BACKGROUND
Exploration campaigns such as Mars sortie require an absence from Earth of over two years without logistical support to provide replacement parts. If several spares are launched for each critical Line Replaceable Unit, launch mass is considerably increased, perhaps by a multiplier of four. If sparing is at the card level, up-mass could be reduced to a factor of 2.5 times. If sparing were at the component level, up-mass could be 1.5 times spacecraft weight. If a spacecraft can be 3D-printed and so materials sparing is possible, sparing might only add 5% to launch mass. The International Space Station presently is experimenting with a 3D printer, using Ultem plastic filament. On the path to achieving 3D printed spacecraft, printed features with electrical physical properties are needed. RF absorbers can be more effective than reflective RF shielding for containment of unwanted emissions and rejection of interference. One application is customized EMI/EME/EMC shielding that could be produced as a custom solution for a project that is failing tests late in the design. Another application is 3D printing a custom antenna RF hat coupler.

Ferrous absorbers such as HOZOX HF2 can be thinner than similarly performing conductive absorbers. Interestingly, modern shielded enclosures are generally iron, the walls of a copper or aluminum enclosure need to be thicker to have the same containment. While ferrous Ultem or PEI filament printer stock is not presently commercially available, at least one ferromagnetic PLA material is readily available. The product uses actual metal, but the PLA insulating matrix would disrupt any currents or eddies and the vendor doesn’t claim it’s conductive. The infused material has higher mass density, and is relatively brittle printer-stock. Interestingly, the vendor claims the material has good thermal conductivity, suggestive that a printed EMI shield could also sink heat from hot spots (electronics processors and amplifiers) or to cold spots. Any product claiming to be magnetic and incorporating ferromagnetic oxides could be explored as well.

This project needs to develop an understanding of broadband RF reflectivity of ferromagnetic PLA and strategies for reducing reflectivity. This project needs to develop an understanding of broadband RF absorption of ferromagnetic PLA and optimizing absorption per mass. Conductive PLA’s produce lower conductivity along the z-axis of the print. This project should demonstrate whether printed ferromagnetic PLA has print-axis-polarized properties, as a thin sheet without honeycomb infill, and with honeycomb infill.

PROJECT/CHALLENGE
The objective of this project is to 3D print either a plastic case for electronic equipment or an antenna hat coupler using conventional printers and inexpensive filament. This project should experiment with several infill patterns, wall thickness, or other printer settings that could be used to control RF performance. The project should evaluate printability of the materials. The project should characterize performance in terms of RF absorption across the spectrum, for example by encasing a broadband antenna.

REFERENCES
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DELIVERABLES
Test article, report
### DESIGN TEAM PROFILE

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Design Project Topic Offered By: NASA JSC, EV8 Branch