

TEAM SPACE COAST UNMANNED AIRSPEW CHALLENGE

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RESOURCES

- This presentation, along with the User Manual and circuit schematics can be found at our Github repository:
- <https://github.com/Space-Coast-Unmanned/AirSpew>

OBJECTIVE

Design a system that:

1. Attaches to a DJI Phantom 4 without permanent modification
 - Remote activation using built in DJI functionality
2. Plays audio output via speaker system
3. Ability to incorporate Software Defined Radio
 - Radio transmission in FM frequency
 - GNURadio compatible
4. Drops one pound of pamphlets

SPACE COAST UNMANNED'S SOLUTION

- All in one solution allowing a single Phantom to perform all aspects the mission
 - Reduces fleet requirement from 3 simultaneous Phantoms to 1 Phantom
 - Significant cost savings to end user due to reduced fleet size and maintenance
- System can be separated into individual modules if desired
 - Would allow much more weight for audio speaker system



CONFIGURATIONS

- Saddles can be removed and replaced for four configurations:

1. FM Transmitter
2. FM Transmitter, Audio Speakers
3. FM Transmitter, Pamphlet Dropper
4. FM Transmitter, Audio Speakers, Pamphlet Dropper



ATTACHES WITHOUT PERMANENT MODIFICATION

- Light Sensor
 - Attaches in place of friction fit clear lens cap for forward LED using velcro
- Pamphlet Dropper/Speaker module
 - Attaches to right side of Phantom landing gear using Velcro
- Raspberry Pi/FM transmitter/Audio amplifier/Battery module
 - Attach to left side of Phantom landing gear using Velcro
- Landing gear standoff attaches to landing gear using Velcro
- No permanent modifications required

CONTROL USING DJI FUNCTIONALITY

- A light sensor module was designed that simply replaces the clear lens cap on one of the forward lights
 - Simple design using only 3 passive components, highly reliable with minimal cost
- Attaches via Velcro for quick modification



AUDIO OUTPUT

- Off the shelf audio amplifier from Adafruit was leveraged to minimize development time and risk
 - Uses Texas Instruments TPA2016D2 chip
 - Example code provided, along with schematics
 - Future versions can be made without purchasing unit from Adafruit for cost savings
- Class D operation is $\sim 90\%$ efficient, allowing longer battery life while maintaining higher output volume



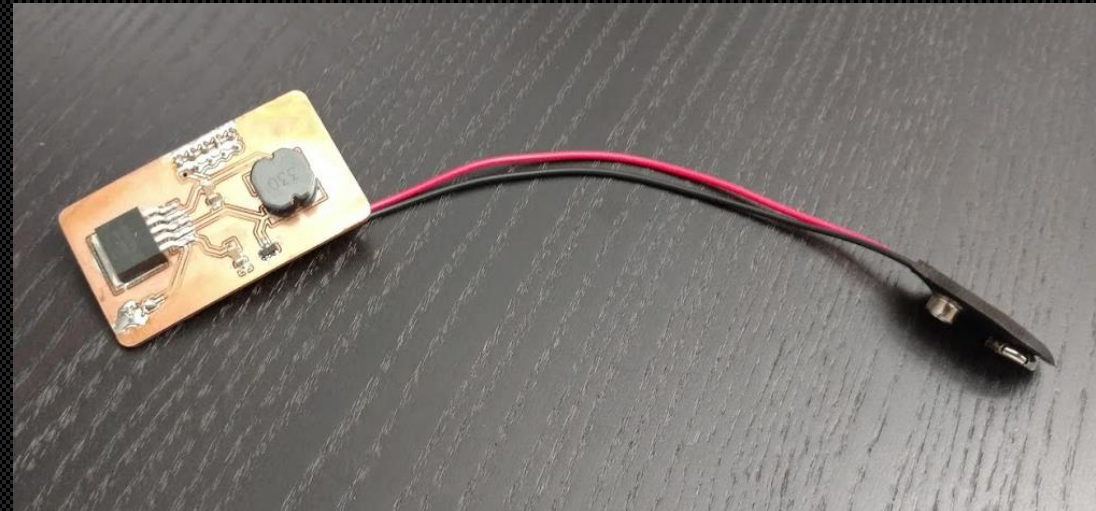
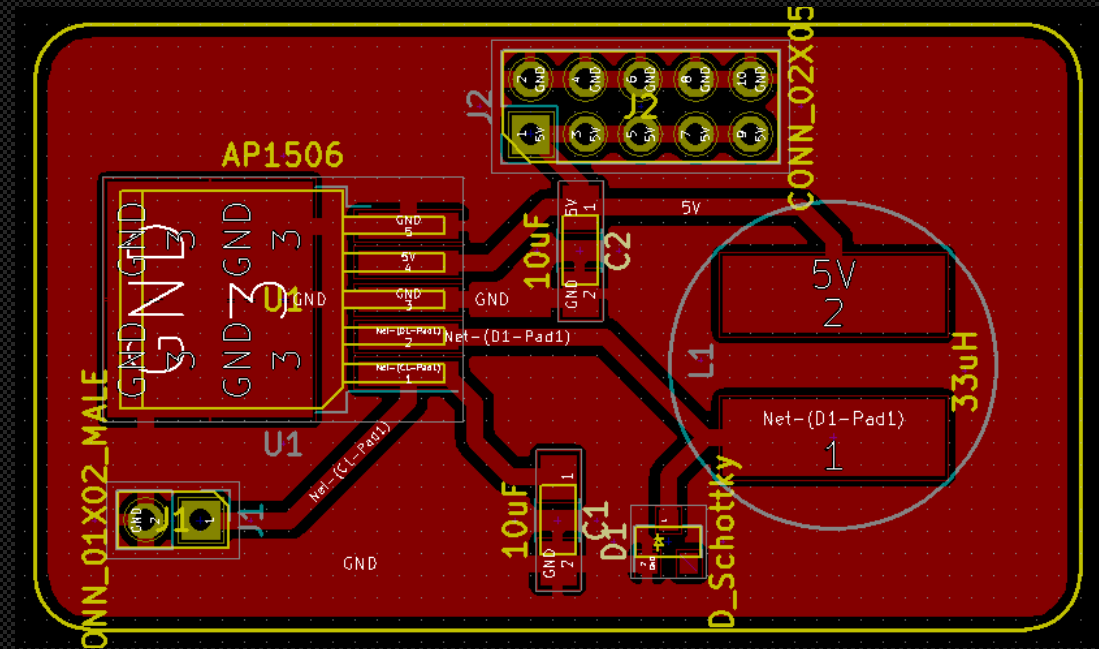
COMPUTING NODE

- Raspberry Pi was chosen for:
 - Processing power
 - Linux OS allows GNURadio compatibility
 - Small form factor
 - Low cost
 - Large pool of resources available online



POWER SUPPLY

- Using high efficiency AP1506 5V 3A DC-DC Switching power supply
 - ~85% efficiency at 9V input
- Module designed, built, and tested successfully

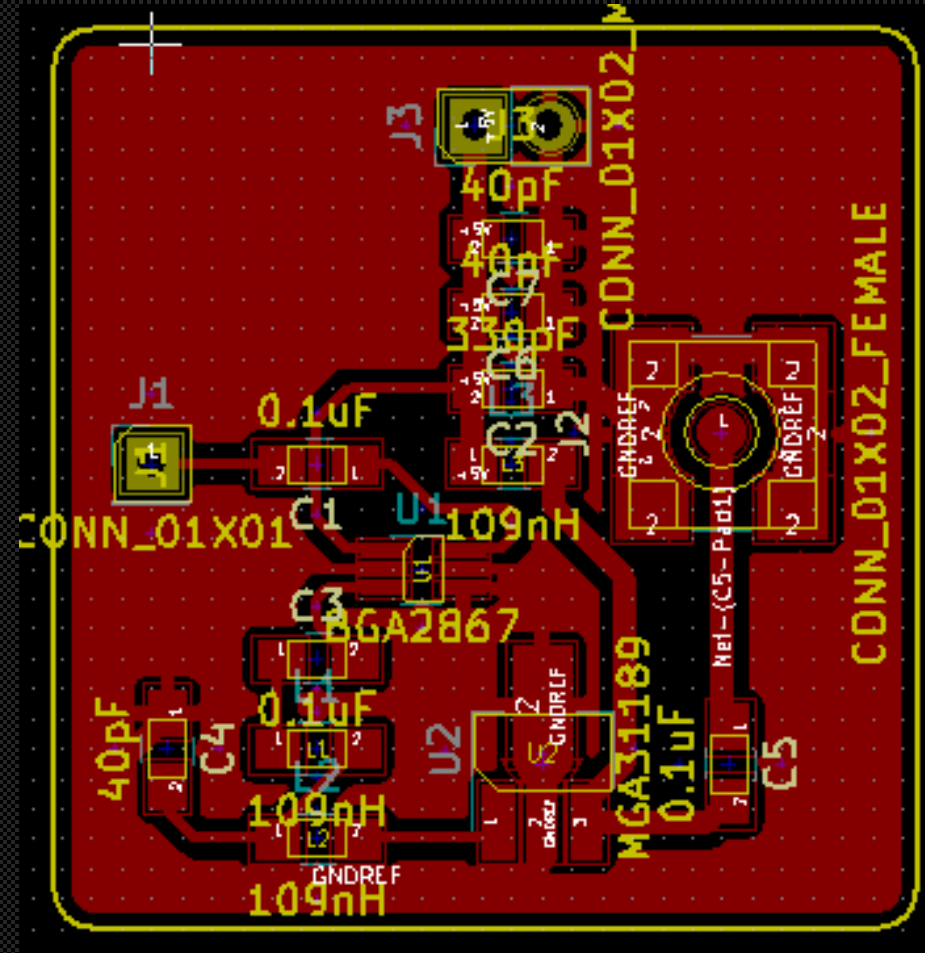


FM TRANSMITTER

- Off the shelf FM transmitter from Adafruit was leveraged to minimize development time and risk
 - Uses Silicon Labs SI4713 chip
 - Example code provided, along with schematics
 - Future versions can be made without purchasing unit from Adafruit for cost savings
- SI4713 does not meet Airspew challenge output power requirements
 - Requirement of 24dBm (250mW) exceeds FCC regulation maximum of 0.01μW
 - <https://www.fcc.gov/media/radio/low-power-radio-general-information>
 - https://apps.fcc.gov/edocs_public/attachmatch/DOC-297510A1.pdf
- Space Coast Unmanned has designed but not built a high power RF amplifier that will meet desired power output

RF AMPLIFIER DESIGN

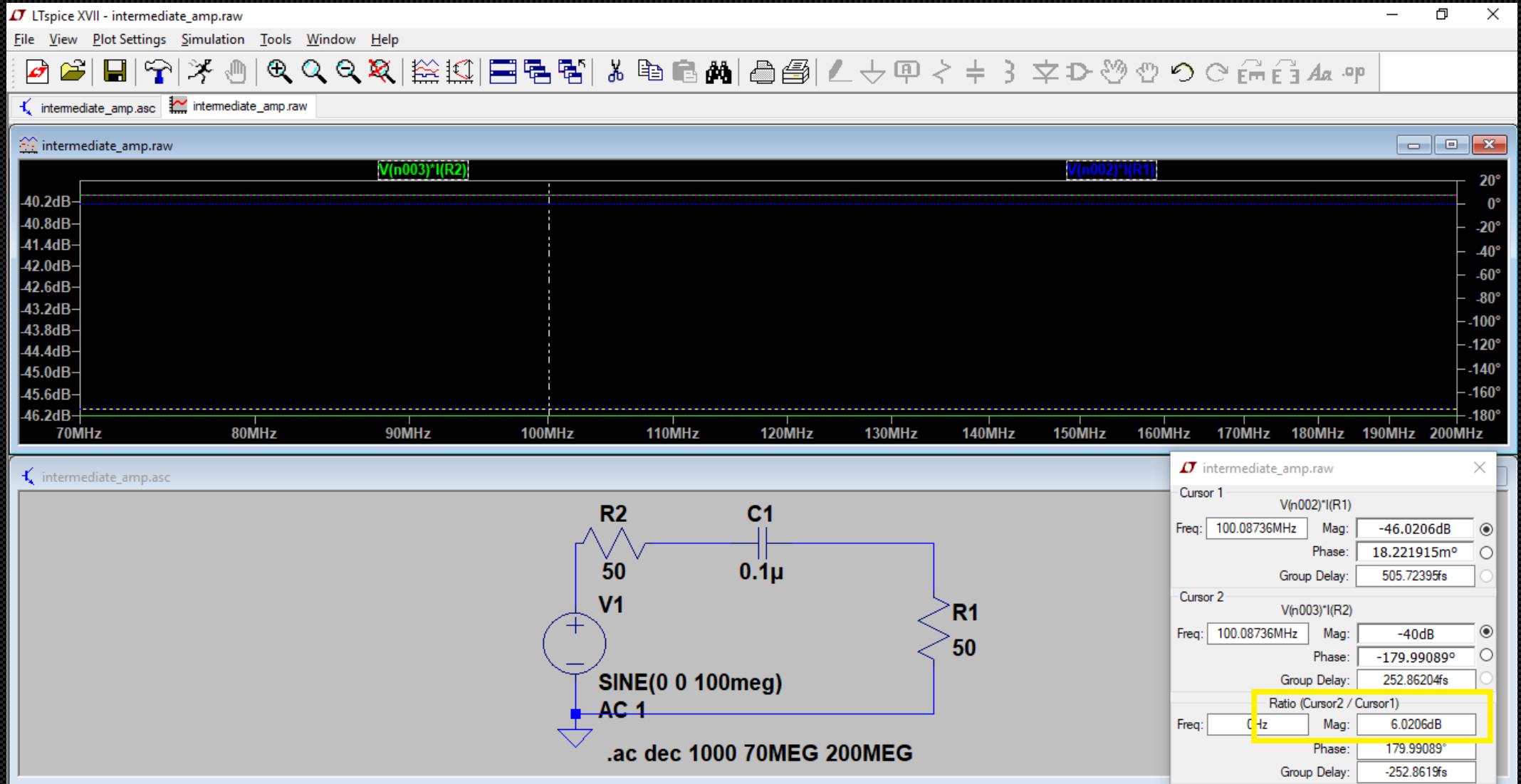
- A two stage amplifier was designed using SPICE simulation
 - Schematics available at Space Coast Unmanned's Github repository
- Accounting for losses, theoretical output is user adjustable between 14dbm and 41dbm
 - WARNING: Significant distortion will occur at output levels over 24dbm and damage is likely over 28dBm



RF AMPLIFIER STAGE 1

- Using BGA2867 small signal amplifier with internal 50ohm matching. Spice circuit and simulation shows roughly 6dB loss in coupling circuit
 - Si4713 max output of 11.5dBm is 8dbm
 - Gain of amplifier is 24dB, with 6dB loss max output of first stage is ~26dBm, but chip is only rated to 5dBm without significant distortion
 - Recommend not exceeding 94 dBμV setting in Si4713 Power parameter

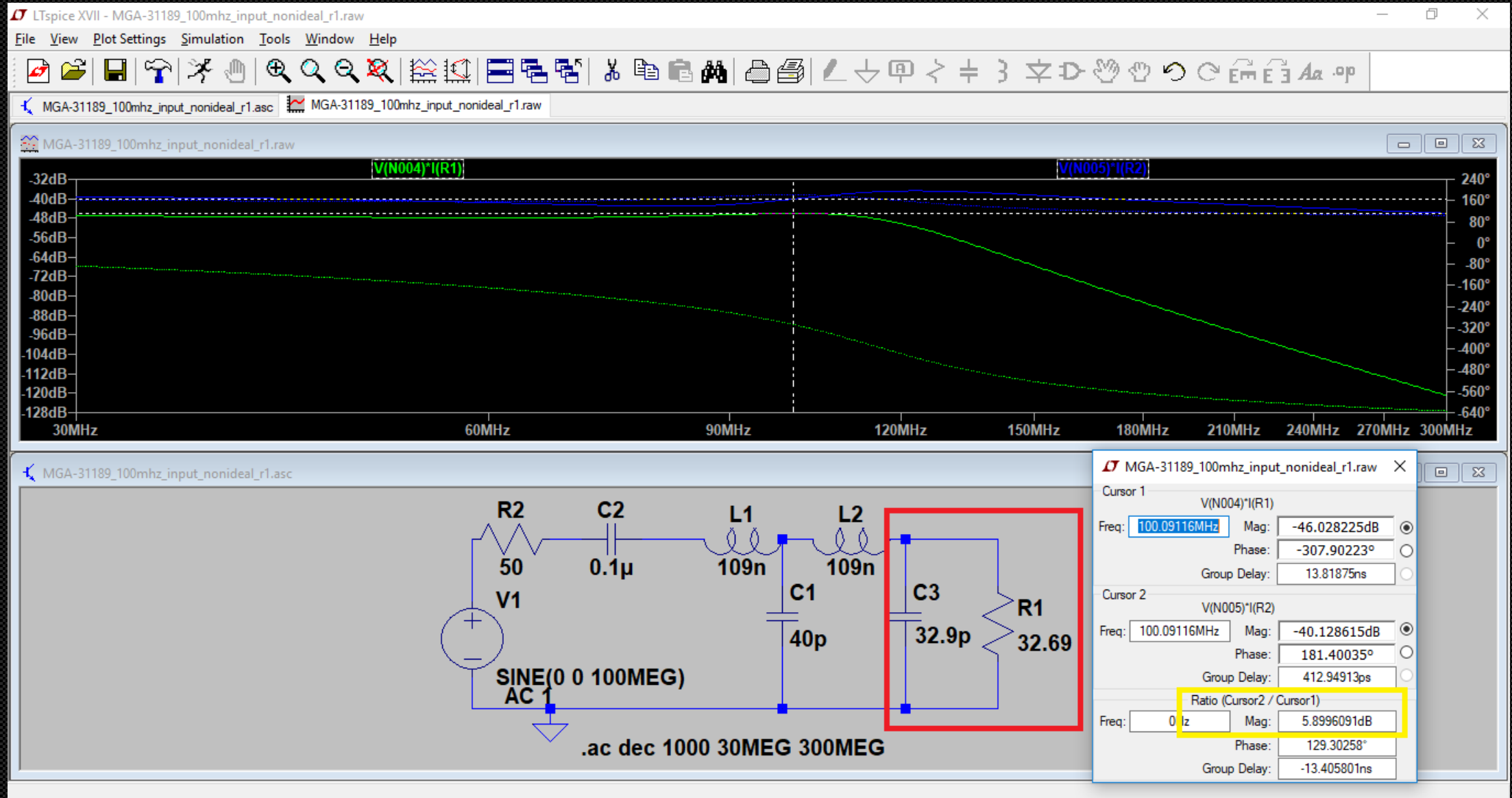
RF AMPLIFIER STAGE 1 SPICE SIMULATION



RF AMPLIFIER STAGE 2

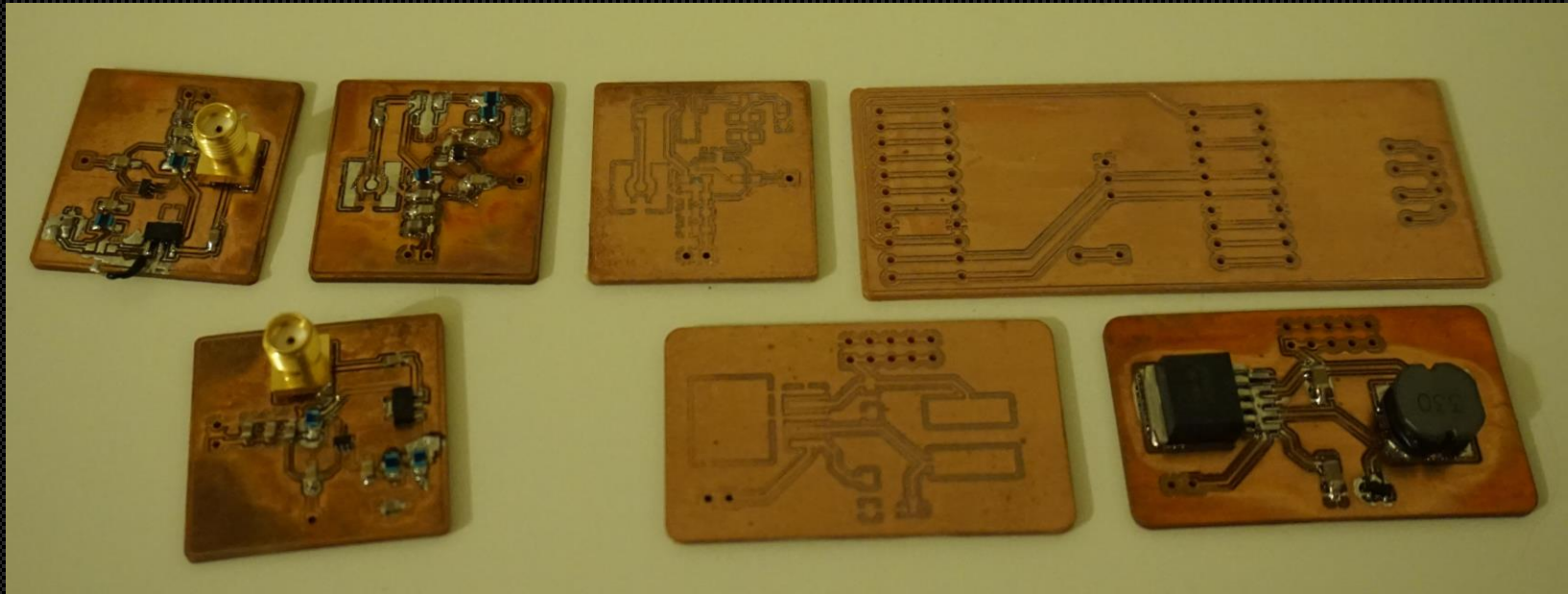
- Using MGA-31189 chip that is rated to 24dBm output without significant distortion
 - Component is not internally matched, and needs matching circuit
 - 21 dB of gain, 5.8dB loss from matching circuit. Theoretical max output of total FM Transmitter is 41dBm (12.6W).
 - WARNING: This is a significant power level and will destroy components. It is not recommended to go higher than 26dBm output.

RF AMPLIFIER STAGE 2 SPICE SIMULATION



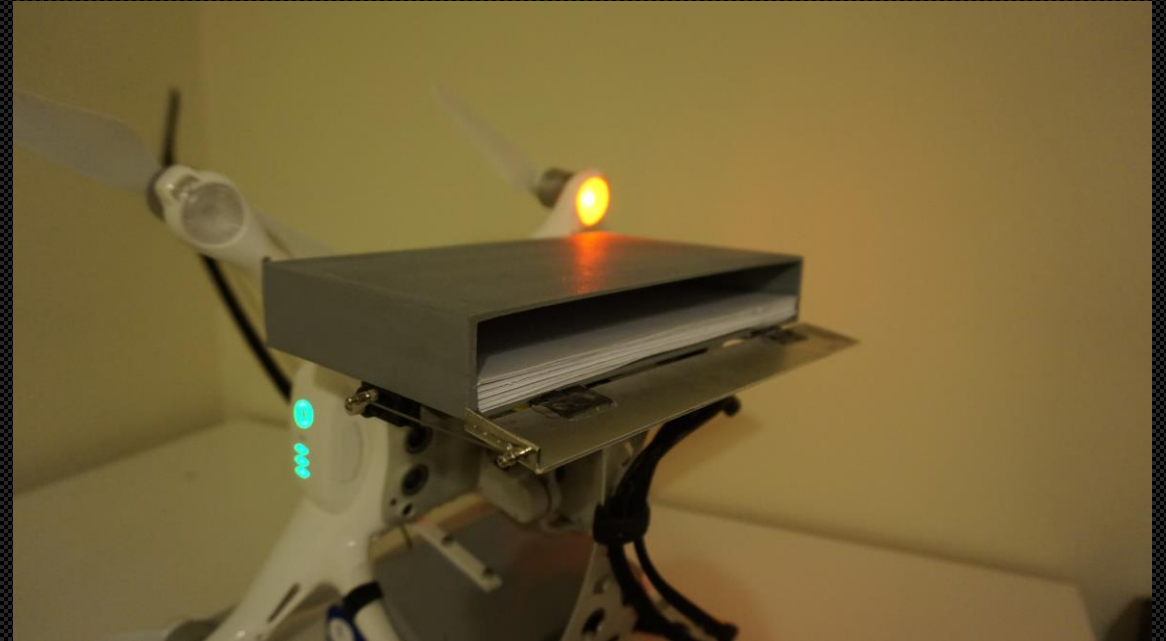
RF AMPLIFIER FABRICATION

- Several boards were fabricated, populated, and soldered
- Due to extremely small tolerances, we were unable to produce an electrically correct completed assembly



PAMPHLET DROPPER

- Tested to 1 pound pamphlet capacity
- Single servo control
- Releases all pamphlets at once in accordance with clarification provided during Q&A session
- Attaches using Velcro for non-permanent mounting



SPACE COAST UNMANNED'S SOLUTION

Offers a system that:

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