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SEMINAR GUIDE

4th MILITARY ELECTRONICS SEMINAR

November 16-17, 2015 I METU CCC , Ankara TURKEY

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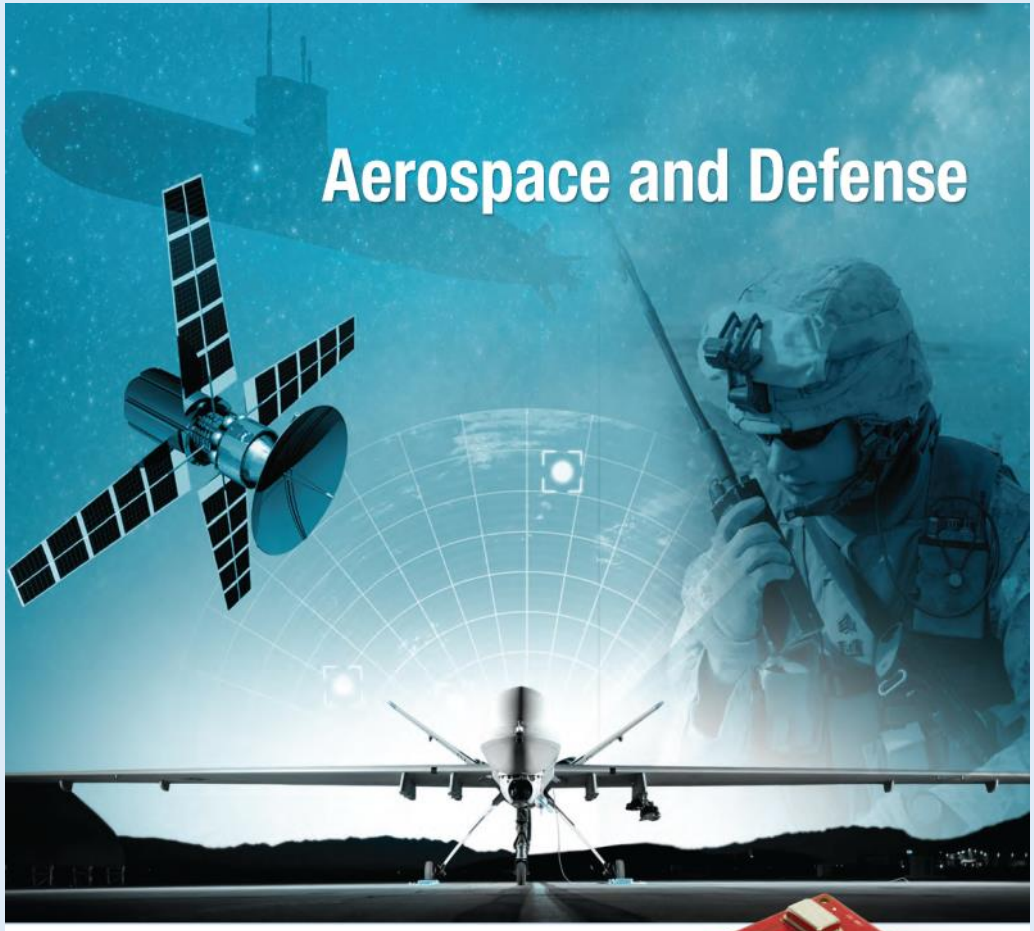

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Nov 16 : SESSIONS

12 WORKSHOPS

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21 SHORT COURSE
Introductory DO-178C

Nov 17 : SESSIONS

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Advanced DO-178C

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37 COMPANY PROFILES

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OPENING PROGRAM

08:00 Registration

09:00 - 09:30 Visiting Exhibition Area

09:30 - 09:45 Opening at Hall A, Electronics Valley, **Dr. Arif Emre ERKOCA**

09:45 - 10:15 Keynote Speaker : **Mr. Vance HILDERMAN**

Top Five Worldwide Aerospace Trends for 2016

How to Leverage in Turkey ?

Mr. Vance Hilderman has founded several technology companies operating throughout the aerospace world, and is a frequent traveler to Turkey for professional and personal pursuits. He firmly believes Tur-key is exceptionally well-positioned for exceptional aerospace and business success thus travels to Turkey frequently to continuously engage with multiple Turkish aerospace leaders. The best solutions result from solving challenges, and challenging times yield the best solutions. Holding a BSEE and MBA from Gonzaga, and a Masters in Computer Engineering from USC (Hughes Fellow). Mr. Hilderman was previously the founder of TekSci (the world's largest avionics software services company), HighRely Incorporated, and Afuzion Inc – performing technical aviation development at all companies.

Mr. Hilderman has focused on safety-critical avionics software, systems, hardware de-velopment and related technical products for 25 years.Considered an expert on safety critical software/ computer systems and certification, Mr. Hilderman has consulted with ninety five of the world's one hund-red largest aerospace companies plus numerous medical, industrial and telecommunications entities. As CEO of several aerospace technology companies, Mr. Hilderman has consulted for 95 of the world's 100 largest aerospace corporations. He and his employees provide a variety of services including training, mentoring, auditing, outsourcing, and sales optimization services. Mr. Hilderman engages in conference speaking for multiple organizations including the world's largest professional speaking organization, "ToastMasters International",with 330,000 members worldwide. Mr. Hilderman has a passion for business and leveraging technology success worldwide, belie-ving there is always a "win/win" solution for high-integrity companies and individuals.

10:15 - 11:00 **New Product Introductions** :

It is a premium platform where companies promote the latest and greatest new high-tech products and services coming to market for the current year.

4th MILITARY ELECTRONICS SEMINAR

METU, CCC – Ankara, Turkey

PROGRAM

NOVEMBER 16, 2015

WORKSHOPS pages : 12-15

11:00-11:45 High Performance Accelerometers for Navigation and Tactical Applications,
Mr. Rabi Sankar SWAIN, INNALABS, HALL A

11:45-12:30 Electromagnetic Shielding-Tent Solutions-
Mr. Ivano SOLIANI, SOLIANI EMC, HALL A

13:45-15:15 ADI Mil & Aero solutions + High Speed RF Convertors
Mr. Jon BENTLEY, Mr. Kağan KAYA, ANALOG DEVICES, HALL A

15:45-17:15 RF/Microwave amplifiers for Military Applications. How to choose and use them/Biasing of RF Amplifiers,
Mr. Jon BENTLEY, Mr. Kağan KAYA, ANALOG DEVICES, HALL A

SHORT COURSE : 09:00-17:15 HALL C
Introductory DO-178C, Mr. Vance HILDERMAN, AFUZION

PRESENTATIONS pages :16-19

11:00-11:45 Migration from Analogue to Digital HD video in Defence and Aerospace Applications, *Mr. Simon HARRIS, PHOTOSONICS, HALL B*

11:45-12:30 Return on Experience of Certifiable Software Development with regard to DO-178C using ANSYS SCADE Solutions,
Mr. Amar BOUALI, ANSYS-ESTEREL HALL B

13:45-14:30 Aerostat Based Low Cost Surveillance Solutions
Mr. Nezir ERTÜRK, OTONOM TEKNOLOJI, HALL B

14:30-15:15 MIL-STD 810 FUNGUS TEST
Ms. Zeynep ÖKTEM, NANOBIZ, HALL B

TALK WITH MR. GÜRKAN ÇETİN 15:45-17:15 HALL B
ANKA S, ODTÜ HUT

NOVEMBER 17, 2015

WORKSHOPS pages : 24-26

09:00-09:45 INTRODUCTION to DO-254 & BEST PRACTICES
Mr. Vance HILDERMAN, FUZION, HALL B

09: 45-10:30 DO-178C and DO-254 Workflow with MathWorks Toolchain
Mehmet Can ERDEM, FİGES, HALL B

11:00-11:45 Saving weight and space through HUMS integration into crash recorder designs ,
Mr. Paul HART, CURTISS WRIGHT, HALL A

13:45-15:15 High Performance CVG for Tactical and Stabilization Applications,
Mr. Rabi Sankar SWAIN, INNALABS, HALL A

SHORT COURSE : 09:00-17:15 HALL C
Advanced DO-178C, Mr. Vance HILDERMAN, AFUZION

SHORT COURSE : 09:00-17:15 HALL D
DC to LIGHT, Mr. Johannes HORVATH, ANALOG DEVICES

PRESENTATIONS pages :27-31

09:00-09:45 Miniature Integrated Telemetry Systems – Fixed or Modular ?
Mr. Gavin GREGAN, CURTISS WRIGHT, HALL A

09:45-10:30 Airborne Telemetry Transmitters for Missile, Rocket, and UAV Applications
Mr. Phil Tannenholz, EMHISER, HALL A

11:00-11:45 The Advantages of VNX (VITA 74) Technology for Deploying Small Form Factor Systems", Mr. Mark ELLINS, CREATIVE ELECTRONIC SYSTEM, HALL B

11:45-12:30 Continued Airworthiness and Usage Monitoring Solutions
Mr. Gavin GREGAN, CURTISS WRIGHT, HALL A

11:45-12:30 Smart Security and Surveillance System, Dr. Cengiz ERBAŞ, ASELSAN, HALL B

13:45-14:30 The Military Internet of Things (IoT), Mr. Yavuz KORUCU, TEKTRONİK, HALL B

14:30-15.15 Customized Shielding Solutions EMC and RFI and common mistakes,
Mr. Ivano SOLIANI, SOLIANI EMC, HALL B

PANEL : 15:15-17:15 HALL B
UNMANNED SYTEMS, Prof Dr. Kemal LEBLEBİCİOĞLU

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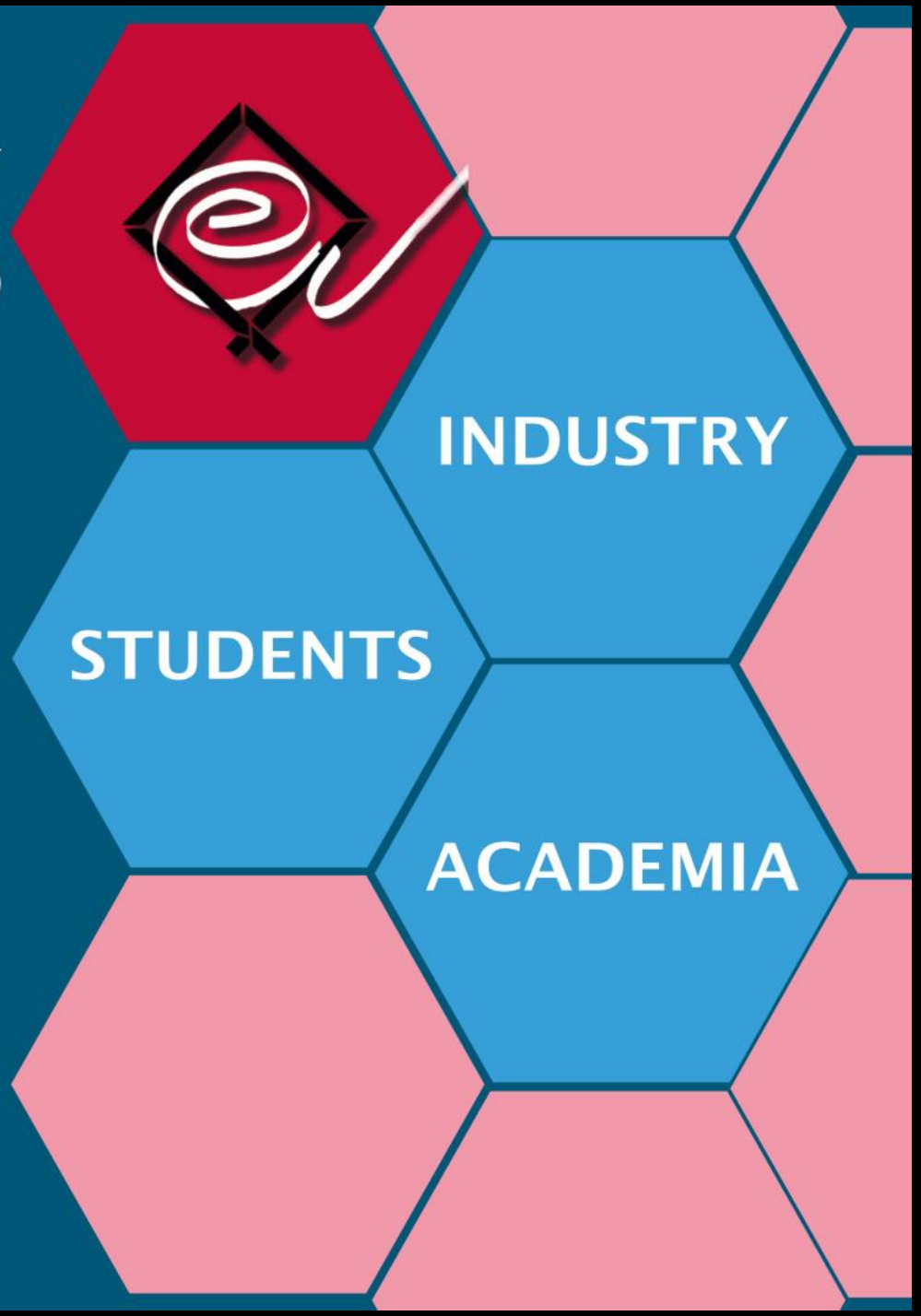

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Nov. 16, 2015 **WORKSHOP** **11:00 - 11:45 HALL A**

High Performance Accelerometers for Navigation and Tactical Applications

Rabi Sankar SWAIN, Application Engineer

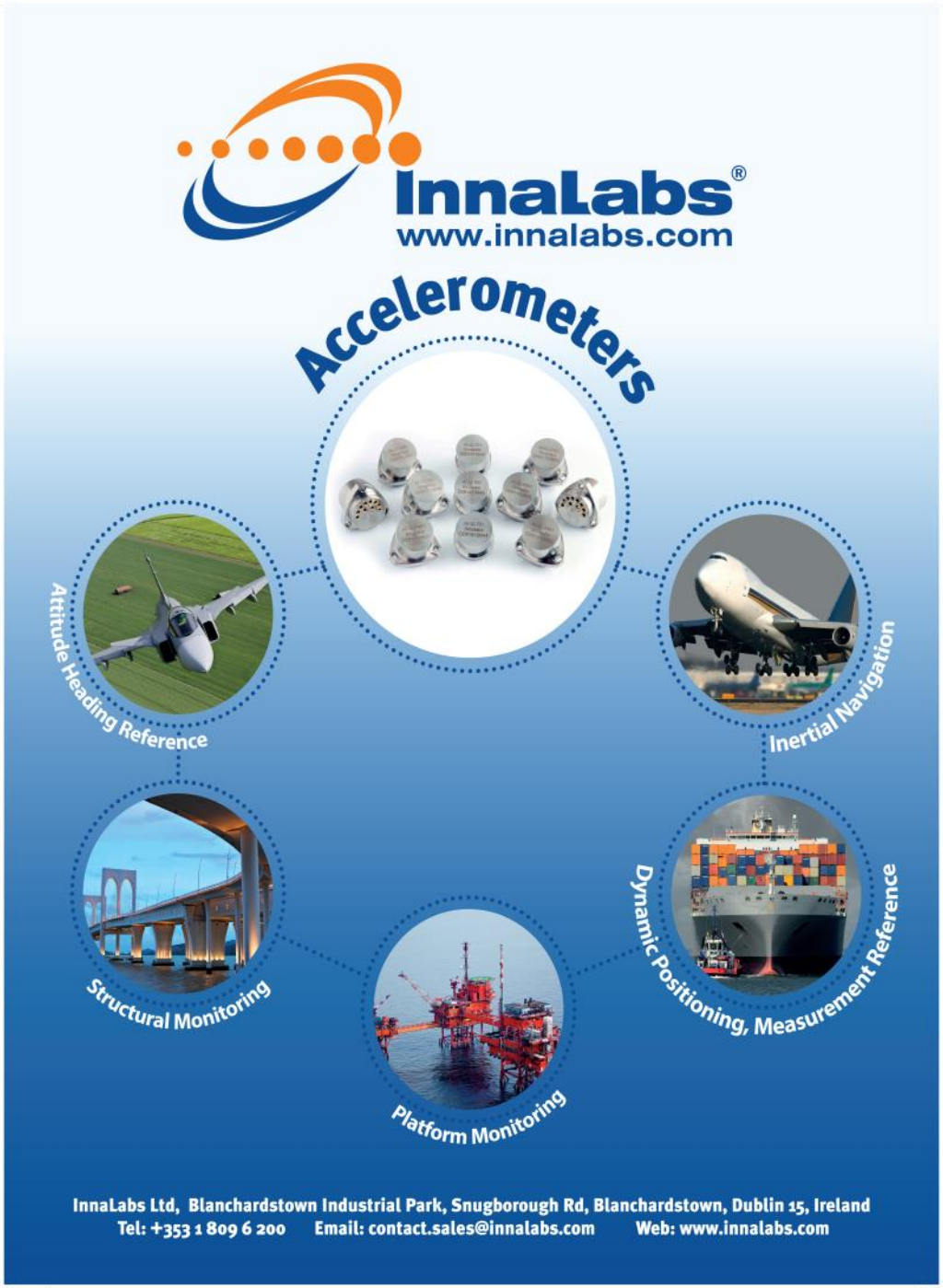
This presentation focusses on the key features of accelerometers which are integrated into navigation, guidance or piloting systems operating under stringent conditions, at sea, on land or in air. These robust systems should provide years of reliable service, typically over the full-life-cycle, given proper installation, use and environmental conditions. When choosing or using a navigation/tactical grade accelerometer performance specifications such as accuracy, stability and linearity should be considered by sensor designers, system integrators and OEMs. To date, the Quartz Pendulous Accelerometer technology is the most widely used for high grade navigation applications because of its ability to meet demanding requirements imposed by such systems and its relative ease of manufacturability.

InnaLabs® Ltd is an Irish company based in Dublin which designs and manufactures **ITAR-free** ***high performance inertial sensors, including tactical grade Coriolis Vibratory Gyroscopes and navigation grade, Quartz Servo Accelerometers***. InnaLabs® offer solutions for the aerospace, subsea, marine, space, energy, civil engineering, transportation and industrial markets. The company has recently completed the development of a range of specialist precision Quartz Pendulous Accelerometers which are today used in a variety of navigation and tactical applications.

After a brief description of the basic physical principles and an overview of the key manufacturing processes developed by InnaLabs®, this presentation provides some results recorded on the AI-Q-2010, AI-Q-1410 and AI-Q-710 accelerometer variants. Some key performance parameters are presented, such as the bias and scale factor stability over temperature and over time, the short-term bias stability (measured using the Allan variance method), the output noise, and the sensitivity to shock and vibration.

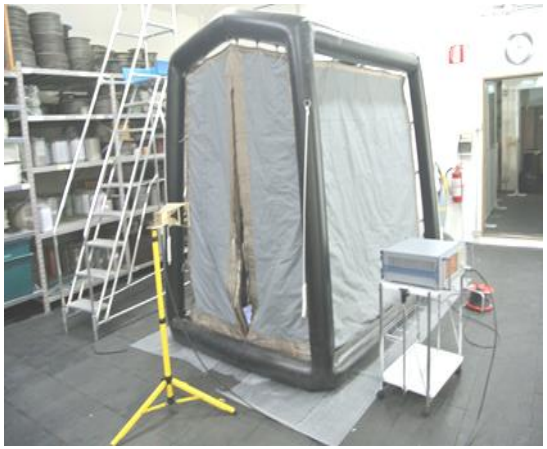
These results demonstrate the capabilities of the InnaLabs® Quartz Pendulous Accelerometer range. These products provide a European source of high grade accelerometers for applications requiring navigation and tactical grade performance.

Engineers who design and implement inertial sensors, controls engineers, system integrators, OEMs, experts in navigation, stabilization, airborne, land, and marine systems are welcome to attend this seminar presentation.



ELECTROMAGNETIC SHIELDING- TENT SOUTIONS -

Ivano SOLIANI, President & CEO



Iveco Lince with jammer protection

SOLIANI EMC utilizes the top-notch techniques in metallization to produce conductive textile of many different kinds. The realization of this technology results in multitude of products including but not limited to EMI/RFI shielding gaskets, EMI/EMC sealed gaskets, conductive paints, EMI shielded windows, air vents, bellows, doors, ... etc. Being applied to the walls, these conductive fabrics are also used to electromagnetically shield the rooms. For several military applications, SOLIANI EMC also offers complete TENT SOLUTIONS to create a perfectly EMI/EMC shielded environment for the use of military personnel. These can also fit in existing tents which have already been used in the field.

SOLIANI EMC products provide superb results in a wide spectrum of frequencies ranging from 10 MHz to 18GHz, achieving even an attenuation level of 75dB in the electromagnetic field strength. The EN 9100 certification "Quality Management Systems - Requirements for aviation, space and defense organizations " is a further recognition for the company and the staff.

In this workshop, Mr. Ivano SOLIANI, the founder of SOLIANI EMC, will discuss all aspects of this unique EMI/EMC Shielding technology with a special emphasis on TENT SOLUTIONS, possessing below mentioned features :

- Flexible, light weight, inflatable, expandable structure, ...
- Installation inside an existing structure (room, tent, truck, ...) without creating a visual appearance from outside.
- Durability and stable surface resistivity against folding actions
- Honeycomb air ventilation system
- Installed Filter line , telephone filter and fibre optic connections

SOLIANI EMC SOLUTIONS are being used in

- Military Applications : Thales Space , MBDA , Selex, Iveco (military vehicle) and some other military applications (replacing shelters)
- Aerospace and Aviation Applications : AIRBUS A400 M , Alenia Aermacchi 346 , Agusta Westland and TAI
- Electronics Industry : TELECOM in Italy, Ericsson
- Medical Applications : General Electric
- Automotive : BMW and Williams

Vast number of sample conductive textiles will also be showcased during this workshop and the participants of this workshop will have a chance to compare different solutions for their electromagnetic shielding needs. Military personnel, avionics engineers, design engineers and EMI/EMC professionals are strongly suggested to attend this 45-minute long workshop.

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RF SIGNAL PROCESSING

Jon BENTLEY, Segment Regional Marketing Director, Industrial & Instrumentation

Kağan KAYA, Applications Engineer, RF/Microwave Group

Section 1: 13:45 - 15:15 HALL A

ADI Mil & Aero solutions + High Speed RF Convertors

This session will cover Analog Devices strategy for Aerospace and Defense and provide an overview of our focus applications and technologies that bring value to these applications using specific examples. With the recent acquisition of Hittite Microwave comes a broad portfolio of RF and microwave components many of which help solve design challenges in the fields of Radar, Military Communications and Electronic Warfare.

We will discuss about signal chain examples for these applications together with the value proposition where high performance products from our RF portfolio together with new very high speed converter technology from our high speed converter organization assist designers in designing their solutions.

Section 2 : 15:45 - 17:15 HALL A

RF/Microwave amplifiers for Military Applications.

How to choose and use them/Biasing of RF Amplifiers

RF Amplifiers are crucially important in T&M and MIL systems. Choosing the right Amplifier for requirements is challenging, which consists of tough trade-offs, proper understanding of system requirements and amplifier capabilities.

In this session, we will go through on main topics that RF System Designers deal with, when they use RF Amplifiers. We will underline basic state of the art performance parameters of ADI RF/uW amplifiers and understand the challenges faced during integration of amplifiers to transceiver systems.

The topics will be covered in this session are listed but not limited to, RF Power Amplifiers in the signal chain

- ADI RF/uW amplifier product variety
- Brief description of important performance parameters for RF Amplifiers, how to choose appropriate amplifier
- The advantages and limitations of various types
- How to bias RF Amplifiers
- ADI Active Bias Controller Products for biasing RF Amplifiers

Migration from analogue to digital HD video in defence and aerospace applications, discussion on the advantages and challenges facing users

Simon A. HARRIS, Director
simon.harris@photo-sonics.co.uk

In this presentation we talk about traditional analolgue video cameras and recording practices and how migration to digital high definition cameras may not guarantee a better overall imaging solution. We introduce common HD image formats and how the recording process can effect the overall image quality. Modern compression CODECS are also discussed and how this poses challenges when inserting time and other data onto HD video. Finally, we show how high performance HD video inserters and recorders solve these challenges and the advantages they can offer the Aerospace or Defence test engineer.

Return on Experience of Certifiable Software Development with regard to DO-178C using ANSYS SCADE Solutions

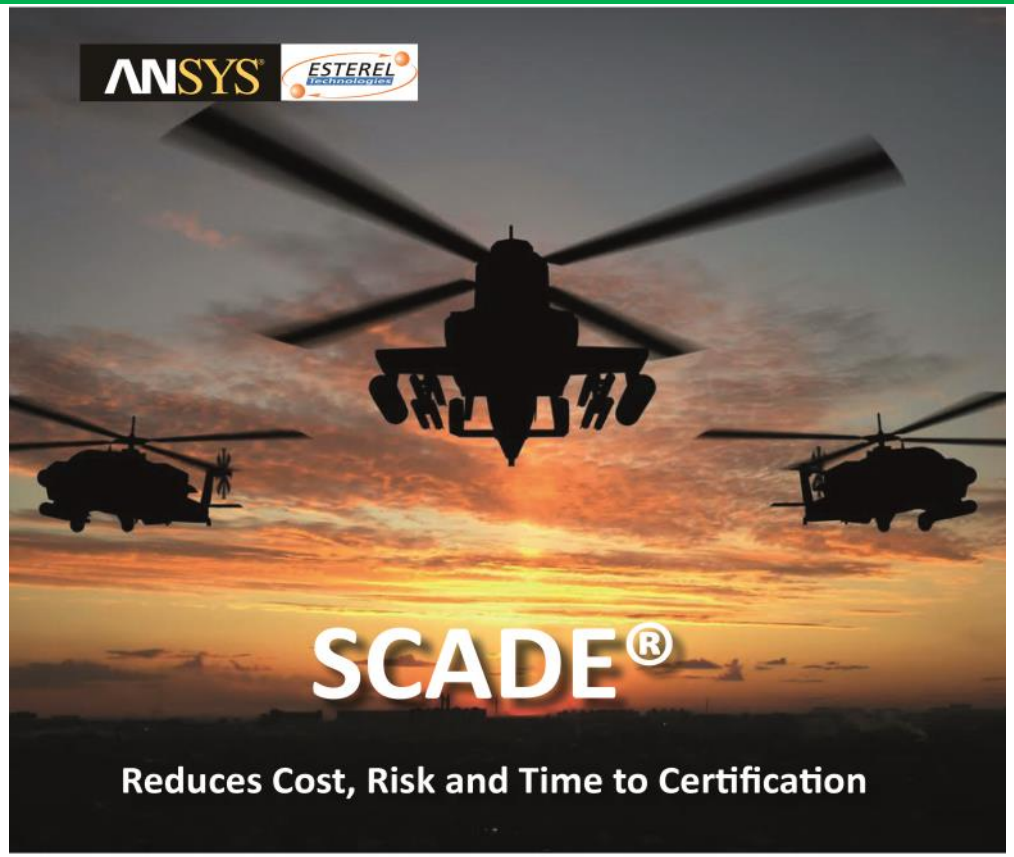
Amar BOUALI, VP Sales South-Europe, Turkey
MEA - ANSYS Systems Business Unit

amar.bouali@ansys.com

For more than 15 years, ANSYS SCADE solutions have provided a complete model-based framework to efficiently develop critical embedded systems meeting the requirements of safety standards from different industries. SCADE's automatic code generation technologies for control and graphical software have been qualified at the highest level of safety across 6 market segments by 10 safety authorities, worldwide.

In aerospace and defense, there are more than 100 DO-178B equipment certifications of which 60 are already flying, facing multiple certification authorities (FAA, EASA, Transport Canada, ANAC, CEAT, CAAC). Today, SCADE is the first model-based code generation technology with a complete DO-178C qualification kit as Criteria 1 tool (DO-330 TQL-1).

The presentation will share the latest return on experience using ANSYS SCADE in on-going programs with DO-178C certification for the embedded software. It will highlight the key benefits of the technology with regard to managing system complexity efficiently and reducing costs of software development and certification.



SCADE® Model-Based Development Solutions for AEROSPACE & DEFENSE

SCADE Product Family is a formal, comprehensive, industry-proven solution for developing critical systems and software, supporting the entire development workflow, from requirements analysis and design through verification, implementation, and deployment. SCADE solutions easily integrate, allowing for development optimization and increased communication among team members.

Esterel Technologies provides production proven, model-based development solutions for critical systems and software engineers that reduce cost, risk and time to certification. Esterel Technologies' industry leading products have been qualified by the FAA, EASA, CAAC, Transport Canada, and ANAC for DO-178B & C up to level A for over 100 systems on more than 50 aircraft programs.

www.esterel-technologies.com

Aerostat Based Low Cost Surveillance Solutions

Nezir ERTÜRK, President & CEO

DORUK

MiniSteer

One of the common requirements of today's security systems is high quality, integrated and persistent surveillance. Airborne platforms have major advantages over others due to extended surveillance range resulting from their higher operating altitudes. On the other hand hourly operating costs of these systems usually restrict their wide use in security systems. Aerostats (tethered balloons) offer an unrivaled cost-efficient solution for the persistence surveillance of certain areas, e.g. land and sea borders, military posts, critical facilities, harbors etc. Advances in sensor technologies and lightweight electronics are leading the development of aerostat based low-cost and high capable surveillance platforms.

Otonom Teknoloji provides two different indigenous aerostat platforms, namely Doruk and Dolunay. Doruk has high wind resistance at different altitudes from 300m up to 1.000m. Dolunay is a compact aerostat platform that can be operated from small and restricted areas. Dolunay can reach up to 500m AGL (above ground level) and can carry various payloads starting from 10kg. Otonom Teknoloji uses an in-house developed unmanned and autonomous generic control unit, MiniSteer, to control different airborne platforms including Doruk and Dolunay. MiniSteer is a modern electronic unit powered by Xilinx SoC (System on Chip) technology. This light-weight but high throughput hardware is accompanied by a modular software architecture based on JAUS (Joint Architecture for Unmanned Systems) standard and an operator friendly Ground Control Unit.

Otonom Teknoloji developed a low cost surveillance solution with electro optic sensors to be used in aerostat platforms. The solution utilizes hardware and software capabilities of MiniSteer, which senses position, heading and attitude of the aerostat platform using embedded satellite navigation and inertial sensors. All movements of the airborne platform are measured precisely and COTS E/O sensor is positioned and directed to align these movements. Otonom Teknoloji used its knowledge on aerostat platforms and developed a surveillance solution that can mimic the capabilities of higher end E/O payloads at a fraction of their costs. This solution enables the end user to select its own PTZ (pan, tilt, zoom) sensor based on its specific needs and converts it into a higher-end sensor with geo-lock, area search and upcoming moving target indicator functionalities.

Otonom Teknoloji is currently working on to further improve the surveillance capabilities of its aerostat and airship platforms. The new features will include the acoustic sensing and fusion of multiple payload data at the airborne platform to increase the platform functionality while reducing the operator workload. Otonom Teknoloji is willing to collaborate with industry and research organizations to better utilize these low cost airborne platforms for various needs including communications, intelligence, surveillance, reconnaissance and more.

MIL-STD 810 FUNGUS TEST

Zeynep ÖKTEM , Co-founder,
Shareholder & General Manager

FUNGUS TEST as one of the MIL-STD 810 Environmental condition tests

The purpose of FUNGUS TEST, being one of the MIL-STD 810 environmental condition tests is to detect, whether fungus (mold) grows on important military and civilian equipment under controlled environmental conditions and whether the fungal growth affects the functionality of the equipment.

Fungi are resistant organisms to the environmental conditions because of their structure, they can grow on many materials from fabrics that we use in everyday life to more important mechanical parts, which can endanger human life in case of operational disfunction. Fungal growth on materials has very different effects. These effects can range from the appearance and bad odor to the loss of function (conductivity, insulation, etc.) because of fungal growth on the material, or the erosion of the material by growing fungal colonies on the material.

Mil-Std 810 Fungus Test in Projects Carried Out Within the Scope of the Defense Industry

Spores of fungi are possible antipersonnel biological weapon agents due to their stability, ease of manufacture, and ease of dissemination in aerosol form. In hot and humid environments, fungus can cause equipment damage and create a health liability. Fungi can degrade products, causing them to malfunction:

- Fungi can degrade gaskets, O-rings, paint, and other components
- Fungi can overgrow a surface such as on a filter and affects its function
- Fungi can short out electrical circuits

Therefore, Fungus Test according to MİL-STD 810 is important to determine if materials or surfaceswill support fungal growth.

Fungus Test for the projects within the scope of the defense industry is carried out with the technological infrastructure and specialized personnel of NANObiz and according to the internationally recognized standard of MIL-STD-810, Method 508.7

NANObiz is the first and only accredited independent laboratory that provides MIL-STD 810 Fungus Testing Services within the quality standards of TS EN ISO/IEC 17025-General Requirements for the Competence of Testing and Calibrating Laboratories. Accreditation is given by TÜRKAK (Turkish Accreditation Agency), so that TURKAK Accreditation supports the reliability and validity of test reports prepared by NANObiz. TURKAK accreditation has domestic and international recognition.

ODTÜ METU

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ODTÜ HAVACILIK VE UZAY TOPLULUĞU

ELECTRONICS VALLEY

EUROAVIA ANKARA

Gürkan Çetin

Gürkan Çetin received his BS degree from the Aeronautical Engineering Department of the Istanbul Technical University in 2002 and his MS degree from the Istanbul Technical University in 2006 where he concentrated on Aircraft and Aerospace Engineering. He worked on the aerodynamics of helicopters and small unmanned helicopters in France EADS in 2004, and at ITU ROTAM between 2005 and 2006. He started his career as a design engineer on the ANKA Project in TUSAŞ Flight Sciences Group in May 2006 After leading the General Design group, he was assigned to the Chief position of the ANKA Aircraft Project in 2011. Since 2014, Mr. Çetin continues to work on the product management of the ANKA-S Project as the Chief of the ANKA Aircraft.

ANKA-S Project

Within the ANKA-S Project which was signed in 2013, various improvements such as satellite communications capability, radio relay, remote command capabilities have been integrated to the ANKA UAV system after it has successfully completed its flight tests. The required design process for starting mass production of the ANKA-S Project was completed successfully. The manufacturing and system integrating operations are going on without interruption. Flight tests will start to be performed in 2016. In this seminar, the ANKA UAV System and the Aircraft will be introduced and experience gained during the development process will be presented.

ODTÜ HUT

ODTÜ HUT is a student community established in the Middle East Technical University. It aims to contribute to amateur aviation and space science activities and to build a bridge between the aerospace industry and students. ODTÜ HUT is also a member of EUROAVIA (European Association of Aerospace Students) as AS ANKARA.

SHORT COURSE- INTRODUCTORY DO-178C FOR ENGINEERS

November 16, 2015, HALL-C, METU CCC

09:00 – 17:15, with a break from 09:45 – 10:45 due to Seminar Opening Session

Avionics system world-wide are now mandated to follow "DO-178C" for literally all phases of development: Safety, Requirements, Design, Code, Test, Quality Assurance, etc. The new DO-178C was introduced in 2012, but the predecessor versions began in the 1980's. Growing from 100 to over 600 pages, this new DO-178C seems complex to follow but almost all aircraft flying today must comply with it: commercial and military planes, UAV's, and rotorcraft. First-time users often complain of costs and schedules doubling while trying to comply. But is DO-178C really complex? What are the true meanings of DO-178C? How can DO-178C be understood and applied cost-effectively the first time? What are the top mistakes when starting DO-178C projects and how to avoid them?

What are the best practices for avionics requirements, design, code, configuration management, test, QA, and certification? All of these topics are explained in this fast-paced Introductory DO-178C one-day session. The teacher is the author of the world's best-selling book on DO-178 and has taught over 9,500 avionics engineers and managers worldwide, including over 500 engineers from fifteen companies in Turkey.

KEY FEATURES:

- Understanding DO-178C's basic principles: DO-178C explained for the "real world": yours
- Understanding DO-178C's true intent by understanding the original authors' goals
- Understanding the avionics development ecosystem of Safety, Software, Hardware and Certification
- Understanding DO-178C's true intent by understanding the original authors' goals
- Think like a DO-178C auditor and pass audits the first time
- Common DO-178C initiation mistakes: from beginner to intermediate quickly

Attendees may include engineers, managers, quality assurance or certification personnel; no DO-178 expertise required.

Please contact Gülperi GÜLŞEN
for reservation and payment
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gulperi@elektronikvadisi.com.tr

Mr. Vance Hilderman

Mr. Vance Hilderman is Afuzion Incorporated's Avionics Certification Manager and has worked with many Turkish aerospace companies on his twenty business trips to Turkey the past decade.

- **BSEE, MSEE, MBA**
- **Founder of two of the world's largest avionics developmentservices companies**
- **Developer of the world's first training in DO-178 and trainer of over 9500 engineers in 45 countries in DO-178, DO-254, DO-278, and DO-200A**
- **Primary author of the world's first, and best selling, book on DO-178 and DO-254 (available at most major bookstores worldwide)**

THE UNMANNED SYSTEMS EXPO 2016

The Unmanned Systems Expo
February 2 – 4 2016
World Forum
The Hague
The Netherlands

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TUSExpo is the dedicated international business platform for the unmanned system industry. It's unique in connecting both European and global companies from the entire supply chain from manufacturers, to component suppliers and end users. In this way TUSExpo supports sales opportunities and new international cooperation in the unmanned industry.

Why exhibit?

- High and global marketing exposure through media and association partner network
- Business opportunities with the presence of all unmanned domains: Air, Ground, Water, Space and Robotics
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TUSExpo is:

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www.tusexpo.com

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- Over 1.500 attendees from 69 countries
- 95% of attendees coming from Europe
- High profile: over 75% of attendees are decision makers
- 63 international media partners
- More than 14 industry partners: The Hague Security Delta, UAS Denmark, UAS Norway, BeUAS, Enterprise Europe Network, EARSC and more
- 90% of 2015 exhibitors will join next 2016 edition

Exhibitor Profile

All segments of the unmanned industry and their entire supply chain will be represented:

- Air
- Water
- Ground
- Space
- Robotics

Please visit **www.tusexpo.com/whyexhibit** for a full exhibitor profile.

Visitor Profile

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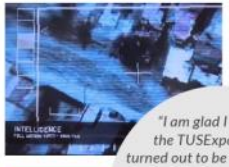

"I am glad I attended the TUSExpo 2015. It turned out to be a good way to gain insights into the UAV sector and meet the right people. I will definitely be attending next edition."
Mr. C. de Graaff

'It was a very successful event for Aerialtronics, with some quality meetings and a very strong PR & Marketing impact for us and the UAV market place. Particular pleasing was the International visitors that came over'
Mr. J. Wigmore, CEO, Aerialtronics

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09:00 - 09:45 HALL B

Introduction to DO-254 & Best Practices

Vance HILDERMAN, Avionics Certification Manager

Avionics hardware is increasingly complex and must follow a defined planning, development, and verification standard named DO-254 / ED-80. Partially copied from avionics software's DO-178/ED-12, DO-254 is a rapidly growing and increasingly important criteria necessary to certify avionics hardware. Previously applied only to commercial aircraft, DO-254/ED-80 is now being required for military aircraft and UAV's. This fast-paced workshop summarizes DO-254, its differences with DO-178C, common mistakes, forthcoming changes, and Best Practices.

09:45 - 10:30 HALL B

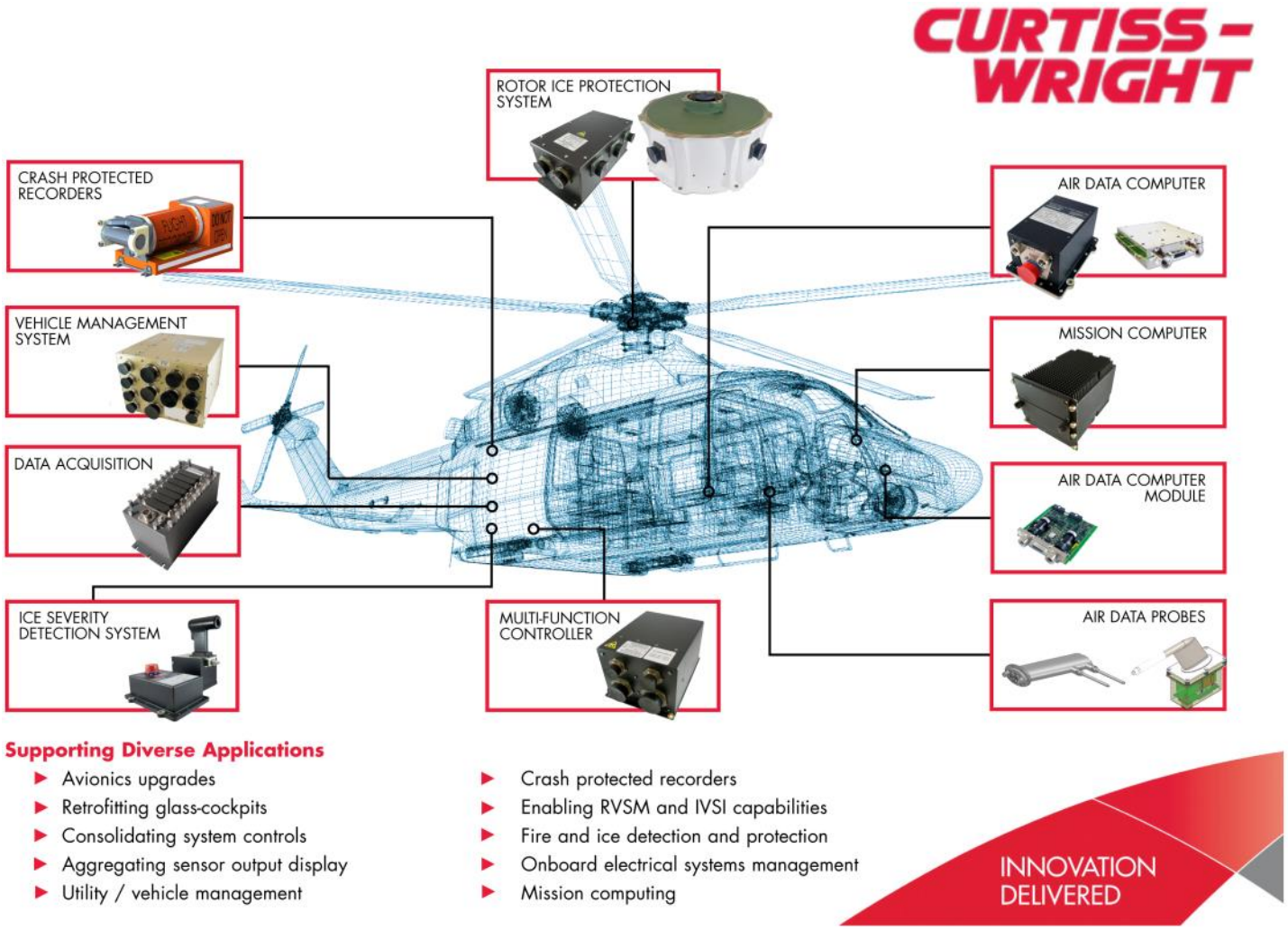
DO-178C and DO-254 Workflow with MathWorks Toolchain

Mehmet Can ERDEM, Embedded Systems,
Verification & Validation Team Leader

The Society of Automotive Engineers (SAE) developed the ARP 4754 standard in 1996 to provide guidance on how system level requirements are decomposed into software (governed by DO-178B) and hardware (governed by DO-254). DO-178B lacked guidance on modern development and verification practices such as Model-Based Design, object-oriented technologies, and formal methods. The core DO-178C document is a relatively minor update to the previous DO-178B standard, but the technology supplements nevertheless provide new guidance in how to adapt these modern technologies on a DO-178C project. Model-Based Design supplement guide DO-331, introduces two important techniques: simulation and model coverage analysis, that may be used to satisfy objectives for design models.

Model-Based Design with automatic code generation is considered as an important and established technology for developing high-integrity embedded systems. MathWorks provides an integrated set of qualifiable verification and validation tools to support these activities. One of the strengths of Model-Based Design is that it can be applied on both software and hardware projects which lets system, software, and hardware engineers collaborate using the same tools and environment to develop, implement, and verify systems.

This workshop intends to present a workflow demonstration which includes all of the steps necessary to help achieve compliance to standards DO-178C and DO-254 with MathWorks toolchain both in model and in software/hardware level.



Saving weight and space through HUMS integration into crash recorder designs

Paul HART , Chief Technology Officer

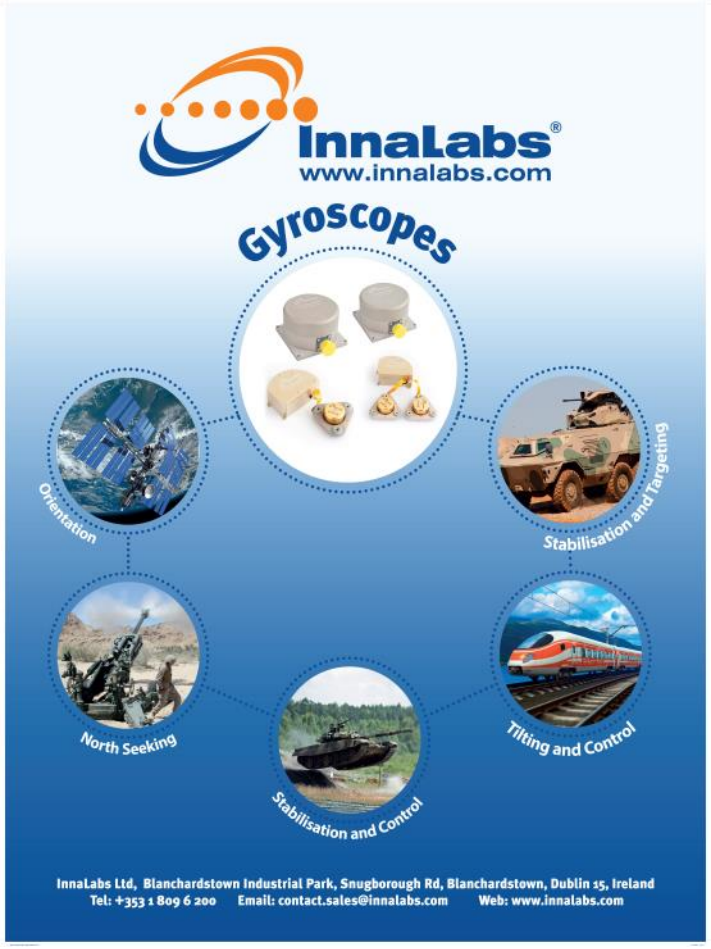
Crash survivable flight data recorders (FDR) have been used for decades to provide accident investigators with vital information to help them discover the cause of an incident and to help the industry improve safety. Modern FDRs contain increasing powerful processing capabilities and storage capacities designed to capture up to 25 hours of voice and flight data. Architectures are being implemented that are based on the concept of individual recording functions being housed within one enclosure using modular boards to support different interface standards and additional data acquisition capabilities.

With such technological advances, there is now the possibility of using FDRs for more than just meeting mandatory recording requirements. Aircraft system designers are continually looking for ways to reduce the size and weight of avionics equipment – this is especially true for rotorcraft which are increasingly using FDRs and Health and Usage Monitoring Systems (HUMS) to increase safety and operational performance. This paper details the development of a FDR that contains a sophisticated HUMS to dramatically save weight and space onboard aircraft without sacrificing FDR or HUMS functionality.

Avionics engineers, Aviation Professionals and Aircraft System Designers are strongly suggested to attend this 45-minute long workshop.

High Performance CVG for Tactical and Stabilization Applications

Rabi Sankar SWAIN, Application Engi-



This presentation focusses on the key features of Coriolis Vibratory Gyroscopes (CVG) which are integrated into attitude control and navigation systems, motion control systems and stabilization systems operating under stringent conditions, at sea, on land or in air. These robust systems should provide years of reliable service, typically over the full-life-cycle, given proper installation, use and environmental conditions. When choosing or using a gyroscope focussed on fulfilling the operational requirements of inertial systems seeking for tactical grade performances, specifications such as low output noise, low bias error, large bandwidth, linearity, accuracy, small size, low weight, robustness and high reliability should be considered by sensor designers, system integrators and OEMs. CVG technology is the most widely used for tactical applications because of its ability to meet demanding requirements imposed by such systems and its relative ease of manufacturability which drives low costs.

CVG gyroscopes have not only many advantages over traditional spinning gyroscopes, but also over gyroscopes based on fibre-optic or laser technologies because they have a stronger structure with lower power consumption. They are made of only a few parts whereas conventional gyroscopes have more parts, are cheaper, more rugged and can be mass produced. Micro Electro Mechanical Sensors (MEMS) technology has helped in significantly reducing the size, facilitated easier integration and enabled high volume production resulting in cheaper systems but reduction in size doesn't improve the performance of these MEMS gyroscopes. InnaLabs® CVG gyroscopes are able to fulfil those unmet needs.

InnaLabs® Ltd is an Irish company based in Dublin which designs and manufactures ITAR-Free high performance inertial sensors, including tactical grade Coriolis Vibratory Gyroscopes and navigation grade, Quartz Servo Accelerometers. InnaLabs® offer solutions for the aerospace, defence, subsea, marine, space, energy, civil engineering, transportation and industrial markets. The company has recently completed the development of a range of specialist Coriolis Vibrating Gyroscopes which are today used in a variety of stabilization and tactical applications.

After a brief description of the basic physical principles and an overview of the key manufacturing processes developed by InnaLabs®, this presentation provides some results recorded on the GI-CVG-U2x00A, GI-CVG-U1x00A and GI-CVG-U2x00D gyroscope variants. Some key performance parameters are presented, such as the bias and scale factor stability over temperature and over time, in-run bias stability, scale factor linearity, angular random walk, the output noise, and the sensitivity to shock and vibration. These results demonstrate the capabilities of the InnaLabs® Coriolis Vibratory Gyroscope range. These products provide a European source of high grade gyroscopes for applications requiring tactical and industrial grade performance. Engineers who design and implement inertial sensors, controls engineers, system integrators, OEMs, experts in navigation, stabilization, airborne, land, and marine systems are welcome to attend this presentation.

Miniature Integrated Telemetry Systems – Fixed or Modular ?

Gavin GREGAN, Area Sales Manager

Miniature Integrated Telemetry Systems – Fixed or Modular?

In modern missile testing there is a continuing trend to integrate data acquisition and telemetry functionality into a single product. Further to this the size of the locations in which the telemetry system can be placed are decreasing, and performance requirements are increasing. This paper discusses the challenges of designing a miniature integrated telemetry system which includes data acquisition, telemetry and power source. Both fixed and modular design approaches are considered. The advantages and disadvantages of either approach are discussed and contrasted.

NOVEMBER 17, 2015

09:45 - 10:30 HALL A

Airborne Telemetry Transmitters for Missile, Rocket, and UAV Applications

Phil TANNENHOLZ,
President of Encore Associates Inc

While the use of Telemetry transmitters in large vehicles, such as manned aircraft or space launch vehicles, is relatively straightforward, the use of telemetry transmitters in smaller airborne vehicles such as missiles, rockets, and UAVs is much more difficult, and requires consideration of many factors before a decision can be made on the proper transmitter to use. This presentation will review those parameters, and discuss the several trade-offs to be made in the selection process. Parameters such as Size, Weight, Power input, Power output, Environmental considerations, Heat dissipation, and VSWR etc will be addressed.

11:00 - 11:45 HALL B

The Advantages of VNX (VITA 74) Technology

Mark ELLINS
Regional Sales Director

The discussion will focus on the new standard called VNX and its advantages for deploying in military applications where rugged and extreme temperatures are key factors. VNX is 1/3 size of VPX based platforms but offers the same level of ruggedness and computing and I/O options. Because VNX is small in size, it can easily be integrated into established equipment such as screens, cameras and other military systems or as a stand-alone system.

11:45 - 12:30 HALL A

Continued Airworthiness and

Gavin GREGAN
Area Sales Manager

The use of aircraft usage monitoring systems continues to grow at a rapid pace as fleet operators seek effective ways of implementing “continuous airworthiness” and “structural integrity” programs. Multiple techniques, applications and abundant generic terminology leads to confusion as to what exactly usage monitoring is, and what particular technique is appropriate in each case. This session will give some definition to the field of usage monitoring, examining the different techniques and what is involved in the implementations.

aselsan

Smart Security and Surveillance System

Dr. Cengiz ERBAŞ
Transportation, Security,
Energy and Automation Systems Business Sector

Recent events, including major terrorist attacks, have lead to an increasing demand for security in society. This in turn is forcing governments to make security a priority in their policies and actions. As a result, the demand for security and surveillance systems is growing in many environments, such as for transportation lines, for energy transmission lines, for urban public places, and for land and maritime borders. Due to its complexity and its non-local nature, it is not conceivable to tackle such threats without receiving significant benefits from technological developments. ASELSAN is developing smart security and surveillance systems primarily (1) to enhance security forces situational awareness, (2) to enable plug-and-play configuration of sensors and platforms to form smart surveillance systems, and (3) to enable real-time information sharing of organizations which have responsibility to respond to crises situations. This presentation will overview ASELSAN's vision, recent technological developments, and products within the areas of security systems.

Dr. Erbaş graduated from the Computer Science and Engineering Department of Hacettepe University. He completed his M.Sc. studies in 1992 and Ph.D. studies in 1994, both in Computer Science from the Southern Methodist University, Dallas, Texas.

Upon completion of his graduate studies, he moved to the Silicon Valley, where he worked for *TRW*, *Wind River Systems* and *Trimble Navigation*., where he managed software engineering teams to develop real-time and embedded systems for high-speed document scanners, for real-time operating systems and for GPS receivers on various embedded platforms. Dr. Erbas joined ASELSAN in 2004. At ASELSAN, he managed numerous image processing and software engineering projects, some of which were funded by European R&D programs. He is currently managing projects within the domain of Security Technologies, where his primary focus is to enhance the existing surveillance systems with smart processing capabilities.

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The Military Internet of Things (IoT)

Yavuz KORUCU, Director of Embedded Systems

In today's connected world with a rapidly growing base of IoT devices, the need for security, safety certification, scalability and virtualization is expanding from optional requirements needed by select industries to a mandatory requirement of all industries when creating next-generation devices. To fully take advantage of the opportunity offered by IoT, Military Electronic Subsystem manufactures must meet multiple challenges like costs, risks, time-to-market.

With this presentation we will look at

- The major characteristics and implementation of IoT in the Military Market,
- How system developers can meet challenges,
- What are the building blocks,
- Use Cases : Situational Awareness, Predictive analytics and Military Cloud

Customized Shielding Solutions EMC and RFI and common mistakes

Ivano SOLIANI, President & CEO

The **SOLIANI EMC** has developed solutions for electromagnetic shielding since 1984.
It's shielding products offer a high degree of protection from electromagnetic interference, allowing the safe operation of facilities and electronic equipments

THE FARADAY CAGE

The specific concept of shielding is related to an easy physical requirement or the concept of Faraday cage or Faraday shield. A Faraday cage or Faraday shielding is formed by conductive material or by a mesh of such material, used to block electric fields. "**Faraday Cage"** is named after the English scientist Michael Faraday, who invented them in 1836.
If we don't take care of this simple idea we can shield nothing, we can only reduce the interference. The concept of "Faraday Cage" is related to the use of electrically conductive materials with a surface resistivity less than 1 ohm square as minimum but today we suggest the surface resistivity of 100 milliohms for the new increasing demand of high frequency range. This limit is also related to the use of the mesh fabric in metal because the holes of the mesh cannot close or cut the frequency range more than 1 MHz and today we have to cover and shield frequency up to 18 GHz and more .

If we assume this reference to consider a shielding properties we can achieve attenuation for different frequency range .It is an important parameter to take care of because we have to consider the open side through which we can enter in the faraday cage. The connections between the inside area of the cage and outside connections are very important. We should also need to ensure the stability of the conductivity surface in the presence of salinity, salt fog or humidity. To be able to obtain better results we must close all points as well to shield the different dB attenuation in all points and in different directions.

After this short suggestion we can start to offer a view of our shielding solutions with some photos …

Fig 1:cabinet enclosure for telecommunication application

Fig 2: inside of the cabinet shielded with gasket EMI RFI and IP.

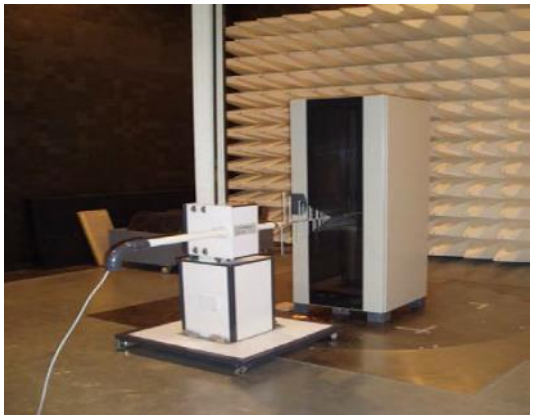

Fig 3: Testing of a cabinet in a shielded room

SHORT COURSE - ADVANCED DO-178C FOR ENGINEERS

November 17, 2015, METU CCC, HALL C

09:45 – 17:15, with short coffee breaks and a lunch break

Since DO-178B was released in the early 90's, the knowledge of software development processes, techniques, and strategies for safety-critical software has vastly improved. In fact, if we had the same problem domain today as we did twenty years ago, we could almost guarantee that software errors could be reduced by over 99 percent. But we do NOT have the same problem domain as twenty years ago. Just as Turkey has advanced, so has the world of aviation software development. Vastly. This advanced DO-178C training workshop will provide the important knowledge for attendees to rise to and understand those advancements.

The solution to successful avionics is software, and that software now has to meet the new standard, "DO-178C"

The trainer at this DO-178C workshop was the founder of two of the world's largest avionics development services companies and has trained over 500 persons in Turkey, but that was primarily for basic DO-178B. The world has changed, because DO-178B could not have foreseen these aviation changes in new development and execution technologies: language advances, modeling advances, certification advances.

Worldwide certification agencies such as EASA and the FAA are staffed with smart, hard-working individuals but typically they have less exposure to recent hands-on software development using these new technologies. These same agencies could see the impending need for adopting new technologies

They formed groups to study these new developments and devise strategies for adoption. They engaged industry experts and technical venues to both gather and disseminate information. They wrote issue papers. They coordinated across oceans. They educated their staff and industry. They adapted. And they knew there was no way DO-178B would survive the continuing technological evolution intact: an updated version, DO-178C, was needed. Thus the basis for this advanced avionics software workshop in DO-178C. This 1-day training is intended for persons with basic familiarity of DO-178B or safety-critical standards. The fast-paced course teaches attendees the true intent of DO-178C and how to apply changes from DO-178B.

EVOLUTION HISTORY

Doc	Year	Basis	Themes
DO-178	1980 - 1982	498 & 2167A	Artifacts, documents, traceability, testing
DO-178A	1985	DO-178	Processes, testing, components, four criticality levels, reviews, waterfall methodology
DO-178B	1992	DO-178A	Integration, transition criteria, diverse development methods, data (not documents), tools
DO-178C	2012	DO-178B	Reducing subjectivity; Allow Supplements for Modeling, OOT, Formal Methods, Tools

Please contact Gülperi GÜLŞEN for reservation and payment
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DC to LIGHT - RF SHORT COURSE

November 17,2015 (09:00—17:15) Lunch 12:30—13:30

METU CCC HALL D

EDUCATION SPONSORS

Section:RF-Basics

With the recent acquisition of Hittite Microwave, Analog Devices now literally offers products that cover "DC to Light". We are going to walk thru the RF signal chain, the discrete components, their important specifications and how to “glue” them together in the signal chain. This course is a review RF conversion technology, and what it requires to keep the quality up high. We will pick a couple of parts and look at them in detail. We end the course with looking at some tools to help in the design and semiconductor selection process.

SectionII:JESD204&Converters

In this course we discover the advantages and disadvantages of the JESD204 high speed serial interface from Converters to FPGAs. We also discuss the FPGA converter, system design/ integration and support offerings from Analog Devices. These are HDL, Evaluation Boards, Simulation Software and Power-Supply solutions. A special section in this course will teach about high speed clocking so we can keep the quality of a conversion between the analog and the digital domain to what the datasheet of a converter specifies.

Section III : The path to build an SDR

We talk about the basics of QAM and the relation to SSB. Basic mathematical model are going to help us, to understand the required hardware. As a reference we talk about a function block diagram build with discrete integrated RF components as Homodyne receiver. Based on this, we learn about the minimum requirements of a SDR. The second part informs about the very latest highly integrated transceiver front-end IC and the extra hardware, which is required to build a full functional, autonomous working SDR. In the last part we will see how the latest Hardware platform works together with the RF Front-end board, based on Open Source OS Linux. It builds an autonomous broad band Transceiver.

Section IV : Radar & pt-pt Radios (1GHz-80GHz)

Radar and Point-Point Radio systems work in the centimeter to millimeter wavelength of radio signal. Components in the analog and the converters to and from the digital domain will be shown in various signal chains. The latest discrete functions like mixer, amplifiers and power amplifiers, switches, attenuators and much more will be mentioned.

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The fees are collected by Electronics Valley. These fees are collected in order to compensate the expenses associated with classroom rentals, equipment rentals, short course material and organization costs, and as such. ANALOG DEVICES Inc. does not claim any portion of these collected fees from the registrants.

ABOUT THE INSTRUCTOR

Johannes HORVATH

Technical Support Manager

ANALOG DEVICES INC

Graduated 1981 From Technical Institute for Telecommunication and Electronics in Austria. Designer for fiber measurement instruments and Videocamera. Joining Analog Devices Austria in 1988 as sales engineer. Since 1993 Field Application Engineer for Austria, Eastern Europe and Russia. Working today as Technical Support Manager, in more then 16 countries. Hobbies:Amateur Radio (OE1JHB), Mountain biking, Catamaran Sailing.

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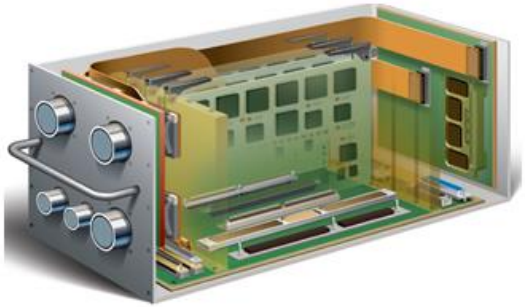

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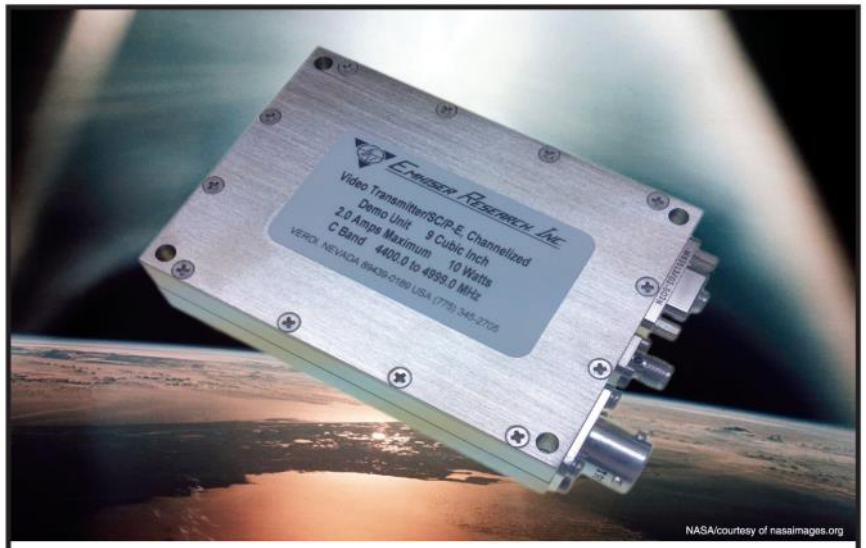

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Afuzion: *When Safety Is Critical* ™

Afuzion Incorporated engineers have been active in Turkey since 2002, and have worked with eight of Turkey's top ten avionics/aerospace companies. Afuzion is an international company, with avionics clients in USA, U.K, Turkey, Canada, China, Australia, Italy, Germany, Spain, New Zealand, Norway, Portugal, and the Middle East. Afuzion partners will local companies to develop best-in-class avionics Training, Development, Testing, and Certification.

Afuzion's founder, Vance Hilderman, founded two of the world's largest avionics services companies and was the primary author of the world's best-selling book on DO-178 and DO-254 avionics software certification. Mr. Hilderman has trained more engineers and managers in DO-178, DO-254, DO-200, and DO-278 that all other trainers in the world, combined. Afuzion's engineers have worked with 95 of the world's largest 100 avionics companies.

Afuzion's engineers specialize in optimizing your avionics engineering development: software, hardware, systems and safety engineering. Afuzion provides training, mentoring, certification, outsourcing, and a ugmentation. Afuzion specialties include:

- Training in DO-178C, DO-254, DO-278, and DO-200A Training
- Avionics Engineering Optimization Workshops & Mentoring in Best Practices
- Avionics software & hardware certification including DER services
- Software verification outsourcing
- Avionics certification to DO-178C DO-254.

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Amphenol is the world leader in the design, manufacture, and supply of high-performance interconnect systems for military and commercial aerospace harsh environment applications. **Amphenol** provides an unparalleled product breadth, from military specification connectors to customized high-speed board level interconnects; from flexible to rigid printed circuit boards; from backplane systems to completely integrated assemblies. Key markets supported are avionics, radar, communications, ordnance, missiles, engines, ground vehicles and tanks, space, and all levels of aviation. **Amphenol** is a technology innovator that designs to meet customers' needs from program inception.

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Amphenol Turkey / Middle East Office coordinates Amphenol activities within the region and operates as a Marketing and Sales office for Amphenol facilities around the world.

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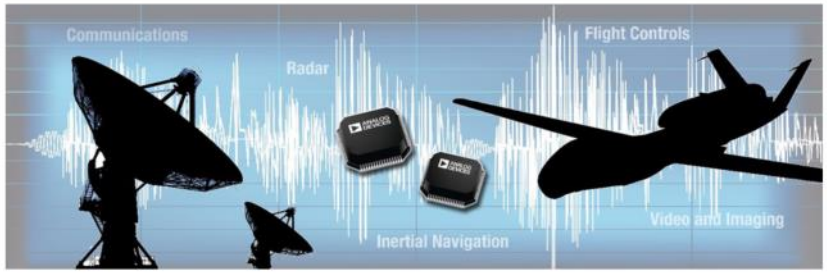
Sales Channels: Arrow, Digi-Key, EBV Elektronik, Elektro Elektronik San. ve Tic. A.Ş, Farnell, Mouser Electronics, Richardson RFPD, Rochester Elec. (Obsolete Products), Silica / Avnet



AHEAD OF WHAT'S POSSIBLE™

ADI enables our customers to interpret the world around us by intelligently bridging the physical and digital with unmatched technologies that sense, measure and connect. We collaborate with our customers to accelerate the pace of innovation and create breakthrough solutions that are ahead of what's possible.

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Mr. Amar Bouali
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Esterel Technologies, a wholly-owned subsidiary of ANSYS, Inc., is the leading provider of critical systems and software development solutions for the aerospace and defense domains. System and software engineers use Esterel SCADE® solutions to graphically design, verify, and automatically generate critical systems and software applications with high dependability requirements. SCADE solutions easily integrate, allowing for development optimization and increased communication among team members.

The SCADE product family includes:

- SCADE System® for System Architecture Design
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SCADE Suite and Display Code Generators have been qualified/certified at the highest level of safety across six market segments by more than ten safety authorities, worldwide, including DO-178B and DO-178C up to Level A - Aerospace and Defense Applications by FAA, EASA, Transport Canada and ANAC.

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Avnet Memec | Silica is the European semiconductor specialist of Avnet Inc., one of the leading global distributors. You may expect state-of-the-art technologies, comprehensive technical support and reliable logistics services of Avnet Memec | Silica as a partner of leading semiconductor manufactures and innovative solution providers over many years. With a team of more than 200 application engineers and technical specialists, Avnet Memec | Silica supports projects all the way from the idea to the concept to production. Fifteen thousand customers throughout Europe are convinced of our service quality – in respect of both technology and logistics, not least because our application engineers focus on solution-oriented „design in" consulting and technical product support.

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Arrow Electronics is a global provider of products, services and solutions to industrial and commercial users of electronic components and enterprise computing solutions, with 2014 sales of $22.8 billion. Arrow serves as a supply channel partner for over 100,000 original equipment manufacturers, contract manufacturers and commercial customers through a global network of more than 460 locations in 56 countries.

A Fortune 150 company with 17,000 employees worldwide, Arrow brings technology solutions to a breadth of markets, including telecommunications, information systems, transportation, medical, industrial and consumer electronics.

Arrow provides specialized services and expertise across the product lifecycle. Arrow does this by connecting customers to the right technology at the right place at the right time and at the right price.

Arrow provides extraordinary value to customers and suppliers - the best technology companies in the world - and connects them through the company's industry-leading services.

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An institution that turns knowledge into power and trust

The Land, Naval and Air Forces Foundations were founded during 1970s with the donations of the Turkish people in order to cover Turkey's military defense needs through national means. ASELSAN became operational in 1970 under the Land Forces Foundation (TAFF). As underlined by the founders of of ASELSAN during the foundation of the company, our basic strategy is to develop unique products and systems by making use of critical technologies.

ASELSAN operates under five business sectors;

- **Communication & Information Technologies Business Sector,**
- **Microelectronics, Guidance & Electro-Optics Business Sector,**
- **Radar & Electronic Warfare Systems Business Sector,**
- **Defense Systems Technologies Business Sector,**
- **Transportation, Security, Energy & Automation Systems Business Sector**

COMPANY PROFILES

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History : Bias Engineering was established in 1997 in order to supply engineering services in Turkey. CAE solutions and test&measurement systems have been added to product portfolio along with the services over the years. In 2007, Test Systems Group has been established to design and manufacture Durability Test Systems mainly for automotive industry. In the same time, test laboratory opened to offer testing services. Today Bias is performing durability tests in the lab and designing custom test systems configured by the customer needs. In 2010, Machinery Group has been established to design and manufacture custom machines mainly for defence and manufacturing industries. Patent pending Bias Multi Servo Press is brought to market. With the strong engineering background and experience, Bias is one of leading engineering companies in Turkey.
Team : Total 50 personnel, (25 engineers + 13 technician) In 3 offices and 2 workshops
Services : Mechanical Design and Prototyping Durability and performance tests Product development and verification
Products : CAE Solutions (MSC Software, Ls-Dyna, Mentor Graphics, nCode etc) Sensors DAQ Systems Fluid Flow Measurement Systems Vibration and Shock Test Systems Durability and Performance Test Systems Servo-Mechanical Press Tranfer Mechanisms
Quality Certificates : ISO 9001:2008 from BSI Test Lab : Approved by TUV-SUD and SGS for 17025.

www.ces-swap.com

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CES designs and manufactures rugged embedded computers engineered to meet the most demanding performance needs for optimal Size, Weight and Power (SWaP) considerations. Our Commercial Off-The-Shelf (COTS) products are made to withstand the extremes of temperature, shock and vibration associated with deployment in Aerospace & Defense as well as Rugged Industrial markets. The ability to deliver products supporting mission-critical or safety-critical functions has created a high demand for our services.

With 30+ years of existence, we leverage our technology expertise and know-how to solve the challenges of today in the following market segments: C4ISR, Rugged Industrial, Commercial Aircraft and Unmanned Vehicles.

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Brady helps you create and maintain safer work environments and comply with regulatory standards. Our high-performance materials clearly identify products, components and other assets, even in the most extreme conditions.

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Cobham Aerospace Communications is the world leader in the design and manufacture of antennas, enabling platforms to communicate with complete confidence on land, at sea, and in the air.
Based on 60 years of experience, Cobham Aerospace Communications designs and manufactures high technology antennas for communication, navigation and surveillance, and data link applications in the world of commercial and military aircraft, space launchers, space satellite, missiles, satellites, infrastructure, tactical mobile ground installations, and naval applications. its antennas are used by customers in more than 100 countries throughout the world.

Always innovating with new technologies, Cobham Aerospace Communications continuously invests to improve performance levels, stealth, reduce weight, drag, and signature.

Cobham Aerospace Communications' top priority is to ensure the highest quality level for its products, as recognized by annual awards received from its major customers.
Airborne: Multiple antennas are supplied by Cobham Antennas for civil and military aircraft to meet VHF, UHF, L-band, Ku-band and Ka-band applications
Land: Cobham Antennas provides a huge range of antennas for fixed, tactical and OTM applications
Space: Cobham Antennas provides a wide range of high-tech embedded antennas for positioning and TT&C
Marine: Robust antennas for naval and commercial vessels

CURTISS-WRIGHT

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Avionics & Electronics is part of the Curtiss-Wright Defense Solutions division and provides system solutions that acquire, consolidate, analyze and record all sensor and avionics data on aircraft. This business group consists of four integrated business units – City of Industry (formerly Autronics US), Penny + Giles (UK), Acra (Ireland) and SES (UK).

CWC-AE invests heavily in research and development to ensure we maintain technology leadership to deliver high performance COTS and custom engineered products. Our core capabilities include certified design and development processes (DO-178 and DO-254) combined with mature quality processes (AS9100). A wide range of product and service offerings enables us to provide solutions for many applications including:

Airborne recording, Aerospace controllers, Air data computing, Flight test, Aircraft ice, fire and hazard systems, Space data handling systems, Ground vehicle computing

Airborne recording applications are served with products including crash protected, mission, flight test and usage data recorders. Scalable and modular data concentrator units are proven for a variety of aerospace controller applications. Highly configurable and reliable air data computing solutions ensure flight safety. Our ice detection and protection systems are designed to operate on a variety of surfaces and allow flight into forecast icing. CWC-AE is also a leading supplier of flight test instrumentation and real-time telemetry systems. Ground vehicles are served with extremely powerful, solid state, processing solutions with market leading environmental specifications.

CWC-AE provides low risk and future proof solutions that have flown on over 300 different aircraft platforms. We build strong relationships with our customers by listening to their needs and providing dedicated support teams and industry leading response times. Customers have the assurance that all products and services are backed by the proven performance of Curtiss-Wright, one of the most experienced and respected suppliers in the defense and aerospace industries.

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Desistek combines the latest technology and the ethical values by its highly qualified staff using innovative solutions.

Desistek is the leader Remotely Operated Vehicle (ROV) manufacturer in TURKEY. Desistek aims to be a key player in ROV market with its high performance products.

SAGA (Underwater Observation Vehicle)
SAGA is a high technology mini remote controlled underwater vehicle. SAGA can be used in several areas including underwater geological research, hydrographic research, archaeological research, oil – gas research, search and rescue, port and ship security. Many underwater applications such as underwater observation, instant high resolution imaging, data gathering, water or object sampling, underwater mapping, etc. can be accomplished in a quick and cost effective way with the use SAGA.

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Empa Elektronik is serving to Turkish Electronics industry with worldwide component suppliers since 1981. First technological workshops in Turkey had been arranged by Empa. Empa, has an important role in the improvement of local electronics industry (Empa research and development department developed the first TV remote control software in Turkey).

From year 2000 Empa, stand out with a regional technical distribution identity in Turkey and Middle East, is the market leader in semiconductors in Turkey.

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Hamza Dere
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FİGES provides engineering services at almost all stages of the design and manufacturing process of a product, mainly on Mechanical Design and Prototype Manufacturing, Turn-key Mechatronics System Development, Finite Element Analyses (including static structural analysis, fatigue, vibration, solid dynamics, blast and explosion, rollover and crash simulations, thermal, fluid dynamics, electromagnetic and acoustic analysis), Model Based System Simulation and custom made engineering software tools development.

Additionally, mechanisms and test equipment, preparation of shop drawings and prototype manufacturing. We have mechanical design engineers in our team, at every office.

Our vision for the future includes engineering partnerships on design, prototyping, manufacturing and physics-based simulation areas and developing our own engineering projects. We work for aerospace and defense industry; land platforms, naval platforms, air platforms, arm systems. Additionally we work with automotive, railway systems, energy, household, appliances, electronic devices, glass and machinery industries.

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InnaLabs® design and manufacture durable, lightweight, low power, high precision inertial sensors for a wide range of platforms and markets. InnaLabs® high performance ITAR-Free inertial sensors include tactical grade Coriolis Vibratory gyroscopes (CVG) and navigation grade Quartz Servo Accelerometers which provide high quality, robust solutions for aerospace, subsea, marine, land, space, civil engineering, transportation and industrial applications.

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AI-Q-Series Accelerometers

InnaLabs CVG Gyroscopes

Out of This World
INTERCONNECT SOLUTIONS

Glenair, Inc. began operations in 1956 as the first company specifically founded to produce electrical connector accessories. Building on that foundation, we now offer a dozen, full-spectrum product lines designed to meet every interconnect requirement, including a broad range of military qualified and commercial connectors.

Glenair is a privately-held company whose strengths include ISO 9001 process quality, full-spectrum product lines, fast "turnaround" on quotes and custom orders, unsurpassed sales and technical support in every major market in the world, and the industry's largest standing inventory of commercial and Mil-Spec electrical connector accessories.

Located in Glendale, California, our connectors, backshells and interconnect cable assemblies are all made either in America or in our facilities in Mansfield, England or Bologna, Italy. With so many interconnect manufacturers moving their production operations to Estonia, Mexico, India, China and elsewhere, Glenair is proud to continue our long-standing tradition of making our products in quality controlled plants here in the USA, or in the case of selected connector products, in Western Europe.

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Moog Protokraft designs and manufactures high-speed optoelectronic components and communication subsystems for use in harsh environment networking equipment applications. The company provides optoelectronic components and communication subsystems for harsh environment optical networks, including electro-optical network switches, optical enterprise and storage area networks (SAN's) and tactical optical access networks. These active optical subsystems integrate the functions of optical transceivers into the natural structure of a passive optical connector.

Moog Protokraft optoelectronic components offer numerous costs, performance and reliability advantages to harsh environment network equipment system designers:

Eliminate intra-enclosure fiber optic cable assemblies and disconnects
High speed signals remain in the electrical domain inside the system chassis
Reduce weight, space, energy consumption and improve overall system reliability

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NANObiz is, a Turkish technology company located in METU Technopolis in Ankara. Main activity areas of the company are biosensors, biological detection and early warning systems as well as decontamination technologies within the concept of CBRN.

NANObiz, is the first and only independent testing laboratory accredited by the TURKAK (Turkish Accreditation Agency), within the scope of MIL-STD 810 Fungus test in ISO 17025 standards and also all tests are performed in the Biological Safety Level-2 laboratory which has both NATO SECRET and NATIONAL SECRET Level Facility Security Certificate.

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Otonom Teknoloji provides unmanned and autonomous solutions, products and services to improve the way of solving high effort and time driven problems.

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Otonom Teknoloji differentiates its sphere of activity by developing cost-effect state-of-the-art technology for contemporary public and environmental safety needs including:

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The operational field of Narda Safety Test Solutions covers the business segments of RF Safety and RF Testing. In both areas, Narda is one of the leading providers of high quality, application tailored measurement solutions.

Narda Safety Test Solutions is the global leader in the development and production of measuring instruments for electric, magnetic, and electromagnetic fields, and possesses 95% of all the published patents for measuring these fields.

RF Testing covers analyzers and equipment for measuring and identifying RF sources. Our product range includes a portable handheld spectrum analyzer for eliminating RF interference and automatic location of emitters, remote controlled analyzers for spectrum monitoring, radio and signal monitoring, as well as control systems.

Narda is part of the L3-Communications technology group, with 51,000 employees worldwide, generating $13,1 billion annual sales. Narda Safety Test Solutions is being supported inTurkey since 1998 by PROTEL.

Photo-Sonics International Ltd.

Leaders in specialised instrumentation products

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Since the founding of the parent company Photo-Sonics, Inc. some seven decades ago, the company's record of performance and integrity is a recognised achievement in the field of photo-optical instrumentation. The contribution by Photo-Sonics Inc., to this discipline, has been demonstrated by the high performance and longevity exhibited by equipment in use at major missile test ranges, defence installations, scientific laboratories, military test ranges, military research centres, on military aircraft, and at major corporations.
In 1973 the European office was opened in the United Kingdom. Since then, Photo-Sonics International have been supplying instrumentation systems to the Aerospace, Military, Ministry, Academic and Automotive communities throughout the world. This 30+ years experience, provides us with an in-depth understanding of our customers requirements and thus helps us to propose practical solutions which are cost effective.

Our current range of products includes :
Electro-optical Tracking Systems (EOTS) for accurate TSPI measurement
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The SOLIANI EMC was founded 30years ago and is located in Como between Milano and Swiss border .Is a SME company and have a specific applications over the electromagnetic shielding protection from interferences . The applications involved in several fields offer a view of our capability to be flexible and to follow the CUSTOM SHIELDING SOLUTIONS required. Production is related to p gaskets, windows, fabrics, silicon and ready products electrically conductive to offer final solutions as tent as with fabrics .

The qualifications are EN9100 EN9001 plus NATO and specific for each customers and our customers are : AgustaWestland,TAI, AleniaAermacchi , Sukoy , AIRBUS, Denel and Aerosud in South Africa , Iveco , BMW plus Formual e 1 and applications for cabinets enclosures plus security applications for Carabinieri , Security Special Forces . The concepts for shielding solutions is made with our experience with test and qualifications actions with our instruments to guarantee the perfect secure results after installation for rooms to COMSEC and TEMPEST final scope .The tent with shielding properties are at the moment one of our best products because we made also our fabric conductive inside in the company .

The persons involved are 25 people where 60% doctor engineers and we have 2 locations for our production and the locations are qualified also from Italian Military Force .

Tech Source
An EIZO Group Company

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Tech Source has been a pioneer in high performance computer graphics hardware solutions for niche markets. With a strong engineering team, the company has evolved over the years, now serving several markets that include Air Traffic Control/Management (ATC/ATM), avionics, military and embedded systems with several COTS (commercial off-the-shelf) and tailored (custom) products. The product range includes graphics, imaging and video capture boards, H.264 encoders and high compression video recorders.

The Raptor product line has served the ATC/ATM market since 1995, with products deployed in over 35 countries through OEMs such as Raytheon, Lockheed Martin, Northrop Grumman, Thales, Indra and Telephonics. The products have evolved over the years through various technologies. The current Raptor 4000 product line is used in a major US program called the FAA STARS program, upgrading the nation's Air Traffic Control systems.

The core of Tech Source's strength has been the ability to design graphics solutions to satisfy specific customer requirements. Our extensive efforts have produced breakthroughs in graphics and imaging technology. From designing graphics processing units (GPUs) and high compression encoders to FPGA targeted special graphics/imaging algorithms, the company has a broad range of knowledge and offers product customizations and new product delivery in a matter of months.

The Condor product line includes a range of XMC/VPX based COTS products that are targeted towards extended temperature and rugged applications such as avionics, defense and industrial applications. Several of the Condor products

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TARGET A.S was founded 40 years ago to serve our country's needs with the latest and most advanced technology available. We are fully committed to ITAR standards and we mean it. Since its inception, Target A.S. has managed to step ahead of others as one of the leading pioneers in the Turkish Defense Industry in cooperation around 40 business partners, both local and international, some of which are ranked among the Fortune 500. These partnerships have been with leaders in their field, establishing customer confidence by providing dependable service whenever required. Our operations in the defense industry cover consultancy services to corporate giants, along with supplying military-grade raw materials, the latest military technology, systems and hardware. In addition to providing many other services for our customers, we produce and install various military exercise systems.

Over the years since its founding, Target A.S. has grown into a group of four companies operating in the defense, shooting, engineering and energy sectors in Turkey, employing close to 20 people and occupying more than 1,000 square meters of office space as well as subsidiaries as engineering Laboratories and R&D facilities.

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TEKTRONIK Engineering and Trade Ltd. was found on 1995, to provide Hi Tech Electronic Technologies to Turkish Electronics Industry and Services sector.

Since her foundation, Tektronik completed the installation of numerous high quality hardware and software solutions for test laboratories, electronics, avionics and defense industry, including COTS components as well as original design and systems integrations.

Tektronik Engineering offers hardware and software which are competitive basis with new technologies and open standards, avionics test solutions and integrated application ready systems.

Our brands : Curtiss Wright Defense Systems, Wind River, AIM Online, RTI, Cm Computer, IAR, QT, MEN Mikro, Lauterbach .

Tektronik Engineering is the single member of Intel IoT Solutions Alliance as Affiliate Member.


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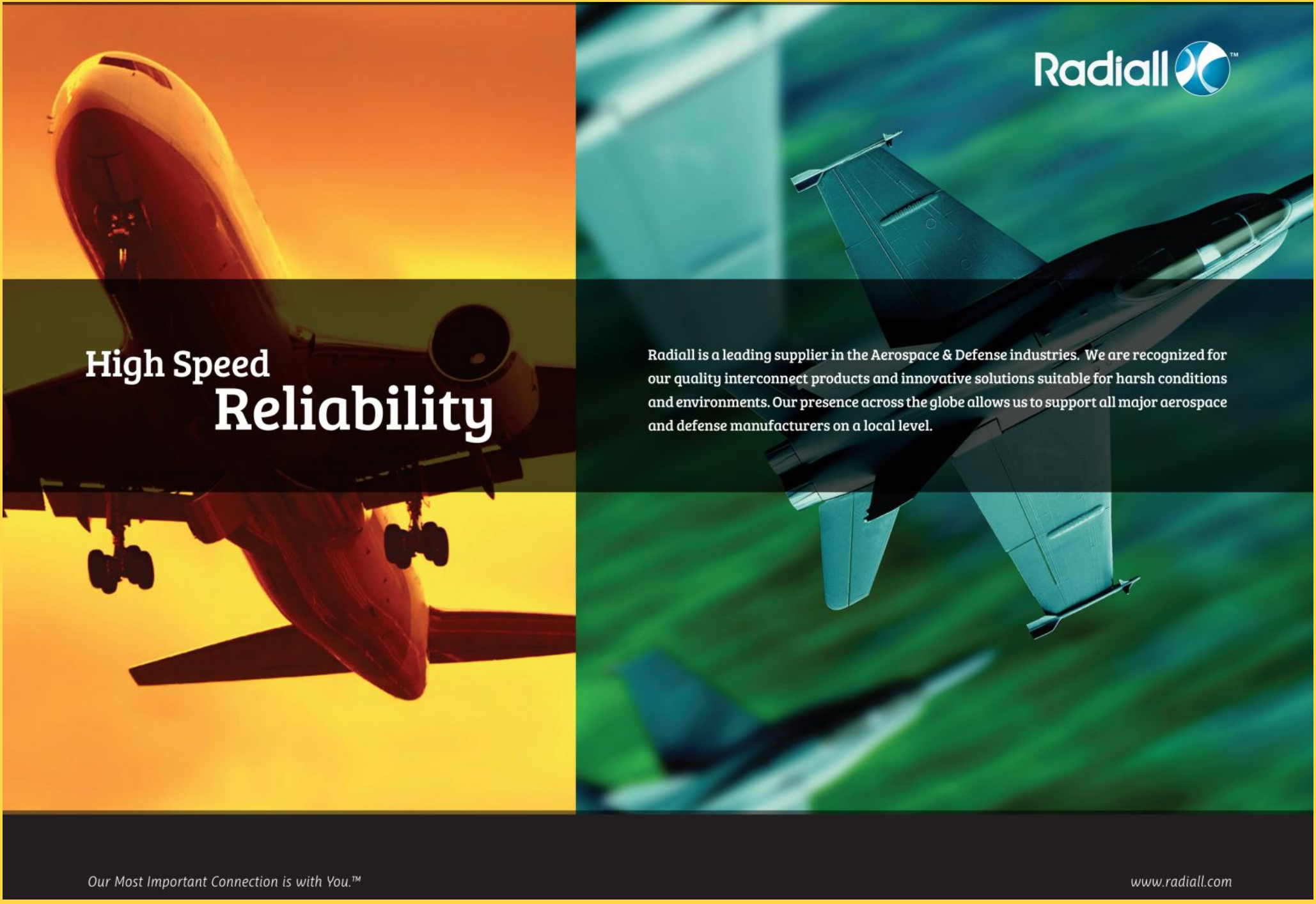
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Determination of Capacitor Life as a Function of Operating Voltage and Temperature

David Evan, Evans Capacitor Company

EVANS CAPACITOR Company
www.evanscap.com

Background

Potentiostatically charged Hybrid capacitors age predictably by a mechanism involving electrochemical reactions that reduce the efficiency of the cathode and consume electrolyte. One of these reactions results in the formation of hydrogen at the cathode which reacts irreversibly with the tantalum foil substrate. The material formed is muchless conductive than the original. The consequence to capacitor performance is an increase in ESR and a decrease in capacitance. It has been assumed that the rate of this wear-out mechanism is directly related to the leakage current in the capacitor. This means that the relative age of a capacitor isproportional to the quantity of charge passed as leakage current. If one knows what

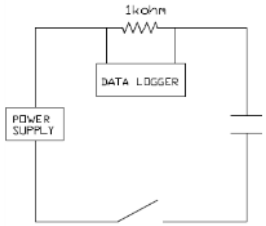
quantity of charge a capacitor can pass over its useful life, capacitor life can be easily estimated by determining the leakage current under any proposed operating conditions. Leakage current in a capacitor at a particular voltage can be determined at least two ways. It can be measured directly by charging the capacitor potentiostatically and reading the steady-state minimum value of current. Typically, several hours or even days are needed

for the capacitor to stabilize sufficiently to properly determine leakage current. Under high temperature and voltage conditions, time spent experimenting can amount to a significant fraction of capacitor life. Since the leakage current typically changes with age, direct comparison of the results at one temperature with the results at other temperatures is complicated. Because the leakage current is usually on the order of tens of microamps, a very stable voltage source is also essential. Any fluctuation in potential results in additional charging and or discharging current that will confound leakage current determination. These characteristics make determination by this method somewhat time consuming and subjective, resulting in probably considerable error and annoyance especially considering the large number of measurements desired. Nonetheless, we found using a form of this approach necessary to determine charge-passed over life as described below. Another approach has been found that yields leakage current as a continuous function of capacitor voltage. This method eliminates the problem of current stabilization because the capacitor is charged only once at each temperature. Since the capacitor needed only be charged a few times for 24 hours, negligible aging occurred. We monitored thevoltage of a capacitor as it discharged open-circuited. Using the data and this formula of the physical definition of capacitance,

I = C dV / dt , we calculated the leakage current as a function of voltage.

As already mentioned, discovery was also made of the time a capacitor will last under potentiostatic charge and the total charge passed as a capacitor ages. As the life with respect to charge is presumed independent of temperature, it was necessary to measure the charge passed under constantly charged conditions lasting the life of the capacitor at one temperature at least. Estimated life equals the charge passed divided by the leakage current.

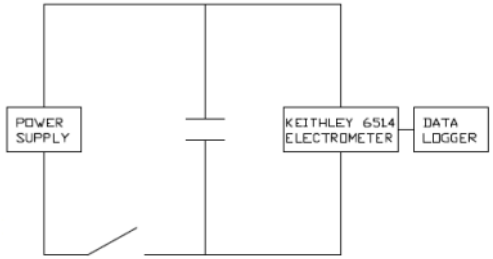
Experimental



1) Measurement of charge life. The circuit shown above in Figure 1 was used tomonitor the charging current on a THQ3100 capacitor. This capacitor was rated at 100 volts. Although the leakage current depends on voltage and temperature, , the experiment was made at 100 volts atthe total charge passed over life does not. In this determination a temperature of 95°C, an accelerated ageing condition. End of life was reached when the ESR doubled. The ESR and capacitance were measured every 250 hours.

2) Measurement of self-discharge voltage. We monitored the open circuit discharge voltage of a single THQ3100 capacitor from 100 volts at various temperatures. The

capacitor was charged for at least 24 hours before opening the switch and allowing the capacitor to self-discharge. To avoid loading the capacitor, a high resistance electrometer having resistance of >200T ohms was used. The experiment was re-



Results

These two figures show the results of the first part of the experiment. As shown in Figure 3 below, the ESR of the capacitor had doubled from the start to the 750 hour measurement, indicating end of life.

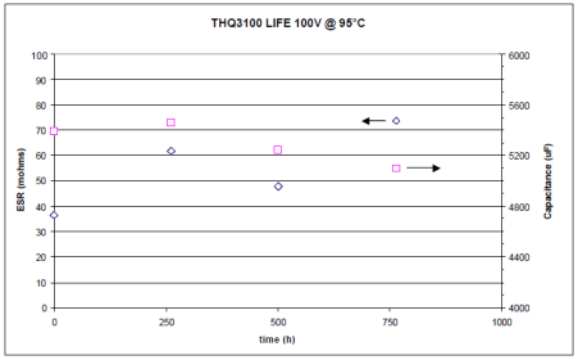


Figure 3.

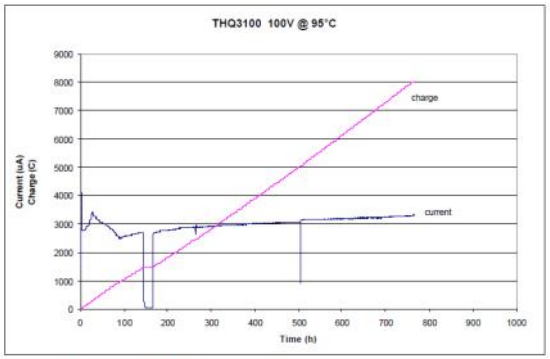


Figure 4. Leakage current and charge over time.

At the end of life, 8050 coulombs had passed. The average leakage current was therefore approximately 3 milliamps as shown in Figure 4. The gap in current from about 150 to 170 hours was due to a power failure associated with "hurricane" Irene. The other breaks ca. 250 and 500 hours indicate stoppages to measure capacitance and ESR.

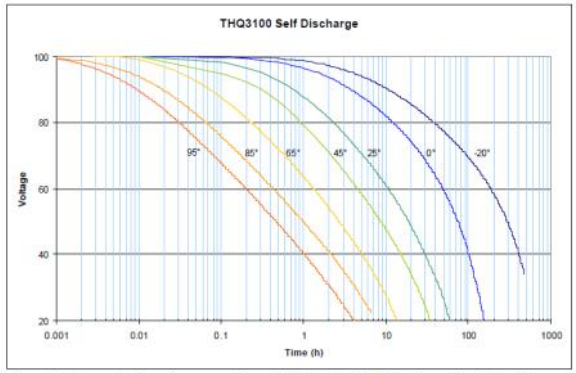


Figure 5. Open circuit voltage over time of THQ3100 initially charged to 100 volts.

The set of second experiments yielded the family of curves of voltage with respect to time shown in Figure 5. The derivation of leakage current from the above data depends on the capacitance value of the device under test. Because capacitance is not constant, but depends on capacitor temperature as shown in Figure 6, a different value of capacitance was used in each calculation. The results are shown in Figure 7.

Using the formula to derive leakage current from the results of the self-discharge experiment assumes the capacitance is known. This assumption may not be strictly correct, as capacitance does change somewhat unpredictably over life. However, since the capacitor did not age significantly in the experiments measuring self discharge, this deviation was ignored. The capacitance also has predictable temperature dependence and

its value at temperature as shown in Figure 6 was used in the calculation. Leakage current at 100V derived from self-discharge compares very closely with the leakage current indicated on a meter for potentiostatic charge at a given temperature. For-instance, the calculated value for leakage current at 100 volts and 95°, 3mA as shown in Figure 7, was identical to the 3mA measured current in the same capacitor charged to 100 volts.

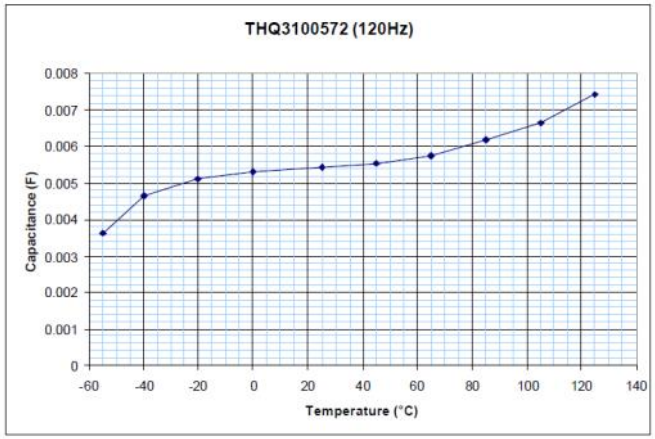


Figure 6. Capacitance depends on temperature.

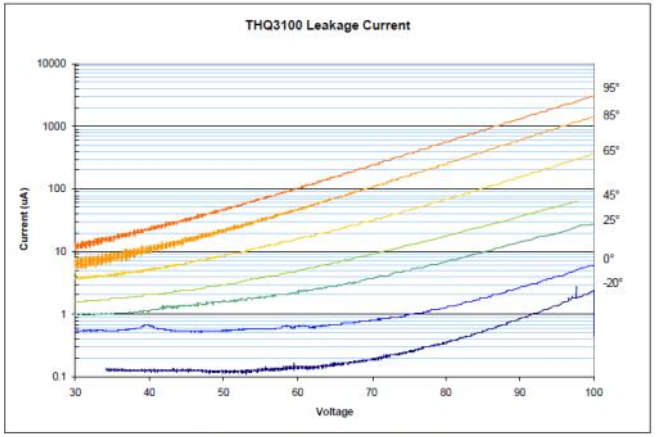


Figure 7. Leakage current depends on voltage and temperature in THQ3100 capacitor.

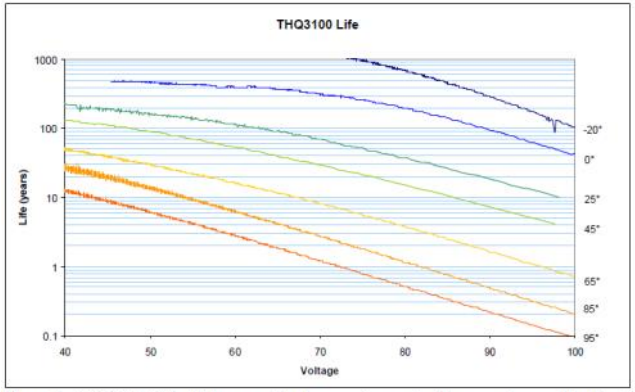


Figure 8. THQ3100 Life. If the operating temperature and voltage are known, the life of the capacitor can be predicted with this chart.

Converting leakage current to estimate life, we divided the 8050 coulombs of charge passed over life by the leakage current. The results are shown in Figure 8.

Conclusion

A useful approach was developed using self-discharge measurements to allow the easy calculation of leakage current and life over a wide range of operating temperatures and voltages. The leakage current increased exponentially in the range of 50% to 100% of rated voltage at each temperature. While predictions of >100 year life are shown for room temperature (and lower) parts operating at 60% or less of rated voltage, this process deals with the only known wear-out mechanism in these capacitors. Others that work over very long times are awaiting discovery so cannot be factored in here. We ignore them at our peril. The data presented are based on the evaluation of just two capacitors, one for the life test and one for the self-discharge measurements. With that understanding, predictions of life extending beyond about 20 years should be used with due caution. Nevertheless, the chart greatly aids relative analysis of the life under various conditions for this capacitor. We have a list of over 70 different hybrid capacitors that await evaluation. Unless facilities are expanded to allow evaluation of several parts at once, it will take many years to complete them all.

SWaP: The RF solution that can mean the difference between flying high and being grounded.

By: Jarrett Liner

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Abstract: commercial and defense airborne platforms differ in many ways; commercial aircraft place high emphasis on safety and system redundancy, while defense platforms may focus on multifunction systems and power management. One area of common concern for commercial and defense airborne platforms is maximizing payload efficiency. Every ounce of weigh, cubic centimeter of space and mili-watt hour of power is carefully planned. Both are focused on Size Weight and Power or SWaP. Advances in RF technology can provided a leap-frog advantage for commercial and defense airborne platforms, manned and unmanned. This abstract will focus on these RF technology advances and give the reader a high-altitude view of the problem followed by a detailed look at a few solutions. Some of the systems discussed are multifunction radar, Electronic warfare and wireless sensor technology.

Flying History

The space shuttle was the work-horse of the United States space program and quite frankly the global space exploration and satellite implementation programs. The shuttle or orbital vehicle (OV), was designed starting in 1969 and reached low orbit in 1981. Specifically, the electrical power system (EPS) was given significant consideration. The EPS consisted of power reactant storage and distribution, fuel cell power plants (electrical power generation) and electrical power distribution and control. My point is that much time and effort was given to the EPS for providing the 28Vdc and 115Vac power rail to the OV. These systems and subsystems were complex, heavy and very inefficient but the electrical system was a significant part of the overall payload calculation.

Fast forward to 2015, there are several Unmanned Aerial Vehicles (UAV) projects in the development phase that fall into a special category: High Altitude Long Endurance (HALE). One project in particular has set the goal of 5 years un-replenished flight.

The challenges of the environmental, airframe and power plant system requirements alone are quite daunting and the attention that will need to be given to the electrical power generation, delivery and recapture will be critical to the success of these programs. The communications systems will also be designed with Size, Weight and Efficiency at the highest consideration. Thankfully Analog Devices Inc. (ADI) has been proactive in their effort to provide such components. A great example of this is ADI's transceiver portfolio; very diverse, full spectrum coverage and highly integrated solutions for low power, small footprint components. Detailed discussions about this and other component solutions are interleaved within this article.

Much of the problems and solutions herein are presented with airborne platform examples, others use shipboard platforms. The reader should be aware that the problem statements and associated solutions for air and sea based platforms have close ties and are often variants of the same system.

What is SWaP?

Size Weight and Power (SWaP) refers to arguable the most important specification in new product, project or platform definition. Nearly all new developments, weather shipboard, airborne, terrestrial, man carried or hand carried, share a common requirement: make it smaller, make it use less of the available resources and make it contribute more to the overall system functionality. In recently speaking to a radar system architect, the discussion was about phased array radar and Active Electronically Scanning Array (AESA),from 50 a thousand foot view, the designer had very intelligent ideas to increase the system accuracy, range and data transfer.

SWaP challenges killed all of his careful calculations. A lean system is more desirable in the current social, economic, political and global environments. Lately, and more often, SWaP seems to be the key driving factor, providing difficult tradeoffs over system performance enhancements and multi-function architectures.

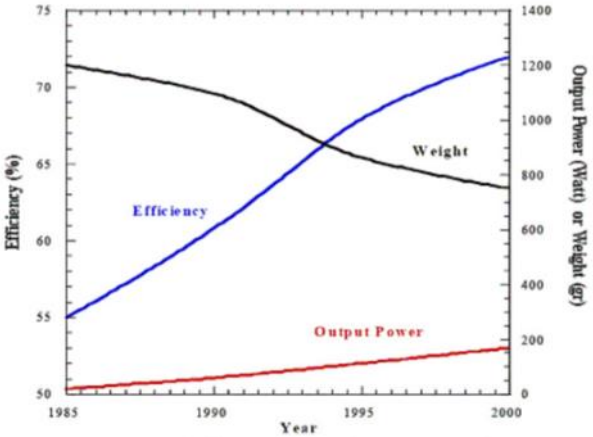
Culprit Identification

Before we discuss some of the solution to the SWaP problems, let's take a look at a few of the miscreants, scandalous offenders, and substantially burdensome characters.

Cu! Copper is the conductor of choice for electrical power transmission. A thousand feet of AWG 5 gauge copper wire without insulation weighs nearly 100 pounds (50Kg). To add further insult to injury, the inherent resistance of wire causes electrical current to be wasted in the form of dissipated heat. The next perpetrator in the line-up is legacy component size. For example, let's examine the case of the ship-board radar local oscillator (LO). The LO feeds both the transmitter and receiver. The LO must produce a stable frequency with low harmonics and the highest stability requirements must take into account; temperature, voltage, and mechanical drift. The oscillator must produce enough output power to effectively drive subsequent stages of circuitry, such as mixers or frequency multipliers. It must have low phase noise where the timing of the signal is critical. Historically the LO was generated and distributed by separate and specially designed subsystem. The same or similar was true for airborne systems. Large size, power hungry and heavy due the solid-state component content.

The legacy component that has provided high power RF to a system is the Traveling Wave Tube (TWT). Great, not broken, why fix it? What is a TWT? A TWT is a specialized vacuum tube that is used in electronics to amplify radio frequency (RF) signals in the microwave range.

The bandwidth of a broadband TWT can be as high as one octave, although tuned (narrowband) versions are more common; operating frequencies range from 300 MHz to 50 GHz. These TWT systems are somewhat efficient, but they are a single point of failure. Reliability is a significant concern with TWTs. Microwave tube reliability is strongly dependent on three factors. First, defects introduced during the manufacturing process adversely effects reliability. Production problems, poor workmanship and lack of process control are major contributors to manufacturing defects. Secondly tube reliability is heavily dependent upon operating procedures and handling. Finally, adequate design margin must exist between the operating point and the ultimate design capability of the tube in order to have reliable operation. These are just three examples of the many enemies of SWaP.



Graph illustrating TWT improvements in Efficiency, Output Power and Weight against Time

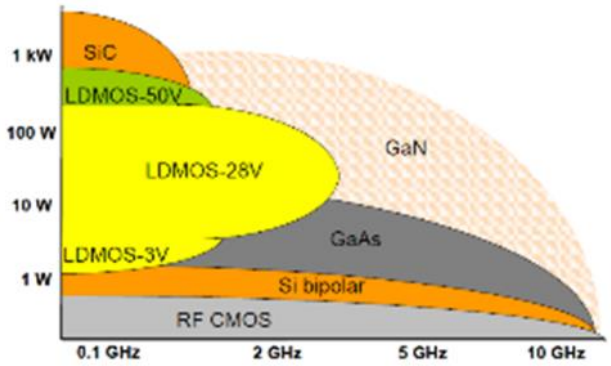
The Superhero's of SWaP

Every villain, needs an associated superhero. Advances in semiconductor technology and component integration have played a significant role in reducing SWaP. The next section of this article will highlight key achievements that directly affect the SWaP equation and enable technological leap-frog advancements starting today and for the foreseeable future.

The next section of this article will highlight key achievements that directly affect the SWaP equation and enable technological leap-frog advancements starting today and for the foreseeable future. The 3 technologies that are discussed in this section: Solid-state power amplifiers, component integration and wireless sensor technology.

Solid state power amplifier (SSPA) are not a new technology. GaAs (Gallium Arsenide) and LDMOS (Laterally Diffused Metal Oxide Semiconductors) have been used for high power amplifiers for many years Silicon-based LDMOS FETs are widely used in RF power amplifiers for base-stations as the requirement is for high output power with a corresponding drain to source breakdown voltage usually above 60 volts. Compared to other devices such as GaAs FETs they show a lower maximum power gain frequency. LDMOS FETs operate with the highest efficiencies below 5GHz. A gallium arsenide field-effect transistor (GaAsFET) is a specialized type of FET that is used in solid-state amplifier circuits at microwave radio frequencies. This spans the spectrum from approximately 30 MHz up to the millimeter wave band.

The GaAsFET is known for its sensitivity, and especially



for the fact that it generates very little internal noise. The power density is limited by the breakdown voltage, you can get 20 volts breakdown on a good day with a GaAs MESFET. Let's review; TWTs have high frequency and high power available, but the reliability, weight and required supporting sub-systems make them undesirable.

LDMOS allows for high power, but operates below 5GHz. GaAs MESFETs operate at very high frequencies, but the low breakdown voltage limit them to the 10W power range. Is there a hero? Is there SSPA leap-frog technology available to save the day? SWaP loves Gallium Nitride on Silicon Carbide (GaN on SiC). Both GaN and SiC are wide band gap material, which means the combined breakdown voltages are as high as 150 volts. This allows higher power density along with a lower load line for easier impedance matching. GaN on SiC allows power gain at frequencies in the millimetre bands (Ft~=90GHz, Fmax~200GHz).

The market acceptance of GaN on SiC LEDs have helped fill the wafer fabs and drive wafer costs down. The device structure of the RF transistors is such that power densities of 5 W/mm can be achieved. The MSL levels for GaN on SiC are near or arrived at industry acceptable ratings. GaN on SiC is widely agreed upon to be interruptive technology and the defence and commercial markets are demanding more of it. The performance of GaN on SiC is limited most by thermal transfer; getting the heat away for the device is the last issue to unravel. Some success has been found with GaN on Silicon, but the reduced thermal conductivity limit the output power to near 10W.

The best performance comes from GaN on Diamond. Scientific calculation point to power densities at up 10 times higher than GaN on Sic available today.

Although, the direct growth of GaN on single crystal diamond has been demonstrated, the single crystal diamond substrates currently available have a maximum size that today limits the adoption of the technology. The Government and Defense contractors are the only early adopters of the GaN on Diamond alliance. Similar to GaAs in the 1980's, GaN on Diamond will be vetted through these government agencies and the commercial market will follow as the reliability increases and the associated cost decreases. The TWT has an integrated SSPA replacement. ADI offers up to 8KW High Power Amplifier (HPA) that combines many GaN on SiC SSPA's into a single unit. The KHPA-0811 uses a small, dodecahedron package to pack a considerable amount of power in a small footprint plus cover a wide bandwidth.

Integration Sinks the Boat Anchor

For clarity, in the US Navy, when large electronic (or other) equipment became obsolete and a burden on the system resources, it was referred to as a "boat anchor". An airborne platform, weather manned or autonomous, will have many forms of communications on board. These comms-links vary from voice, navigation, data-link, on board sensor links, radar, munition tracking and the list gets longer as the skies get more crowded and the warfare theatre becomes more complex. In the past, any one of these systems require significant real-estate, power resources and supporting subsystems. The fact that the airborne platforms were actually airborne is amazing. Every ounce was accounted for, every mili-watt was calculated and the physical system design was considerable to fit into the allotted space. There had to be a better way.

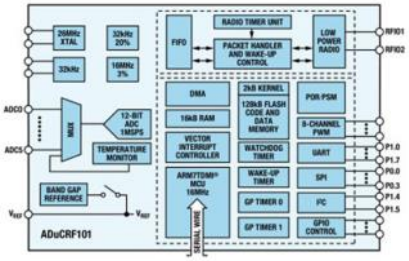
Integrated circuit (IC) design advancements along with System in Package (SiP) and System on Chip (SoC) advancements have made boat anchors of those bloated systems of yesterday. Let's take a closer look at a great example of system integration. Analog Devices (ADI) has released an industry leading transceiver that puts the capabilities of a massive and power hungry comms-link into a 10mm by 10mm package. The AD9361 is a high performance, highly integrated radio frequency (RF) Agile Transceiver. Also from ADI, the AD9671 is designed for low cost, low power and small size.

The original design was intended for eight channel ultrasound implementation, but many commercial and defense systems designers are looking to use COTS components because of the level of integration, lower cost and availability. The ADF7242 ultra wideband, low power, low cost transceiver would be another example of an integrated design that is being considered for systems outside of the scope of the original design. Drop the boat anchors, reel in the SiPs and SoCs.

Cut the Copper Umbilical Cord

Commercial and defence aircraft, manned and unmanned, have hundreds if not thousands of sensors and many have redundancy and back up support systems. These sensor range from flap and aileron position sensors, navigation and positioning sensors, engine vibration, brake temperature, the list is long and growing. Each of these sensors along with their associated redundancies, are connected to a central processor via large heavy cables comprised of copper wiring and stainless or aluminium connectors. The point is, significant platform resources are consumed to support these cable s and interconnects. RF technological advancements will once again save SWaP by reducing the dependency on these cables. Many major airframe manufactures are working together to qualify commercial-off-the-shelf (COTS) technology for a low cost, reliable replacement for copper interconnectivity.

For example, take an Inertial Measurement Unit (IMU) sensor with output data bandwidth requirements less than 10's of KHz, combined with a Precision Analog Microcontroller ARM Cortex M3 with RF Transceiver from Analog Devices. The ADuCRF101 is a fully integrated, data acquisition solution that is designed for low power, wireless applications. It is designed with emphasis on flexibility, robustness, ease of use, and low current consumption. This marriage is purely hypothetical, but would be one example of Avionics sensor technology pairing with COTS RF components. Standby for this type of RF implementation to save SWaP in the very near future



In Summary…

The social, political and economic environment of today require airborne platform designers to put increased focus on saving size, weight and power. The reduced loading on the system resources allows for longer flight times, reduced fuel requirements and more efficient payload allowances. The most significant and most interesting advancements to save SWaP come directly from the technological advancements made in the RF community. The most advantageous progress revolves around size reduction from TWT's to SSPA's, component integration and reduced dependency on copper cable interconnects. RF technology will keep the aeronautical industry flying high for many years to come. The solution that provides reduced SWaP is spelled RF.

Biography

Jarrett Liner is an RF Systems Application Engineer with Analog Devices Inc. in the Aerospace and Defense group, Greensboro North Carolina. He has significant experience in the area of RF system and component design. Formerly, Jarrett was an applications engineer for GaN on SiC amplifiers for the military and aerospace sector. His prior experience also includes design and test of RF IC WLAN power amplifier and front-end modules for 13 years. He served 6 years in the United States Navy as an Electronics Technician. Jarrett received his BSEE from North Carolina Agricultural and Technical State University located in Greensboro NC in 2004. When Jarrett isn't simulating circuit solutions or taking data in the lab, he might be found mountain biking, teaching cycle class at the gym, running or chasing his 4 kids around the yard. He can be reached at Jarrett.Liner@Analog.com.

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The breadth of rotary position and velocity feedback devices on the market has greatly increased over the last several years making the selection process challenging. Your application is your guide to selecting the most appropriate feedback option. Below, are three types of feedback options, their core technology, and how it may apply to your application. We will also highlight some key specifications that will allow you to cross reference the type of feedback device for your application needs.

Resolvers

Resolvers are essentially an electromechanical transformer with one primary winding and two secondary windings that are phased 90 mechanical degrees as shown in Figure 2. They convert the angular position and/or velocity of a rotating shaft to an electrical signal, and deliver signals proportional to the sine and/or cosine of the shaft angle. Resolvers are used in conjunction with a resolver-to-digital converter, which converts these signals to a digital output corresponding to the shaft angle and/or velocity.

One of the specifications in a resolver is its number of speeds. The output in Figure 3 is the output of are solver with a single speed output. The number of speeds is equivalent to the number of amplitude modulated sinusoidal cycles in one revolution of the resolver. Multiple speed resolvers are achieved by increasing the number of magnetic poles in the rotor and stator equally. However, a single speed resolvers essentially a single turn absolute device. By increasing the speeds of a resolver, the absolute information is lost. If space allows, mounting a single speed resolver on top of a multiple speed resolver will provide the higher accuracy and absolute benefits.

Resolvers & Encoders How to Choose the Right

Summarizing the difference between encoder and resolver feedback technology and understanding which type of motion control is right for your application.

Resolver

Absolute Encoder

Incremental Encoder

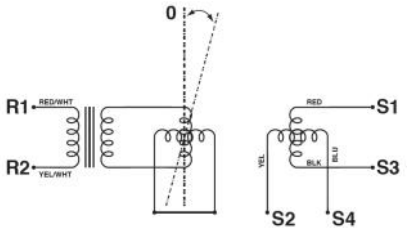

Figure 2

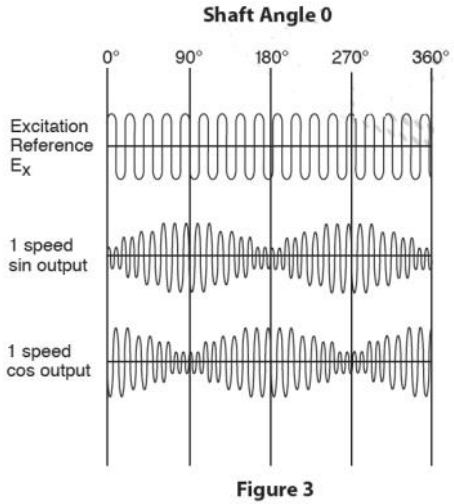

Figure 3

Resolvers lend themselves to maximum duty applications because of their simple component similarity to electric motors (windings, laminations, bearings, and carrier). The lack of optics and precision alignment makes them the device of choice for high shock and vibration applications. The lack of both optics and solid state electronics allows for use in high radiation environments. Another key advantage to using a resolver is its infinite resolution and lack of onboard electronics. During power outages or voltage drops a resolver will never lose its positioning, and can be restarted immediately where the power failure occurred, where as encoders require a hard restart or reboot to relocate its home position, thereby resolvers save precious time and cost during frequent power failures.

Resolvers have been time tested and proven over many decades. The most popular use of resolvers is in permanent magnet brushless ac servo motors in military and aerospace applications, and among a wide range of industrial applications. Resolvers have excellent accuracy and hold-up extremely well in high temperature, dirty environments. They also offer excellent shock and vibration performance.

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Absolute Encoders

Absolute devices provide a means of knowing the exact angle of the rotation with respect to a fixed device. An absolute encoder uses a unique binary pattern that doesn't repeat itself within the revolution, giving the encoder its absolute attributes. The feedback will also change when the rotational position is changed when power is removed from that device. When a gear train is used to track the number rotations of an encoder, it is a multi-turn encoder.

In an optical absolute, a disc rotates between the LED and sensor, light is either allowed to pass to several sensors or blocked, based on the disc's pattern. This, ultimately, is what provides the "on-or -off" of each bit in the digital signal from the encoder.

At the cost of precision manufacturing and an optimal application environment, optical encoders provide excellent resolution and accuracy. Optical absolute encoders can provide over 4 million counts in one revolution of a shaft at a thirty-six arc-second accuracy.

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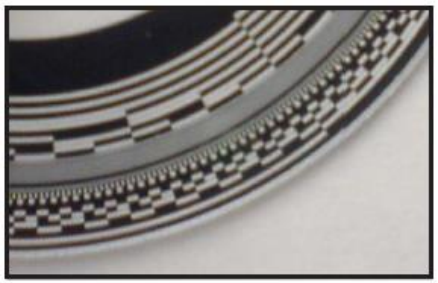
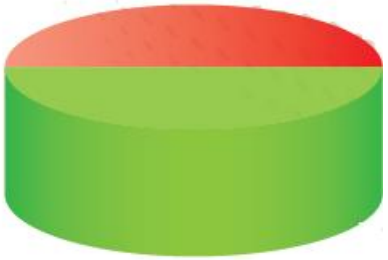


There are several means of transmitting the absolute position. The first absolute feedback devices transmitted their position by using parallel data. In parallel data, each binary digit has its own wire which is interpreted by a controller. Next, there are serial encoders where absolute position is transmitted in sync with a clock pulse. SSI or Synchronous Serial Interface is the most common protocol of serial encoders. BiSS encoders manipulate the clock pulses to provide bidirectional communication.

Bus encoders are now on the market. They allow for several encoders to be wired in line or taped off of a single transmission cable. DeviceNet, Profibus, and Interbus are among the most popular bus protocols.

In magnetic absolute encoders, absolute information can be obtained by rotating a magnet axially above a sensor network as shown in Figure 1. The sensor is typically either a Hall-effect chip type or magneto-resistive sensor circuit.

In terms of environment, the same rules would be followed for absolute or incremental. However, absolute encoders use is growing worldwide due to increased complexity in machine design that requires multiple axis to be synchronized and operate efficiently and safely. Incremental encoders rely on secondary devices, such as limit switches, to operate functionally for accurate position feedback. Absolute encoders, whether optical or magnetic, do have their limitations in the areas of shock and vibration and high temperature. This limits their use in extreme environments.



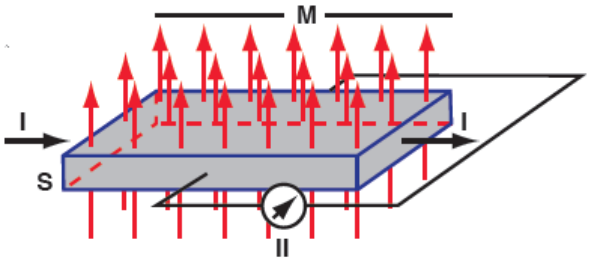
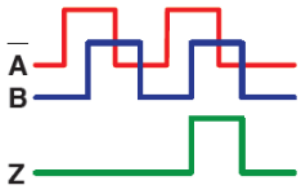


Figure 1

API Delevan Harowe Resolvers®

Incremental Encoders



Incremental encoders rely on external electronics to interpret the position based on the count of the events that occurred on that device. The outputs for incremental encoders can come in the form of a single square wave(A), phased square waves(A and B) to determine direction of rotation, or phased square waves and an index or one pulse per revolution (A, B, and Z). The concept of phasing square waves to determine rotational direction is often referred to as “quadrature”. The means of achieving an incremental signal are typically referred to as the encoder engines. The two primary encoder engine categories are optical and magnetic. In both engines, similar sensor alignment is performed to provide output compatibility.

In the optical design, light is generated by an LED and detected by a chip-level sensor. Between the two is a code disc, typically made of glass, metal, or plastic. In an incremental encoder, the code disc is etched, coated, or punched (if metal) with a fine grating of similar lines around the circumference. In the magnetic design, there is a magnetic wheel or disk, a magneto-resistive sensor, and a conditioning circuit. The disk or wheel is magnetized with several poles.

The sensor converts the sinusoidal change in magnetic field to an electrical signal as the disk or wheel rotates. That electrical signal is multiplied, divided, or interpolated by the conditioning circuit to produce the desirable square wave output.

Incremental encoders excel in the area of speed feedback. Incremental encoders are the most widely used of all rotary feedback devices for low cost commercial applications. With the ease of solid state circuit and software design, devices that accept incremental encoder input are widely available.

You can find drives, panel meters, counters, and PC cards that interface with incremental encoders. Optical encoders can be found in office environment applications such as copiers, and industrial applications such as automated guided vehicles(AGV’s), magnetic encoders are typically used in harsh conditions where optical encoders may show significant performance decrease.

The Bottom Line

The application should be the guide when deciding between resolver or encoder feedback. Control electronics and environment are the two biggest factors to consider when both of these are answered, the choice becomes clear. Below, you’ll find quantified ratings that reflect the comments in this paper.

Comparison of Angle Sensors:

	Resolver	Absolute Encoder	Incremental Encoder
Accuracy (Arc-Min)	■	■	■
Resolution	∞	2^{22} cpr	10,000 PPR
Output Signals	Absolute Angle	Absolute	Incremental
Shock	■	▲	▲
Vibration	■	▲	▲
Heat Resistance	■ Up to 200°C	▲ -10°C to +85°C	▲ -10°C to +85°C
Reliability	■	●	●
Anti-Noise	■	●	●
Features	Absolute Position Detection, High Reliability, Excellent Environmental Resistance	High Resolution, Poor Reliability	High Resolution, Poor Reliability

■ Excellent ● Good ▲ Poor

Application / Industries: Aerospace & Defense, High Lift, Spoiler and Horizontal Stabilizer, Motor Commutation, Guidance and Navigation, Cockpit Controls, Control Surface Feedback, Electro-Optic and Radar, Nosewheel Feedback, Target Acquisition Systems, Gun Trunnions, Forward-Looking-Infra-Red (FLIR) Systems, Electro-Optical Systems, Radar Systems, Missile Seekers Downhole Oil & Gas, Well Drilling, Formation Evaluation, Well Intervention, Oil and Gas Production Medical, Medical Instrumentation, Medical Imaging

www.delevan.com E-mail : resolver@delevan.com

THE ROLE OF INERTIAL SENSORS IN MISSION CRITICAL APPLICATIONS

Advances in inertial sensors are helping commercial and military markets meet an ever increasing demand for greater accuracy and reliability across a broad range of applications. Inertial sensors such as high performance accelerometers and gyroscopes provide critical information required for a range of stabilisation, guidance and navigation platforms

What are inertial sensors and what are they used for?

An inertial sensor is a sensor whose operation is based on the physical property of inertia, and typically refers to accelerometers – transducers which measure linear acceleration (measured in meters per second squared) or gyroscopes – transducers which measure angular rate of rotation (measured in degrees per second).

Inertial sensors are used to detect and measure five distinct motions – acceleration, tilt, rotation, vibration and shock.

- Acceleration sensing refers to the movement of an object from one point to another along a straight line or axis and includes translational movement such as position and orientation.
- Tilt sensing measures inclination or angle of change relative to gravity.
- Rotation sensing measures the angular rate in degrees per second of change, or how quickly an object turns in reference to the three axes, namely yaw, pitch and roll.
- Vibration sensing detects acceleration or deceleration.
- Shock sensing measures and detects sudden impacts.

The inertial sensors market comprises of a wide range of products which vary greatly in terms of performance and price, ranging from the highest grade (often referred to as navigation grade) found in products such as inertial navigation systems to the lowest grade which is found in automotive and consumer electronics. Inertial sensors are commonly classified under four performance categories:

- Navigation Grade
- Tactical Grade
- Industrial Grade
- Automotive Grade

according to the stability of the output of the sensors over time.

Inertial sensors range in form, fit and function, from tiny, highly integrated MEMS sensors to large high-precision ring laser gyroscopes.

InnaLabs quartz servo accelerometers and coriolis vibratory gyroscopes combine high precision with rugged design and compact sizing making them an ideal solution for a wide range of industrial, aerospace and defence applications.

Inertial sensors are used in a variety of defence applications, with each application having its own specific requirements in terms of size, power, weight, dynamic range, bandwidth, bias stability, noise and ruggedness.

Overview of uses of inertial sensors in military applications

Military applications represent approximately 50% of the value of the annual inertial sensors market worldwide, or approximately $650M in 2014. The demand for high performance inertial sensors in military applications continues its steady growth, as defence forces push for progressively higher performance at lower cost.

The largest military application for the highest performance (so-called navigation grade) gyroscopes is in the navigation of airborne, marine or land-based systems. Low end navigation grade and tactical-grade gyroscopes are predominantly used in either platform stabilisation or missile guidance applications, in addition to AHRS or backup instrumentation applications.

The predominant use of accelerometers in military applications is in inertial navigation systems (INS), in attitude heading and reference systems (AHRS) and in flight control systems for fly-by-wire military aircraft. These safety critical applications require accelerometers with very high accuracy over time, in addition to exceptional reliability, which makes quartz servo accelerometers the ideal solution.

Coriolis Vibratory Gyroscopes

The principles of Coriolis gyroscope technology date back to Foucault's experiments in Paris in 1851, where he used a pendulum to measure the earth's rotation. In the latter half of the 20th century, gyroscopes based on the Coriolis principle have become increasingly common, with a variety of sensor types being used, based on tuning forks, planar rings, hemispherical and cylindrical structures.

InnaLabs proprietary Coriolis Vibratory Gyroscope (CVG) technology is based on the control of a number of standing waves in a highly-tuned resonator, whose performance which is optimised for maximum sensitivity to Coriolis forces, and with maximum rejection of noise and interference from external sources. These resonators are the core of each sensor, and are shown in Figures 1 and 2 below.

Figure 1. InnaLabs Sensitive Element Manufacturing

Figure 2. InnaLabs Sensitive Elements

Each CVG resonator is operated in a resonant mode, where a stable standing wave in the metallic structure is sensitive to rotation applied to the gyroscope. When the sensor is rotated about its sensitive axis, the resulting Coriolis forces acting on the resonator's vibrating mass elements are sensed by piezo-electric elements, and are transduced into an angular rate signal.

Benefits of CVG Gyroscopes

InnaLabs proprietary CVG technology is based on many of the principles which are used in HRG technology, but implemented in metal rather than quartz or silicon, and with piezo-electric pickoffs rather than capacitive transduction.

This allows InnaLabs CVGs to offer excellent bias stability across a high bandwidth, and with very high shock survivability. Furthermore, the key differentiators of InnaLabs CVGs are the very low noise and very high MTBF (500,000 hours) which the sensors offer.

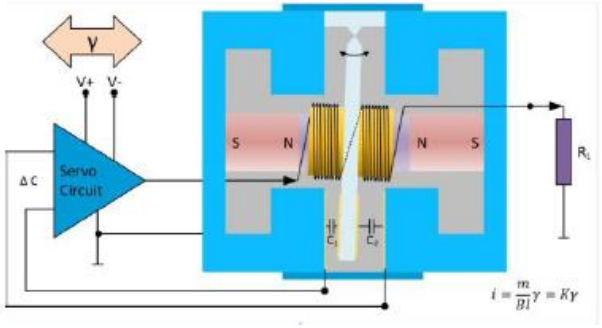
Quartz Servo Accelerometers

An accelerometer is an electromechanical device that measures the force of acceleration. This force can be static (such as gravity) or dynamic (caused by changes in velocity during shocks, vibration or movement). There are many different types of accelerometer which cater to different application requirements.

These range from MEMS based accelerometers commonly found in applications requiring lower performance sensors, to high grade quartz servo accelerometers in the most demanding aviation and navigation applications.

Servo accelerometers operate on a principle where acceleration causes a seismic mass (known as a "pendulum") to move. When it does so, its motion is detected by a position-sensing device, whose output is an electrical signal which is fed to a servo control system that functions to generate an electromagnetic force to restore the pendulum to a neutral position.

This 'corrective' signal is directly proportional to the acceleration, and is output from the accelerometer. Servo accelerometers provide high accuracy and a high-level output and can be used to sense microgravity accelerations right up to ±100g.



Case Study – Inertial Navigation unit for missile

Inertial navigation systems have been widely used in missile system design with traditional missiles focused on precision and strategic strikes where terminal accuracy is the primary requirement from the INS to the more advanced guided missiles designed to intercept air and ballistic threats where accurate pointing of the seeker is required for target acquisition.

High performance accelerometers such as the InnaLabs AI-Q-2000 series quartz servo accelerometers provide a critical component for the inertial navigation system which provides the essential navigation data position, velocity and attitude information to flight control systems.

Figure 5 InnaLabs AI-Q-20x0 Series Quartz Accelerometers

Conclusion

Advances in inertial sensor technology are helping commercial, industrial and military markets to meet an increasing demand for accuracy and reliability across a broad range of applications, and at lower cost.

As Military systems have extensive qualification processes, which take considerable time, the need to build long-term solution-oriented relationships which offer benefits of ease-of-doing-business and supply chain flexibility are ever important.

InnaLabs inertial sensors are ITAR-free and cost-competitive per performance grade. We are a flexible, innovative and high-quality partner for your strategic programs.

Future Optical Network Architecture for Phased Array Antenna

Radiall Active Components Division, Mathias PEZ, Director of the Active Components Division

Abstract

This white paper describes the D-Lightsys vision for optical network based next generation active antennas and radars. Full optical network architecture, from the processing board up to the antenna Transmitter/Receiver Modules (TR modules) and down to the display and control station, is presented accordingly to the wide offer of D-Lightsys high performances optical modules.

Introduction

Active antenna enables new radar architectures by increasing modularity, reliability and improving beam forming and multiple targets tracking, but the reverse of the medal is that the bandwidth demands increase in consequence. Optical interconnect solutions are very promising to solve the bandwidth, performance, cost, weight and scalability compromise. Thanks to D-Lightsys high performances optical interconnect solutions with the world smallest power consumption by bit rate and by mm², Electrical to Optical (E/O)conversion can find advantages and places everywhere in the radar system. This paper doesn't intend to reveal any specify radar architecture, it presents a generic active antenna radar architecture and describes where optical interconnects can find a place and details their main advantages.

Radar and Active Antenna Architecture

Electronic integration and performances increased has change the classical way to design radars: single rotary large reflector antennas have been replaced by multiple elementary phased controlled radiating elements. Phased array antenna allows the design of more compact multiple mission radars.

Phased array radar architecture are mainly constructed around three mains parts:

- The active radiating elements: generally composed of several transmitter/receiver sub-system (TR Module) interconnected in a matrix way. Each of the TR module is responsible to generate/receive the electromagnetic field with a specific phase.
- The computing equipment: this element, controls the overall phase plan of the field to be generated by controlling each TR modules phase, it treats the received signals from the TR module and is responsible for the beam forming processing.
- The control and displays: this part is the interface to the radar operator. The decoded information is displayed and the main system parameters are controlled and operated.

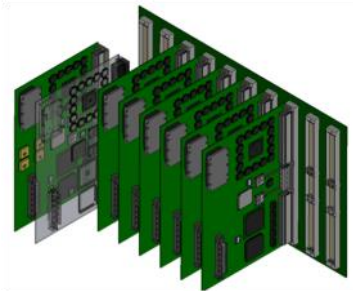
Each of the previous elements could be integrated together into a complete system such in a fighter aircraft or separated by several meters like in field or radar operated missiles battery, or eventually by kilometers for communication spy or counter measure systems.

Each elementary radiating elements, the TR module, are controlled independently in phase by the processing unit to form the radar beam. The number of TR modules could easily be higher than 100 for on boarded radar and higher than 1000 for larger antennas; interconnecting all the TR modules together is really challenging and become now days the network bottleneck. Optical communication withn the antenna, is therefore needed to overcome the bandwidth needs and to reduce the Electromagnetic Interferences (EMI) sensitivity. D-Lightsys optical transceivers and parallel interconnect solutions are good candidates as they have been designed for severe environment applications with the world smallest form factor and the lower power consumption.

Full optical interconnect radar architecture

A full optical interconnect radar architecture is detail in this paragraph, we describe where optical solution could be integrated to benefit of fiber and optical communication advantages. The network architecture described here, allows a simpler with higher performances, light weight and scalable radar design. A simplified full optical interconnect architecture is presented on fig.2. In this architecture, the fiber is used from the radar processing equipment up to each TR Module and down to the control station.

The antenna is composed with several TR modules connected through an interconnect matrix. An optical link is proposed to provide the information from and to the processing unit located behind the antenna or several meters or kilometers away. The processing unit is mainly based on a parallel architecture to overcome the bandwidth and computing needs.



Each sub processing nodes exchange data with the others to form the beam and decode the received signals. The treated information is therefore routed to the control and display station to operate the eventual missile launch or the coun-

Fig. 2 : Full optical network active antenna radar architecture.

Active antenna

The TR modules that composed (fig. 3) the active antenna integrates a radiating element (the antenna itself) followed by a circulator/duplexer that connect the antenna to the transmitter power amplifier (PA) or the receiving low noise amplifier (LNA). The phase of the local oscillator (LO) is controlled through a digital circuit by the processing equipment. The received signal, after amplification and filtering, could be digitalized and transferred to processing equipment.

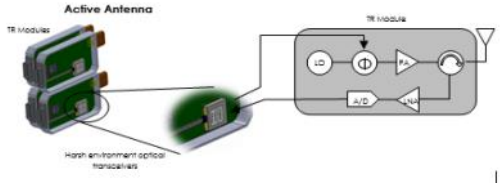


Fig. 3 : TR module details.

to D-Lightsys highly integrated optical transceivers, the E/O conversion could be achieved directly within the TR module. Both the phase controlled data (low bit rate) and the digitalized "video" signals could be transmitted over fibre. The main benefits of this architecture are:

- No need of expensive low loss SHF cable, as the fibre losses are negligible.
- The antenna wiring is simplified as it is not EMI sensitive, the fibre cable bending radius are much lower than the SHF cable.
- Lighter antenna, especially interesting for on board radar.
- Antenna could be physically separated from the processing equipment from meter to kilometer by using optical fibre communications.
- Use of cheaper, lighter and integrated rotary joint.

The E/O conversion, according to the TR module bandwidth and radar application, could be done at sub-system level, integrating several TR module in a sub-system. The sub-system generally regroups 4, 8 or more TR modules and E/O conversion is done in the backplane of the electrical interconnect layer. A optical active or passive interconnect matrix could be used to simplify the wiring and allow some switching pre-/post- processing at the antenna level.

Processing unit

The processing unit is retrieving the information to the antenna. Beam forming algorithm, Fast Fourier Transform and several other mathematical operation are done on the signals to provide to the operator or system the relevant application. This equipment is mainly a rack mounted distributed DSP/processors/FPGA computing boards interconnected through a dense high performance backplane exchanging intermediate processing results in real time. The bandwidth demand could very high to maintain the real time requirements and optical interconnect

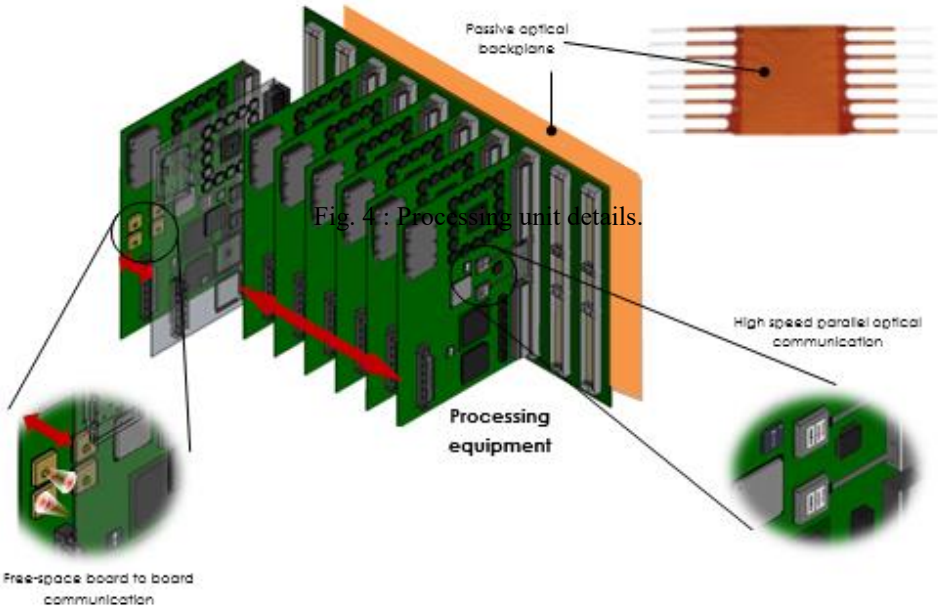


Fig. 4 : Processing unit details.

D-Lightsys offers two types of optical transceivers/modules that could be used directly in the processing unit: Parallel optical modules (D-Light Family) could be used to interconnect the boards together, a single module package could handle an overall bit rate of 50Gbps to 120Gbps (12 channels at 4.5Gbps/ch or 10Gbps/ch). One couple of multiple channel Tx and Rx module could be place onto the processing board or a mezzanine one and interconnected to a passive optical mesh backplane.

The optical backplane could be designed and changed according to a specific mission profile without modifying the electrical backplane. The fig. 4 present a flexible optical backplane that realize a 8x8 interconnection matrix.

Free-space optical interconnect (FSOI) solutions could also be used to communicate from board to board within the processing rack. D-Lightsys recently introduce a family of product (F-Light) designed for short distance optical communication ranging from 1cm up to 60cm with misalignment tolerances compatible with rack vibration and alignments: with lateral misalignment of +/2cm and angular misalignment of +/-1°. This solution simplify the design and the manufacturing of the electrical backplane as no high speed tracks need to be routed though the backplane connectors and long distance.

Thanks to a expanded beam design, the F-Light solution is dust and humidity robust and compatible with differential board vibrations. Simple holes in boards allows communication from one board to any others. The main advantages for FSOI into the processing unit is the power consumption reduction (no need for pre-emphasis/equalization techniques), design simplification, increase of mission scalability, cost reduction.

Display and control station

The human interface allows the radar operator to assign mission and retrieve the treated operation in order to operate missile or counter measures. The control station is sometime far from the processing unit or antenna and need optical communications compatible with field operations to match the distance/bandwidth requirements.

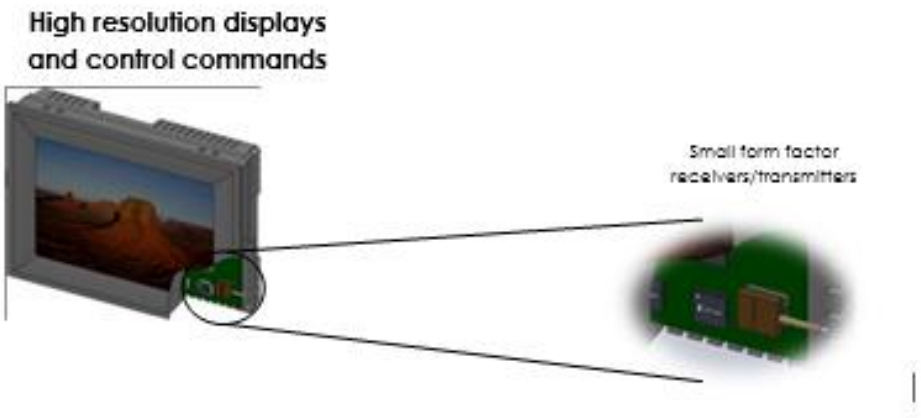


Fig. 5 : Full optical network active antenna radar architecture.

High performances, and very low profile optical transceivers are needed to enable high resolution displays. With a very small form factor package (12x13x5mm) S-Light devices are perfectly adapted for such applications as they are compatible with ARINC 818 standard and allows 3.125Gbps communications over 500m using a multimode 50/125µm fibre.

Conclusion

The wide D-Lightsys high performances optical interconnect offer covers the whole communication needs for high performances phased array radar. Radar could benefits of the main advantages of optical communication (low weight, galvanic isolation, EMI insensitivity, integration, scalability and reliability) from the TR module down to the control/ display station via the processing unit thanks to D-Lightsys products.

INVISIO®

Noise Induced Hearing Loss

Sound contains a vast amount of very complex information. This is why hearing, together with sight, is the most advanced human sense. Our ears can register incredibly detailed information (sound).., Hhowever, if the sounds are too loud, they become harmful noise. Such noise damages the sensitive structures in our inner ear, causing Noise-Induced Hearing Loss (NIHL).

NIHL is caused by the degeneration of tiny sensory cells (hair cells) in the inner ear, which leads to a reduced conversion of the received sound into electrical signals to the brain. Once these cells are damaged, the hearing loss is beyond repair. NIHL can, only to a certain degree, be compensated for by hearing aids.

Extreme noise can be grouped into two categories: Continuous exposure over extended periods of time (such as transport in helicopters, aircrafts or heavy vehicles) and intense impulse noise (explosions, gunfire). As both categories are part of everyday life for many military units and special forces, both types of noise can result in NIHL. NIHL is a physical – but invisible – injury located in the inner ear. This decay in hearing will increase almost seamlessly and the person may not notice it for a while, until perceiving sounds to be distorted or muffled.

Consequences of NIHL

Soldiers who choose not to use hearing protection often end up with NIHL (tinnitus, short-term or permanent hearing loss or even deafness). As a result, soldier's cognitive abilities are severely reduced, and the ability to heard commands (over radio, intercom or simply face-to-face) and to carry out assignments may be lost. Off duty, soldiers suffering from NIHL will be isolated and have difficulties socializing with friends and family

.

As a consequence, military authorities have a high focus on alleviating this human suffering and to reduce the compensation costs for occupational injuries. For military personnel, NIHL is the #1 physical hazard in health statistics; in the US alone the government spends pays more than USD 1 BillionSEK 7 [IN USD???] billion a year in compensation and for treatment of its military veterans who have been affected by NIHL while on active service. This number does not include the significant investment loss for soldier training, when hearing impairment suddenly makes soldiers incapable of duty.

The answer to NIHL: User accepted hearing protection

To prevent NIHL, world class hearing protection is required. However, to carry out the assignments successfully, the applied hearing protection technology cannot shut out important sounds. All too frequently, soldiers avoid using simple hearing protection in order to fully be able to register important information in their surroundings, as blocking the ears with a common hearing protector will cause an immediate loss of situational awareness due to its attenuating nature.

At the same time, for these individuals, reliable (radio-) communication can be the difference between success and failure, or even between life and death. A hearing protection system must not only protect against unavoidable noise, but also allow the use of radio communication under these extreme conditions.

Finally, an important selection criteriacriterion for a hearing protecting system is the user acceptance in terms of ease-of-use, comfort, and fit - even on longer missions.

INVISIO's reply to the NIHL challenge

Since the launch of the first INVISIO Hearing protection system in 2009, the company has continuously optimized its portfolio to reduce the soldiers' risk and ensure mission success.

An INVIVISIO hearing protection systemmes consists of anon in-ear headset with built in passive hearing protection, combined with an externmal microphone for hearing external sound ("situational awareness"). The headset utilizes a the unique INVISIO patented Bone Cconduction Ttechnology, which providesing clear radio communication even under extreme noisy conditions. The headset is connected to an interface unitint, which connects to radios and other communication devices, and provides PTT functionaltyfunctionality and control of the stuationalsituational awrenesawareness volume.

This unique technology guarantees a very high level of hearing protection, while still allowing the user to hear the surroundings as well as register the source and direction of sounds. It The lightweight system can be interfaced simultaneously to up to four communication devices, existing commucation systems, such as radios, intercom, mobile phones and moreincluding. Besides bBeing used by military and police special forces units worldwide, large military programs have extensively tested and selected INVISIO hearing protection systems to be issued to their soldiers. Recent programs to deploy an INVISIO system include THPS (UK), TCAPS (US), ISSP (CAN), and LAND125 (AUS).

Flexible Switching for Flight Test Networks

Diarmuid Collins, Curtiss-Wright Dublin, Ireland

ABSTRACT

The network switch is a critical element in the flight test network. All devices in the network are configured, synchronised and managed via the switch. In addition to this all acquired data is routed through the switch. For these reasons, the flight test network switch has always needed to be rugged and reliable with high throughput and simple intuitive setup. Ethernet technology and the move towards open standards within FTI systems have enabled flight test networks to become increasingly flexible and heterogeneous. Modern FTI networks may have different synchronisation and data transmission protocols running simultaneously. It is also important to quickly switch network configurations for different flight profiles and to enable new features to be easily added to existing installations. This paper examines the increasing network interoperability and flexibility challenges and discusses how the network switch is best placed to provide solutions.

Keywords: Ethernet, switching, FTI, PTP, SNMP

1 INTRODUCTION

In Flight Test Instrumentation (FTI) as the acquired volume of data increases, the industry is migrating from IRIG 106 chapter 4 PCM to Ethernet networks.
Ethernet has a long history in the commercial and industrial markets. Since the initial definition in the 1970s to the first agreed IEEE 802.3 standard in 1983, Ethernet has grown both in commercial market size to a multiple billion dollar market and the technology has developed to be capable of transferring data rates in excess of 100Gbps.

Using Ethernet in FTI networks brings a number of significant advantages:

- Wide range of off-the-shelf commercial Ethernet products, from switches, network interface cards, recorders amongst other equipment.
- Mature standards build around Ethernet for the transmission of data, the configuration of networking equipment, synchronization of network elements.
- Wide range of software, both commercial and open sourced, for interfacing and manipulating Ethernet data and equipment.

1. Scalable network infrastructure and data rates from 10Mbps to 100Gbps with a future path to higher rates.

FTI networks have a number of requirements that necessitate specific consideration and place constraints on Ethernet networks.
Traffic on FTI networks tend to be heavily asynchronous, that is to say that the data rates and volume of traffic on an FTI network in one direction are far higher than in the opposite direction.
Determinism and loss-less transmission are two highly desirable features in an FTI network. To ensure the transmission and recording of all the acquired parameters, packet loss on the network is not acceptable, regardless of the network layer or application layer protocol being used. In many commercial implementations, the reliability of the data transfer is handled by the transport layer, requiring retransmission for lost packets.

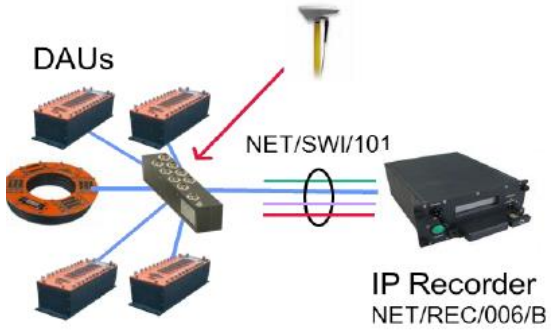


Figure 1 FTI Network Elements

2 THE NETWORK SWITCH

The core of an Ethernet network is the switch. An Ethernet switch may operate at one of more layers of the OSI network model [1]:

1. **Layer 1.** The lowest layer switch is known as a repeater or a hub. It is simple device which does not manage the traffic through the device.
2. **Layer 2.** A network bridge which switches Ethernet packets based on MAC addresses.
3. **Layer 3** / 4. Commonly known as routers. Switches network traffic based on IP, TCP, UDP and application layer data.

FTI network switching typically requires layer 3 and 4 switching, at a minimum where traffic is routed and switched based on UDP ports, IENA [2] and iNET [3] stream identifiers.

3 SWITCH DESIGN

COTS Ethernet switches and switch cores support a wide range of features and requirements driven by commercial Ethernet networks. Dynamic switching and self-learning of network topologies are required to support dynamic and changing networks in benign environmental conditions.

FTI networks on the other hand may not require all of these features but instead need to be rugged and very reliable. Ruggedness is dictated by a number of environmental standards, specifically DO-160 [4] and MIL-STD-704 [5]. These two standards define a minimal set of environment test conditions, covering: temperature, humidity, shock, vibration, power interface to the aircraft, among others.

Network switches can be implemented primarily using two approaches. Application Specific Integrated Circuits (ASIC) can be implemented to perform switching and configuration of the network switch, usually with on chip microprocessors (MCU). These MCUs run management and configuration firmware on an RTOS or even embedded OS such as Linux.

ASIC development is very expensive undertaking and as a result, a very limited number of large companies such as Marvell [6] and Intel design very flexible switching products which are then sold off the shelf. OEM manufactures integrate these products, customising the firmware to implement the feature set of interest for their product. Customisation to the lower level hardware is not possible without commercial justifications in the hundreds of millions of dollars range.

A second approach is implementing the switching and management functionality in Field Programmable Gate Arrays (FPGA). FPGAs have the advantage of much shorter and cheaper development cycles, with some trade off in the volume of supported features. The switch manufacturer can design the feature set of interest for their product line and exclude the unwanted functionality that the more general purpose ASIC switch cores support.

For an ideal FTI switch the latter approach has significant advantages. Within the FPGA, a store and forward switch fabric can be implemented using state machine based code. Dynamic learning algorithms for routing and on board OS are not required due to the more limited set of requirements reducing the time from power up to operation, simplifying the design and consequently, increasing the reliability of the switch.

The static forwarding and filtering configuration, stored in on-board non-volatile memory, allows the switch to start routing based on a pre-defined set of rules as soon as power is applied. As an example, the NET/SWI/101 from Curtiss-Wright powers-on, achieves link up and is transmitting within 2 seconds [7].

In certain FTI networks, the ability to tap an Ethernet link for monitoring purposes can be a very useful feature. Most switches can be configured to perform such functionality, however minimising the latency through the switch can be challenging. The FPGA based designs can be configured to bypass the core keeping latency to the minimum for “tap”-like performance.

4 TIME SYNCHRONIZATION

Ethernet networks support a number of well-defined and supported time synchronisation protocols. The two most widely known and used are Network Time Protocol (NTP) [8] and Precision Time Protocol (PTP)

NTP

NTP is a time synchronisation protocol widely used to synchronise desktop computers on packet switched networks, most famously the Internet. Sub second accuracy is possible, with simplified implementations known as SNTP also available. The accuracy is good enough for consumer applications.

PTP

PTP is an IEEE standard used to synchronise clocks in a network, using similar principles to NTP. Unlike NTP, it was designed to achieve sub-microsecond accuracy. This accuracy makes it more suitable to FTI networks than NTP. The original standard was agreed in IEEE 1588-2002 [9] and is known as PTPv1. The second revision of the standard was agreed in IEEE 1588-2008 [10], improving accuracy precision and robustness. However PTPv2 is not backward compatible with PTPv1.

PTP in FTI Networks

Synchronisation of all data acquisition units in an FTI network is a key requirement. The time correlation of the data on the network is a function of the synchronisation accuracy. Clearly the time synchronisation protocol of choice is PTP. This raises the requirement for the support of a number of PTP related features in the ideal FTI switch.

In a PTP-synchronised network, one element in the network acts as the master to all the time slaves, this is the Grandmaster (GM). The GM acquires time from an external time source such as GPS, IRIG Analog and Digital or a battery backed Real Time Clock (RTC) and synchronises the slaves to this time source. With non-backward compatible standards in PTPv1 and PTPv2, support for both grandmasters is required

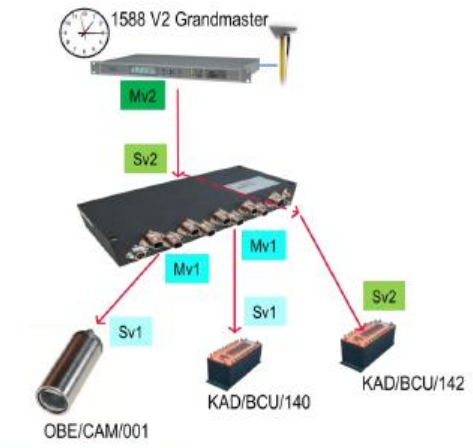


Figure 2 Mixed PTP clients

In a larger network where the switch is not a PTP grandmaster, to improve on the synchronisation accuracy, the switch should appear invisible to the PTP conversation. This is known as PTP transparency. The propagation time of the PTP packets through the switch is measured and the timestamps are adjusted accordingly, removing the propagation delay. Support for PTP transparency is required in both PTPv1 and PTPv2 modes of operation.

With non-backward compatible protocols, it is not uncommon for network devices supporting either PTPv1 or PTPv2 to co-exist on the same network. Ensuring that these PTP clients are synchronised to the one time source requires the FTI switch to support the translation or bridging between the two protocols. This is a very powerful and useful feature allowing the network designer to mix clients comfortably on the one network.

While PTP is the time synchronisation mechanism on the network, the absolute time needs to be acquired by the Grandmaster to allow for accurate absolute time synchronisation.

Historically IRIG-B was a standard created by the US military defined in 1960, the latest revision of the standard published in 2004. This standard is widely supported in FTI networks both in analog and digital formats.

The Global Positioning System (GPS) is another very popular space-based location and time synchronisation system. If the FTI switch supports GPS, it allows the time to be synchronized to the satellite based atomic clocks. This is a very accurate and cost effective mechanism for acquiring absolute time.

Time Synchronization in the ideal FTI Switch

As described, there is a long list of time synchronisation features that the ideal FTI switch should support, to a high level of accuracy. Acting as a PTP v1 or v2 GM, taking time sources from GPS, IRIG or free running from an on-board RTC. The bridging of PTP protocols allows the FTI engineer to define a per port PTP protocol selecting between v1 and v2.

5 TRAFFIC FILTERING

As previously mentioned, switches typically route data based on a certain level of the OSI model. In a level 2 switch, the Ethernet MAC address are used to automatically route traffic to ports on which that particular networking interface is connected. A level 3 or 4 Ethernet switches can route traffic based on IP address or UDP ports as an example.

FTI networks are heavily asymmetric with a large number of sources but a limited number of sinks. These sinks may have very different requirements.

Network recorders typically have a very large bandwidth and storage space so will generally record all the traffic on the network for later analysis and archiving. As a result the network switch will generally route all traffic to ports on which the record is connected, filtering none of the traffic.

In certain applications it may also be desirable to separate certain high volume traffic to a dedicated recorder. One example of this may require all video traffic to be recorded on a dedicated recorder. Such selective switching could be implemented using a dedicated multicast IP address for video traffic. The FTI switch is then required to switch this traffic to the dedicated video recorder.

Transmitters on the other hand have a very limited bandwidth but give engineers on the ground very valuable insight into key information on the FTI network. In this scenario the switch is required to filter based on very specific parameters from the Ethernet traffic. In IENA traffic, a specific stream identifier in combination with a UDP port may contain parameters of interest. The FTI switch therefore requires the ability to switch based on multiple header fields at all layers of the OSI model.

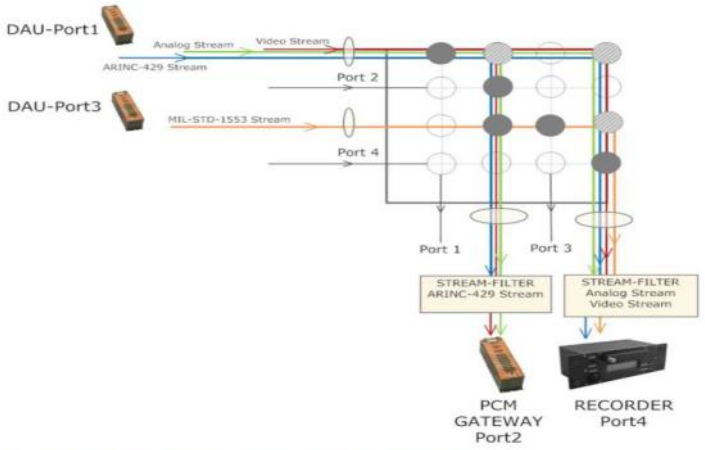


Figure 3 Dynamic routing in a configurable crossbar

An on-board data processing unit connected to the network would have similar requirements to the transmitter, in that it could only process a subset of the traffic during the flight. However in addition to filtering the traffic, the required switching configuration could change during the flight to allow the engineer to perform analysis at different phase of the flight. For example on take-off, the switch could be configured to pass stream identifiers in the range 0x1 to 0xF to the data processing unit, then at altitude, filter this traffic, allowing all traffic on UDP port 4444.

The FTI switch therefore, should have a rich set of filtering and switching functionality built into the switch core. A standard set of switching based on layer 2 and 3 header fields should be supported. In addition to this, it is desirable that custom switching rules can be implemented at the application layer. Even more powerfully, the engineer could define fields within the payload of the packet and filter based on these values. This level of flexibility results in a very powerful switch. All these filters should be stored on the switch in non-volatile memory, in an efficient lookup table to allow the traffic to be filtered at line speed through the switch, avoiding any bottlenecks in the data path.

6 CONFIGURATION OF NETWORK SWITCHES

With the expanding features and configuration options available on FTI switches, ease of configuration is more important than ever. The configuration of such devices can be implemented either proprietary configuration software or open standards which have been adopted for such purposes.

TFTP [11] is a file transfer protocol that has been developed specifically for light weight file transfer. The server can be implemented with a minimum of CPU and RAM requirements making it suitable for embedded devices. For the transfer of large configuration binary files, it is a widely adopted protocol used on switches.

Simple Network Management Protocol (SNMP) [12] is an open internet standard for managing devices on an IP network. It is typically used to monitor and configure switches and recorders. It is a self-documenting protocol that is used to configure smaller volumes of configuration data. Off the shelf SNMP managers are widely available for Windows, Linux and OSX operating systems which can then be used to manage the networked devices.

This configuration phase itself can be split into two distinct phases, dynamic, on the fly configuration and static configuration prior to acquisition. FTI network topologies are generally relatively static and as a result prior to flight, these networks can be defined and the switches configured with the routing and filtering tables. With a broad range of options available, the configuration at this point can be significant with settings for different filtering options to be setup for a number of phases of the flight. The configuration would ideally be stored in a local setup file on the engineers PC, to make iterative changes to the network configuration simple. An example of such a file format is XidML (eXtensible Instrumentation Definition Markup Language). [13]

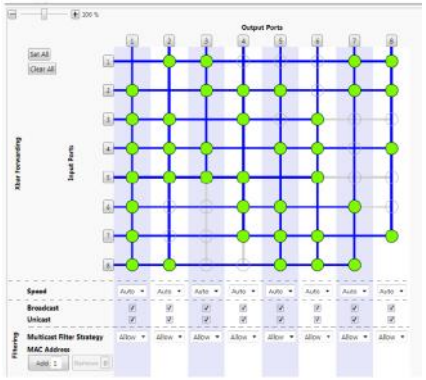


Figure 4 Simple crossbar configuration

Once this configuration has been completed, programmed and stored locally the switch is configured and ready for flight. Once in flight, this static configuration will not be modified, however now the dynamic configuration aspect takes place. The FTI engineer may want to monitor network traffic, link status and the health of the network as well as switch, between the various phases of the flight. SNMP managers running on PCs connected to the network can select between the various configurations that were preconfigured, in a seamless manner, with little or no packet loss.

Monitoring, using an SNMP manager allows the FTI engineer to query the health of the network switch, however it can be useful to have automatic or passive health reporting. Such a facility would allow the switch to periodically report on various metrics in a status packet. This status packet could easily be telemetered to the ground as well as recorded. The advantage of such approach is that a query/response mechanism is not required, which in many telemetry links is not possible, and the information density of a status packet makes it a very efficient use of the limited telemetry bandwidth.

7 Future-Proofing Network Switches

Over time, as the size and complexity of airborne networks continues to increase, the demand for additional features and performance upgrades continues. Some of these upgrades will require replacing existing hardware in the instrumented airplane, however there is significant scope for FPGA-based designs to incrementally upgrade the programmed “firmware” of the FPGA. This mechanism allows the user to remotely upgrade the feature set of the switch without physically removing or even accessing the switch. The upgrade process can be implemented in a similar mechanism to the static programming of the device over the Ethernet interfaces using TFTP.

Such an upgrade could feasibly be executed in minutes between flight tests, if the demand arose. Naturally, such a process has potential to be interrupted so significant effort and measures need to be taken to ensure that the process cannot result in a non-working or unusable switch. “Fall-back” firmware images are untouched on the switch to ensure any interruptions in the programming cycle do not result in a non-working switch.

8 Conclusion

FTI network switches, which sharing some commonality with COTS Ethernet switches have specific demands of their own. The relatively static nature of FTI networks in combination with stringent reliability and rugged requirements places specific demands that many switches cannot meet.

Flexible switching and filtering requirements, advanced time synchronisation mechanism and rugged, deterministic and scalable performance are key to modern flight test network switches.

9 Glossary NTP Network Time Protocol
PTP Precision Time Protocol
FTI Flight Test Instrumentation
ASIC Application Specific Integrated Circuit
FPGA Field Programmable Gate Array
TFTP Trivial File Transfer Protocol
COTS Commercial Off The Shelf
CPU Central Processing Unit
RAM Random Access Memory
GM Grand-Master
RTC Real Time Clock
SNMP Simple Network Management Protocol
iNET Integrated Network Enhanced Telemetry

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The Challenges of Data Acquisition in Harsh Remote Places

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ABSTRACT

In modern flight test installations there is a continuing trend to move the data acquisition closer to the sensors. As a consequence the data acquisition chassis needs to be mounted in locations that are small, inaccessible and subject to harsh environmental conditions. On top of this there are an increasing number of measurements required for each new flight test campaign. This paper discusses the challenges of designing a small lightweight data acquisition chassis which can provide hundreds of channels of measurement capability while operating in tight spaces which are exposed to fluids, high vibration and extremes of temperature. The paper suggests ways of designing and installing the data acquisition chassis in order to optimize the available installation space while mitigating the effects of the harsh environmental conditions.

Keywords: Data Acquisition, DAU, Modular, Flexible, Remote, Miniature, IEEE 1588, INET

1 INTRODUCTION

In a drive to reduce the wiring of flight test installations there is a continuing trend of moving the data acquisition chassis closer to the sensors. As a consequence the data acquisition chassis needs to be mounted in locations that are small, inaccessible and subject to harsh environmental conditions. This paper discusses the implications of these requirements on the design of the data acquisition chassis. The paper begins with a recap of some of the more important data acquisition design concepts such as reliability and modularity which are so important for flight test equipment. The paper then investigates how small the data acquisition chassis can get while maintaining modularity and flexibility. The paper also presents some solutions to the difficult environmental conditions that are found in remote locations, such as high temperature and exposure to fluids. Finally the paper examines some of the system requirements placed on miniature modular data acquisition chassis.

2 DATA ACQUISITION DESIGN CONCEPTS

Modern data acquisition chassis require a very high degree of flexibility and configurability. Flexibility can be provided on the chassis level by designing each chassis to consist of multiple acquisition cards, with each acquisition card carrying out a different function

Further flexibility can be provided at the card level by allowing the behavior of the acquisition card to be configured. At the chassis level the flight test instrumentation engineer can create almost any configuration with a large catalog of acquisition modules.

Depending on the platform, the size envelope available to install a data acquisition chassis will vary. Therefore it could be argued that the flight test instrumentation engineer requires multiple chassis types, each of which will house different sized data acquisition cards. In this scenario each chassis will come with its own catalog of acquisition cards. However this approach has its disadvantages. Firstly the flight test instrumentation engineer will not be able to mix and match his acquisition cards between different chassis. A card from one chassis will not necessarily fit into a second chassis type. Secondly it is unlikely the vendor of the equipment will support all interfaces in all chassis types. Therefore many possible configurations will not be supported.

In fact it is possible to create many different chassis shapes and sizes using the same sized data acquisition cards. Figure 1 shows many examples of a KAM 500 chassis all of which use the same data acquisition cards. This solution allows you to tailor your chassis for different size envelopes while choosing acquisition cards from a single large catalog.

Figure 1 KAM 500 Chassis Shapes and Sizes

All the chassis in Figure 1 are solid chassis in the sense that the there is a chassis into which data acquisition cards are inserted. Another method of building chassis is to construct the chassis out of the acquisition cards themselves. Using this "slice of bread" method there is no separate chassis. The chassis is formed by connecting several acquisition cards together and securing them via some locking mechanism. This method has the advantage that the flight test engineer can build a chassis with any number of slots up to a maximum value. However the "slice of bread approach" also has a number of disadvantages.

Firstly when removing a module from the chassis it is not a simple matter of removing the module that you would like to change. The entire chassis must be disassembled in order to remove any module. Secondly the orientation of the modules in the chassis cannot change. Using the solid chassis approach shown in Figure 1 the orientation of the acquisition cards in the chassis can changed to create a long narrow chassis or even a circular chassis which could be mounted on a rotor. Furthermore it is also possible with the solid chassis approach to create a chassis which is any number of slots in length, up to a maximum value.

Arguably the most important feature of a data acquisition chassis is reliability. If the acquisition chassis malfunctions during flight then the test points will need to be re-flown. This incurs a large expense. It has been shown that designing data acquisition chassis using FPGA based state machines produces extremely reliable data acquisition products. Even if the system gets into an unforeseen state due to power dips during flight it will cycle out of that state within one acquisition cycle and begin operating normally again. It is quite common for processor based systems to not recover fully after such an event. Also in the event of a brief loss of power to the acquisition chassis, a chassis designed using an FPGA based state machine approach will begin acquiring data immediately after resumption of power. This is due to the fact that there are no processors which need to reboot. Acquiring immediately on power up enables test points to be completed even when there is a temporary power interruption to the acquisition system.

3 MOVING CLOSER TO SENSORS

It was noted in section 2 that using a solid chassis approach chassis of many different shapes and sizes can be created, all of which use the same catalog of data acquisition cards. However there is a limitation to how small you can make a data acquisition chassis which houses a particular type of data acquisition card. In order to house at least one card the chassis must be larger than the dimensions of a single card. In practice the chassis needs to be significantly bigger than a single acquisition card as the minimum requirement for a chassis would typically be an acquisition card, a transmitter card (to send data via Ethernet or IRIG 106 chapter 4 PCM) and a power supply. The amount of wiring required on a flight test installation has always been a concern for flight test instrumentation engineers. The time taken to define and install the wiring, the necessity to drill holes through structures and the sheer weight of the wiring bundle are all reasons why there is a continuing drive to reduce the quantity of wiring on a flight test article. One way to reduce the quantity of wiring is to move the data acquisition chassis closer to the sensors. This has the advantage of replacing a section of the wiring loom with a single Ethernet cable from the chassis. As the data acquisition chassis moves closer and closer to the sensors the available locations where a chassis can be installed get smaller. In some cases the space envelope may be smaller (at least in 2 dimensions) than the dimensions of the data acquisition card that is used in the rest of the configuration.

One solution for these locations could be the creation of a dedicated acquisition box which fits in the required dimensions with a small number of measurements. However a dedicated acquisition box will solve the acquisition needs of only one location on one test article. A new box would need to be defined and created for every other location, which would typically have a different number and different types of measurements.

The way to solve this generally would be to create a miniature modular chassis which could be populated with miniature acquisition cards.
However even this approach has its limitations. As noted previously the smallest modular chassis will typically require an acquisition card, a transmitter and a power supply. As data acquisition chassis get smaller the power supply is increasingly becoming a larger percentage of the volume. This is due to the fact that any piece of equipment which is connected to aircraft power must comply with standards such as MIL STD 704 to ensure that it can be used safely on the aircraft.

In order to fit the acquisition into even smaller spaces it may be necessary to mount the acquisition card itself in a separate location to the chassis. This acquisition card would send its acquired data back to the chassis via a serial cable from which it would also be powered. This would ensure that the acquisition card could fit in a space that was just marginally larger than its own dimensions. Multiple of these remote cards could be connected to single chassis to allow a network of miniature acquisition to be placed in the tightest of spaces. The fact that these cards could be used internal or external to the chassis would allow a relatively large catalog of cards to be created.

4 ENVIRONMENTAL CONCERNS

Another consequence of moving the data acquisition chassis closer to the sensors is that the chassis will get placed in more inhospitable places. For example one location for remote chassis is in the engine casing. During some phases of the flight test the ambient temperature of the casing will be in excess of 100 degrees Celsius. The electronics of the acquisition chassis will also add some self-heating. The 2 primary means of removing heat from a chassis are convection via air flow and conduction via the surface that the chassis is installed on. However in some locations there is very little airflow and the surface on which the chassis is installed is not thermally conductive. In this case depending on how much power is being consumed in the chassis, the chassis may be between 20 and 40 degrees hotter than ambient. This can result component temperatures outside the operating range of even military grade components.

One potential solution is to add a large heat sink to the chassis to increase the surface area and allow more heat to be dissipated by convection. However this results in a much bigger chassis, negating the advantage of a small sized chassis, and prevents the chassis from being installed in many of the locations it could have been installed without the heatsink.
Another potential solution is to locate many of the acquisition cards remotely from the chassis. This drastically reduces the heat generated in the chassis itself as most of the power will be consumed by the electronics on the acquisition cards. Also the surface area of each acquisition card would be sufficient to dissipate significantly more heat than if the cards were physically located together in chassis.

Another inhospitable location for a miniature data acquisition chassis is the landing gear of a fixed wing aircraft. While the temperature will be more benign in these locations the chassis may be more exposed to the elements and sprayed with various fluids while on the ground. One of the challenges with a modular chassis is ensuring that the chassis is fully weather sealed. A chassis that is designed to allow modules to be quickly and easily removed may have small gaps between the modules when they are installed in the chassis. These gaps can be filled using form in place gaskets. Form in place gaskets use elastomer to provide sealing between two surfaces. The elastomer is applied to one side of the acquisition mod-

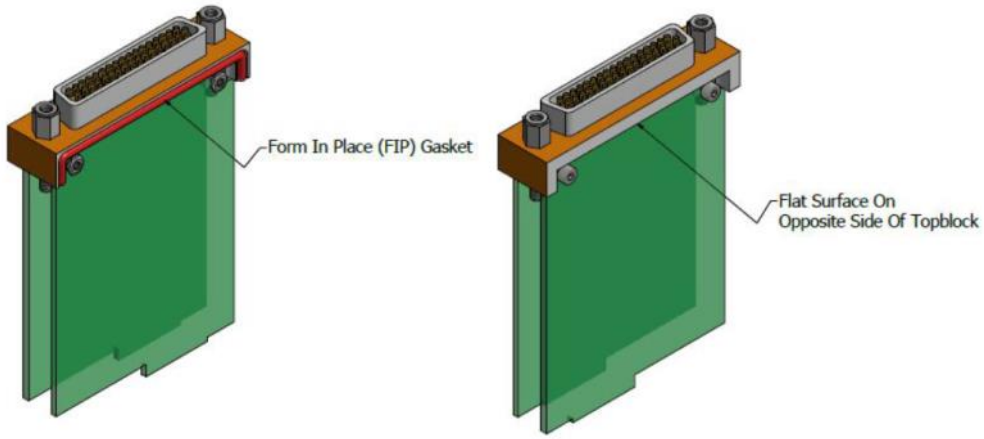


Figure 2 Form in place Gaskets

5 SYSTEM SOLUTIONS

In section 3 we discussed how the requirement to move the data acquisition chassis ever closer to the sensors could necessitate a miniature acquisition chassis with its own catalog of acquisition modules. However it is important to note that any miniature chassis would need to be fully compatible with existing data acquisition chassis such that a heterogeneous network of standard and miniature chassis could be created. It should be possible to program both chassis types from the same configuration software.

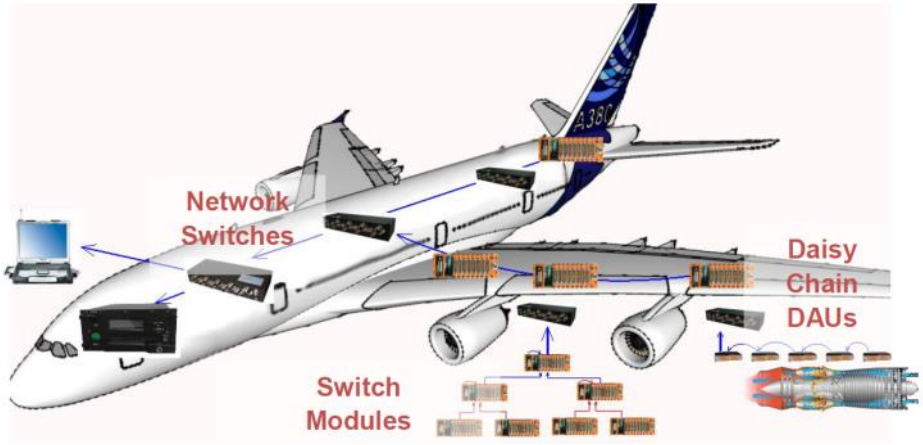
The entire configuration should be stored in a single configuration file, for example XidML [1]. It should be possible to analyze the acquired data from both chassis together in the same analysis software. Moreover in order to correlate the parameters from all channels in a heterogeneous network all channels must sample simultaneously. The network synchronization protocol IEEE 1588 [2] can be used to synchronize each chassis such that each chassis has the correct absolute. However it is equally important that both chassis have the same sampling strategy. For example if each chassis samples at the start of an acquisition cycle and at equal intervals thereafter and if the acquisition cycle is tied to absolute time then once the chassis are synchronized via IEEE 1588 they will also sample data simultaneously.

In fact to provide full flexibility of configuration each miniature chassis should be a full network node. This would allow any number of the miniature chassis to be added to a network which also included third party equipment. There is a large of number of open standards which can be used on Ethernet networks to ensure interoperability between equipment from different vendors.

In particular the INET working group [3] is defining a superset of these standards which should be supported such that there is consistent interface on flight test equipment from all vendors. In order for a miniature data acquisition chassis to be placed in any network, support for these INET standards is an important requirement.

In order to simplify the definition, installation and setup of the network it is also important that the miniature data acquisition chassis communicate with each other via Ethernet. In a typical flight test network a data acquisition chassis will acquire and packetize data, and forward those packets on to a recorder, a telemetry bridge or an on board processor. In modern flight test networks the telemetry bridge, recorder and processor may in fact be housed in one of the data acquisition chassis.

In an Ethernet network multiple nodes are connected via a network switch. The network switch can be a standalone box or a module that fits into the data acquisition chassis. While it is a necessity that a miniature acquisition chassis be able to house a switch module, in some configuration all of the slots in the chassis may be used for acquisition cards. One potential solution to this is to add daisy chaining capability to the chassis. In this scenario the controller card in the chassis would accept an Ethernet input from another chassis and combine the packets it receives from that Ethernet input with its own output packets for transmission upstream. By this method a number of chassis could be installed in tight spaces and connected together without the need for network switches or switch modules. Additionally given that the chassis is an independent network node, third party network equipment could also be daisy chained to the chassis in this way.



6 CONCLUSION

The trend to move the data acquisition chassis closer to the sensor leads to many challenges for the design of a data acquisition chassis. With the use of a solid chassis approach many different sized data acquisition chassis can be created. This has the advantage that the same acquisition cards can be used in all chassis regardless of whether they are located in the cabin or remotely. However in some cases the small space envelopes available for the installation of the chassis lead to the requirement for a miniature chassis.
A miniature chassis will have similar requirements to the standard chassis in particular modularity and reliability. It has been proven that designing data acquisition chassis using FPGA based state machines produces extremely reliable data acquisition products. One complication of modularity is that there is a limit to how small a miniature modular chassis can be made. One potential solution to this is to locate the acquisition cards remotely from the chassis. This will allow data acquisition solutions to be fit into very small locations.
Locating the data acquisition chassis closer to the sensors can also lead to the chassis being placed in inhospitable places. Placing the chassis in high temperature zones can cause the components to reach temperatures outside of their specification.

This can be a particular problem for miniature chassis where a large amount of electronics is squeezed into a small box. Building a chassis with remotely mounted modules may also serve to alleviate this problem. Fluid ingress is another challenge for modular chassis that are installed in locations which are exposed to the elements. However weather sealing can be accomplished using such technologies as form in place gaskets.
Finally it is important that a miniature chassis operates in a heterogeneous network with standard chassis from the same vendor and equipment from third parties. To ensure this, the chassis must be a full network node supporting open standards, including the soon to be published INET standards. In order to connect multiple miniature nodes to the network, it would be a significant advantage if the chassis had the built in capability to daisy chain other network nodes without needing a separate module. With these capabilities the remote miniature chassis would solve many of the challenges flight test engineers are currently facing.

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Wireless Data Acquisition in Flight Test Networks

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ABSTRACT

The use of wireless data networks is ubiquitous in the consumer world. They have gained significant traction due to advantages afforded by the lack of wires. These same advantages can prove valuable in Flight Test for data acquisition. Sensor nodes are ideal candidates for low bandwidth wireless networks. Located in remote, hard to reach and hostile environments, wirelessly acquiring data from such sensor can solve a number of existing issues for FTI engineers. Implementing such wireless communication introduces a number of challenges such as guaranteeing reliable transfer of the sensor data and time synchronization of the remote nodes. This paper addresses wireless sensor acquisition, the associated challenges and discusses approaches and solutions to these problems.

Keywords: WSN, Wireless Sensor Networks, LXRS, Wireless LAN

1 INTRODUCTION

Flight Test Instrumentation (FTI) systems extensively utilize wired networking technologies because they are a proven technology; however, in a number of scenarios wired networks present significant shortcomings. Most of these shortcomings, ironically, relate to the unavoidable fact that the networks involve wires.

One of the most significant of these limitations is accessibility, in a number of scenarios it is simply not possible to route a wire to a remote sensor thereby making acquisition impossible. Another limitation is weight. As networks increase in size and complexity, the weight of the wires contributes to a significant proportion of the total weight of the acquisition system. Additionally, the inflexibility of a wired network is another aspect which limits the utility of such a system and can significantly increase the cost of testing.

Wireless networks alleviate many of these issues. The ability of the wireless network to easily and quickly change its topology and augment an already installed network is a significant advantage that wireless brings. This paper will examine these issues and will propose solutions based on wireless technology. In particular, solutions involving wireless sensor networks will be addressed.

2 WIRELESS DATA ACQUISITION SCENARIOS

There are a number of specific use cases that can be considered for wireless data acquisition. Addressing these scenarios can help to identify the particular requirements for each scenario and therefore help in selecting the most suitable technology. The following are a list of uses cases identified in FTI

2.1 USE CASES

1. Wireless Sensors: Remote sensors gather measurements and the data is transmitted to a wireless data acquisition user module that allows the measurements to be transmitted on the wired network

2. Point-to-point Wireless Data Acquisition: Data acquired from various sensors and busses is acquired in a wireless remote DAU.

The acquired data is then transmitted wirelessly to a receiving wireless DAU.

3. Wireless Bridge. Two wired Ethernet networks can be bridged using a wireless link. This allows two networks which may be physically impossible to connect, be bridged using a wireless link.

4. Wireless Access Point: Multiple remote wireless RDAUS can associate with an Access Point and transmit the acquired data wirelessly to the access point. An access point is typically a router and a wireless bridge in the one unit. This unit also allows wireless clients such as real time analysis PCs connect to the FTI network.

5. Wireless Data Mining: A PC with a wireless network card can connect to the FTI network to mine the data recorded from the acquisition system.

6. Telemetry: A long-range Ethernet link to the ground to allow part of the acquired data be transmitted to the ground as well as commands sent to the FTI network.

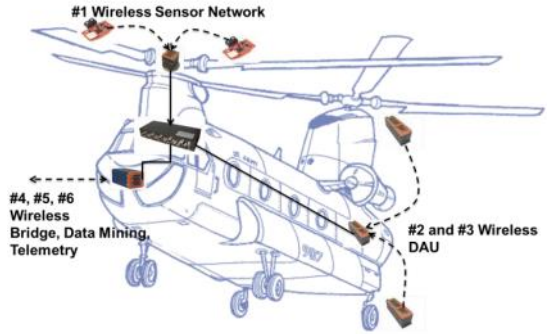

Figure 1 Wireless Acquisition Scenarios

2.2 FTI SPECIFIC CHALLENGES

Wireless networks in commercial spaces have already addressed a number of the issues which wireless communications systems encounter. Network contention is primary among these. Many protocols use a Carrier Sense Multiple Access with Collision Avoidance (CSMA/AC) schemes as a channel access method. This mechanism introduces packet latency, packet loss and a reduction in the transmit determinism and still may suffer collisions due to the hidden terminal problem or simultaneous transmission. These are all undesirable factors in FTI networks, where guaranteed delivery of packets, is a strict requirement. As a result, mechanisms to mitigate against packet loss should be accounted for in FTI wireless networks.
The variability in the packet delay through the network has a significant impact on time synchronization mechanisms such as Precision Time Protocol (PTP) [1]. PTP is a widely used time synchronization mechanism in FTI networks, allowing remote data acquisition units to be synchronized accurately to a common time source. In replacing wired links with wireless connections, the time synchronization of remote DAUs need to be maintained or replaced with equivalent schemes.

3 WIRELESS TECHNOLOGIES

There are a number of wireless standards that are currently in use in the commercial world. To match the FTI scenarios previously identified to wireless standards, it's important to compare these standards, identifying advantages and disadvantages.

3.1 WIRELESS LAN

IEEE 802.11 is a set of standards that operate primarily in the 2.4GHz and 5GHz bands. This standard is commonly known as Wi-Fi, and widely used in the office and at home. There are a number of protocols defined using this standard, currently the most widely used being 802.11g and 802.11n. The key features are briefly summarized here

	802.11b	*802.11g*	*802.11n*	*802.11ac*
Release	1999	2003	2009	2014
Frequency (GHz)	2.4	2.4	2.4/5	5
Max Data Rate (Mbit/s)	11	54	150	1000+
Modulation	DSSS	DSSS, OFDM	OFDM	OFDM
Range (LOS m)	100	100	250	

Figure 2 Wi-Fi Standards

The key features that Wi-Fi brings are relatively high data rates and wide adoption in the commercial world. The data rates approach or exceed 100Base-T Ethernet rates, making it suitable for scenarios where significant data is transmitted such as a Wireless Network bridging and Wireless Access Points. However with such data rates, come significant power requirements. A single chip WLAN module could easily draw up to 1000mW when transmitting at 802.11g data rates. [2] For devices line-powered this could be acceptable but for battery powered devices which need to remain autonomous, this is quite high power consumption. For wireless sensor networks, the combination of high data rates and high power consumption is not ideal.

3.2 ZIGBEE

Zigbee is a networking standard generally used for low data rate, home automation and industrial control applications such as lighting control. It is based on the IEEE 802.15.4 radio standard and supports applications that require periodic short data transfers up to 250kbit/s over distances to 75m. The standard provides for low end-to-end latency and is a relatively mature standard. However there are still a number of shortcomings in the standard that has been explored in previous papers and experimental developments. [3] Contention when accessing the network has a significant impact on the aggregate data rate. Time synchronization of the remote Zigbee nodes is also not part of the standard, whereas accurate timestamping of wireless samples in FTI is crucial. Zigbee provides a very interesting option for Wireless Sensor Networks while not having the complete answer.

3.3 BLUETOOTH

Bluetooth is another wireless standard for use over short distances. It's was originally standardized as IEEE 802.15.1 but is now maintained by the Bluetooth SIG. Data is transmitted using a Time Division mechanism which makes is suitable for FTI wireless sensor networks. Bluetooth is generally considered a short-range communication protocol which is typically less than 10 meters. However the radio uses a frequency-hopping spread spectrum mechanism, which can complicate regulatory compliance in a tightly regulated environment on a plane.

3.4 ANT+

ANT is a proprietary wireless technology developed by Dynastream Innovations. It's a targeted at low data rates using a TDM system in the 2.4GHz spectrum. The data rates supported are quite low (~20kbps) which limit the application area.

4 WIRELESS SENSOR NETWORKS

A Wireless Sensor Network (WSN) is network of spatially distributed sensors that monitor physical or environmental conditions such as temperature, pressure, strain, etc. These wireless sensors transmit the acquired data to an acquisition system. Wireless sensors are typically small with ultra-low power requirements running on batteries or utilizing energy harvesting schemes.
The ease of installation of wireless sensor networks brings advantages to debug or temporary installs. The install time for a wireless sensor

network is quicker than a wired network. Furthermore, modification of an existing sensor network is significantly quicker than modification of wired installs. This has been demonstrated in a Cabin Comfort install on the A350 MSN2. [4]

4.1 DATA SOURCES

Typically sensors are sampling analog data sources with varying profiles of data rates.

1. **Acceleration.** Typical accelerometers contain multiple channels to measure on three planes of motion. Sampling rates vary but can reach rates of kHz. As a result they can be quite demanding on bandwidth.
2. **Temperature.** In many scenarios, temperature changes are relatively slow allowing low sampling rates.
3. **Strain.** Similar to accelerometers, strain measurements range from very low sampling rates measure in samples per hour to hundreds of Hz.

In many of these measurements the acquisition systems follow a similar approach. The data is sampled, some signal conditioning is performed and the resulting data is logged. The signal conditioning can vary between applications and installations so should be programmable.

4.2 LXRS

As previously mentioned there are a number of wireless protocols that can be used for wireless sensor networks, however many come with limitations. An alternate approach is to use a proprietary wireless protocol that specifically addresses these limitations. LXRS is a wireless communication protocol which is designed for (but not limited to) the IEEE 802.15.4 communication standard. LXRS describes a method for guaranteed data delivery, mitigation of channel contention, and measurement synchronization. All of which, are essential features of a wireless measurement system..

Medium Access Control 4.2.1 Data transfer using the LXRS protocol follows a Time Division Multiplexed (TDM) approach. The bandwidth on the network is divided into time slots. Each sensor node on the network is programmed to transmit only during the assigned time slot. Multiple time slots can be assigned to a node to meet the aggregate data rate requirements of the node. This approach removes the impact of collisions to the data transfer, increasing the determinism and network throughput while significantly reducing the number of retransmits.

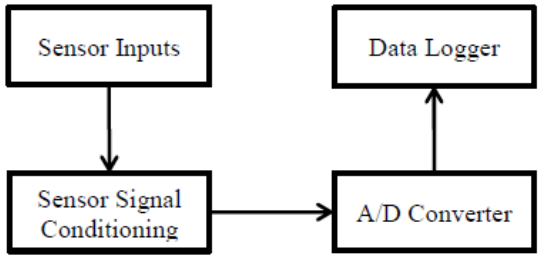

Figure 4 Signal Acquisition

4.2.2 Time Synchronization

In FTI networks, the accuracy of timestamping of analog samples is a key requirement. The ability to synchronize and align samples taken from a wireless sensor with samples from standard wired sensors is crucial in the analysis of the acquired data. To achieve this on the wireless sensor network, the LXRS protocol supports time synchronization accuracy of ±32 microseconds. Upon startup, all sensor nodes within the network synchronize their sampling intervals to a broadcast beacon signal from the wireless gateway. The wireless sensors use high precision real-time clocks to maintain time stability between beacon resynchronizations which occur every 20 seconds. In a setup where the Wireless gateway is integrated into a wired Ethernet network, the source time could eventually come from a PTP grandmaster.

Data Integrity 4.2.3

While implementing a TDM based data transfer mechanism reduces packet collisions between wireless nodes, due to the nature of wireless networks, elimination of all packet loss is still a significant challenge. The channel environment itself posts a number of challenges which a communication system needs to overcome. Specifically, due to a changing environment with multiple transmission paths, the wireless signal can suffer serious degradation which varies over time. Sensors can be moved or physical obstructions can temporarily interfere with transmit and receive paths. Temporary radio interference from other transmission sources may also cause packet loss.

LXRS includes a mechanism for overcoming the packet loss due to these temporary interference scenarios. Packets which are successfully received by the wireless gateway are acknowledged in a handshaking mechanism. Each wireless sensor contains some non-volatile memory in which the wireless samples are stored. Packets that are not acknowledged remain within NVM on the node and are scheduled for retransmission at later time. The time-stamping of the sample is also recorded so that the timestamp matches the sampling time and not the transmit time, meaning that the timing fidelity of the measurement is maintained despite being buffered.

Extended Range 4.2.4

WSN which been designed to utilize LXRS have also been designed to support a larger transmit range. The transmit range is a function of the transmit power and the nature of the environment. In a line of sight application the range is between 1.5 km and 2 km depending on the regulatory requirements. In more confined and congested environments the effective range is reduced. Additionally, in harsh RF environments characterized by severe frequency selective fading, the increased transmit power serves to increase the reliability of the RF link by increasing the link budget.

4.3 POWER CONSUMPTION AND SENSOR AUTONOMY

The ideal wireless sensor will consume no power, allowing the sensor to remain installed with no power source or requirement to change batteries. However for the sensor to measure, process or transmit, some power will be consumed. Minimizing this power consumption will extend the time between either replacement of the battery or recharging of the battery.

The operation of the wireless sensor can be split into three distinct modes of operation

1. Logging and processing of sensed data. Typically 5mW.
2. Wireless transmission of sensed data. Typically 45 mW.
3. Sleeping between data samples. Typically 0.02mW [5]

To maximize battery life of the remote sensor each mode of operation should be optimized. However it is clear from the figures that limiting the wireless transmission operations would have the largest impact on the battery life. By locally logging the sensed data in the wireless sensor and then transmitting a burst of samples would be a more efficient use of the battery rather than transmitting each sample. LXRS supports such a mechanism [6].

Judiciously configuring the remote sensor to sample at the minimum rate needed to meet the measurement requirement would be the next approach in maximizing battery life. With two orders of magnitude between sleep mode and logging of data, it is clear that only sampling data at the minimum required rate will maximize battery life.

Energy Harvesting 4.3.1

While the ideal wireless sensor consuming no power is not achievable, an alternate solution is to use an energy harvesting mechanism on the sensor. This would provide for a fully autonomous sensor, removing the requirement for battery replacement or recharging. However the efficacy of such a device is highly depended on the amount of non-electrical energy (vibration, thermal gradients, cyclical strain, etc…) found within the environment. Each harvester requires a significant level of customization to operate within specific scenarios.

Due to the power consumption of the measurement and transmission system, this facility is best suited to low sampling rate measurements like strain or temperature. At 10Hz it has been shown than power consumption of a wireless sensor node can be implemented at 90µW [7]. This level of power can be satisfied by piezoelectric energy harvesters or photovoltaic sources.

Higher samples rates have been achieved in a number of applications including monitoring the loads on pitch-links continuously at 128 Hz [8] and rotor system vibration periodically at 4 kHz. [9]

4.4 INTEGRATION IN ACQUISITION SYSTEMS

The Wireless Sensor Network, once acquiring data from remote sensors, needs to be integrated into the same acquisition system as all the wired sensors, forming a homogeneous network.

This includes:

1. Programming the WSN using standard network protocols such as TFTP and SNMP.
2. Transmitting acquired data using the same packet formats, for example IENA or iNet-X.
3. Time synchronization using PTP or NTP.

With modern open standards such as XidML [10], it is possible to store information on how data is acquired, processed and transmitted in an FTI network. When used in combination with configuration software such as DASStudio [11], it is possible to configure and acquire data from WSN, just as easily as from wired sensors.

Once recorded, the source of parameters, whether wired or wireless, is transparent to the FTI engineer analyzing the results. This makes it even easier to move between wired and wireless sensors.

5 CONCLUSION

It is trivial to imagine a number of scenarios in which wireless technology can solve existing FTI problems or make existing solutions more flexible, efficient and cheaper. However the introduction of wireless technologies will not be without its challenges. In Wireless Sensor Networks, reliable transmission of acquired data and time synchronization issues present challenges which can be addressed using wireless standards such as LXRS. Integration of such protocols into existing network infrastructure is possible by using acquisition modules like the Curtiss-Wright KAM-500 module, the KAM/WSI/104. The gains that wireless sensor networks promise provide an attractive goal for the move to wireless.

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Jammers

High-resolution spectrogram analysis for reconnaissance and optimization of jamming systems for CDMA, TETRA, GSM, UMTS and LTE Services.

According to international telephony agreements, interfering with or suppressing wireless links is prohibited globally. There are, however, exceptions to this general rule, which nevertheless always require the official consent of the national telecom authorities. Examples include inside prisons and courtrooms, to prevent any prohibited communication, or within concert halls and other locations to avoid interruptions from disruptive telephone calls.
This Application Note looks at the effective legal application of jammers using a GSM link as an example. The results also give some indication of how to trace illegal jammers.

When jammers are used legally, the problem is basically to ensure that: 1 Wireless traffic is suppressed completely in all the three dimensions of frequency, time and space, and
2 Interference does not affect other areas at the same time.
Because of this, the aim will always be to radiate signals into the building to be protected, although this requires immense effort to ensure complete coverage. Having antennas within the building is advantageous.
When suppressing mobile communications, preventing reception of the downlink is a good idea, since the signals received by cell phones are at a relatively low level, and doing this effectively disables the phones.

Wideband jammers use FM or OFDM modulated signals, among others. These are only effective if they linger long enough to ensure that the now extremely powerful error correction of the communications channel is unable to compensate for the loss of information.

The jamming signal
The jamming signal shows up as an exaggeration in the noise floor, as depicted in figure 1. The signal can be generated using OFDM or using wideband pseudo-noise modulation. The noise floor starts just below the downlink band (925 – 960 MHz) and is easier to see because there are very few information signals superimposed on it there.
Figure 2 shows an FM emission that also overlaps the upper limit of the downlink range to some extent.
Both these images are examples of how a jammer can appear in a quick overview measurement outside a protected range.

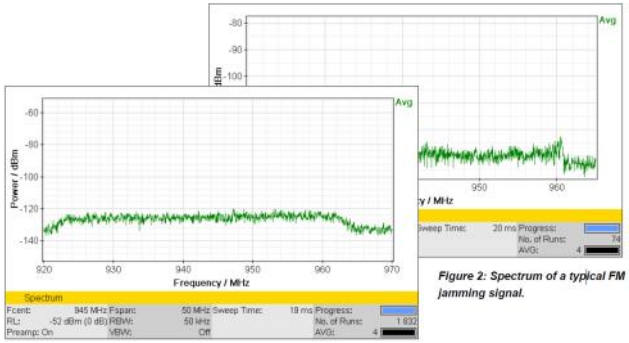

Figure 1: Downlink suppression by increasing the noise floor.

Figure 2: Spectrum of a typical FM jamming signal.

Interference and information signals in spectrograms
The conventional spectrogram based on just a few sweeps shows a jammer signal that starts just below 925 MHz and stretches across the entire displayed frequency range at intervals of 50 kHz. The jammer signal is blanked from the 9th to the 15th second for demonstration purposes.
A similar picture is seen regularly when measurements are made outside the irradiated area. The jammer is positioned inside the building, so it is screened from the outside by the structure itself. It is thus relatively effective but unobtrusive.

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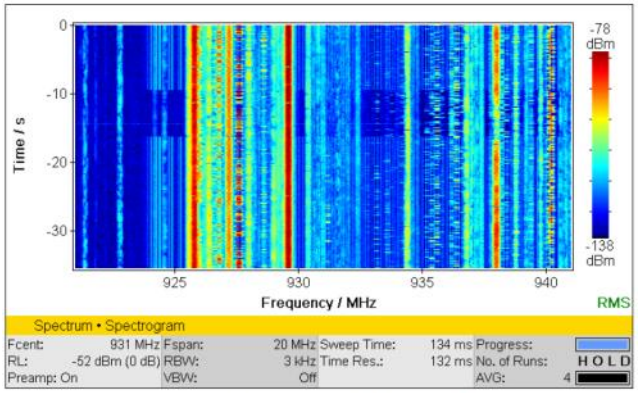

Figure 3 Jammer signal shown as a conventional spectrogram.

Interference and information signals in high-resolution spectrograms

The high-resolution spectrogram (HiRes Spectrogram) allows capture and display without any time gaps. Figure 4 shows a frequency range of 1.6 MHz. The time display range is zoomed in from 125 ms to 16 ms. The measurement was made outside the building. Although the interference lines from the jammer can be seen, their level is not high enough to suppress the GSM link

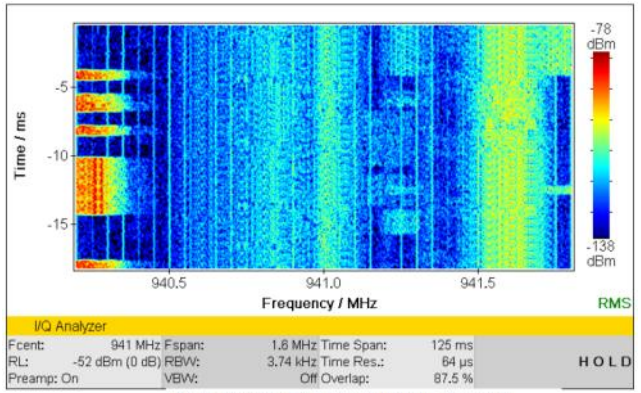

Figure 4: Gapless spectrogram. Zoomed display of field strength measurements made in front of the building.

The downlink signal level drops strongly and the level of the in-house jammer rises as strongly inside the building. Figure 5 corresponds to the previous image but shows the entire 125 ms.

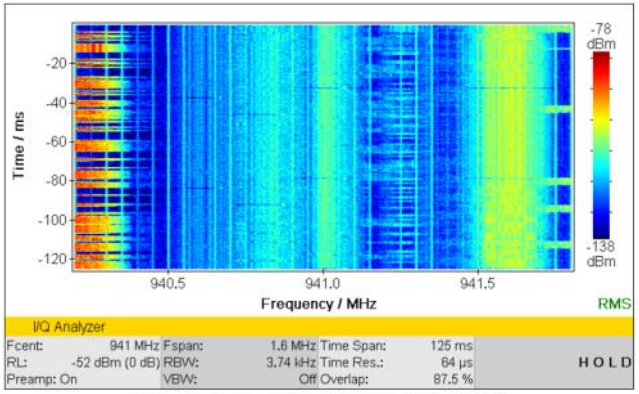

Figure 5: Gapless spectrogram. Field strength measurement inside the building, not zoomed.

In addition to the amplitude versus frequency, the persistence spectrum or luminance diagram shown in figure 6 also indicates the frequency with which each particular level occurs. This incidence display makes it possible to also see in-band interference signals. This is the same data set as was used for figure 5. The Interference and Direction Analyzer IDA 2 can produce all these different displays from the same data sets, allowing specialists to make crucial time correlative analysis.

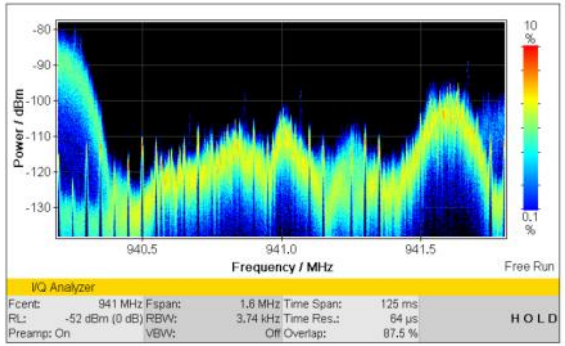

Figure 6: In-band interference detection by means of persistence display.

Checking the effectiveness of a jammer

A single jammer is not enough in most cases. Standing waves and shadowing occur in every room, and these also change according to the occupancy of the room. Such alterations are simply caused by moving, inserting or removing objects such as metallic items, musical instruments, containers, and the like.

A few main points:

• The required jamming power is least at the point of reception, so the downlink frequency is used for GSM.

• The jammer polarization is aligned to the information signal. Cross polarization is expedient for GSM.

• Spatial gaps can be minimized by radiating from different directions and / or by antenna diversity, i.e. by feeding the same signal to offset antennas.

A simple test using a cell phone merely shows a very incomplete picture. Where security is paramount, the frequency, location, signal amplitude and time must all correlate. FFT analyzers with a broad capture range (FFT span) are useful for this. No part of the signal is missed, thanks to gapless and overlapping FFT window computation.

The spectrogram algorithm of conventional spectrum analyzers is successive, i.e. the signal is acquired, processed, and displayed. This causes significant gaps in the display between the individual spectrums, because the sweeps (traces) or FFT blocks are arrayed one at a time.

In contrast, the block acquisition of 250,000 I/Q data pairs in HiRes mode of the IDA 2 captures a continuous data set from the demodulated base band with a width of up to 22 MHz. The recording time for this in this example stretches over 7.8 ms, which is more than one GSM frame. The display builds up quickly, so it can be used to directly show the relevant or worst covered points in the building or room that is to be protected.

It is important to check the GSM emissions regularly for any changes. This can be done continuously or at specific times of the day. It is usually enough to make a measurement at a few reference points such as in a particular room or at the corners of the building.

AN_IDA_1076_Jammer 7 / 8 Subject to change The gapless spectrogram display is better than the delta spectrum for emissions such as GSM because it shows all events in detail in their chronological relation.

Figures 7 and 8 are examples of an effectiveness test of a jammer. Both show an interference signal of about 20 MHz bandwidth. The same data set was used to generate the gapless spectrogram in figure 7 and the persistence diagram in figure 8. You can see at a glance that the effectiveness of the jammer is questionable at least at 925.7, 927.5, 929.6 and 938 MHz.

Figure 7: Gapless spectrogram. The weak signals can also be seen in the artificially generated blanking gaps in the jammer signal.

Figure 8: Persistence display. The weak signals can be seen here even without blanking the jammer.

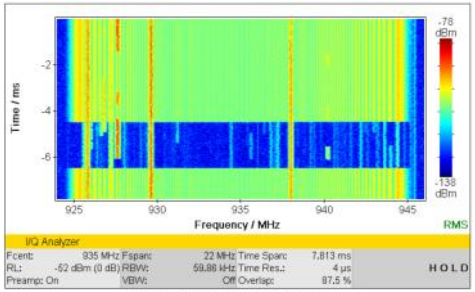

Figure 7: Gapless spectrogram. The weak signals can also be seen in the artificially generated blanking gaps in the jammer signal.

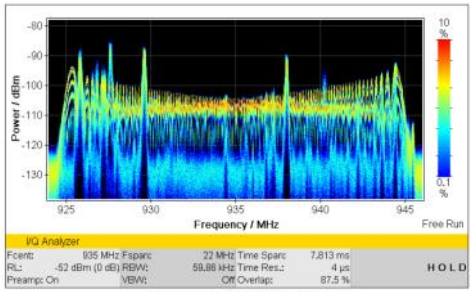

Figure 8: Persistence display. The weak signals can be seen here even without blanking the jammer.

All HiRes displays have their advantages. Since it is easy to save the data set on which they are based, they can all be regenerated and the spectrogram zoomed in detail at a later time.

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MIL-DTL-38999	I,II	K
MIL-DTL-5015	MS340,MS345	J
MIL-C-81703	3	J
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Specification	Series/Class
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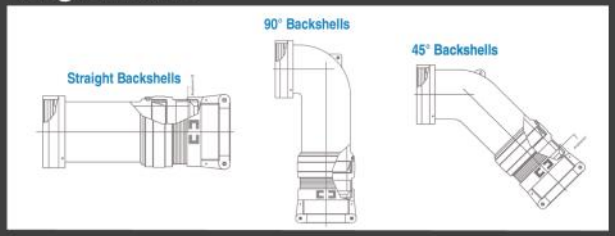

Coupling Style

FLIGHT SAFETY, THE ROLE OF FLIGHT SURGEON

Hasan Fehmi TÖRE, M.D. Prof. In Cardiology, Flight Surgeon
Medicana International Ankara Hospital, Aero Medical Center

The earth is very large compared to the size of a human body. Previously, people went to the nearby places on foot. But exploration the world and the curiosity and desire to go to the far distance directed them to invent different types of transportation systems. Even this curiosity and desires pilled out of the world into space and is still ongoing. In early times, they used some animals, like horse, for to go faster and farther. Later, they invented some vehicle working human power like bicycle and some other vehicle can go on water like kayak. They also invented some vehicle using motor power like car, train for going faster and farther more. But all these vehicles could only move on land and water. Then they observed the birds were flying. So human being realized that they could go faster and farther by flying, than they invented airplane. So currently in the World the fastest, the most comfortable and the safest means of travel is an airplane.

Flight Safety, briefly can be said, that is the all of the necessary measure and procedure that doing an accurate and proper flight, without accident from one place to another.

Flight Safety is abroad concept, including even manufacturing and maintenance of an airplane, airfield, the beginning of a flight, passengers on board, meteorological conditions, additionally the health of people involving to all procedures and everything comes to mind in this subject. Aviation accident happens, like an example Swiss cheese, in all these complex processes, becoming in a succession line of a lot of negation. There is a lot of negations not always create an accident since because of the inhibition of this negations in some places of the chain it can be prevented. Then, the main purpose of flight safety is to prevent aviation accidents. The prevention of aviation accident could be able to provide by doing all these complex parameters that make up the flight safety, smooth and accurate enough and as it is supposed to be.

Where is the flight surgeon in flight safety? Almost in every stages of the flight safety human beings have a role. Mostly he will do a mistake in some time. These men while doing their work, of course, they will know all professional knowledge and skill, but all of them before, they should have healthy physical and mental conditions that could be able to do their work. In case of not having a healthy status, it is very difficult to speak about flight safety.

The illness of the aviators can be grouped into three categories. The first group contains chronic diseases and its sequelae that disincentive of flight duty. In this case, flight crew could be permanently banned from flight. In the second group, which diseases and its sequelae could recover fully flight crew can return to their duties after medical examination. If they do not fully recover from the disease, according to the one percent rule, is less than one percent, with the acceptance of National Civil Aviation Authority, flight crew could return to flight duty with some limitation. These two groups of diseases are controlled and followed by Aero Medical Centers and Flight Surgeons. The third group consists temporary and daily diseases. There is not enough control and monitoring by the authority for this group of civil aviators. They are assumed to be had examined by medical units of the airline companies and the aviation organizations.

To prevent of their health of the aviators is responsibility of their own. The duty of flight surgeons are not only to control and follow up periodically, in the mean time, it is necessary to guide them how they will prevent their health and on issues of life style, nutrition, diet, sports and exercises. As we, in Medicana International Ankara Hospital, Aero Medical Center ourselves, are serving with this point of view and perspective to the aviators.

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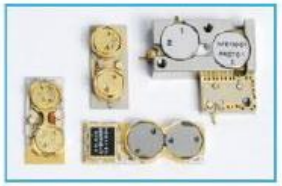

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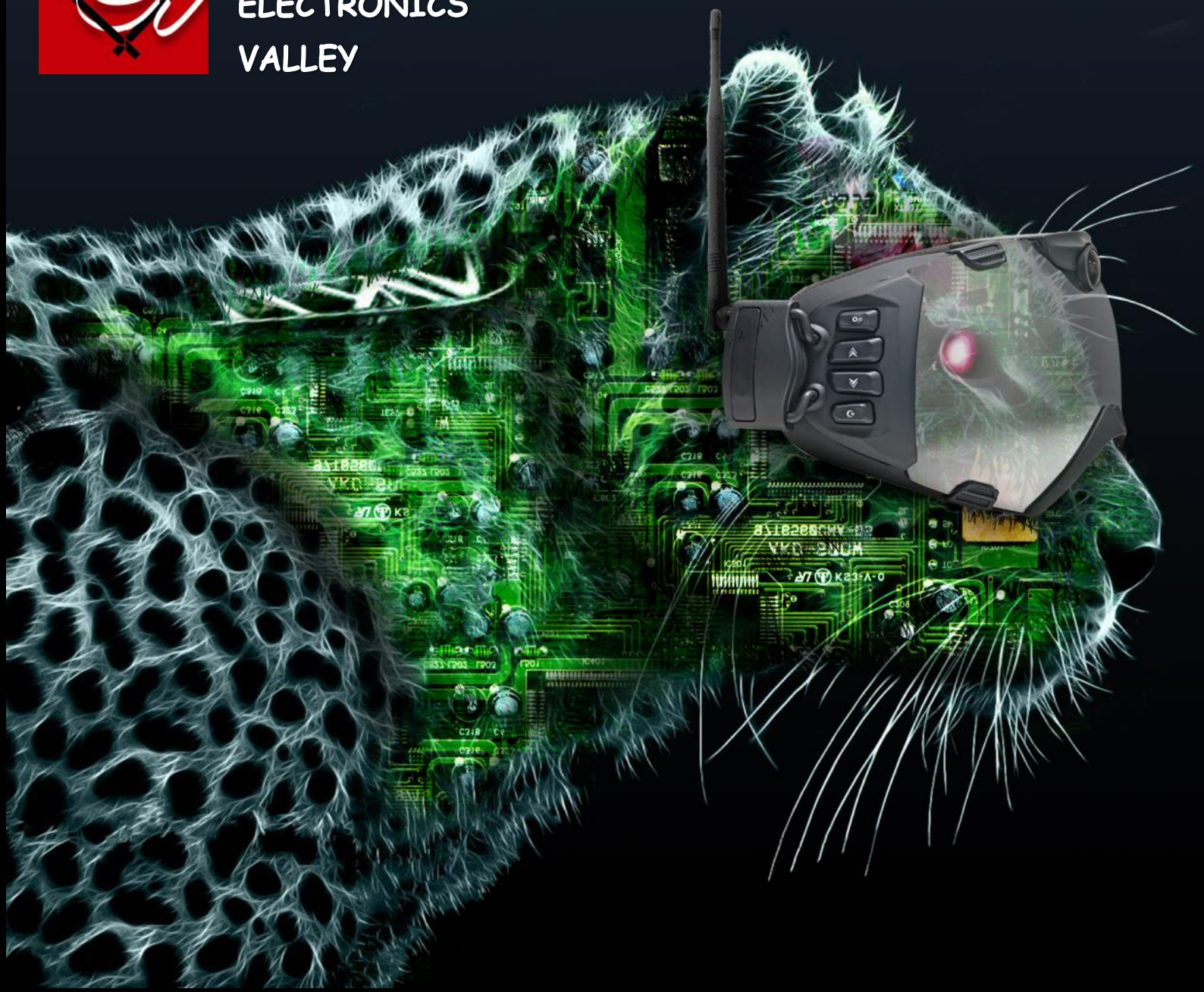

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