Goddard Space Flight Center

Summer Tasks on UAV Radar

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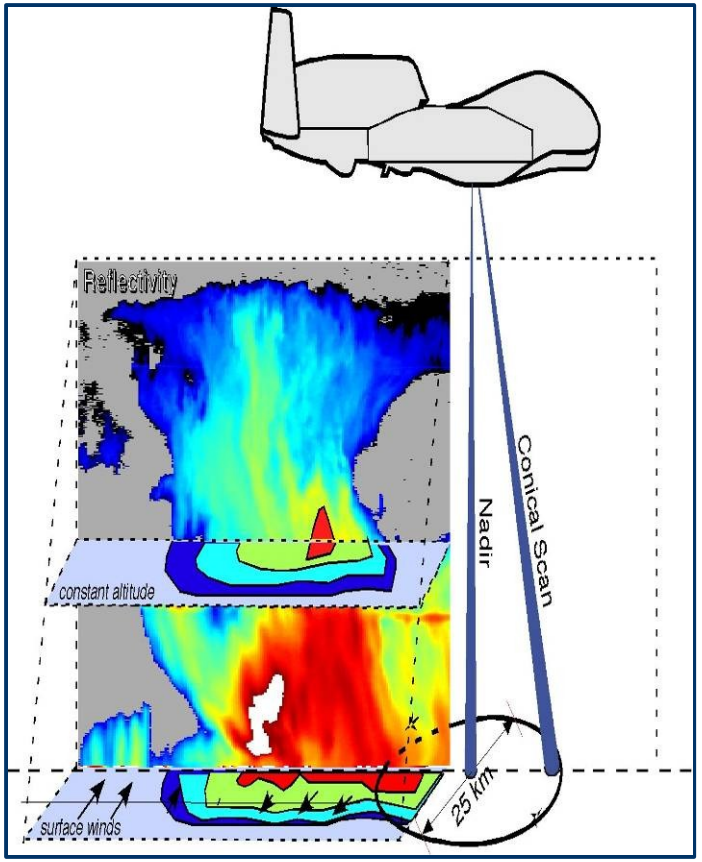
Objective

- NASA IDEAS-ER grant received.
- Develop a background on radar design while contributing to the UAV project.

UAV Radar Project

- The planned radar will have capabilities of ER-2 Doppler Radar (EDOP).
- Nadir beam for vertical winds and precipitation structure.
- Conical beam for ocean surface winds and surveillance of the precipitation regions of the storm.



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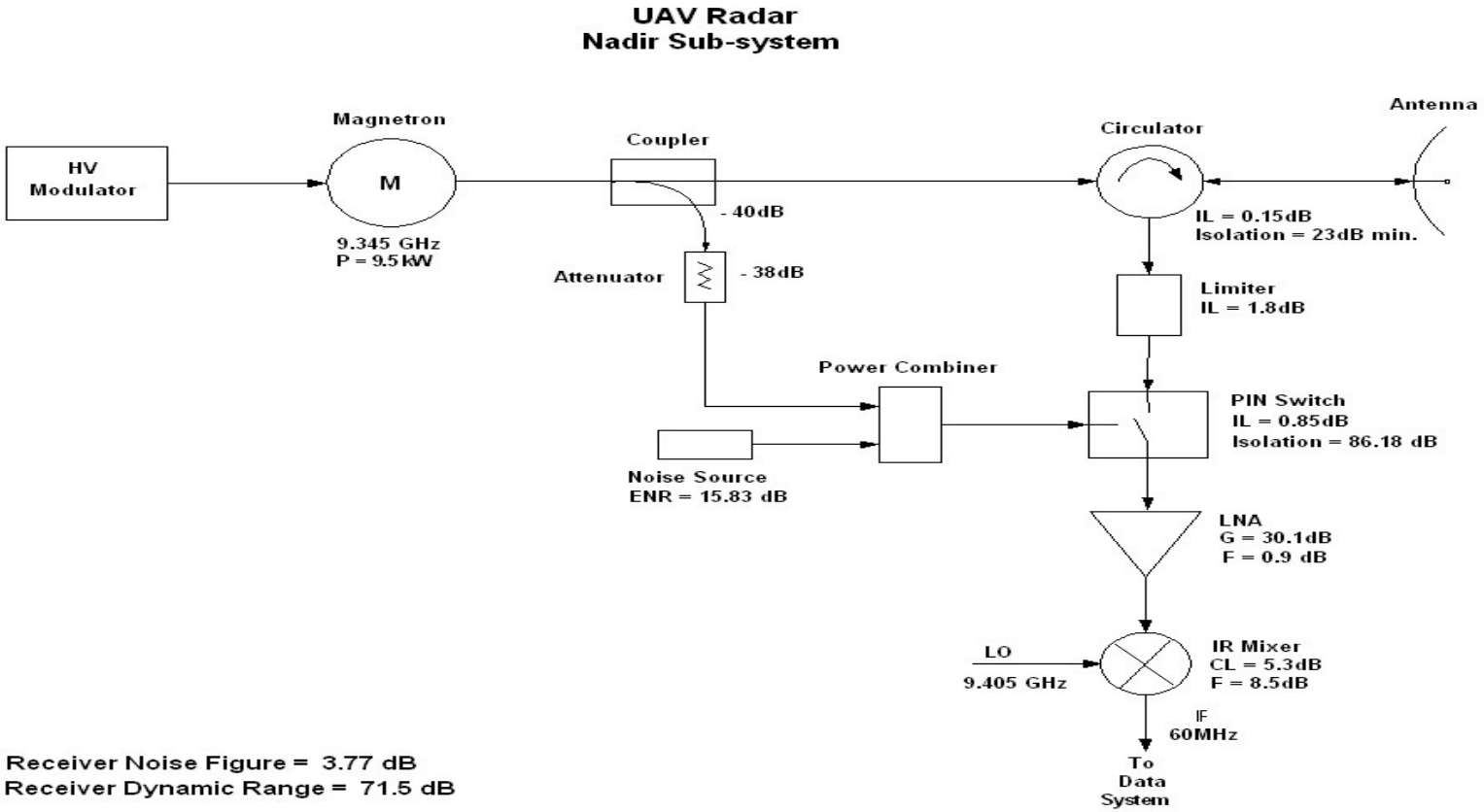
Tasks

- Study radar literature.
- Redesign UAV's nadir sub-system RF front end block diagram.
- Help bench test UAV's conical sub-system Tx and Rx paths.
- Design 80MHz/5MHz clock PCB.
- Design a PCB for UAV's Vicor power modules.

UAV's RF Front End Block Diagram

- Requirements
  - Magnetron frequency = 9.345 GHz
  - Intermediate frequency = 60 MHz
  - Calibration noise injection loop
  - Receiver noise figure calculations

UAV's RF Front End Block Diagram



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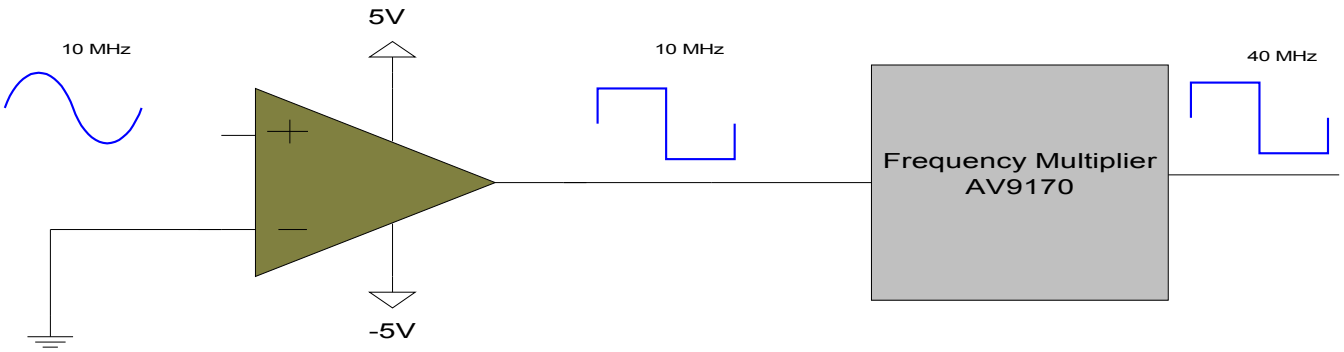
80MHz / 5MHz PCB

- Requirements
  - Single 10MHz sine wave input.
  - 80MHz and 5MHz TTL clock outputs for DAQ card.
  - Four amplified analog sensing lines.
  - Low profile components.
  - PMC daughter card format.
  - Original circuit design done by Shannon Rodríguez.

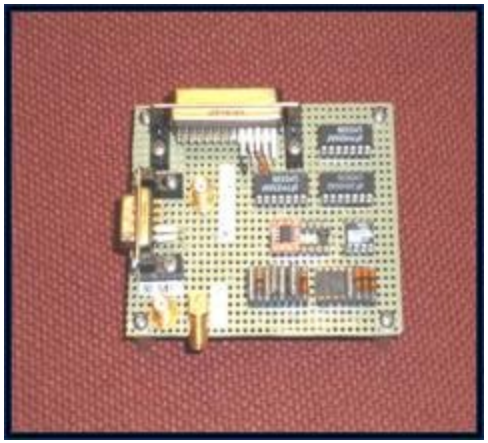
80MHz / 5MHz PCB

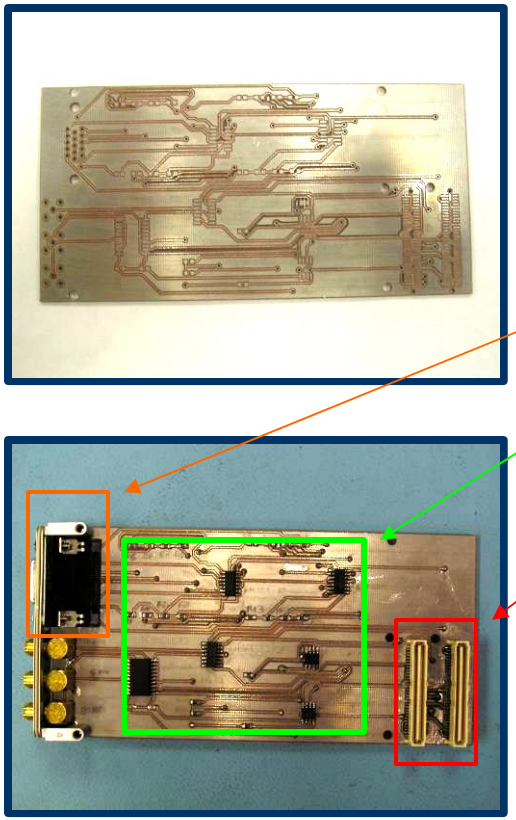
Clock Block Diagram:



80MHz / 5MHz PCB

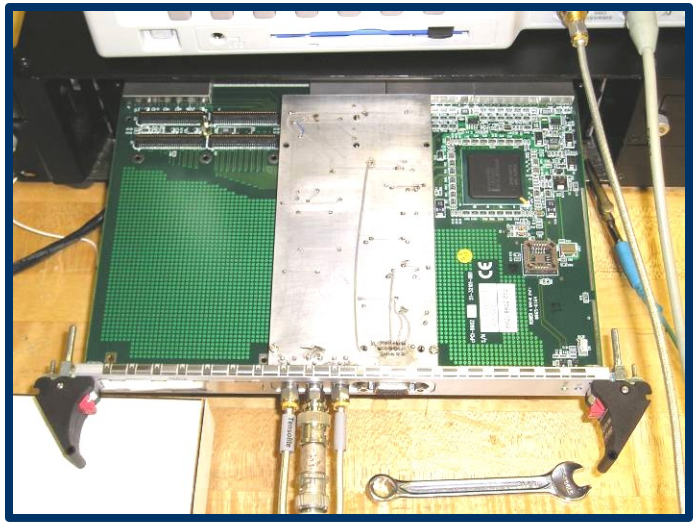
- **PCB Construction**
  - Board schematic and layout done with Orcad software.
  - Built using router in building 22.

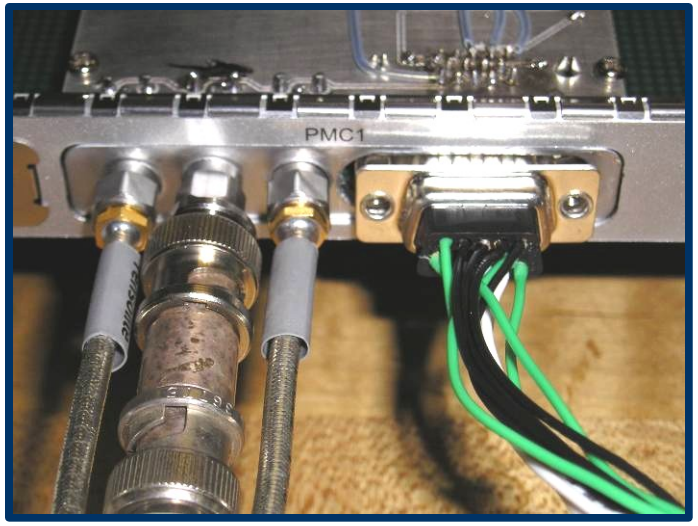




80MHz / 5MHz PCB

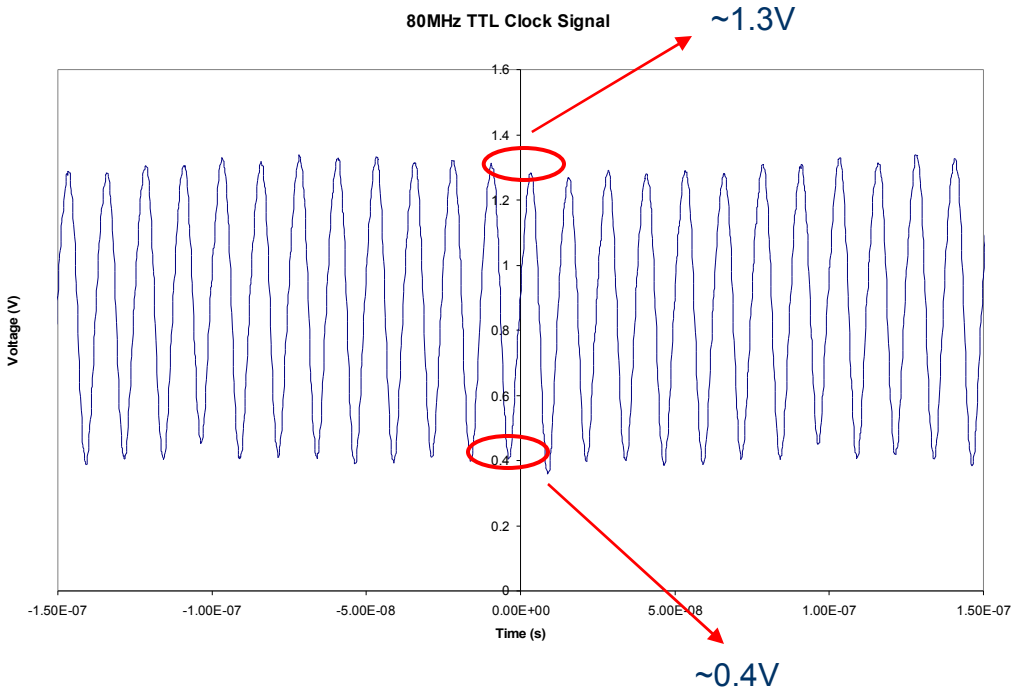
- **Board Testing**
  - CPCISYS carrier board with daughter card.
  - Only DC Power from carrier board used.
  - Still undergoing debugging process.





80MHz / 5MHz PCB

- **Test Results**
  - 80MHz Clock Signal



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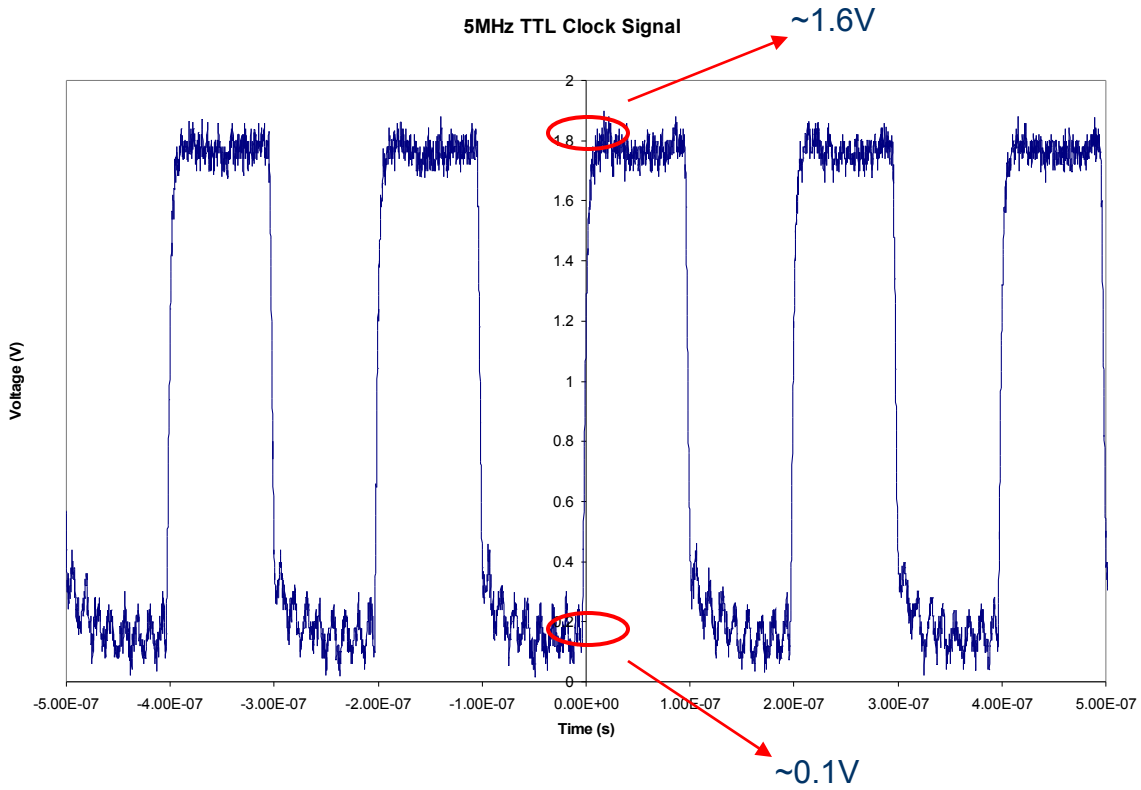
80MHz / 5MHz PCB

- 5MHZ Clock Signal SMA



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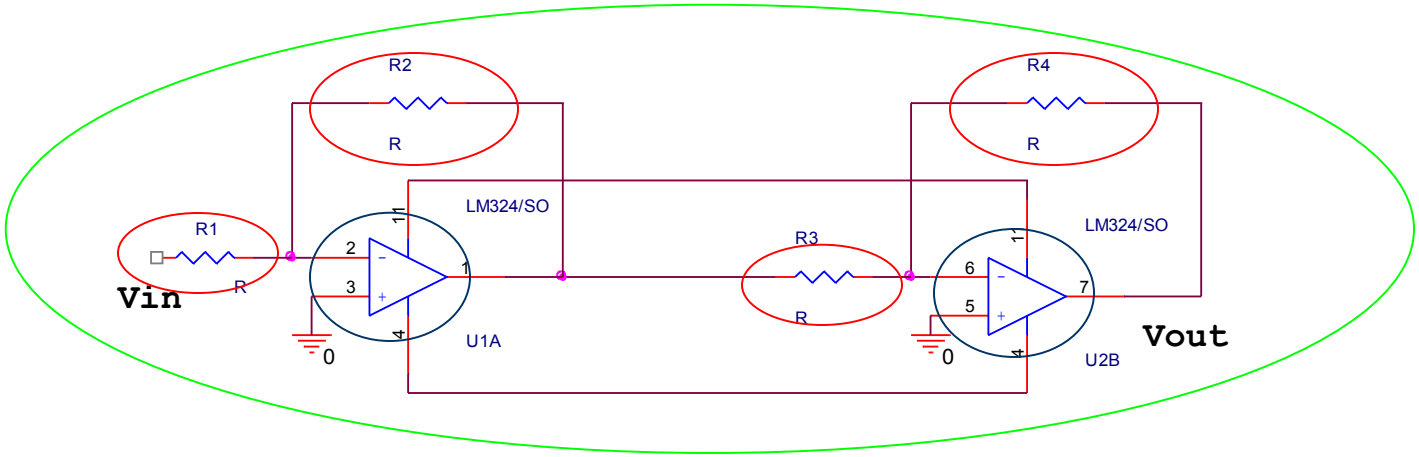
80MHz / 5MHz PCB

- **Sensing Lines**
  - Two additional lines were added.
  - Two inverting amplifier stages.
  - Gain values were changed.



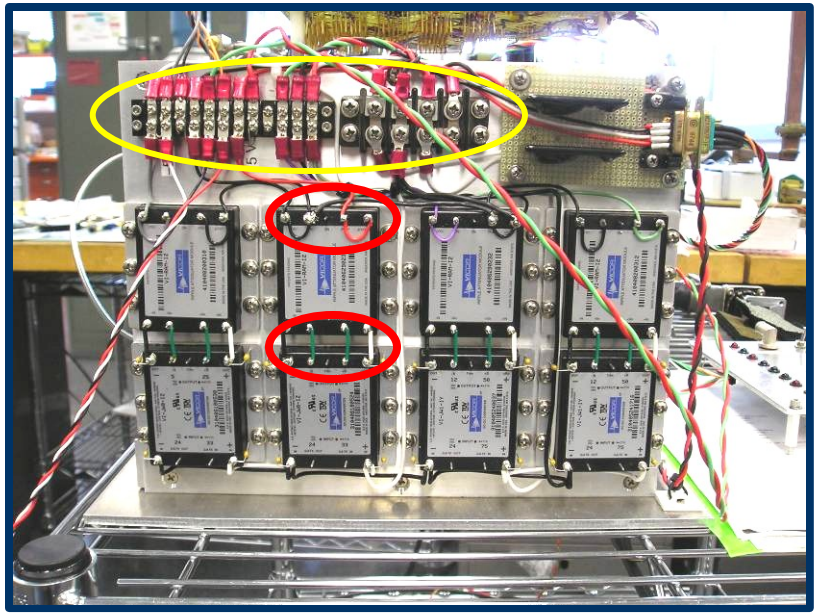
80MHz / 5MHz PCB

- **Sense Lines**
  - Tested using 10Vpp 1kHz sine wave.
  - Theoretical voltage gain value = 2.25.
  - Gain variations may be caused by tolerance in resistances.

Sense Line	Output Voltage (Vpp)	Voltage Gain
1	19.53	1.953
2	20.31	2.031
3	19.53	1.953
4	19.53	1.953

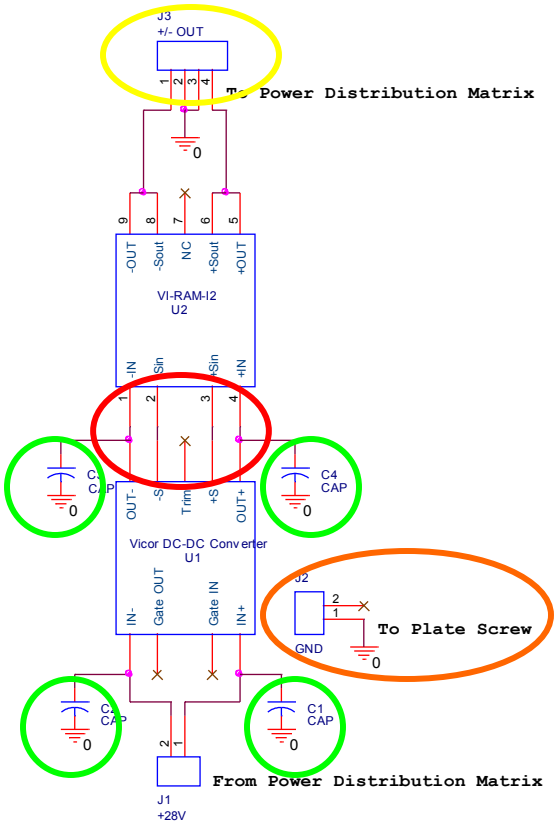
Vicor Power Modules PCB

- **Requirements**
  - Eliminate wire connections between modules.
  - Reduce mounting time.
  - Only one board for both +/- voltage configurations.
  - Output voltages should be accessible and easy to change(+/- 5V, +/-12V, +/- 15V).



Vicor Power Modules PCB

- **Design Schematic**
  - Power modules PCB.
    - Voltage selection jumper and output.
    - Wire connections elimination.
    - Bypass capacitors.
    - Chassis ground connection.

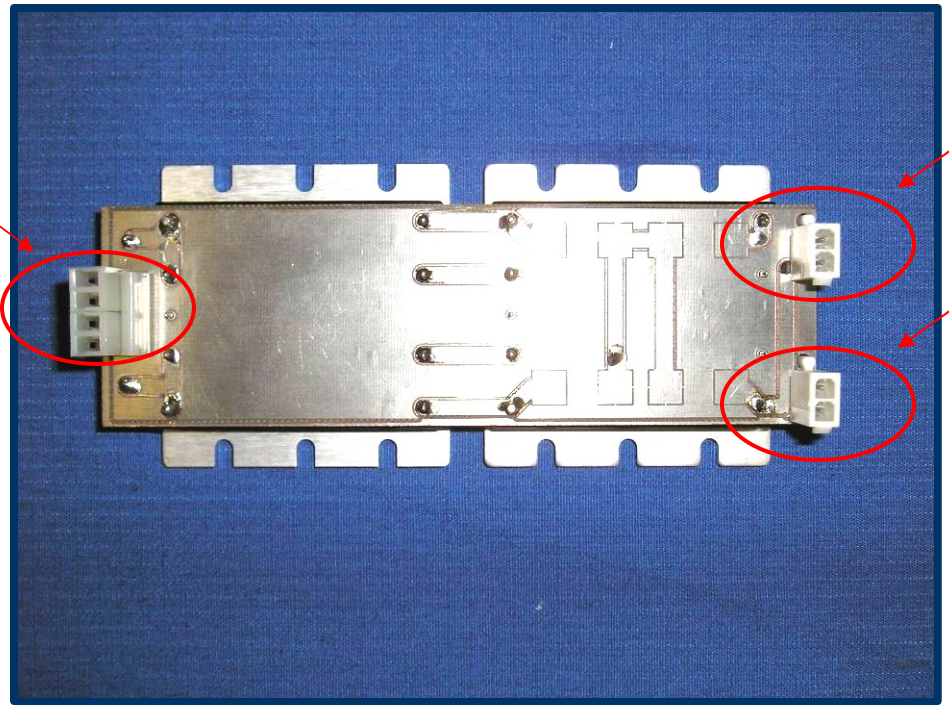


Vicor Power Modules PCB

- **PCB Construction**
  - Maximum load currents calculation.
    - I_{max} = 5 A @+24V_{IN} for 5V module.
    - 12V and 15V modules have lower output currents.
    - Track widths for 10˚C temperature increase = 110 mils.
    - Track clearances for +28V = 29 mils.
    - Entire design done using standard low-cost 1oz. Cu thickness board.
  - **Components selection.**
    - Connectors with unexposed contacts.

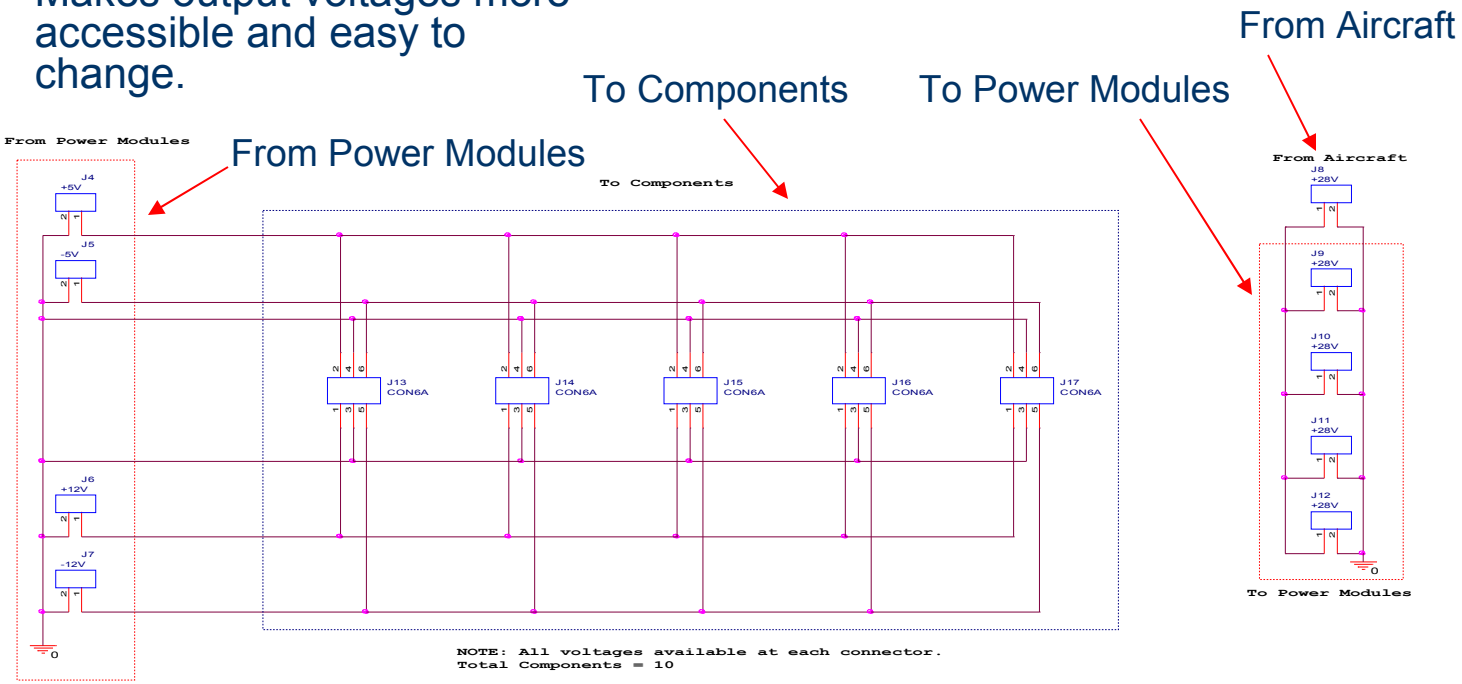
Vicor Power Modules PCB

- **Finished Board**



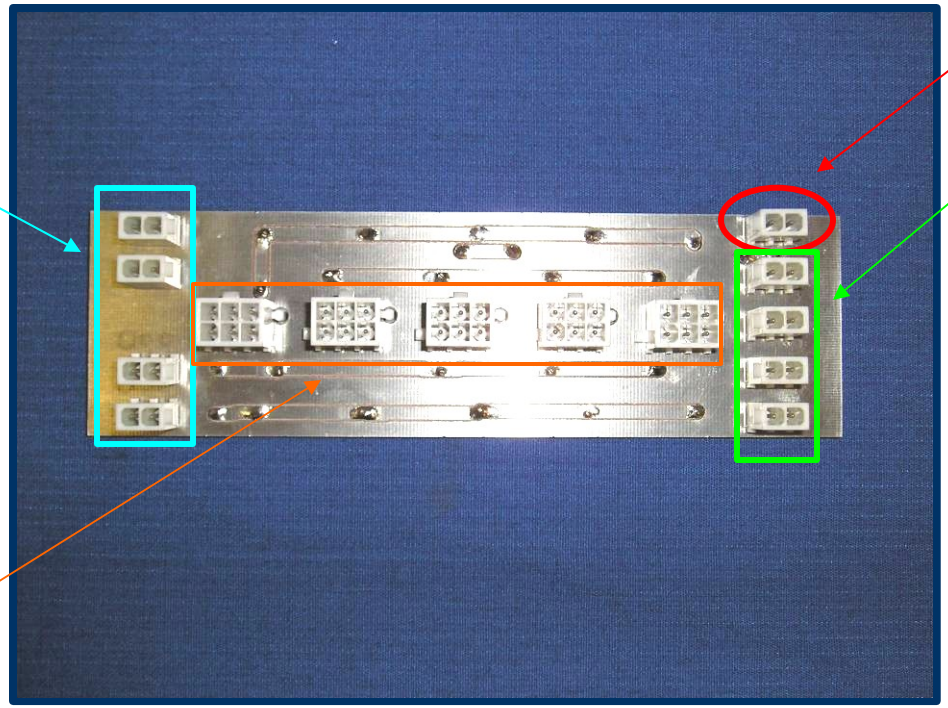
Vicor Power Modules PCB

- **Power Distribution Matrix**
  - Used to eliminate barrier block.
  - Makes output voltages more accessible and easy to change.



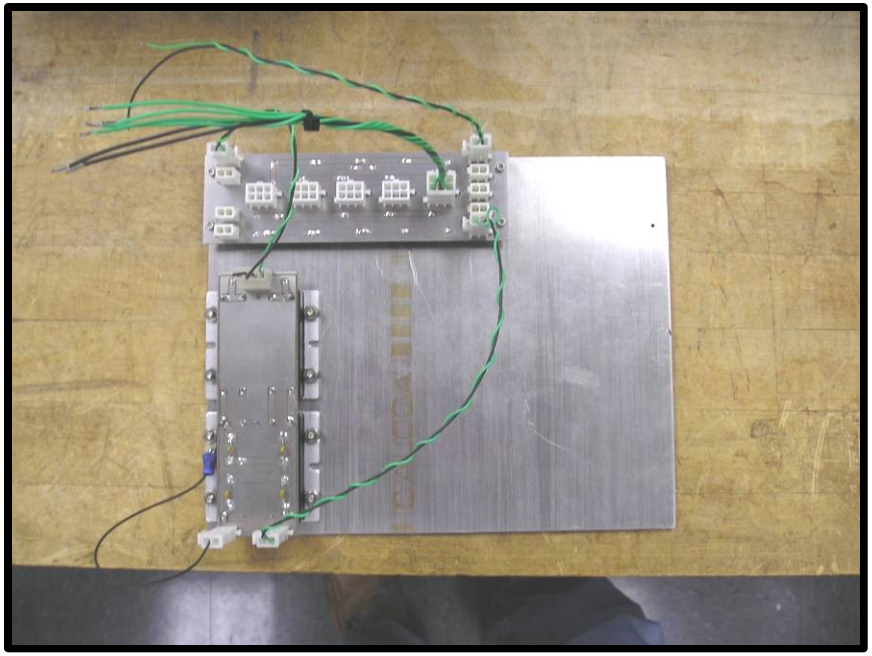
Vicor Power Modules PCB

- **Finished Board**



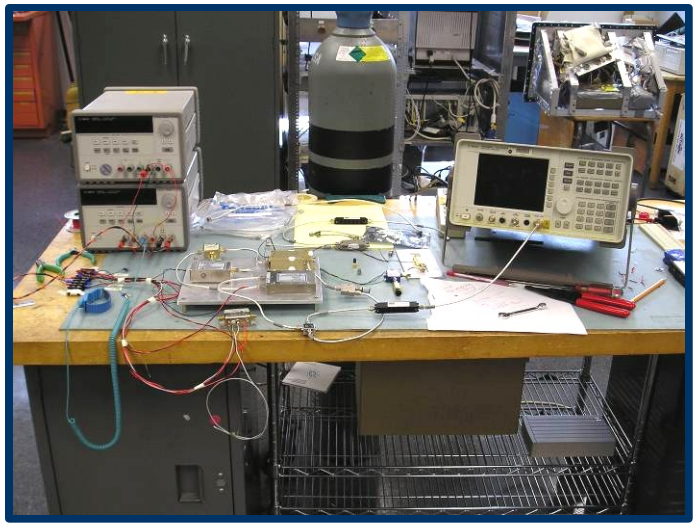
Vicor Power Modules PCB

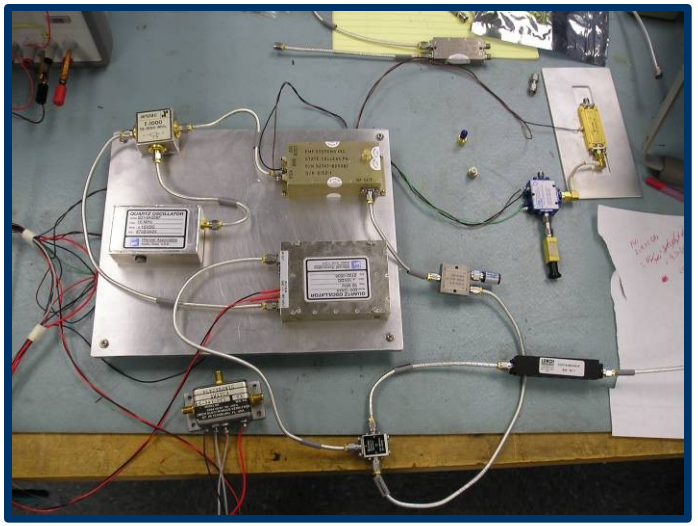
- **Final Configuration**



UAV's Conical Sub-System Tx and Rx Paths Testing

- Task performed to gain hands-on experience.





Learning Experience

- Radar Theory Background
  - RF Front End Design
  - Power Requirements
- PCB Design
  - ORCAD
  - Routing machine
- Design Implementation

Conclusions

- Goals achieved!
  - 80MHz/5MHz daughter card PCB developed
  - Power Modules PCB design developed
- Gained valuable hands-on experience.

Questions

List of Acronyms

- UAV – Unmanned Air Vehicle
- IDEAS – Initiative to Develop Education through Astronomy and Space Science
- DCAS – Distributed Collaborative Adaptive Sensing
- PCB – Printed Circuit Board
- TTL – Transistor-Transistor Logic

Acknowledgements

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