Is a Weighing Scale's Accuracy and Resolution the Same Thing?

Intended Audience

- Plant Managers
- Process Engineers
- Control Engineers
- Maintenance Managers

Manufacturing Area

- Process & Packaging

Applications

- Inventory Management
- Batching & Blending
- Filling & Dispensing
- Packaging
-

Focus

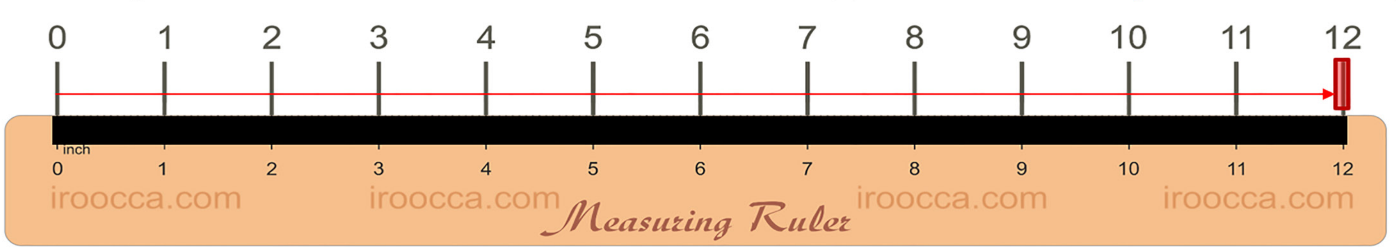
- Weight Measurement in Industrial Manufacturing

Many people use the terms **resolution** and **accuracy** interchangeably, in relation to industrial scales. Yet there is no relationship between accuracy and resolution in industrial scales. Scales consist of a number of components: a single or multiple load cells; a junction box with summing card for multiple load cells, and a weighing instrument (such as a weight processor or weight controller). Accuracy is established/defined by the load cell/s used. Resolution is established/defined by instrument used. Let take a more detailed look into each of these terms, i.e. scale specifications.

Accuracy is expressed as a PERCENTAGE OF FULL SCALE CAPACITY. The term full scale capacity means rated capacity and is referring to the "measuring device". In the case of our industrial scale this would be the maximum capacity of a single load cell, or multiple load cells used by the scale. A load cell's accuracy is defined (specified) as being less than or equal to a plus/minus percentage of its rated measurement capacity, expressed as a unit of weight e.g. lbs, kgs etc. As an example Hardy's load cell's accuracy specifications are typically <= ± 0.02% of rated capacity e.g. 1000 lbs, within in a defined temperature range of -10 to +40 degrees C (centigrade)

Let's take a look at an easier-to-understand example, by drawing a comparison between a ruler and a load cell. In the case of a 12 inch ruler (shown below) and using the same accuracy specification as a typical Hardy load cell, we would say the ruler is accurate to better than or equal to plus/minus 0.02% of 12 inches. Expressed in inches that would be accurate to <= ± 0.0024 inches. Why would the ruler vary in length? In this case, this ruler is made of wood. Actually wood fiber and it contains some moisture. So if we put this ruler in a controlled oven and vary the temperature between -10 and +40 degrees C, it would expand and contract ± 0.0024 inches.

Accuracy - the ruler is accurate to 12 inches, plus/minus 0.02% (+- 0.0024 inches)



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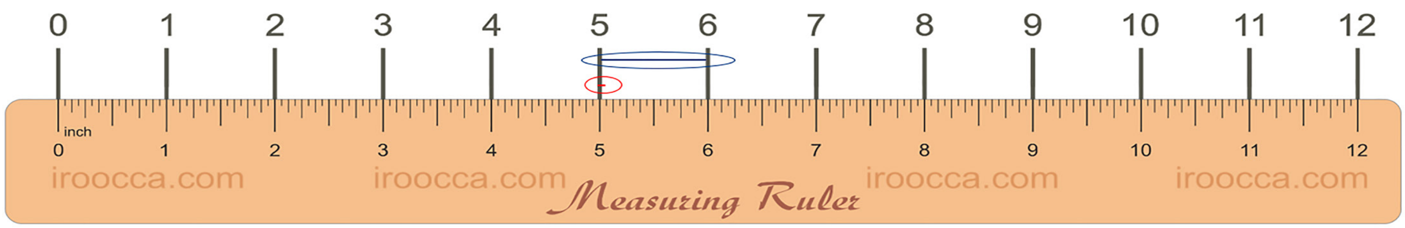
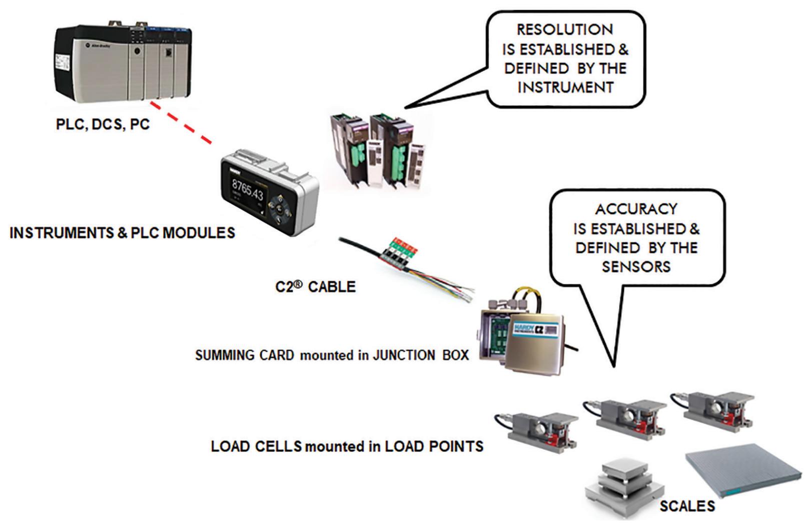
Resolution - the resolution of the top ruler is 1:12 or 1 inch
- the resolution of the bottom ruler is 1:192 or 1/16th of an inch



Returning to load cells, we have a similar situation. Load cells are made of what is essentially a metal spring and 4 or more strain gauges. If we put a 1000 lb rated capacity load cell in the same oven, put a 1000lb weight on it and varied the temperature from -10 to +40 degrees C, the load cell would also expand and contract, causing a slight change in the load cells output which in this case would be <= ± 0.2 lbs. Which we can also express at 1 part in 5000 (1000lbs/0.2lbs).

Resolution on the other hand, is expressed as the NUMBER OF, OR SIZE OF THE INTERVALS, INCREMENTS OR DIVISIONS (all these words mean the same thing in Industrial Scales) that can be resolved and displayed. Relating to the "granularity" of the measurement an observer sees on the scale. Resolution is usually expressed not as a percentage, but as 1 PART IN X, or by the size of the granularity that is the size of the increment e.g. 0.1lb.



If we use the ruler again as an example, the resolution on the first ruler shown above is 1 part in 12 (written as 1:12) or 1 inch. 12 increments of 1 inch. Looking at the second ruler shown above, the resolution the observer sees is 1:192 or 1/16th of an inch. Which is 0.0625% of an inch. So very clearly, the ACCURACY (of the ruler on the previous page) and RESOLUTION of the ruler above aren't the same.

Returning to scales. We mentioned above that resolution is established/defined by the instrument used. In fact it is defined by the ADC (Analog to Digital Converter) used in the design of the instrument. The ADC converts the analog signal from the output of the load cell into a digital number that it can filter, span and display for an observer to read as weight. Hardy's instruments have recommended resolutions of 1:10,000, 1:20,000 or 1: 30,000 for a stable weight reading and 1:100,000 as a max resolution. Note that depending on the environment (external vibration or electrical noise levels) that the scale is located in, using the max resolution setting may make the weight reading unstable and not readable.

Usually industrial scale resolutions are set to be 2X or 3X higher than its accuracy. There is a logical reason for this. Being able to observe a weight reading at a higher resolution, than the scale can deliver an advantage during calibrations. That said, there are specific regulatory instances where industrial scales resolution are limited to their load cells accuracy specification. This happens in legal for trade scales where good are bought or sold by weight and legal tender documents are being printed with calculated government taxes. This constraint is a legal limit not a functional limit of the scale. Even though today's instruments can deliver much higher resolutions, bodies collecting taxes on behalf of govenments constrain the resolution i.e. the number of scale increments. In these cases, the maximum resolution for Legal for Trade applications is typically limited to 1:3000, 1:6000 or 1:10,000 to match a specific load cells accuracy specification after the scales have been submitted, tested and approved to a government approved regulatory body such as NTEP in the USA.

In summary, the ACCURACY of the scale discussed in this example is <= ± 0.02% of rated capacity 1000 lbs (1:5000). The RESOLUTION of the scale discussed would be 1:10,000, 1:20,000 or 1:30,000 for a stable weight reading, depending on which Hardy instrument we select to build this industrial scale.

Hopefully, we have demonstrated by use of these examples that ACCURACY and RESOLUTION are clearly not one and the same thing. That being the case, the best way to discribe a scales performance would be … the bulk load out scale on manufacturing line 4 has a FULL SCALE CAPACITY of 1000 lbs, an ACCURACY of <= plus/minus 0.02% (0.2lbs) and a displayed RESOLUTION of 1:20,000 (0.05 lbs)

Hardy Process Solutions are considered thought leaders in using weight to solve problems in process & packaging. The above article was written by Rodger Jeffery. who has been with HARDY PROCESS SOLUTIONS for 11 years and in the industry for 40 plus years. He has solved simple and complex weighing related problems in many manufacturing industries and has installed thousands of INDUSTRIAL WEIGHING solutions across the globe.

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