

Packing by Weight system

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Abstract

An electronic packing by weight system has been developed and used to pack bushels (bags) of corn, wheat. Four systems are installed on 18 ton per day shift production line for agriculture products with high accuracy and high throughput.

The system is composed of electronic scales, PLC system, pneumatic valves, silo, hooper, and bag holder or controller.

1. Introduction:

- **The packing by weight system is an essential part of production and distribution of agriculture products. Table1 shows the technical specifications of the system.**
- **Weight / Packing machine: the main target of the system is to pack agriculture products with the required weight with a high accuracy and high throughput(short pack time /bag)**
- **The static accuracy of the machine is 20 gm, with speed reach to12 package/min.**
- **The continuous hi speed packaging accuracy is 60gm.**
- **The machine has the ability to change the set point to pack more than one package with different weights (e.g. from 5 kg to 100 kg with step of 1kg between set points).**
- **The machine can compensate the weight error that might happen during the process of weighting and eliminate such errors to reach to the required weight with required accuracy.**
- **Control of weight using adaptive correction algorithm.**
- **The system is composed of a mechanical system, electronic scale, control panel, PLC system, pneumatic valves, and compressor**

2. The Mechanical System:

The packing system contains several mechanical subsystems.

- The mechanical system consists of a hopper, package holders, and the gates of the hopper, and Silo all are controlled by the pneumatic valves
- The very fast pneumatic valves provide a fast operation, lower cost, and easy to maintenance.

Table1. Technical data:

Model					
Grain	Up to 5 ton/hr				
Packing Net Weight	5 – 150 kg				
Packing Speed	Depend on Packages <table border="1"><tr><td>5 kg. Packages</td><td>10 kg. Packages</td></tr><tr><td>800 Package/h</td><td>400 Package/h</td></tr></table>	5 kg. Packages	10 kg. Packages	800 Package/h	400 Package/h
5 kg. Packages	10 kg. Packages				
800 Package/h	400 Package/h				
Accuracy	Static accuracy 20 gm Continuous operation 60 gm.				
Packing bag	Paper, Plastic, Paper & Plastic				
Typical material	Corn, Wheat, Bean				
Storage container size	3100 Liter				
Operating environment	Temp. : -10 to + 45 Relative Temp. : < 95% Wind Speed : <50Km/h (outdoor work)				
Air supply	10 Bar				
Consumption	10m³ /h				

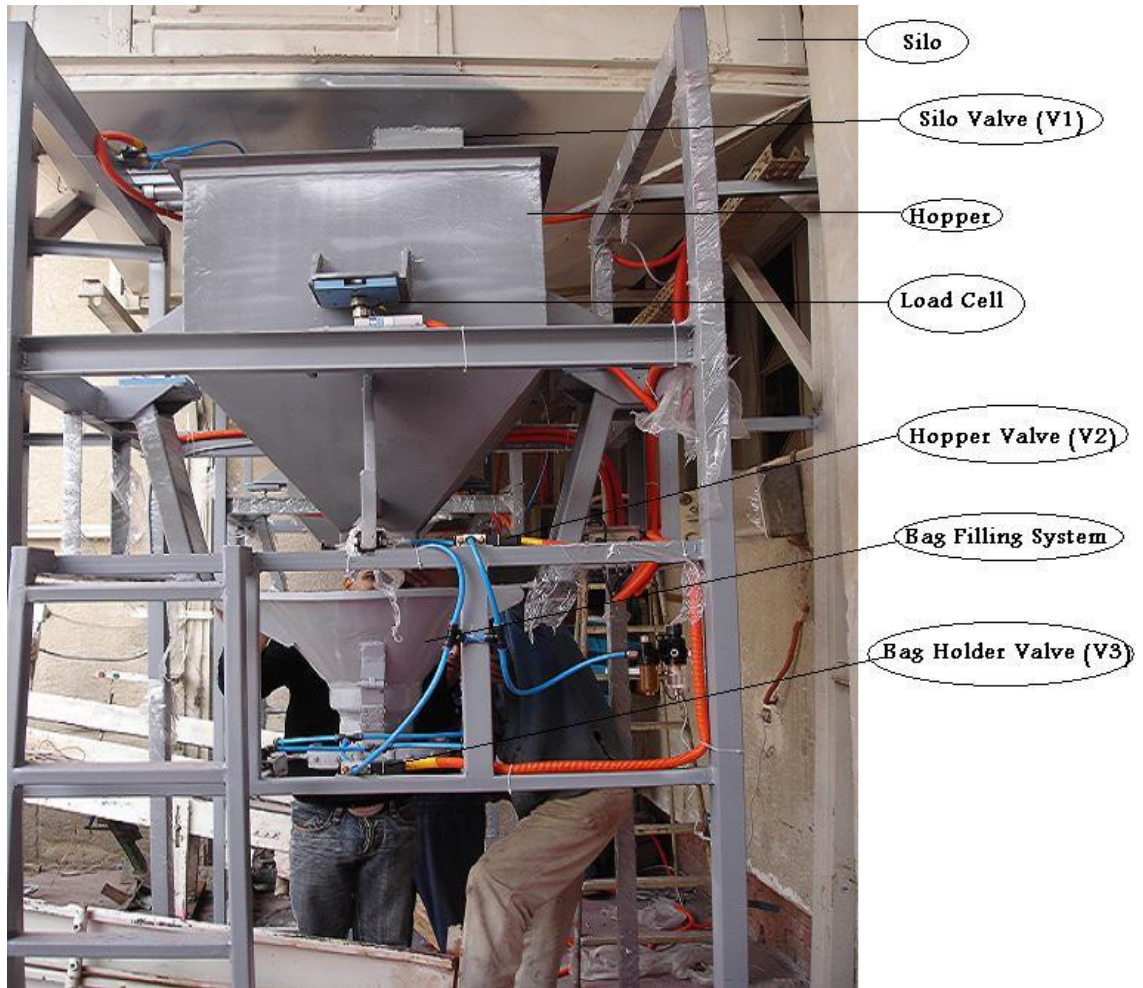


Figure 1: The Complete packing by weight system



Figure 2: A photo of the mechanical bag holder, and the pneumatic valves/ pistons

3. Control Panel:

- The control system [1,2 and 3] is made of ALTUS , PICOLO PLC 105R and 143R modules, which provide fast response to the input/outputs, easy maintenance, and the ability to work for long time.
- The control panel is provided with options that allows operating the machine in case of PLC failure or scale failure, to ensure that the machine will not stop
- The control panel is provided with 24 V power supply to feed the PLC and the whole control circuit.
- The panel is provided with a circuit breaker to ensure maximum protection.
- The panel door contains all the required push buttons and indicators to operate two scales with all options.

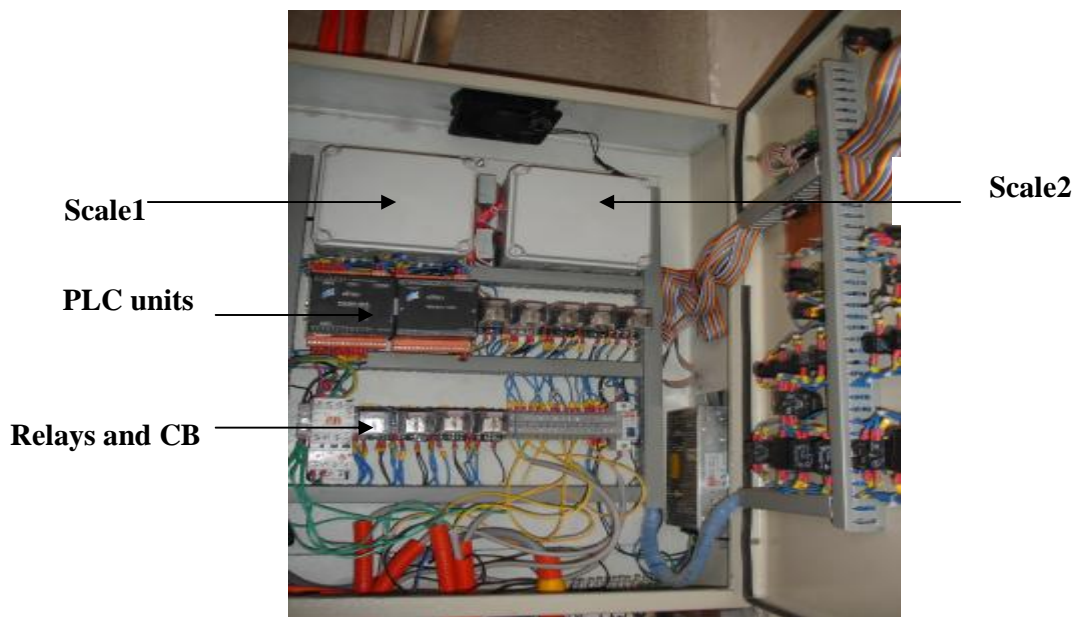
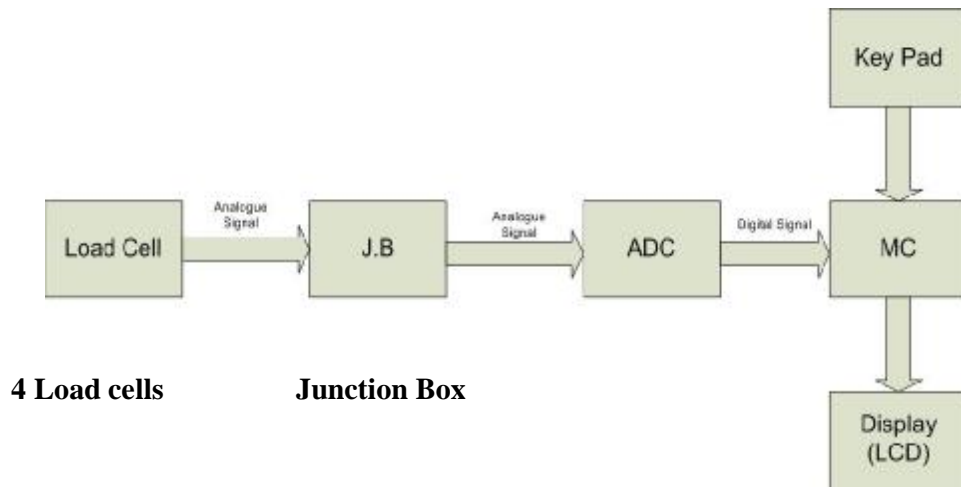


Figure 3: the control panel

- The elements of the control panel are shown on figure 3, 4, and 5.
- It contains the following components:
 - Altus PICOLLO 105 PLC.
 - 12 inputs / 6 outputs.
 - Relay output type.
 - 24 V Power supply.
 - 24V DC Input
 - AC. / DC. Output
 - Altus PICLLO 143/R digital I/O extension
 - 16 inputs / 16 outputs module

- 2 * G1050 Weighting system.

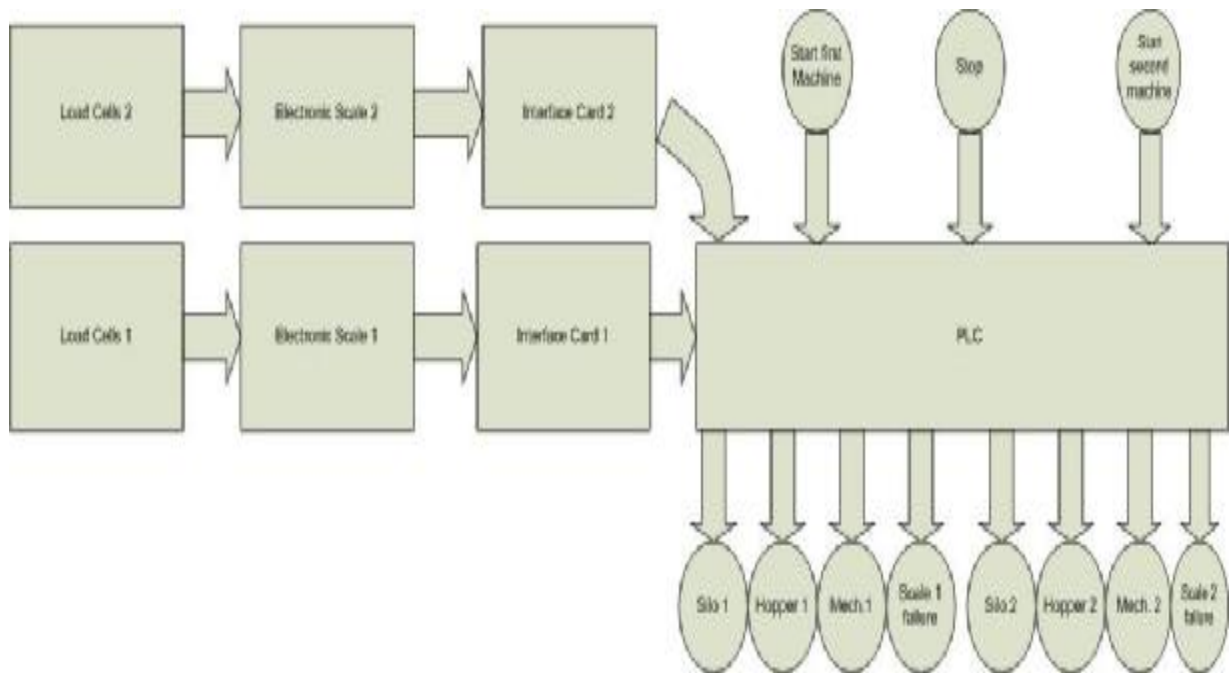
Which is an electronic system used to measure the weight.
It consists of "LCD, Keypad 12 switch key pad, Scale board, Load Cells, and junction box."



4 Load cells

Junction Box

Figure 4: The block diagram of the electronic system
Figure 5: Block Diagram of the two Packing unit System



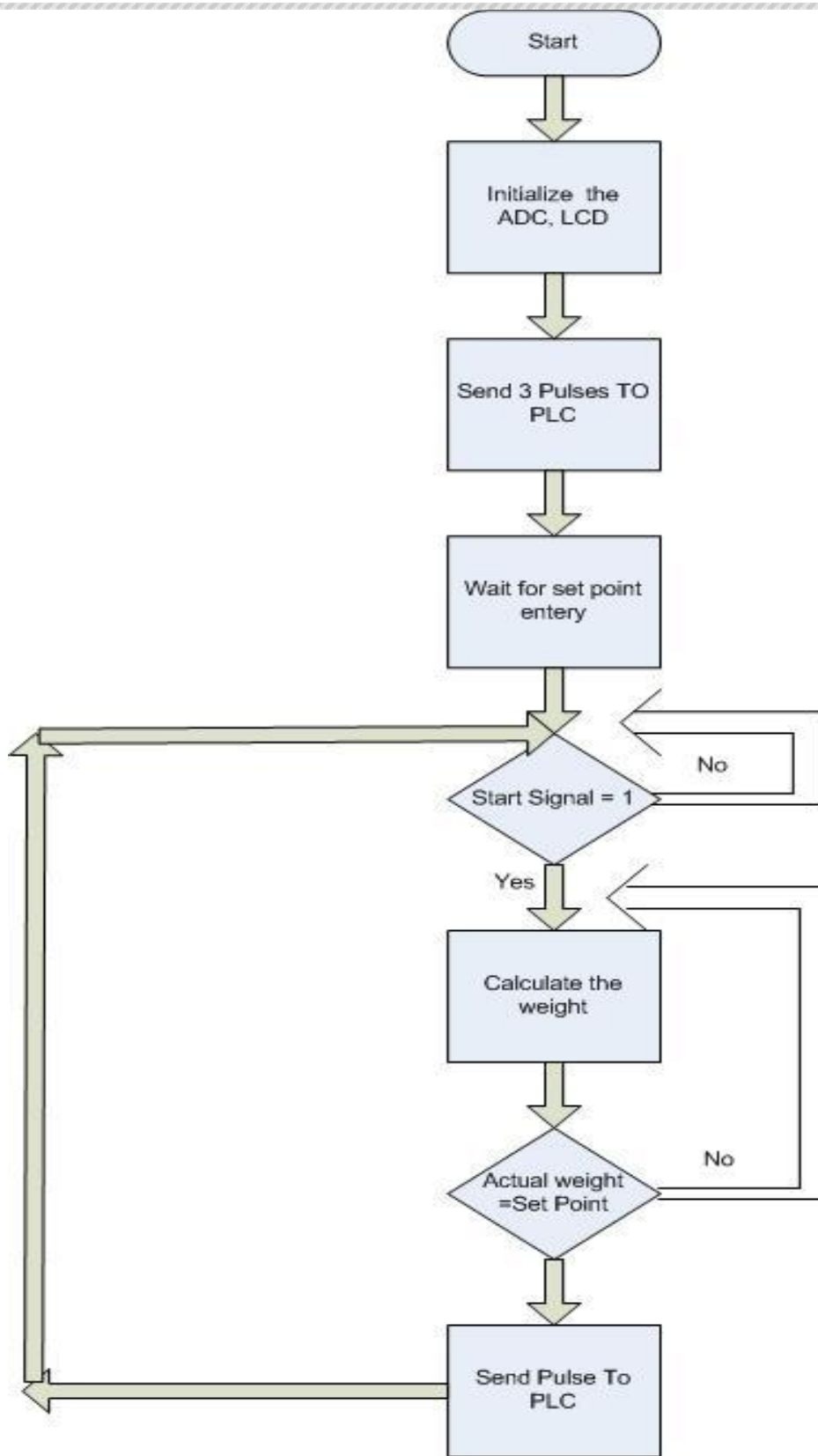


Figure 6: Flow Chart

4- Software Description:

The software flow chart is shown in figure 6.

The software is implemented to perform the following:-

- An interface with the display devices such as: LCD Display.
- having a memory to let the system remember the required gain of weight measurement and the error correction even if the system is restarted , this is done by using a 2K bytes electrically erasable programmable ROM (E2PROM) 'AT24c16'
- Simple user interface with a user friendly keypad software
- Interface with the sigma delta analog to digital converter AD7730BN from Analog Devices Co. with 24 bit resolution[3].
- A good calibration procedure to overcome the fixed point arithmetic error that occur due to the 8 bit micro controller AT8052 simple resources 'fixed point arithmetic problem'

A key advantage of this software is that it adapts automatically to any material in use e.g. Corn, Wheat....etc.

The weight and control algorithms start by initializing the main parameters then the start button is pushed to start the operation.

After the start button pressed a pulse is generated for closing the hopper piston and then opening the silo piston. The system goes to an infinite loop waiting for the target weight to be reached. An error correction value is calculated before a pulse is sent out for closing for the silo and opening the hopper to empty the material in the package.

The error is corrected as the follows:

- The software collects 5 continues readings and stores this reading in an array.
- The software compares the array most repeated readings with the set point to calculate the error.
- The error value is eliminated from the set point at the 6th reading.
- This algorithm is repeated again.

5- Summary and Conclusion:

- A high speed 24MHZ ATMEL microcontroller AT89C55 is used to measure the weight of material.
- The material is moved from a storage silo to a bag for packing via a hopper and pneumatic valves.
- An ALTUS PICOLO PLC system is used to control the system and holds the bag during packaging.
- The system provides high packing by weight speeds as shown on Figure 7..

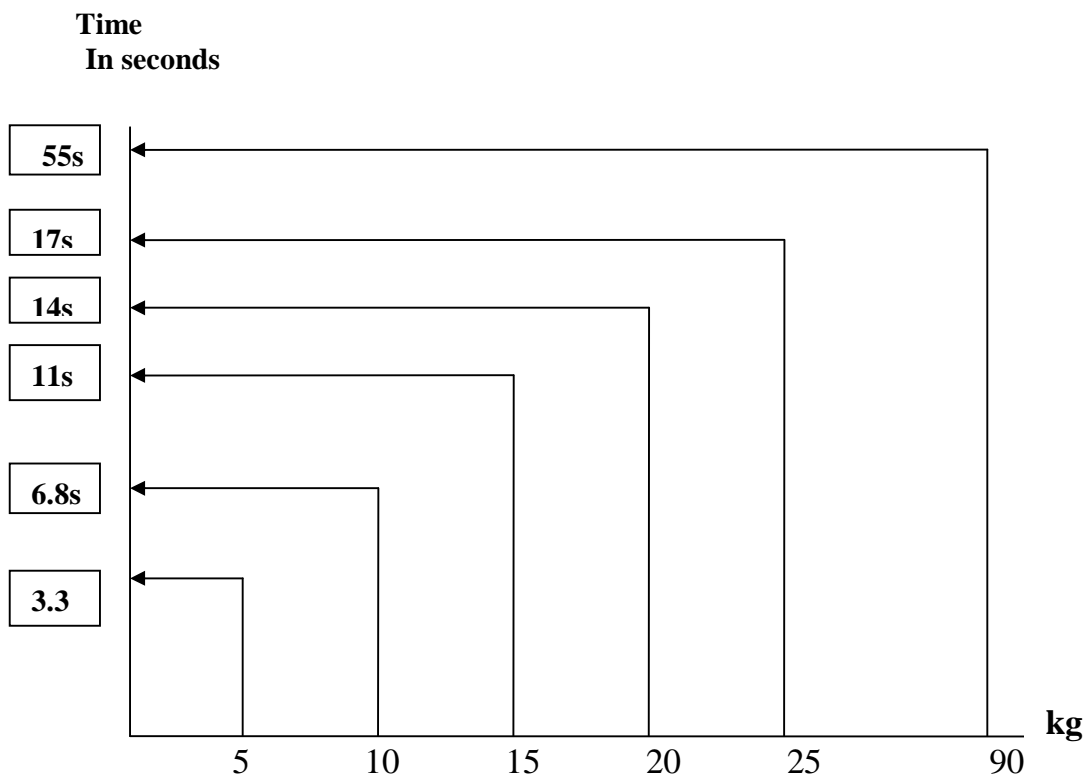


Figure 7: Timing diagram for various reading

References:

- 1- Web site of www.gwdt.net
- 2- www.altus.com.br
- 3- User manual pf AD7730, Analog Devices, www.anlog.com