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Controllers for Stirling Conversion

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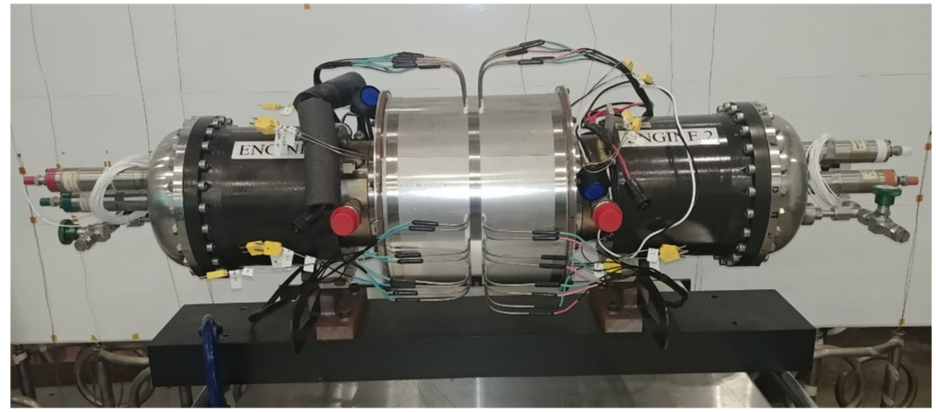
ANS American Nuclear Society

NASA

Why is a controller needed?

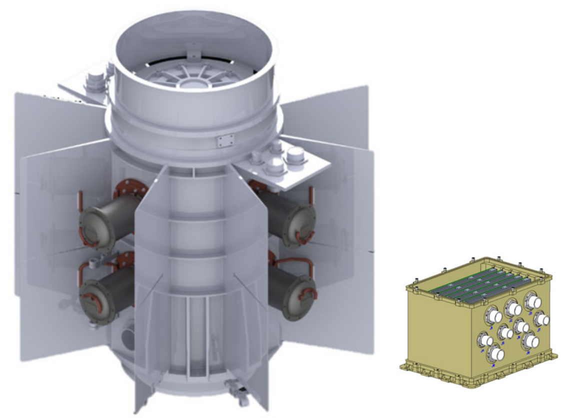
- Power conditioning (i.e. 28V for RPS)
- Control piston amplitude via proper electrical load
- Power factor correction
- Spacecraft bus fault handling
- Power conversion telemetry



kW-class power (Fission source)

What are the requirements?

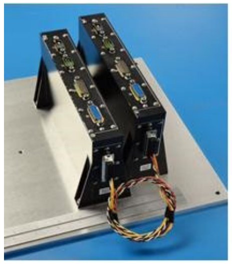
- Deep space, Lunar, planetary
- GCR, Jovian radiation belts, reactor proximity
- High efficiency (>85% for low power, >94% for kW-class)
- Long-term continuous operation (i.e. 17 yrs for outer planets)
- Internal fault tolerance (i.e. redundancy)
- Simple spacecraft con-ops (behaves like RTG to user)

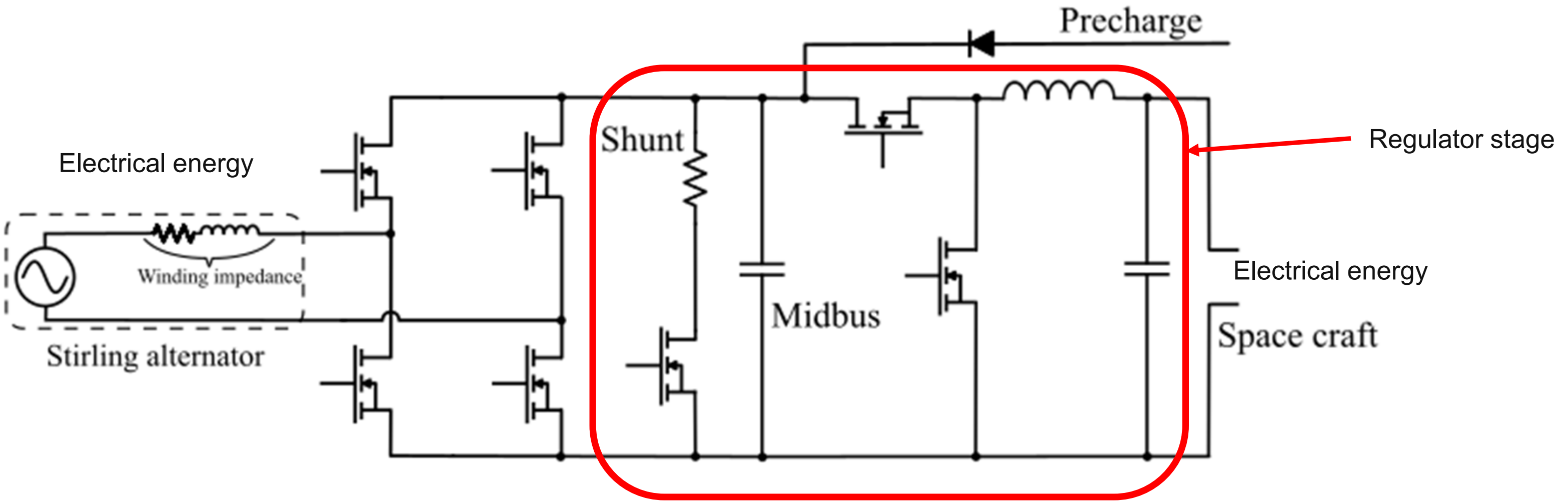


Stirling RPS (100s of watts)

How does a Stirling convertor controller work?

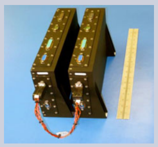
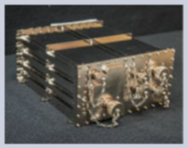
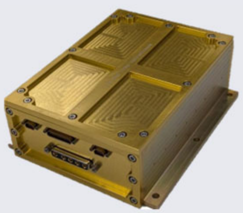
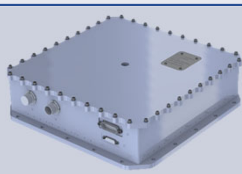
- Active algorithm-controlled H-bridge negates alternator inductance
- Piston amplitude controlled via reference voltage setpoint
- Regulator stage to provide 28V regulated power and handle bus faults
- Shunt (external) to dissipate power in absence of spacecraft





Active power factor correction controller schematic

Current Status

		Name	Org	Status	Hardware Level
Legacy	 	SCC (single), DCC (dual) HVCC (high-voltage) ACU	JHU APL Lockheed Martin	Demonstrated Stand-by	Engineering Units
Analog	 	NAC (NASA analog controller)	NASA GRC	Demonstrated, Needs development	Breadboards
		Capless NAC	NASA GRC		
Digital		NASA Digital controller	NASA GRC	Demonstrated Convertor + balancer Dual convertor Active development	Engineering Units
		SCSC (single convertor)	West Coast Solutions (Phase II SBIRs)	Demonstrated Convertor + balancer Active development Multi-convertor in dev	Engineering Unit

GRC Internal Controller Dev Status