

# *Diagnostics & Trouble Shooting*

**Diagnostic and Error Handling in Case of Trouble**

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## General

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The Zahner instruments are established with internal self test diagnostic procedures, which in almost any case will detect hardware problems due to internal device failure or degradation within the starting up phase of the measurement software. The corresponding diagnostic messages are described within the chapter "**Startup self-test errors**". If you are able to set up your measurement without getting messages of the type mentioned, you should rely on the results of the instrument. Nevertheless, physical-chemical experiments may provide some unexpected traps even to the experienced users and measurement results which are in contradiction to the scientists intuition may occur. Mostly the reason for the confusion can be fixed by carefully checking of the wiring and the test object set-up and by taking into account their parasitic properties. To exclude at all problems potentially passing thru the automatic diagnostics and to guarantee the user, that no instrument problem is present, a detailed testing feature is provided. It is described in the section "**Extended Hardware Test**".

A logging function, which will automatically protocol abnormal situations like internal software errors is built in to Thales. You can find the corresponding protocol as an ASCII-file in the directory \fink under a filename, corresponding to the ini-file connected to your Thales-icon. The default name is "usb.log" (the meaning of the ini-file is described in the section 4.3 'More then one IM device controlled by one PC') of the Chapter "Installation & Unpacking". In the default case this log-file contains start- and end time of Thales sessions, and, if occurred, information on errors. You may pass this file to us for diagnostic purpose. Besides fixing hard errors, this protocol feature may be used under individual control of the user, for instance, when script programs have to be debugged. The logging information may be visualized also at runtime online by means of the "Z-Trace" function. In the section "**Z-Trace Features**" the handling is described in more detail.

Zahner computer systems - impedance measurement units Zennium/IM6 as well as general purpose data acquisition systems based on the AMOS/ANDI family - are reliable instruments in industry and research. Nevertheless not one computer on the world does work without sporadic errors in software or in hardware, because computers are 'very sensitive' instruments. Noise on power lines, wrong handling or strong electromagnetic interference sometimes may confuse a computer.

Our software is subject to continuous tests and improvements being initiated by our users. On the other hand nobody can execute all possible entries to a submenu or a sub function. Thus software failures may occur at certain circumstances. These failures will be recognized by the operating system and an error message is passed to the log-file followed by an automatic resume operation. As many time sensitive and time intensive subroutines are running on the assembler level, non-trivial system errors may occur too. A malfunction may also result in a hang-up. For both types of errors examples are shown. Commonly the error of a computer will be followed by a message given from the operating system and will then end with a system restart where all data will be lost. A unique feature of Thales is, that the normal program flow may be re-established in a simple way for most cases with no data loss. The chapters 3, "**Errors by the operating system**" and 4, "**Program crash – what to do?**" will describe possible recoverable errors and offer ways to reanimate a measuring program or a simulation process.

# 1. Extended Hardware Test (TestBox)

## 1.1 TestBox Hardware

The *TestBox* shipped with the Zennium/IM systems is calibrated to the individual IM. This is the reason why it has got a serial number. If you have more than one IM system in you lab, please be careful not mixing up the *TestBoxes* because in this case the self test would show deviations or even errors.

The *TestBox* is connected to the BNC terminals of the IM instrument in the same way as an electrochemical cell. The four connection cables are in the same colors like the BNC connectors.



The TextBox has a four-position switch on top. Its settings are:

<b>Position</b>	<b>Function</b>
<b>HiZ</b>	High impedance circuit for DC/EIS self-test
<b>LoZ</b>	Low impedance circuit for EIS-I/E demo / test
<b>Lin</b>	Special circuit for EIS self-test
<b>Exp</b>	Special circuit for CV demo / test

## 1.2 TestBox Script Software

The *Zennium/IM* systems come with an executable script application **testbox.rtm** which in combination with the *TestBox* hardware allows you to carry out an instrument self-test, easily.

**Start the self-test script** as follows:

1. Click on the **EXE** button of the main menu



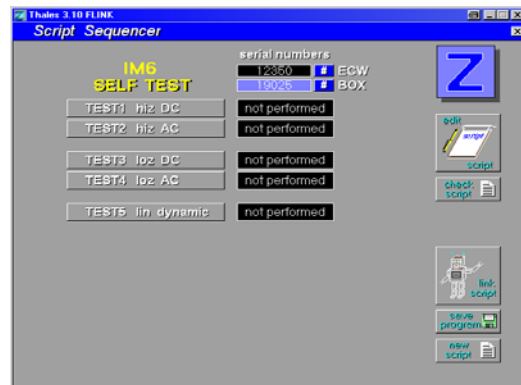
2. Select **[browse]** from the box appearing and navigate to the path

`c:\thales\examples\applications`

Select **testbox.rtm** and confirm.



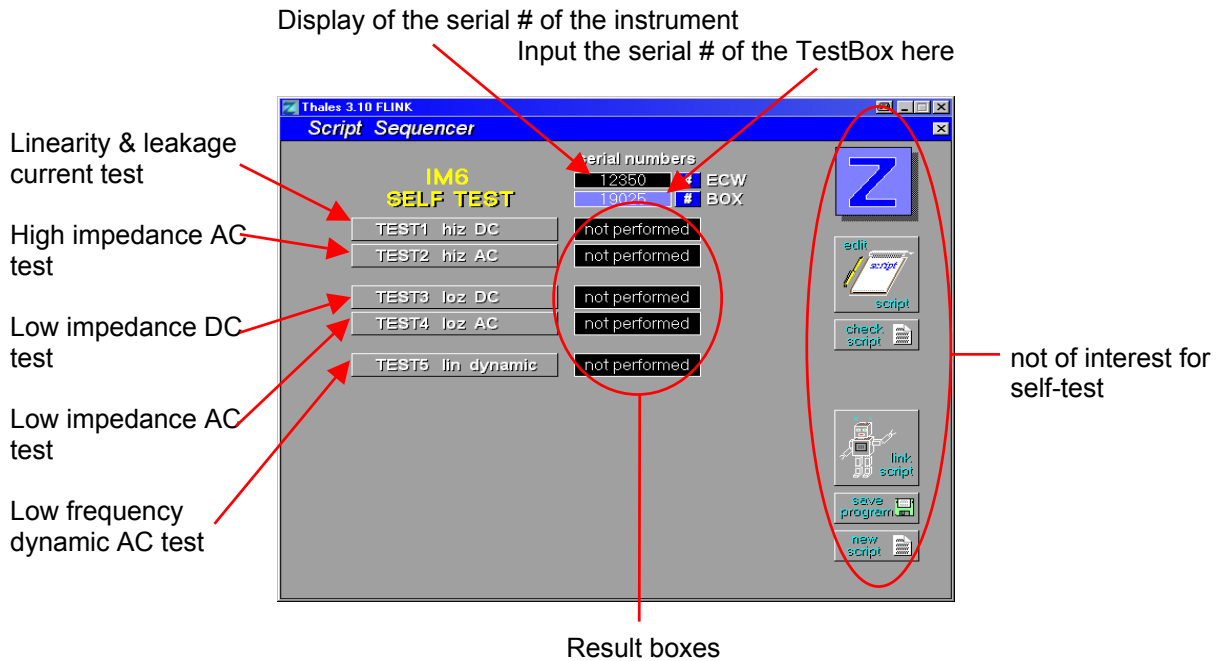
3. You will end-up in the main menu of the **TestBox** script.



Before starting the self-test routines, input the serial number of the **TestBox** shipped with your instrument. The input will be activated by clicking on the corresponding `#` button.

The system test is cut down to five individual tests. Each individual test is part of the final factory system test. The test data are shipped with each IM system on the floppy disc named **Calibration Data**. You have copied the data along with the system calibration data when you run the calibration data installation as described earlier. These data are used as a reference. The deviations must be inside a small tolerance range for to pass the self-test. If a test is passed, the data will be displayed in green or yellow colour, if it did not pass you will see the data in red.

The main menu page of the self-test script:

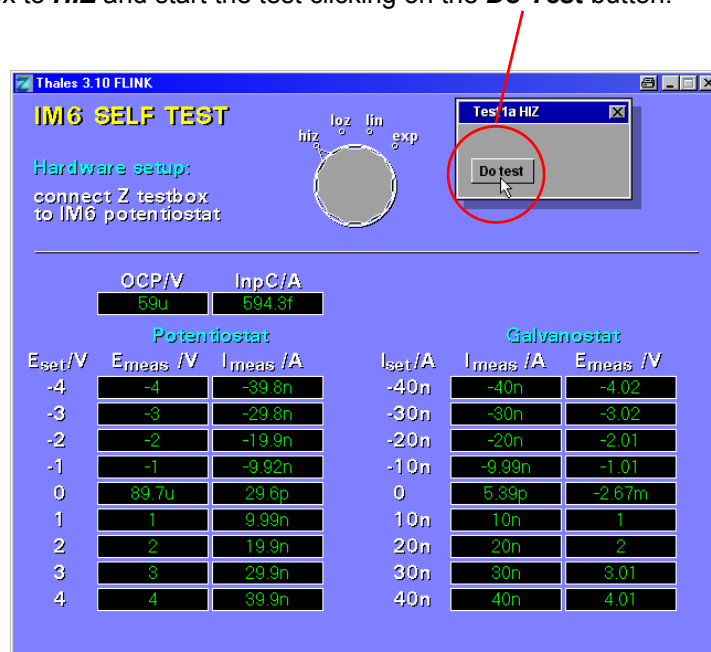


1.2.1 TEST 1 : Linearity & Leakage current

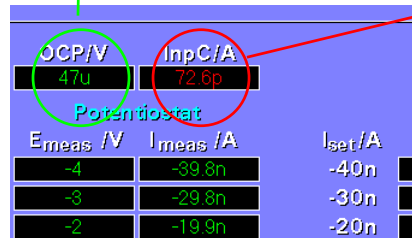
TestBox setting: **HIZ**

Script button:

This test checks the linearity and the leakage current of the potentiostat (galvanostat). Set the range switch of the TestBox to **HIZ** and start the test clicking on the **Do Test** button.



The system is tested in potentiostatic and in galvanostatic mode. In potentiostatic mode potentials from -4 V to +4 V are set and the response is measured and displayed. In galvanostatic mode currents from -40 nA to +40 nA are set and the response is measured and displayed. Values within the tolerance range are shown in green colour, values out of the tolerance range are shown in red colour.



Before you assume an error of the system consider the external conditions, e.g. high humidity, which may fake a high leakage current. Then the following info-box will be displayed:

Unexpected derating of specifications!

The measurement of very low currents in the 100nA-range is affected by an unexpected high leakage current probably caused by humidity.

ZAHNER specifies an accuracy of 0.5% at a relative humidity up to 60%.

**WARNING:**  
Operating the instrument at very high humidity or in condensing atmosphere may cause permanent derating of the low current performance.

### 1.2.2 TEST 2 : High impedance AC test

TestBox setting: **HIZ**

Script button:

This test checks the high impedance measuring ranges ( $1k\Omega \leq R_{shunt} \leq 10M\Omega$ ) of the IM system.

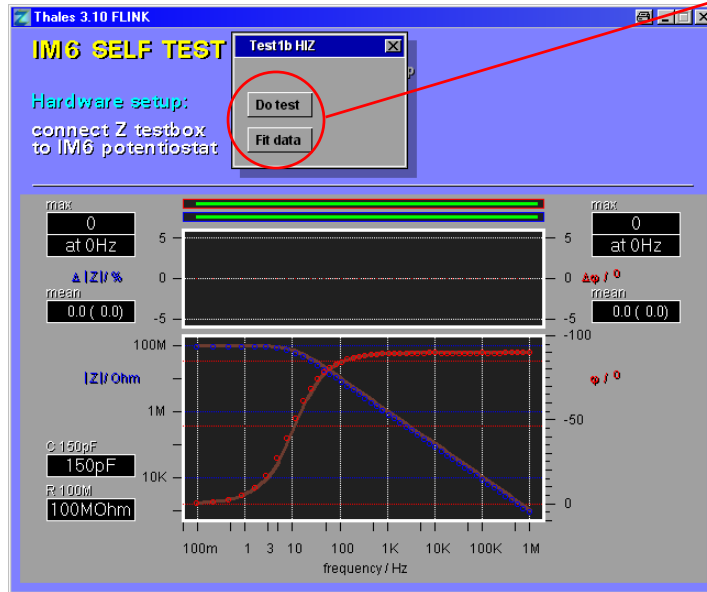
For that purpose an impedance spectrum is recorded. The measured spectrum will be compared with the spectrum recorded at the final factory test. An error will be indicated if impedance or phase of both spectra differ by more than 5%. To check the system take a look at the curve. The measured curve must be smooth and steady. Starting from 1MHz down to about 100Hz you should observe the characteristic slope of a capacity

$$|Z| = \frac{1}{\omega \cdot C} \quad , \quad \varphi = 90^\circ$$

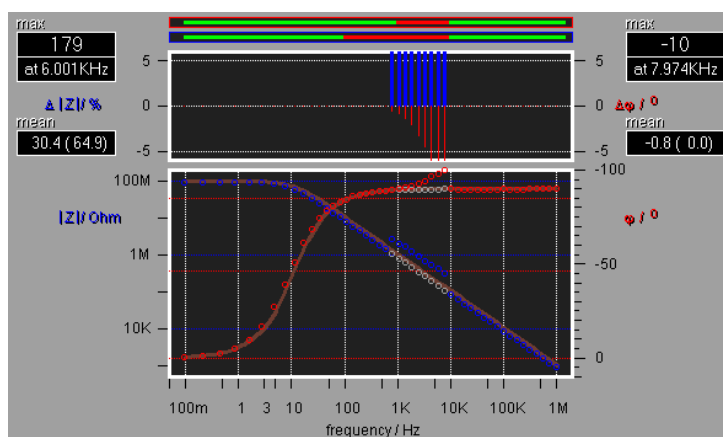
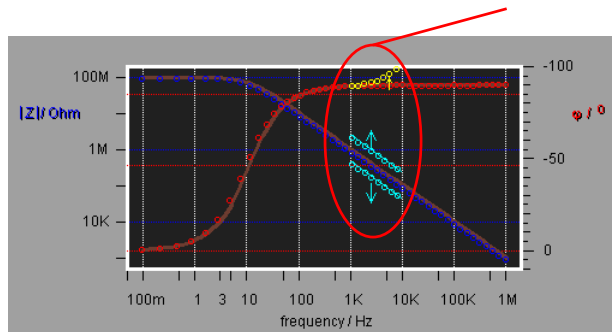
Below 1Hz you must observe the characteristic of a resistor ( $|Z| = \text{const.}$ ,  $\varphi = 0$ ), here

$$|Z| = 100M\Omega \quad , \quad \varphi = 0^\circ$$

Run the test by setting the range switch of the *TestBox* to *HIZ* and clicking on the *Do Test* button.



A defective measuring range will be indicated by a shift of the  $|Z|$  AND the  $\varphi$  data.

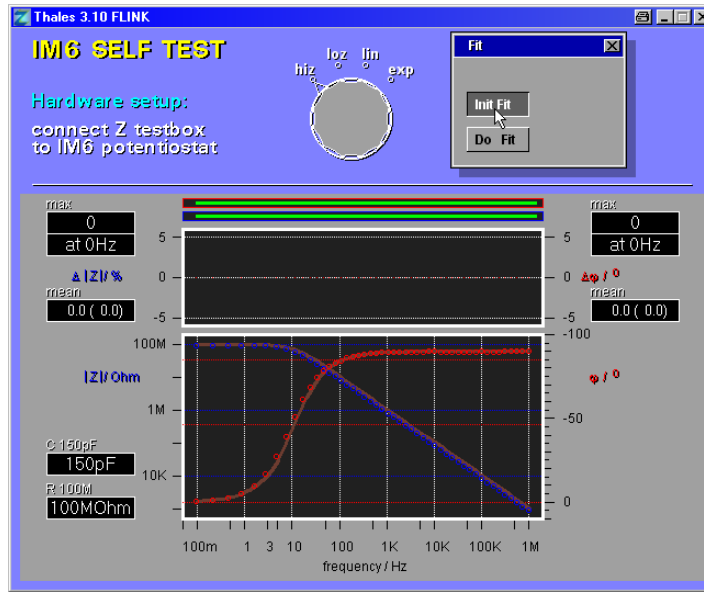


The measured data finally can be fitted to an equivalent circuit  $R \parallel C$  with the values of

$$C = 150\text{pF} \pm 10\text{pF}$$

$$R = 100\text{M}\Omega \pm 5\text{M}\Omega$$

The tolerances take into account and accept only a small possible long-time drift of the *TestBox* components. More dramatic changes of the *TestBox* properties, in particular due to high air humidity may lead to erroneous failure messages!



### 1.2.3 TEST 3 : Low impedance DC test

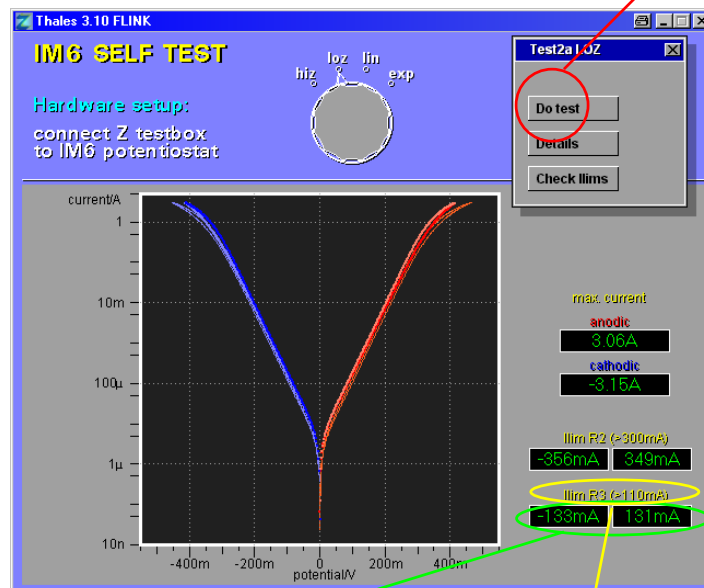
TestBox setting: **LOZ**

Script button: **TEST3 loz DC**

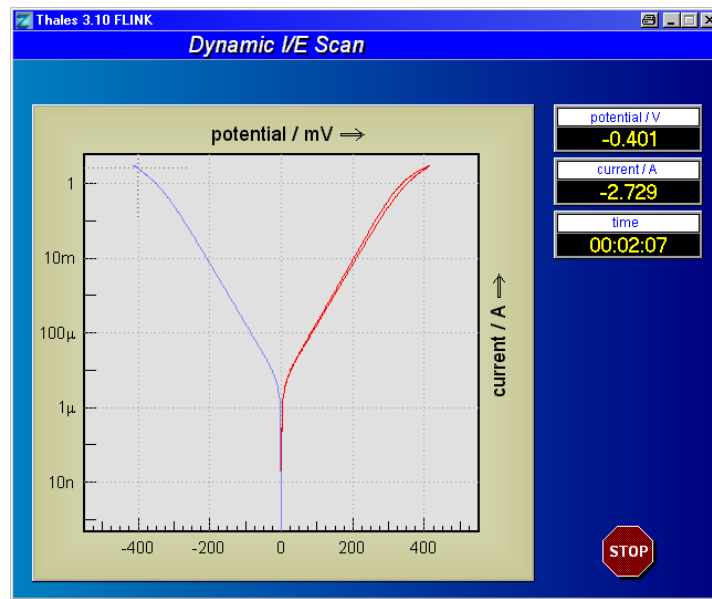
This test checks the low impedance measuring ranges ( $10\text{m}\Omega \leq R_{\text{shunt}} \leq 10\text{k}\Omega$ ) of the IM system.

For that purpose, a current/potential curve (I/E) is recorded. The measured data are compared to the data recorded during the final factory test. The maximum current and the switching limits of the protection circuit of the potentiostat are checked in both current directions.

Run the test by setting the *TestBox* to the **LOZ** position and by clicking on the **Do Test** button.



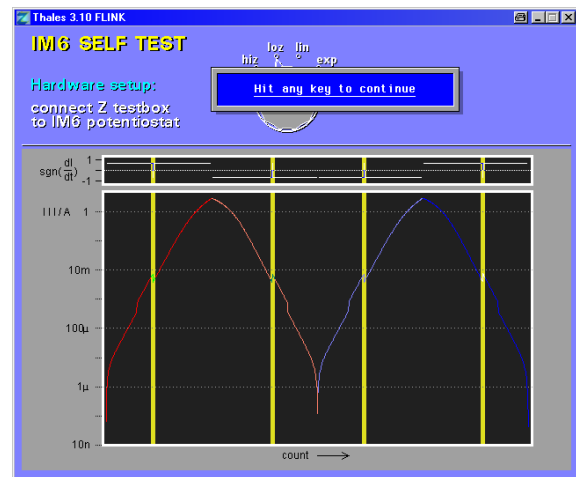
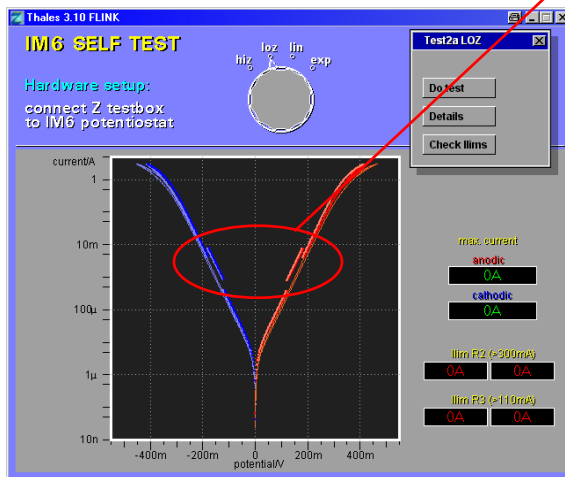
The measured currents (green boxed values) must exceed the yellow marked values.



An indication of a defect is given by the slope of the I/E-curve. The sign of the slope must be constant within one phase

Phase	Pot	sign of slope of current
1	0...reverse positive	+1
2	reverse positive...0	-1
3	0...reverse negative	-1
4	reverse negative...0	+1

An error will be indicated if the sign of the slope changes within one phase.



### 1.2.4 TEST 4 : Low impedance AC test

TextBox setting: LOZ

Script button:

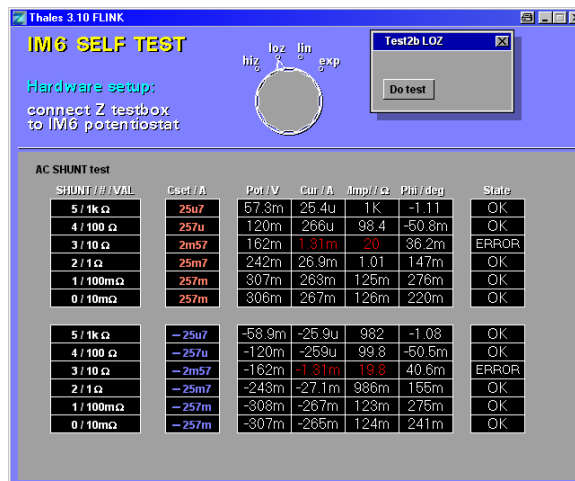
This test checks the low impedance measuring ranges ( $10\text{m}\Omega \leq R_{\text{shunt}} \leq 1\text{k}\Omega$ ) of the system.

This test uses the impedance method. The selected shunt is fixed while the potentiostat drives a Schottky power diode to a defined inner resistance (= impedance). That impedance and the flowing current as well as the applied potential are measured in the positive and in the negative direction.

Run the test by setting the *TextBox* to the **LOZ** position and by clicking on the **Do Test** button.



In case a shunt resistor is defective or inaccurate the corresponding row is highlighted.



### 1.2.5 TEST 5 : Low frequency dynamic AC test

TestBox setting: LIN

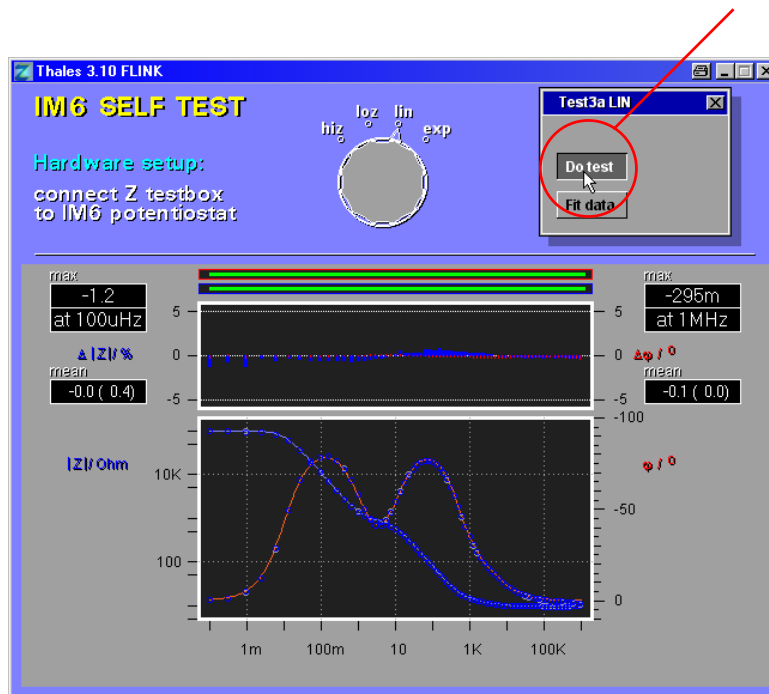
Script button: TEST5 lin dynamic

This test checks the potentiostat and the frequency response analyser down to the minimum measuring frequency of  $f_{min} = 100 \mu\text{Hz}$

An impedance spectrum is recorded and the measured data are compared with those recorded during the final factory test. An error will be indicated if impedance or phase of both spectra differ by more than 5%.

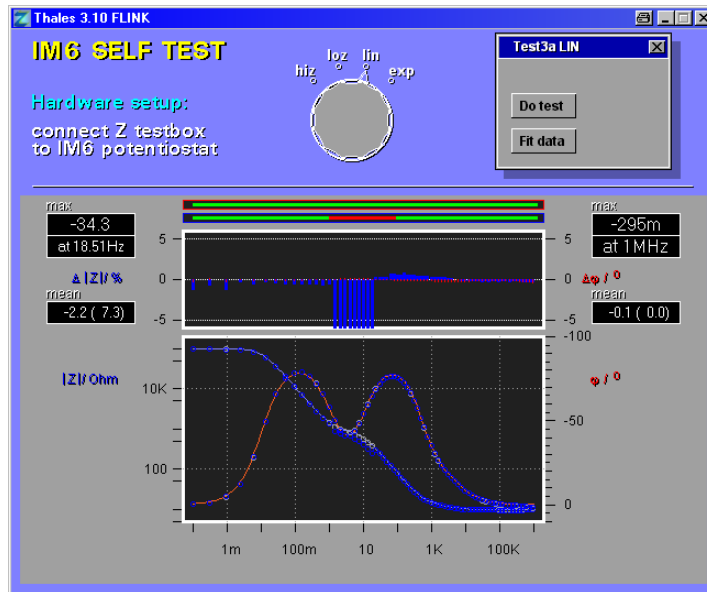
Additionally, you may check the measured curve visually. It must be smooth and steady.

Run the test by setting the TestBox to the LIN position and by clicking on the Do Test button.

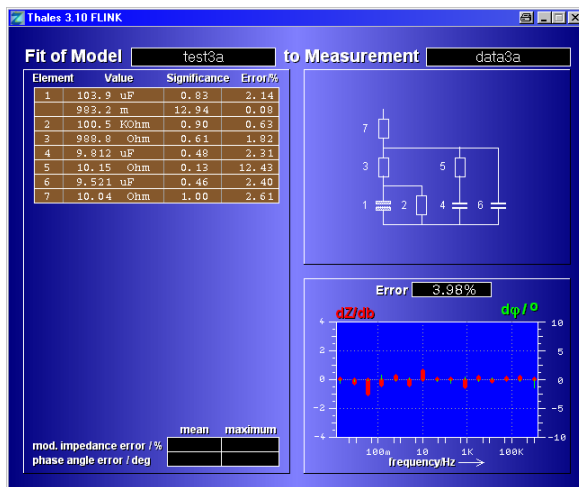


**!** Test 5 will take up to 14 hours.





The measured data finally can be fitted to an equivalent circuit.



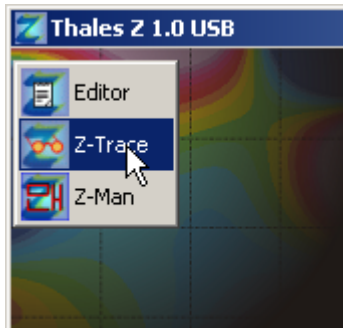
The fitted data will be compared with the typical values of the *TestBox* components used in position *LIN*. The tolerances take into account a possible long-time drift of the *TestBox* components. A message will appear as soon as the tolerance range is violated.

## 2. Z-Trace Features

Z-Trace is a diagnostic program to visualize selected logging information in real time. A predefined logging information set can be selected by the user in the **AC Mode Parameters** of the **EIS** software. For more information about this diagnostic log-file settings refer to *Chapter 5.4* of the **EIS** manual. Generally, messages of the script-processor and error messages are transferred to the Z-Trace. Besides this, user defined entries may be created by means of the LOG()-function. Start the Z-Trace by the corresponding icon on the desktop

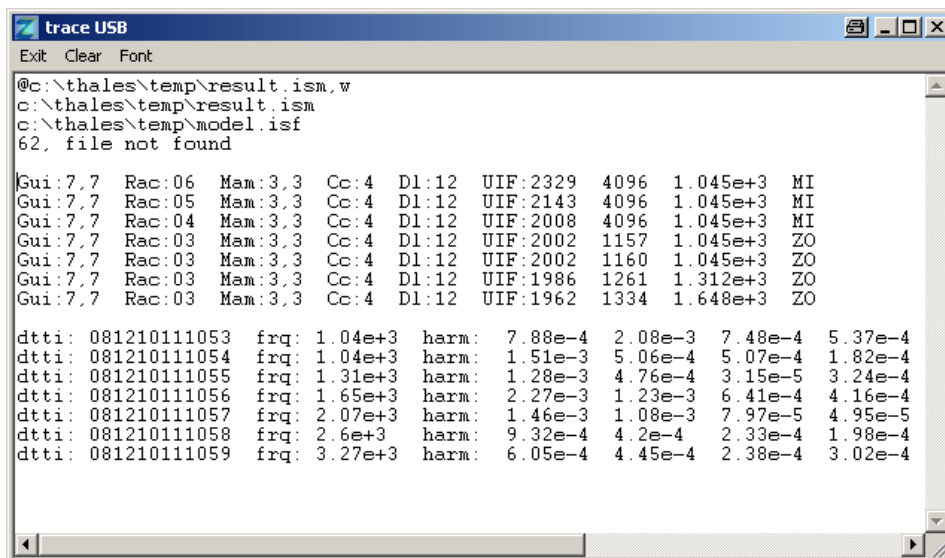


or press the second entry of the pull-down menu from the Thales task bar.



The display window opens, and incoming logging information will be shown. To clean the Z-Trace screen, use the **CLEAR** button. This will only clear the screen, the data stored in parallel in the log-file are not affected.

By means of the **FONT** button, you may change the font, for instance in order to force a clear column structure by choosing fixed spacing fonts. Z-Trace entries may be edited, marked and transferred by the usual copy & paste sequences.



Example: Z-Trace-Window with entries. The first four entries are typical debug-messages of a running script. The next data set shows logging information about ranging and intermediate results while an impedance measurement is running (log-file entry parameter in the AC control parameter field of the Global measurement settings is one). The last block is the output of the table of harmonics appearing in an EIS measurement, when the log-file entry parameter is set to two.

The protocol of arbitrary information by means of the LOG() – function is described at the end of the script manual.

### 3. Errors by the Operating System

An example of a system error message is shown below.

```
av#7 exception
pc=00085d44 sr=2700..s7 us=00000e00 ss=000002d2
d0=00004a0d d1=08104010 d2=00000001 d3=00000000
d4=00000002 d5=3000002c d6=00000002 d7=0000018d
a0=00020002 a1=00081d6a a2=00000414 a3=00000540
a4=00085d42 a5=00000540 a6=00000543 a7=000002d2
085d44 08100000 btst #0, (a0)
```

System errors usually do confuse the computer but mostly do not destroy the program and the data structure. It is strongly recommended not to wildly hit keys at the keyboard. Instead, type <x> and return to the BASIC-program manager and follow to [Chapter 4. Program crash – what to do?](#)

### 4. Program crash – what to do?

Thales is programmed to prevent program crashes as good as possible. Anyway, it may happen that the program does not respond any more. The reason may lie on the PC side (Windows) or on the instruments side (Thales). If it is on the Thales side, it may be due to a software bug (“Only outdated software is free of bugs!”), nonsense data, or a hardware defect. For most of these cases the Thales operating system offers the possibility to restore the precious measurement data and analysis data.

After a program crash, normally either the mouse nor the keyboard will act in the normal way. That is the case if the operating system or the user software are trapped in an infinite loop or if the system communication is broken. To resume operation, try first to press the NMI toggle switch located on the USB interface board once or, if no response, twice. Then you should see the blinking text cursor somewhere and you should continue with the key sequence **Shift** + **F6** (see also below).

If double-NMI doesn't bring you to the basic input mode you have to move the switch to the RESET position for a short moment. You will come out in the start-up menu. Press the **B** key!



**DO NOT PRESS THE **D** or the **S** BUTTON! THIS WILL DELETE ALL RAM-RESIDENT DATA AND COLD START THALES!**

After “B”, the system will respond with the message

ready.

As we are in the basic input mode now, you can perform a warm start of the software by pressing the buttons **Shift** + **F6**

The program will show the main menu or a sub menu of the program partition where the crash occurred. Your data are still resident and you may save them to the hard drive. Then you may try to continue with your experiment. Normally, the system will work properly, now.

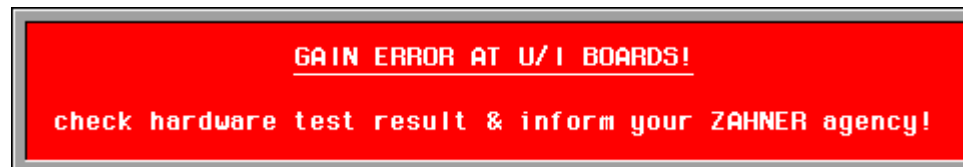
Another reason for a program crash can be the opening of corrupt measurement data or a data set exceeding the limits of the software or the memory. Measurement data causing for instance numerical overflow may develop for instance from storage media errors. In the case that precious data are affected, please contact Zahner and/or send the corrupt data set to Zahner by email. We may try to recreate the data set. If you observe strange or unexpected data which you want to be checked then:



Please only send ORIGINAL measurement data (Thales format). Do NOT send ASCII data or EXEL diagrams!

## 5. Startup Self Test Error

If messages in red boxes similar to the displayed one appear on start up of measurement tasks, enter the Thales Text Editor where you see a list of calibration parameters.



GAIN ERROR AT U/I BOARDS!

```
Slope= 0.0e+0
Delta= 0.0e+0
Pfact= 9.9979e-4
Cfact=-1.0
Compoffset= -0.3
ADoffset= -0.3
Uoffset= 0.0
Ioffset= 0.0
Poffset=-256
```

Such messages are severe hints, that hardware drift or damage occurred. It is not recommended then to continue with measurements, due to probably erroneous results. Please send the parameter list to Zahner by fax or email. It will help us to fix the problem and for instance, locate the defective board.