ICE-G Platform Development

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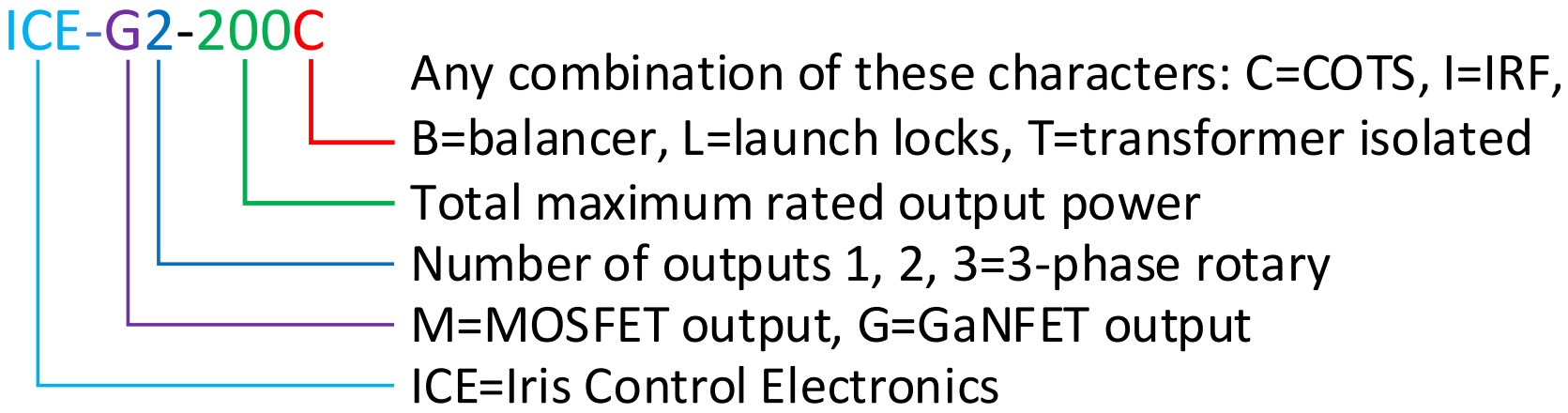
History

- Iris Technology has a long history of designing and developing cryocooler control electronics (CCEs)
- Recently Iris Technology has made efforts to advance the state-of-the-art in CCEs by introducing new innovations utilizing the latest available space-grade parts
- These innovations have added three new CCEs, equivalent in performance to legacy devices in the Iris Technology product line
- In addition, Iris Technology is developing a 1000-watt CCE to address higher-power cryocoolers

Nomenclature



Iris Control Electronics: Making Space Cool!

Introduction to ICE-G

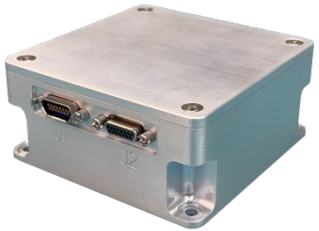
- The ICE-G series of cryocooler control electronics (CCE) provides cost and performance enhancements to the Iris CCE product line
- These enhancements are provided through the addition of GaN FET output stages and microcontroller-based control
  - Higher efficiency power performance
  - Easy customization to meet mission needs
  - Lower unit costs

ICE-G Provides Cost and Performance Enhancements

First Target - mLCCE to ICE-G1-30

- The first development was a size reduction of the mLCCE
- The mLCCE is a successful product used in the SmallSat community
- The ICE-G1-30 reduced the volume of the CCE by 32%
- First delivery 2019

mLCCE (9.1 x 9.1 x 3.4 cm)
288 cm³



ICE-G1-30 (7.9 x 7.9 x 3.1 cm)
195 cm³

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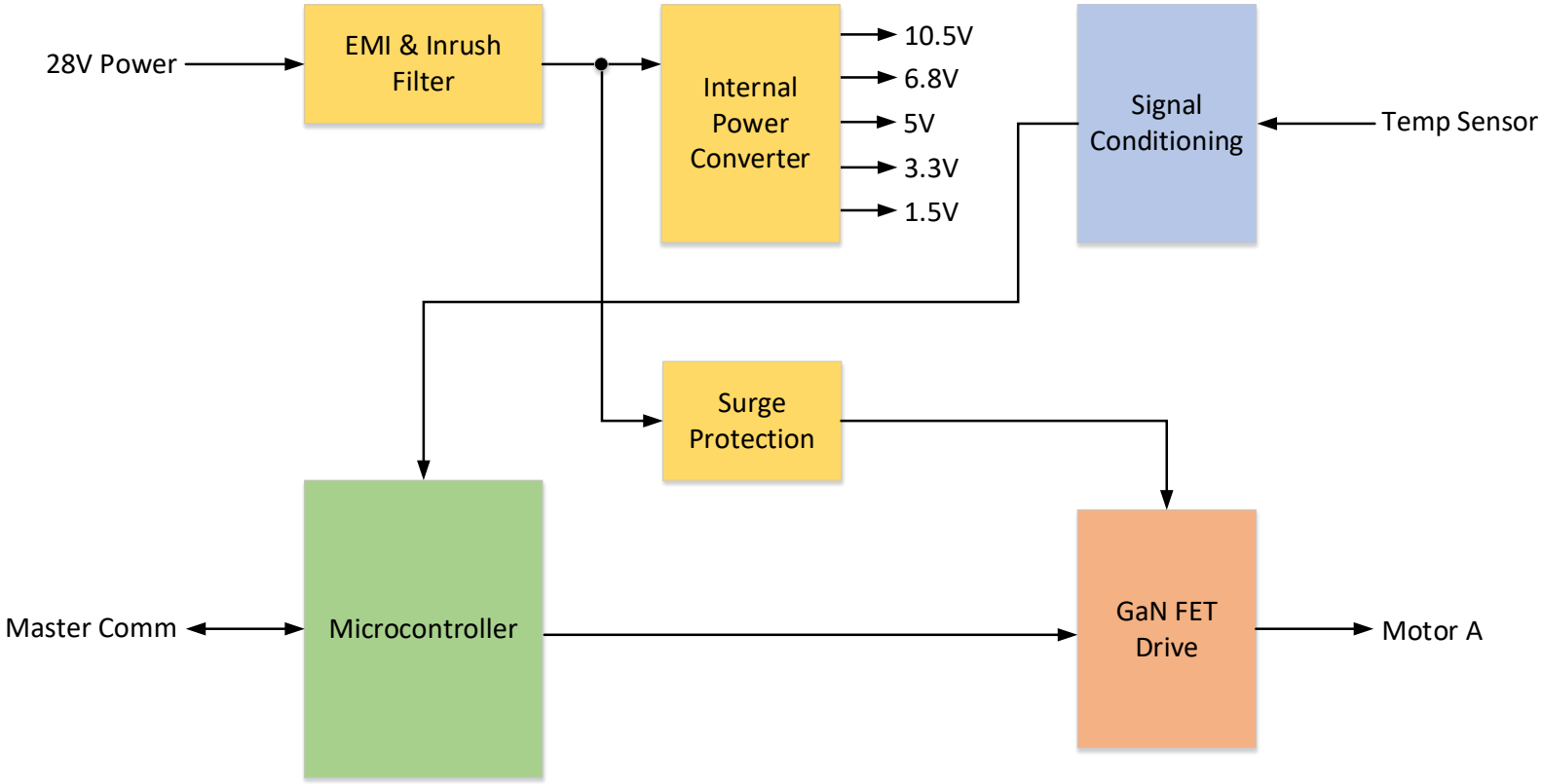
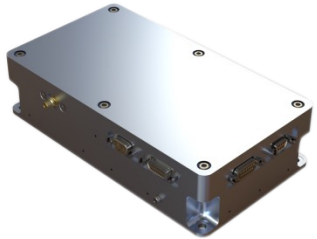
ICE-G1-30 Block Diagram



Next Development ICE-G2-60

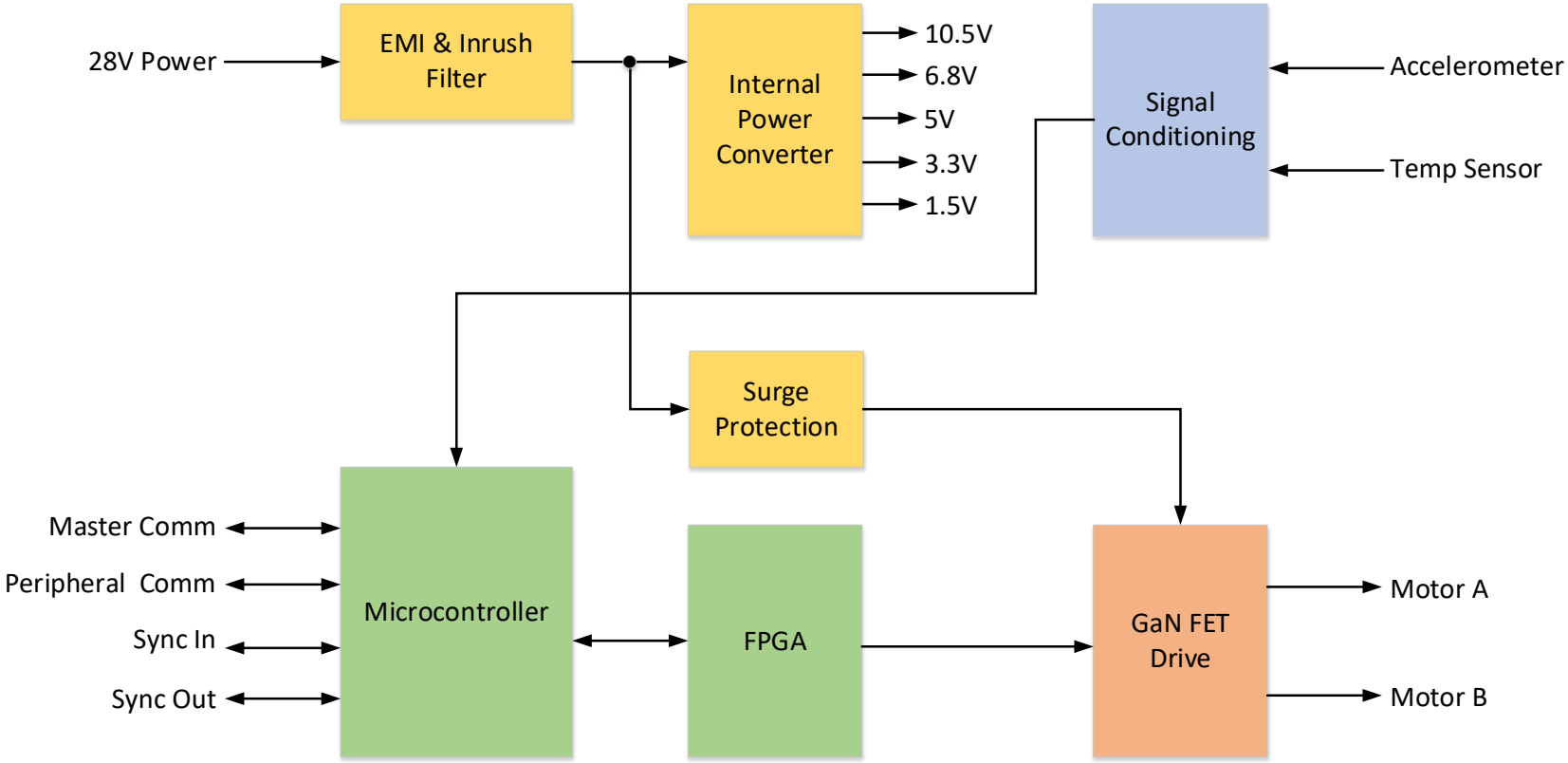
- The ICE-G2-60 is a reduced-size version of the LCCE with several enhancements
  - Active vibration control
  - Multi-CCE communication
  - Multi-CCE synchronization (w/ arbitrary phase)
- The ICE-G2-60 reduced the volume of the CCE by 25%
- First delivery 2020

LCCE (12.6 x 14 x 3.1 cm)
547 cm³



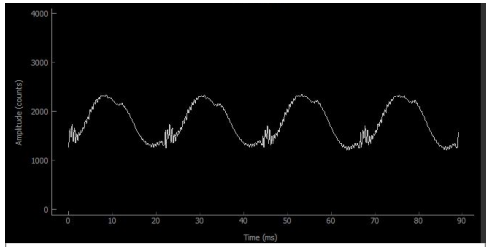
ICE-G2 (14.4 x 7.9 x 3.7 cm)
413 cm³

ICE-G2-60 Block Diagram

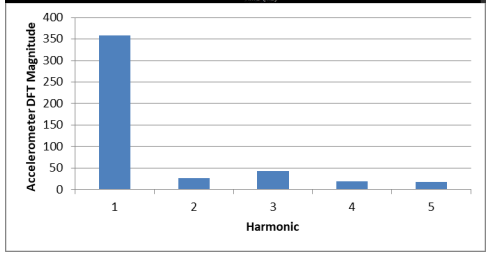


ICE-G2-60 Measured Vibration Reduction

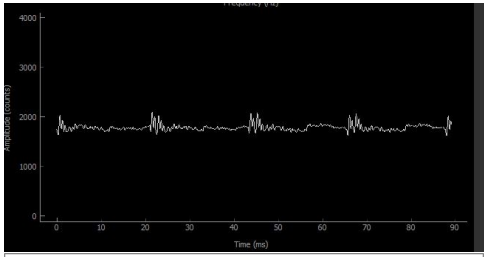
- The ICE-G2-60 incorporates Iris Technology's patented vibration cancellation algorithm
  - This algorithm can significantly reduce the vibration in the axis of piston motion



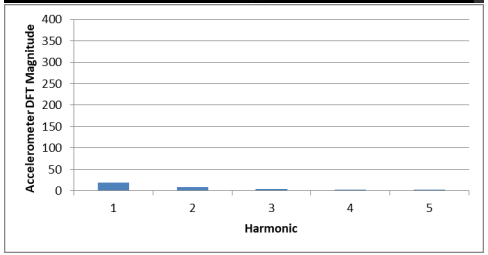
Vibration Signal Before Correction



Vibration DFT Before Correction



Vibration Signal After Correction



Vibration DFT After Correction

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Next Development ICE-G2-200I

- The ICE-G2-200I is a lower-cost, higher-performance version of the HPLCCE2 (ICE-M2-200I) with several enhancements
- Cost and performance enhancements while adding new features
- Note that this model is a performance demonstration that could be reduced in size
- First delivery 2022

HPLCCE2 (18.5 x 18.5 x 7.6 and 5.0 x 9.0 x 3.4 cm)
2775 cm³

ICE-G2-200IL (23.3 x 20.7 x 6.8 cm)
3231 cm³

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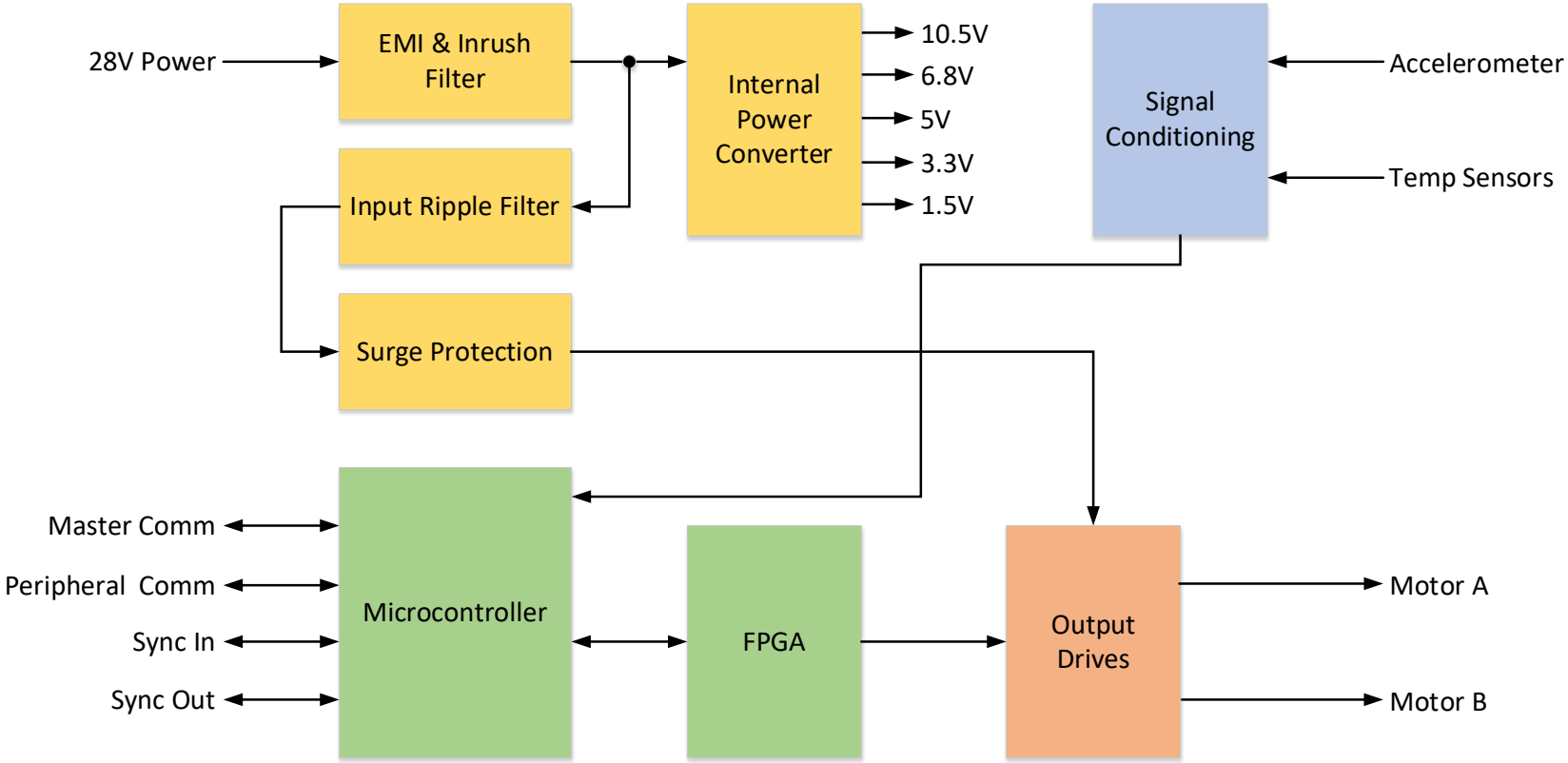
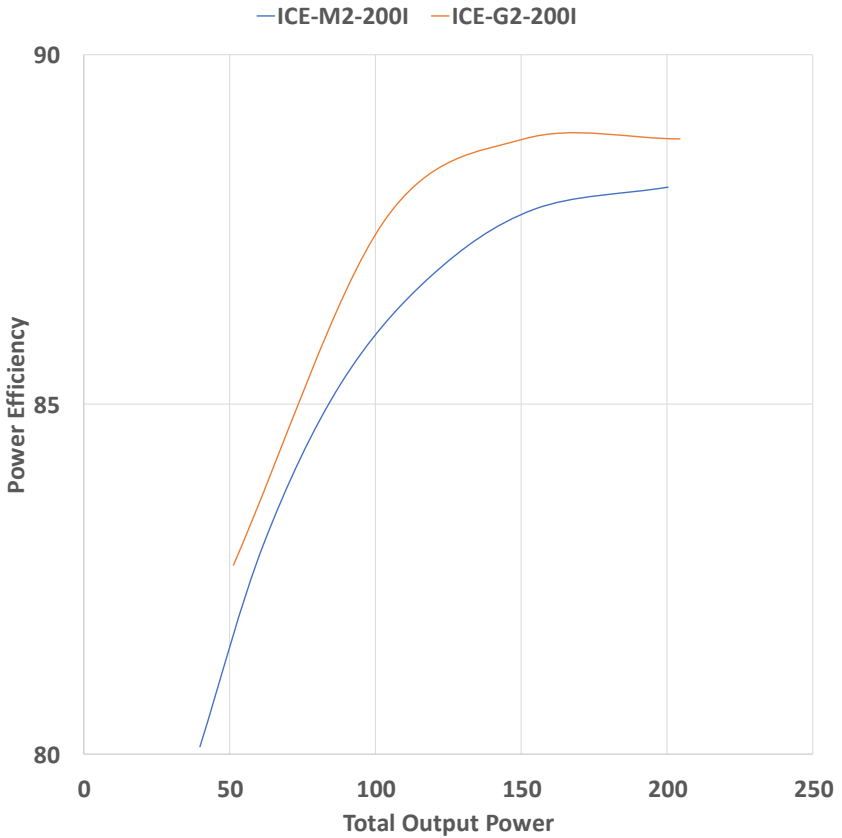
ICE-G2-200I Block Diagram



ICE-G2-200IL Efficiency

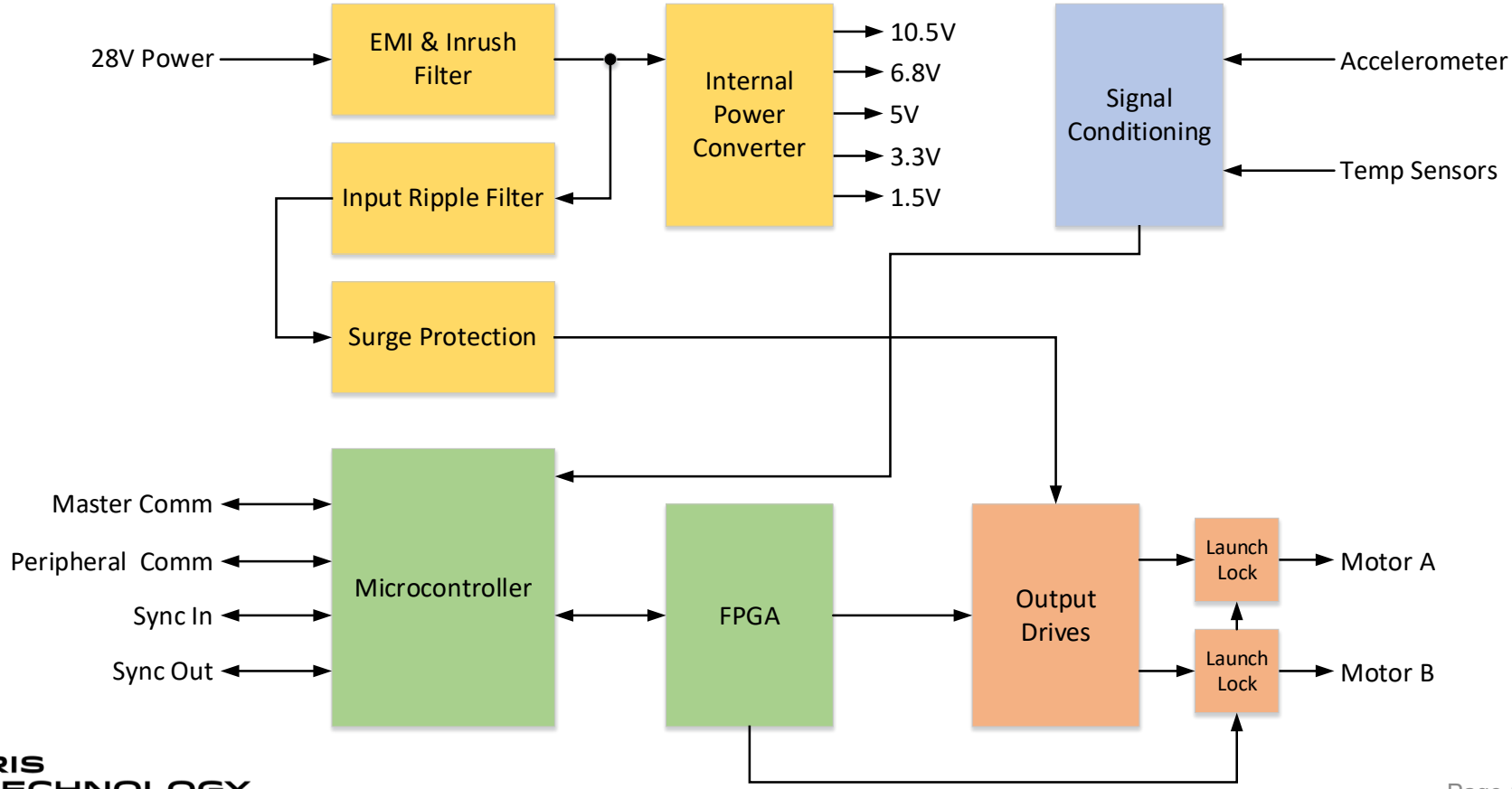
- The ICE-G2-200I is not only less expensive than the MOSFET version but also more efficient
- The ICE-G2-200I shows a clear efficiency advantage over the ICE-M2-200I



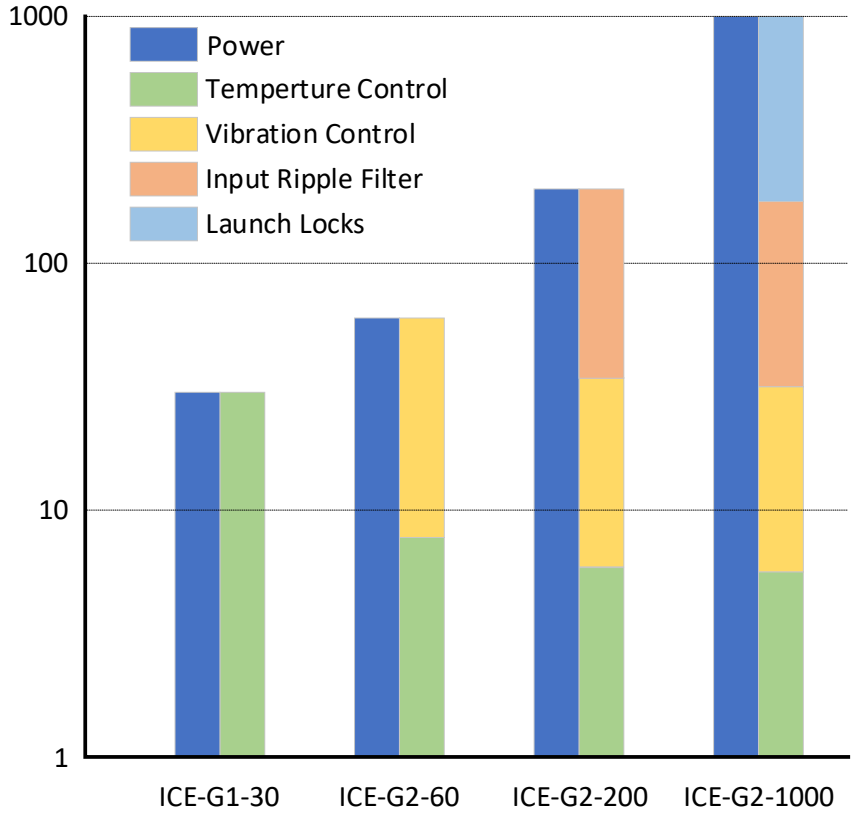
Current Development ICE-G2-1000IL

- Iris Technology is currently developing a higher-power ICE unit, the ICE-G2-1000IL
- This unit will target a design that provides
  - Up to 82 peak volts
  - Up to 17 peak amperes
- Currently being funded on Iris IRAD
- Expecting brass board completion in Fall 2023

ICE-G2-1000IL Block Diagram



Power levels and capabilities continue to increase



- Aerospace market continues to require designs with increasing power and additional features
- Iris continues to fund IRAD projects
- Future designs will be flexible with the ability to incorporate various design modifications
- Modifications can include:
  - Higher power level
  - Launch locks
  - Input ripple filters
  - Multiple CCE synchronization
  - Temperature-based power limiting
  - Additional temperature sensors

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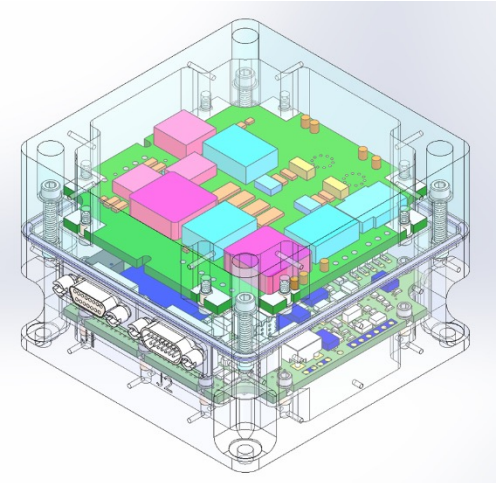
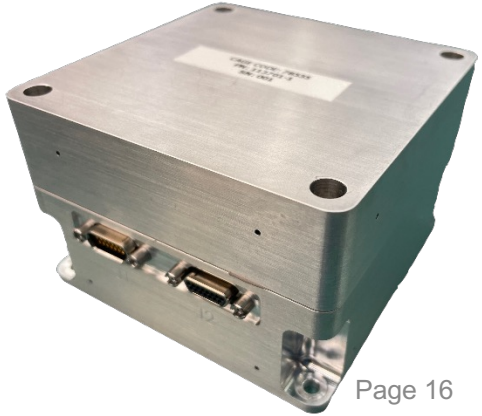
Customization Available on all ICE Gx Platforms

- Customization of existing designs is a feature of the ICE-Gx products
- Algorithm customization is easily accomplished through software updates
- Hardware customization is also available
- For instance, a customer wanted an input ripple filter (IRF) and launch locks on an ICE-G1-30 CCE
  - Develop a second (stacked) board with new electronics
  - Developed a clamshell enclosure to house the board stack





Conclusions

- Iris Technology has developed a new ICE architecture that is smaller, less expensive, and more robust than current-generation CCEs
- This new architecture is extensible to our entire line of ICE from 30 Watts to 1000 Watts

Thank you!

https://www.iristechnology.com/aerospace/control-electronics/