## Performance Specifications

### Sensor Lineup

<table>
<thead>
<tr>
<th>Sensor Type</th>
<th>Source Type</th>
<th>Measurement Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beta-ray</td>
<td>$^{85}$Kr</td>
<td>0 to 1,200 g/m²</td>
</tr>
<tr>
<td>X-ray</td>
<td></td>
<td></td>
</tr>
<tr>
<td>For mid range</td>
<td>Reflection type X-ray tube and tungsten target</td>
<td>0 to 600 g/m²</td>
</tr>
<tr>
<td>For high range</td>
<td>Transmission type X-ray tube and tungsten target</td>
<td>0 to 1,200 g/m²</td>
</tr>
</tbody>
</table>

### Frame Lineup

<table>
<thead>
<tr>
<th>Frame Type</th>
<th>Sheet Width</th>
<th>Number of Installable Sensors</th>
<th>Drive System and Processor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compact O frame</td>
<td>800 mm or less or 1,500 mm or less</td>
<td>One</td>
<td>Linear servo drive system and frame processor</td>
</tr>
<tr>
<td>Build-in frame</td>
<td>800 mm or less or 1,500 mm or less</td>
<td>One</td>
<td>Linear servo drive system, frame processor, and local box</td>
</tr>
</tbody>
</table>

### System Platform

<table>
<thead>
<tr>
<th>Platform Type</th>
<th>System Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operator Station</td>
<td>For workstation computers and Windows 7 64-bit</td>
</tr>
<tr>
<td>Profile Stack Server</td>
<td>For workstation computers and Windows 7 64-bit</td>
</tr>
<tr>
<td>Measurement Manager Station</td>
<td>Board type device that can be housed in 19-inch racks</td>
</tr>
<tr>
<td>System Network</td>
<td>Ethernet (100BASE-TX)</td>
</tr>
</tbody>
</table>

### Main System Functions

- Measurement sequences (such as SCAN and AUTCAL), profile calculation, smoothing calculation, coat weight calculation, synchronization measurement, judgment of coated or non-coated part.
- Operation screen (such as Profile panel, Zone Trend Profile panel, and 3D Profile panel), Grade Control screen, Synchronous Measurement Tuning screen.
- Maintenance screen (such as System Administration screen).
- Saving profiles to output them in CSV format.
Battery Production requires a Dedicated Coat Weight Measurement System

"WEBFREX3ES is a YOKOGAWA’s new solution based on more than 20 years of our experience in battery production application. It is a coat weight measurement system specifically designed for battery electrode sheets that contains latest application know-how and an advanced sensor technology. This measurement system helps the improvement of the safety and performance of the battery and the cost optimization, that are important for the coating process of rechargeable battery electrodes.”

YOKOGAWA will continue to contribute to the development of the battery fulfilling customer needs.

The rechargeable battery technology has brought information revolution through mobile devices, facilitating a low carbon society through EV and HV. It is expected to be applied to large scale electricity storage technology with the increased interest in renewable energy. This battery technology is changing not only industry but also our lives and culture.

WEBFREX3ES measures coat weights of battery electrode sheets with high accuracy on battery electrode production lines, contributing to the improvement of the safety and performance of the battery and to the cost reduction.

WEBFREX3ES System Configuration
WEBFREX3ES consists of up to five frames which accommodate a beta ray or X-ray type sensor, a measurement manager station which generates the coat weight profiles, operator stations, and a Profile Stack Server.

The system is equipped with various functions provided for battery electrode process; i.e., high-speed and high-precision synchronization scanning, automatic identification of coated or non-coated part, Zone Trend panel, profile data tracking and Material Coefficient window.

Moreover, all major components are originally-developed and manufactured at own factories, under the high quality control policy proven by highly reliable DCS and field instruments.
High-density Measurement by High-speed Scanning

Since the coat weight of a battery electrode sheet influences both the battery performance and the cost of battery electrode sheets production greatly, accurate measurement is very important. Moreover, in order to trace the quality and performance of a battery at the final inspection or after shipment, the measurement data in each cell is indispensable.

Totally redesigned drive mechanism provide three (3) seconds scan (shortest time of one-way scan), and perform high-density measurement.

- High-speed scanning by linear servo motor
- Specific sensor for battery electrode coating process having significantly improved response time
- Dedicated processor providing high-speed data processing

Direct drive linear servo motor which excels on smooth driving and precise position control by adopting the technology of unique glass scale and inner liner encoder. Since there are no solid rotating parts, such as a ball screw, no metal powder and dust are produced. This motor can be used in a clean environment such as coating facilities.

High Accuracy Measurement by Sensors Suitable for Battery Applications

Beta-ray or X-ray transmission method sensors are available. The sensors measure basis weight under the principle in which radiation is attenuated while being transmitted to the materials between the source and the detector according to the amount of material. However, the measurement sensitivity to the weight differs between the Beta-ray sensor and the X-ray sensor depending on the combination of the base material and coating material. Since it determines the measurement performance, the sensor selection is very important for accurate measurement.

In WEBFREXES, the Beta-ray sensor and two types of X-ray sensors are available. From small capacity batteries, such as for mobile devices to large capacity batteries such as for EV, the fittest sensor can be provided.

- WG41B1B: Beta-ray sensor (radiation source: 85Kr)
- WG41X2B: X-ray sensor (for mid range)
- WG41X5B: X-ray sensor (for high range)

The sensor consists of a pair of upper and lower units. In the upper sensor module the detector is mounted, and in the lower the radiation source or the X-ray tube is assembled.

Space-saving Frame Installable in Any Position

Compact designed frames can be installed in the limited space of a battery electrode production facility. The build-in type frame can be installed in the coating-machine’s walls or pillars directly, so it can be installed in a very tight space, such as between the coating-head and the entrance of the dryer.

Two types of frames are available: Compact O frame (WG41F11B) and Build-in frame (WG41F12B). Since these frames have the same basic specifications, such as a drive mechanism, a mountable sensor, and a processor, either of the frames can be chosen depending on the installation site.

- WG41F11B: Compact O frame
  The WG41F11B Compact O frame is a space-saving frame designed for coating machines. The processor is accommodated in the B-end column.
- WG41F12B: Build-in frame
  The WG41F12B Build-in frame is a frame designed to mount onto a coating machine. The processor is accommodated in the remote local box.

The Built-in frame can be mounted into a coating machine. It fits to installation a narrow space, such as a wet part (before dryer) and contributes to quicker action on adjusting coat weight profiles.
**FINE**  Precise Synchronization measurement by Dedicated Processor

The coat weight is obtained by an indirect measurement method: i.e. by subtracting before coating weight from the after coating weight.

In the coat weight measurement data of each scanner contains the process variations caused by uniformity of the base sheet and fluctuation of the coated material. To obtain the accurate coat weight with the indirect measurement method, detecting the same spot of the object with every scanner, "the Synchronization Measurement" is absolutely important.

In WEBFREX3ES, all the frames in a system measure the exact same spot by the key technologies: e.g. 1/1000 mm position resolution in the liner servo motor and the synchronization scan management by the independent processor. All these technologies proved by the field experiences enable the sensor performance fully to provide the accurate coat weight data.

- Precise position control in the linear servo motor.
- Accurate synchronization control by the dedicated processor and network.

Example of a synchronization test result. The lines made by the pens attached on three sensor heads are aligned within 1 mm.

**FUNCTIONAL**  Various Functions Assisting in Production Management and Quality Management

- Quality tracking of shipped products.
  Measuring the coat weight profile of each cell by high-speed scanning and storing the data into Profile Stack Server.

  Since the weight profile of each scanner is stored as indexed data with the length of the roll, it can be simply tied to cells of packaged batteries. Moreover, the stored weight profile data can be output in CSV format, and it can be used to trace the quality of shipped products.

- Variety of coat weight profiles
  Variety of weight profiles, such as the independent coat weight of top and bottom, weight of the wet part and the total coat weight can be generated depending on the requirement of production process.

- Wet measurement
  Installing the frame before the dryer allows coat weight adjustment based on data from the wet part, allowing to decrease the amount of lag time of the drying process.

**FRIENDLY**  Intuitive and User-friendly Human Interface

The human interface delivers the process information to all relevant staffs clearly and assists them to make quick judgment and actions.

- Measurement of various coating patterns
  WEBFREX3ES is ready to measure various coating patterns, such as intermittent coating and stripe coating.

  While in scan measurement mode, the system automatically judges coated or non-coated area, and the Operation screen highlights profiles of the coated area.

- Real-time zone trend profile
  The screen shows the trend of average coat weight and CD profile of each zone simultaneously. It supports the quick and exact weight adjustment of coating process.

- Real-time 3D profile
  The screen shows a bird’s-eye view of coat weight profile of a whole roll. Zoom-in, zoom-out and rotation functions assist intuitive quality management.

- Easy customization for Operation screen
  The Operation screen can easily be customized using the Profile, Trend, Digital Display and other panels.

- Showing stored weight profile
  The stored profile in the database of Profile Stack Server can be shown on the Operation screen. With referring to the previous data, operators can identify the changes or differences.

- 3D Profile View function
  Bird’s-eye view indicates the long-term process change.

- System Overview
  The screen shows the status and conditions of all the components of WEBFREX3ES.

- Zone Trend panel
  The screen visualizes the trend of average coat weight and CD profile of each zone simultaneously.

- Improving the traceability of the product using Profile Stack Server.

- Reducing production loss with the wet part measurement.