Advanced Electronics Company

(An Economic Offset Program Company)

Radar Symposium 2014
Photonics Based ELINT for Interception and Analysis of Radar Signals

Presented By:
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Senior Vice President - Engineering & Development
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Agenda

• AEC Brief
• Border Surveillance and Protection
• Radar Integrated with ELINT
• Photonics as Solution
• Electronic Counter Measures
• Photonics Capabilities in AEC
AEC Brief
Advanced Electronics Company

Activities
Design, manufacture, upgrade and support of electronic products and systems for military, civil and industrial customers.

Established
Sept. 1988

Locations
1- HQ: Industrial Park, KKIA, Riyadh, Saudi Arabia
2- BD and PM Offices in Different locations
AEC Staff

• Total AEC’s Employees 1105
   947 at AEC Facility
   158 at customer’s premises

• Customer focused
• Highly skilled, well trained professionals.
• Work to highest quality standards.
• More than 71% employees are Saudi nationals
• About 79% of AEC engineers and technicians are Saudis

Graph charts show employee at AEC facility only as of 1 July 2014
**Core Competencies**

**Development (E&D)**
Strong Engineering design & development capabilities include:
- Products
- Systems
- Support

**MANUFACTURING**
A world-class factory fully-equipped to manufacture all types of electronic products and systems

**REPAIRS**
A stand alone facility specialized in testing, trouble shooting and repairing wide range of electronic equipment

**TOTAL SOLUTION : SYSTEMS INTEGRATION**
AEC Recognition

- King AbdulAziz Quality Award – First Position -Industrial Sector
- Certified to ISO 9001: 2008
- AS9100 Rev “C” Aerospace Quality Management System
- AS9110:Rev “A” Aerospace Quality Assurance requirements for maintenance organizations
- CMMI - Capability Maturity Model Integration, L3
- Council member of European Aerospace Quality Group, International Aerospace Quality Group
- Obtained highest quality rating from leading international companies, examples:
  - Boeing “Gold” Supplier
  - Raytheon Performance “Blue Rating”
  - Alcatel Lucent Grade “A” Supplier
  - Lockheed Martin “Star” Supplier
  - Sikorsky “World Class”
  - Thales “Target Supplier”
  - EADS “QSF-B”
Future Opportunities

Future Trends

- EW / C4i / Cyber
- Renewable Energy
- IT for Public Sector & Education

Military Programs

1988

Telecom Programs

1995

Industrial Programs

2002

ICT Programs

2005

Future Trends

2013 - 2015
Radars in Border Surveillance & Protection

- Long range radars are not suitable for Border protection from low altitude flights such as UAV
GAP Filler Radar

• GAP fillers overcomes limitations related to:
  - Earth Curvature
  - Low altitude objects
  - Silent objects detection

• use of fixed & portable radars to enhance operational performance

• Cost Effective solution

What if the Radar is Jammed or deceived?
Radar Integrated with ELINT
Electronic Intelligence

- Passive Receiver
- Monitor’s EM
- Detect transmitters
- Determine freq, BW .. etc
- Supports radar during ECM or jamming

<table>
<thead>
<tr>
<th>Class</th>
<th>Frequency</th>
<th>Power</th>
<th>Sensitivity</th>
<th>Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>VHF</td>
<td>100 MHz</td>
<td>10 watts</td>
<td>-90 dBm</td>
<td>749.9 km</td>
</tr>
<tr>
<td></td>
<td>300 MHz</td>
<td>50 watts</td>
<td>-90 dBm</td>
<td>559.6 km</td>
</tr>
<tr>
<td>UHF</td>
<td>500 MHz</td>
<td>50 watts</td>
<td>-90 dBm</td>
<td>335.8 km</td>
</tr>
<tr>
<td></td>
<td>1 GHz</td>
<td>50 watts</td>
<td>-90 dBm</td>
<td>167.9 km</td>
</tr>
<tr>
<td>S</td>
<td>2 GHz</td>
<td>50 watts</td>
<td>-90 dBm</td>
<td>83.9 km</td>
</tr>
<tr>
<td></td>
<td>4 GHz</td>
<td>200 watts</td>
<td>-90 dBm</td>
<td>83 km</td>
</tr>
</tbody>
</table>

ELINT depends on LOS, power and frequency
Radar is an active detector utilized for silent objects.

ELINT is a passive detector utilized for transmitting objects supporting radars during jamming & ECM.
Silent Object not detected in ELINT range
Object detected in Radar range
Radar coverage
ELINT coverage
Radar coverage
Object jamming radar
Radar coverage

ELINT coverage

Radar can no longer be utilized. ELINT can pick up transmission. ELINT can feed back information to Radar to overcome jamming / deception.
Several ELINTs

- **ELINT geo-location**
  - One ELINT: Bearing
  - Two ELINT: Absolute position
  - Three ELINT: Longitude + Latitude + Transmission time
  - Four ELINT: Longitude + Latitude + Altitude + Transmission time

Two ELINTs can be integrated with Radar for geo-location verification with Radar
Traditional Electronic Intelligence Limitations

- **Limitations:**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency Range</td>
<td>Usually limited to 18 GHz</td>
</tr>
<tr>
<td>Instantaneous Bandwidth</td>
<td>Usually limited to 4 GHz</td>
</tr>
<tr>
<td>Sensitivity</td>
<td>Usually up to -80 dBm</td>
</tr>
<tr>
<td>Selectivity</td>
<td>Usually up to 10 MHz</td>
</tr>
<tr>
<td>SWAP</td>
<td>Bulky in size, weight and consumes a lot of energy</td>
</tr>
</tbody>
</table>
Photonics As Solution
Photonics Based Electronic Intelligence

- Covers frequency ranges from 0.02 to 40 GHz (Using one device)
- POI 100% (Cover the entire wideband range)
- Sensitivity of receiver is typically ~ -90 dBm
- Immune to EMI and designed for harsh environment
- Capability of integration with Radar database
- Capability of detecting 650 M pulses/s
# Photonics ELINT vs. Electronic ELINT

<table>
<thead>
<tr>
<th>Features</th>
<th>Electronics</th>
<th>Photonics</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency Range</td>
<td>0.01 - 18 GHz</td>
<td>0.02 - 40 GHz</td>
<td>1 receiver vs. 2 receivers</td>
</tr>
<tr>
<td>Instantaneous Bandwidth</td>
<td>4 GHz</td>
<td>Custom (Up to 40 GHz)</td>
<td></td>
</tr>
<tr>
<td>Sensitivity</td>
<td>-70 to -85 dBm</td>
<td>-90 dBm</td>
<td></td>
</tr>
<tr>
<td>Selectivity</td>
<td>250, 50 and 10 MHz</td>
<td>Custom (down to 1 MHz)</td>
<td>Due to the four above limitations of traditional electronics</td>
</tr>
<tr>
<td>POI</td>
<td>Nearly 100%</td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>DF Accuracy</td>
<td>2°</td>
<td>1°</td>
<td></td>
</tr>
<tr>
<td>Weight</td>
<td>Less than 125 Kg</td>
<td>Near 30% less</td>
<td></td>
</tr>
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</table>
# Photonics Features

<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Unmatched range</strong></td>
<td>In a single device (design, fabrication materials and manufacturing techniques)</td>
</tr>
<tr>
<td><strong>Immune to Electro Magnetic Interference</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Very High Data rates</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Easily maintained due to</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Couplers and switches works in close</strong></td>
<td><strong>Modular design</strong> allowing integration to multiple systems</td>
</tr>
<tr>
<td><strong>proximity</strong></td>
<td></td>
</tr>
<tr>
<td><strong>complete isolation</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Cost effective</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Upgradable</strong></td>
<td></td>
</tr>
</tbody>
</table>
# Feature Summary

<table>
<thead>
<tr>
<th>Feature</th>
<th>Receiver Type</th>
<th>Photonic</th>
<th>Wide Band Crystal Video</th>
<th>TRF Crystal Video</th>
<th>IFM</th>
<th>Narrow Band SUPERHET</th>
<th>Wide Band SUPERHET</th>
<th>Channelized</th>
<th>Microscan</th>
<th>Acousto-optic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instantaneous Analysis Bandwidth</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Very Wide</td>
<td>Narrow</td>
<td></td>
<td>Very Wide</td>
<td>Narrow</td>
<td>Moderate</td>
<td>Wide</td>
<td>Wide</td>
</tr>
<tr>
<td>Frequency Resolution</td>
<td></td>
<td></td>
<td>Good</td>
<td>Very Poor</td>
<td></td>
<td>Good</td>
<td>Very Good</td>
<td>Poor</td>
<td>Fair</td>
<td>Good</td>
</tr>
<tr>
<td>Sensitivity</td>
<td></td>
<td></td>
<td>Very Good</td>
<td>Poor</td>
<td></td>
<td>Fair</td>
<td>Poor</td>
<td>Very Good</td>
<td>Fair</td>
<td>Very Good</td>
</tr>
<tr>
<td>Dynamic Range</td>
<td></td>
<td></td>
<td>Good</td>
<td>Fair</td>
<td></td>
<td>Good</td>
<td>Very Good</td>
<td>Fair</td>
<td>Good</td>
<td>Fair</td>
</tr>
<tr>
<td>Speed of Acquisition</td>
<td></td>
<td></td>
<td>Very Fast</td>
<td>Very Fast</td>
<td></td>
<td>Slow</td>
<td>Very Fast</td>
<td>Slow</td>
<td>Fast</td>
<td>Very Fast</td>
</tr>
<tr>
<td>Short Pulse Width Capability</td>
<td></td>
<td></td>
<td>Very Good</td>
<td>Good</td>
<td></td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
<td>Fair</td>
<td>Fair</td>
</tr>
<tr>
<td>Retention of Signal Characteristics</td>
<td></td>
<td></td>
<td>Good</td>
<td>Fair</td>
<td></td>
<td>Fair</td>
<td>Poor</td>
<td>Good</td>
<td>Poor</td>
<td>Fair</td>
</tr>
<tr>
<td>Applicability to Exotic Signals</td>
<td></td>
<td></td>
<td>Good</td>
<td>Poor</td>
<td></td>
<td>Good</td>
<td>Poor</td>
<td>Fair</td>
<td>Good</td>
<td>Fair</td>
</tr>
<tr>
<td>RF Range (Ghz)</td>
<td></td>
<td></td>
<td>0.02 - 40</td>
<td>0.5 –40</td>
<td>0.15 - 18</td>
<td>0.5 - 40</td>
<td>0.01-40</td>
<td>0.5-18</td>
<td>0.5-60</td>
<td>0.5-8</td>
</tr>
<tr>
<td>High Signal Density Performance</td>
<td></td>
<td></td>
<td>Good</td>
<td>Poor</td>
<td></td>
<td>Fair</td>
<td>Poor</td>
<td>Fair</td>
<td>Good</td>
<td>Poor</td>
</tr>
<tr>
<td>Simultaneous Signal Capability</td>
<td></td>
<td></td>
<td>Good</td>
<td>Poor</td>
<td></td>
<td>Fair</td>
<td>Poor</td>
<td>Fair</td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td>Max Instantaneous Analysis Bandwidth</td>
<td></td>
<td></td>
<td>Very Good</td>
<td>Good</td>
<td></td>
<td>Good</td>
<td>Very Good</td>
<td>Poor</td>
<td>Poor</td>
<td>Fair</td>
</tr>
</tbody>
</table>

*Anthony C. Lindsay. Wideband Guided-Wave Photonics for Electronic Warfare Applications. 1 (ERL-0617-PR), p7*
Photonics in ECM
Photonics Based ECM (Radar Deception 1/2)

- Photonics based ECM can be used to deceive radars
- Fast and optimized
Photonics Based ECM (Radar Deception 2/2)
Photonics Based ECM

- Wideband Radar Deception
- **Variable** Radar Cross Section (RCS)
- Frequencies from 0.02 to 40 GHz
- **Cost effective** compared to RF solutions
- Suitable for land, navy and air applications including **UV**
- **Fast response**
- Weight is around 3 Kg
Photonics, EW and Radar Capabilities in AEC
Photonics, EW and Radar Capabilities

- Manufacturing
- Repair
- Fielding
- R&D and Design
  - EW Lab
  - General photonics research lab
  - Qualified Saudi Engineers
Production & Manufacturing

- Clean room class 100
- SMT Line
- Assembly Line
Production Testing

• Functional Testing
• Environmental Testing
Radar Components

AEC is under license to Raytheon for Manufacturing and Repair for the following F15SA Radar LRUs:

- Analog Signal Converter (ASC)
- Low Voltage Power Supply (LVPS)
- Receiver Exciter (RE)
Chaff & Flair

• AEC own chaff and flare production capabilities
  ❖ Counter measure
  ❖ Divert radar guided anti craft missiles
  ❖ Confuse infrared anti aircraft missiles
Tactical surveillance Vehicle (Deployed Systems)

- Wide band ELINT
- Tactical communication systems
- Intercom system
- Integration of radar and ELINT interface
شكرًا

Thank You