Capabilities and Accomplishments

Aug 5, 2014

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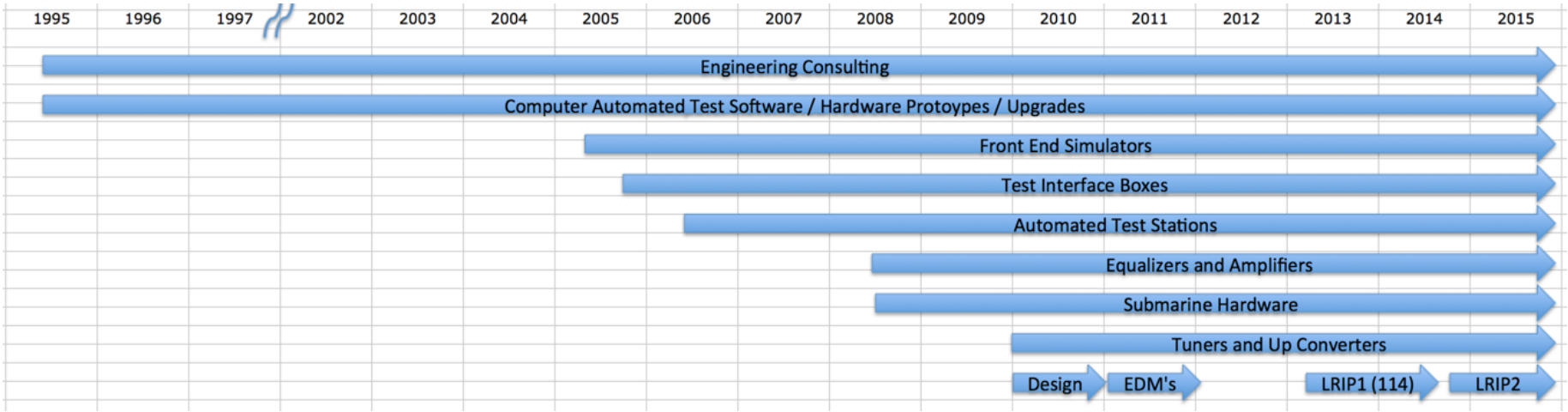
Introduction/History

- **Started business in 1995**
  - **Initial focus on engineering consulting to help other companies:**
    - » **RF system design / modeling**
      - **Prior experience with GE Aerospace Electronics Systems Department in Radar, EW, ECM Systems**
    - » **Computer automated RF test software**
- **2005 started building custom RF/microwave hardware**
  - **Front end simulators for submarine EW/Comms systems**
  - **Automated test stations (and software)**
- **2008 deliver custom equalizers and amplifiers for wide bandwidths**
  - **Surface mount RF/microwave design**
- **2010 design/build Microwave Tuners (Down Converters) and Up Converters**



Consulting Services

RF System Design Expertise

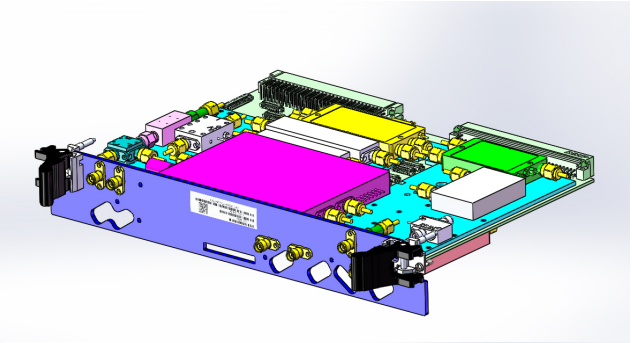
- Flow Down from top level system requirements to component designs
- Specification Development
- RF Path Analysis

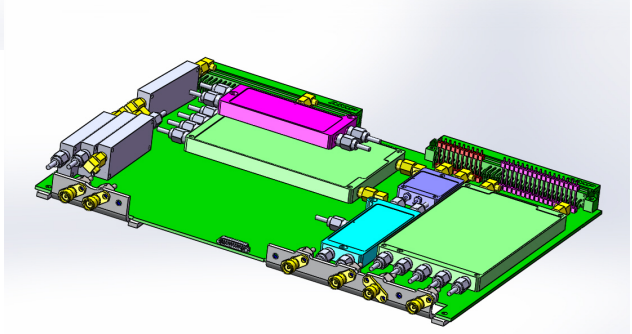
RF/Microwave Circuit Design Modeling

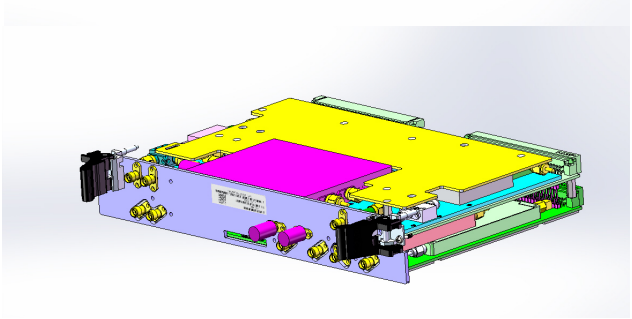
- Very accurate circuit design model and optimization
- MUSTAG

3-D Mechanical Modeling

- SolidWorks

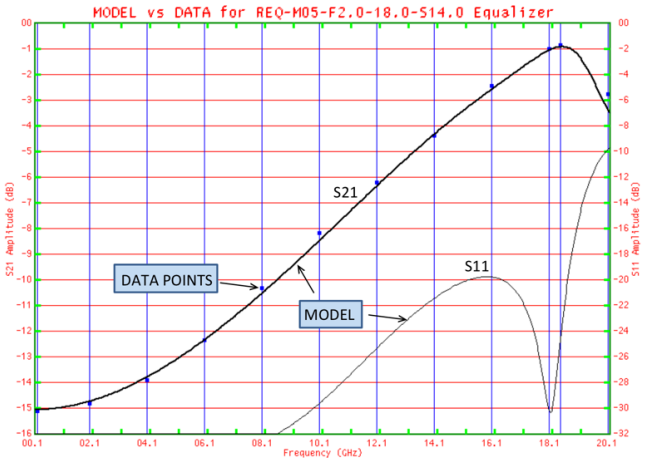






LIBREFNO	Part Type	Description	Nominal Gain v	CUM Gain	Noise Figure v	CUM Noise Figure	SIG1 Power	SIG2 Power	T.O. O.I.P v	CUM T.O. I.I.P.	Pout 1dB v	SIG2 Diff From Comp Pt	Device T.O. Spurs	CUM Pin 1dB
			-3	-3	3	3	-57	-2	150	153	150			154
			10	7	6.5	9.5	-47	8	28	21	18	-10	-40	12
			-1.7	5.3	1.7	9.55	-48.7	6.3	40	20.82	30	-23.7	-67.4	11.82
			-4.5	0.8	4.5	9.8	-53.2	1.8	40	20.76	30	-28.2	-76.4	11.76
			0	0.8	0	9.8	-53.2	1.8	109	20.76	99			11.76
			-1	-0.2	1	9.89	-54.2	0.8	50	20.75	30	-29.2	-98.4	11.71
			0	-0.2	0	9.89	-54.2	0.8	150	20.75	150			11.71
			-8	-8.2	8	11.9	-62.2	-7.2	15.5	18.97	6	-13.2	-45.4	10.1
			0	-8.2	0	11.9	-62.2	-7.2	150	18.97	150			10.1
			-1	-9.2	1	12.3	-63.2	-8.2	150	18.97	150			10.1
			-1.5	-10.7	1.5	13.1	-64.7	-9.7	45	18.97	27	-36.7	-109	10.1
			0	-10.7	0	13.1	-64.7	-9.7	109	18.97	99			10.1
			0	-10.7	0	13.1	-64.7	-9.7	109	18.97	99			10.1
			-1.5	-12.2	1.5	14	-66.2	-11.2	45	18.97	27	-38.2	-112	10.09
			9.6	-2.6	3.7	16.8	-56.6	-1.6	33.9	18.89	20.3	-21.9	-71	9.91
			-1.5	-4.1	1.5	16.9	-58.1	-3.1	109	18.89	99			9.91
			9.6	5.5	3.7	17.2	-48.5	6.5	33.9	18.43	20.3	-13.8	-54.8	8.92
			-0.5	5	0.5	17.2	-49	6	150	18.43	150			8.92
			-4	1	4	17.2	-53	2	150	18.43	150			8.92
			-2	-1	2	17.2	-55	0	150	18.43	150			8.92
			-1.5	-2.5	1.5	17.3	-56.5	-1.5	109	18.43	99			8.92
			9.7	7.2	3.5	17.4	-46.8	8.2	36.8	18.23	21.6	-13.4	-61.2	8.04
			0	7.2	0	17.4	-46.8	8.2	109	18.23	99			8.04
			-1.5	5.7	1.5	17.5	-48.3	6.7	109	18.23	99			8.04
			0	5.7	0	17.5	-48.3	6.7	109	18.23	99			8.04
			-3.3	2.4	3.3	17.5	-51.6	3.4	109	18.23	99			8.04
			-3	-0.6	3	17.5	-54.6	0.4	109	18.23	100			8.04
			0	-0.6	0	17.5	-54.6	0.4	109	18.23	99			8.04
			0	-0.6	0	17.5	-54.6	0.4	109	18.23	99			8.04
			-1.5	-2.1	1.5	17.6	-56.1	-1.1	45	18.22	27	-28.1	-92.2	8.01
			-1.5	-3.6	1.5	17.6	-57.6	-2.6	45	18.22	27	-29.6	-95.2	7.99
			0	-3.6	0	17.6	-57.6	-2.6	150	18.22	150			7.99
			-8	-11.6	8	18.4	-65.6	-10.6	15.5	17.69	6	-16.6	-52.2	7.63
			-1	-12.6	1	18.7	-66.6	-11.6	150	17.69	150			7.63
			15.2	2.6	2.1	19.3	-51.4	3.6	36.3	17.58	19.9	-16.3	-65.4	7.27
			-1.5	1.1	1.5	19.3	-52.9	2.1	109	17.58	99			7.27
			-1.9	-0.8	1.9	19.3	-54.8	0.2	37	17.54	24	-23.8	-73.6	7.21
			-3.5	-4.3	3.5	19.4	-58.3	-3.3	150	17.54	150			7.21
			15.7	11.4	1.9	19.5	-42.6	12.4	41.1	17.28	22.6	-10.2	-57.4	6.02
			0	11.4	0	19.5	-42.6	12.4	109	17.28	99			6.02
			-1.5	9.9	1.5	19.5	-44.1	10.9	109	17.28	99			6.02
Final Path Analysis:														
IFFILTER1_5DB	Filter	IF FILTER 1.5 dB	-1.5	9.9	1.5	19.5	-44.1	10.9	109	17.28	99			6.02

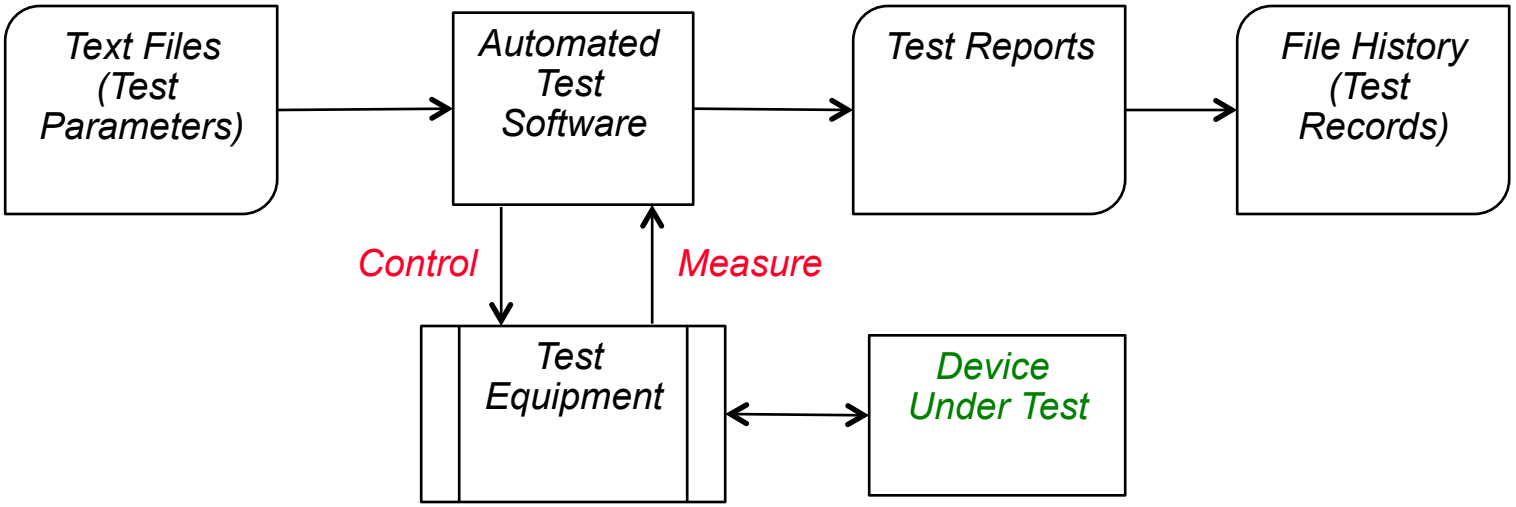
RF Path Analysis Spreadsheet



2-18 GHz equalizer model and measured data

Automated Test Software

- **Initial experience with automated RF Test Software on B1 program in 1980's using HP Basic**
- **Realized the significant advantage of automated test software to reduce actual test time, create reports, file results**
- **We have developed a suite of Automated Test Software (LabVIEW) to perform many types of RF, DC and Analog tests**
  - **Tests can be created with text-based script files – no programming required**
  - **One button "Start" to "Finish"**
  - **Software supports all product lines and equipment setups**



Front End Simulators

- **Front End Simulators simulate the RF characteristics of on-board installed hardware to reduce system integration/test time and cost**
  - **Noise Figure, Gain, Dynamic Range, Noise Levels**
  - **Multiple RF Channels**

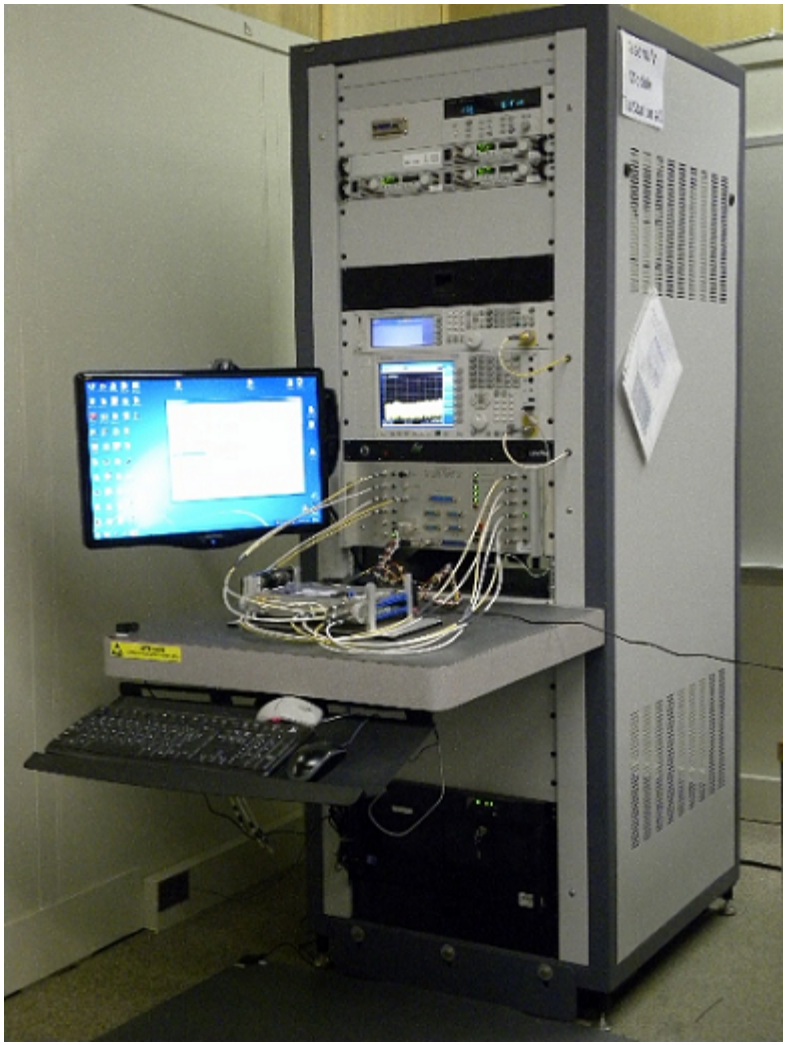
Simulators

- **Front end simulators for various masts and subsystems**
- **Frequency ranges from 3 kHz to 40 GHz**
- **Capability to terminate inputs**

Automated Test Systems

- **Progressed from Automated Test Software to Automated Test Systems (Racks)**
  - **Software capability**
  - **Custom hardware capability**
  - **Test fixtures**
- **Expertise in automated sensing and measurements**
  - **RF Measurements**
    - » **Signal generators**
    - » **Spectrum analyzers**
    - » **Network analyzers**
  - **DC Control**
  - **Digital Inputs/Outputs**
  - **Analog Inputs/Outputs**

Custom designed Test Interface Box

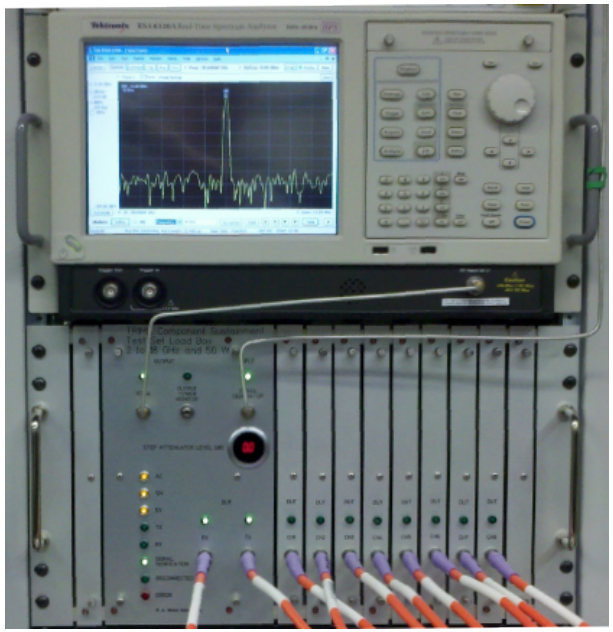


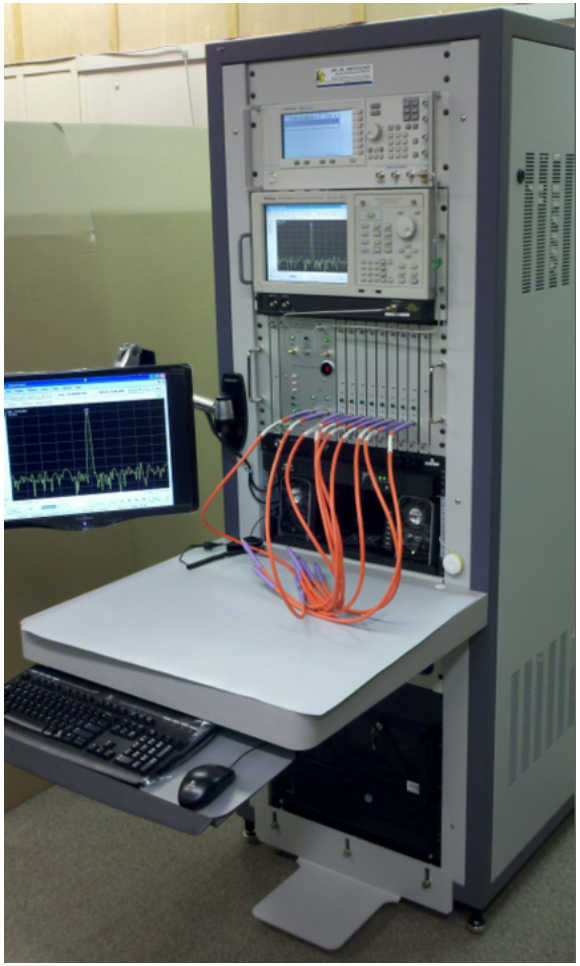
Developed with funding from Navy ManTech SEWIP Block 2 Improvements Project

Automated Test Systems - Crane NSWC

- 2 unique Automated Test Stations delivered to NSWC Crane
- State of the Art 10-Port Network Analyzer and Real Time Spectrum Analyzer
- Custom designed RF Interface/Load Panels and LabVIEW SW drivers

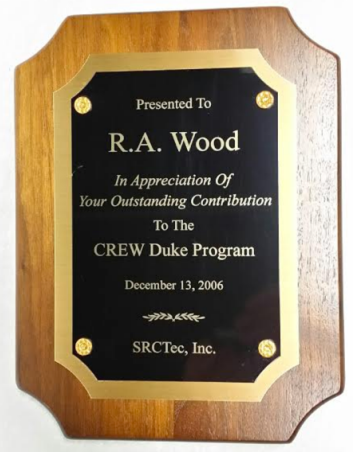
References available on request

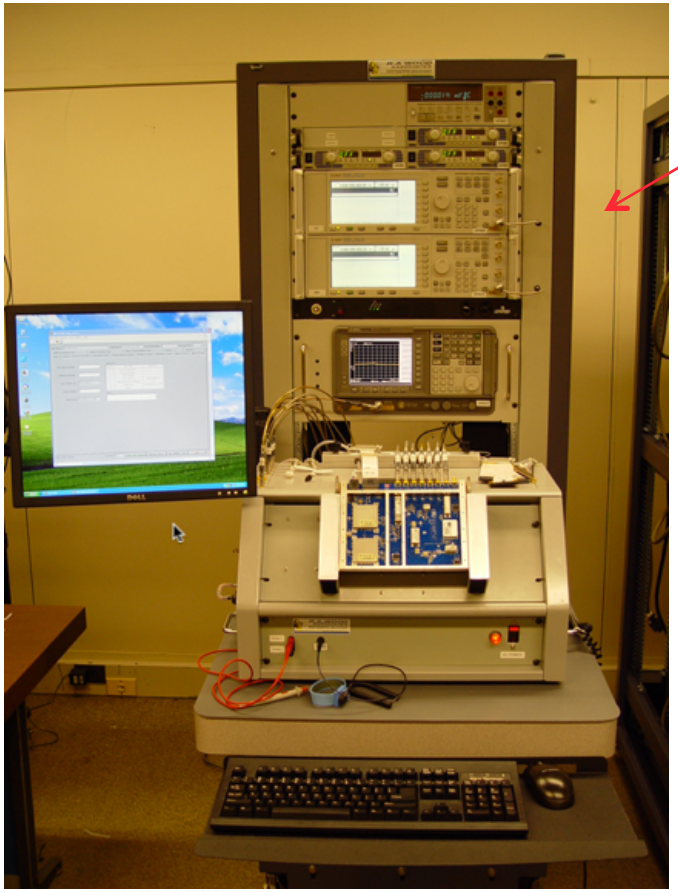




Automated Test Systems – SRC/SRCTec

- **Developed automated test software for testing 7 unique RF modules for Crew Duke program**
- **Designed and built Test Interface Units (32)**
- **Designed and built Complete Test Systems (18)**



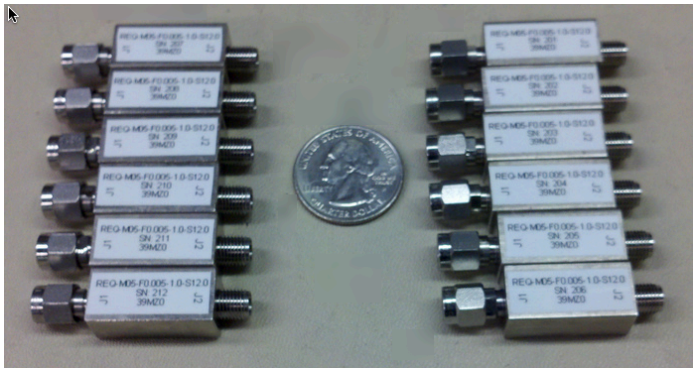


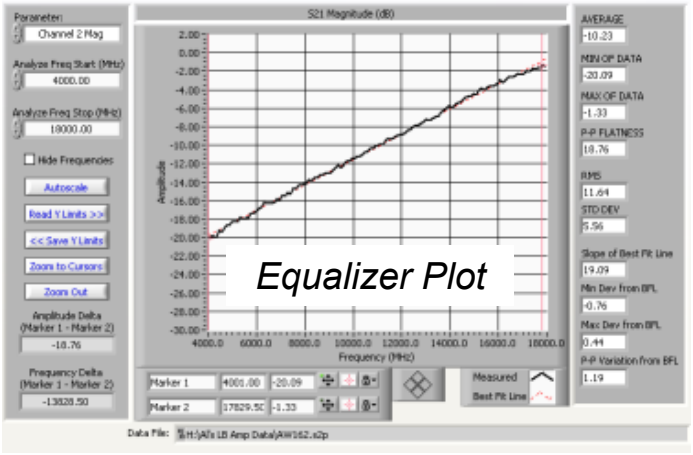
Complete Test System

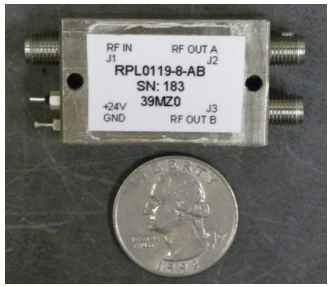
Test Interface Unit

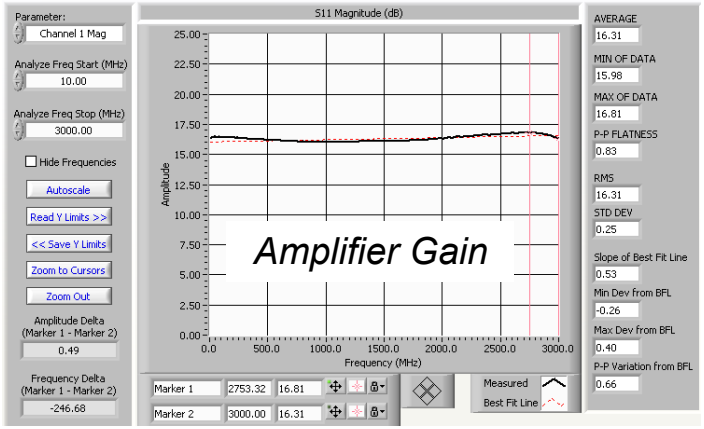
Equalizers and Amplifiers

- **Designed ultra-wideband amplifiers not available in industry (5 kHz to 3 GHz)**
- **Started designing custom equalizers to offset cable and amplifier slopes**
- **Equalizers use surface mount components (resistors, capacitors, inductors**
  - **Available quickly off the shelf**
  - **Components have been characterized for self resonances and parasitics up to 20 GHz**
  - **Over 200 designs available!**
  - **4-6 week delivery best in industry**



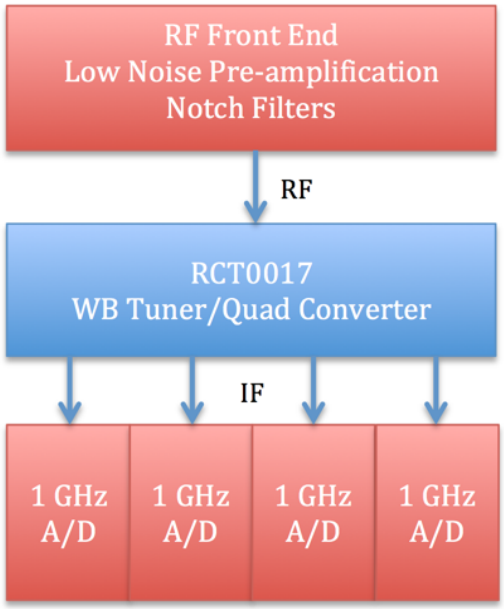






Microwave Tuners

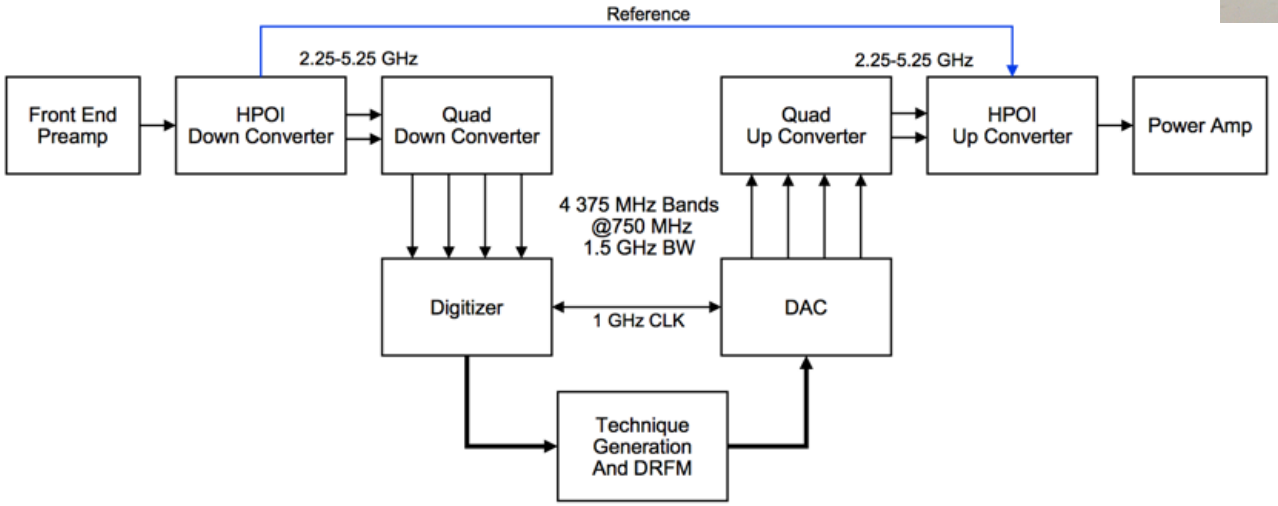
- We have moved into designing and producing higher level microwave Tuners and Up Converters
- Designed from the ground up for high dynamic range, low phase noise, wide instantaneous bandwidth
- We are currently in production for quantities of 114
- These products leverage all our previous strengths
  - Surface mount RF design (10 RF SubAssemblies)
  - Computer automated testing
  - RF system design / mechanical modeling



Typical Application

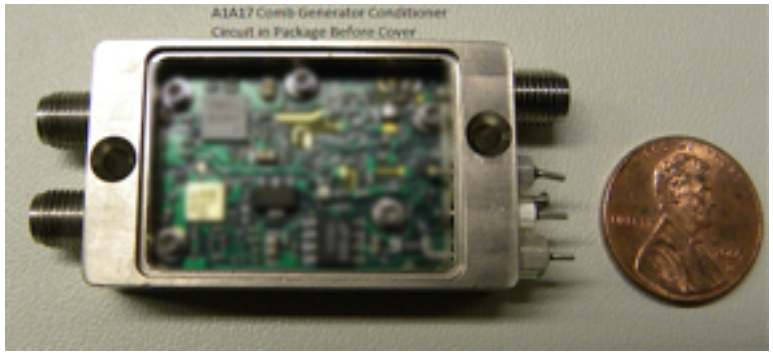
Down and Up Converters

- **Have built matching Up and Down Converters for ECM application, covering 6-18 GHz**
- **Leveraged existing Tuner (Down Converter) design to develop Up Converter**
  - **Same mechanical packaging, re-layout inside packages**
  - **Many similar components**



Wideband RF Boards Using Surface Mount Assembly Processes

- **We work directly with Trenton Technologies, a board manufacturer, on the first floor of our building, for surface mount RF boards**
  - **We work very closely with them for process improvements, work instructions, feedback on builds**
- **A2 RF Surface Mount Board Example:**
  - **870 parts assembled to each board using pick and place machinery, at a cost of $80.00 per board**
  - **95% of these parts are low cost surface mount parts purchased on reels at <6 cents each**
  - **These parts have been characterized up to 20 GHz for self resonances and parasitics so we can use them in wide bandwidth microwave applications**
- **Simple package designs**
  - **Machined packages**
  - **Simple aluminum plate covers**
  - **Much simpler assembly compared to chip and wire assemblies**
- **This is the future for low cost RF/microwave designs!**

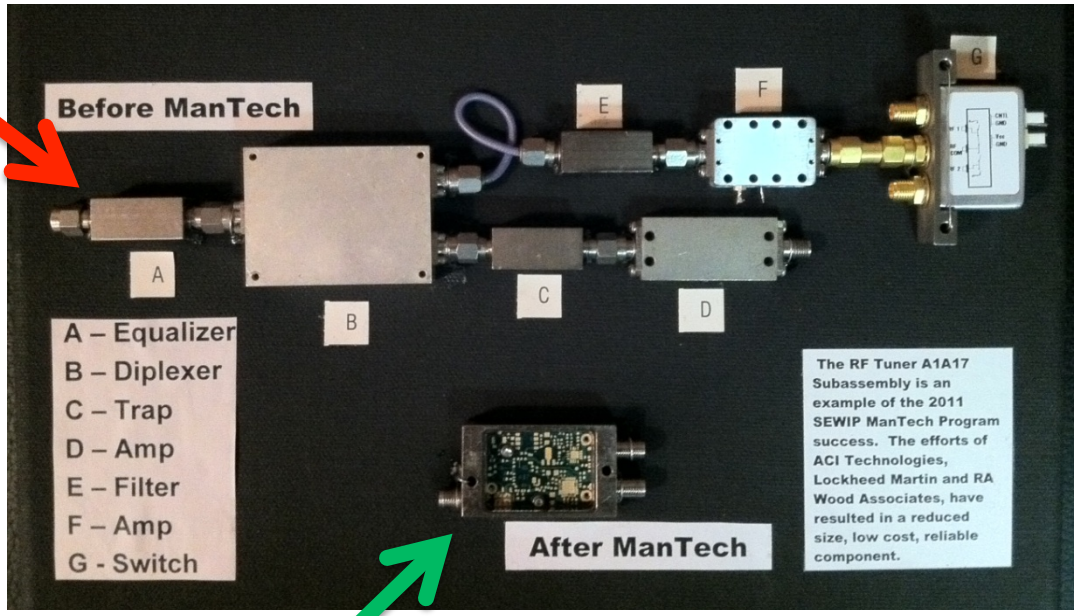


A1A17 RF SubAssembly provides LO signals up to 15 GHz

Objective 1 – Improved Packaging

R.A. WOOD ASSOCIATES
ENGINEERING SOLUTIONS FOR TODAY'S INDUSTRIES
1001 Broad Street, Suite 450, Utica, NY 13501

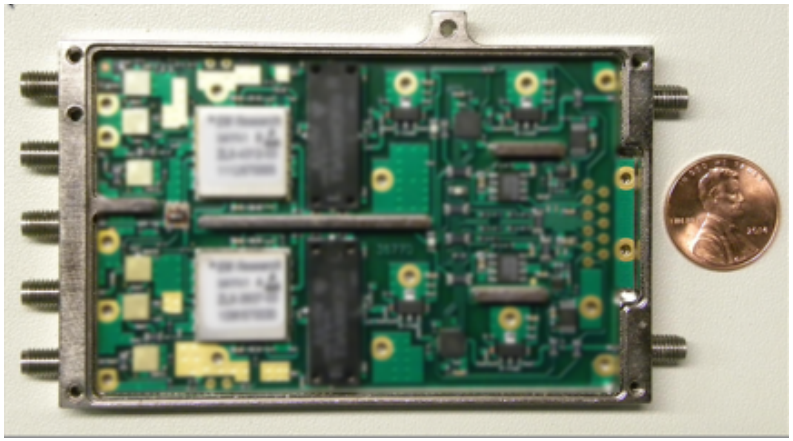
- **Goal:**
  - *Improve performance, manufacturability, ease of assembly, and unit cost by combining discrete components into single surface mount subassemblies, which can then be manufactured using an automated pick and place machine.*
- **Baseline 9”x2”**

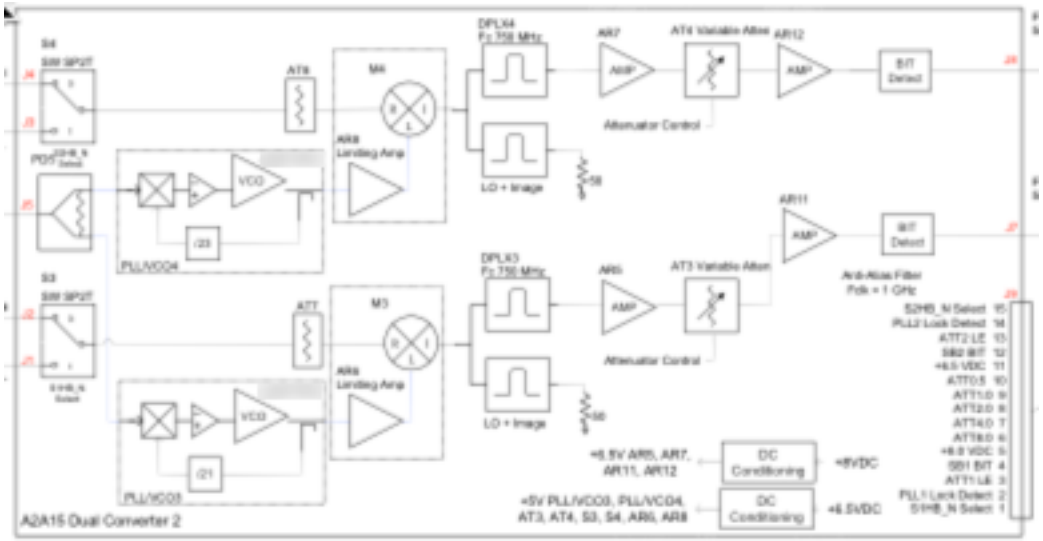


- **Scope**
  - *Re-design of the current A1A17 Comb Generator Conditioner subassembly*
- **After ManTech 1.75”x1”**

Miniaturization Possibilities

- **A2A15 Dual Converter Package**
  - **Board assembled with pick and place surface mount assembly at Trenton Technologies**

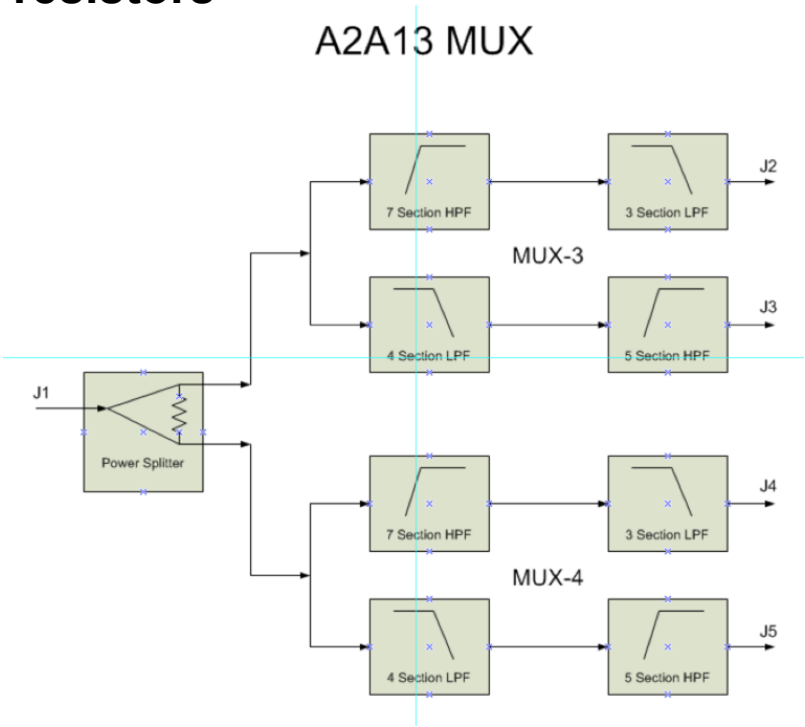


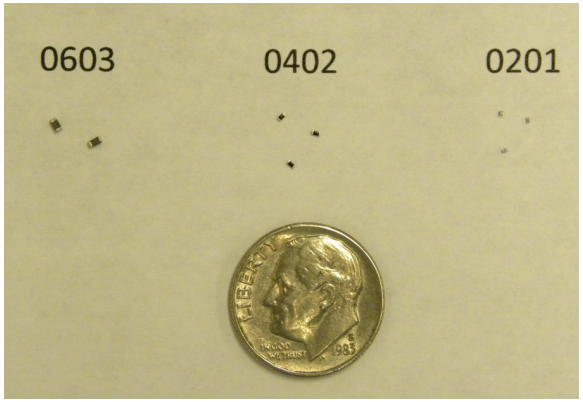


Dual Converter Block Diagram

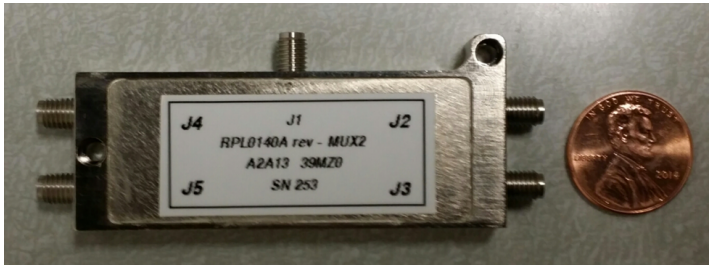
Miniaturization Possibilities

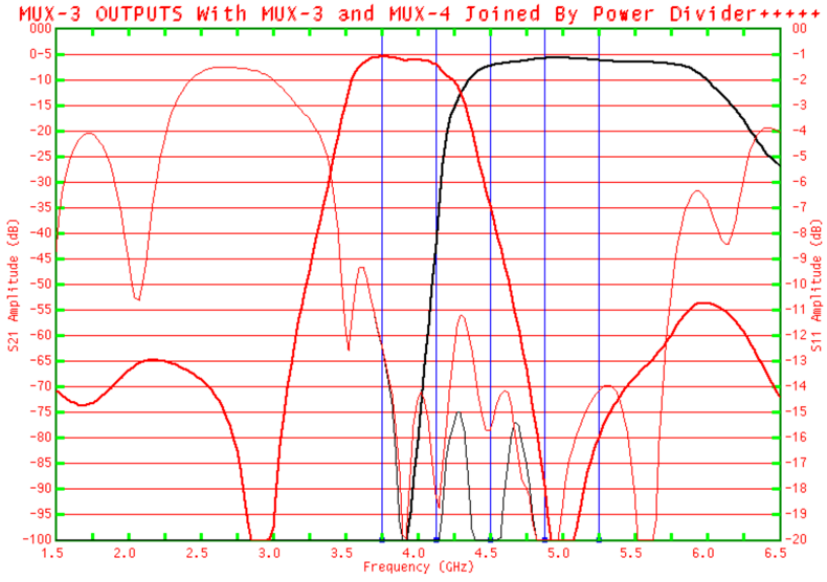
- **Create highly complex filter structures using surface mount inductors, capacitors and resistors**





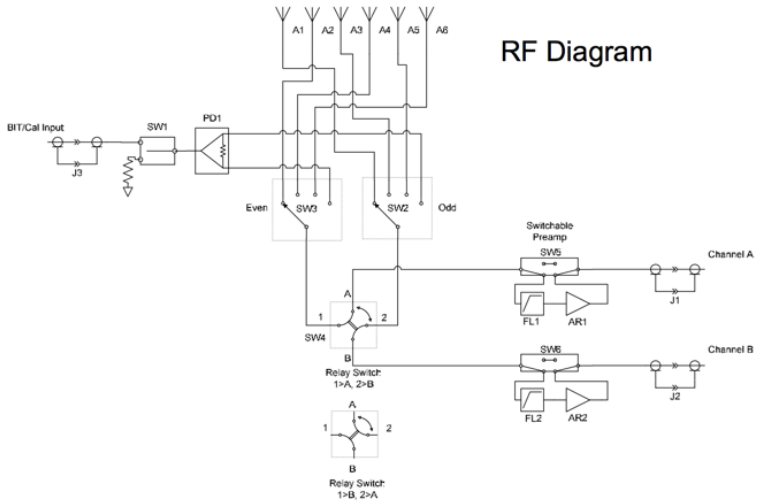
RF component sizes

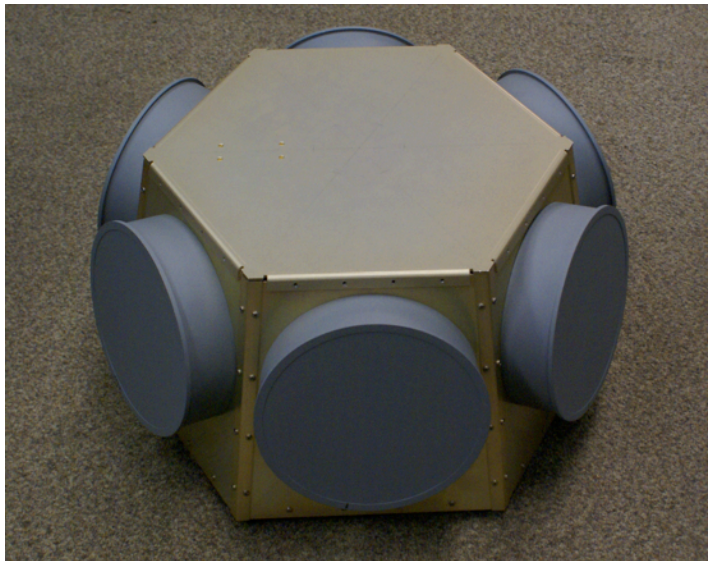




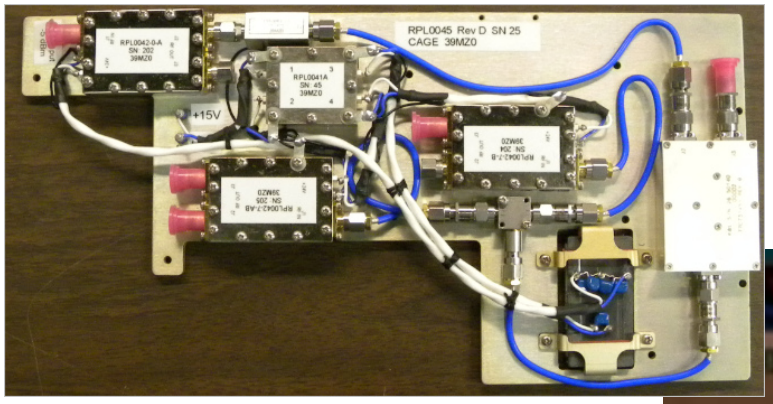
DF Antenna Subsystem

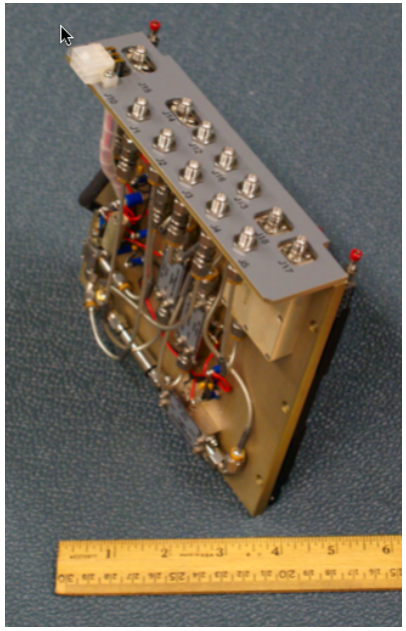
- We designed and built a DF Antenna Subsystem (6 Months)
- Capability to provide amplitude and phase DF between antenna pairs
- 360 degree angular coverage
- Low cost, universal design (can be used with many different receivers)
- Low noise figure RF front end (~3.5-4.0 dB) for Receive, and Transmit Path
- Calibration injection to calibrate receiver amplitude and phase
- Wide frequency coverage (500 MHz to 3 GHz), high dynamic range
- Digital Compass for DF Antenna Assembly pointing information

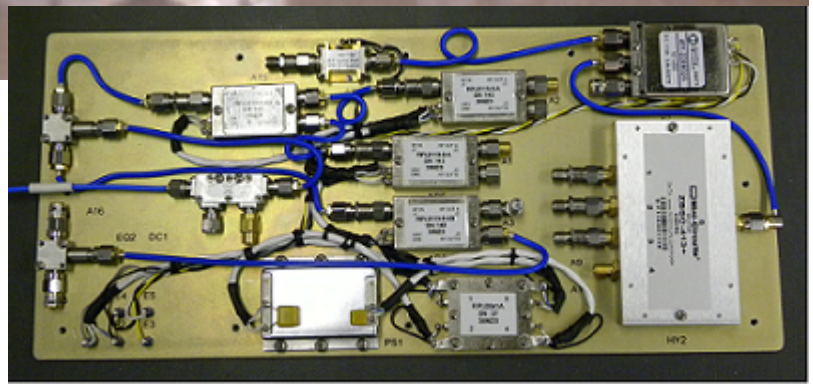




Navy Submarine Hardware







Qualifications and Certifications

- **Quality**
  - **2nd Party certified to ISO 9001:2008 by Lockheed Martin**
- **ESD**
  - **MIL-STD-1686 Certified Compliant**
- **Security**
  - **Personnel have SECRET clearance, SECRET container storage**

Current Approvals

You are logged on as

Vendor:	LM0084402
Name:	R A WOOD ASSOCIATES
House no/street:	1001 BROAD ST STE 6
City:	UTICA
Region:	NY
Postal Code:	13501-1546

View [Standard View] Print Version Export

Vendor	Name	Address	City	Rg	ZIP Code	Apprvl Cd	Apprvl Code Desc	Disposition	Spec Nbr	Expiration Date
LM0084402	R A WOOD ASSOCIATES	1001 BROAD ST STE 6	UTICA	NY	13501-1546	ELXA168600	MIL-STD-1686C ELECTROSTATIC DISCHARGE CONTROL PROGRAM	APPROVED	MIL-STD-1686	12/20/2014
LM0084402	R A WOOD ASSOCIATES	1001 BROAD ST STE 6	UTICA	NY	13501-1546	SQZR900184	ISO 9001:2008 QUALITY MANAGEMENT SYSTEM - NO EXCLUSIONS (2ND PARTY)	APPROVED	ISO 9001:2008	02/26/2015

Team of Awesome People!

- **We have highly talented people working for us**
  - ✓ RF Circuit / System Design Expertise
  - ✓ Automated Test Software
  - ✓ Test Station Experience
  - ✓ Superb Assembly Capability
  - ✓ RF Test and Troubleshoot Expertise
  - ✓ Awesome production management
  - ✓ Configuration control
  - ✓ Mechanical Modeling
  - ✓ Quality control
  - ✓ Purchasing, Administration

- **We continue to impress our customers**
  - Quality Products
  - On-time deliveries
  - Develop new products
  - Expand surface mount technology into higher frequencies, wider bandwidths
  - Keep our costs low
    - » Help keep our customer's costs low