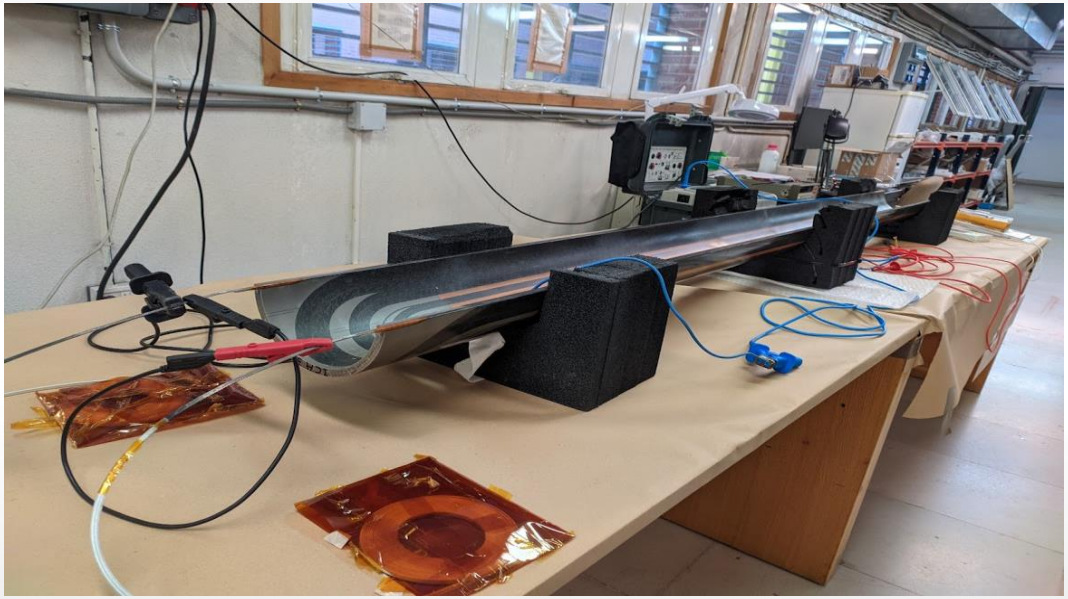
Electrical Tests on MCBXF Coils



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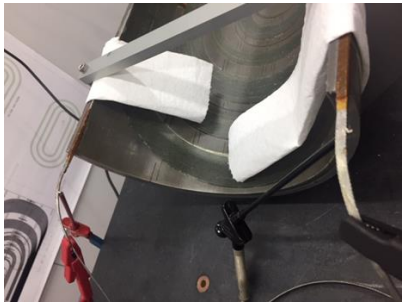
Outline

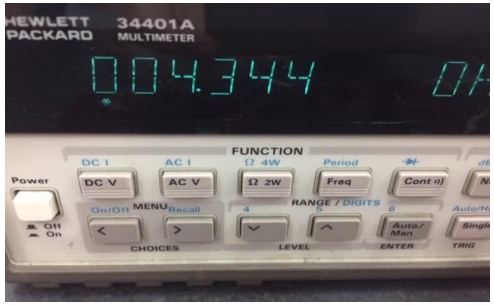
1. Before starting the tests
2. DC Resistance test
3. Insulation test
4. Impedance test: frequency sweep

Electrical Tests

- Before starting the tests:
  - Coils should be thermally stabilized: 6h at 22±2 degrees Celsius and RH < 60%
  - Measuring equipment switched on one hour in advance
  - Coil current leads should be kept away from each other and properly insulated to avoid undesired electrical contacts

- RDC: DC resistance test
  - 4-wire R measurement usually enough
  - For very low R, a current source should be used (usually 1A)

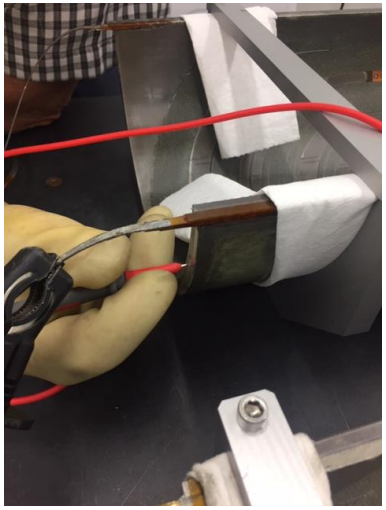




		Ref margin=	2	%					
	Reference	Ref Top	Ref Bottom	OCBS04	OCBS05	OCBS06	OCBS07	OCBS08	OCBS09
R	4.14265	4.225503	4.059797	4.2158	4.265	4.097	4.078	4.145	4.136
T	20	20	20	16	21	18.4	17	19.8	20.9
Rcorr	4.14769235	4.2306462	4.06473851	4.28207238	4.24823855	4.12276194	4.12607962	4.14825797	4.12137097

Electrical Tests

- Insulation
  - HV test: Megger. With MCBXF up to 1000V
  - Test all the accessible metallic parts versus the coil to assure a correct insulation
  - 30 seconds (Leakage + Polarization currents) and 300 seconds (Leakage current) tests



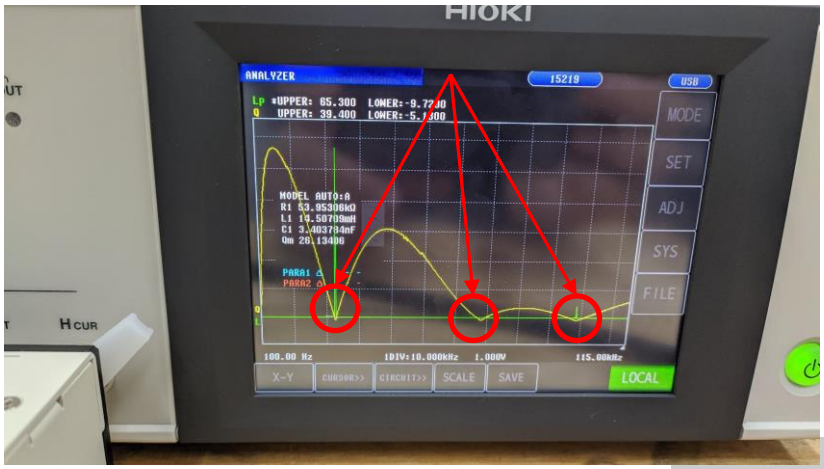
MCBXFA COIL OCA505	Insulation resistance	U[test]	time	measured	nominal	measured	nominal
		[V]	[s]	[GΩ]	[GΩ]	[nA]	[nA]
	Loading plate (Layer jump)	1000	30	387.00	>1	2.63	<1000
	Loading plate (Layer jump)	1000	300	>2T	>1	0.08	<1000
	Loading plate (No Layer jump)	1000	30	238.00	>1	4.27	<1000
	Loading plate (No Layer jump)	1000	300	1986.00	>1	0.51	<1000
	Central post (leads side, outer)	500	30	>1T	>1	0.12	<1000
	Central post (leads side, outer)	500	300	>1T	>1	0.01	<1000
	Central post (leads side, inner)	500	30	>1T	>1	0.27	<1000
	Central post (leads side, inner)	500	300	>1 T	>1	0.00	<1000
	Central post (return side, outer)	500	30	>1T	>1	0.04	<1000
	Central post (return side, outer)	500	300	>1 T	>1	0.00	<1000
	Central post (return side, inner)	500	30	>1T	>1	0.07	<1000
	Central post (return side, inner)	500	300	>1T	>1	0.00	<1000
	Endshoe (leads side, outer)	1000	30	700.00	>1	1.45	<1000
	Endshoe (leads side, outer)	1000	300	>2T	>1	0.03	<1000
	Endshoe (leads side, inner)	1000	30	842.00	>1	1.21	<1000
	Endshoe (leads side, inner)	1000	300	>2T	>1	0.06	<1000
	Endshoe (return side, outer)	1000	30	429.00	>1	2.37	<1000
	Endshoe (return side, outer)	1000	300	>2T	>1	0.05	<1000
	Endshoe (return side, inner)	1000	30	1575.00	>1	0.75	<1000
	Endshoe (return side, inner)	1000	300	>2T	>1	0.04	<1000

- Impedance measurements
  - Impedance Analyser Hioki IM3570
  - We apply a frequency sweep (variable frequency sinusoidal signal) from 100 Hz to 100 KHz
  - Maximum voltage 5V peak to peak…
  - …and few mA: extremely safe test!
  - Objective: find the resonant frequencies
  - Measured parameters: L and Q (Quality factor)

- Why are the resonance peaks so important?
  - The peaks are very narrow, happening at a very specific frequency, any little change in the coil characteristics will change them in a perceptible way

$$f_0 = \frac{1}{2 \cdot \pi \cdot \sqrt{L \cdot C}}$$

  - *"This is a coil… There should be only L!!!!"*
    The ideal coil does not exist, so we have indeed several C's: capacitance to ground, inter-turn capacitance, inter-layer capacitance, etc. This is why we can see several resonance peaks
  - *"Those C's should be negligible!!!!"*
    That is only true at very low frequencies. At high frequencies they can even have a higher value than the actual L
  - How do we find them?
    - L parameter (green): Zero crossing
    - Q parameter (yellow): graph minimums (reaches zero). Much easier to detect

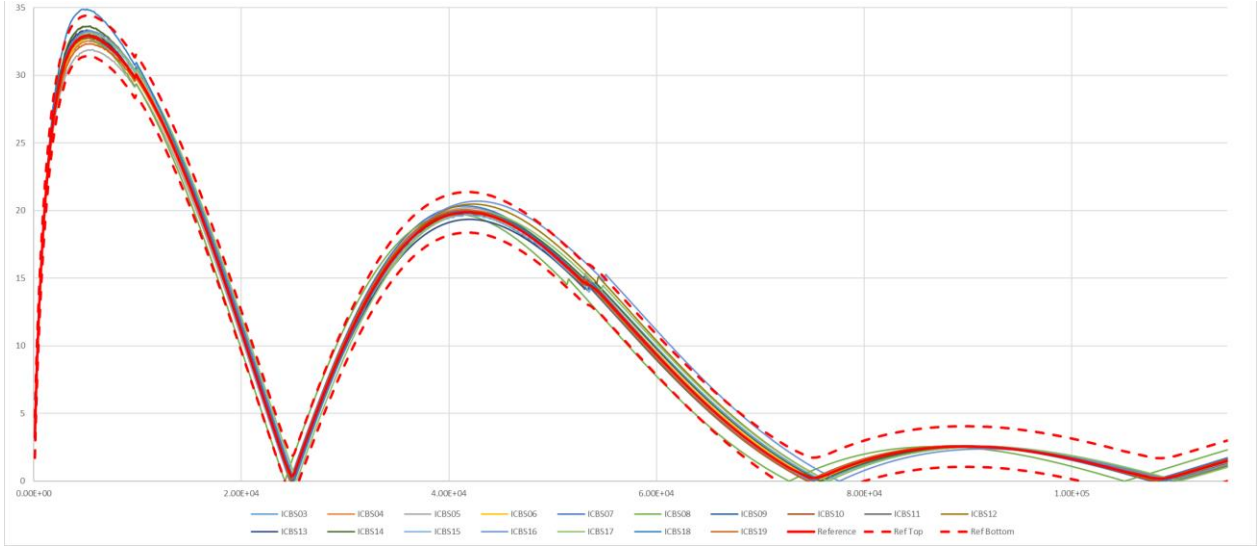


- The quality factor (Q) of a coil is very sensitive to an inter-turn short circuit:

Sound coil

Short-circuited coil

- This is mainly a comparative test. Database with reference and window margin to compare results



Thank you for your attention!