



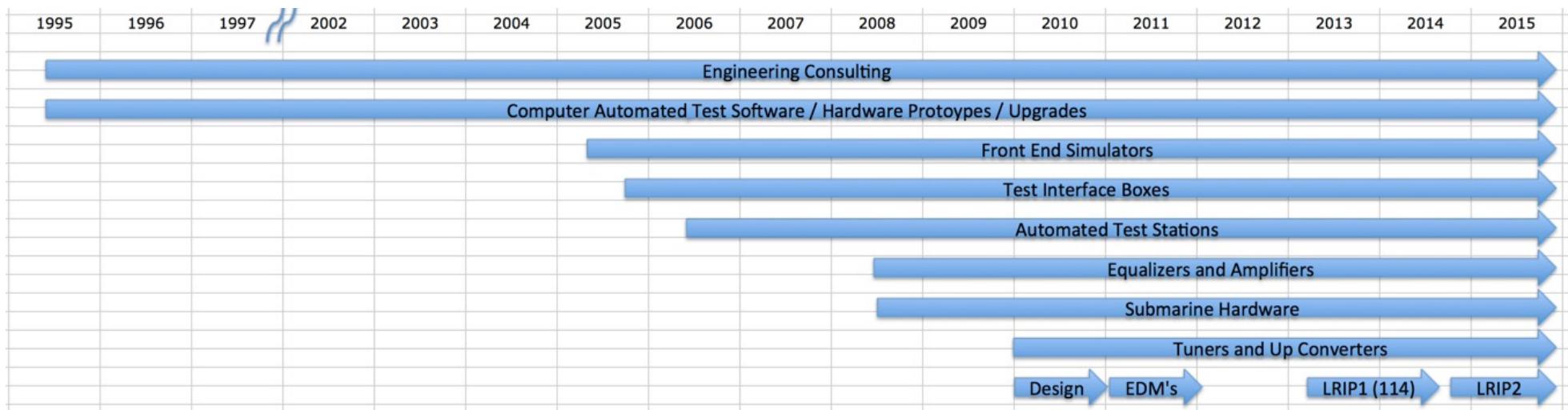
# Capabilities and Accomplishments

*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**



## RF System Design Expertise

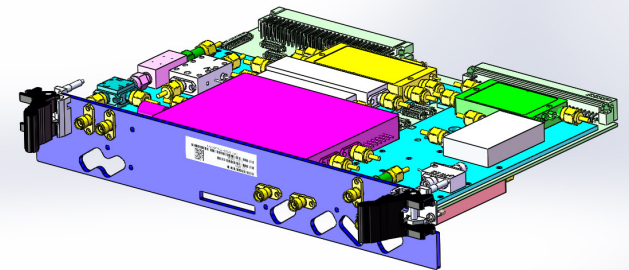
- Flow Down from top level system requirements to component designs
- Specification Development
- RF Path Analysis

## RF/Microwave Circuit Design Modeling

- Very accurate circuit design model and optimization
- MUSTAG

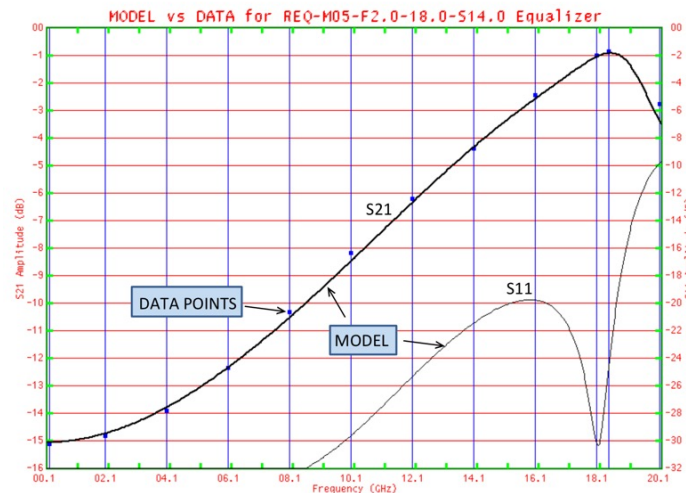
## 3-D Mechanical Modeling

- SolidWorks

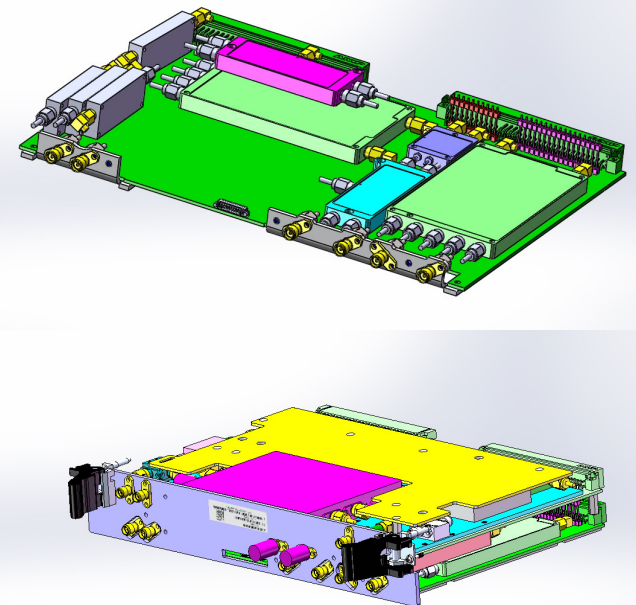


LIBREFNO	Part Type	Description	Nominal Gain	CUM Gain	Noise Figure	CUM Noise Figure	SI01 Power	SI02 Power	T.O. I.P.	CUM T.O. I.P.	Post 1dB	SI02 Diff From Comp Pt	Device T.O.	CUM Pin
CPAD-03	Attenuator	PadAttenuator (3 dB)	-3	-3	3	3	-57	-2	150	150				154
HPVIBAMP06P10	Amplifier	HPVIB Amp G6 P10	10	7	6.5	9.5	-47	8	28	21	18	-10	-40	12
SWTCH_FILTER_STLB	Switch	Switched Filter SP2T LB	-1.7	5.3	1.7	9.55	-48.7	6.3	40	20.92	30	-23.7	-87.4	11.82
SWTCH_FILTER_STLB	Switch	Switch Filter SP2T LB	-4.5	0.8	4.5	9.8	-53.2	1.8	40	20.76	30	-28.2	-76.4	11.76
SubAssembly In	Marker	I	0	0.8	0	9.8	-53.2	1.8	108	20.76	99			11.76
CSWA2-63DR60	Switch	SP2T SW Term SM 20GHz	-1	-0.2	1	9.89	-54.2	0.8	50	20.75	30	-29.2	-88.4	11.71
CPAD-00	Attenuator	PadAttenuator (0 dB)	0	-0.2	0	9.89	-54.2	0.8	150	20.75	150			11.71
MARVM23	Mixer	M23 Mixer	-8	-8.2	0	11.9	-62.2	-7.2	15.5	18.97	6	-13.2	-45.4	10.1
CPAD-00	Attenuator	PadAttenuator (0 dB)	0	-8.2	0	11.9	-62.2	-7.2	150	18.97	150			10.1
DIPLEXFC	Filter	IFC Diplexer	-1	-9.2	1	12.3	-63.2	-8.2	150	18.97	150			10.1
CSWA2-63DR60	Switch	SP2T SW Term SM 60GHz	-1.5	-10.7	1.5	13.1	-64.7	-9.7	45	18.97	27	-38.7	-109	10.1
SubAssembly Out	Marker	I	0	-10.7	0	13.1	-64.7	-9.7	109	18.97	99			10.1
CSWA2-63DR60	Switch	SP2T SW Term SM 60GHz	-1.5	-12.2	1.5	14	-66.2	-11.2	45	18.97	27	-38.2	-112	10.09
SubAssembly In	Marker	I	9.6	-2.6	3.7	17.2	-49.5	6.5	33.9	18.43	20.3	-21.9	-71	9.91
TUNE1.50SLP.5.70	Time	IF1 Equalizer 5.7dB FH	-1.5	-4.1	1.5	16.9	-58.1	-3.1	109	18.99	99			8.91
BITCOUPLER-BBF	Coupler	Coupler	-0.5	5	0.5	17.2	-49	6	150	18.43	150			8.92
POV2-IFDIST	Pwr Dvdr	Two-way power divider	-4	1	4	17.2	-53	2	150	18.43	150			8.92
CPAD-02	Attenuator	PadAttenuator (2 dB)	-2	-1	2	17.2	-55	0	150	18.43	150			8.92
TUNE1.50SLP.5.70	Time	IF1 Equalizer 5.7dB FH	-1.5	-2.5	1.5	17.3	-56.5	-1.5	109	18.43	99			8.92
SubAssembly Out	Marker	I	9.7	7.2	3.5	17.4	-48.8	8.2	38.8	18.23	21.6	-13.4	-81.2	8.04
IFFILTER1.50B	Filter	IF FILTER 1.5 dB	-1.5	5.7	1.5	17.5	-48.3	6.7	109	18.23	99			8.04
SubAssembly In	Marker	I	0	5.7	0	17.5	-48.3	6.7	109	18.23	99			8.04
QUADINPUTMUX	Pwr Dvdr	Pwr Dvdr 2 Way IF4	-3.3	2.4	3.3	17.5	-51.6	3.4	109	18.23	99			8.04
SubAssembly Out	Marker	I	-3	-0.6	3	17.5	-54.6	0.4	109	18.23	100			8.04
CSWA2-63DR60	Switch	SP2T SW Term SM 60GHz	-1.5	-2.1	1.5	17.6	-56.1	-1.1	45	18.22	27	-28.1	-92.2	8.01
SubAssembly In	Marker	I	0	-0.6	0	17.5	-54.6	0.4	109	18.23	99			8.04
CSWA2-63DR60	Switch	SP2T SW Term SM 60GHz	-1.5	-3.6	1.5	17.6	-57.6	-2.6	45	18.22	27	-29.6	-95.2	7.99
CPAD-00	Attenuator	PadAttenuator (0 dB)	0	-3.6	0	17.6	-57.6	-2.6	150	18.22	150			7.99
MARVM23	Mixer	M23 Mixer	-8	-11.6	8	18.4	-65.6	-10.6	15.5	17.69	6	-16.6	-52.2	7.63
DIPLEXFC	Filter	IFC Diplexer	-1	-12.6	1	19.7	-66.6	-11.6	150	17.69	150			7.63
TUNE1.50SLP.2.00	Time	Equalizer IF2	-1.5	1.1	1.5	19.3	-52.9	2.1	109	17.69	99			7.27
MC276-1505-PRD0BLF	Amplifier	MC 276-1505-PRD0BLF	-1.9	-0.9	1.9	19.3	-54.8	0.2	37	17.54	24	-23.8	-73.6	7.21
CPAD-03.5	Attenuator	PadAttenuator (3.5 dB)	-3.5	-4.3	3.5	19.4	-58.3	-3.3	150	17.54	150			7.21
SubAssembly Out	Marker	I	15.7	11.4	1.9	19.5	-42.6	12.4	41.1	17.28	22.6	-10.2	-57.4	6.02
IFFILTER1.50B	Filter	IF FILTER 1.5 dB	-1.5	9.9	1.5	19.5	-44.1	10.9	109	17.28	99			6.02
Final Path Analysis:														
IFFILTER1.50B	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

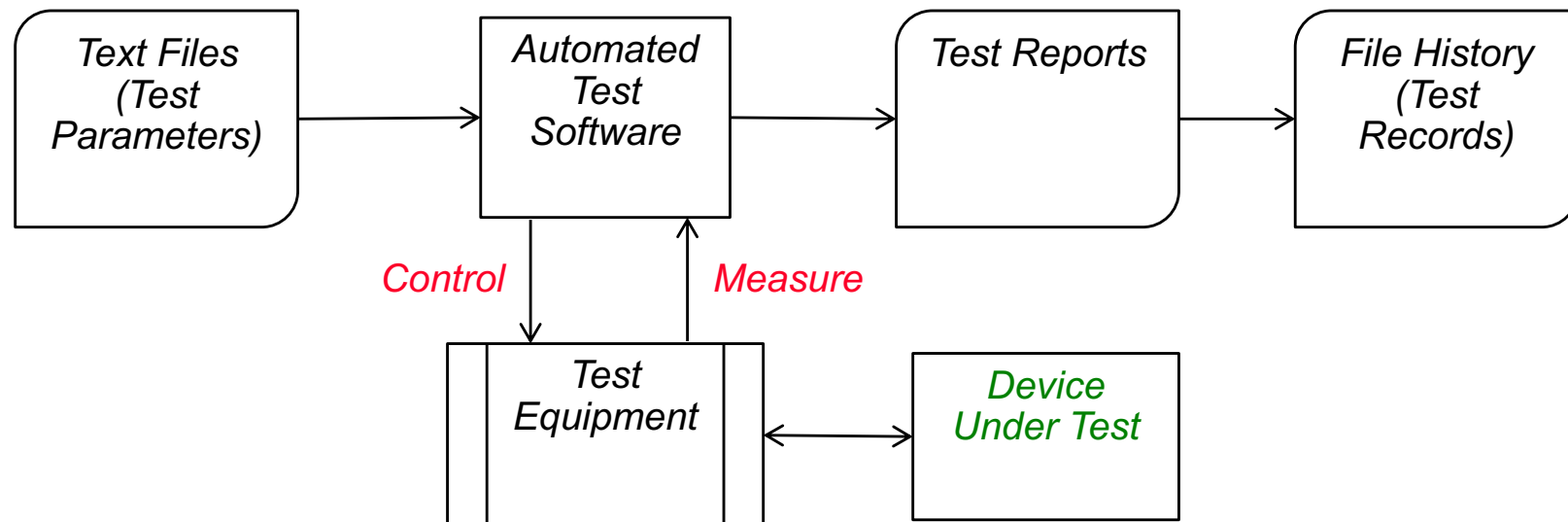


2-18 GHz equalizer model and measured data



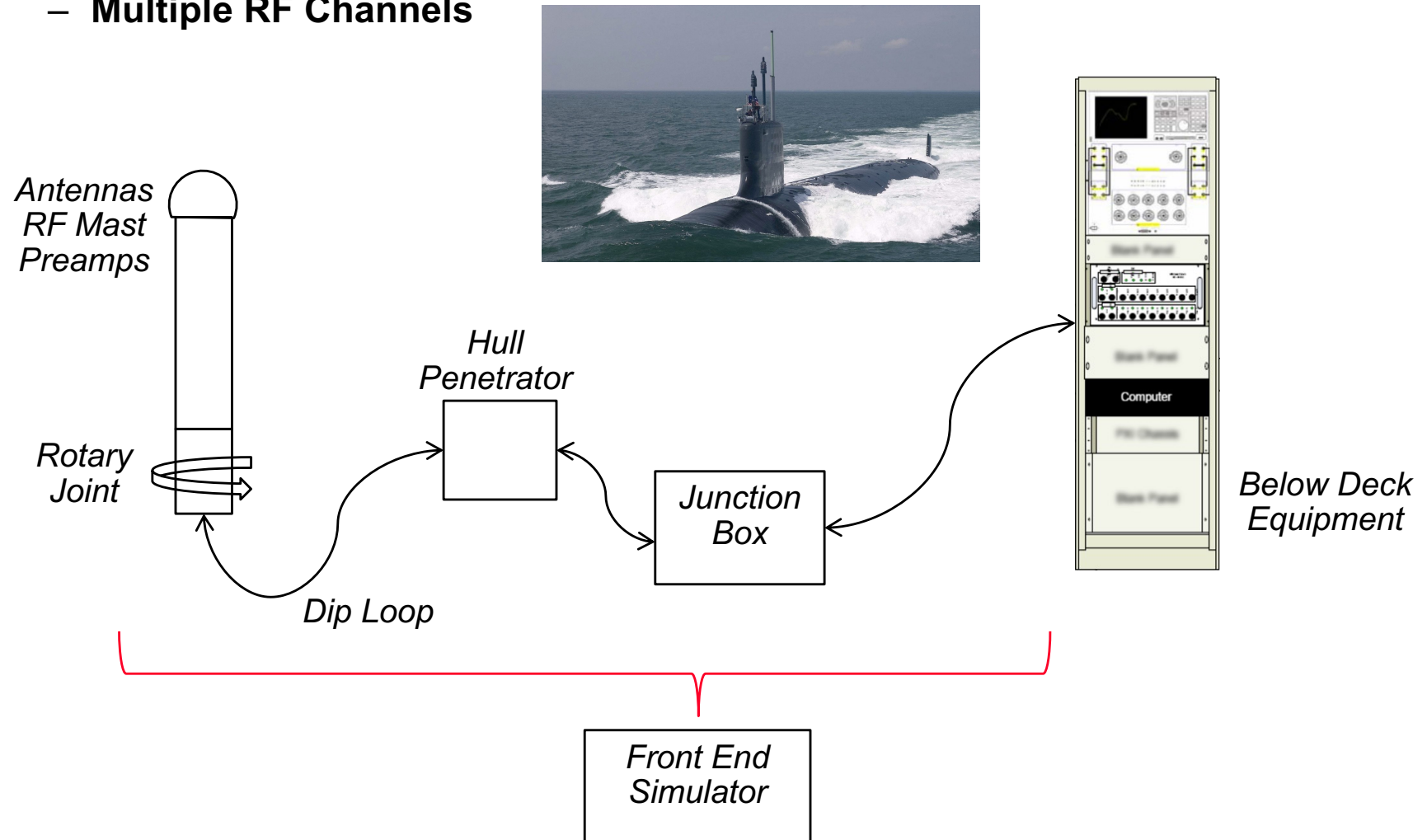
# Automated Test Software

- 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



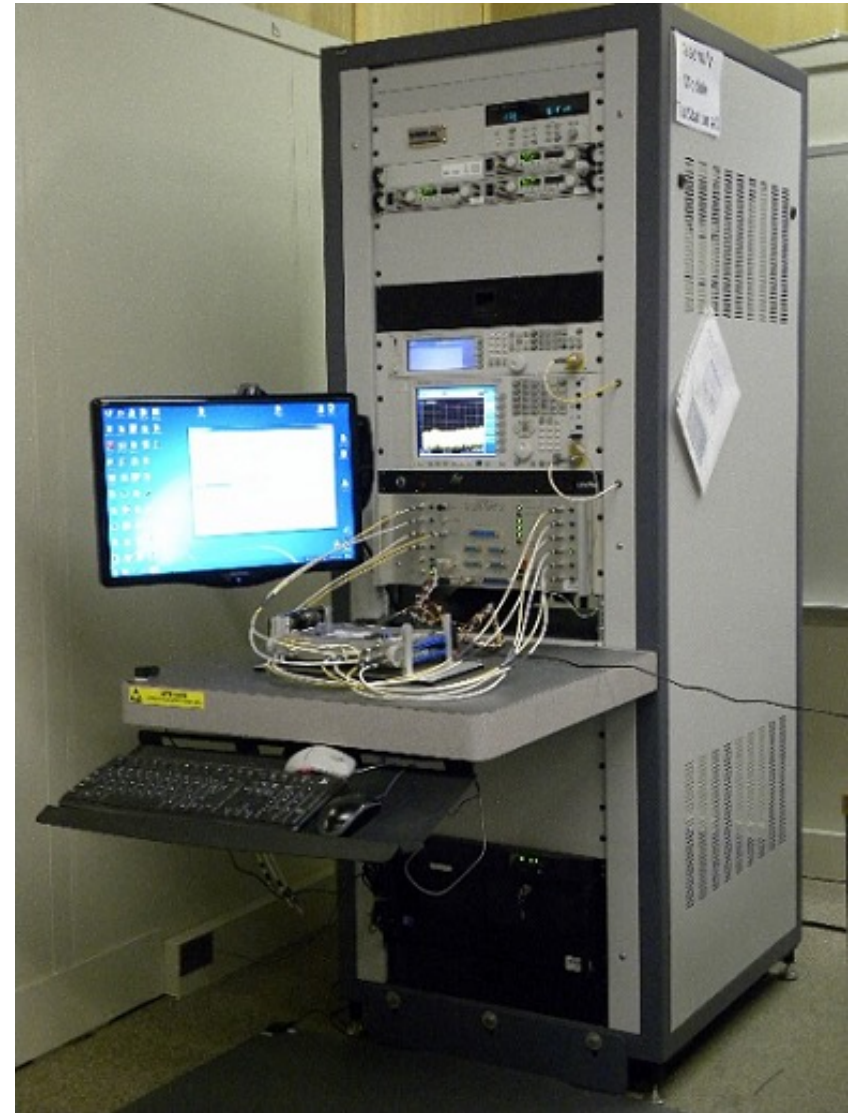


# Automated Test Systems

- 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*

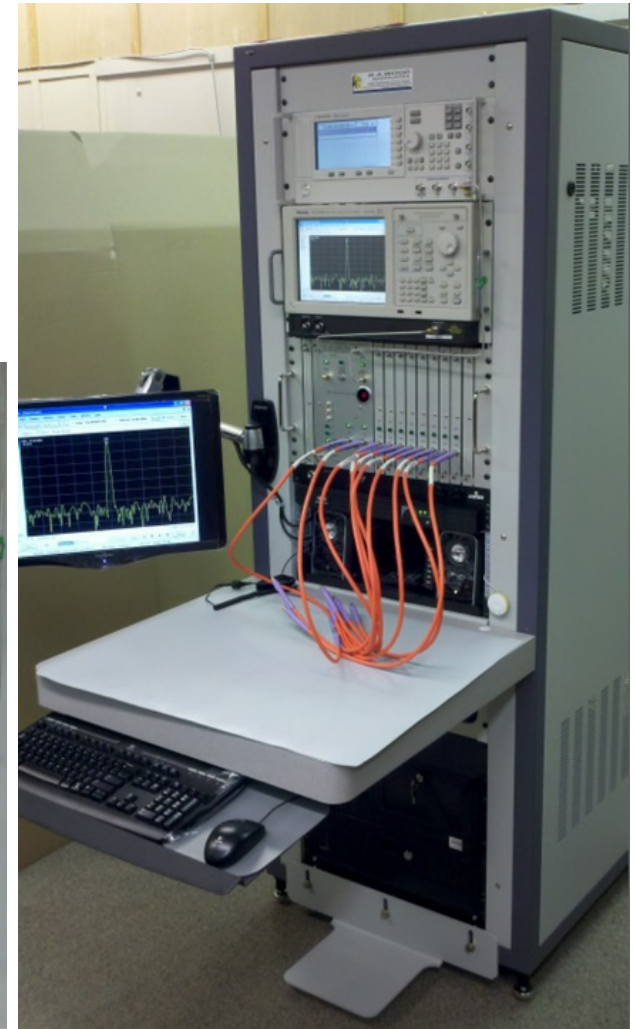
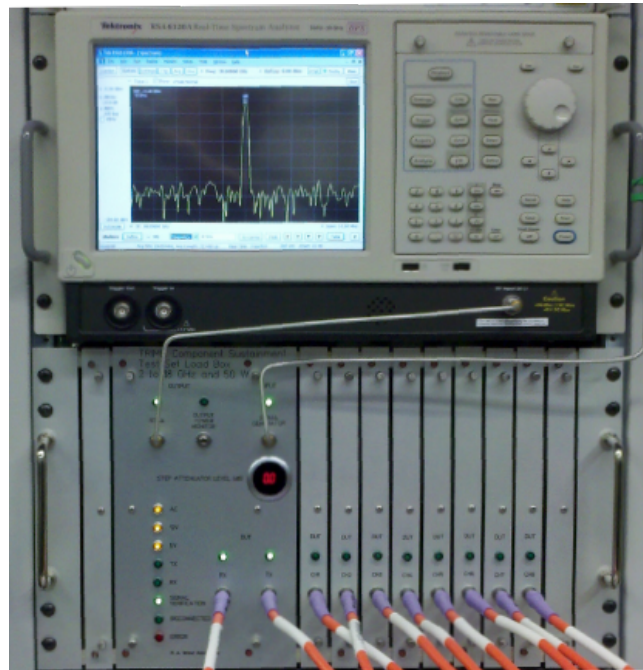


*Developed with funding from Navy ManTech  
SEWIP Block 2 Improvements Project*

# 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

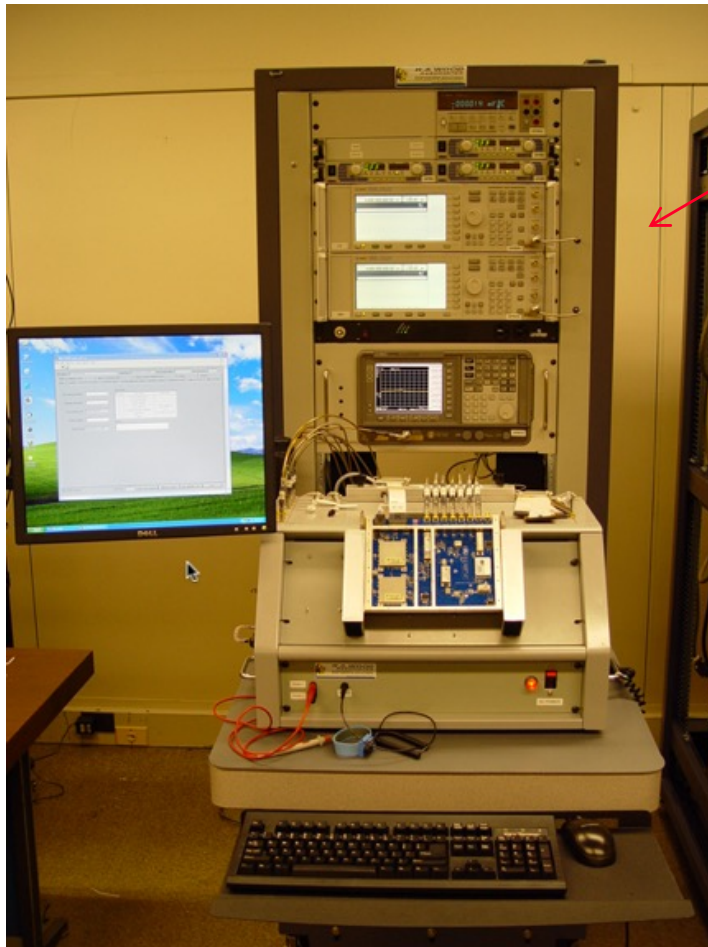
*References available on request*





# 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)



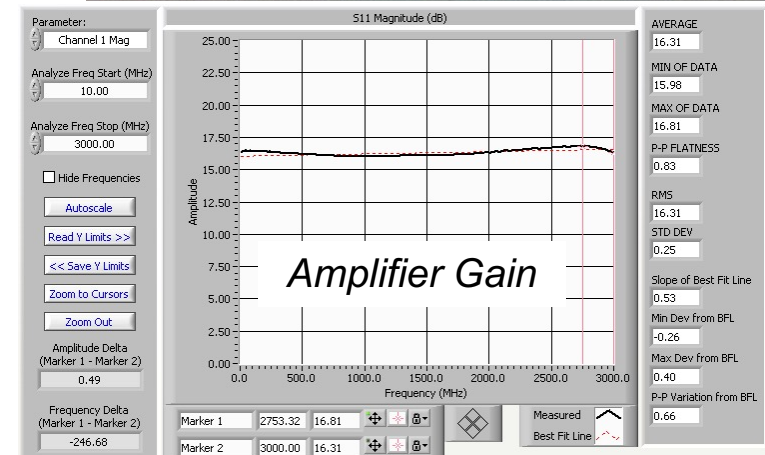
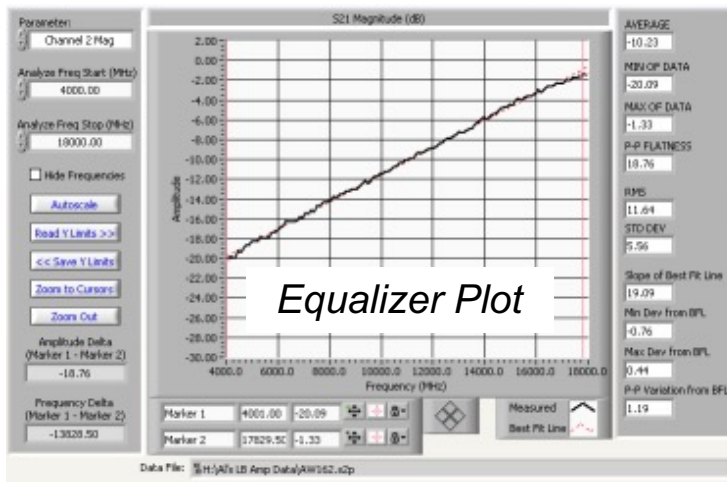
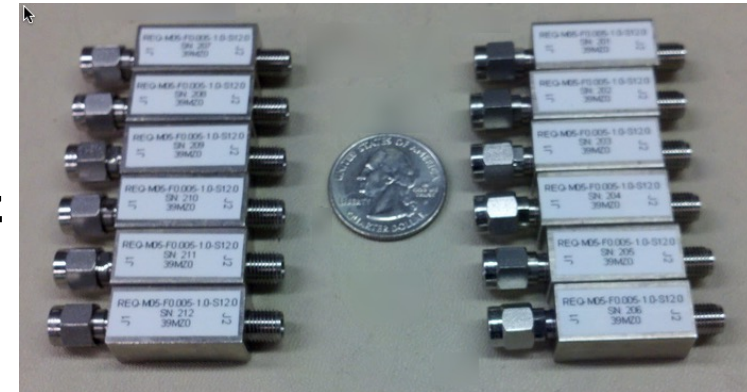
*Complete  
Test  
System*



*Test  
Interface  
Unit*

# Equalizers and Amplifiers

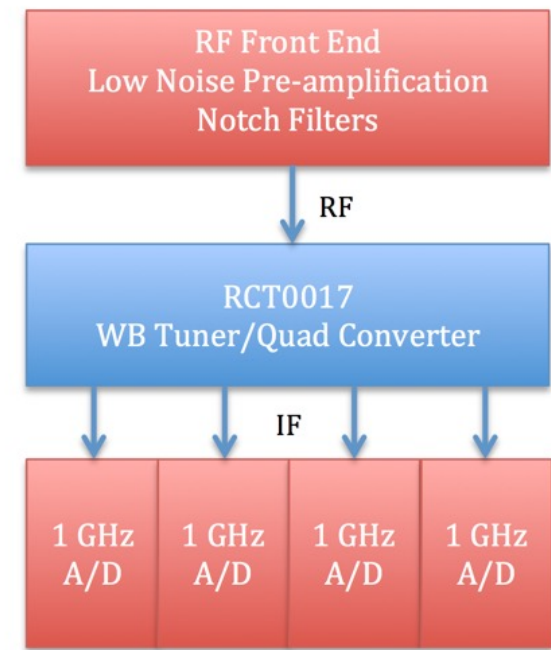
- Designed ultra-wideband amplifiers not available in industry (5 kHz to 3 GHz)
- Started designing custom equalizers to offset cable and amplifier slopes
- Equalizers use surface mount components (resistors, capacitors, inductors)
  - Available quickly off the shelf
  - Components have been characterized 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

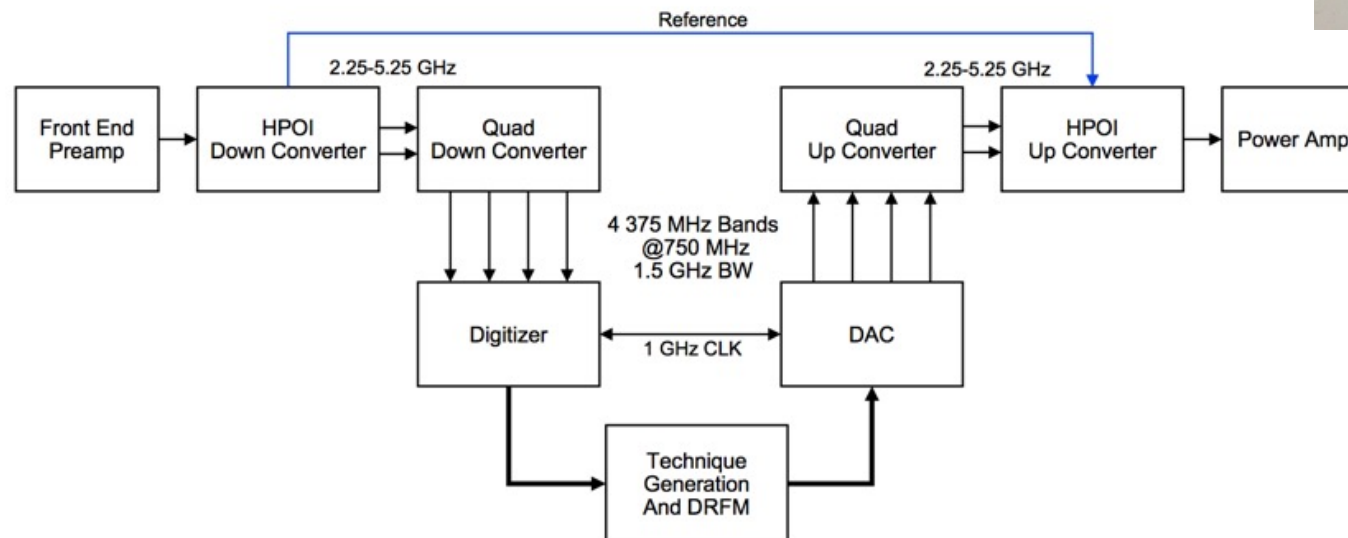


*Typical Application*



# 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!**



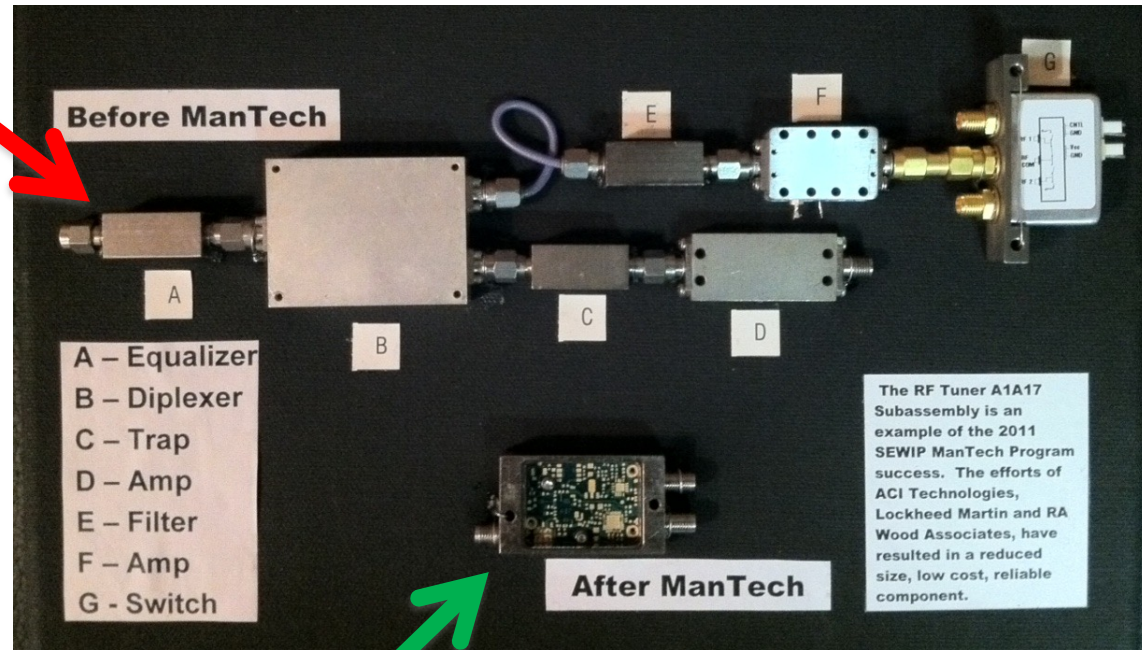
*A1A17 RF SubAssembly provides LO signals up to 15 GHz*

# Objective 1 – Improved Packaging

## ■ 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"

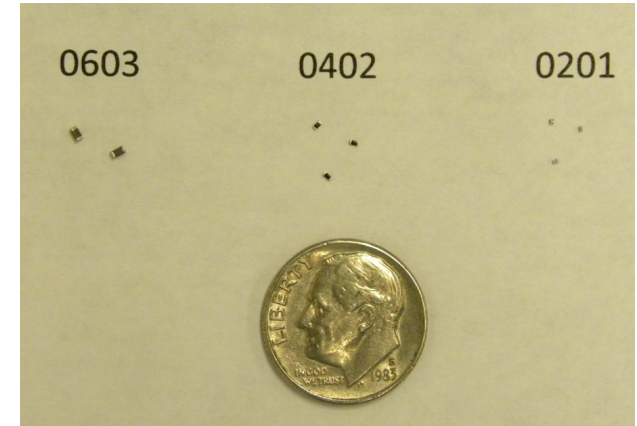
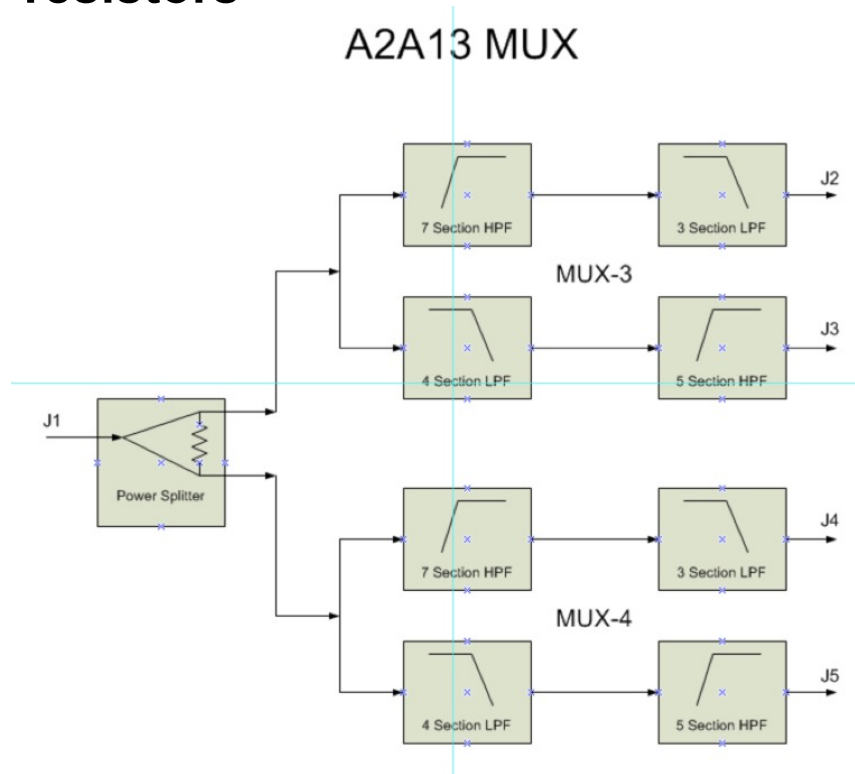


## Miniaturization Possibilities

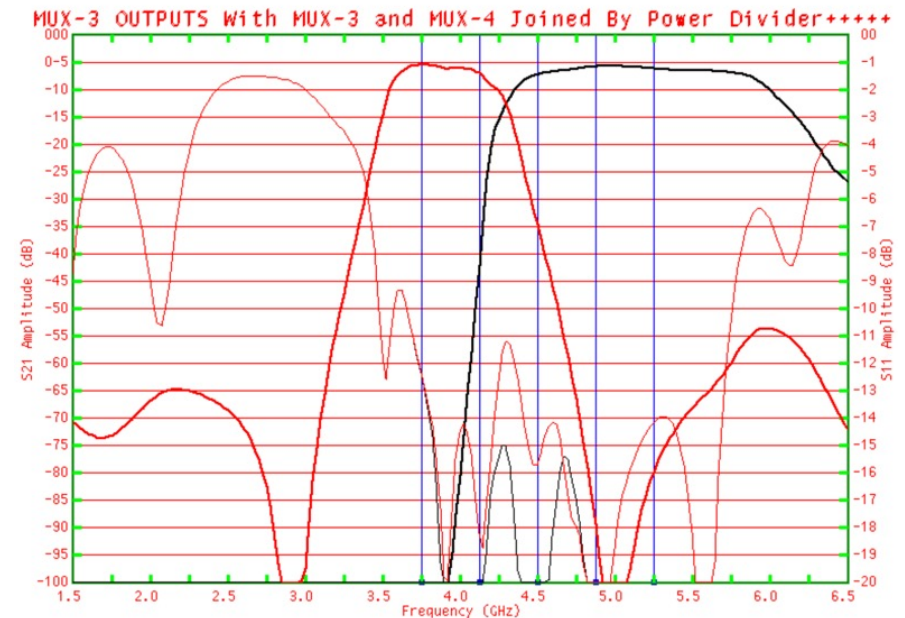
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# Miniaturization Possibilities

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

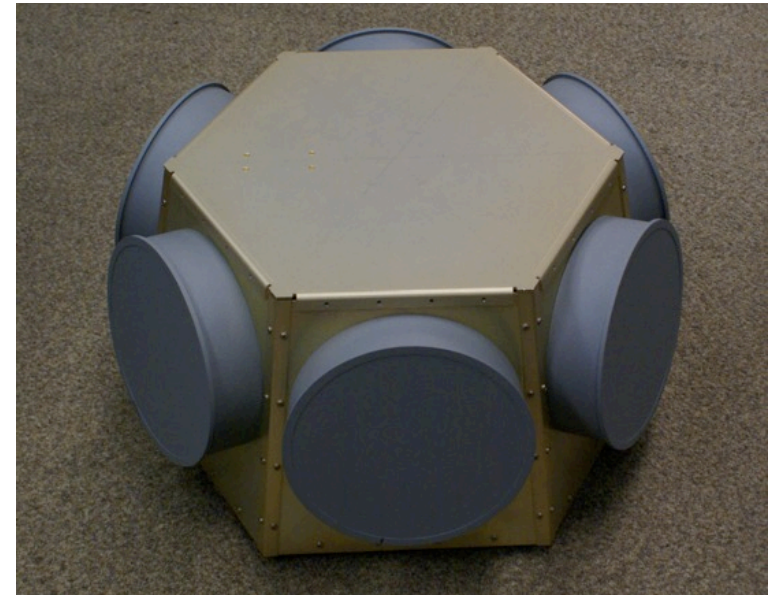
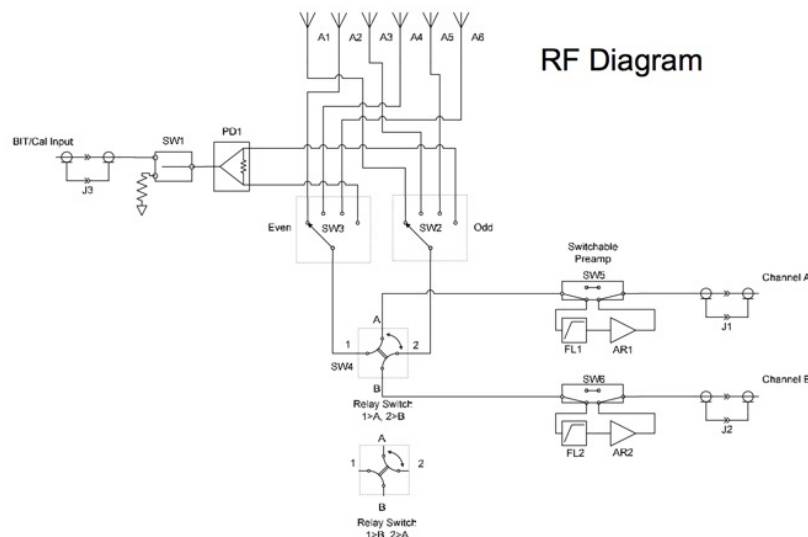


*RF component sizes*



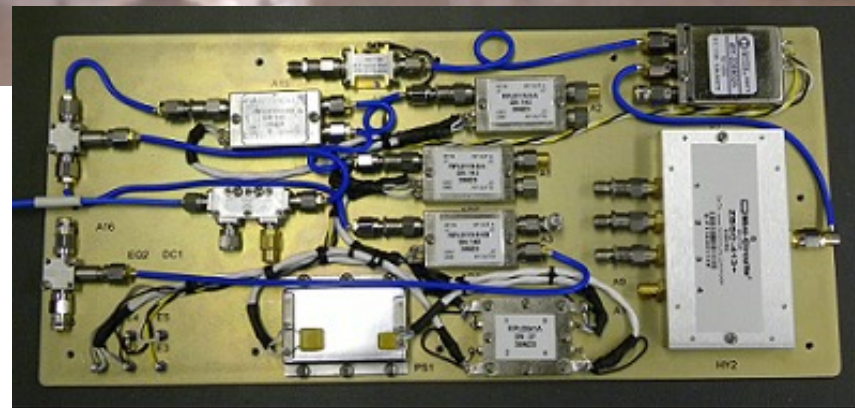
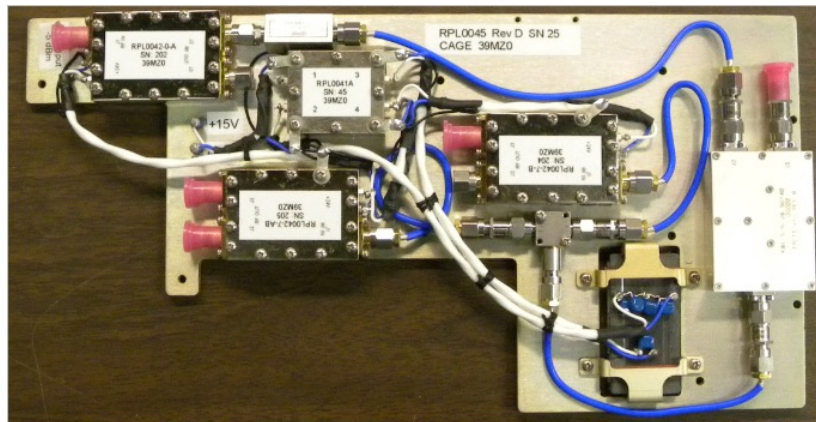
# DF Antenna Subsystem

- 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 ( $\sim 3.5\text{-}4.0$  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**
  - **2<sup>nd</sup> Party certified to ISO 9001:2008 by Lockheed Martin**
- **ESD**
  - **MIL-STD-1686 Certified Compliant**

## 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

