# Introduction of

## IBEX (Battery Quality, SOH, Tester)
## IBwatch (Battery Diagnosis System)



Revised February, 2010







## Contents

1. Powertron history

2. IBEX-Series
   - 2-1. Accessories
   - 2-2. Exmons Pro Ultra (Diagnostic S/W)
   - 2-3. Sales Reference

3. IBwatch (Battery Monitoring System)

# 1. POWERTRON History

**POWERTRON has been manufactured "Automatic Chargers and Parts, Battery Portable Tester and Battery Monitoring System" since 1984.**

- Jan. 1984: Established.
- Jan. 1992: Exported "Automatic Charger" to Japan & Taiwan.
- Dec. 1994: Developed Current Transducer (4,000A) for Seoul Subway.
- Feb. 1996: Exported "components of Automatic Charger" to Japan.
- Jun. 1999: Developed "Q-class DC Power/S" for Nuclear Power Plant.
- Nov. 2000: Began to R&D for Battery Diagnosis algorism (KT sponsored).
- Aug. 2004: Developed "Newest Technology for Batteries Diagnosis".
- **Sep. 2004: Certified "Newest Technology of Ripple rejection Algorithm" from Korean Government.**
- **May. 2005: Registered "3 or more -Patents" by Korean Intellectual Property Office, and supplied "Battery Portable Tester" to local major customer (KT Telecom, KEPCO Electric, Gas, Airport and etc)**
- **Nov. 2006: Exported "Battery Portable Tester" to USA, China, , etc**
- **Dec. 2006: Certificated CE (IBEX-1000 / IBEX-1000P)**
- **Feb. 2007: Certificated CE (BDS/pro)**
- **Dec. 2008: Authorized 'Korean World Class Product Award 2008' by Minister of Knowledge Economy**
- **Jan. 2009: Registered Patent USA No: US 7,567,085 B2**






# 2. IBEX-Series

# Portable Battery Tester

# 2. What is the IBEX?

- IBEX is a cutting edge digital battery diagnostic tester meeting all IEEE Std. recommendations for all stationary applications such as telecommunications back up power, utility switching power, uninterruptible power systems (UPS) and more.
- IBEX is the only diagnostic tester to measure the accurate internal ohmic Resistance (R), or conductance (Siemens), Jar voltage (V) and Jar temperature(°C/°F) utilizing the world's first ripple-removing algorithm within a very short time under floating charge or off line condition.
- IBEX is the only internal ohmic measurement tester in the market today providing results by using less than1~2 amps AC testing current for all types of batteries. That results in no affects to any batteries to be aged by AC testing current .
- World first technology owned by POWERTRON allows IBEX/BDS to accurately calculate internal ohmic resistance/ Conductance to maintain reading accuracy. **(Patents registered in USA, China and etc.)**






# (1) IBEX Strengths

- IBEX automatically measures data in less than 4 seconds.
- IBEX measuring Data is almost same in Charge or Discharge case.
- IBEX is compact & lightweight (fits in the palm of your hand).
- IBEX measures data of batteries in 15 different types of banks.
- IBEX uses a Li-ion battery for max. usage time (over 4 hours).
- IBEX meets all IEEE Std. recommendations for all Stationary Battery Systems.
- IBEX trends battery measurement data to detect impeding battery failures before power backup system is affected.
- IBEX offers the most comprehensive diagnosis and reporting software package (Exmons Pro 2005, or Ultra).
- IBEX Software (Exmons Pro 2005 or Ultra) allows user to view battery SOH (aging status) in graphs, export to excel, provide information and 3D graphs in a report.
- IBEX Exmons Pro Ultra supports you multi-user environment.

# (2) IBEX utilize a patented Ripple-Removing Algorithm

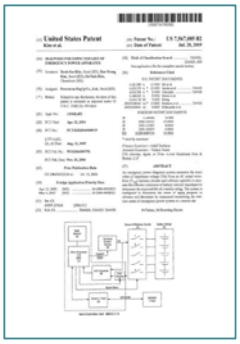
- The patent for "Ripple-Removing Algorithm" applied to IBEX for analyzing the effective RMS voltage immunized against mixed ripple noise on charging, was registered as Korea Patent No.0494489 on Jun.05, 2005, and this patent (PTC) filed also to USA, Canada, Japan, China, and India.
- USA patent registration no: US 7,567,085 B2
- China patent registration no: ZL 2004 8 0006211.0

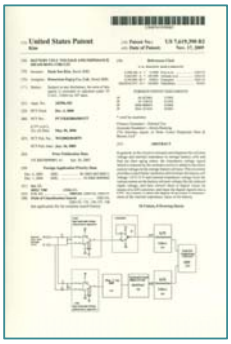
- The Internal Ohmic measurement can be done with connecting a load or on charging by the "Ripple-Removing Algorithm", therefore the merged data by IBEX is very accuracy and no deviation on float charging conditions.
- As a result, IBEX is superior than other testers.






# (3) Patent Certification



USA Patent Certification



China Patent Certification

# (4) CE Certificate

EC Declaration Of Conformity

CE

according EMC Directive 89/336/EEC

We herewith declare,

POWERTRON ENGINEERING CO., LTD.
639 ILWON-DONG, KANGNAM-KU,
SEOUL, KOREA

that the following equipment complies with the appropriate basic safety and health requirements of the EC Directive based on its design and type, as brought into circulation by us. In case of alteration of the equipment, not agreed upon by us, this declaration will lose its validity.

Equipment Description : Intelligent Battery Quality Tester
Equipment Type : IBEX-2000
Family name: IBEX-2000 pro
Applicable EC Directives : EMC Directive (89/336/EEC)
Applicable Harmonized Standard : EN 61326/1997 +A1:1998 +A2:2001
Authorized Signature/Date : June 09, 2005
Title of Signatory : Deuk Soo, Kim / President

EC Declaration Of Conformity

CE

according to Low Voltage Directive 73/23/EEC & EMC Directive 89/336/EEC

We herewith declare,

POWERTRON ENGINEERING CO., LTD.
#639 ilwon-dong, Kangnam-Ku, Seoul, Korea

that the following equipment complies with the appropriate basic safety and health requirements of the EC Directive based on its design and type, as brought into circulation by us. In case of alteration of the equipment, not agreed upon by us, this declaration will lose its validity.

Equipment Description : Intelligent Power Quality Monitoring System
Equipment Type : iPQMS/BDS 24C-4
Family Model : iPQMS/BDS 56C-4 iPQMS/BDS 64C-10 iPQMS/BDS 448C-10
Applicable EC Directives : Low Voltage Directive (73/23/EEC) EMC Directive (89/336/EEC)
Applicable Harmonized Standard : EN 61000-6-4 : 2001 EN 61000-6-2 : 2001
Authorized Signature/Date : June 20, 2005
Title of Signatory : Deuk-Soo Kim / President







# (5-1) IEEE Std.1188-1996

New Excellent Technology

## Battery's Internal Ohmic Measurement

1) Impedance measurements can be performed by passing a current of known frequency and amplitude through the battery and measuring the resultant ac voltage drop across each cell/unit. The ac voltage measurement is taken between the positive and negative terminals of individual cells or the smallest group of cells possible. Compute the resultant impedance using Ohm's law.

2) Conductance measurements can be performed by applying a voltage of known frequency and amplitude across a cell/unit and observing the ac current that flows in response to it. The conductance is the ratio of the ac current component that is in-phase with the ac voltage, to the amplitude of the ac voltage producing it.

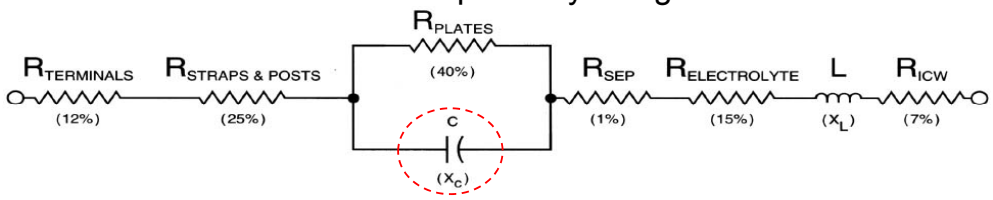
3) Resistance measurements can be performed by applying a load across the cell/unit and measuring the step change in voltage and current. The ohmic value is calculated by dividing the change in voltage by the change in current.

In the absence of specific guidelines from the instrument manufacturer, changes in ohmic values in excess of 20% should be considered significant. Such changes should be discussed with the battery manufacturer. In the absence of consultation with the battery manufacturer, a performance test should be run to determine the reliability of the battery system.

Significant changes in the values typically indicate a significant change in the cell, which may be reflected in its performance. However, limited changes in the specific values obtained do not necessarily indicate that the cell is free of defect or deterioration.

# (5-2) IBEX / BDS measure internal ohmic resistance except capacitance

- Following is Battery Equivalent Circuit. In IEEE Std.1188-1996, Internal Ohmic Measurements can be performed passing a current and measuring the resultant ac voltage across cell, and the internal Ohmic Resistance/conductance is computed by using AC ohm's law.




Conventional Impedance Tester can measure total Impedance including Xc (capacitance) and this impedance measuring is unrelated to battery surfation or aging.

- Xc (capacitance) is varied by testing current frequency.
- But, IBEX/BDS can measure only internal ohmic resistance except for Xc capacitance, the reason why IBEX can compute the ratios of AC impedance voltage that is in-phase with AC current by IEEE recommendation.






# (5-3) IEEE 2001. Paper

## Discrete Frequency Immittance Spectroscopy (DFIS™)
### A New Technique for Battery Instrumentation

**Keith S. Champlin[a] and Kevin Bertness[b]**

[a]*University of Minnesota, 5437 Elliot Avenue South, Minneapolis, MN 55417 (champlin@ece.umn.edu)*

[b]*Midtronics, Inc., 7000 Monroe Street, Willowbrook, IL 60521 (k.bertness@midtronics.com)*

**ABSTRACT**

We describe a new technique for accurately determining a lead-acid battery's performance without actually discharging it. The battery is excited with periodic currents and its complex impedance (or admittance) is determined at **n** discrete frequencies. By mathematically combining the **2n** measured quantities, the elements of a **2n**-element equivalent circuit model of the battery are evaluated. The electrical elements represent actual physical and/or electrochemical processes occurring within the battery and their values yield previously unavailable information concerning the battery's performance.

# (5-3) IEEE Std.
# Battery's Internal Ohmic Measurement

We describe a new methodology, "Discrete Frequency Immittance Spectroscopy" (**DFIS**™), to accurately evaluate previously unavailable battery performance parameters. The cell/battery is excited with periodic currents, and its complex impedance $\mathbf{Z = R + jX}$ (or complex admittance $\mathbf{Y = 1/Z = G + jB}$) is determined at the excitation's fundamental frequencies. By measuring complex **Z** (or **Y**) at **n** discrete frequencies and mathematically combining the **2n** measured quantities, **DFIS**™ evaluates elements of a unique **2n**-element equivalent-circuit model of the cell/battery. These **2n** values contain virtually the same information as the continuous **Z** (or **Y**) spectrum expressed over a wide frequency range. However, the elements themselves represent actual physical and/or electrochemical processes occurring within the cell/battery and can potentially provide:

$Z = R + jX$ or $Y = 1/Z = G + jB$

IEEE AUTOTESTCON 2008, 8-11 Sept. paper

*Power Fade*: The loss of cell power due to an increase in cell impedance during aging is known as power fade. In this paper, we determine the power fade of the battery from the EIS test. The actual power from the EIS test is calculated as:

$$P = \frac{V^2}{R} \quad (13)$$

where $V$ is the voltage (5mV for EIS test) and $R$ is the total resistance, ($R_{HF}$+$R_{tc}$), obtained from EIS data using nonlinear least squares. Hence, power fade is computed as follows:

$$Power\ Fade = 1 - \left(\frac{Power(k)}{Power(0)}\right) = 1 - \frac{R(0)}{R(k)} \quad (14)$$

where Power(0) is the power at the beginning-of-life (BOL) and Power($k$) is the power at the desired time (week).

As proved by paper;IEEE AUTOTESTCON 2008, 8-11 Sept., SOH (Power Fade) is proportional(or inverse proportional) to Internal Resistance R or Siemens G based on paper calculation(13) and calculation(14).






# (5-3) Real Part of Y(1/R ) Frequency Spectroscopic

POWERTRON Core Technology:

Near 300Hz, "Internal Resistance R or Siemens G" becomes High, therefore Validation is good

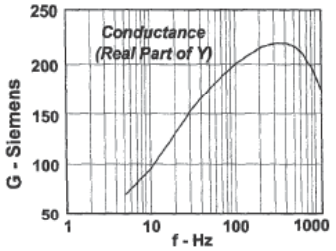



Figure 2. Conductance spectrum of 12V SLI battery

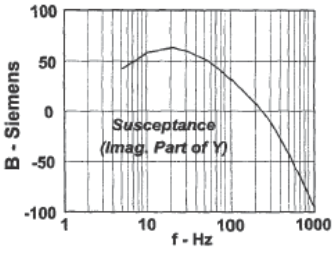



Figure 3. Susceptance spectrum of 12V SLI battery

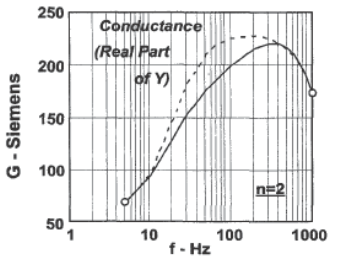



Figure 7. Comparison between measured conductance and that calculated from model of Figure 6.

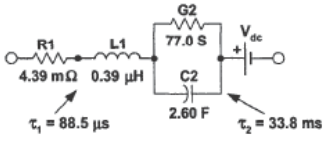



Figure 6. DFIS™ results for n = 2.

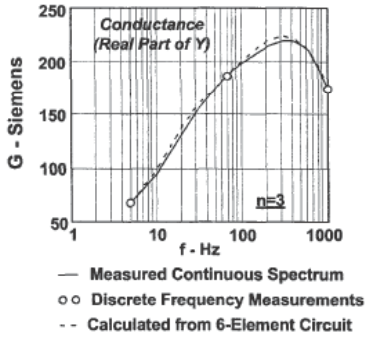



Figure 10. Comparison between measured conductance and that calculated from model of Figure 9.

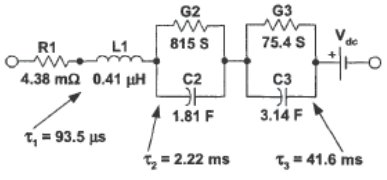



Figure 9. DFIS™ results for n = 3

# (6) Specification and Characteristics for IBEX

| Items | IBEX-1000 | IBEX-PRO | IBEX-Ultra |
|---|---|---|---|
| ▪ Data Storage | 600 | 600 | 4,800 |
| ▪ Measuring Items<br>Cell Voltage<br>Cell Resistance<br>Interconnect Resistance<br>Temperature on (-) terminal<br>% Ripple Current, FFT Analysis | <br>0.1Vdc ~60.0Vdc<br>3/30/300mΩ(auto)<br>3/30/300mΩ(auto)<br>-20℃~+80℃<br>N/A | <br>0.1Vdc ~60.0Vdc<br>3/30/300mΩ(auto)<br>3/30/300mΩ(auto)<br>-20℃~+80℃<br>N/A | <br>0.1Vdc ~60.0Vdc<br>3/30/300mΩ(auto)<br>3/30/300mΩ(auto)<br>-20℃~+80℃<br>Available Ripple % with connected DC Clamp Meter. |
| ▪ Capacity Range | 5AH~6,000AH | | |
| ▪ Accuracy: Voltage, Temp.<br>Resistance/ Siemens | ±0.5% class, ±2.0 class (-20℃~+80℃)<br>±1.0 % rdg. ±8 dgt. (3milli ohm full-scale) across test range | | |
| ▪ Resolution:<br>Voltage, Temp. Resistance, | 10mV, 0.5℃, 0.01mΩ | | |
| ▪ Measuring mode, speed/ cell | **Normal** (less than 4 seconds for measurement), **Fine** and **Automatic** | | |
| ▪ Download and Analysis S/W | ▪ **SerialComm** (download and Excel file conversion S/W)<br>▪ **Exmons Pro 2005/Ultra** (Integrated Diagnosis S/W Stationary Application)<br>Database construction and control by site, bank, cell<br>2D, 3D graph display of changes against basic values or by period<br>Printing of data and analysis report including graph | | |
| ▪ probe types (5) | ① 4-Pin ② Clip ③ Clip with thermal sense ④ Mini-pin ⑤ Temperature | | |
| ▪ Data Format | Excel 2000/ 2003, Windows 98/ 2000/ XP/ Vista compatible | | |
| ▪ Build-in Battery | 2,200mAh, 11.1V | | |
| ▪ Wight, Exterior size (mm) | World first compact size 650g, 95W * 42D * 175H can fits in the palm of your hand | | |







# (7) IBEX-1000 (Economy) Item list


| IBEX-1000 (Economy) | |
|---|---|
| US$ is distributor price. | |
| 1 | IBEX-1000 Body (no printable means) |
| 2 | Li-ion Battery inside Body |
| 3 | Soft Poly-Vinyl Bag |
| 4 | Standard Charger for Body, 100Vac to 240Vac |
| 5 | 4-Pin type Probe |
| 6 | USB Cable to upload PC |
| 7 | Bundled Software : SerialComm |
| 8 | English User's Manual |

# (8) IBEX-PRO (Standard) Item list


| IBEX-PRO (Standard) | |
|---|---|
| US$ is distributor price. | |
| 1 | **IBEX-Pro Body with printable means** |
| 2 | Li-ion Battery inside body |
| 3 | **Soft Poly-Vinyl Bag with Zero Adjust Plate** |
| 4 | Standard Charger for Body, 100Vac to 240Vac |
| 5 | **4-Pin type Probe** |
| 6 | **Clip Type Probe** |
| 7 | **Temperature Probe** |
| 8 | English User's Manual |
| 9 | Shunt (50mV/50A, 1mΩ, 1.0Class) |
| 10 | USB Cable to upload PC |
| 11 | Diagnosis Software, Exmons Pro 2005 |
| 12 | **Plastic Carrying Case(450×340×120)** |
| 13 | Spare 4-Pin Tip |
| 14 | Spare Li-ion Battery |
| 15 | **IR Thermal Printer** |
| 16 | Spare Paper Roll for IR Thermal Printer |
| 17 | 220V AC Standard Charger for IR Thermal Printer |






# (9) IBEX-Ultra Item list


| IBEX-Ultra | |
|---|---|
| US$ for distributor price. | |
| 1 | **IBEX-Ultra Body with printable means** |
| 2 | Li-ion Battery inside body |
| 3 | **Soft Poly-Vinyl Bag with Zero Adjust Plate** |
| 4 | Standard Charger for Body, 100Vac to 240Vac |
| 5 | **4-Pin type Probe** |
| 6 | **Clip Type Probe** |
| 7 | **Temperature Probe** |
| 8 | English User's Manual |
| 9 | **DC Clamp Meter to measure a ripple current %** |
| 10 | USB Cable to upload PC |
| 11 | Diagnosis Software, Exmons Pro Ultra |
| 12 | **Plastic Carrying Case (450×340×120)** |
| 13 | Shunt (50mV/50A, 1mΩ, 1.0Class) |
| 14 | Spare 4-Pin Tip |
| 15 | Spare Li-ion Battery |
| 16 | **IR Thermal Printer** |
| 17 | Spare Paper Roll for IR Thermal Printer |
| 18 | 220V AC Standard Charger for IR Thermal Printer |

# (9-1) IBEX-Ultra Strength

❖ **Exmons Pro Ultra** supports a multi-user environment in data management.

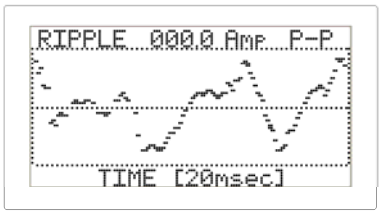
❖ Possible to analyzing Content Percentage (%) of Charging Ripple Current.

❖ Data Storage

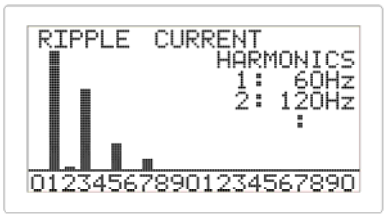
| Model | IBEX-1000, PRO | IBEX-Ultra |
|---|---|---|
| Data Storage | 600cells Max. | 4,800cells Max. |

❖Alarm Setting Files

| Model | IBEX-1000, PRO | IBEX-Ultra |
|---|---|---|
| **Alarm Setting Files** | 4 | 80 |




[RIPPLE WAVEFORM ]



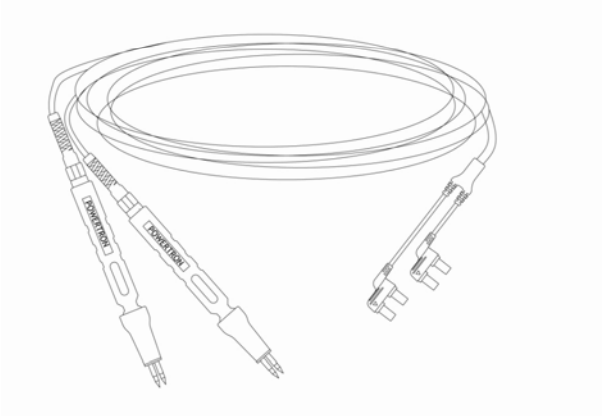

[RIPPLE FFT]







# 2-1. Accessories
## (1) Accessories drawing



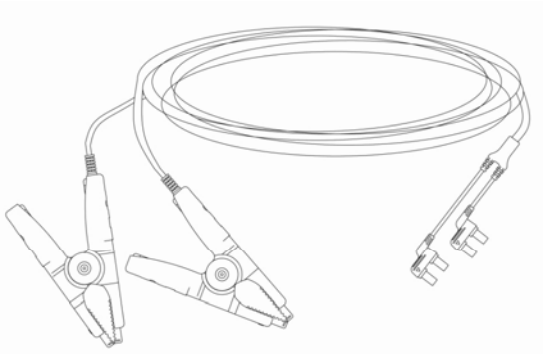
4-Pin type Probe

(Included in Economy, PRO, Ultra model)

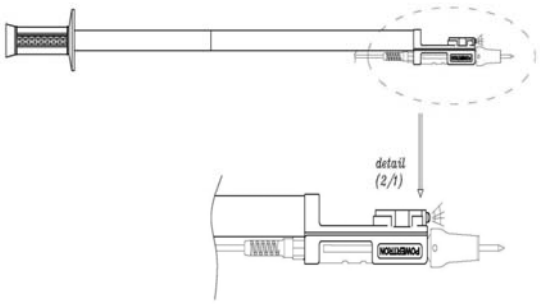
Temperature Probe

(Included in PRO, Ultra model)

# (2) Accessories drawing



Clip type Probe
(Included in PRO, Ultra model)




Probe Extension for inside cabinet battery testing.
(additional price item)






# (3) Accessories drawing

Clip with Temperature sensor type Probe
(additional price item)

Mini-pin type Probe
(additional price item)

# (4) Accessories drawing


IR Thermal Printer

Charing adopter Thermal Printer

Shunt (50mV/50A, 1mΩ)
for simplicity calibration






# (5) Accessories drawing

Spare Paper Roll

Spare 4-Pin Tip

Standard Charger for IBEX
Body, 100Vac~240Vac

# (6) LCD Display for 1000 /Ultra model

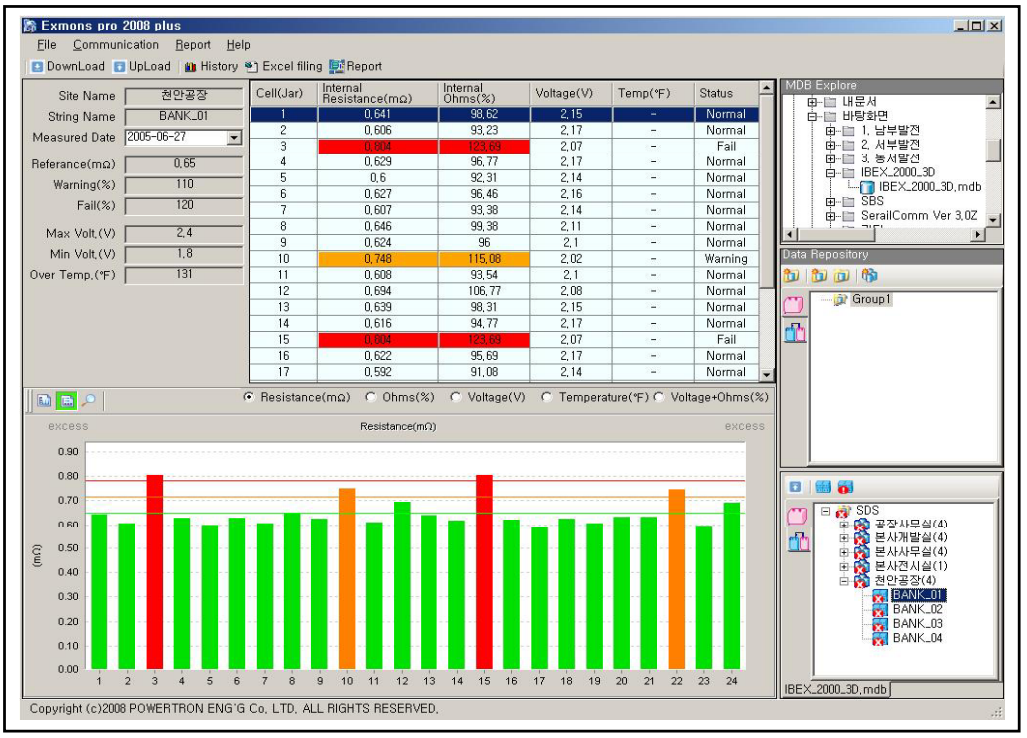




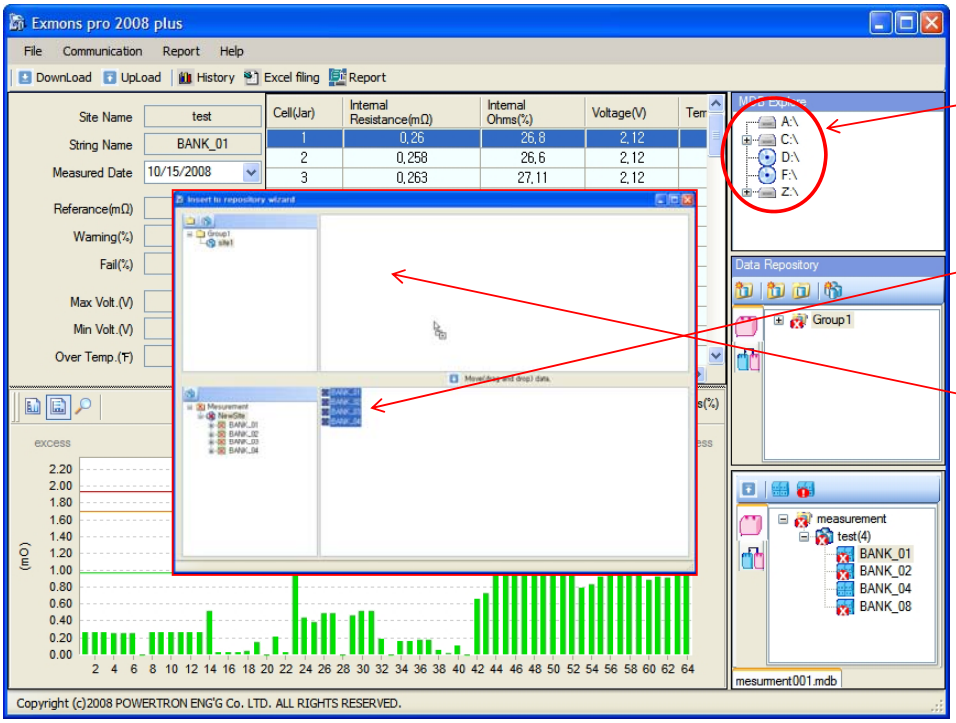



# 2-2. Exmons Pro Ultra

**supports a multi-user environment in data management.**



# 2-2. Exmons Pro Ultra strength




1. Double-click 「mdb」 file by Searching it in MDB Explore. Then, you can see the data of selected 「mdb 」 file in lower window
**This is user-friendly function for Multi-user Environment.**

2. Please select Measurement Date nodes in the Data list of lower window.

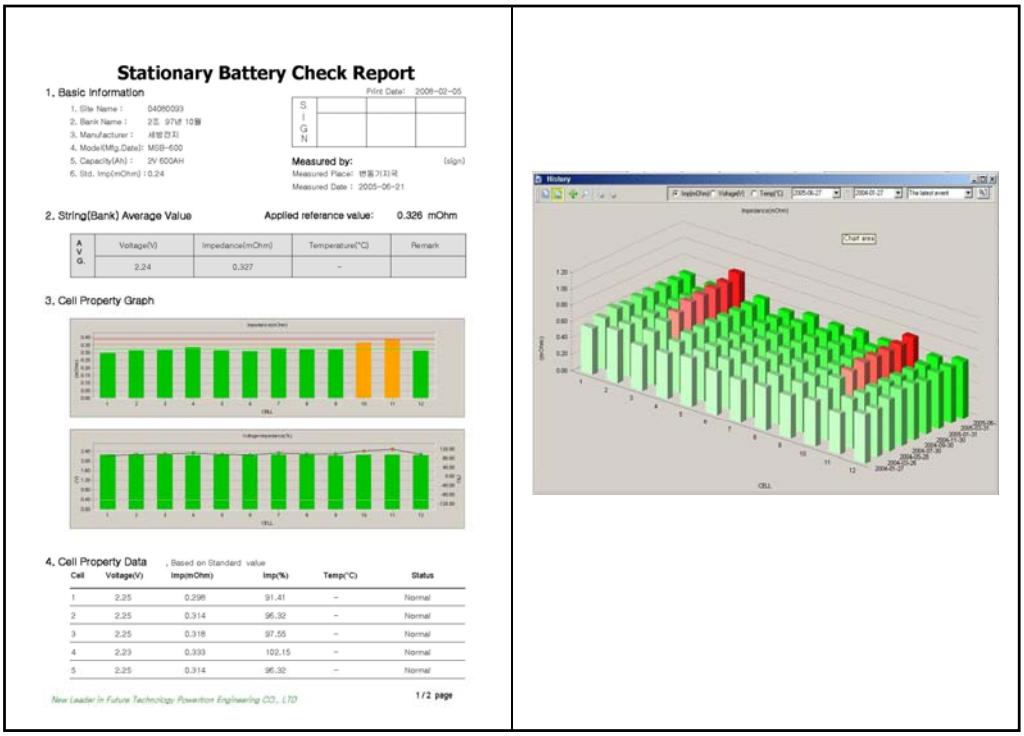
3. Please drag and drop nodes to the site of Repository list in upper window for constructing database of measured data with Strings.

4. Measured data in the Data list of lower window can be added to the previous String in upper Repository Window, that is the same string can be managed by date in one String. Therefore, you can easily analyze the aging status by date order with 2D, 3D graph, measured data and etc.






# 2-2. Report Form / 3D Trend



# 2-3. Sales Reference – USA(1)


**An Exclusive dealer in USA**

**http://eepowersolutions.com/**







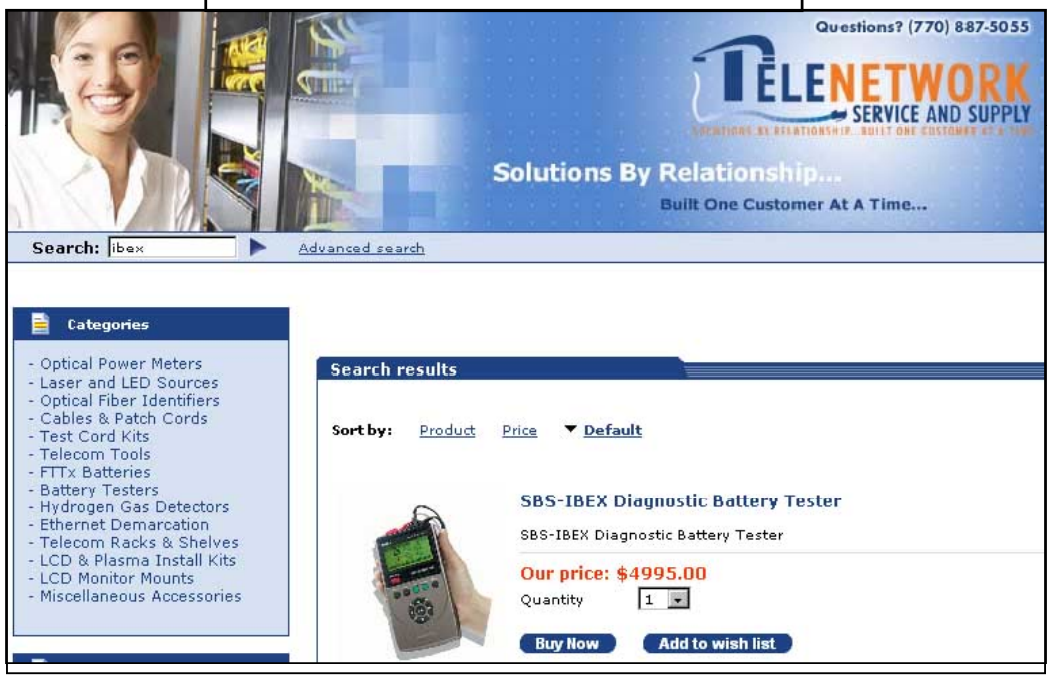
# 2-3. Sales Reference – USA(2)


**Another dealer in USA**

**www.sbsbattery.com**

# - USA(3)

www.telsupply.com







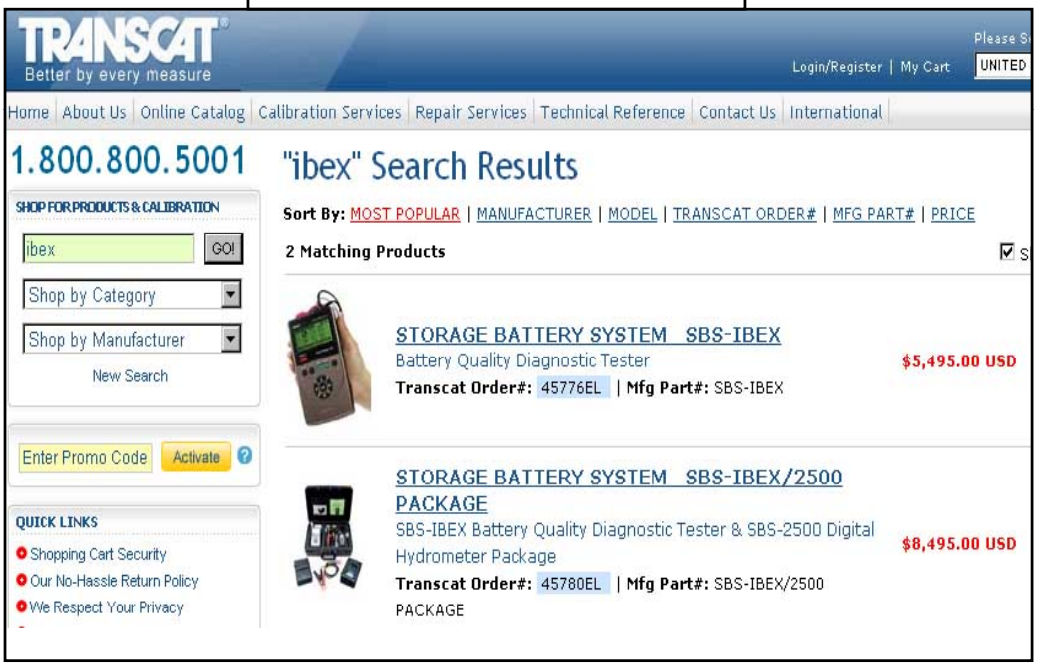



# - USA(4)

www.ebay.com

## -USA(5)

**www.transcat.com**









# 3. IBwatch

# Battery Monitoring System


# 3. IBwatch

We manufacture 2 types of Battery Monitoring System (BMS).

| Type | Special Features | Target Customer |
|---|---|---|
| **BDS/pro** | ■ is a compact type of Battery Diagnostic System assembled in a case.<br>■ is suitable to measure 24 jars in a string. | Electric (Utility), Internet Data Center, Railroad, Substation, Factory, Building, Telecom, Mobile, Small UPS and etc. |
| **BMS i-com** | ■ is a compact type of Battery Monitoring System assembled in a case.<br>■ is suitable to measure 4 or 8 jars in a string. | Substation and etc. |





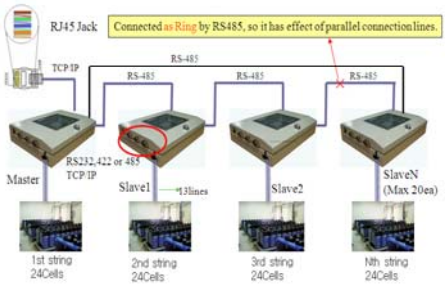

# (1) Technical Specifications

Our product is satisfied with IEEE Std.1188-1996/2005 "IEEE Recommended for Maintenance, Testing, and Replacement of Valve-Regulated Lead-Acid (VRLA) Batteries for Stationary Applications.

| Type | Technical Specification |
|---|---|
| **BDS/pro** | • Automatic measuring; a string voltage, a jar voltage, charging & discharging current, jar internal resistance, and a jar temperature of 10% jars (all is optional).<br>• Measuring speed (3 sec/jar), measuring and storage interval (5 min. to 41 days), interface (RS-232/485, TCP/IP)<br>• Monitoring software; display a numerical and graphic bar and is capable of monitoring without specific program, which is 'Centroid Snet'. |
| **BMS i-com** | • As similar as upper. |

# (2) Unit Type and Names

Our product has better quality, moreover a sufficient competitive compared with others

| | | |
|---|---|---|
| **BDS/pro** for UPS, Telecom batteries. |  270*230*60mm (World compact size) |   |
| **BMS i-com** for substation batteries. |  137*121*47mm (World compact size) | |

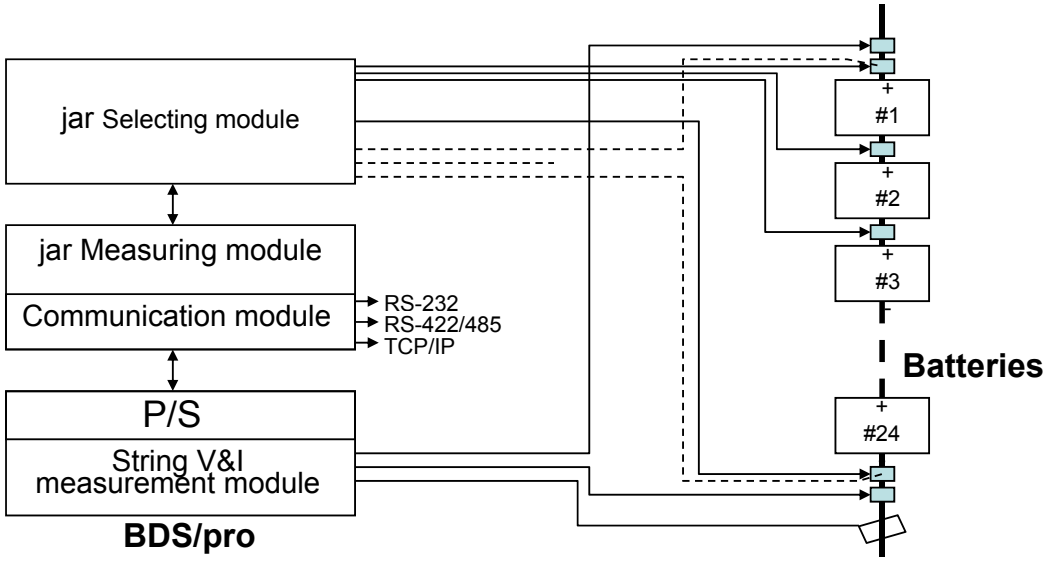






# (3) BDS/pro

## ① Block Diagram




- BDS/pro is compact, because all modules is contained inside one case.
- BDS/pro installation is simple, because of simple wiring & connection.
- BDS/pro operation is easy, because of web-based Software.
- iPQMS/BDS as well as BDS/pro are compact, simple and easy.

# (3) BDS/pro

## ② Strength

BDS/pro Network composition for multi communications through RS485 Serial port to each battery strings.

RJ45 Jack

Connected as Ring by RS485, so it has effect of parallel connection lines.




**Merit: Each BDS/pro(max 20 sets connection is possible) connected by RS485 communication. This system is ring connected, so even though any RS485 line is disconnected but it does not any effect to communicate with other BDS/pro.**







# (3) BDS/pro

## ③ Installation View (1)

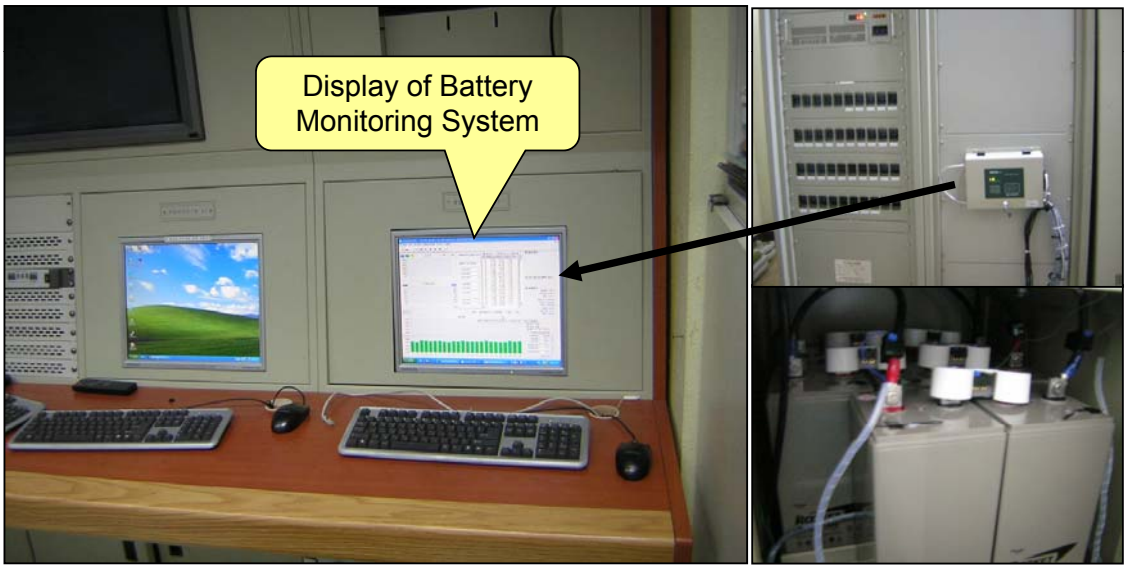
BDS/pro was installed in Network Provider.
Easy to connect battery string with BDS/pro by RS485.


2V/ VGS 1600AH, 24 jars

# (4) BDS/pro

## ③ Installation View (2)

BDS/pro was installed at the headquarter of Nuclear Power Plant.










# (4) BDS/pro

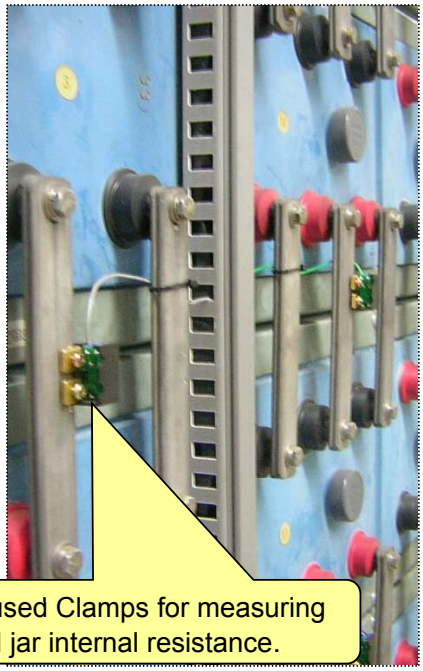
## ③ Installation View (3)

BDS/pro was installed at Telecom company.

# (4) BDS/pro

## ③ Installation View (4)

**BDS/pro** was installed at Internet Data Center.



Special designed Fused Clamps for measuring a jar voltage and jar internal resistance.







# (5) BMS i-com

## ① Installation View

BMS i-com was installed at City Hall.


# (6) iPQMS/BDS ① Installation View(1)

**iPQMS/BDS** was installed at City Hall.

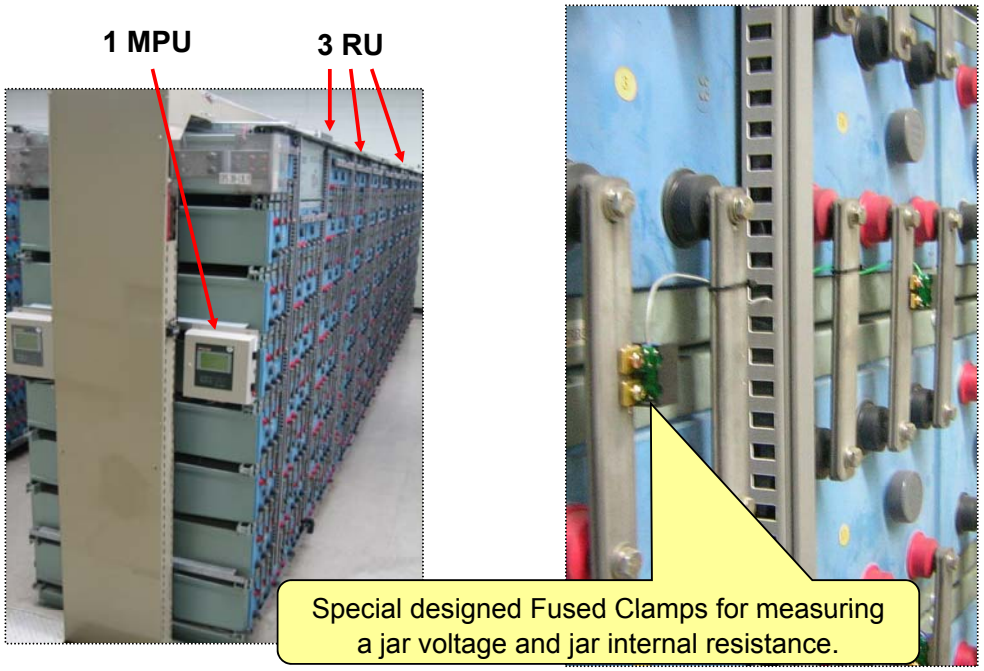




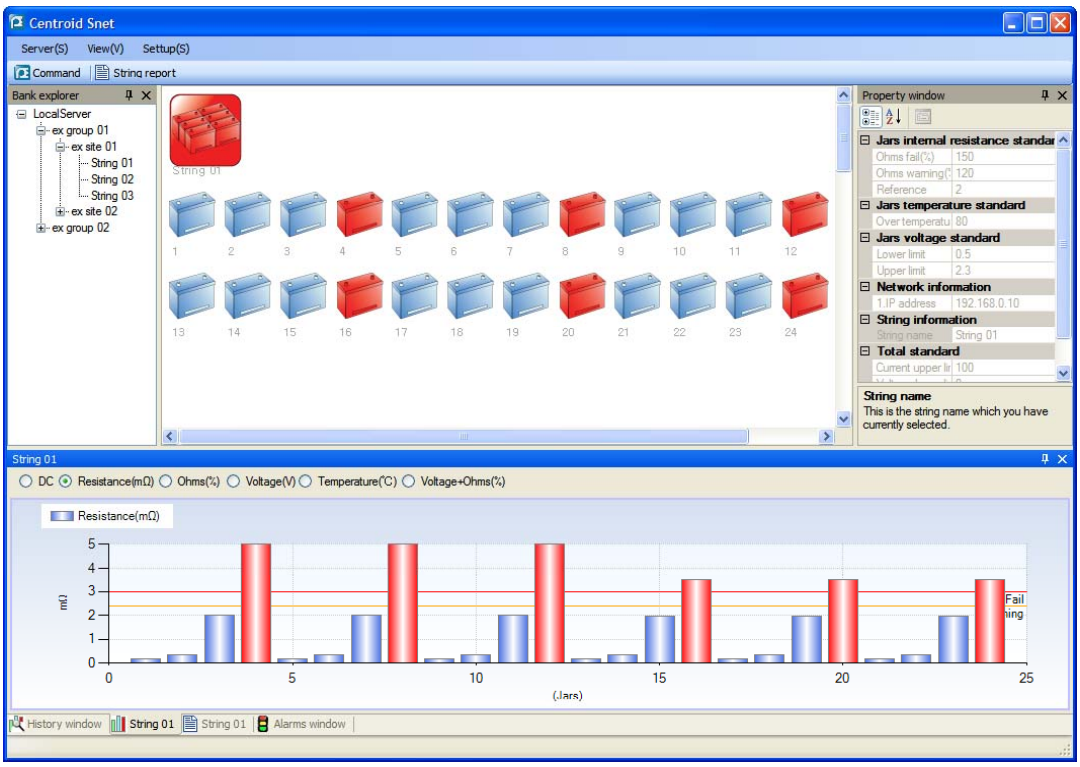



# (6) iPQMS/BDS ① Installation View(2)

**iPQMS/BDS** was installed at Internet Data Center.



# (7) Centroid Snet – Diagnostic S/W

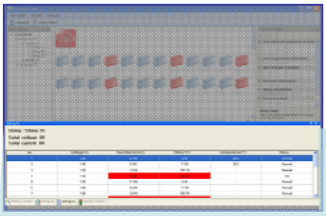







POWERTRON

# (7) Centroid Snet – Diagnostic S/W



String 01

String :String 01
Total voltage 0V
Total current 0A

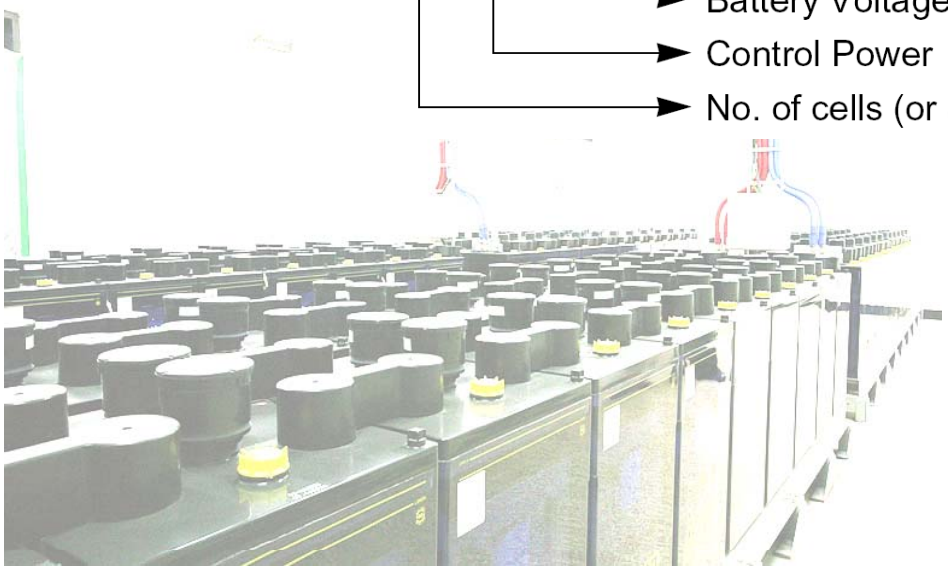
| Jar | Voltage(V) | Resistance(mΩ) | Ohms(%) | Temperature(℃) | Status |
|---|---|---|---|---|---|
| 1 | 1.00 | 0.168 | 8.40 | 28.5 | Normal |
| 2 | 1.00 | 0.351 | 17.55 | 28.5 | Normal |
| 3 | 1.00 | 2.014 | 100.70 | - | Normal |
| 4 | 1.00 | 7.087 | 354.35 | - | Fail |
| 5 | 1.00 | 0.169 | 8.45 | | Normal |
| 6 | 1.00 | 0.349 | 17.45 | - | Normal |
| 7 | 1.00 | 2.015 | 100.75 | - | Normal |

History window String 01 String 01 Alarms window

# (8) Ordering Options

**BDS/pro, BMS i-com** XXC-10-2

- Battery Voltage
- Control Power
- No. of cells (or Jars)







**If you have any questions, contact us.**

**E-mail: biz@powertron.co.kr**

**Phone: 82-2-445-5787(Ext:1)**

*New Leader in future technology*, POWERTRON

Thank you!