FC IMPEDANCE METER KFM2030

FC Impedance Meter

Dimensions / Weight (approx.)
430(455)W × 88(105)H × 380(450)Dmm / 9.5kg

Accessories
Operation manual, Power cord, Sensing line, Load line, Application software (CD)

Options
■ Rack mount bracket
KRB100-TOS (JIS standard)/KRB2-TOS (EIA standard)

Application software
• Cole-cole plot
• Current-voltage characteristic measurement testing (I-V characteristics)
• CC mode testing (for aging)

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 mΩ range (60 mA AC rms); 30 mΩ, 100 mΩ, 300 mΩ, AUTO
500 mΩ range (80 mA AC rms); 10 mΩ, 30 mΩ, 100 mΩ, AUTO
Measurement alternate current ........ 60 mΩ (165 mΩ range), 180 mΩ (500 mΩ range), OFF
Measurement resolution.............. 10 mΩ range: 1 μΩ
30 mΩ, 100 mΩ range: 10 μΩ
300 mΩ range: 100 μΩ
Measurement value display .......... Four types of measurement value can be chosen
for display freely from R, X, | Z |, voltage, and current.
Measurement accuracy ............. 10 kHz 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
(insulated output for the load)
input 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

Average setting
The integral average (1 to 32) and the moving average (1 to 256) may be used in combination.
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 MΩ or more (500 VDC)
[between AC line and chassis]
Withstand voltage ............ 1500 VAC/minute
[between AC line and chassis]

Fuel cell characteristic, variation, and service life testing can be done with ease!
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 meter can obtain impedance values at different frequencies by means of AC impedance measurement and display the obtained values in a Cole-Cole plot. 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.

Features
■ 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 , V, and I.
■ Equipped with GPIB, RS-232C 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.

*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.
KFM2150 system
FC Impedance Measurement System

Dimensions / Weight (approx.)

- KFM2150 SYSTEM 1000-01: 45kg
- KFM2150 SYSTEM 1000-02: 21kg
- KFM2150 SYSTEM 660-01A: 22kg
- KFM2150 SYSTEM 165-01A: 13.5kg
- KFM2150: 430(455)W
- Dimensions / Weight (approx.):
  - KFM2150 SYSTEM 7000-04: (570)W×(1430)H×(1025)Dmm / 215kg
  - KFM2150 SYSTEM 1980-03A: (570)W×(1430)H×(875)Dmm / 170kg

Includes:
- FC Impedance Meter
- Electronic load unit

- Constant current mode
- Ammeter
- Constant voltage mode
- Voltmeter

Table:

<table>
<thead>
<tr>
<th>Model</th>
<th>FC Impedance meter</th>
<th>Electronic load unit</th>
<th>Type</th>
<th>Operating voltage</th>
<th>Current</th>
<th>Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>KFM2150 SYSTEM 165-01A</td>
<td>KFM2150</td>
<td>PLZ164WA (1 unit)</td>
<td>Bench top type</td>
<td>0 to 150</td>
<td>33</td>
<td>165</td>
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<tr>
<td>KFM2150 SYSTEM 660-01A</td>
<td>KFM2150</td>
<td>PLZ664WA (1 unit)</td>
<td>Bench top type</td>
<td>0 to 150</td>
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<td>660</td>
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<td>KFM2150 SYSTEM 1320-02A</td>
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<td>PLZ664WA (2 units)</td>
<td>Bench top type</td>
<td>0 to 150</td>
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<td>1320</td>
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<td>KFM2150 SYSTEM 1980-03A</td>
<td>KFM2150</td>
<td>PLZ664WA (3 units)</td>
<td>Rack mount type</td>
<td>0 to 150</td>
<td>396</td>
<td>1980</td>
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<tr>
<td>KFM2150 SYSTEM 2640-04A</td>
<td>KFM2150</td>
<td>PLZ664WA (4 units)</td>
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<td>2640</td>
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<td>KFM2150 SYSTEM 3300-05A</td>
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<td>3300</td>
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<tr>
<td>KFM2150 SYSTEM 1000-01</td>
<td>KFM2150</td>
<td>PLZ1004W (1 unit)</td>
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<td>1.5 to 150</td>
<td>200</td>
<td>1000</td>
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<tr>
<td>KFM2150 SYSTEM 3000-02</td>
<td>KFM2150</td>
<td>PLZ2004WB (1 unit)</td>
<td>Bench top type</td>
<td>1.5 to 150</td>
<td>600</td>
<td>3000</td>
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<tr>
<td>KFM2150 SYSTEM 1000-01</td>
<td>KFM2150</td>
<td>PLZ1004W (2 units)</td>
<td>Rack mount type</td>
<td>1.5 to 150</td>
<td>1000</td>
<td>5000</td>
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<tr>
<td>KFM2150 SYSTEM 3300-05A</td>
<td>KFM2150</td>
<td>PLZ2004WB (3 units)</td>
<td>Rack mount type</td>
<td>1.5 to 150</td>
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<td>7000</td>
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<tr>
<td>KFM2150 SYSTEM 2640-04A</td>
<td>KFM2150</td>
<td>PLZ2004WB (4 units)</td>
<td>Rack mount type</td>
<td>1.5 to 150</td>
<td>1800</td>
<td>9000</td>
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</tbody>
</table>

**Impedance measurement system that supports stack fuel cells**

The KFM2150 system is a fuel cell impedance measurement system configured with an FC impedance meter KFM2150 and an electronic load PLZ-4W series. Combination of KFM2150 and PLZ-4WA series (0V input type) supports impedance measurement for single cell of fuel cell. In addition to impedance measurement with AC impedance method, KFM2150 system provides IR measurement with current interrupt method. Application software enables test for each characteristic of fuel cell such as I-V characteristics, Constant Current characteristics, Constant Interrupt method and Cole-Cole plot by the AC impedance method. Moreover, each test can be performed in a specified order.

**Features**

- Capable of measuring impedance in the frequency range from 10 mHz to 20 kHz.
- Parallel operation by same model of PLZ-4W series enhances current capacity and power capacity.
- Power capacity:
  - 1000 W, 200 A, load input terminal: 1.5 V to 150 V (KFM2150 system 1000-01)
  - 660 W, 132 A, load input terminal: 0 V to 150 V (KFM2150 system 660-01A)
- Measuring AC current can be set from 0.1% to 10% (0.1% unit) of DC load current.
- Capable of IR measurement with the current interrupt method.
- Capable of varying DC load current while keeping measuring AC current setting (%).
- Equipped with low voltage protection
- External interface equipped as standard (RS-232C, GPIB, USB)

**Accessories**

- Operation manual, Power cord, Sensing wire, Flat cable, Application software (CD-ROM), RS-232C cable, Cables for parallel connection (2 pcs. per set./KFM2150 SYSTEM 1320-02A, KFM2150 SYSTEM 3000-02 only)

**Specifications**

<table>
<thead>
<tr>
<th>Model</th>
<th>Units configuring the system</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Operating voltage</td>
<td>Current</td>
</tr>
<tr>
<td>KFM2150 SYSTEM 165-01A</td>
<td>0 to 150</td>
<td>33</td>
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<tr>
<td>KFM2150 SYSTEM 660-01A</td>
<td>0 to 150</td>
<td>132</td>
</tr>
<tr>
<td>KFM2150 SYSTEM 1320-02A</td>
<td>0 to 150</td>
<td>264</td>
</tr>
<tr>
<td>KFM2150 SYSTEM 1980-03A</td>
<td>0 to 150</td>
<td>396</td>
</tr>
<tr>
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<td>528</td>
</tr>
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<td>0 to 150</td>
<td>660</td>
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<td>1.5 to 150</td>
<td>200</td>
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</tr>
<tr>
<td>KFM2150 SYSTEM 2640-04A</td>
<td>1.5 to 150</td>
<td>1800</td>
</tr>
</tbody>
</table>

**Comment**

- KFM2150 series cannot be operated. KFM2150 system only FC impedance meter KFM2150 needs to be combined with PLZ-4W series and calibrated.

**Features**

- Capable of measuring impedance in the frequency range from 10 mHz to 20 kHz.
- Parallel operation by same model of PLZ-4W series enhances current capacity and power capacity.
- Power capacity:
  - 1000 W, 200 A, load input terminal: 1.5 V to 150 V (KFM2150 system 1000-01)
  - 660 W, 132 A, load input terminal: 0 V to 150 V (KFM2150 system 660-01A)
- Measuring AC current can be set from 0.1% to 10% (0.1% unit) of DC load current.
- Capable of IR measurement with the current interrupt method.
- Capable of varying DC load current while keeping measuring AC current setting (%).
- Equipped with low voltage protection
- External interface equipped as standard (RS-232C, GPIB, USB)

**Accessories**

- Operation manual, Power cord, Sensing wire, Flat cable, Application software (CD-ROM), RS-232C cable, Cables for parallel connection (2 pcs. per set./KFM2150 SYSTEM 1320-02A, KFM2150 SYSTEM 3000-02 only)
Common Specifications

**Impedance measurement function**

**AC impedance method**
- Frequency range: 10 mHz to 20 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, and 9.00)
- Measurement range: 0.0001 mΩ to 9.9999 Ω, indicated in five digits.
- Measurement items: R, X, | Z |, θ
- Current interrupt method
  - Measurement range: 0.0001 mΩ to 9.9999 Ω, indicated in five digits.
  - Measurement item: IR (internal resistance)
- External control interface: RS-232C, GPIB, USB
- Average setting: Moving average, 1 to 256 times

**Protection function**
- Low-voltage protection (UVP): Turns the load off at –2 V to 150 V (settable). Issues an alarm signal.
- Load protection: Turns the load off upon receiving an alarm signal from the PLZ-4W series unit. Issues an alarm.

**Input voltage range**
- Bench top type: 90 VAC to 250 V, single phase
- Rack mount type: 180 VAC to 250 V, single phase

**Input frequency range**
- 47 Hz to 63 Hz

**Power consumption**
- 550VA (SYSTEM165-01A)
- 1600VA (SYSTEM660-01A)
- 3100VA (SYSTEM1320-02A)
- 260VA (SYSTEM1000-01)
- 460VA (SYSTEM3000-02)
- 4600VA (SYSTEM1980-03A)
- 6100 VA (SYSTEM2640-04A)
- 7600 VA (SYSTEM3300-05A)
- 660 VA (SYSTEM5000-03)
- 860 VA (SYSTEM7000-04)
- 1060 VA (SYSTEM9000-05)

FCTester (Application software)

With the FC Tester, KFM system will be controlled by a PC and it offers the test for each characteristic of the fuel cell such as I-V characteristics, constant current characteristics, current interrupt method and Cole-Cole plot by the AC impedance method. In addition, each test can be performed in a specified order. Furthermore, it offers the sequential measurement of each cell's impedance by switching them off with the FC Scanner KFM2151.

**Features**
- Fuel cell-friendly start-up and shut-down sequences are equipped.
- Test modes such as I-V characteristics, constant current characteristics, current interrupt method, and Cole-Cole plot by the AC impedance method are equipped.
- Capable of performing cycle test for fuel cell with a combination of sequence functions.
- 2D/3D real-time graph function is equipped.
- Capable of observing the voltage and the current waveform of when performing the current interrupt method.
- A panel control function that is operable by PC equivalent to KFM2150’s panel operation is equipped.
- Capable of performing the impedance measurement of each cell with a combination with the FC Scanner (KFM2151).
- FC Tester consists of 3 programs, Configuration Tool, Condition Editor and Executive.
KFM2151

FC Scanner

Dimensions / Weight (approx.)
430(435)W × 44(60)H × 270(285)Dmm / 3.5kg

Accessories
Operation manual, Power cord, Metal fitting (4pcs.), Metal fitting screws (4pcs.), KFM2150 connection cable (1m), Screwless terminal connector (8 poles, 8pcs.), Screwless terminal connector (2 poles, 2pcs.)

Features
■ Capable of impedance measurement that is up to 150V of input voltage when connected to KFM2150 with the dedicated cable.
■ Capable of 32ch/unit input, and it is expandable to 160ch in a parallel connection.
■ Capable of voltage and impedance measurement of arbitrary cells in a single connection due to the function that allows the ability to change the allocated terminal of the channel.
■ Capable of setting OVP and UVP to each channel.
■ Capable of voltage monitoring with the 32 channels/sec. of the scanning speed.
■ Capable of an individual operation as a voltage monitoring.

Specifications

<table>
<thead>
<tr>
<th>SENSING terminal</th>
<th>Number of inputs</th>
<th>32 ch/unit (expandable to 160 ch with 5 units)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated input voltage</td>
<td>±150 V (±200 Vpeak maximum)</td>
<td></td>
</tr>
</tbody>
</table>

Interface
Remote control: RS-232C
For connecting the FC Impedance Meter: Dedicated interface
For channel expansion: Dedicated interface

Voltage measurement section
Number of channels: 32, A SENSING terminal can be assigned to each channel.
Range: 2 V, 20 V, 200 V, and auto range
Scanning speed: 32 channels/s
OVP: –2 V to 200 V, Can be set for each channel.
Resolution: 0.01 V
UVP: –2 V to 200 V, Can be set for each channel.
Resolution: 0.01 V

Voltmeter: Maximum display: 19999
Accuracy: ±(0.1 % of rdng\(^{1}\) + 0.1 % of rng\(^{2}\) )

Impedance measurement switching section
Number of channels: 32, A SENSING terminal can be assigned to each channel.
Output terminal: Number of outputs: 1 ch
Output voltage: Input voltage × 1/10
Accuracy: ±1 %: For DC
Scanning: Auto or manual
Frequency characteristics: 126 Hz or less: 2%
(value to be added to the measurement accuracy of the KFM2150)\(^{3}\)
158 Hz to 3 kHz: 2%
3.16 kHz to 9 kHz: 3%
KFM2150: 10 kHz to 20 kHz: 5%
Input voltage range: AC100V to 240V(AC90V to 250V), single phase
Input frequency range: 47Hz to 63Hz
Maximum power consumption: 30 VAmax
Insulation resistance: 500 VDC, 30 MΩ or more
Withstand voltage: No abnormalities at 1500 VAC for 1 minute
(Between the primary circuit and chassis)

Configuration example of the impedance measurement system of KFM2150/KFM2151/PLZ-4W series (electronic loads devices)

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**Notes:**

1. rdng: Indicates the read value.
2. rng: Indicates the range.
3. The basic measurement accuracy when combined with the KFM2150 FC Impedance Meter is obtained by adding a percentage indicated for a specific frequency range to the percentage of the |Z| reading on the KFM2150: ±((percentage of the |Z| reading) \times 3 mΩ) for the 10 mΩ range.

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**Units listed for the parallel operation are the maximum number of available units**
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Distributor/Representative

1744 Rollins Road, Burlingame, CA 94010
Phone: 650-259-5900 Facsimile: 650-259-5904

www.kikusui.us
1-877-8762807

Room, D-01,11F, Majesty Bld, No.138, Pudong Ave, Shanghai City
Phone: 021-5887-9067 Facsimile: 021-5887-9069

www.kikusui.cn
021-5887-9067

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