Wayne Kerr
Electronics

1946

深圳市稳科电子仪器有限公司

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Wayne Kerr Electronics

公司概况

诞生

Wayne Kerr → 1946 → 世界上第一台LCR电桥测试机诞生，至今任然专注于LCR领域。

进入中国

深圳稳科电子 → 2006 → Wayne Kerr 亚洲第一家分公司成立

收购

Danbridge → 2011 → 该公司为全世界最专业的电容及电阻测量厂商之一，极大的扩充Wayne Kerr的产品线。

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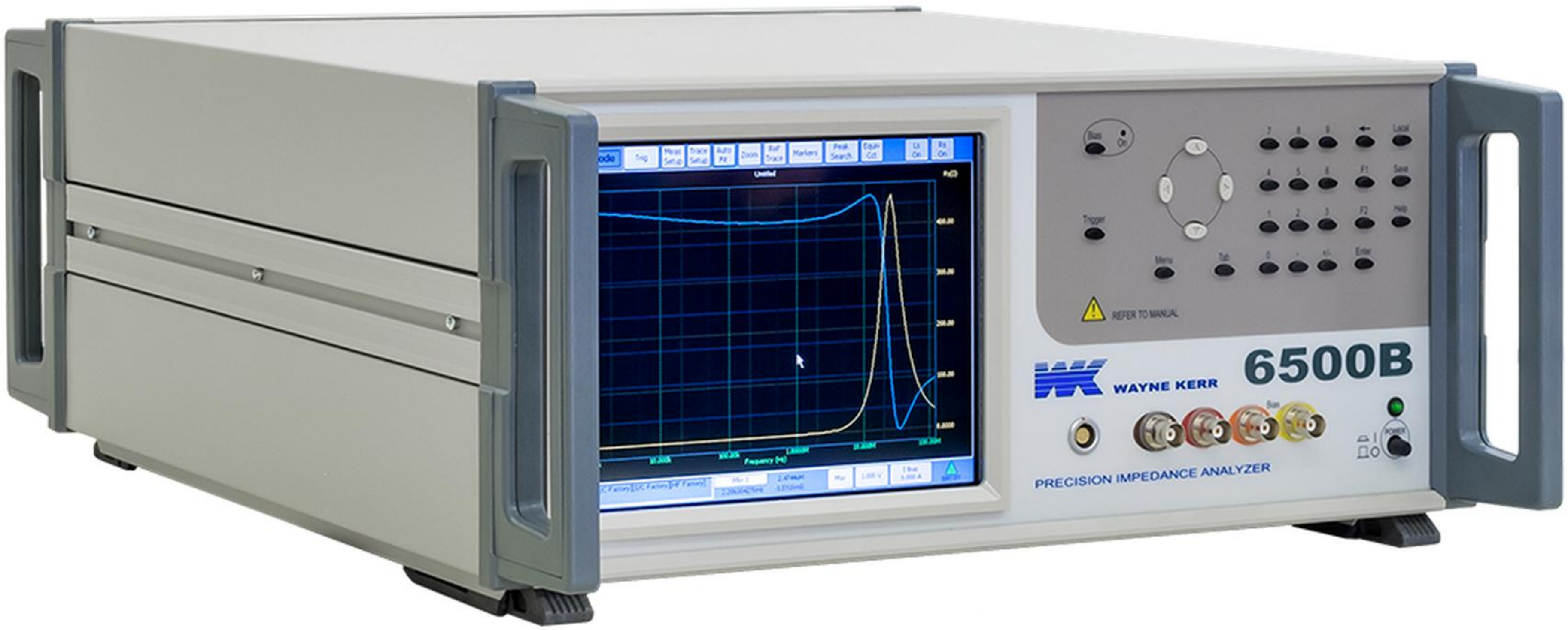
产品目录

WK产品型号	描述	技术条件
6500系列	精密阻抗分析仪/高频LCR Meter	20Hz~120MHz，0.05%
6565系列	高频直流偏置电流源	单台10A，可叠加6台
6440/6430	精密元件测试0.02%的测试精度	20Hz~3MHz，0.02%
3260/3255	电感/变压器标准测试仪器	20Hz~3MHz，0.1%
3265	直流偏置电流源	单台25A，可叠加12台
4100/4300	经济型LCR Meter	20Hz~1MHz

DB产品型号	描述	功能特性
DB503	直流电阻测试电桥	高速高精度自动化测试
DB62X	绝缘测试（兆欧表）	绝缘电阻和漏电流测试
CLT10	被动元件线性测试	元件、连接器的失真测试
DB23X	电容测试仪	对生产线上的薄膜电容进行自动测试

※明星产品6500

精密阻抗分析仪、高频LCR Meter



20Hz~120MHz,可分为七种机型，最高频率：5MHz、10MHz、15MHz、20MHz、30MHz、50MHz、120MHz
0.05%基本精确度，频率分辨率≤0.1mHz。
测试参数：阻抗、相位角、电容、电感、电阻、品质因数、损耗因数、谐振频率、介电常数、磁导率、实部虚部等电学参数。

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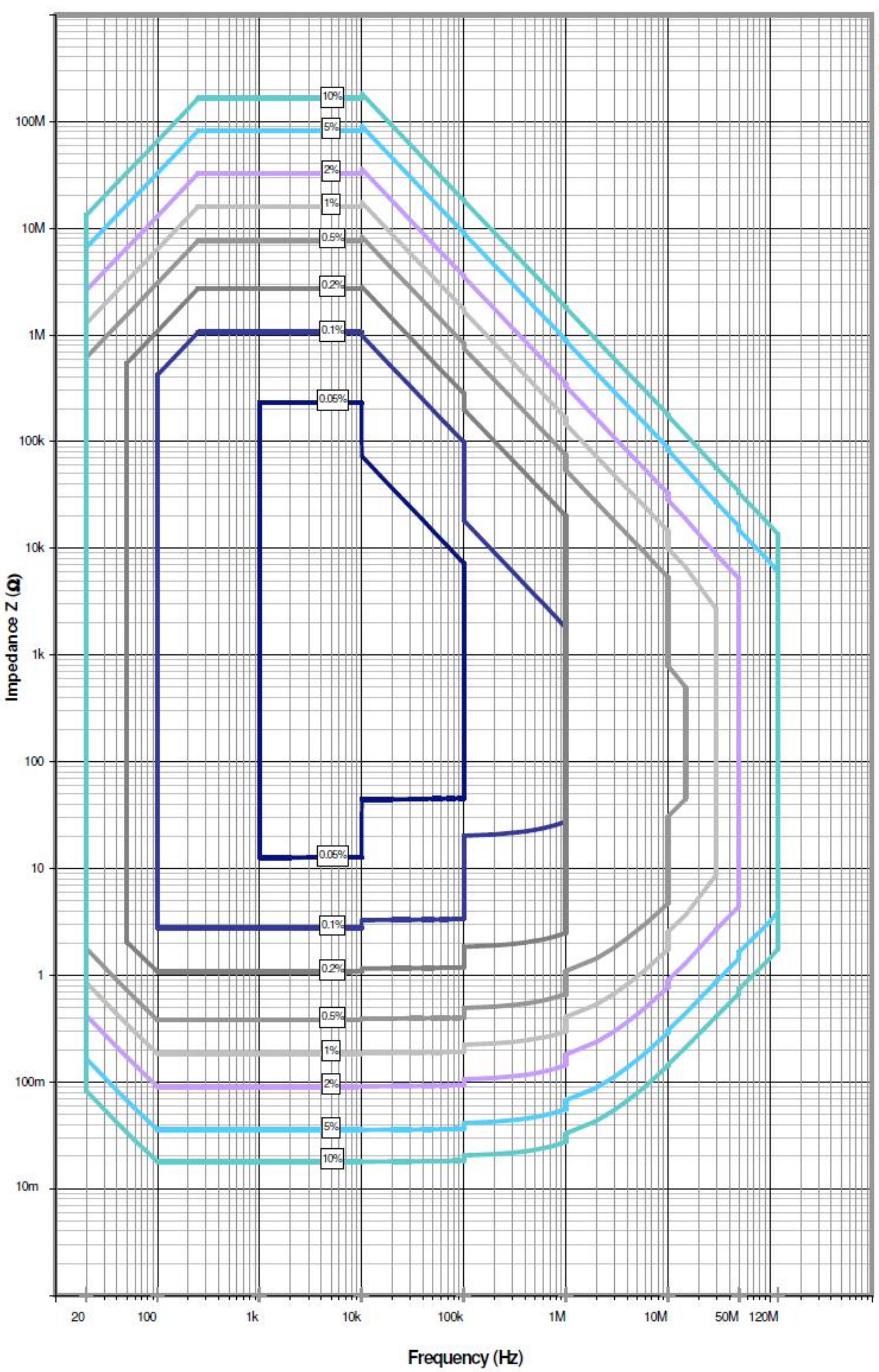
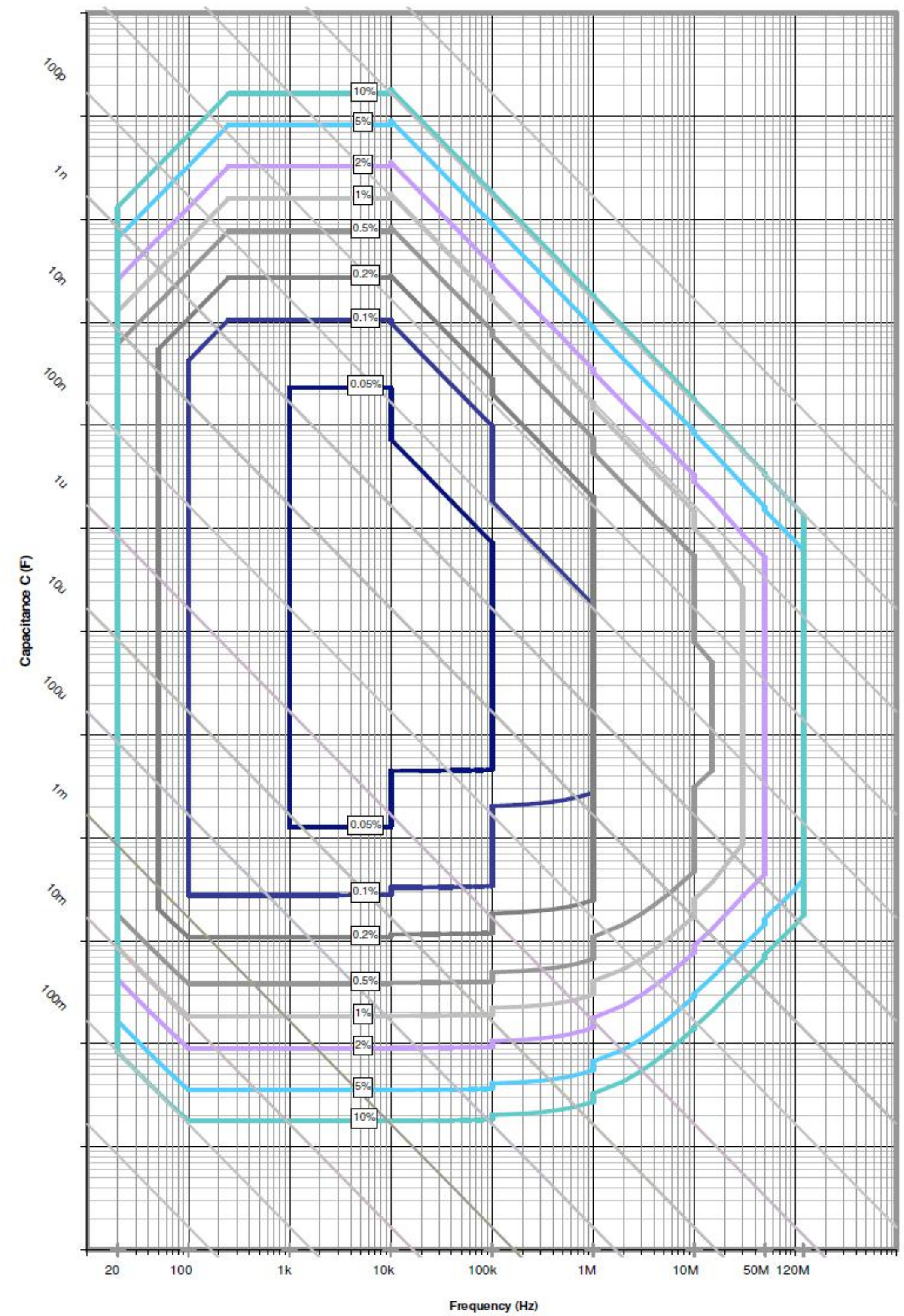
6500B Impedance Measurement Accuracy



Conditions
AC Drive Level:
1V/20mA
Speed: SLOW
Fixture: 1J1011
Temperature range:
23±5℃

6500B Capacitance Measurement Accuracy



Conditions
AC Drive Level:
1V/20mA
Speed: SLOW
Fixture: 1J1011
Temperature
range:
23±5℃

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※明星产品6565

高频直流偏置电流源

输出电流：0~10A （可并联6台到60A）
分辨率：1mA~1A 总计999点，分辨率1mA
1.01A~10A 总计899点，分辨率10mA
偏置电流精确度：±1%
频率范围：20Hz~120MHz

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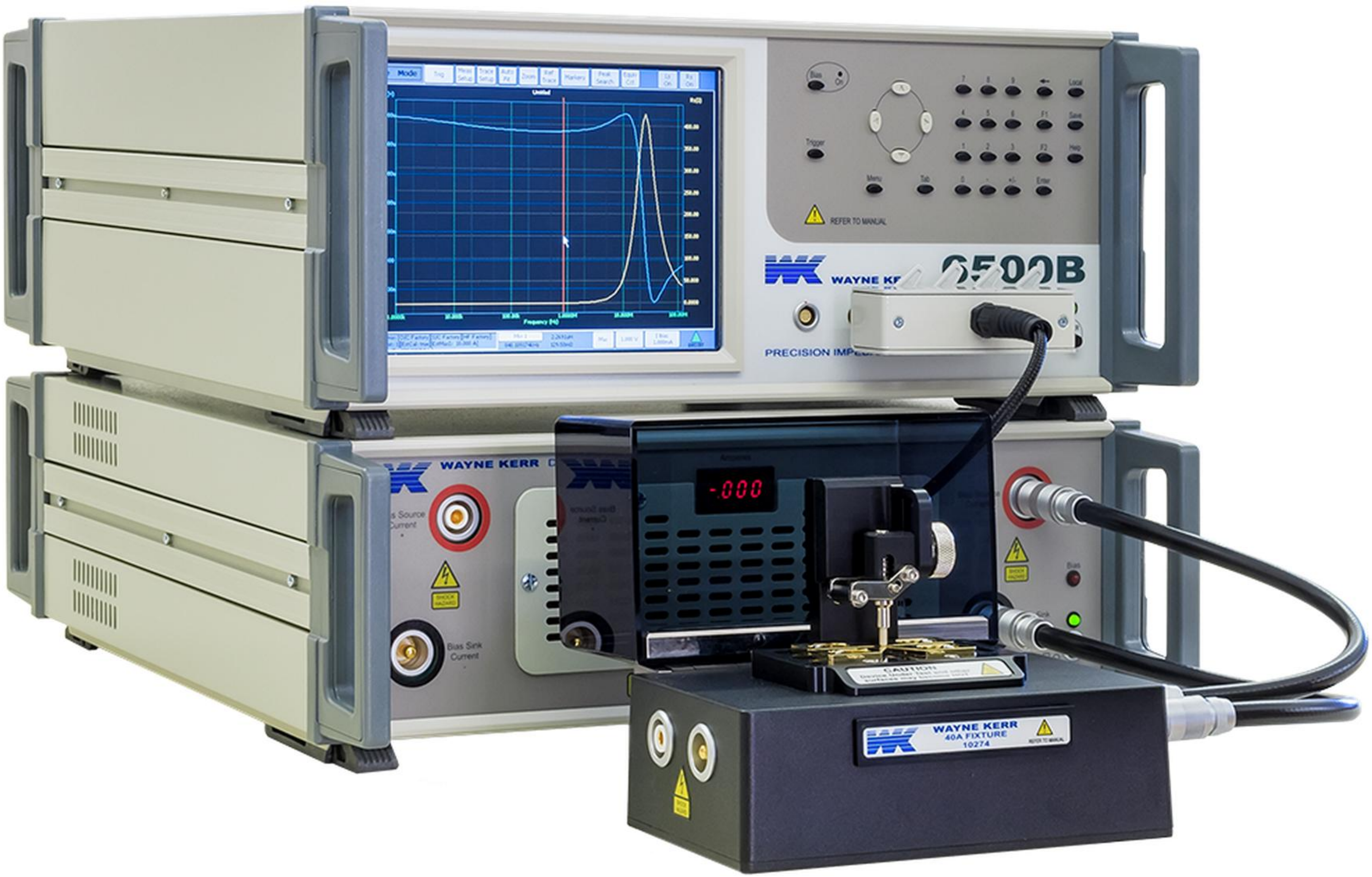
WK6500B+WK6565测试系统



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※WK6440/WK6430

精密元件分析仪

基本精度：0.02%
测试频率：20Hz~3MHz / 20Hz~500KHz
测试参数：Z、ø、Rac、Rdc、C、D、L、Q、B、G、X、Y
交流信号：1mV~10Vrms；50µA~200mA

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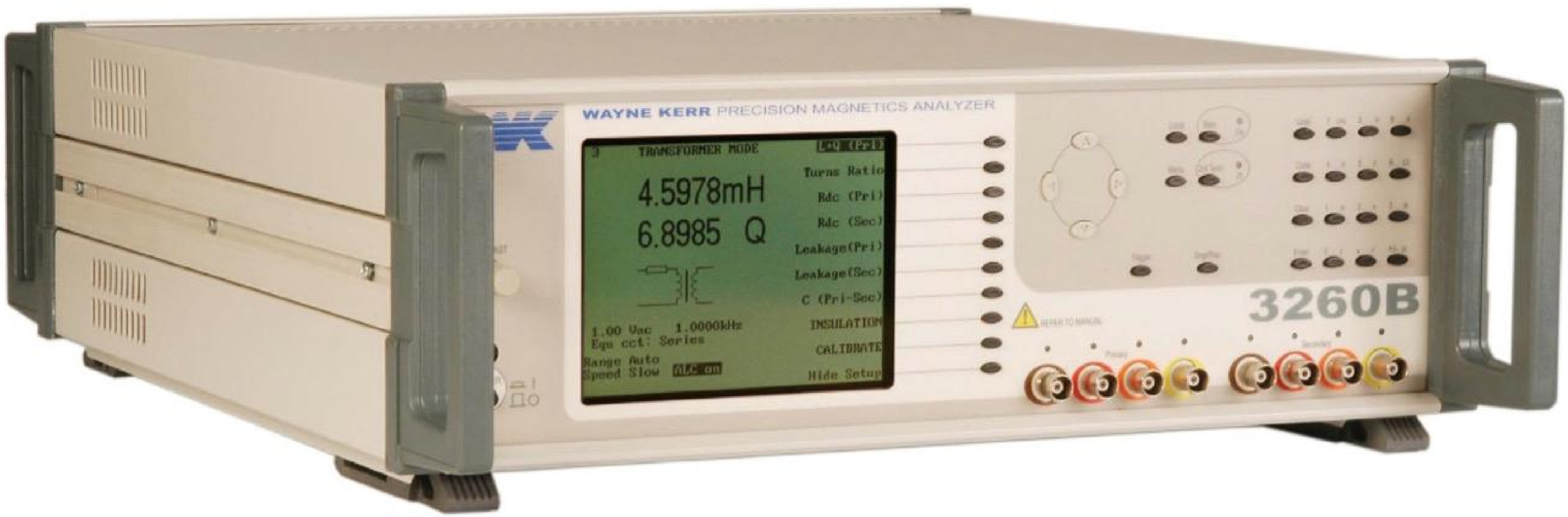
※WK3260/WK3255

精密磁性元件分析仪/电感分析仪



基本精度：0.1%
测试频率：20Hz~200KHz / 20Hz~500KHz / 20Hz~1MHz / 20Hz~3MHz
测试参数：Z、ø、Rdc、Rac、C、D、L、Q、漏电感、圈数比、层间电容
交流信号：1mV~10Vrms；50μA~200mA

※WK3265/WK3265BQ

高电流直流偏压源

25A高电流偏置电源-WK3265B
25A/台，可叠加12台
高达300A的DC偏置电流

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※WK4300/WK4100

WK4300 LCR Meter系列

基本精度：0.08%
测试频率：20Hz~1MHz
测试参数：Z、ø、Rac、Rdc、C、D、L、Q、B、G、X、Y

WK4100 LCR Meter系列

基本精度：0.1%
测试频率：20Hz~1MHz
测试参数：Z、ø、Rac、Rdc、C、D、L、Q、B、G、X、Y

电容测试仪

频率范围	100Hz/1KHz/100KHz/1MHz
测试速度	＜20ms
基本精度	0.05%
测量范围	0.1pF~1mF

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高速直流电阻电桥

电阻测试范围	10mΩ~1GΩ
测试速度	＜10ms
基本精度	0.01%

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兆欧表/绝缘测试扫描

电压范围	1V~500V/1KV/2KV/5KV
精确度	±2%，±1pA
量测范围	10KΩ~1PΩ

CLT10/CLT20三次谐波测试仪

量测低于 -160db 的三次谐波，符合mil-prf55182H标准

典型应用：

元件，连接器，接触器的失真或者噪声测试；电阻的可靠性测试；精密元件的质量控制；通用三次谐波测试仪

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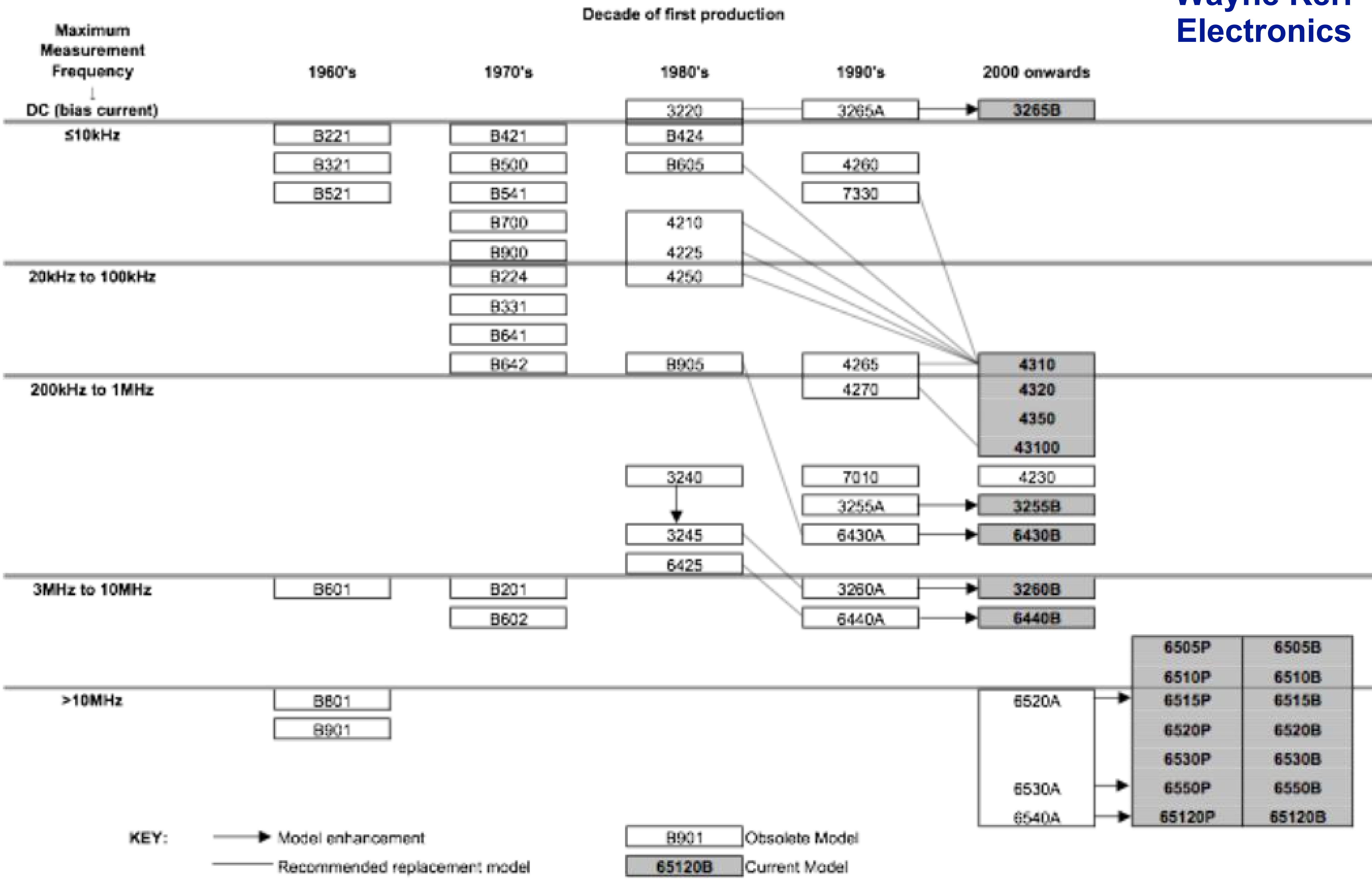
高频功率电感——直流偏置测试

测试：评估磁芯性能，通常的测试手段是，搭建一台LCR和偏执电流源协同工作的测试系统，LCR测试频率至少需要覆盖样品工作频率，偏置电流源能够提供样品测试的最大工作电流。
当今市面上的电流源都基本上都是被频率限制了，通常的频率范围是20Hz~3MHz。这是因为高的偏置直流源匹配高频的LCR测试是非常困难的，导致困难的原因不仅是直流偏流源的问题，还要考虑到电源负载、测试夹具和连接线等诸多方面带来的寄生现象。

20Hz~3MHz，偏置电流最大做到300A
原型机为1990年3265A，2000年更改为3265B
这款产品我们做了近30年时间。

WAYNE KERR MODELS OVER TIME



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2013年8月推出6500+6565测试系统

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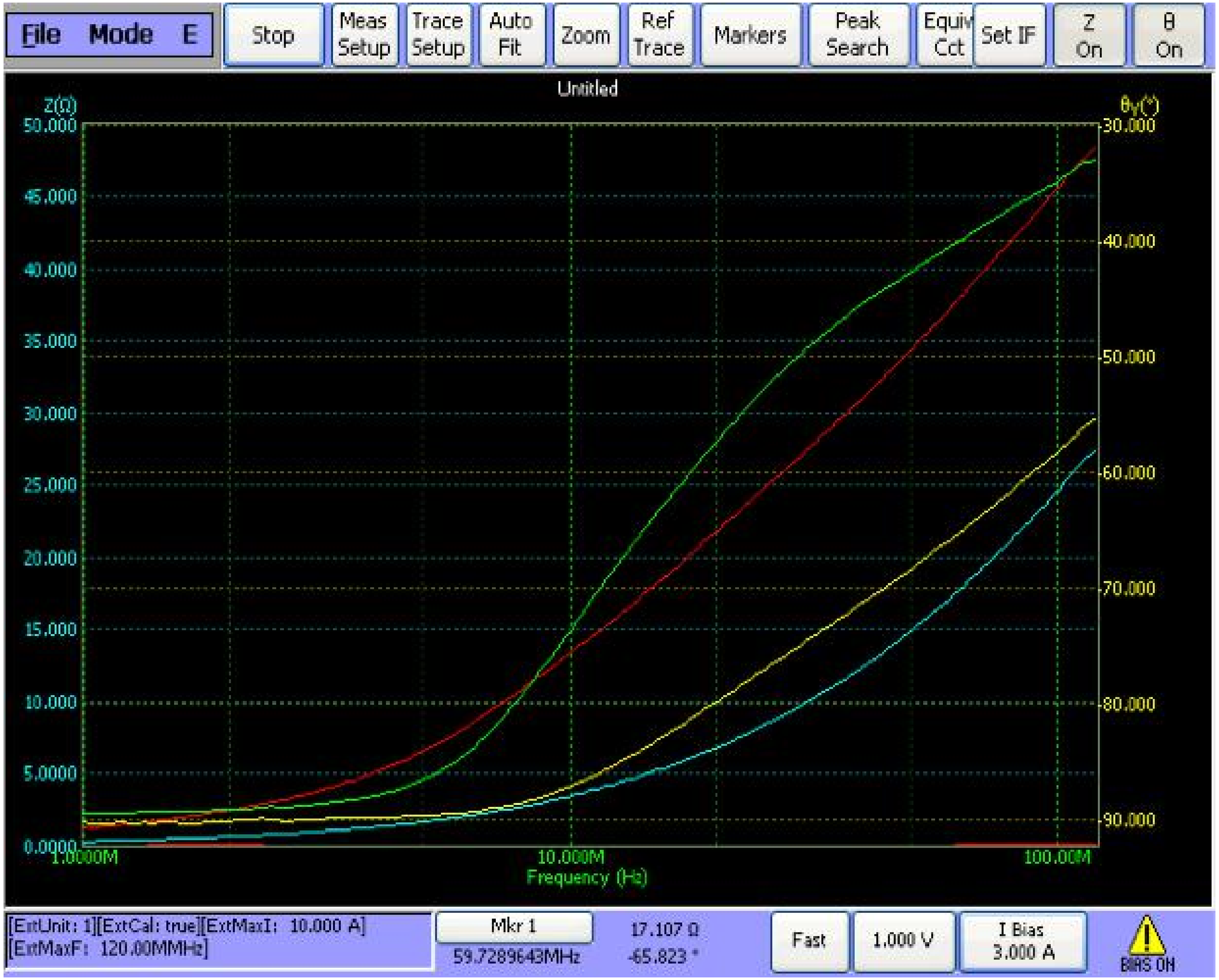


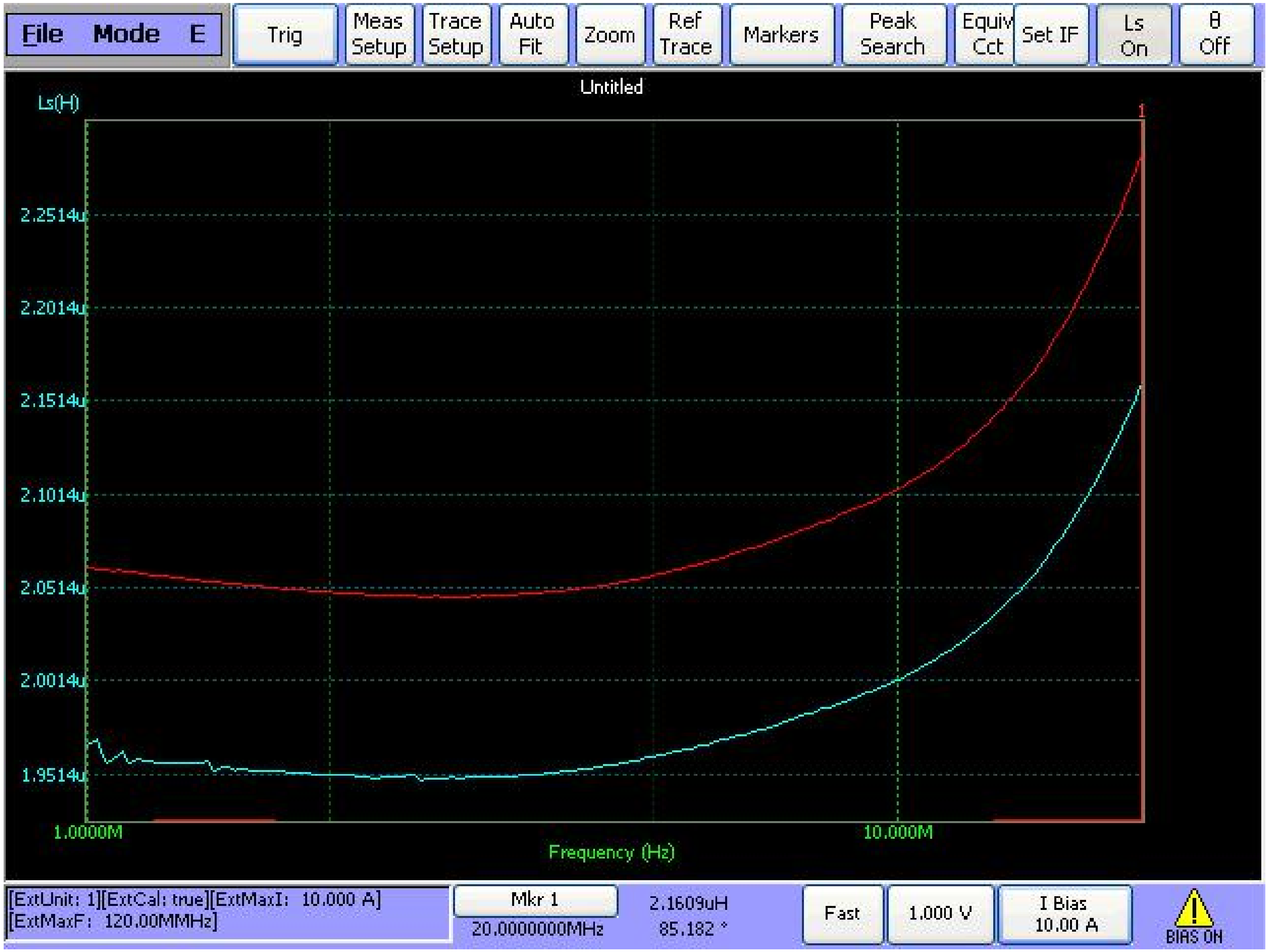
0A DC Bias 阻抗曲线

0A DC Bias 相位角曲线

3A DC Bias 阻抗曲线

3A DC Bias 相位角曲线

Showing the impedance of a ferrite bead. The phase response behaves similarly where the green trace is with bias off and amber trace with bias on. The red trace shows performance at zero bias while the blue trace shows the impedance at 3A bias current.



0A DC Bias 电感曲线

10A DC Bias 电感曲线

Showing how a 2.2uH ferrite core rated at 10A behaves with bias.

The red trace shows the original coil inductance variation between 1MHz and 20MHz. The blue trace shows the 5% inductance reduction at the rated current.

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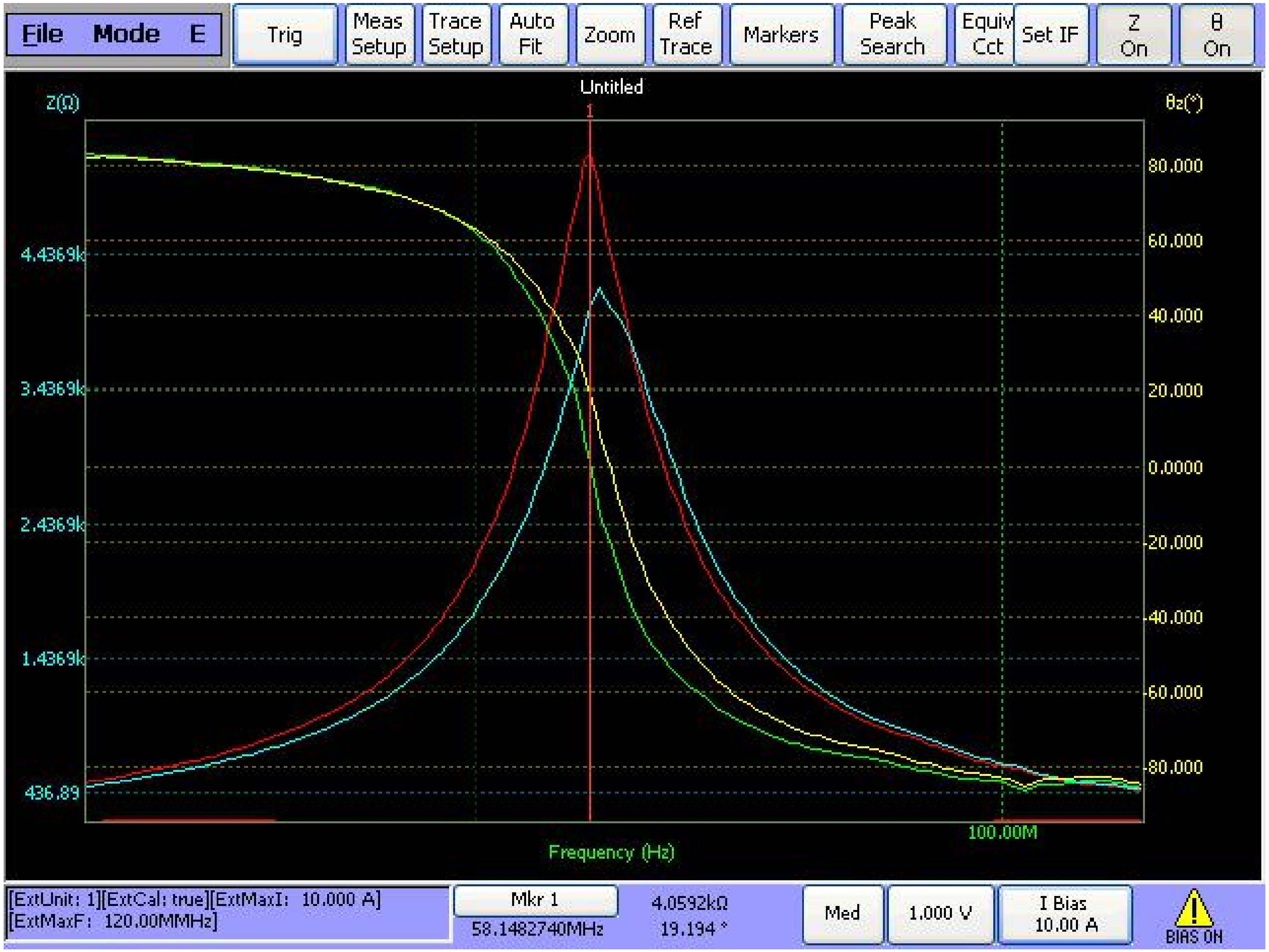

0A DC Bias 阻抗曲线

0A DC Bias 相位角曲线

10A DC Bias 阻抗曲线

10A DC Bias 相位角曲线

Showing the same 2.2uH coil at resonance (approx 58 MHz). The red trace shows the magnitude (Z) response, while the green trace shows the phase. The blue and amber traces show how the coil behaves with 10A applied. Note that the resonant frequency has increased and the Q-factor has reduced.

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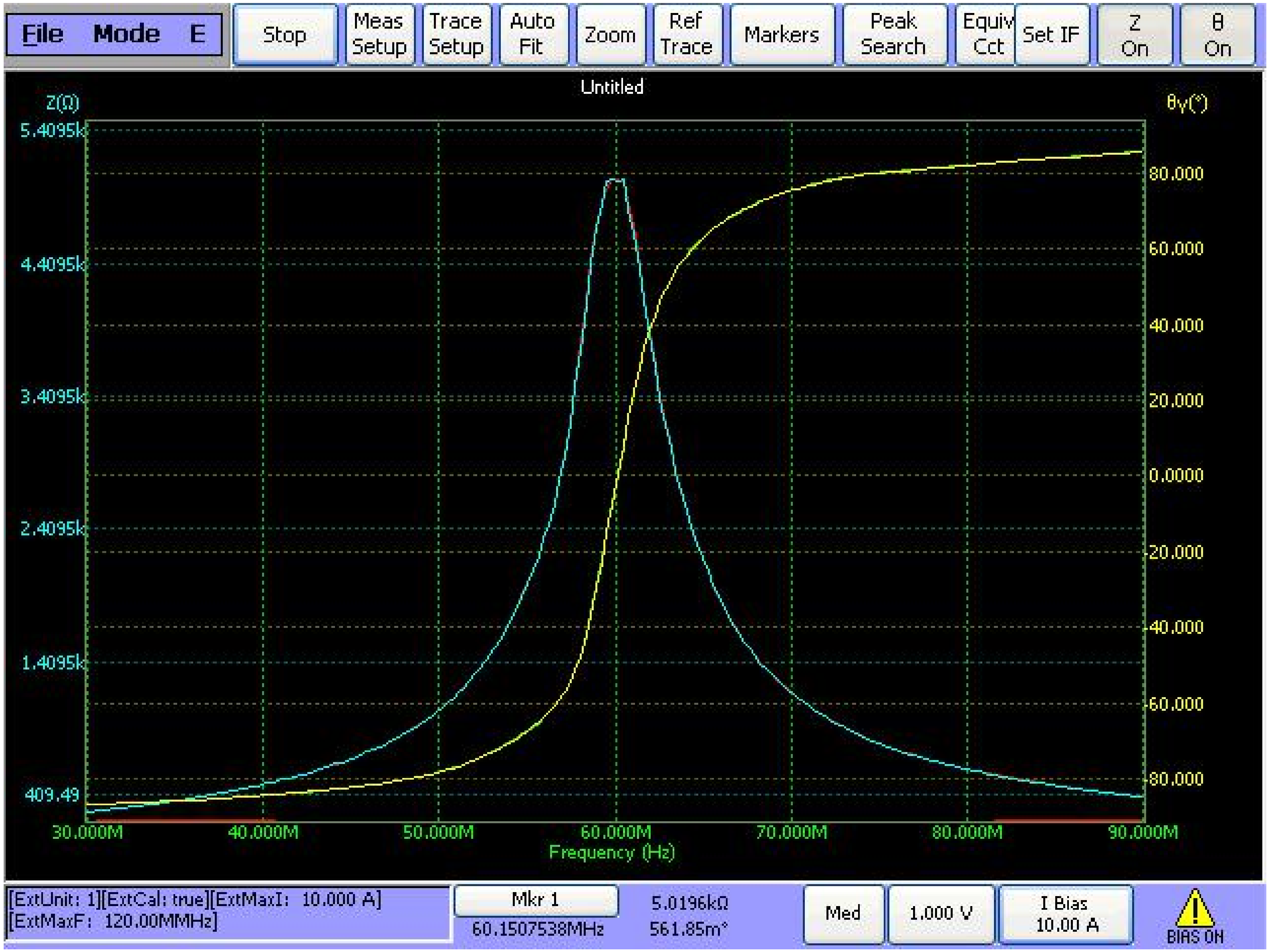

0A DC Bias 阻抗曲线

0A DC Bias 相位角曲线

10A DC Bias 阻抗曲线

10A DC Bias 相位角曲线

This screenshot shows and air-cored coil of similar value with the bias on plot compared to bias off. As can be seen the two sets of plots are very closely aligned.

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关 LCR+直流偏置电源的测试系统，我们需要解 难点：

1、直流电源的高频隔离，直流回路不能影响LCR的精准量测

2、如何保证直流电源的稳定性

3、如何解决测试夹具、连接线所带来的寄生参数

1、高频隔离电路设计

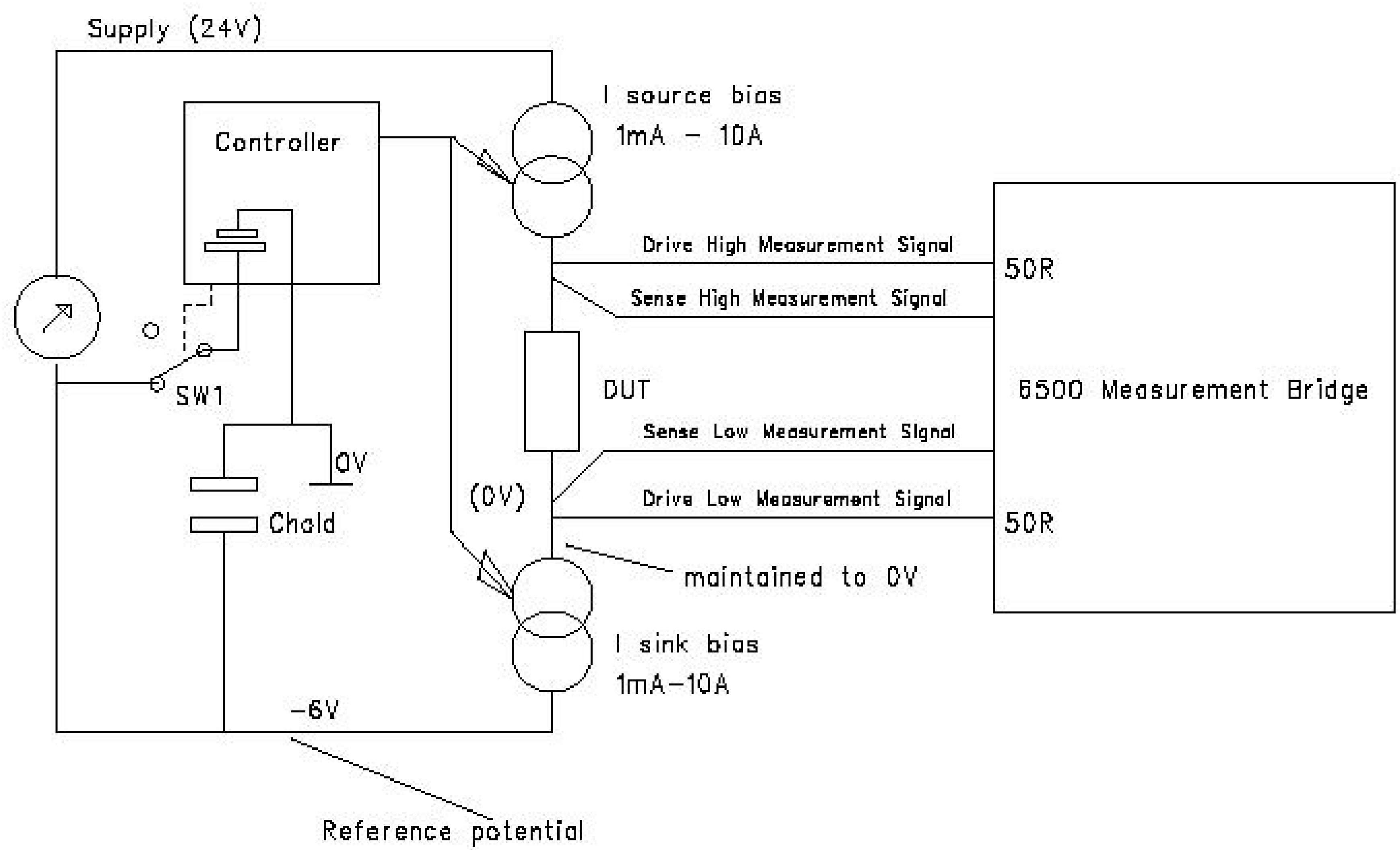
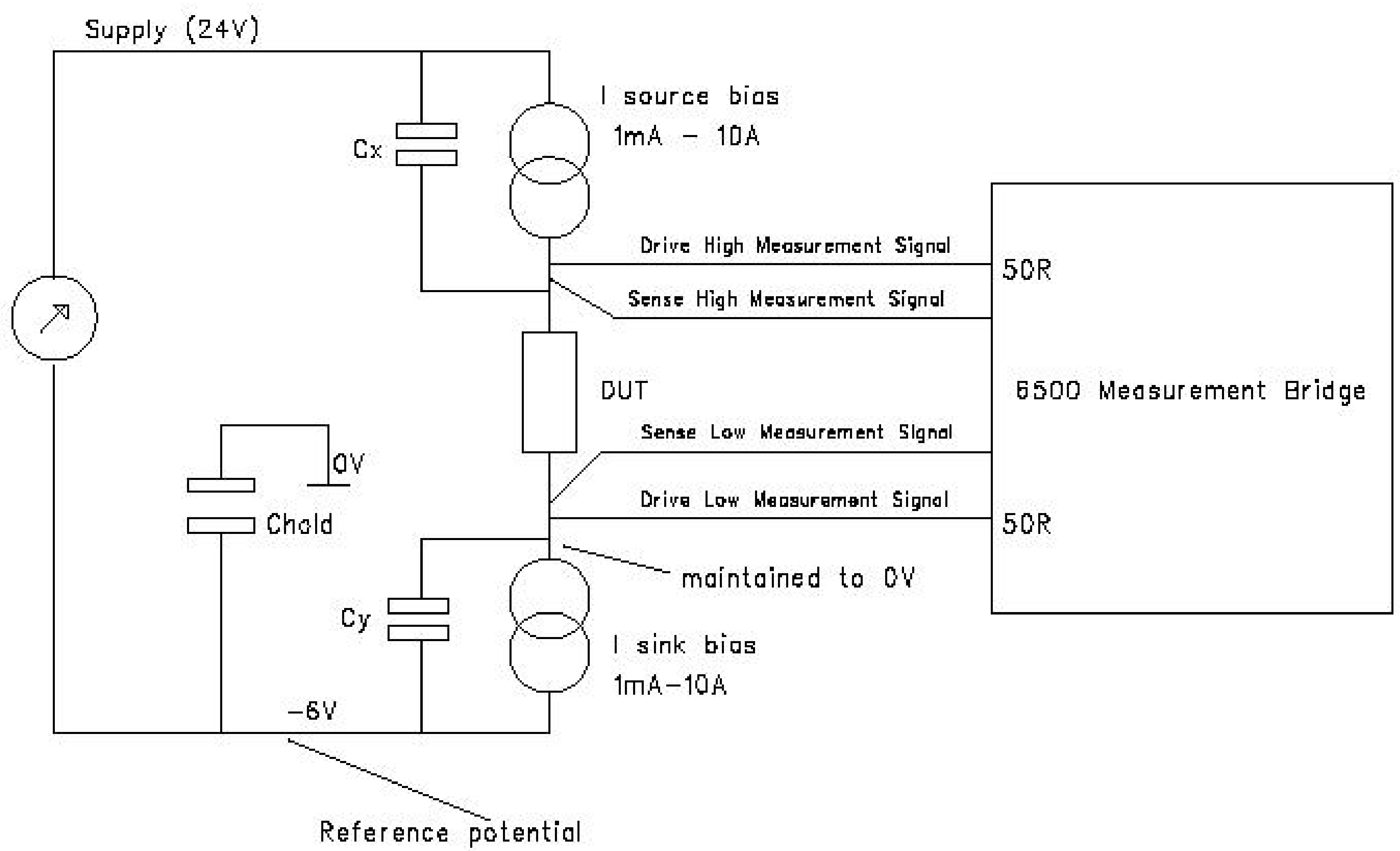


Fig. 1 Showing a prior art design current bias unit operating with an impedance measurement bridge.

Referring to fig1, this shows a typical bias unit made to a prior art design. It consists of two opposing current sources set to the same current value by the controller unit. These supply the bias current through the Device Under Test (DUT). A large capacitor, Chold forms a reservoir to hold about 6V for the working voltage of the sink circuitry. When the bias is off, this potential is maintained by a control circuit via SW1. When the bias is active, this voltage is maintained by differential control of the two current sources. The Impedance Analyser (6500) will then measure the value of the DUT at the set bias current.

1、高频隔离电路设计



In fig 2 we see that the bias current sources are not perfect but instead have significant stray capacitances Cx and Cy associated with them. Each can be of the order of 10,000pF. These capacitances are highly undesirable as they both shunt and cross-couple signal currents across the bridge network of the Impedance Analyser via the 24V supply. Since the 24V supply can be considered as an ac signal short circuit, if we perform a T to transformation as in Fig3 we can see that there are 3 impedances formed, Z1, Z2 and Z3. Z2 is particularly unwelcome because it appears in parallel with the DUT. Furthermore, these impedances can also be highly variable with bias current and hence make them impossible to trim out effectively.

1、高频隔离电路设计

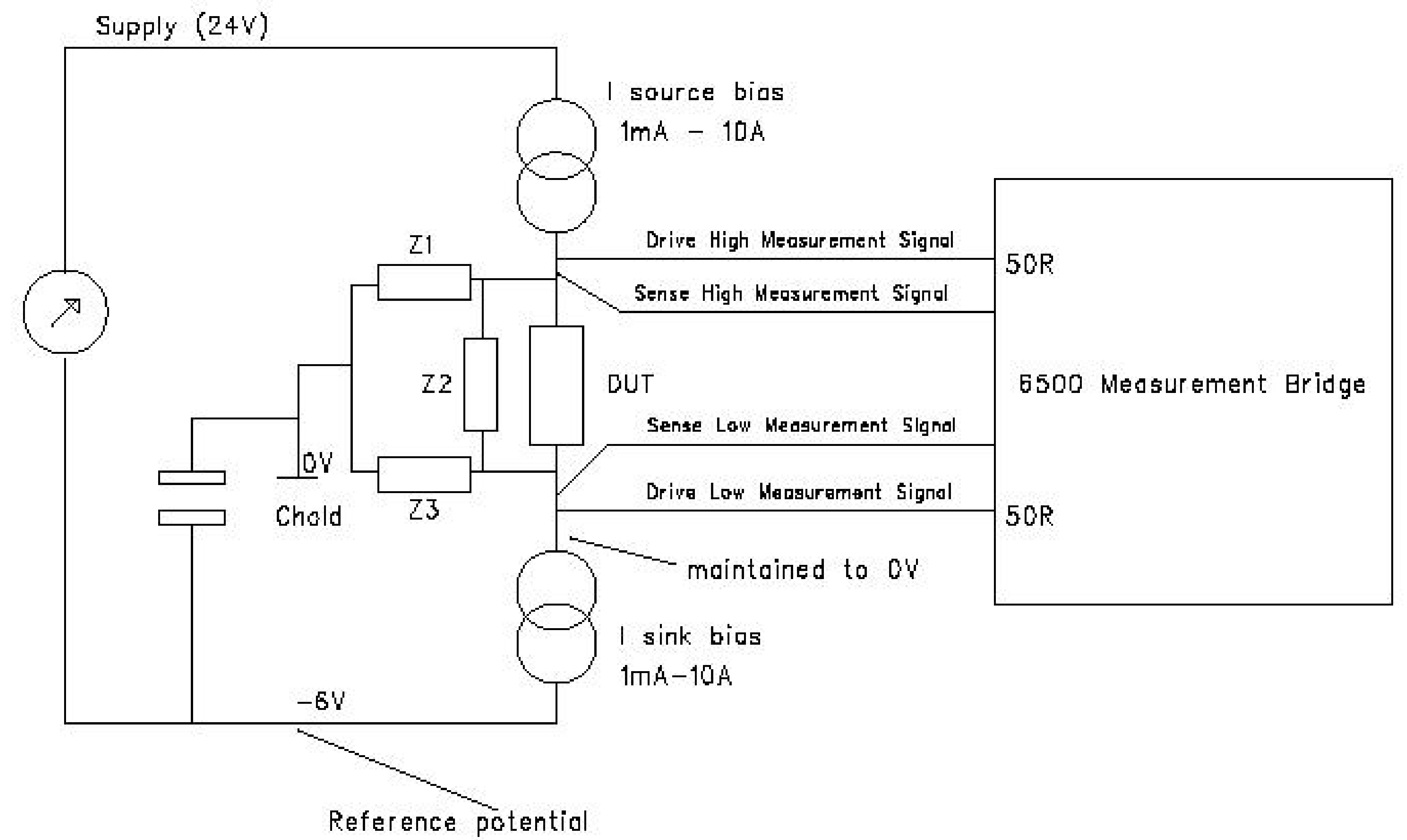


Fig. 3 Illustrates how the same capacitances Cx and Cy form Pi impedance across the DUT.

A method of avoiding this problem used in prior art designs was to employ the use of tuned circuits as shown in Fig 4. Here, L1, C1 and L2, C2 are arranged to give relatively high impedances at the frequency of test by tracking the test frequency used by the measurement bridge circuitry. This can be accomplished by switching in and out different inductors and capacitors in order to cover the necessary range of frequencies. There are several major problems with this technique. To provide coverage for

1、高频隔离电路设计

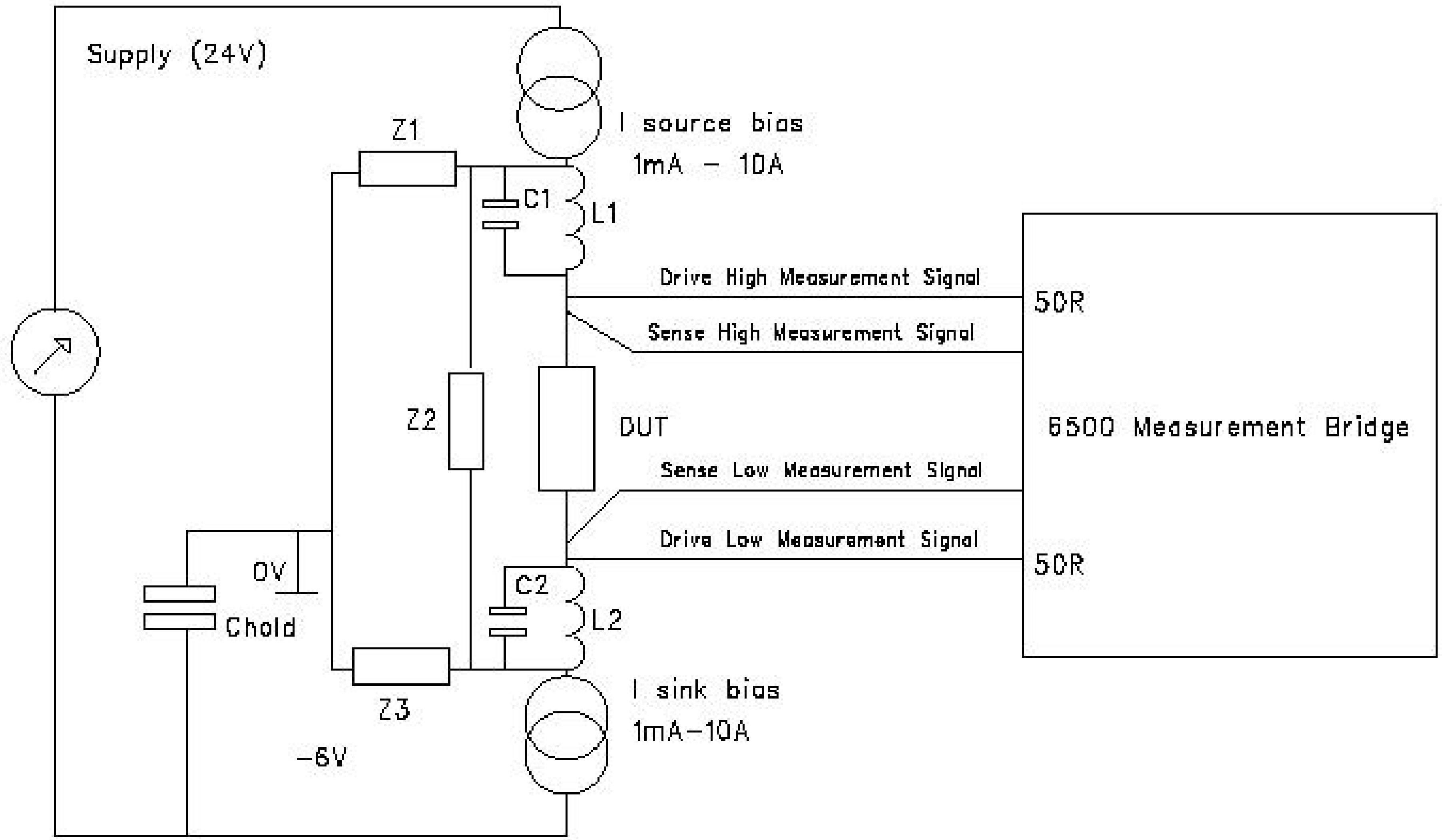


Fig. 4 Showing the additional elements L1+C1 and L2+C2 to tune out the loading effects of Z1–Z3

in practice become quite heavy too. The method also necessitates high current switching and hence power relays of considerable current carrying capacity are needed. A further problem occurs at lower frequencies, well into the audio region where the LC resonance technique provides little or no benefit, but where the capacitance and other losses related to the current sources are still appreciable. This commonly occurs around 10KHz where the employment of a suitable inductor is impractical. What happens is that the losses create significant shunt impedances at the impedance analyser ports and various compensation techniques have to be employed to offset the errors these create. Likewise at the other end of the spectrum, large bulky chokes and high current relays are not suitable to isolate against high frequency RF signals.

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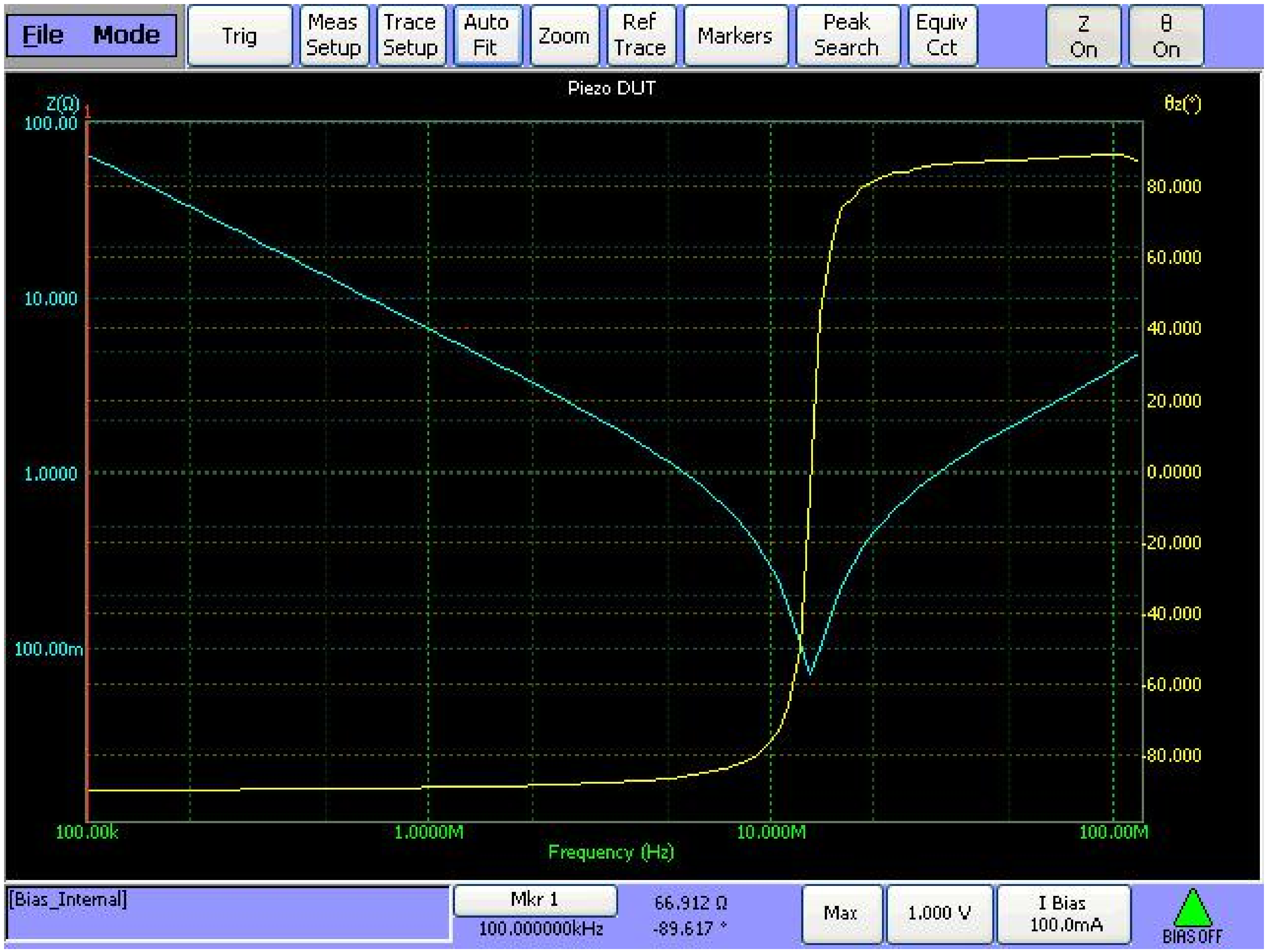
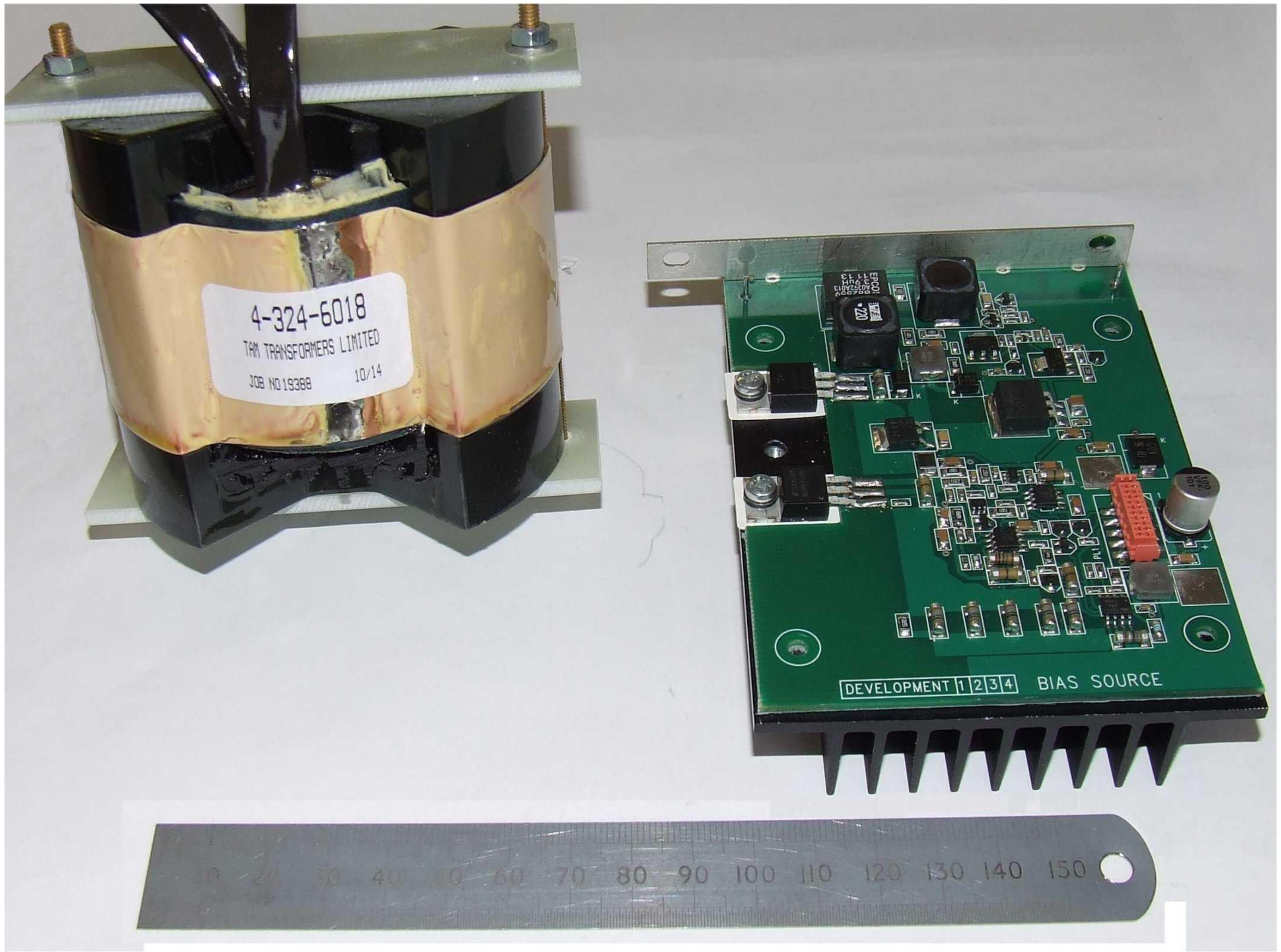
2、如何保证直流电源的稳定性



如果被测物是一个很小的电感，电流量很大，被测物吸收了很小一部分的电压，而电流源就需要吸收将近整个测试电压。通常，电流源输出最大电流时，偏置电流源就需要承受非常大的功率损耗，这些功率损耗都会以发热散发出来。散热工作，将会变得尤为重要，如果发热量无法仅仅通过散热片和风扇解决，电流源的稳定性将无法得到保障

6565如何解决发热带来的稳定性问题



6565采用了多个不同的的电流源模块，可以根据被测物上面的电压来切换不同的模块，这意味着，不管被测物的直流电阻是多大，**6565**只需要消耗实际需要的电流功率，这样设计会使电流源的功率损耗大大减小，进而解决散热问题，这样的设计，使得内部环境稳定恒定，保证仪器长时间可靠测试。再之，穿过被测物上的电压保持一个常量，各种不同因素的杂散现象的影响也会减小。

3、如何解决测试夹具、连接线所带来的寄生参数

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Impedance measurement errors can be divided into two types: Offset and scalar.
Offset errors are typically introduced at the fixture. At lower frequencies they tend to affect impedances at the low and high ends of the impedance measurement range. These errors are removed using the standard open-circuit and short-circuit trim routines.
Offset error example: A 1 pF o/c trim error represents a 10% error when measuring 10 pF, a 1% error when measuring 100 pF and a 0.1% error when measuring 1 nF.
Scalar errors can be introduced by both the extension cables and the fixture and generally start to become significant at higher frequencies. These errors affect both the magnitude and phase of the measured impedance. The effect on the measurement at any particular frequency is a scalar (gain) effect
This type of error is corrected using the High Frequency Lead Compensation routine.