

HM8118: Measurement of capacitors and coils

From the expert's desk

Products:

| HM8118

1. Introduction:

The HM8118 is an LCR Bridge with a basic accuracy of 0,05%. The test frequency can be set from 20Hz up to 200kHz. This Application Sheet helps to perform first measurements on capacitors and coils without having a doubt concerning the results. It does not claim to be complete. All information has been compiled with care. However errors can't be ruled out.

2. General information about the measurement principle

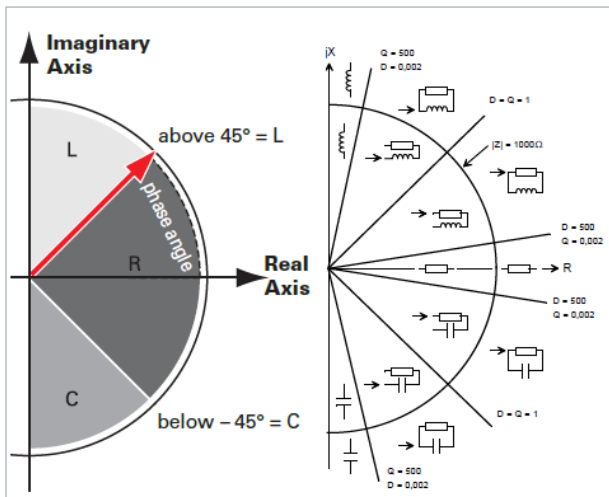
The HM8118 is not a typical Wien, Maxwell or Thomson bridge based instrument. It measures the impedance Z and the phase angle Φ with an AC stimulus signal. In combination with other known parameters (e.g. frequency) the desired characteristics can be calculated.

When performing measurements always remember, that e.g. the capacity varies with certain parameters, specially over the frequency. Also aging, temperature, the level of the measurement signal and additional bias are dependency factors.

The equivalent circuit of each DUT always contains inductive, real and capacitive parts. E.g. a capacitor will have inductive and real parasitics.

This means, that ideal Φ (90° =pure inductive, 0° = pure ohmic, -90° =pure capacitive) will never be reached.

It is also important, that due to the opositional parasitic parts each measurement contains a certain inaccuracy being a systematic measurement error.



Extraction from the user manual: Phase angle and integral parts of L, C, R

As an example a bigger coil always contains a parasitic ohmic and capacitive part in addition to the inductive essential part. The inductive part will prevail, while the capacitance can not directly be measured with the HM8118. However this coil will have a self resonance showing the capacitive part to be present.

3. Test assembly

It is important to always keep in mind, that the test assembly may have appreciable influence to your measurement. When talking about capacitors in the range of picofarads, the position of the clamps has definitely influence to the measurement.

You can easily give it a try by performing the following steps:

- use the basic setting (1kHz / Single Mode)
- shorten the clamps and perform a short calibration
- lay down the clamps with at least 20cm difference and perform an open calibration
- change to C-D Mode
- Now hold the clamps, that the tips are just not touching and check the measurement result.

➔ I can achieve more than 3pF with this method

So always choose the best test adaptor for your application. The HZ181 is a great tool for leaded (through hole) components avoiding such distance issues:



4. Alignment of the test structure

We recommend to align the instrument on all available frequencies (20Hz – 200kHz in 69 Steps) when measuring unknown devices. After choosing the right test assembly and have the instrument warmed up for at least 30 minutes, please perform the following steps:

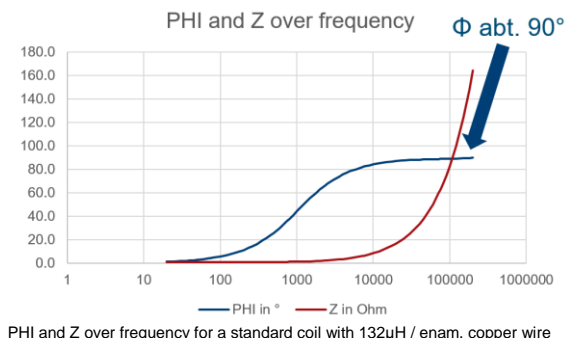
- Perform a Factory Preset to start with a dedicated setup:
 - Press [RECALL] [9]
- Prepare the instrument to calibrate on all frequencies:
 - Press [SELECT] [3]
 - Change to (Mode) using the rotary knob

- Press the rotary knob to select this menu point
- Change from "SGL" to "ALL" and press the knob again
- Leave the menu using [ESC]
- Perform a complete alignment:
 - Shorten the clamps and press [SHORT]
 - Now the short calibration will run for about two minutes.
 - Open the clamps (If using e.g. kelvin clamps take care to have about the same position as it will be for the measurements to come) and press [OPEN]
 - Also this procedure will take up to two minutes

5. Measurement of an unknown coil

Preliminary remarks: Coils containing ferromagnetic core materials may not give exact results as the core material is specified for a certain frequency range. This has to be checked before.

- Switch on the measurement voltage / current monitor:
 - Press [SELECT] [2]
 - Change to (Vm/Im) using the rotary knob
 - Change the value to "ON" and press the knob again
 - Leave the menu using [ESC]
- Connect the unknown coil to the test structure
- Change to Z / Phi Measurement by pressing [Z - Φ]
- The phase angle should already be positive
- Now search for the best acquisition frequency
 - Press [FREQ]
 - Use the rotating knob to change the frequency as long as Φ is closest to 90°
 - Press [L-R]
 - Now the nominal inductance is displayed in combination with the serial resistance
 - Check the voltage not to drop down too much (down to 35% of the nominal voltage is fine – in this case the nominal voltage is 1V; see section "LEV" on the left upper display)

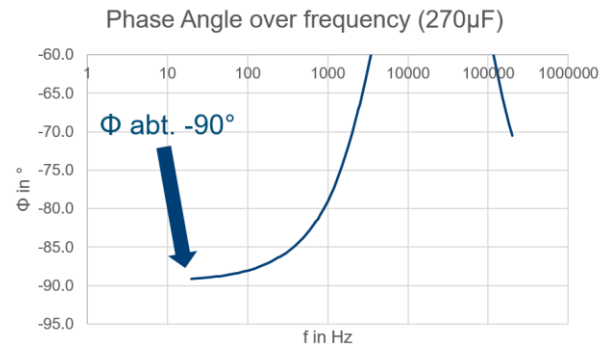


5. Measurement of an unknown capacitor

Preliminary remarks: Gold caps can not be measured with the HM8118 as they are too inert for that kind of measurement.

- Switch on the measurement voltage / current:
 - Press [SELECT] [2]
 - Change to (Vm/Im) using the rotary knob
 - Change the value to "ON" and press the knob again

- Leave the menu using [ESC]
- Connect the unknown capacitor to the test structure
- Change to Z / Phi Measurement by pressing [Z - Φ]
- The phase angle should already be negative
- Now search for the best acquisition frequency
 - Press [FREQ]
 - Use the rotating knob to change the frequency as long as Φ is closest to -90°
 - Press [C-D]
 - Now the nominal capacitance is displayed in combination with the serial resistance
 - Check the voltage not to drop down too much (down to 35% of the nominal voltage is fine – in this case the nominal voltage is 1V; see section "LEV" on the left upper display)



6. Additional Information

- ➔ If the voltage drops down to less than 35% of the nominal frequency, switch on the constant voltage mode. The calibration done before is still valid when changing to this mode.
- ➔ In the constant voltage mode the impedance of the HM8118 is fixed to 25 Ω , meaning that the output voltage is held constantly to the preset level for devices with an impedance of more than 25 Ω . This can improve the results mostly for lower inductance values. It is important to remark, that the accuracy is reduced by the factor of 2 when working in this mode.
- ➔ It is also possible to acquire the DUT's behavior using the intended working frequency without tuning. If this is pur posed, the calibration can also only done for this very frequency using "SGL" Mode (see "calibration, calibrate all frequencies")

References:

- R&S HM8118 User Manual
- R&S FAQ "How to startup your HM8118 using a specific calibration"
- R&S FAQ "HM8118 different measurement result of the same coil"
- R&S FAQ "HM8118 tu use external BIAS"

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