

# Battery Manufacturing

Industry Application

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## Overview

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Roll-2-Roll Technologies provides advanced sensor solutions designed for the spatial constraints and precision requirements of modern battery manufacturing. As the industry moves toward wider webs and faster line speeds to reduce cell costs, precision becomes critical. Our **one-sided, integrated sensor design** combines light source, optics, and camera into a single compact unit—eliminating the need for bulky external gantries while delivering **0.016 mm resolution. No programming is needed**—operators can set up the system in minutes, reducing engineering overhead and total cost of ownership.

## The Engineering Challenge

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Battery manufacturing lines involve harsh environments and extreme precision requirements that defeat traditional sensing methods.

- **Spatial Constraints:** Critical measurement points inside drying ovens or immediately before calender presses are notoriously tight. Traditional C-frame sensors simply do not fit.
- **Electrode Misalignment:** Anode and cathode coatings must overlap with extreme precision. Drifting by even a fraction of a millimeter can cause lithium plating or short circuits.
- **"Lost Edge" Stops:** Heavy battery foils wander during splices or speed ramps. Narrow-view sensors lose the edge, triggering costly machine E-stops.
- **Calendering Damage:** If the web enters the high-pressure calender nip slightly skewed, wrinkles are pressed into the electrode, destroying the material.

## The R2R Technical Advantage

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We address these challenges with a unique architectural approach that prioritizes accessibility and performance. Effectively, you get a **Vision System in a Sensor Package**.

- **Line Scan Camera Technology:** While marketed as a sensor, the device functions as a one-dimensional line scan camera with a pixel array ranging from 768 to over 14,000 pixels. This provides the "spatial awareness" to see multiple edges and features simultaneously.
- **Linear Optical Technology:** Unlike traditional cameras with circular lenses that cause distortion, our patented fiber optic array provides 1:1 image magnification. This ensures measurement accuracy is

identical across the entire field of view.

- **Compact, One-Sided Installation:** Our sensors operate from a single side of the web, allowing installation in restricted areas (typically around 10-15 mm from the web) where traditional frames won't fit.
- **Wide Viewing Area:** We offer a significantly wider viewing area (up to 960mm) compared to standard sensors, ensuring continuous tracking even when the web wanders significantly during process upsets.
- **Sub-Pixel Precision:** Proprietary algorithms push effective resolution to 0.016 mm, critical for holding tight coating tolerances.

## Key Applications

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### 1. Electrode Coating Alignment & Width Measurement

Ensure precise overlay of anode/cathode coating on current collectors. The **wide viewing area** allows for real-time monitoring of both the coating edge position and the total coating width. The sensors use **contrast detection** to measure the distance between the edge of the metal foil and the edge of the active material coating, ensuring the coating is properly centered and applied.

### 2. Calender Infeed Guiding

Space is at a premium near high-pressure calender rolls. Our **compact, one-sided sensors** can be mounted immediately adjacent to the nip point. This proximity reduces "dead time" (transport lag), providing the web guide with real-time data to correct high-frequency disturbances before wrinkles occur.

### 3. Trim and Tab Measurement

The system can simultaneously measure multiple specific widths, such as "trim one width," "trim two coating width," and "tab width." In the slitting and notching phase, accurately measuring these dimensions is critical for quality control. R2R's high-resolution sensors provide the precision needed to verify tab tolerances in real-time.

### 4. Electrode Slitting

Accurate width measurement is used during the slitting of anode and cathode materials to ensure precise dimensions before cell assembly. With **0.016 mm resolution**, operators can detect even minor width variations immediately, ensuring consistency across the entire roll.

### 5. Oven-Internal Monitoring

Unlike bulky thru-beam frames, the R2R sensor can be mounted inside the drying oven environment (with appropriate cooling/shielding) to monitor web stability during the critical drying phase, preventing coating defects caused by flutter.

## Supported Web Guiding Solutions

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Our controllers come pre-loaded with multiple guiding software modules, allowing one system to adapt to various battery production needs.

- **Center Guiding:** Uses two sensors to track both edges of the anode or cathode foil, keeping the centerline perfectly aligned during coating or calendaring. Essential for maintaining symmetry on varying width foils.
- **Edge Guiding:** The most common application. Uses a single sensor to track the foil edge or coating edge for precise positioning entering the dryer or slitter.
- **Master-Slave Guiding:** Critical for lamination. One web (the master) is tracked, and the second web (the slave) is guided to align perfectly with it, ensuring accurate anode-cathode overlap.

## Digital Integration & Connectivity

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Our controllers support major industrial protocols like **EtherNet/IP, PROFINET, and EtherCAT**, enabling seamless integration with battery line PLCs for automated control. The system also offers app-based data logging, allowing quality assurance teams to download width and position logs to CSV files for batch validation.

## Technical Comparison

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**The "Scanner vs. Laser Pointer" Analogy:** Comparing an R2R Sensor to a standard photo-eye is like comparing a flatbed scanner to a laser pointer. A laser pointer only tells you if something is blocking a specific spot (on/off). An R2R sensor "scans" the entire edge profile, allowing it to understand exactly what is there (foil edge, coating edge, or defect) and where it is.

- **Installation:** Traditional optical sensors require two-sided frames. R2R uses a **one-sided, compact mount** suitable for tight battery lines.
- **Sensing Window:** Standard sensors have a narrow window (10-20mm). R2R provides a **Wide Viewing Area** (up to 960mm) to prevent lost-edge stops.
- **Resolution:** Pixel-limited sensors struggle with microns. R2R achieves **0.016 mm Sub-pixel resolution**.
- **Components:** Instead of separate emitters and receivers, R2R offers an **All-in-One Integrated** unit with lower TCO.