A LOW PROFILE HIGH POWER INDUCTOR FOR HIGH RELIABILITY SPACE APPLICATIONS

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A WORLD OF SOLUTIONS

MIL-STD-981 OVERVIEW

Design, Manufacturing and Quality Standards for Custom Electromagnetic Devices for Space Applications

Materials and Construction:

- Outgassing per ASTM-E-595
- Dielectric Strength - tapes, films, and Insulating materials
- Magnet Wire – MW-1000 standard, minimum wire size spec
- Internal solder melt temp > 260 ºC
- Solder and Flux per J-STD-005 – No pure Tin
- Wire winding & placement
- Terminals – anti-rotation features, twist
- Impregnation and potting – degassing required

POWER INDUCTORS

- Current rating > 1A
- Typically used for energy storage in DC-DC converters and high power filtering applications.
- Core materials and wire selected to achieve desired DCR, AC Loss, frequency response, and inductance value among other specifications.
- Wound on various core and bobbin types, i.e., Toroid, pot cores, E-cores,…

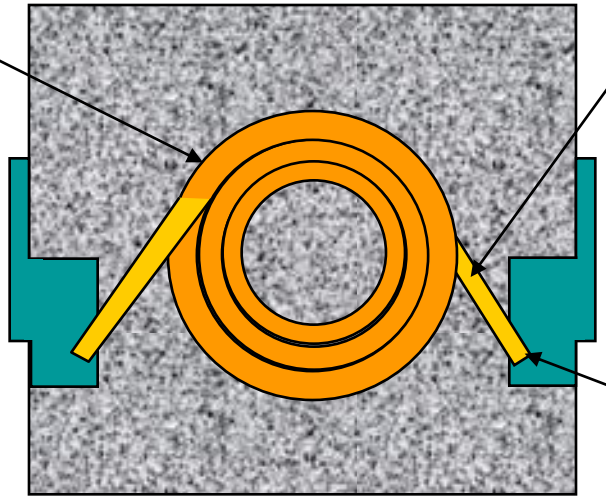



DESIGN CONSIDERATIONS FOR A SPACE GRADE POWER INDUCTOR

- Low Loss
- High saturation current – for transient response
- Low aging – stable electrical characteristics over time
- Wide operating temperature range – -55 to >150º C
- Mechanical Stability – high vibration/shock environments
- Low Outgassing – per NASA/ASTM-E-595
- Low Profile – for limited board space
- SMD packaging – high density routing

COMPONENTS OF THE IHLP INDUCTOR

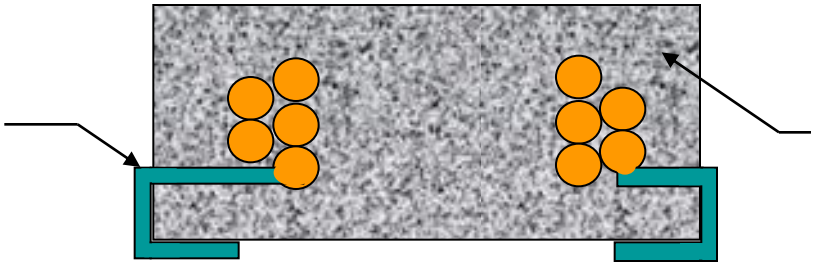
200°C
Polyester/Polyamide
Insulation



Copper Wire

High Reliability
Ultrasonic Weld

Copper Lead-Frame



Low Loss Iron Powder

DC RESISTANCE (DCR)

Copper losses (I^2R loss) due to the DC resistance of the winding and terminals.

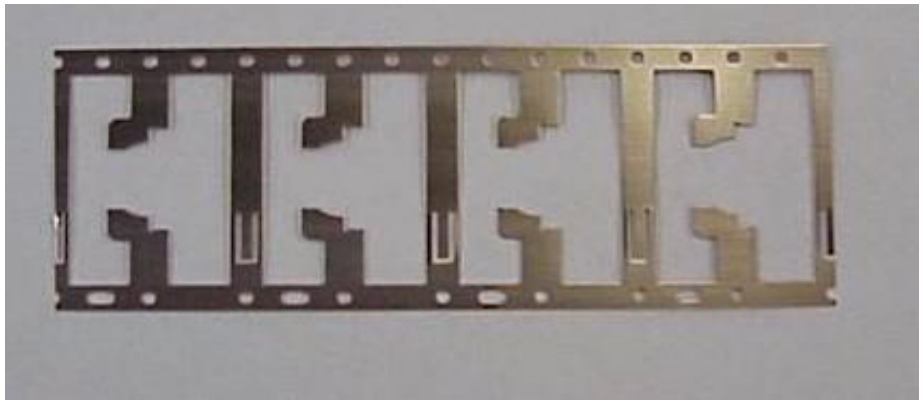
- Frequency independent
- A function of temperature coefficient of the copper wire - increases with temperature

COPPER WIRE:

- Oxygen free Cu
- Polyamide Coating
  - 5KV Breakdown
  - High Temp Operation 200 C

CONTINUOUS LEAD FRAME:

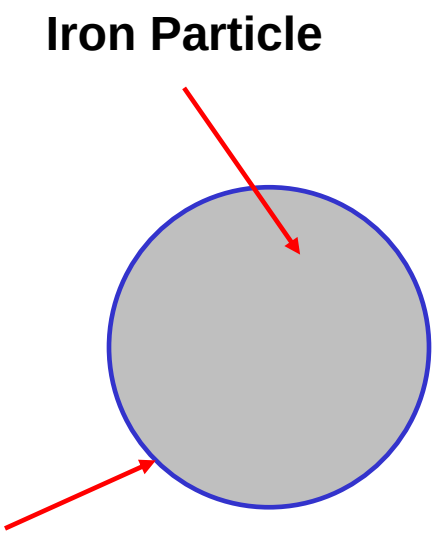
- Oxygen free Cu
- Sn/Pb Plating over Nickel Base Layer



THE CORE MATERIAL

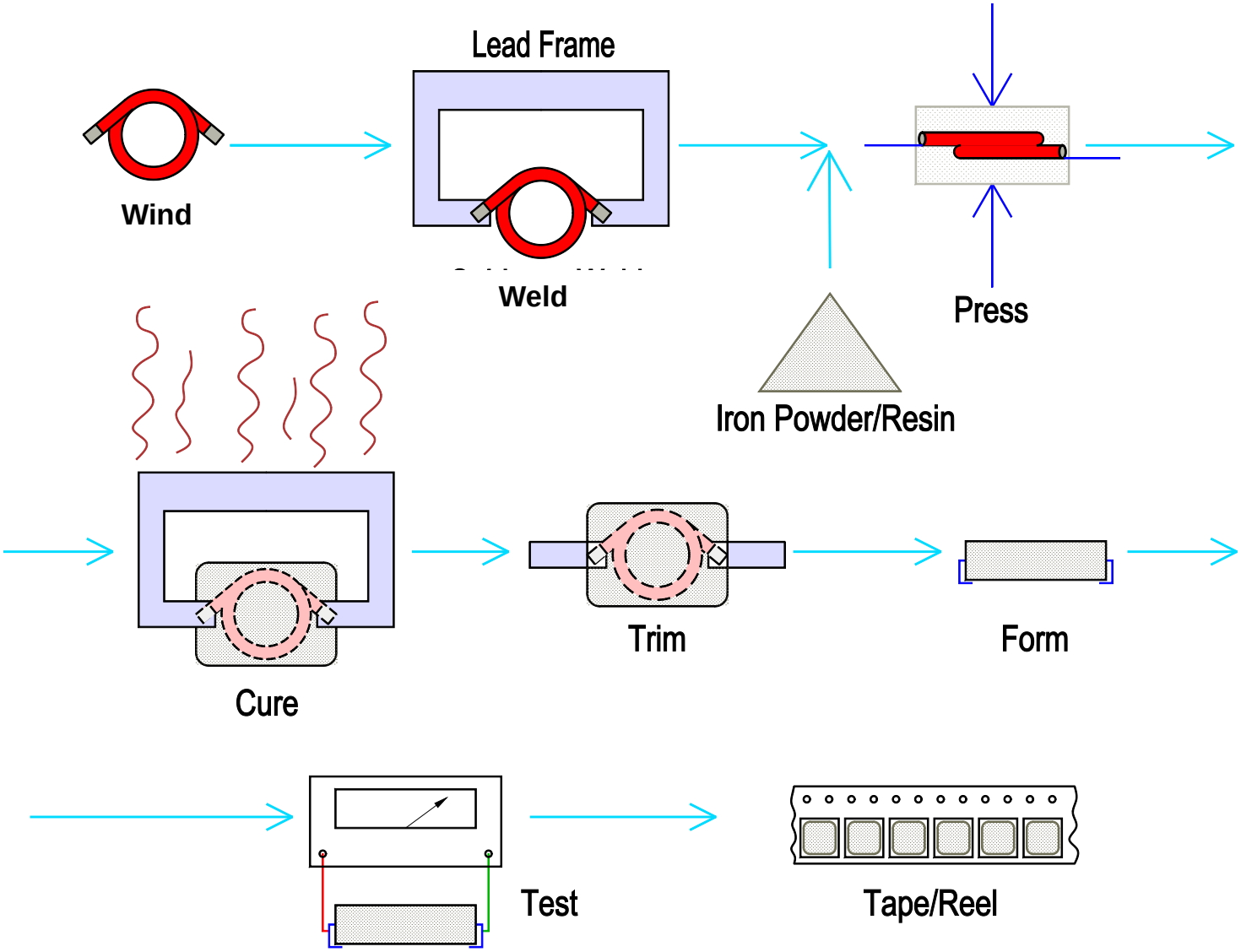
- Base material is a proprietary atomized iron alloy

- Insulating coating is applied to iron particles
  - Insulation provides a distributed gap core
  - Reduces eddy currents and core loss
  - Provides good saturation characteristics
  - A distributed gap reduces EMI

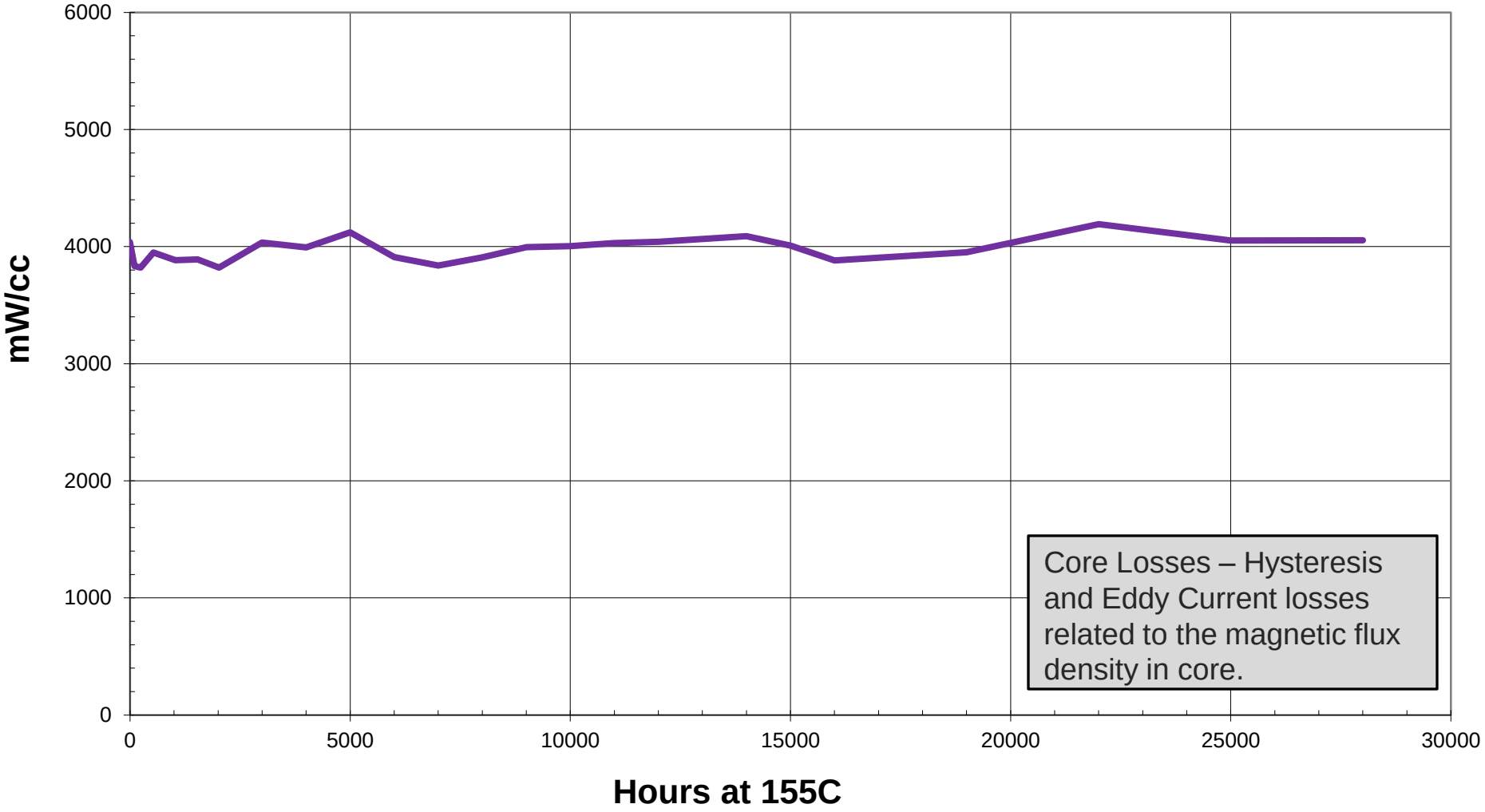


- High temperature epoxy resin is added
  - Strength
  - Durability for thermal & Mechanical stability

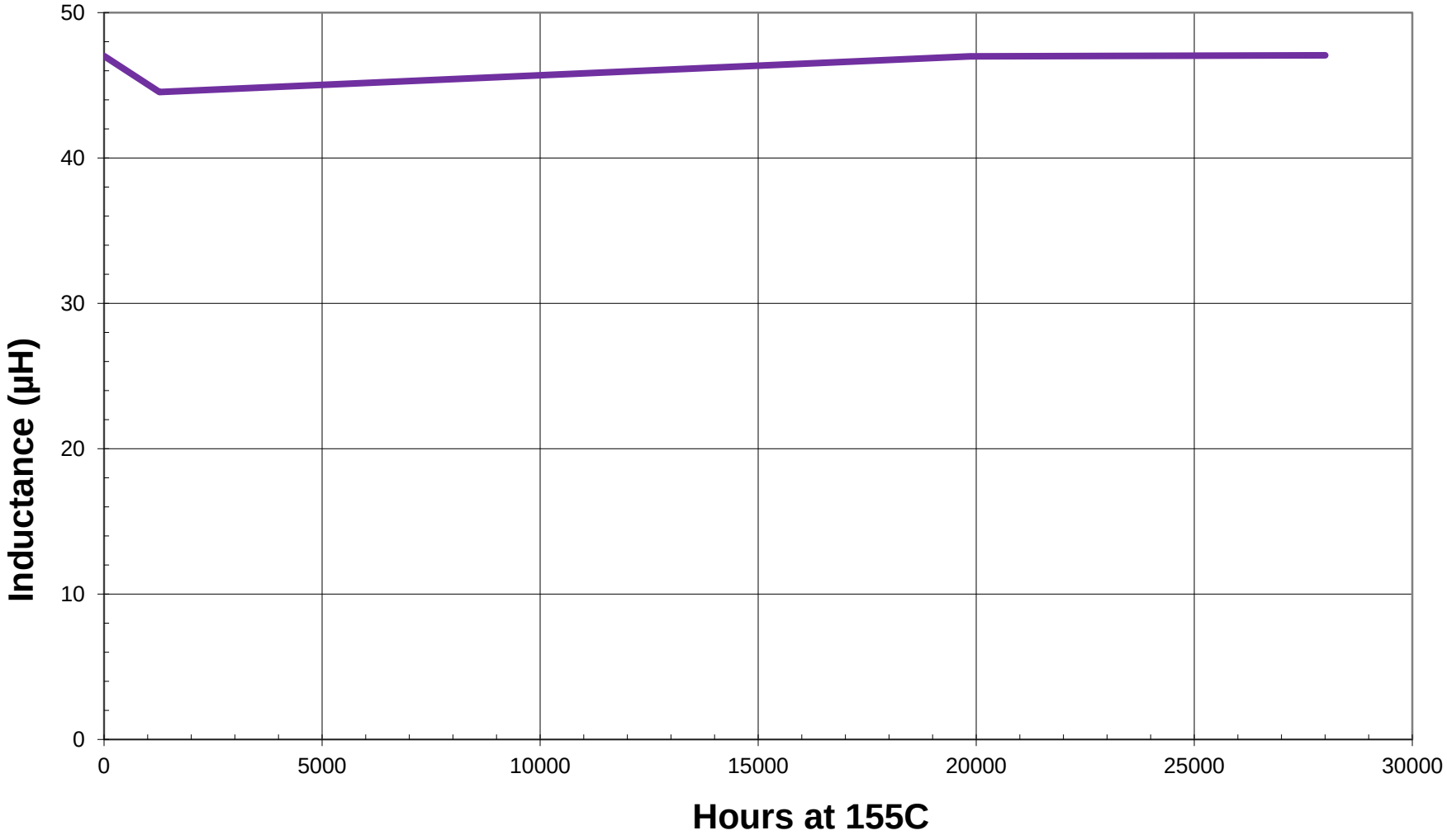
MANUFACTURING PROCESS



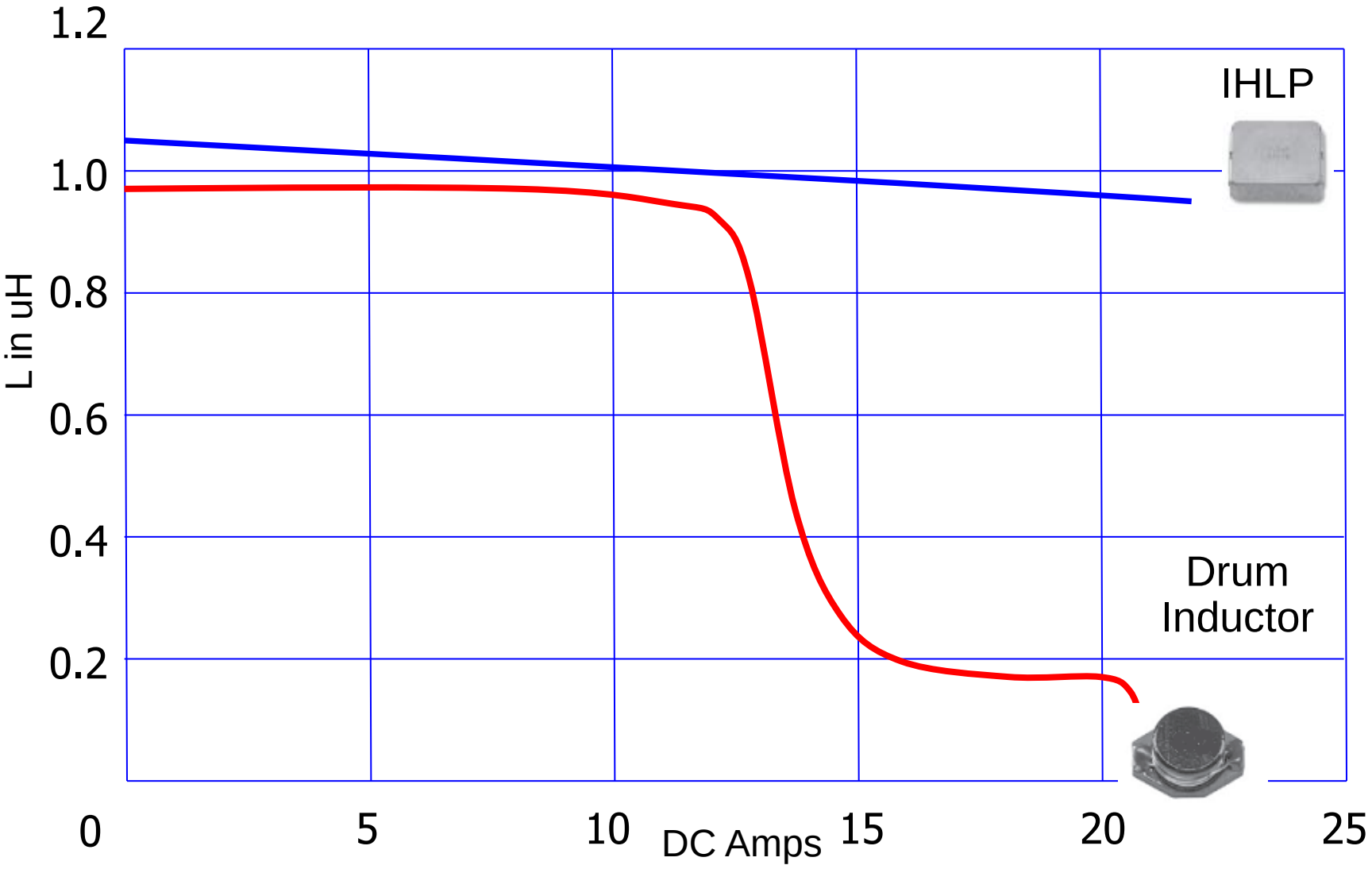
Core Loss vs. Time



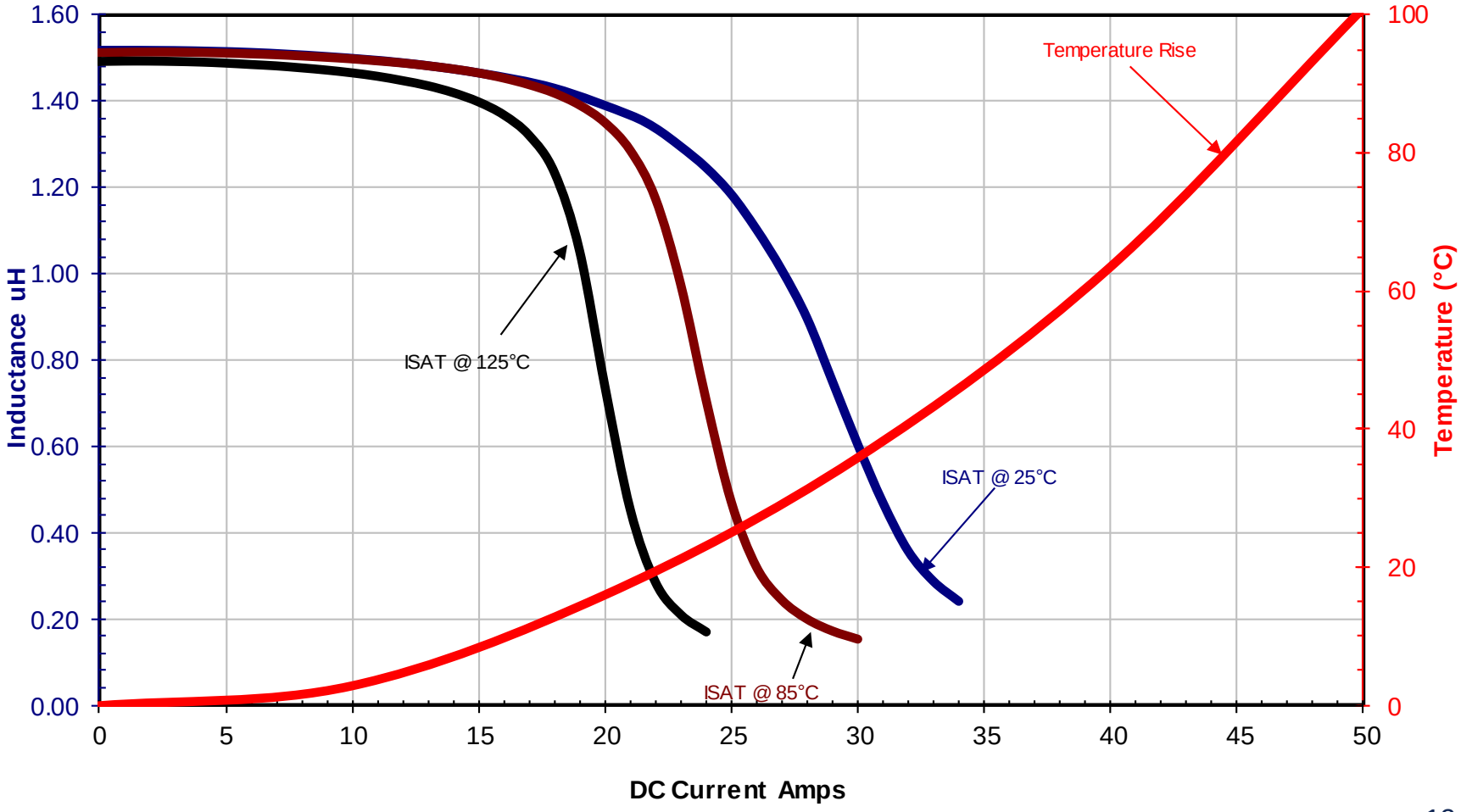
Inductance (L) vs. Time



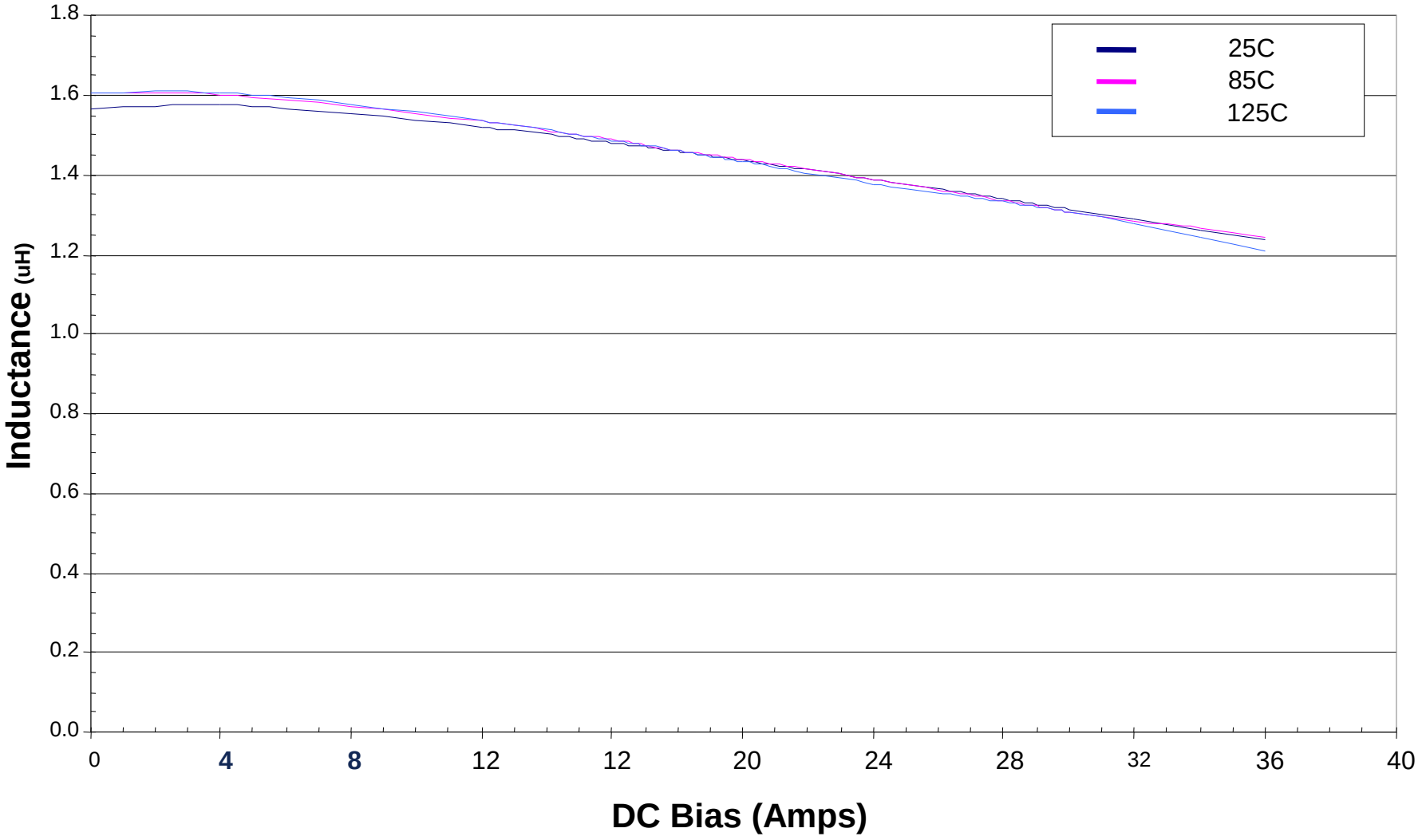
Saturation Comparison



Saturation vs Temperature - Ferrites



Saturation VS. Temperature - IHLP



SUMMARY

- High Current, Low Profile Inductor
- Ultrasonic welding – No solder joints/internal reflow issues
- Solid Lead Frame – Minimal connection points and DCR
- Shock Resistant – Tested to 50G
- SMD
- Mechanical Stability » Electrical Stability

THANK YOU!