*International*
*Journal*
*Of Advanced Research in Engineering & Management (IJAREM)*
*ISSN: 2456-2033 || PP. 65-69*

# Calibrating Cable Error

S.Arunachalam[1], B.Uma Maheswari[2]
*[1] B.E IVyear, [2] Assistant professor*
*Instrumentation and Control Engineering*
*Sri Sairam Engineering College*

**Abstract:** In today's scenario, to make the process cost efficient and to produce high quality products almost all industries tend to move toward Automation. In place where the process is simple and can be controlled using a pre-defined set of instruction Programmable Logic Controllers (PLC) are used. In more complex and where the process variable needs continuous update and monitoring Distributed Control System (DCS) is used. The control system attains data from field instruments via Instrument cable. The measuring or field instrument measures the variables and these variables can be physical, mechanical or chemical and it is converted into equivalent electrical value. During the course of transmission due to external parameters the output displayed many vary due the change in resistance of the transmission cable and this effect is absent in optical cable but they are not cheap. The measuring instrumentsare used to measure the process variable such as flow, pressure, temperature, pH, concentration and many others. Some of these process variables tend to play a vital role in a process depending upon the product being manufactured. The measured parameter from the field instrument is transmitted in the value of 4-20mA because the current tends to same irrespective distance between the control system and the instrument. This paper reviews the method to rectify these errors in a transmission cable.
**Keywords:** 4-20mA, DCS and PLC, hart display, calibration, Error, non- linear system**.**

## I. INTRODUCTION

DCS and PLC are considered as most effective means to control any process in any industry. Both of the Control System receives data in any one of the following type either 4-20mA or AC of some sort and sometimes it is voltage. Only magnetic flow meter tends to give value in AC and most of the instrument gives only 4-20mA and the input given these instruments is 0-24V DC. The output of these instruments starts from 4mA because in instrumentation 4mA is called as live zero. When no physical variable is given to the measuring instrument then the output of the instrument should be 4mA.This indicates that instrument is working perfectly. But if the output is 0mA then the instrument is said to be faulty and 0mA is called as dead zero. Mostly current is preferred because when transmitted over a large distance there is no loss. By knowing the value of the minimum physical variable & maximum physical variable going to be measured by the instrument. The minimum value is assigned to 4mA and maximum value is assigned to 20mA. Any change in physical parameter causes a change in output proportional to the change in input.Thus by knowing the output current the physical parameter can be calculated using interpolationmethod. In PLC the input are mostly switches since it uses ladder logic. It is easy to write coding for a simple process using it and thus can be monitored easily. Any error in value can largely affect the process controlled using PLC compared to DCS.

Instrumentation maintenance engineer often hears about process value mismatch from field transmitter display reading and control room DCS/PLC reading. This may happens because of 4-20mA loop current drop also. In this paper we will be discussing about the impact of loop current drop in Field & Control room readings and a method to rectify it.

## II. A.REASON FOR MISMATCH OF READING:

Generally we see the readings mismatch between field & DCS happening due to the improper configuration either at transmitter or in control room (DCS/PLC).

Example: It was noted that the mounted instrument in the field is a temperature transmitter shows 112$^{o}$C reading in the field local display and 89.6$^{o}$C in the control room HMI/SCADA. It was checked & found that Field Transmitter configured range is 0$^{o}$ to 250$^{o}$ C whereas in DCS the configured range is 0$^{o}$ to 200$^{o}$ C. Because of this improper configuration, we have mismatch in readings between field & control room.

Let’s assume that the configurations are properly done in field transmitter and in DCS but still we are getting some difference in readings.

The 4-20mA loop current drop may happen due to the following:

1. **Little bit High Main cable / Branch cable resistance :** Theoretically there will be NO current drop in the loop but sometimes (practically on different rare situations) there will be small amount of current drop can be seen due to cable problems like high resistance, insulation damage, noise, elf etc.
2. Improper Transmitter Analog output card calibration/configuration.
3. Loose connections in the loop.
4. Rusted components or terminals.
5. Insulation damage.
6. Jacket swelling.
7. EMC problem/ Shielding Losses.

Above listed are the some possibilities for 4-20mA loop current drop.

Theoretically loop current will be same in the total loop but we sometimes find a very small amount of loop current drop. We will discuss the effects of the 4-20mA loop current drop.

The easiest way to measure existing loop current is to connect a multi-meter in series with the loop and note the loop current value, for example say multi-meter displays 5.99mA.

Now to check whether the measured loop value is correct, HART communicator is connected to the transmitter and check Analog Output Current reading in HART display, let say it shows 6.00mA. If there is loop current drop then HART display shows correct reading as this value directly coming from transmitter processor/CPU.

Even if transmitter inbuilt digital to analog card not working properly also the HART Display shows the correct reading in most cases as it taking the value from transmitter processor/CPU and not from transmitter D/A card.

Now we got these readings:

- HART display shows 6.00 mA
- Multimeter shows 5.99 mA

The difference between Actual reading (HART Display) and Present reading (multimeter) is 0.01mA. Let’s see what is the impact of this very small amount of 4-20mA loop current drop will do to a process.

## III. A. CRITICAL LOOP CURRENT DROP.

Consider a Flare flow meter having a range of 0 to 150000 kg/hr. we will apply above discussed parameters here i.e. HART display shows 6mA and multimeter showing 5.99mA.

HART Display @ 6mA Shows 18750 kg/hr

Process value Multimeter in loop measures 5.99mA, when we calculate equivalent process value then we have 18656.25 kg/hr

Now the difference between field reading and control room reading is 93.75 kg/hr. approx. Percentage of error is 0.06%. Here percentage of error remains same but there is a considerable amount of loss in process value. The main reason for this is due to higher span range of transmitter. Well in this case, we cannot neglect the small amount of loop current drop.

Remember that there will be no impact of loop current drop in field transmitter display (considering transmitter has inbuilt display) as it getting the value from internal transmitter processor/CPU and definitely there will be impact in control room reading. Also if you connect an external loop power indicator in series with the loop then this loop power indicator reading also effected as same as control room because loop power indicator & control room have same input i.e. 5.99mA as per our example.

Consider what will be the effect 1mA in this process.

## IV. B. ERROR CALIBRATION IN INSTRUMENTS

Every instrument in the field has to be calibrated from time to time for better response and to ensure the quality and the quantity of the product manufactured in any industry for that matter. As per present trend it has many industry have started to use cloud based data storage in order to retrieve and analyze the data from any part of the world.

This calibration of instrument is done with by other organization whose instruments are calibrated by with national organization whose are in turn calibrated according to international standard to maintain similarity and same quantitative analysis all over the world and there are certain standard laid by ISA, ASME, etc., for what type of instrument should be used under what condition and hence making it easy to use.

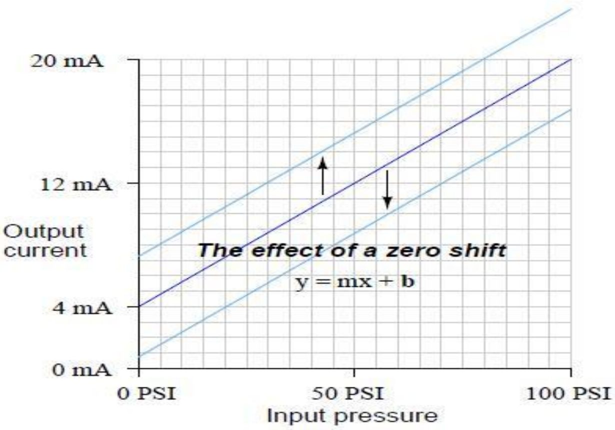
This instrument that is used as standard for field instrument is known as reference. These reference are of high accuracy generally for flow meter the reference instrument is ROTAMETER. For temperature measuring instrument it is high accuracy Thermocouple or thermistor depending upon the temperature range. These reference instruments always have higher accuracy compared to local field instrument.

Instrument error can occur due to a variety of factors: drift, environment, electrical supply, addition of components to the output loop, process changes, etc.

Since a calibration is performed by comparing or applying a known signal to the instrument under test, errors are detected by performing calibration. An error is the algebraic difference between the indication and the actual value of the measured variable.

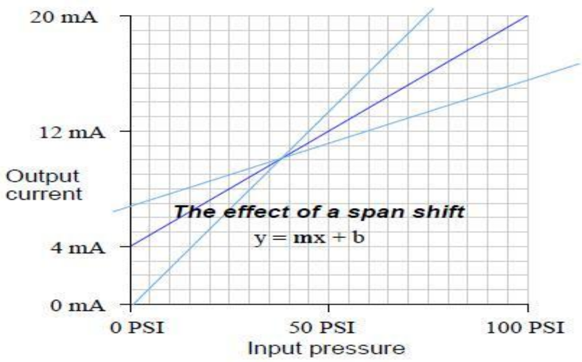
## V. A. STANDARD ERROR IN INSTRUMENTS:

**Zero shit error:** partner-pub-0562 FORID:10 UTF-8 A zero shift calibration error shifts the function vertically on the graph. This error affects all calibration points equally, creating the same percentage of error



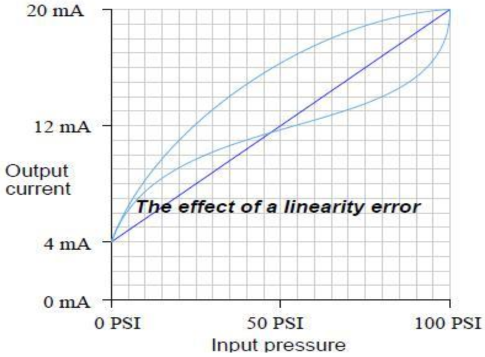

across the entire range:

**Error due to span shift:** A span shift calibration error shifts the slope of the function. This error's effect is unequal at different points throughout the range:

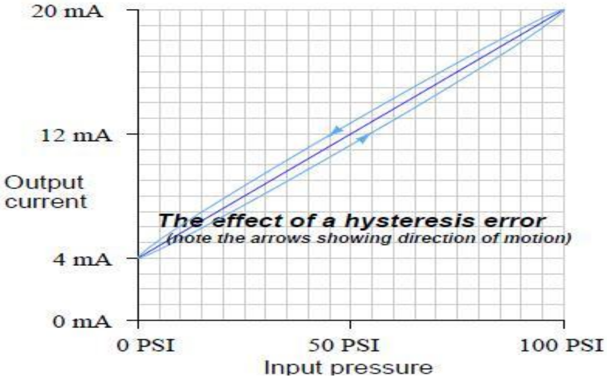



**Linearity error:** A linearity calibration error causes the function to deviate from a straight line. This type of error does not directly relate to a shift in either zero (b) or span (m) because the slope-intercept equation only describes straight lines. If an instrument does not provide a linearity adjustment, the best you can do for this type of error is "split the error" between high and low extremes, so the maximum absolute error at any point in the range is minimized:

*International*
*Journal*
*Of Advanced Research in Engineering & Management (IJAREM)*
*ISSN: 2456-2033 || PP. 65-69*




**Hysteresis error:** A hysteresis calibration error occurs when the instrument responds differently to an increasing input compared to a decreasing input. The only way to detect this type of error is to do an up-down calibration test, checking for instrument response at the same calibration points going down as going up:




Hysteresis errors are almost always caused by mechanical friction on some moving element (and/or a loose coupling between mechanical elements) such as bourdon tubes, bellows, diaphragms, pivots, levers, or gear sets. Flexible metal strips called flexures – which are designed to serve as frictionless pivot points in mechanical instruments – may also cause hysteresis errors if cracked or bent.

## VI. B. RECTIFICATION OF ERROR:

**Zero** and **span errors** are corrected by performing a calibration. Most instruments are provided with a means of adjusting the zero and span of the instrument, along with instructions for performing this adjustment.

The zero adjustment is used to produce a parallel shift of the input-output curve. The span adjustment is used to change the slope of the input-output curve.

**Linearization error** may be corrected if the instrument has a linearization adjustment. If the magnitude of the nonlinear error is unacceptable and it cannot be adjusted, the instrument must be replaced.

In order to detect and correct instrument error in industry, periodic calibrations is being performed. Even if a periodic calibration reveals the instrument is perfect and no adjustment is required, it cannot be known unless the calibration is performed. And even if adjustments are not required for several consecutive calibrations, we will still perform the calibration check in the next scheduled due date as all instrument in industry are small brick of a larger building. Periodic calibrations to specified tolerances using approved procedures are an important element of any quality system.

## VII. SOLUTION SUGGESTED:

Almost all industries are moving towards complete automation and cloud based data storage and each and all industries have their own tag number for each and every instrument being used. They have their own datasheet. These tag number can be stored in a spreadsheet or database and can be accessed from any part of the plant to which tag number indicates which instruments.

The same technique can used to upload the real time data from the field by the field engineers from either HART display or measuring instrument which are of non-contact type in the field (like optical thermometer, laser reflection type to measure distance, etc.,.). Thus uploading the real time data in to online database can be retrieved while calibration of the instrument is done in laboratory and correspondingly Non- Linear system (Such as Hysteresis, spring type, etc.,) can be introduced into the instrument in order to nullify the error during transmission.

Example: If the DCS value is indicated as 7mA instead of 7.1mA which is the field reading then the necessary span shift can be introduced into the instrument in order to make the DCS value equivalent to the Field reading and instrument has to be calibrated in such a way that the HART display will be displaying the same value as that of the field and the same must be displayed in the DCS.

Thus introducing a non – linear system into the instrument makes sure that the calibrated instrument is free from error due to transmission loss.

## VIII. Advantages

1. Cost effective.
2. Ensure quality and quantity.
3. Reduces replacement cost and time.

## IX. Disadvantage

The calibration may tend to be less effective when there is an external factor involved error.

## X. Conclusion:

Thus the process can be made error free by introducing nonlinearity into the source. Thus making sure that the quality of the process ensured. Furthermore accuracy can be easily reached and it costs less when being implemented in existing plant. Unlike calibrating field instruments the interval of calibration can be done with larger time gap.

## XI. Reference

[1]. https://www.isa.org/pdfs/calibration-principles-chapter1
[2]. https://instrumentationtools.com/?s=Error+due+to+cable
[3]. https://instrumentationtools.com/field-instrument-calibration-errors/
[4]. www.ingus.com>_wpck>pdf>US_en
[5]. https://www.predig.com>indicatorpage
[6]. https://www.dataq.com/blog/data-acquisation/4-20-ma-current-loop-measurements/
[7]. https://www.surecontrols.com/why-calibration-of-your-measuring-instruments-is-important/
[8]. https://www.instrumentationtoolbox.com/2012/12/understanding-instrument calibration.html?m=1#axzz4bJbscsel