FERRITE WATT LOSS TESTING: COMMON MANUFACTURING PROCESSES

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Agenda

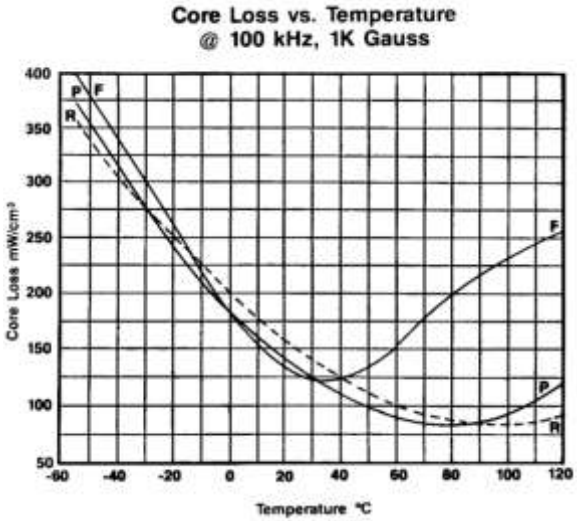
- Magnetics Background
- Typical Watt Loss Measurements
- Test Procedure and Equipment
- Limits and Performance Curves
- Customer Correlation

Magnetics Background

- Manufacturer of Magnetic Cores
  - Mn-Zn Ferrites (Power Ferrites)
  - Distributed Air-Gap Powder Cores – MPP, Kool Mu, XFlux
  - Strip Wound Cores – SiFe, 50% NiFe, 80% NiFe
- R&D Focused
  - New material and core geometry development.
  - Existing material improvement.
  - Testing standardization.
  - Customer specification correlation and design.

Typical Loss Measurements

- Power Ferrites – Core Loss
  - Low losses at high frequencies and drive levels.
  - Minimum loss is temperature dependent.
    - R (2300 μ @ 100°C)
    - P (2500 μ @ 80°C)
    - F (3000 μ @ 25°C)
  - Measurement taken on ungapped shapes or toroids.



Typical Loss Measurements

- High Perm Ferrites – Loss Factor
  - Indication of the impedance frequency response.
  - Cores are commonly used in common mode chokes.
  - Typically measured at 25°C.
  - Measurement is taken on ungapped shapes or toroids.

FIGURE 9

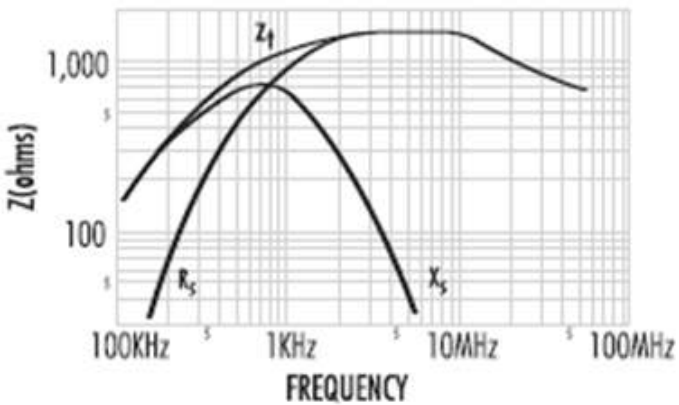
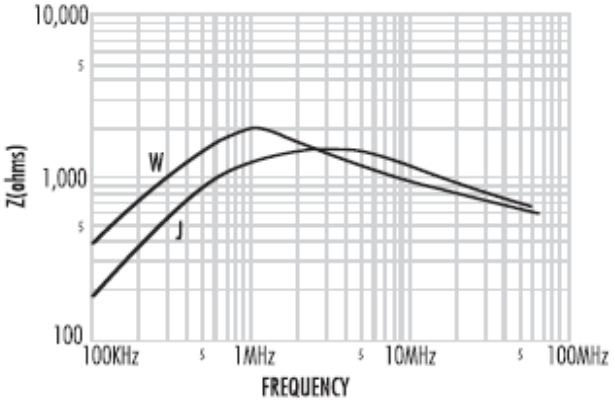


FIGURE 11



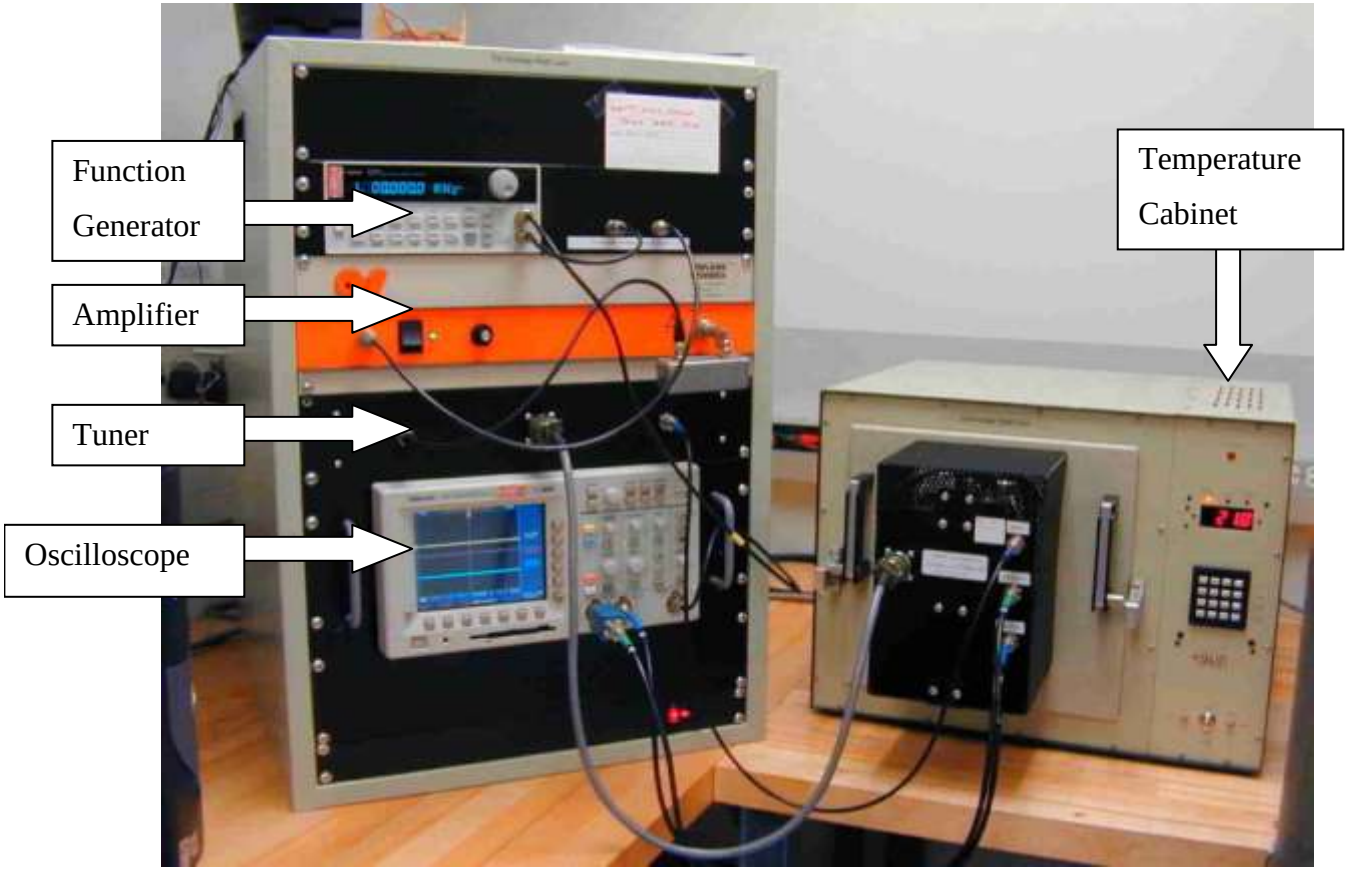
Typical Loss Measurements

- Nickel Zinc
  - Commonly found in toroid, tube, multi-hole and cable shield form.
  - Used in EMI Suppression.
  - Low permeability (80μ to 1700μ).
  - Loss Factor and impedance at specific frequencies are common specifications.

Test Procedure and Equipment

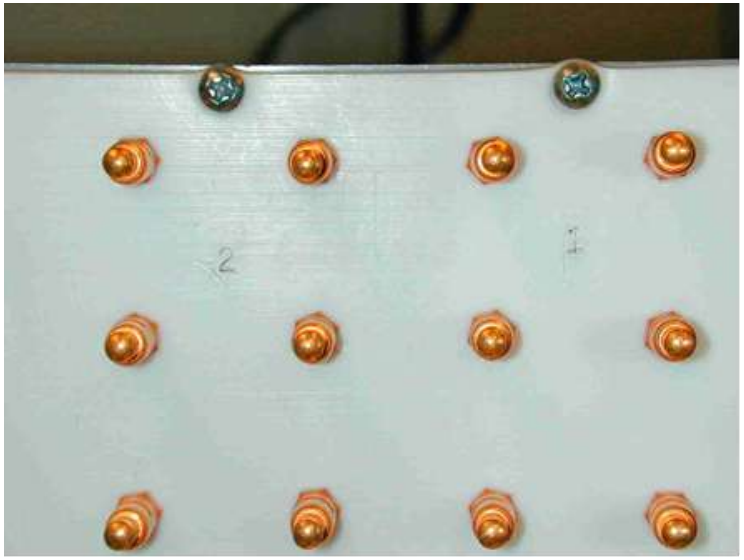
- Function Generator – Agilent 33120A
  - Used to create test waveform (Sine wave at desired frequency).
- Amplifier – Amplifier Research
  - Used to amplify test waveform.
- Oscilloscope
  - To monitor current and voltage phase angles for power loss measurement.
- Computer and Custom Program
  - Core information stored in database.
  - Controls testing once cores are loaded in cabinet.
  - Processes information from oscilloscope to calculate watt loss.
  - Can also be operated in manual mode for non-standard cores.

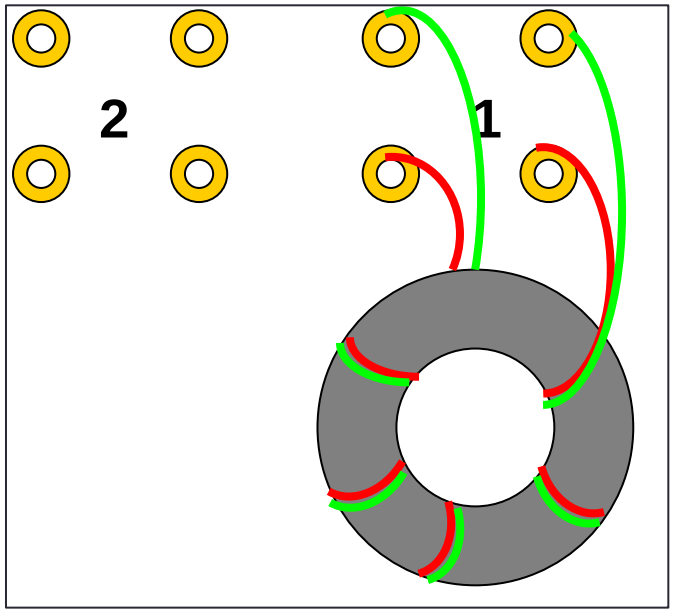
Test Procedure and Equipment



Test Procedure and Equipment (cont.)

- Temperature Cabinet
  - 32 Cores at a time
  - -60°C to 200°C





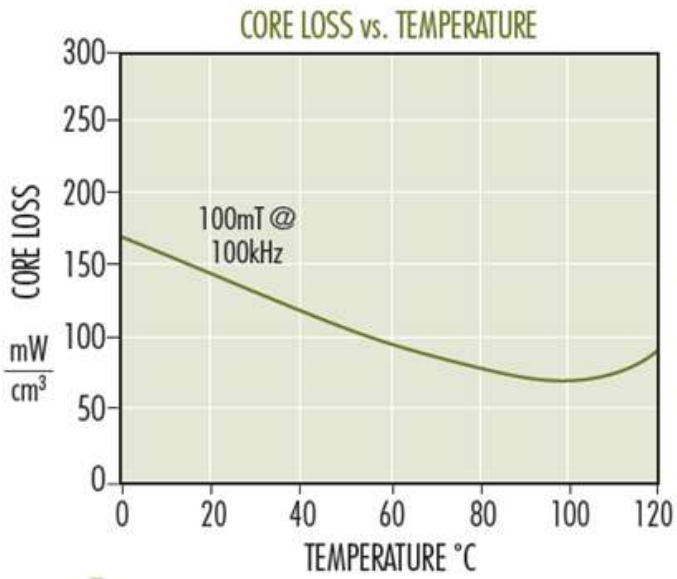
Test Procedure and Equipment (cont.)

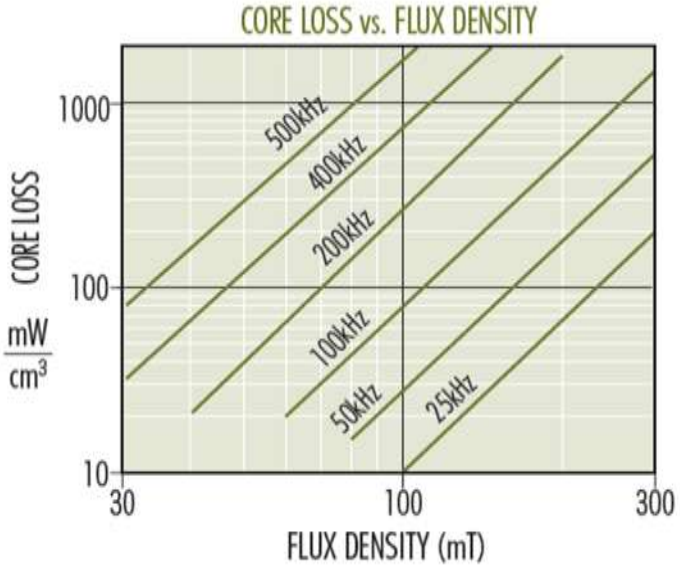
- Watt Loss
  - Cores are wound with two strands bifilar wire.
  - Drive winding and pick up winding.
  - Use Faraday's Law to calculate # of turns
    - Drive voltage greater than 1 Volt but less than 60 V.
    - Wire size acceptable for signal current.
  - 6 Cores per lot are tested
- Loss Factor
  - Cores wound with 10 turns.
  - ——
  - R_s and L_s as well as μ_i are measured on an LCR bridge.

Limits and Performance Curves

- Typical performance curves are provided in the catalog.
  - Based on empirical data from toroid tests.
  - Mistake is to use these as limits in design.
    - Spec sheets have the limits.
  - Curve fit equations also available for use in modeling software.
    - Good estimation tool, but curves are most accurate.

P Material Curve (@ 100° C)





Limits and Performance Curves

- Limits are defined for each part number.
  - Provided on each individual spec sheet.

ZP-42915-TC

CORE LOSSES		
P_L max	Production lot limit Max avg	Test conditions
674 mW (123 mW/cm^3)	614 mW (112 mW/cm^3)	100 kHz, 100 mT, 100°C

ZW-42915-TC

ELECTRICAL LOSSES			
tan δ / μ_i	Production lot limit Average	Test conditions	
≤ $3.5 \cdot 10^{-6}$	≤ $3 \cdot 10^{-6}$	10 kHz	0.5 mT, 25ºC
≤ $55 \cdot 10^{-6}$	≤ $45 \cdot 10^{-6}$	100 kHz	

Customer Test Correlation

- Customers typically do not test for watt loss
  - Equipment is not available to them, wouldn’t be useful anyway.
  - Q Factor is a common measurement for power materials.
    - Relates to efficiency of the wound unit.
    - —
  - Problem: Measures core and winding properties, not dependent on watt loss alone.
    - Q is not guaranteed by a core supplier, only losses that they are measuring are guaranteed.
  - Temperature Rise
    - Source of heat is from losses.
    - Both material and winding losses contribute.
    - In ferrites, wire losses would most likely be the culprit.
  - Correlation is the only logical action.

Questions?

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