Fuel Cell Impedance Meter
KFM2030

Measurement of fuel cell impedance characteristics using AC impedance measurement
Capability to measure cells of up to 20 V in the range of 10 mHz to 10 kHz
Two constant current mode ranges - 30 A and 5 A - supported as the load rating
Load current setting resolutions of 1 mA (30 A range) and 0.1 mA (5 A range) with maximum power consumption of 60 W
Various protection functions
Equipped with GPIB, RS232C and USB interfaces as standard

KIKUSUI

Fuel cell characteristic, variation, and service life testing can be done with ease!

Fuel Cell Impedance Meter

KFM2030

- **Equipped with GPIB, RS232C and USB interfaces as standard**
- **Application software included**

The impedance meter KFM2030 is intended to enable the impedance characteristics of a fuel cell to be measured easily through the use of the AC impedance measurement method. Using the applicat ion sof tware that comes with it, the data acquisition is possible for the I-V characteristic, the Constant Current characteristic, and the Cole-Cole plot by using the AC impedance method. With a low-power DC load (60 W) built in it, KFM2030 supports fuel cell load testing at up to 20 V, at up to 30 A.

- **Impedance of cells of up to 20V can be measured in the range of 10 mHz to 10 kHz. (The cell voltage can be read back as well in the 0 V-20 V range.)**
- **Two constant current modes ranges for the load rating: 30 A and 5 A Load current setting resolutions of 1 mA (30 A range) and 0.1 mA (5 A range) are available, with maximum power consumption of 60 W.**
- **Undervoltage protection, overvoltage protection, overpower protection, overheat protection, overcurrent protection, and line cut detection are supported.**
- **The backlit LCD offers enhanced visibility.**
- **Four types of measurement value can be chosen for display freely from R, X, |Z| θ, voltage and current.**
- **Equipped with GPIB, RS232C and USB interfaces as standard.**
- **Impedance measurements can be made in the range of 10 mHz to 10 kHz as well on both primary and secondary cells.**

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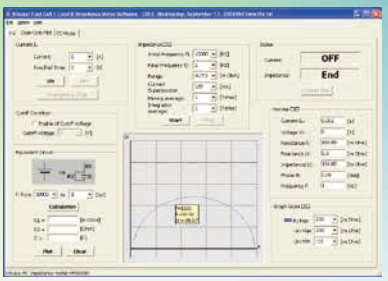
Why is impedance measurement necessary?

Not only fuel cells but also many other types of cells do not allow performance adjustment in the post-manufacturing stages. It is nonetheless necessary to run and test the cells in order to verify that they provide the expected levels of performance and meet the required specifications. However, running every manufactured cell for testing purposes is by no means easy. One way to examine the characteristics of individual cells in a short time is to conduct accurate impedance measurement.
Knowing impedance characteristics provides clues as to the characteristics and performance variation of cells as well as their service life.

Application software

●Cole-Cole plot



▲Cole-Cole plot test screen

Impedance measurement method - AC impedance measurement

There are several impedance measurement methods, including:

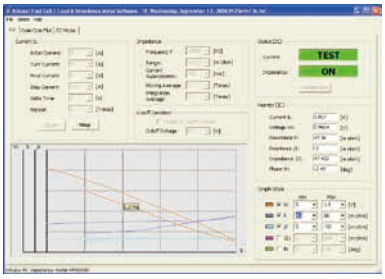
(1) AC impedance measurement, (2) current interrupt method, (3) fast Fourier transform, (4) litharge method, (5) impedance bridging, and (6) oscilloscope measurement.

Of these, AC impedance measurement is the most popular method. To measure large currents, the current interrupt method has been the technique of choice. This method, however, is often problematic in terms of data reproducibility and accuracy.

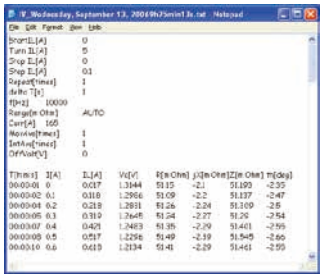
The AC impedance measurement method applies alternate current-induced vibration to the device under test (fuel cell), calculates the complex impedance from the amplitude of the resulting voltage and current and the phase difference, and then plots the impedance in a complex coordinate system. By varying the vibration frequency of alternate current, the method obtains the equivalent impedance from the plotted trajectory.

- Constants of the approximate equivalent circuit of the fuel cell are determined by the data obtained through multiple-point plotting of frequency (3 to 70 points).

●Current-voltage characteristic measurement testing (I-V characteristics)



▲I-V test screen

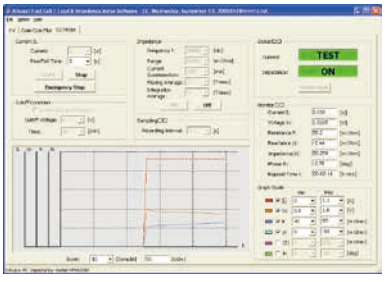


▲I-V characteristic file

- The cell voltage and internal resistance are measured with respect to the load current, and a Tafel plot is displayed.

  The quantity of gas flow is made constant, thus rendering it possible to conduct cell evaluation and to measure the current density based on the reaction area.
- The maximum resolution can be adjusted in 1 mA steps in the range of 0 A to 30 A. The software reads voltages with the specified resolution. The measurement can be repeated any number of times including infinitely.

●CC mode testing (for aging)



▲CC mode test screen

- The rise and fall times can be set to a maximum of 999 seconds each.
- The logging interval can be adjusted in the range of 1 to 99999 seconds.
- The measurement current can be applied continuously on a single frequency, thereby making it possible to measure load current impedances as high as 30 A.
  (It is also possible to cut off the measurement alternate current.)

●KFM2030 Specifications

Impedance measurement part

Measurement frequency..... 10 mHz to 10 kHz
Frequency resolution ..... 14 points/decade - 1.00, 1.26, 1.58, 2.00, 2.51, 3.00, 3.16, 4.00, 5.00, 6.00, 6.30, 7.00, 8.00, 9.00
Measurement range *1 ..... 165 mA range (60 mA AC rms): 30 mΩ, 100 mΩ, 300 mΩ, or AUTO
500 mA range (180 mA AC rms): 10 mΩ, 30 mΩ, 100 mΩ, or AUTO
Measurement alternate current ..... 60 mA rms (165 mA range), 180 mA rms (500 mA range), OFF
Measurement resolution ..... 10 mΩ range: 1 μΩ
30 mΩ and 100 mΩranges: 10 μΩ
300 mΩ range: 100 μΩ
Measurement value display ..... Four types of measurement value can be chosen for display freely from , X, |Z|, θ, voltage, and current.
Measurement accuracy ..... 10 mHz to 900 Hz R, X: ±2 % of range *2
1 kHz to 4 kHz R, X: ±3 % of range *2
5 kHz to 10 kHz R, X: ±4 % of range *2

DC voltage/current measurement part

Voltage range..... Automatic switch between two ranges: 2 V and 20 V
Voltage measurement resolution..... 2 V range: 100 μV
20 V range: 1 mV
Voltage measurement accuracy..... 2 V range ±(0.2 % of rdg *3 + 6 digits)
20 V range ±(0.7 % of rdg *3 + 8 digits)
Current measurement resolution..... 1 mA
Current measurement accuracy..... ±2 % for 30 A
Monitor output..... Voltage monitor: Outputs 10 V for sensing input
(insulated output for the load) ..... Voltage of 20 V.
Voltage monitor accuracy: ±0.05 V
Current monitor: Outputs 10 V for load current of 30 A.
Current monitor accuracy: ±0.2 V

Electronic load

Operation mode..... Constant current
Range..... Two ranges - 5 A and 30 A
Maximum load current..... 30 A
Input voltage range..... 0 V to 20 V
Maximum input power..... 60 W
Current setting accuracy..... ±(0.5 % of set *4 +10 mA)
External control *5..... 5 A range: 0 A to 5 A for 0 V to 10 V
30 A range: 0 A to 30 A for 0 V to 10 V

Display

240 dots × 64 dots LCD with cold-cathode ray tube backlighting
Impedance measurement part ..... 10 mΩ → XX.XXX mΩ, 30 mΩ/100 mΩ → XXX.XX mΩ
300 mΩ → XXX.X mΩ
DC voltage measurement part ..... 0.0000 V to 2.0000 V and 2.000 V to 20.000 V

External control interface

GPIB, RS232C, and USB

Average setting

The integral average (1 to 32) and the moving average (1 to 256) may be used in combination.

Protection functions

Overvoltage protection (OVP) ..... The load is cut off if a voltage of 21 V or higher is applied to the sensing terminal.
Overpower protection (OPP)..... Power of 63 W or higher activates the CP and lights the OVER LOAD LED lamp.
Overheat protection (OHP)..... The load is cut off if the temperature inside the load unit becomes abnormally high.
Overcurrent protection (OCP) ..... If a load current of 31.5 A or higher flows, the LCD displays "ALM:OCP" and the load is cut off.
Undervoltage protection (UVP)..... The load is cut off if the voltage applied to the sensing terminal falls below the set voltage limit. This voltage limit can be set in the range of –2 V to 20 V.

General specifications

External control
Input..... CC control, LOAD ON/OFF, load range: 0/5 V
Output..... V monitor, I monitor, alarms, load status
Environment
Warm-up time..... 30 minutes or more
Installation altitude..... 2000 m or less
Storage temperature and humidity range..... -10 °C to 60 °C (14 °F to 140 °F), 90 % or less (no condensation)
Operating temperature and humidity range..... 0 °C to 40 °C (32 °F to 104 °F), 20 % to 85 % or less (no condensation)
Guaranteed temperature and humidity range..... +15 °C to +35 °C, 20 % to 85 % rh or below (no dew condensation allowed)
Power
Allowable power voltage range..... 90 VAC to 132 VAC, 180 VAC to 250 VAC
Power frequency range..... 45 Hz to 65 Hz
Maximum power consumption..... 600 VA or less
Dielectric resistance..... 50 MW or more (500 VDC) [between AC line and chassis]
Withstand voltage..... 1500 VAC/minute [between AC line and chassis]
Dimensions (maximum)..... 430 (455) W × 88 (105) H × 380 (450) D mm
Weight..... Approx. 9.5 kg (20.94 lb)

Accessories

Power cord: 1, Sensing line: 1, Load line: 1, User's manual: 1, Application software (CD): 1

Options

Rack mount bracket.....KRB100-TOS (JIS), KRB2-TOS (EIA)

*1 Values up to four times the range can be measured. Note that, in cases where the drift or ripple of the fuel cell is large or there is much noise, a value lower than the range may be regarded as exceeding the range.
*2 range: Measurement range
*3 rdg: Reading of input voltage
*4 set: Value set for input current
*5 The set full scale can be fine-tuned.

●Rear Panel

[Dimensions]