Digital Stored Grain Quality Management

BinMaster Level Controls
Lincoln, Nebraska, USA
Why monitor stored grain?

- Early detection protects against losses
- Reduce shrink to maximize grain weight and profit
- Minimize handling and energy consumption to reduce operating costs
- Increase visibility of what is happening inside the bin
Detect Biologic Activity

• Protect damage and losses due to:
  – Insects
  – Mites
  – Mold
  – Fungus
  – Bacteria
  – Any other biologic activity
Keys to Improving Stored Grain Quality

1. Sensing: monitoring temperature and moisture
2. Controlling: using data to control or change conditions in the bin
3. Reporting: tracking data to detect trends or changes
4. Managing: making informed decisions to maximize profits
What Needs Measuring

Three parameters:
1. Temperature and moisture of stored grain
2. Temperature and moisture of the air in the silo
3. Temperature and moisture of the outside air

They are impacted by:
1. Condition of grain when harvested and processed
2. Climatic conditions under which it is stored
3. Current weather conditions

*Once grain is in the bin, the only operational control option you have is aeration.*
Safe Storage

- **Temperature** and **Moisture** of the grain are the two key parameters.
- **Insects** are a major risk above 62° - 68°F (17° – 20°C).
- **Fungus** is a major risk when grain moisture content exceeds 15 – 18% (depending on the temperature).
- **Safe Storage** can only be achieved for a longer period of time if temperature and moisture are brought to the “safe condition”.
All-Digital Technology Platform

- Digital sensors with accuracy within 1°F
- No sensor drift for greater precision over time
- Built rugged for minimal maintenance
- Long service life and low total cost of ownership
- 15+ year life expectancy
- Low-friction, long wearing, small diameter cable
- Innovative 1-wire platform reduces wiring cost
- Digital RS-Bus simplifies installation
- No need for extra components
  - No signal amplifiers or analog-to-digital signal convertors
Digital Versus Thermocouple Cables

- Digital technology uses 1-wire platform using microchips
  - Multiple chips reside on a single wire
- Chips are polled by remote-sensing units (Master-Hub)
  - Data from multiple sensors is transmitted in one string
- Faster and more reliable transmission rate than analog
- Each digital cable requires only one termination or switching point
Digital Temperature Monitoring

- Temperature records allow for fast response to changes occurring within grain.
- Changes in grain temperatures can be the first sign of potential problems.
- Digital temperature sensor cables are hung from the roof in several locations in the bin.
- Temperature is measured by individual sensors spaced 6 to 10 feet apart down the length of the each cable.
- Local biological activity is detected by a change in temperature by any sensor, anywhere in the bin.
Digital Moisture Sensing

- Measures relative humidity in the air
  - Humidity in the air is in equilibrium with the moisture in the grain kernels
  - Relative humidity is used to calculate grain moisture

- Moisture sensor cables have three sensors
  - One in the head space and two in the grain

- Sensors in the grain are calibrated to calculate grain moisture content using the equilibrium moisture curve (EMC).

- The data from the moisture sensors is used to optimize aeration control
  - Determines when fans must be run
  - Just enough remove excess moisture
  - Eliminate over-aeration that causes shrinkage

402-434-9102
www.binmaster.com
Weather Stations

- Monitors ambient air conditions outside of the bin
- Temperature and relative humidity data are used to optimize aeration control
- Determines when and for how long aeration should be used to maximize grain value

Weather Station Pro

Weather Station LC
Sample Configurations of Digital Solutions

- Temperature and relative humidity data are used for efficient aeration control.
- Helps determine when and for how long aeration should be used to maximize grain value.
MONITORS
- Temperature Sensing
- Moisture Sensing
- Headspace RH/Temp
- Outside Weather
- Level

CONTROLS
- Aeration Fans
- Roof Ventilation
MONITORS
- Temperature Sensing
- Moisture Sensing
- Headspace RH/Temp
- Level

Note: Sensor placement based on 54' diameter bins. Please contact us for recommended placement of sensor cables for other bin sizes
CP-PRO II

Temperature Monitoring Cable
CAT5-E Communication Cable

Handheld Temperature Reader plugs into the panel on the exterior of one bin

Junction Box

Junction Box

Note: Sensor placement based on 54' diameter bins. Please contact us for recommended placement of sensor cables for other bin sizes

2500-PC model also has the option of automatically transferring data to a PC using software on the memory stick included in the kit.
Diagram 1: MODBUS master/Slave network to SCADA System/PLC
# Recommended Placement of Sensor Cables

- **Temperature Cables**
- **Moisture and Temperature Cables**

## Diagrams

- **26'**
- **36'**
- **42'**
- **48'**
- **54'**
- **60'**

## Table

<table>
<thead>
<tr>
<th>Silo Diameter</th>
<th>Number of Sensor Cables</th>
<th>Sensor Cables in Center</th>
<th># of Sensor Cables First Ring</th>
<th>First Ring Radius</th>
<th>Angle between Sensor Cables</th>
<th># of Sensor Cables Second Ring</th>
<th>Second Ring Radius</th>
<th>Angle between Sensor Cables</th>
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<tbody>
<tr>
<td>26'</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1/2 x R</td>
<td>360</td>
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<td>1/2 x R</td>
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<td>1/2 x R</td>
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<tr>
<td>48'</td>
<td>4</td>
<td>0</td>
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<td>1/2 x R</td>
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<tr>
<td>54'</td>
<td>6</td>
<td>1</td>
<td>5</td>
<td>2/3 x R</td>
<td>72</td>
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<tr>
<td>60'</td>
<td>7</td>
<td>1</td>
<td>6</td>
<td>2/3 x R</td>
<td>60</td>
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<tr>
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<td>11</td>
<td>0</td>
<td>3</td>
<td>1/4 x R</td>
<td>120</td>
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<td>3</td>
<td>1/4 x R</td>
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<td>2/5 x R</td>
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<td>10</td>
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<td>105'</td>
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<td>6</td>
<td>2/5 x R</td>
<td>60</td>
<td>12</td>
<td>4/5 x R</td>
<td>30</td>
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</tbody>
</table>
Dash Board Manager Software

- Grain level
- Roof fan status
- Weather station data
- Aeration fan status

Temperature or moisture cables. Cursor triggers dropdown window with details.
Automated Aeration Fan Control

• Automatically controls running of aeration fans to help control moisture conditions in the bin.
• Factors such as climate, season, and humidity are set up in the control parameters.
Set acceptable ambient temp range

Set time window for fan operation

Set minimum temp difference between grain and ambient.

Set acceptable relative humidity
# Matrix View of Each Sensor Cable

## BinMaster Demo

### Facility

- All
- BinMaster Demo

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### BinMaster Demo

#### S1 - Type: Corn

- **010301**
  - H: 23.70
  - L: 22.20
  - 7: 23.00
  - 6: 23.20
  - 5: 23.70
  - 4: 23.20
  - 3: 23.20
  - 2: 23.00
  - 1: 22.20

#### Grain Pile 1 - Type: Wheat

- **010302**
  - H: 23.70
  - L: 22.00
  - 7: 23.00
  - 6: 23.20
  - 5: 23.70
  - 4: 23.20
  - 3: 22.50
  - 2: 22.20
  - 1: 22.00

- **010303**
  - H: 23.50
  - L: 22.00
  - 7: 22.70
  - 6: 23.20
  - 5: 23.50
  - 4: 22.70
  - 3: 22.00
  - 2: 22.00
  - 1: 22.00

- **010304**
  - H: 25.50
  - L: 22.70
  - 7: 23.00
  - 6: 23.00
  - 5: 23.50
  - 4: 22.70
  - 3: 23.00
  - 2: 24.00
  - 1: 25.50

- **010305**
  - H: 23.50
  - L: 23.00
  - 7: 23.00
  - 6: 23.00
  - 5: 23.50
  - 4: 23.50
  - 3: 23.50
  - 2: 23.20
  - 1: 23.00

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**Legend**

- **High**
- **Low**

**Each sensor in the cable**
Thank You!

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