

Automated Calibration Of Digital Weighing Systems

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Abstract

This article discusses methods of calibration of the weighing system (WS) in usage without the use of standard loads. It is shown that the calibration of WS must be based on the determination of the margin of error between the indications of the DLC and maintaining the stability of the misalignment angle during the loading of the platform in the entire weighing range. As a result of the research, it was proved that the given method is economically expedient and perspective way of calibration and verification of WS.

Keywords: calibration, digital load cell, weighing platform, misalignment of the load, weighing system, the transmission element, discretion, the standard load, sensitivity, verification division, resolution capability, the maximum weighing limit, the smallest weighing limit (SWL).

1. INTRODUCTION

Calibration of the WS is made by the standard loads (weights) at several points [1, 2, 3]. The use of some digital load cells (DLC) matching the requirements of the high precision in the WS necessitates the constant calibration in the process of the exploitation.

Using of the standard loads is a very time-consuming and financially costly procedure. It is recommended to use the method of the calibrating of the digital WS by analyzing the tolerances for deviation from the angular loading of the mechanical transmission elements.

2. REQUIREMENTS TO THE DIGITAL SENSORS OF THE WEIGHING SYSTEMS

To develop calibration techniques it is necessary to consider technical parameters DLC depending on the number of verification intervals of the WS. Calibration of DLC, the obtaining of technical parameters and the formation of the standard characteristics DLC depending on the verification scales should be made by standard loads which correspond to the binary power function [4], so each DLC will have the technical parameters corresponding to the requirements of the standard value of the load and the resolution capability which is expressed through the number of verification scale [5,6,7].

The main technical characteristics of this approach is the dependence of the resolution on the number of verification scale of the DLC determined in dependence on the sensitivity expressed in terms of the analog to digital converter DLC (picture 1).

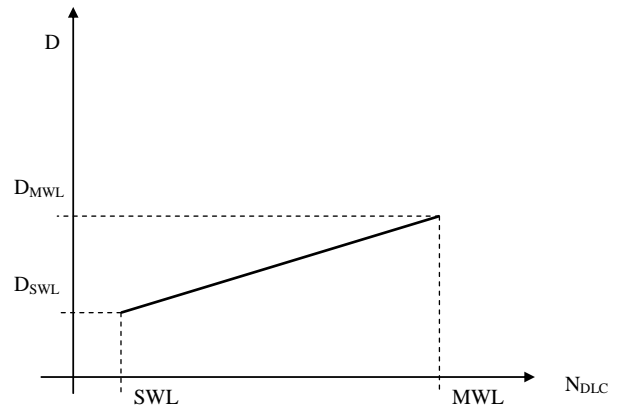


Fig. (1).-Dependence of the DLC resolution capability on the number of verification scale of the DLC

The relation between sensitivity and verification scale of the DLC

$e = n * d_a$, where n is an integer number

d_a -sensitivity, defined in terms of an analog to digital converter DLC;

e -testing division DLC, equal to the verification scale interval WS.

3. CALIBRATION OF THE WEIGHING SYSTEM

Let's take a look at the scheme of loading the weights with the maximum weighing limit (MWL) equal to 40 tons on the four DLC with the number of verification scale equal to 4000 (Figure 2).

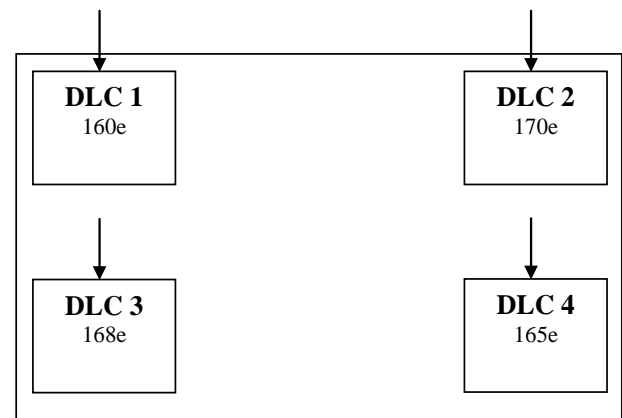


Fig. (2). – The loading scheme of the DLC of the weighing system with MWL equal to 40 tons

When loading four DLC of the weighing platform there are various misalignment for each DLC on the weighing platform. Electronic block the WS in accordance with a predetermined algorithm displays the values of the DLC in verification scale depending on the load of the weighing platform. So the difference of the indications

$$\Delta_{1-4} = 5e, \Delta_{1-2} = 10e, \Delta_{1-3} = 8e, \Delta_{1-1} = 0e$$

Thus we get a variety of error indications of loading misalignment between the load sensors. This error provided with the platform stiffness and stability of the misalignment angle is maintained during the loading throughout the whole range of maximum weighing limit (MWL) of the scales.

In accordance with the technical characteristics of the scales and acceptable deviations throughout the whole range there is possibility to determine the margin of error between the indications of the DLC at each weighing and, thereby, to prove that the weighing system functions correctly in accordance with the standard characteristics of the DLC.

The resulting basic data of the DLC while loading weighing platform is a starting artificial zero, and in accordance with the requirements of the weighing system has the value of the specified tolerance.

In the manufacture of DLC we obtain technical parameters presented in digital form, in accordance with which there is an opportunity to build a standard characteristic.

To establish the value of the resolution for each load cell we take into account the sensitivity and the nominal value of resolution for each DLC,

For the DLC MWL is equal to 10000d, where d-sensitivity (the minimum discrete load in kg) i.e. DLC is equal to 20,000 kg d = 2kg.

Nominal resolution DLC $D_{MWL} = 10^6$ units ADC, sensitivity in terms of the ADC is

$$d_a = \frac{D_{MWL} * d}{MWL} = \frac{10^6 * 2}{20000} = 100 \text{ units ADC}$$

For the weighing system with MWL equal to 40,000 kg and the number of verification scale equal to 4000, we obtain the verification scale interval e = 10 kg, or e = 5d.

Thus, for the sensor with MWL equal to 20 tons, and with the discrecity of loading 10000, the discrecity of WS with MWL of 40 tons will be determined with the formula:

$$N_{ws} = \frac{MWL \cdot 4 \cdot 10000d}{4 \cdot MWL_d} = \frac{40000kg \cdot 4 \cdot 10000d}{4 \cdot 20000kg} = 20000d$$

$$N_d = \frac{N_{ws}}{4} = 5000d$$

Where

N_{ws} -the number of discrete loadings of WS;

N_d -the number of discrete loadings of DLC

The amount of the nominal value for each DLC, based on the number of verification scale intervals for the weights will be equal to:

$$N_{dlc1} = 160e + 1000e = 1160e;$$

$$N_{dlc2} = 170e + 1000e = 1170e;$$

$$N_{dlc3} = 168e + 1000e = 1168e;$$

$$N_{dlc4} = 165e + 1000e = 1165e;$$

for $e = 5 * d$ и $d_a = 100$ units ADC, get $e=500$ units ADC.

Initial program zero position of the WS should be set for each DLC entering the value of the load from weighing platform and the value of the nominal resolution for the MWL weighing system and do in accordance with the requirements of the WS in terms of the least weighing limit.

Thus, the characteristic WS is built, depending on the units of dividing ADC, which is compared with the standard characteristic obtained in the manufacture of DLC.

4. SUMMARY

The proposed method of weight calibration in the process of using DLC is a perspective direction.

Reading technical parameters of DLC in the laboratory during production, we get technical specifications, which are the standard.

The analysis of the various characteristics (their deviations) during the operation allows to detect malfunctions of WS and exact parameters without calibration by standard loads.

5. CONCLUSION

Using the WS calibration techniques with the help of weights calibration [8] using a model of tension calibrator (with the use of a minimum number of standard loads), and also the use of DLC in WS allows the calibration without using standard loads in real scale of time. This method results in significant cost savings and increases the precision of calibration of automobile and carload scales.

6. CONFLICT OF INTERESTS

The authors confirm, that the research does not contain any conflict of interests.

7. ACKNOWLEDGEMENTS

The work was done with the support of the Ministry of Education and Science of the Russian Federation.

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