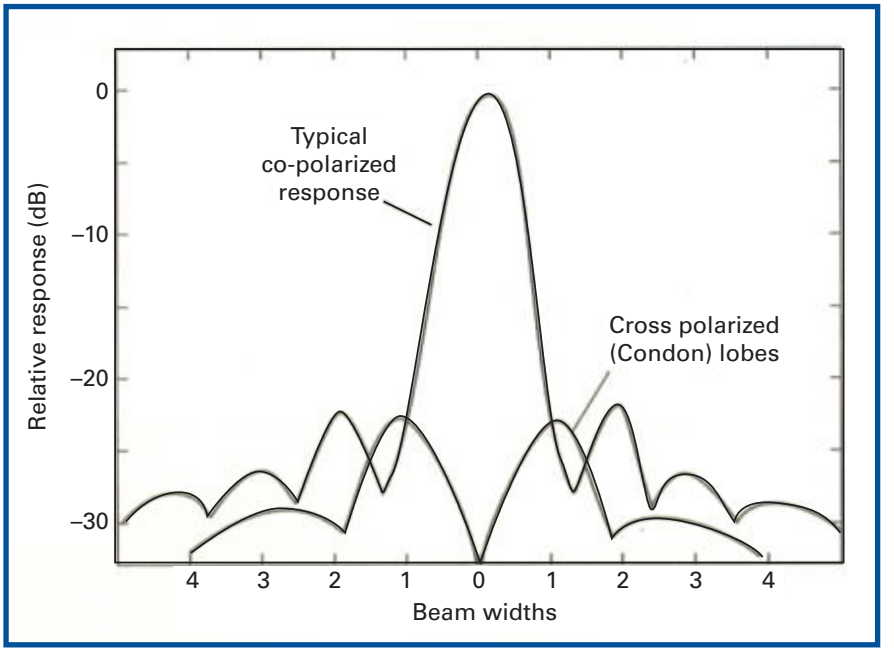

Fig. 2: *As shown here, the Condon lobes are significantly smaller than the co-polarized main lobe of the antenna.*

CROSS POLARIZATION JAMMING

As shown in Figure 3, a cross polarization jammer has a receiving antenna (vertically polarized in the figure) that is routed to a transmitting antenna (horizontally polarized in the figure). It also has a horizontally polarized receiving antenna that is routed to a vertically polarized transmitting antenna. Both of these signal paths have significant amplification. The result is the generation of a jamming signal that is cross polarized to the received signal – regardless of the received polarization.

As shown in Figure 4, the jammed radar's transmitted signal has weak Condon lobes if the radar antenna has a parabolic dish reflector. However, the

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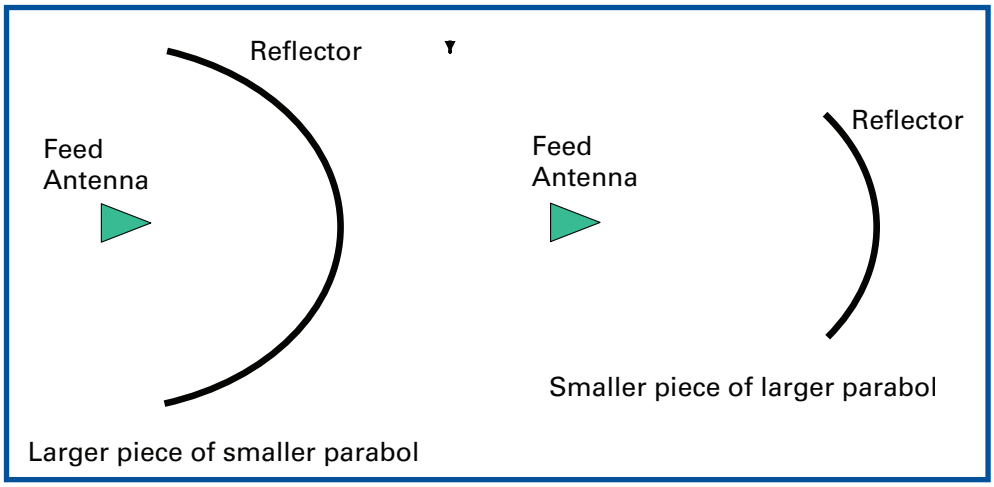


Fig. 3: A "parabolic antenna" includes a reflector that is a parabolic section and a feed antenna at the focus of that parabola. The reflector can be either a large section of a small parabola or a smaller section of a larger parabola.

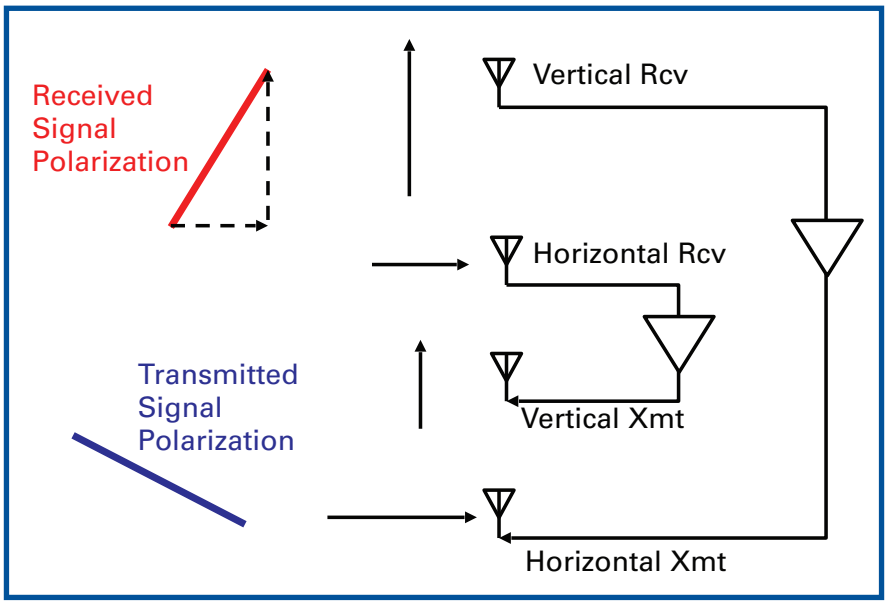


Fig. 4: A cross polarization jammer has two orthogonally oriented receiving antennas. Each passes its received signals to a cross polarized transmitting antenna. The result is transmission of a cross polarized jamming signal.

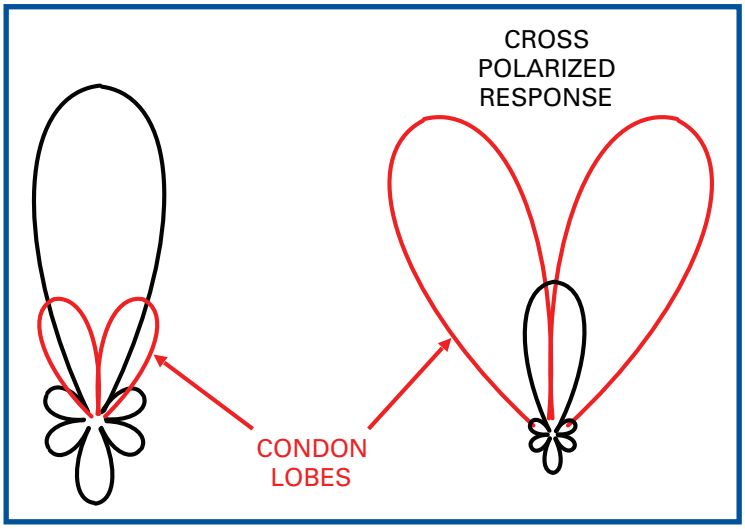


Fig. 5: A cross polarization jammer creates a strong jamming signal that is cross polarized to the received radar return signal from the target. This means that the jammed radar antenna will receive the jamming signal in a Condon lobe.

cross polarized signal retransmitted from the jammer has significant gain. The cross polarized signal from the jammer is much larger than the co-polarized signal reflected from the target. This will cause the radar lock up on a Condon lobe and thus direct its antenna away from the target.

This same antenna configuration can also generate a cross polarized circular scan jamming signal. (e.g., produce a right hand circularly polarized response to a left hand circularly polarized signal)

The left side of Figure 5 shows the jammed radar's main beam and Condon lobes, focusing on the received signal gain pattern to signals with polarization matched to the radar's transmitted signal. This is the case when there is no electromagnetic protection (EP). The right side of the figure shows the radar antenna receiving gain response to a cross polarized signal. Note that the main beam is significantly reduced, while the cross-polarized Condon lobes are significantly increased. With a strong enough cross polarized jamming signal, the radar will steer its antenna in the direction of a Condon lobe.

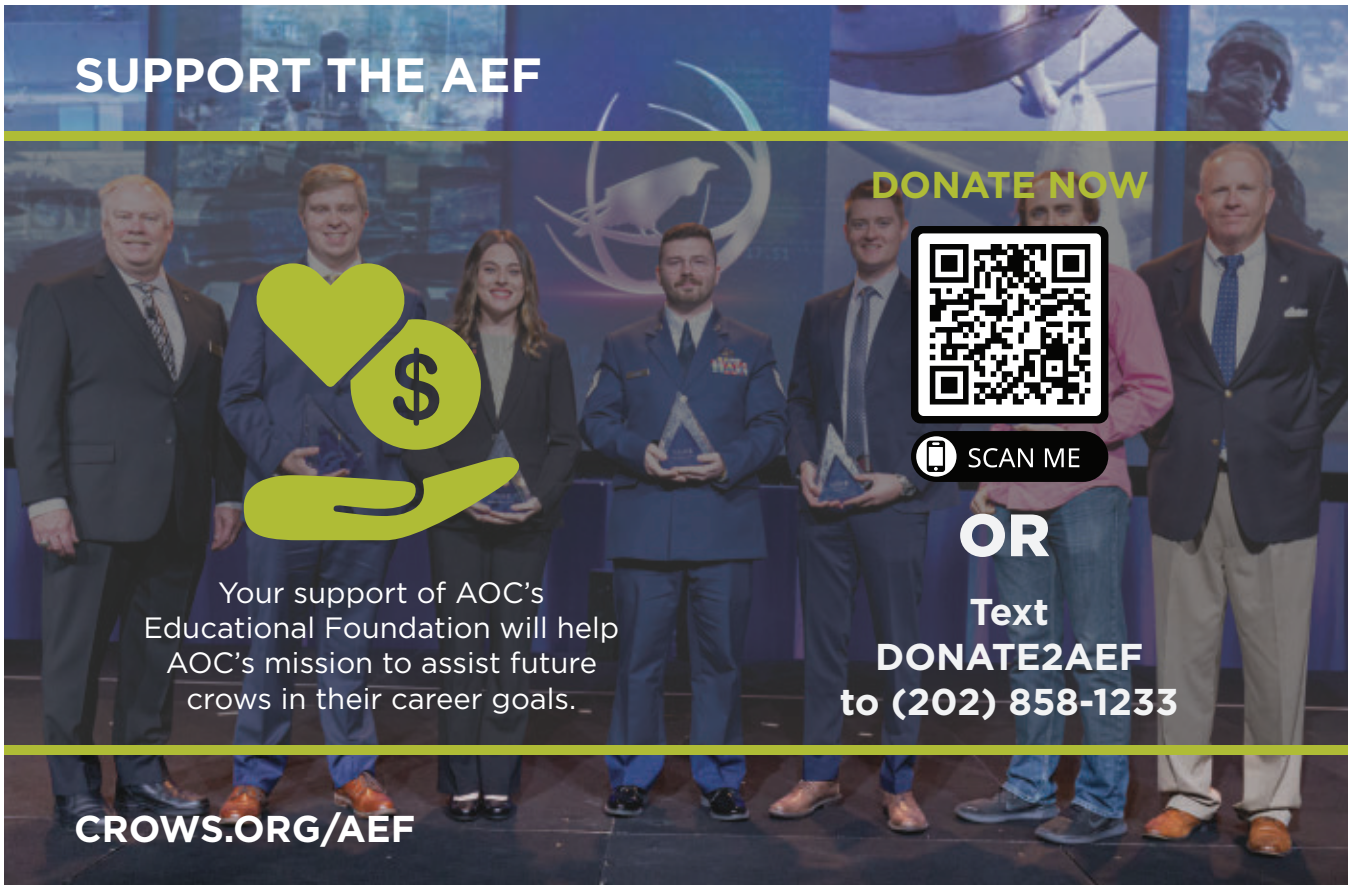
This is very effective jamming.

EP AGAINST CROSS POLARIZATION JAMMING

There are two ways for radars to decrease the effectiveness of cross polarization jamming. One way is to use a flat phased array antenna, without beam sharpening, that has no Condon lobes. This means there will be no cross-polarization jamming. Another approach is to add a polarization filter to the radar antenna. This will prevent cross polarized signals from entering the radar receiver or significantly reduce them.

WHAT'S NEXT

Next month, we will continue our radar EP discussion with the description of pulse-Doppler radars. Dave Adamy can be reached at dave@lynxpub.



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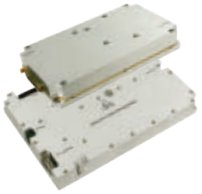

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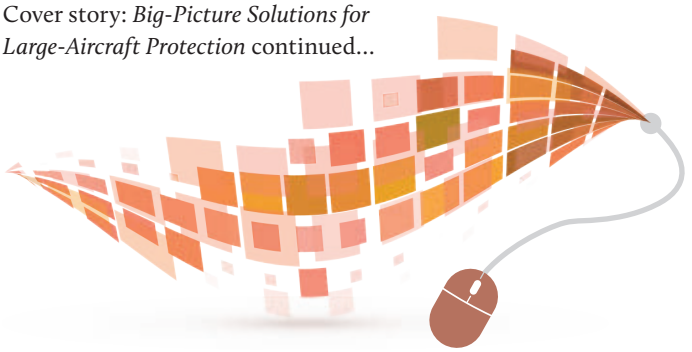

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The US Navy has also become increasingly aware of the need for RF countermeasures for its large-aircraft platforms, and BAE Systems has been working on a "quick-turnaround" effort for the Navy to add an RFCM capability to the P-8A Poseidon maritime-patrol aircraft. The system being evaluated is a lightweight pod mounted to the aircraft consisting of a small form factor jammer, a high-power amplifier and the AN/ALE-55 Fiber-Optic Towed Decoy (FOTD). According to BAE's Roske, they've been doing a lot of work on the system through their Cyber and Electromagnetic Activities (CEMA) integration organization. "We're working with various jammers that can be deployed on the platform with some very good success in terms of flight testing and demonstrating capabilities in our small form factor programs. It may seem odd to put small form factor items on some of these large platforms, but sometimes those are the nooks and crannies that you can put things into."

BAE's CEMA has also been closely involved with the AN/ALE-55 FOTD work. Says Roske, "Getting a towed decoy to work and to fly in a stable fashion is a difficult space, but we've been able to demonstrate excellent performance with the ALE-55." Roske also notes with regard to integration with existing RWR systems on platforms, "What we've done in the past, and on many of the platforms we work with, was create federated interfaces between the RWR and jammer. The downside of this arrangement, however, is that information is passed back and forth at slower time scales, and where it starts to collapse is when you get into modern threats that require much faster jamming responses. You don't have time for that kind of response timescale."

MULTI-SPECTRAL THREATS, ARTIFICIAL INTELLIGENCE, AND THE TOTAL THREAT PICTURE

With both an increasing mix and growing sophistication of threats, single-spectrum detection and countermeasure systems have become inadequate for the large-aircraft protection task. Says Northrop Grumman's Neel, "Today, our large-aircraft platforms require advanced, integrated, multi-spectral survivability systems to execute their missions with IR and RF capabilities really needing to work more collaboratively on the platform."

In addition, says Conroy, "We should expect future adversary weapon systems will be better integrated, utilize more complex waveforms, and incorporate dynamic behavior guided by artificial intelligence and machine learning (AI/ML) to make them harder to detect and counter. To deal with these threat systems, our large aircraft platforms will need to fuse information from multi-domain, multi-spectral sensors and effectors. By combining multispectral capabilities together with AI, we'll be able to not only more quickly engage these threats and assess what countermeasures to bring to bear to protect own aircraft, but also look at solutions that more holistically help to protect an entire group of aircraft."

Roske says BAE is also focused on this requirement. "I work closely with my counterparts in the IR domain and the battle-management and sensor-fusion domains to make sure that we have the right processing allocated into each of those segments, such that we can indeed create an integrated, common operating picture across a fully-distributed battle management suite with AI and cognitive-EW algorithms in the right spaces."

NETWORKED DATA SOURCES AND THREAT-RESPONSE TIMELINES

In addition to their susceptibility to MANPAD weapons, large-aircraft platforms are also particularly vulnerable to long-range threats. One reason for this is simply that they are in fact large and present considerable radar cross sections. As BAE's Roske pointed out, "Because large platforms are relatively easy to detect in the first place, the threat can really come from anywhere, with possible responses ranging from vectoring a defensive counter-air patrol toward you to the use of surface-to-air missiles along the way." But the good news he says is, "no-one is flying alone, so each aircraft can work as part of its own network and battle management suite, as well as work across the full spectrum (RF, IR, optical) to make sure that the right assets are working at the right places at the right times."

USAF PHOTO

Roske says, one way to accomplish is to look at and evaluate the activity across an adversary's own networks. "You want to make sure that you're monitoring and understanding changes in those networks' behavior and, if you see some increased activity someplace, that is probably an area that you want to play closer attention to. For example, if there's an indication of a detection, take a look at the waveforms to get an understanding of what that radar thinks of you, and draw some conclusions as to whether or not you are detectable and what you should be looking out for."

Northrop Grumman's Conroy agrees, noting that he "can easily envision the day when we have to transcend single-ship survivability to multi-ship survivability. That multi-ship survivability is obviously going to require interfacing over a network structure such as Joint All Domain Command and Control (JADC2) to really share data between platforms to be successful." This is something Conroy says his company is provisioning for in a number of their products – "to enable the sharing of data but also, as the platforms receive data, they are actually elevating and leveraging that data as well." As an adjunct to this, he adds that "what's going to be critical for some of those things is not only knowing where each of those multi-ship platforms are residing, but also the timing of the data or data latency associated with it."

Neel adds that, "besides making sure that you're connected into networks that allow you to understand the total threat environment, you need to ensure that the timelines needed to provide protective actions are adequate." He emphasizes that, "countermeasure are all about timelines. You need enough time to defeat the threat which means you first have to find it, and the sooner you know there's a threat out there, even if you can't see a launch, it's important to get that information quickly." Neel references a recent demonstration of such capabilities at the AUSA Annual Meeting. "We have a program that is actually looking at doing flight planning and having that flight planning be more dynamic, where threat warning, or potential threat warning information, comes not only from the platform itself and from other platforms, but also from mission planners and other sources. Then, you'll know about that threat with enough time to dynamically change the mission plan for the platform. These are the types of things that will allow for a robust enough timeline to be able to defeat the threat."

Raytheon's Baladjanian also sees the criticality of networked threat warning and rapid response times, pointing out that the US Air Force is working toward a way for all assets to be able to share their information in real-time. "Defending our High Value Airborne Assets (HVAA), such as AWACS, Rivet Joint, JSTARS and Compass Call, has become so important that the loss of even one could seriously impact US warfighting capabilities or provide the enemy with significant propaganda value."

MODULARITY AND OPEN ARCHITECTURES

Another key element to successfully bringing capable, agile, and affordable self-protection systems to large-aircraft fleets is the adoption and implementation of open architecture designs and standard interfaces.

US NAVY PHOTO

Baladjanian says Raytheon has definitely embraced DOD's shift to open-standard architectures. "We've shown this capability in various demonstrations, which enables a faster innovation cycle at lower cost. Future self-protect systems must be designed to ensure scalability, adaptability, agility and affordability, while delivering critical capabilities."

Northrop Grumman is also on board. Says Neel, "We're not only looking at open architectures and modularity in terms of what we can do to evolve system capabilities along with the threat, but also what we can do on the platforms – new and existing – to evolve with the mission of the platform, as well as the threat. It used to be that the systems put on platforms only had to work with the installed system, but now they have to actually interact with the rest of the platform, and that means you have to have open architectures that allow for rapid development and upgrades. Open architectures and standards, like the Future Airborne Capability Environment (FACE) and Modular Open Systems Approach (MOSA), will allow us to continue to evolve and connect more of the systems on the platform and provide operators with a more holistic picture of the environment that their flying through. Our adversaries are not slowing down with their changes, and we need to be able to keep up with those threats. This is the way to do that."

Conroy adds that open architectures and standards also "enable best-off-breed capabilities to be implemented on platforms. We not only have open architectures within our systems, but we also leverage a lot of commonality between different systems such that we can take in and leverage the investments made across multiple customer communities."

NEXT-GENERATION TECHNOLOGY

Of course, regardless of what level of technology is available and being deployed today for large-aircraft self-protection, the future will demand more and better. This is why EW companies are constantly looking forward to anticipate the future threat environment. At Northrop Grumman, Neel says, "We're always looking at different things that we can do, such as upgrading lasers and improving multi-spectral sensors with larger focal plane arrays together with advanced software architectures."

For his part, Conroy says it's important to recognize that, in future, the threat will not be limited to systems exploiting in-

dividual parts of the EMS working independently, but will be multi-spectral threats collecting and correlating data for greater effect. "We'll have to likewise be able to accord appropriate responses to those advanced threats," he says, pointing out that they're doing a lot of advanced science and technology (S&T) work to ensure that large-aircraft self-protection systems are "not only able to automatically detect, track and jam threats, but also provide situational awareness up to the flight deck so they have all the information they need to make informed decisions on how to execute their missions."

Going forward, he foresees the evolution of the RF EW space shifting from a very hardware-focused to a hardware-enabled, software-defined capability. "Systems are going to need to be very agile – able to sense the environment and make some reasoning as to how they will respond. New types of machine-learning or AI software algorithms will have to come into play at some point in time. In the near-term, it will be more like rationalization or statistical processing – more Boolean-Logic-based or clear yes/no answers, but later it will involve evaluating what kind of confidence you have in those answers. That will be the stepping stone from where we are today to the future goal of re-writing source code on the fly."

In addition, however, Conroy says that together with looking at new and emerging technologies, they also have to continue to emphasize design priorities, such as reducing SWaP-C. "Adding capability always requires a balance between what needs to be accomplished in order to address future threats while still enabling the warfighters to meet mission requirements and, as the threat environment continues to evolve, we have to keep very abreast of that. For the larger platforms, and for multi-ship protection, this means you also have to consider some of the off-boarding capability options available through very small SWAP-C suppression of enemy air defense (SEAD) technology. You have to be able to pair high-value assets with low-value assets that won't be coming back at the end of the day."

At BAE, Roske says they're looking into the future with a recognition that "the days are gone when you had to go get new hardware to bring something new to the fight. Today, the fight is constantly and rapidly changing, and that approach isn't going to work." Instead, he says their focus is on convergence and open-architecture solutions. "This allows us to have a high-rate production line that provides some commonality of both reprogrammable hardware, supports third-party insertions, and can bring new capabilities to the fight on a regular basis. Some of these architectural standards are still in their infancy, but it's the right answer for the warfighter to be able to support items that do indeed work together across industry and across government and military development."

One example of BAE's work in this area is the company's recently-introduced Storm EW™ Modules aimed at accelerating the delivery of software-based EW capabilities through a common-core architecture. Their scalable design provides a hardware baseline that can be customized and integrated into multiple airborne platforms to reduce engineering and life-cycle costs.

Says Roske, "These are highly-capable systems that provide the ability to detect and respond at the speed-of-the-fight, which is one of the most important things to consider as you're building an EW suite. There are some things that you can take more time to digest and understand, but when push comes to shove, speed is life, and it's critical to get your electronic responses out at the right – and very fast – times to defeat the threat."

Another focus area at BAE, says Roske, is looking at "where we go with cognitive EW and information fusion, and how do we learn from the battlespace while we're in the fight, from fight to fight, and from day to day, to make sure that we're using all of the assets in the environment for what their purpose is, as well as fusing common information." In pursuit of this, Roske says they're approaching the challenge from a perspective that "doesn't just look at EW as something you have to have to protect yourself while you do your real mission, but rather looks at EW as the real mission and using the spectrum to help spoil the enemy's day."

As with many EW mission areas, the way we protect large aircraft is entering a new era. After decades of focusing almost exclusively on self-protection strategies, large aircraft survivability in the future will depend on many offboard resources that provide situational awareness, dynamic mission planning, support jamming and even fighter escorts. As threat technology continues to evolve, major EW systems houses are focused on developing survivability solutions that can be fielded ahead of those threats.