National Aeronautics and Space Administration

Miniaturized Telecom UHF Power amplifier

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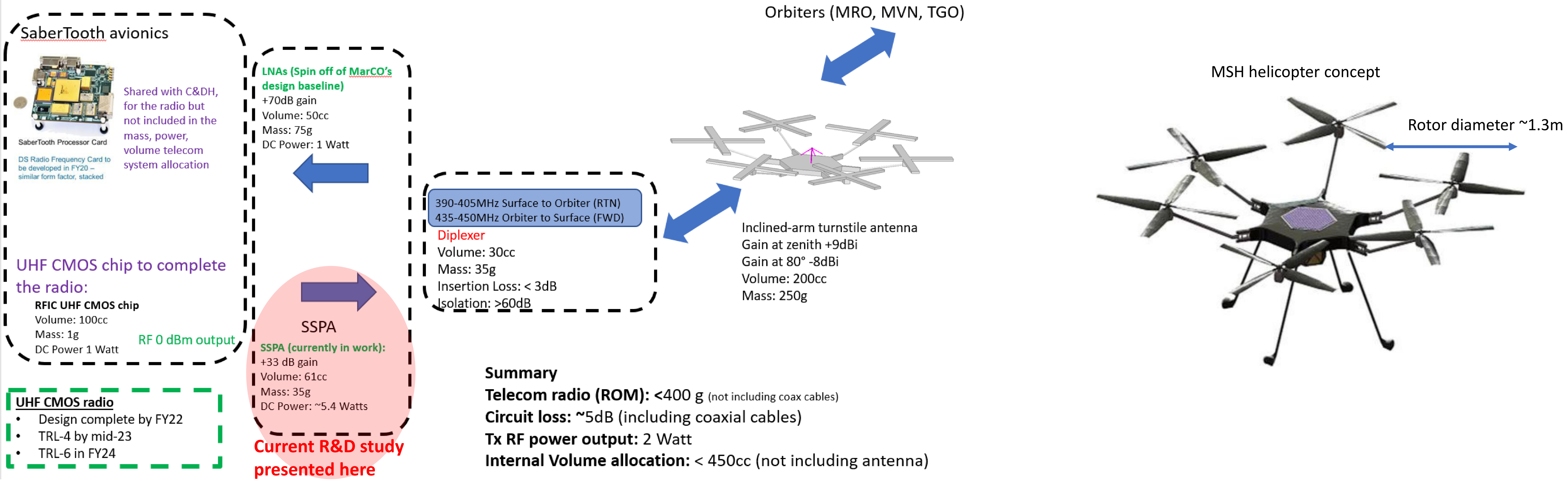
Objectives: Our goal was to design and test a miniaturized UHF (390-405 MHz) solid state power amplifier (SSPA) with a radio frequency (RF) power output of more than 2 Watt and a mass of less than 35 grams, to demonstrate feasibility for a Mars Science Helicopter low size, weight and power telecom system.

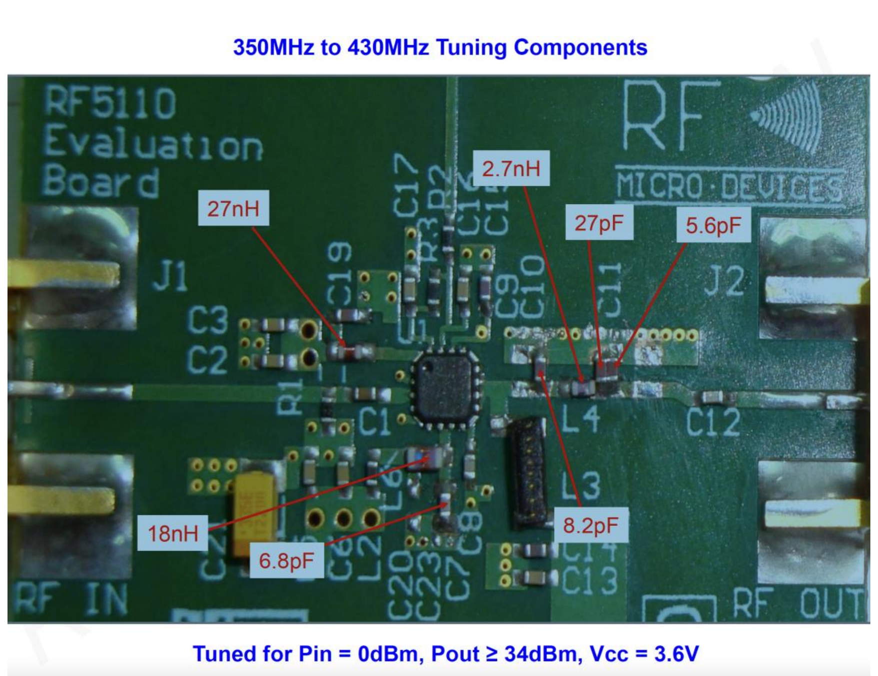
Background:

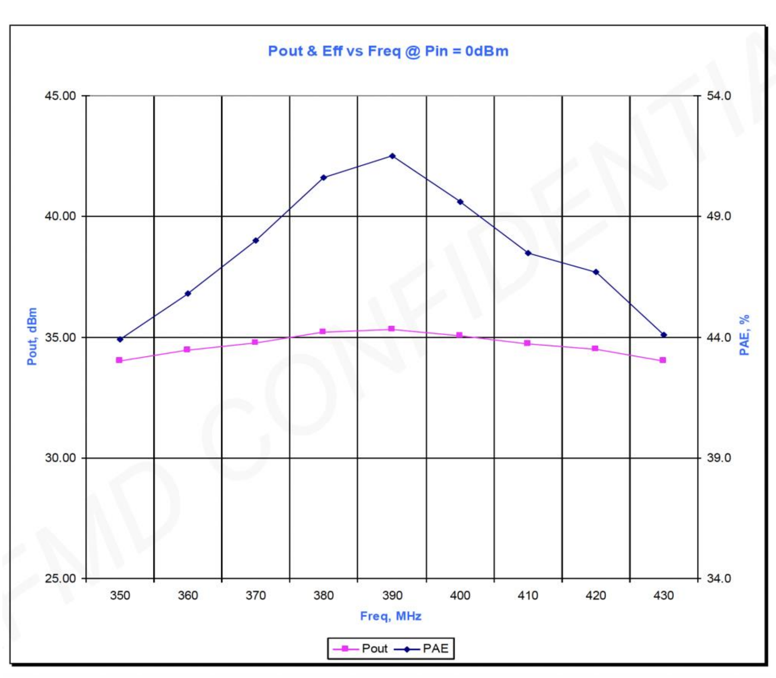
With the success of the Ingenuity helicopter, there is a growing desire for follow-on Martian aerial assets capable of carrying science instruments To this end, JPL is developing the Mars Science Helicopter (MSH) mission concept. The Ingenuity engineering demonstration helicopter utilizes a short distance link, < 1500 meters, to the Perseverance Rover. To minimize mission cost and mass delivered to the Mars surface, a future helicopter based science mission must plan to communicate directly to a Mars orbiting relay asset with a nominal slant range of 1000 km. A key component required to enable such future Mars missions is a low size, weight and power (SWaP) Solid-State Power Amplifier (SSPA) to deliver enough RF power to the orbiters. A telecom link analysis shows that a 2 Watts radio frequency (RF) output power at UHF frequency band (390-405 MHz) is required to support a 150 Mbits per pass link for science data return. In addition, the mass limit of the SSPA for MSH is targeted to 35 g. Current off-the-shelves components have a mass of more than 72 grams and are not optimized to our UHF frequency band nor qualified for the Mars surface space environment.

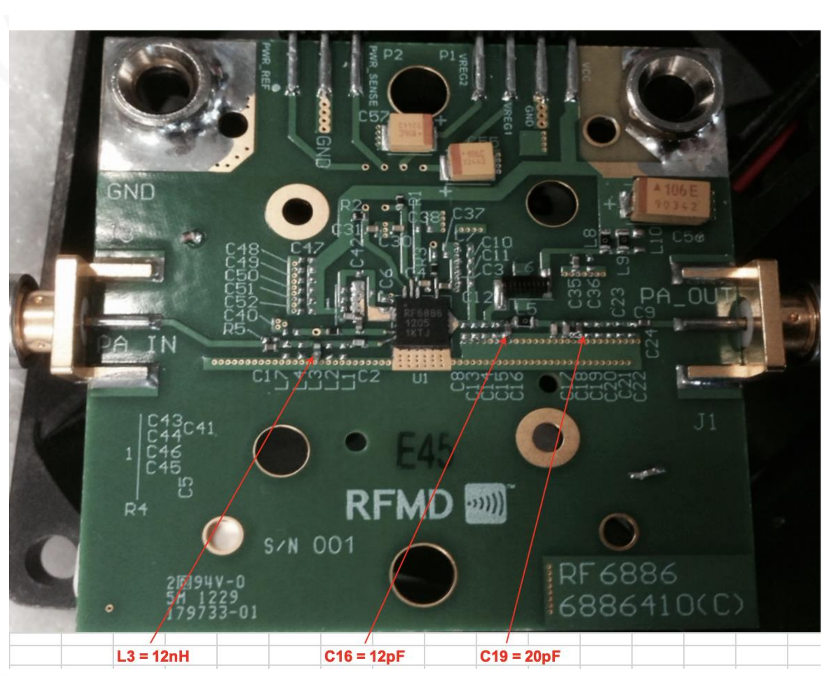
MSH telecom system architecture concept

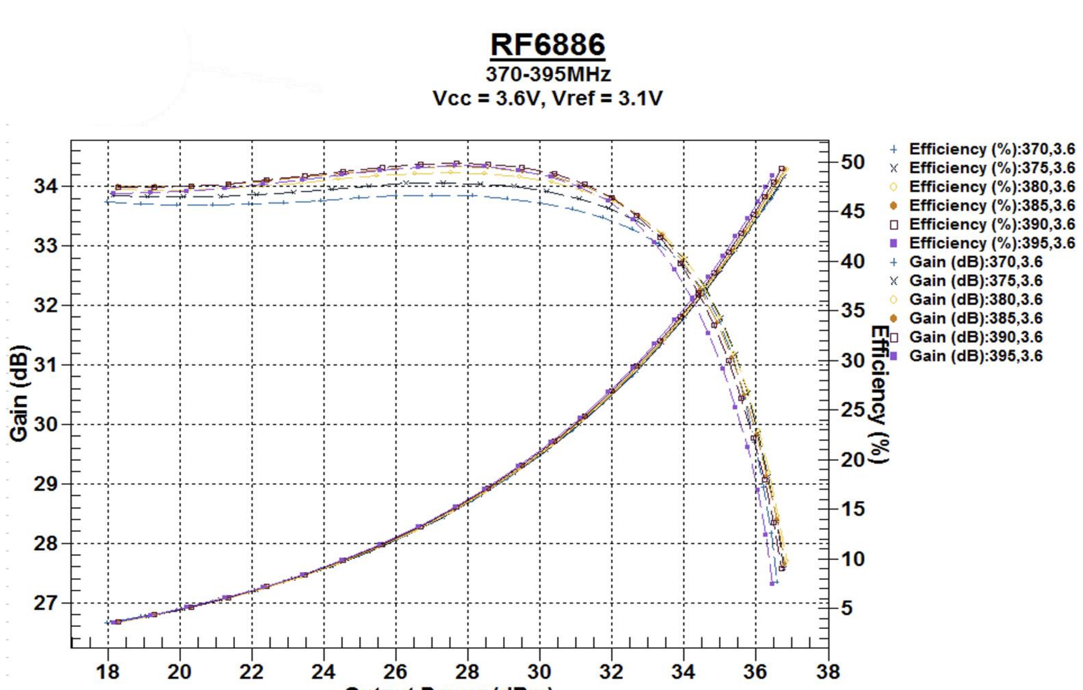


Approach and results: Heritage components were taken into consideration to help guide this effort and provide a path to flight. In the first couple of months, the team was dedicated to the selection of all components and analysis of the circuit board. Several topologies were considered, for instance using 2 cascaded amplifiers as opposed to one commercial packaged chipset. We identified two candidate SSPAs from Qorvo (RF5110 and RF6886) . The commercial evaluation boards were not designed to the Mars relay UHF bandwidth, so they were modified to allow the measurement within the frequency bandwidth of those devices. In addition, a path for flight to qualify the SSPA was discussed with 5x organization to mature the technology readiness level in the near future.









Significance/Benefits to JPL and NASA:

This work started in June and ended in September (4 months). The design topology was modified from a 2-stage original design to a single custom chip. The design using a single chip power amplifier dramatically reduced mass but introduced new thermal management challenges. JPL does not have a current solution to fly a low SWaP radio on Mars and utilize the Mars relay network. This SSPA develop work is an enabling first step for a new rotorcraft on Mars.

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