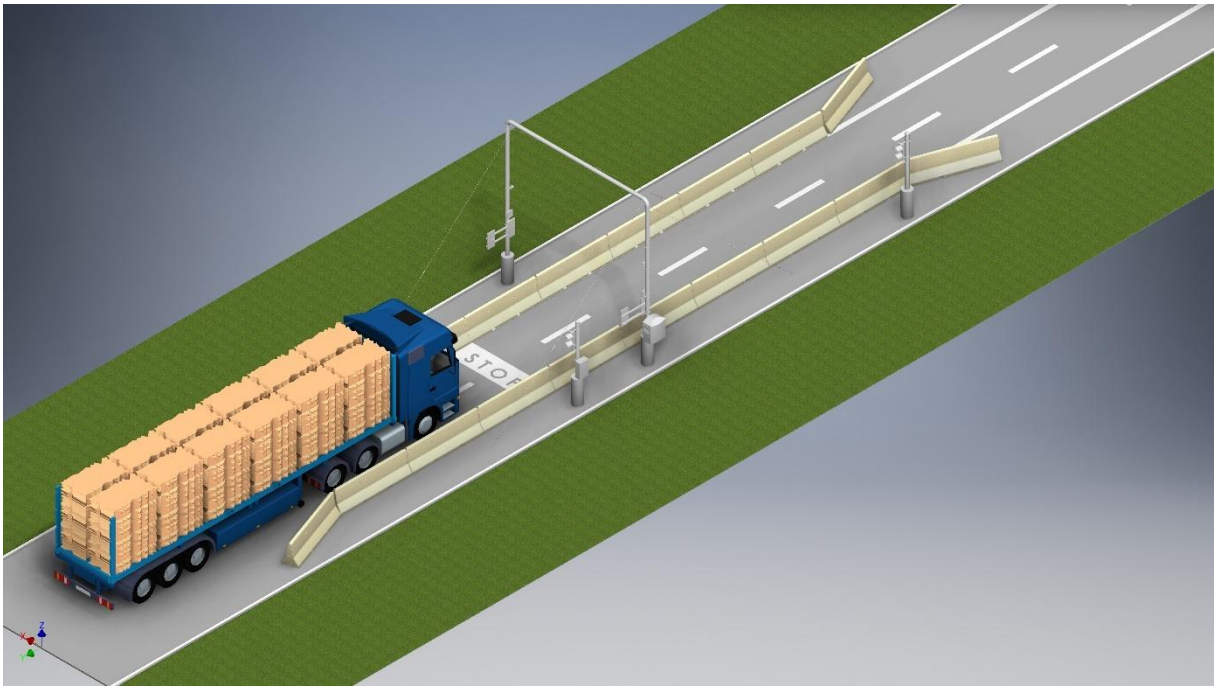
Industrial Moisture Gate for Straw Bales (IMG-S)
System overview

August 2025

How IMG-S works



The basic principle of IMG-S

The Industrial Moisture Gate for Straw Bales (IMG-S), previously referred to as the HPNA system, is designed to measure the moisture content of straw bales delivered by truck.

The system provides:

- High-capacity measurement – the entire truckload is assessed in a single operation.
- Rapid results – the process is completed in less than two minutes (typically within one minute, depending on the sensor configuration).
- Automation and objectivity – measurements are fully automated and cannot be influenced by operating staff.
- Seamless integration – collected measurement data is automatically transferred to the ERP system via standard IT communication channels.

During operation, the system acquires data on key material properties and processes this information to calculate the average moisture content for the complete load.

To achieve accurate results, two distinct subsystems are employed for data collection, each contributing to the reliable determination of moisture content.

a) The **Microwave system** generates more multiply polarised low-power electromagnetic fields. The changes in the electromagnetic fields are caused by water, which provides information about the water in the load.

b) The **3D optical system** collects physical data on the load, such as the width, length, height, speed of the truck, its structure - missing bales, gaps between bales, etc. -, the start and end of the load, the size of the platform, and uses this data to control the microwave system and calculates the volume of the load.

Layout of IMG-S

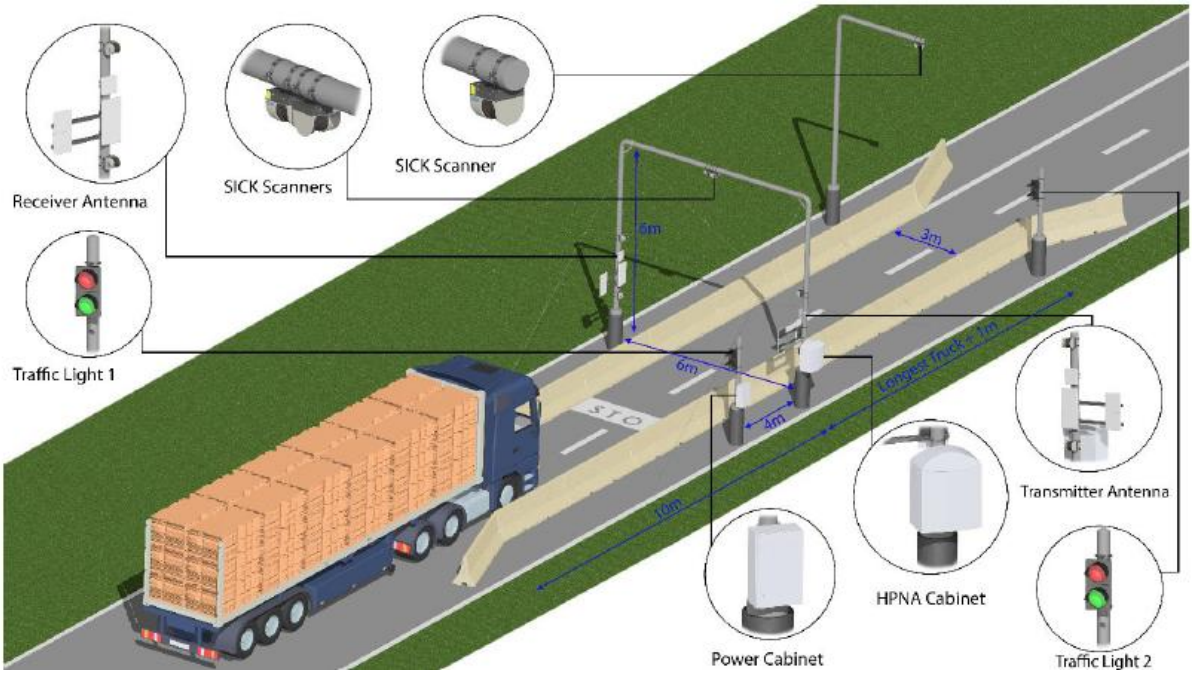
The layout of the Industrial Moisture Gate for Straw (IMG-S) is designed to accommodate both closed trucks with tarpaulins and open deliveries.

Closed trucks with tarpaulins:

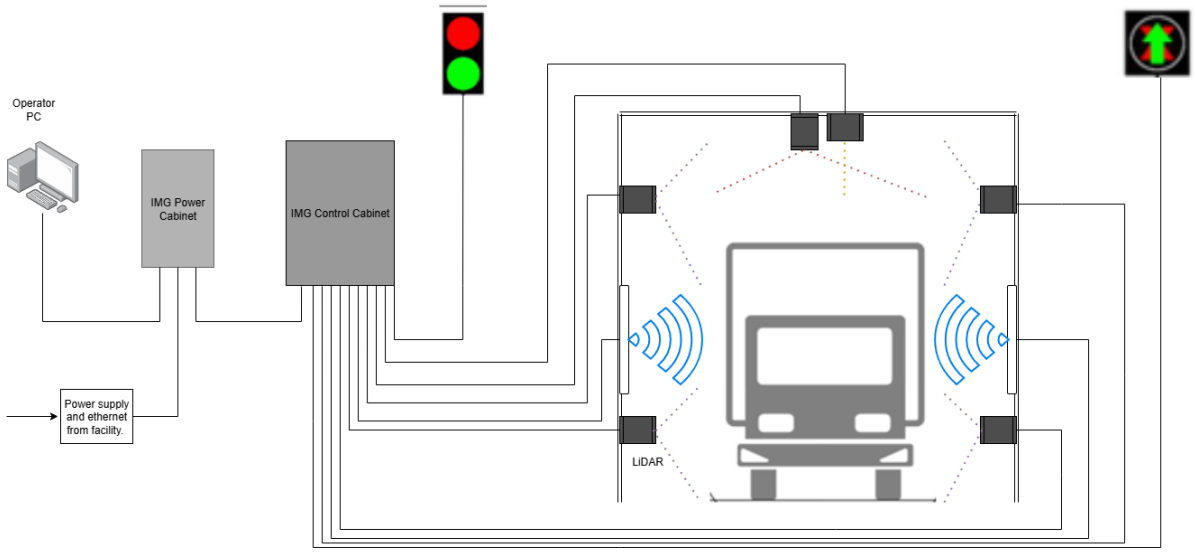
For proper measurement, the tarpaulin must be drawn back on both sides of the vehicle—one side pulled open toward the front of the load and the opposite side pulled open toward the rear.

Open deliveries:

In the case of uncovered loads, no additional preparation is required, as the system can directly access the material.



Configuration overview:



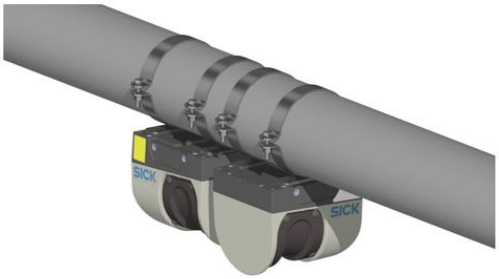
Note: All 6 scanners are installed at the 1st gate, and Scanner #7 is installed at the 2nd gate.

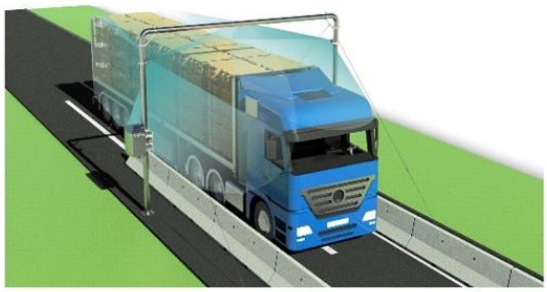
Function of each element

a) Antennas:

The antennas are responsible for emitting the multi-polarized electromagnetic waves generated by the microwave unit within the IMG-S Cabinet. These waves pass through the load, where they are received by antennas positioned on the opposite side, enabling accurate measurement of material properties.

b) 3D LIDAR





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LiDAR (Light Detection and Ranging) is a laser-based sensing technology that combines laser and radar principles for mapping, monitoring, and surveying surfaces and objects. Within the IMG-S system, 3D LiDAR ensures:

- High-precision spatial mapping of the truck load.
- Accurate, repeatable measurement results.
- Reliable inspection of both moving objects and material geometry.

c) IMG-S Cabinet

The IMG-S Cabinet serves as the central processing unit of the system and includes:

A high-performance industrial PC, dedicated to processing LiDAR signals, handling control data, and executing the calculation models.

A microwave unit, typically comprising three software-defined radios to generate radio signals at the required frequencies.

Integrated power supply units, ensuring stable and efficient power delivery to all components.

Requirements for the measurement

To ensure accurate and reliable operation of the IMG-S system, the following conditions must be met:

1) Load arrangement: Straw bales must be stacked with minimal spacing between them along the length of the truck.
2) Load height:
    - Minimum measurable bale height: 1.6 m
    - Maximum height: not limited
      (Note: metal gates or similar structures interfering with microwave transmission must not be present.)
3) Load width: The minimum required width of the loaded straw is 1.7 m.
4) Visibility for LiDAR: The laser scanners must have an unobstructed view of the complete load.
5) Truck speed: During measurement, the truck must not exceed a speed of 5 km/h.
6) Load securing: Horizontal metal bars or other securing elements must be removed prior to measurement.
7) Closed trucks with tarpaulins: The tarpaulins must be pulled back fully on both sides before measurement, ensuring clear side access to the load.
8) Open deliveries with tarpaulins: Any tarpaulins covering the load must be completely removed before measurement.
9) Containers: Loads delivered in metal containers cannot be measured by the system.

Important: Each load must consist of a single type of straw. Mixed materials require a dedicated, individual measurement process.

Measurement process

The system can operate as a standalone solution. However, it delivers the greatest efficiency when integrated with the facility's ERP system (e.g., SAP). Once connected, it supports fully autonomous operation, eliminating the need for human interaction. As a contingency, the system can also revert to manual operation, for example, if the ERP system becomes unavailable.

IMG-S follows a defined workflow. While the process can be tailored to local requirements, the core steps are as follows:

1) Data entry
   - Data can be entered manually via the Dashboard
   - Alternatively, it can be transferred automatically from the ERP system.

2) Start measurement
   - In manual mode, the operator initiates the process by clicking the **START** button on the Dashboard
   - In automatic mode, the measurement can be triggered by:
     - ERP system
     - Card reader kiosk
     - ANPR camera (licence plate or registration number)
     - Other configured sources

3) Measurement
   Once triggered, the system autonomously carries out the measurement process. Vehicle movement within the measurement zone is managed by traffic lights and continuously monitored during the procedure.

4) Calculation
   After the vehicle exits the measurement zone, the system processes the collected data and calculates the average moisture content of the load.

5) Results
   The final result is displayed on the Dashboard and, if connected, automatically transmitted to the ERP system.

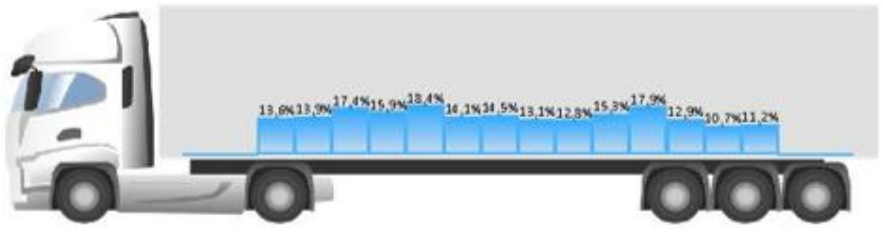
Displaying measurement results
(measurement data sent to the IT system)

Straw Bale - Moisture Measurement Report

Report generated on: 21.04.2023 12:15

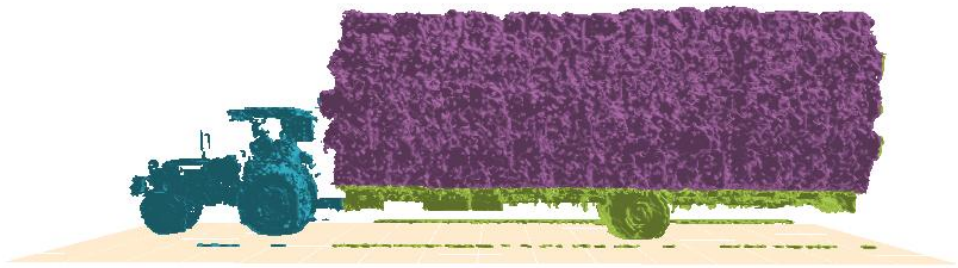
Measurement	Date/Time:	21.04.2023 09:07
	Ticket Number:	**282268**
	Plate No.:	AA123AA
	Straw type:	5000000095
	Supplier:	610967
	Weight:	
	Moisture Average:	**14.4 %**

Profile:



This is an automatically generated report, based on the information stored in the database of HPNA system (ser.no.: HPNA4P/0622/89/DK).

Example - 3D system generated 3D model
(**not** sent to the IT system)



Parameters of the measuring system

The IMG-S system operates with the following technical parameters:

a) Measurement characteristics

- Moisture measurement range: 6% to 50% gross moisture content of straw
- Microwave signal frequency: up to 930 MHz (ISM band)
- Transmitted signal power: 10 mW
- Sender–receiver distance: approx. 6 m
- Microwave dynamic range: approx. 70 dB

b) Measurement outputs
During each measurement, the system determines and records the following parameters of the load:

- Average moisture content of the complete load
- Load parameters (geometric and structural characteristics)
- Total load volume
- Truck speed during measurement
- Identification of missing bales and gaps between them
- Measurement date and time