The impedance measurement can be performed using AC impedance method. Impedance of cells of up to 20V can be measured in the range of 10 mHz to 10 kHz. Two ranges of the constant current mode in 5A and 0.5A are available for the load rating. Load current setting resolutions of 0.1 mA (in 5A range) and 0.01 mA (in 0.5A range). Capable of 0V operating voltage, equipped built-in electronic load with maximum power consumption of 60 W (applied to the single cell testing). Application software included as a standard accessory. External control of the load current, various protection functions are equipped. Equipped with GPIB, RS-232C and USB interfaces as standard.
The measuring instrument and the electronic load are integrated in one single device!

Possible to acquire the Tafel plot and the Cole-cole plot of the micro fuel cell (such as cellular phones, laptop computers, and electric power-assisted bicycles, etc.)

The impedance meter KFM2005 is designed for testing of the fuel cell with the small current (5 A or less), and not only the current-voltage characteristic test, the KFM2005 can easily measure the impedance of a fuel cell using the AC impedance method, and the Cole-Cole plot. Using the measurement data of the Cole-cole plot, it is possible to calculate the circuit constant of the approximate equivalent circuit of the fuel cell. The built-in DC load (60W) is capable to operate from 0 V, and it can perform the test for the fuel cell up to 20 V and 5 A.

**Fuel Cell Impedance meter**

KFM2005

- Application software included as a standard accessory
- Equipped with GPIB, RS-232C and USB interfaces as standard.

**The impedance measurement using AC impedance method**

- Frequency range: 10 mHz to 10 kHz
- Frequency resolution: 14 points/decade
- Impedance measurement range: 100 mΩ, 300 mΩ, 1 Ω, 3 Ω
- Measurement alternated current range: 16.5 mA range, 50 mA range
- The selected range of measurement AC current can be set for 10% to 100% of the rated value in 0.1% step. The impedance measurement can be measured by the dummy rated voltage which varies automatically for the measured AC current to become at 5 mVpp of the detected terminal voltage of the DUT.

**The built-in DC load (60W) is capable to operate from 0 V**

- Not only for stack cell, it can also apply for single cell testing
- Operating mode: Constant Current
- Current range: 0.5 A range, 5 A range
- Current setting resolution: 0.01 mA (0.5 A range), 0.1 mA (5 A range)
- Input voltage range: 0 V to 20 V
- Maximum input power: 60 W

**Various controls by external control functions**

The KFM2005 allows you to control not only from the panel or through the communication interface but also using external signals from the control terminal.

- Controlling the load current using an external voltage
  - 0.5 A range: 0 V to 10 V at 0 A to 0.5 A
  - 5 A range: 0 V to 10 V at 0 A to 5 A
- Turning the load current on/off
- Switching the load current range
- Voltage monitor output: outputs 10 V at 20 V of the sensing input voltage
- Current monitor output: outputs 10 V at 5 A of the load current
- Alarm output: occurred when abnormal state is detected such as OHP, Over Load, OCP.
- Status output of the LOAD ON/OFF (output of the ON/OFF status of the load device)

**External control by Interfaces**

Equipped with GPIB, RS-232C and USB interfaces as standard.

**Useful application software is included**

It is possible to start immediate testing for the measurement of Cole-Cole Plot, I-V characteristics, and Constant Current characteristics simply by entering the parameters and acquiring the test data easily.

**System Requirements**

- CPU: Pentium IV 1GHz or higher/ Memory: 512MB or more/WINDOWS 2000 (SP4+Update Roll up) /WINDOWS XP (SP2 or later with intel x86), Windows Vista (Intel x86, x64) /USB interface

**Various protection functions**

The protection function of UVP / OVP / OPP / OHP / OCP / OPEN are equipped as standard.

**For the secondary or the primary battery testing**

The impedance can be measured in the range of 10 mHz to 10 kHz.
The data acquisition of each characteristic test is possible by the application software included as a standard accessory. Each test data can be created in the text file in the TAB (Tab separated value) format.

- **Cole-Cole plot**
  The impedance measurement is used by the AC impedance measurement method. The AC impedance measurement method applies alternate current-induced vibration to the DUT (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.

- **Current-voltage characteristic measurement testing (I-V characteristics)**
  Measures the cell voltage (contact point of the sensing terminal) to the load current, and displays the Tafel plot.
  The maximum resolution can be adjusted in 0.1 mA steps in the range of 0 A to 5A. The software reads voltages with the specified resolution. The measurement can be repeated any number of times including infinitely. Even while the load current is passing through, it is also possible to measure the internal resistance (the impedance value of the single frequency measured by the AC impedance measurement method).

- **Constant Current characteristic (for aging test)**
  The rise or fall time can be set to a maximum of 999 seconds.
  Measures the change of cell voltage at constant load current.
  The logging interval can be extended from 1 s to 86,400 s. Even while the load current is passing through, it is also possible to measure the internal resistance (the impedance value of the single frequency measured by the AC impedance measurement method).
Specifications

Impedance measurement part

<table>
<thead>
<tr>
<th>Measurement frequency</th>
<th>10 mHz to 10 kHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency resolution</td>
<td>14 points/decade</td>
</tr>
<tr>
<td>Measurement range</td>
<td>± (0.5% of ± (4% of 5kHz to 10kHz of R,X variable ratio) 5mA range</td>
</tr>
<tr>
<td>Measurement altered current</td>
<td>± (0.5% of 1kHz to 4kHz of R,X variable ratio) 18mA range</td>
</tr>
<tr>
<td>Measurement value display</td>
<td>± (0.5% of range : 0.0µm to 999.9µm, 1,000µ to approx.4,000Ω 300mΩ range</td>
</tr>
</tbody>
</table>

Measurement display items

| Measurement accuracy | ± (0.5% of range : ± (0.5% of range : 10mHz to 900Hz of R,X x (2% of | Z | reading +0.5% of range +1m / variable ratio) 1kHz to 4kHz of R,X x (3% of | Z | reading +0.5% of range +1m / variable ratio) 5kHz to 10kHz of R,X x (4% of | Z | reading +0.5% of range +2m / variable ratio) |

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 ± 6 digits) , 20 V range ± (0.7% of rdg ± 8 digits) |
| Current measurement resolution | 100 µA |
| Current measurement accuracy | ± 1% of 5A ± (50mA) |
| Monitor output | Voltage monitor: Displays 10 V for sensing input voltage of 20 V |
| (insulated output for the load) | Voltage monitor accuracy: ± 0.05V |

Electronic load

| Operation mode | Constant current |
| Range | Two ranges - 0.5 A and 5 A |
| Maximum load current | 5A |
| Input voltage range | 0 V to 20 V |
| Maximum input power | 60W |
| Current setting accuracy | 0.5A range | ± (0.5% of range : ± (0.5% of range : ± (0.5% of range : 5mA range | 0.5A range | ± (0.5% of range : ± (0.5% of range : ± (0.5% of range : 0 A to 0.5 A for 0 V to 10 V 0.5A range | ± (0.5% of range : ± (0.5% of range : ± (0.5% of range : 5 A for 0 V to 10 V 5A range | ± (0.5% of range : ± (0.5% of range : ± (0.5% of range : 0 V to 10 V |

Display

240 dots X 64 dots LCD with cold-cathode ray tube backlighting

External Control Interface

GPB, RS-232C, USB

Options

- Rack mount bracket: KRB100-TOS, KRB2-TOS

Accessories

- Power cord (100 VAC): 1 Sensing cable: 1 Load cable: 1 Operation manual: 1 Application software (CD): 1

Protection functions

- Overvoltage protection (OVP): If the load is cut off if a voltage of 21 V or higher is applied to the sensing terminal.
- Overpower protection (OPP): If power of 63 W or higher activates the CP and lights the OVER LOAD LED.
- 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 flows higher than 5.25 A, the LCD displays “ALM-OCP” and the load is cut off.
- Undervoltage protection (UVP): If 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.

Protection functions

- External Control Interface

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
- Storage temperature and humidity range: -10°C to +60°C, 90% rh or below (no dew condensation allowed)
- Operating temperature and humidity range: 0°C to +40°C, 20% to 85% rh or below (no dew condensation allowed)
- 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: AC90V to 125V, AC180V to 250V Single phase
- Power frequency range: 45 Hz to 65 Hz
- Maximum power consumption: 600 VA or less
- Dielectric resistance: 50 MΩ or more (500 VDC) [between AC line and chassis]
- Withstand voltage: 1500 VAC/minute [between AC line and chassis]
- Dimensions (maximum): 430 (455) W × 180 (205) H × 380 (450) D mm
- Weight: Approx. 9.5 kg

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