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
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 application software 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.
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

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)

- 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)

- 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 kHz to 10 kHz
- Frequency resolution: 14 points/decade - 1.0, 1.26, 1.58, 2.00, 2.51, 3.00, 3.36, 4.00, 5.00, 6.00, 6.30, 7.00, 8.00 kHz
- Measurement range: 165 mA range (60 mA AC rms): 10 mΩ, 30 mΩ, 100 mΩ, or AUTO
- Measurement alternate current: 60 mΩ rms (165 mA range), 180 mΩ rms (500 mA range), OFF
- Measurement resolution: 10 mΩ range: 1 μΩ
- Measurement value display: Four types of measurement value can be chosen for display freely from: X, T, X, V, 8, voltage, and current.
- Measurement accuracy: ±0.01% ±10 μV
- Measurement resolution: 200 dots × 64 dots LCD with cold-cathode ray tube backlighting
- Measurement accuracy: 10 mΩ to 900 kHz, ±2% of range *2
- 1 kHz to 4 kHz: ±3% of range *2
- 5 kHz to 10 kHz, ±4% of range *2

DC voltage/current measurement part
- Voltage range: Automatic switch between two ranges: 2 V and 20 V
- Voltage measurement accuracy: ±0.005% ±6 µV
- Current measurement resolution: 1 mA
- Current measurement accuracy: ±3% for 30 A
- Monitor output: Voltage monitor: Outputs 10 V for sensing input
- Voltage of 20 V
- Voltage monitor accuracy: ±0.05 V
- Current monitor output: 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 A range: 0 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 → XXXX mΩ, 30 mΩ/100 mΩ → XXXX XX mΩ
- DC voltage measurement part: 0.0000 V to 2.0000 V and 2.000 V to 20.000 V

Rear Panel

[Dimensions]

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: +15 °C to +35 °C, 20% to 85% rh or less
- Humidity range: 20% to 85% or less (no condensation)

Electrode 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)

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Printed in Japan
Issue: Nov. 2019
201911PDFEC21a