ABB INTERSTAND DIMENSION CONTROL, IDC IMPROVED TOLERANCES IN PROFILE MILLS[1]

Mats G Olsson[2]

Abstract

IDC, Interstand Dimension Control, introduced to the market 1998 is now launching the next generation of U Gauges and IDC concept configuration. Field experience is proving not only improved product tolerances but also increased mill productivity. In a typical mill, the tolerances can be halved with IDC implemented compared to the normal performance. Final rounds in the range of 60 -70 mm have been rolled to a 1/8 DIN tolerance via 2-3 IDC controls in a 4-6 Horizontal/Vertical mill stand configuration. The same tolerances are achieved for 20 mm round dimension rolled width 3 IDC controls. The IDC system gives the rollers immediate measurements of Height, Width and position of the bar out of a roll gap. The rollers immediate response to how the mechanical adjustments of roll gap, rolls and guides will affect the bar dimensions and position out of a stand will result in a more consistence mill setup and improved pass schedules.Our ABM 2005 paper will give an overview to the IDC concept as well as results and experience from rolling mill installations.

Key words: IDC; U Gauge; Profile mill.

[1] 42nd Rolling Seminar - Processes, Rolled and Coated Products, 25-28, Oct. 2005, Santos- SP - Brazil

2 Product Manager IDC, ABB Automation Technologies AB, Metals and Mining

1 INTRODUCTION

Fierce competition among steel producers leads to a constant need for product improvements in order to stay in the market. Traditional rolling methods in rod and bar mills are based on minimum tension control and loop control. These methods are not sufficient to meet the increasing market demands on quality and tolerance. ABB's Industrial[IT] Interstand Dimension Control, IDC, provides the tool for the continuous improvement and control of the rolling process for long round products.

2 IDC SUCCESS

Fundia, Boxholm Fine Section Mill, one of Europe's leading manufacturers of long steel products, is not only a successful supplier of a portfolio of more than 2,000 products in different steel grades, but also a world-class supplier of close-tolerance round products. In order to maintain market leadership with regard to tolerances, yield and availability, Fundia decided to invest in ABB's IndustrialIT Interstand Dimension Control, IDC. The tolerance demands for the rolled round products, in total ~ 84 different dimension in the range Φ 39 - 14 mm were < ¼ DIN. The project was divided into two stages

Stage 1, Φ 39 - 30 mm, μ ± 0.150 mm
Stage 2, Φ 30 - 20 mm, μ ± 0.100 mm
Φ 20 - 14 mm, μ ± 0.075 mm

By measuring the width, height and position of the rolled material after each stand in the mill the IDC identified problems related to mechanical adjustments, pass design, and temperature. After mechanical modifications and pass design changes the final IDC control configuration was optimized to a few strategic positions in the mill, see Figure 1.

Final acceptance tests were run in may 2003, and the IDC system exceeded Fundia's expectations regarding the tolerance specifications for round products. With the help of the IDC system tolerance of ±0.04 mm for Φ 20 mm bars, see Figure 2, was achieved. This is less than half that normally obtained with sizing mills.

The successful results are not only attributable to IDC but also to the Fundia crew's competence, their process know-how and dedication to the rolling of world-class products.

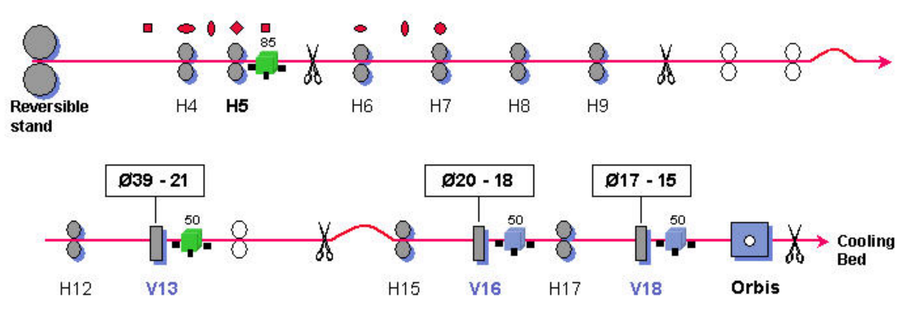

Figure 1. Final IDC control layout. U Gauges for control are used after stand 5, 13, 16 and 18.

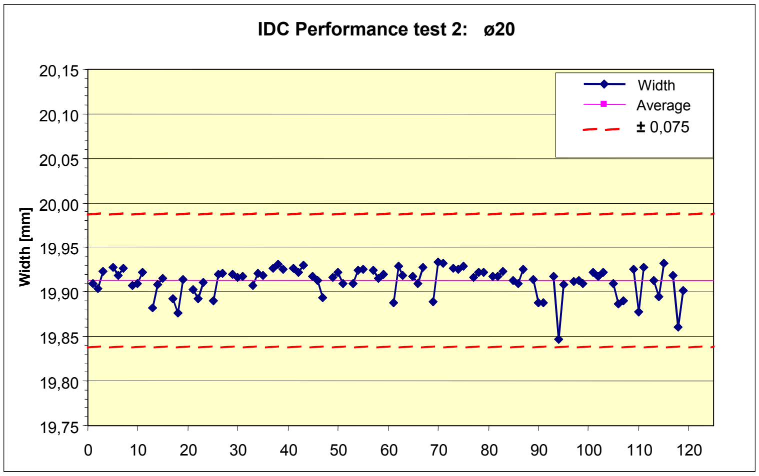

Figure 2. IDC performance on round 20 mm, tolerance of ±0.04 mm

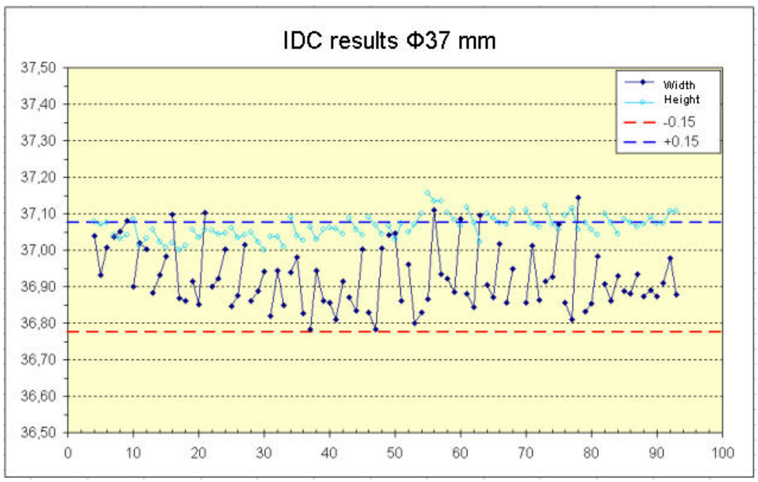

Figure 3. IDC performance on round 37 mm, tolerance of ±0.15 mm

3 IDC CONCEPT

3.1 Case

ABB developed the IDC system to help mill owners to increase material yield, raise plant availability and improve the final dimensional tolerances. By ensuring dimensional consistency of a rolled bar, IDC can reduce the number of loop controls needed in an existing mill and space becomes available that can be used for cooling zones, which in turn improves the material properties. Another trend in the industry is towards endless rolling, in which billets are welded together to form a continuous billet to increase yield by reducing the number of rest ends occurring when billets are cut to customer length. An inherent problem of endless rolling is that temperature as well as the dimension can differ from billet to billet. Traditional control systems compensates for these differences through head end adaptation of tension on every new billet entering the mill, but at endless rolling just one head end occurs and the rest of the welded body is uncontrolled. The solution to this problem is an IDC control that keeps the width of the welded billet constant from head to tail.

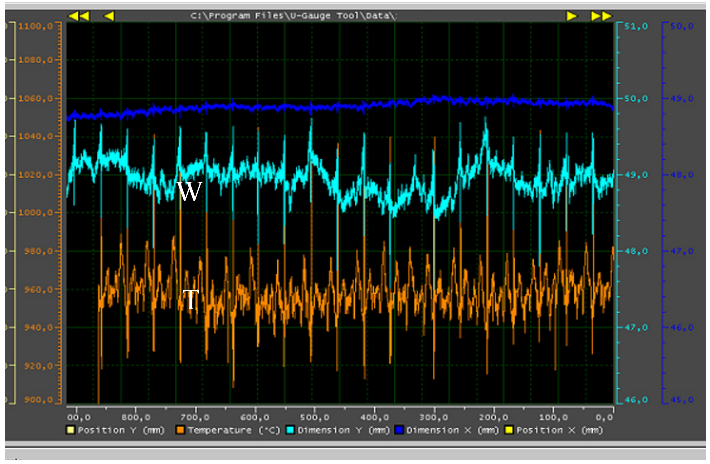

Figure 4. Endless rolling, welding points found as spikes in temperature (T). Height is almost constant and Width (W) differs from billet to billet.

3.2 Components

IDC is applicable to both old and new profile mills and it is easy to integrate into an existing automation system.
The IDC system is available as Measuring system, Mass flow control systems, Stand-alone control system, and Integrated control system.
The concept is based on the latest developments in process control and wireless communication and consists of:
The U Gauge sensor for on-line measurements from head to tail. (Figure 11)
The IDC process control in AC800 RMC controller
The TCP/IP gateway with web server and interface for external users
The U Pads, specially developed user interface for Pocket and Tablet PCs working with WLAN
The U Gauge tool, a PC based operator and maintenance interface.

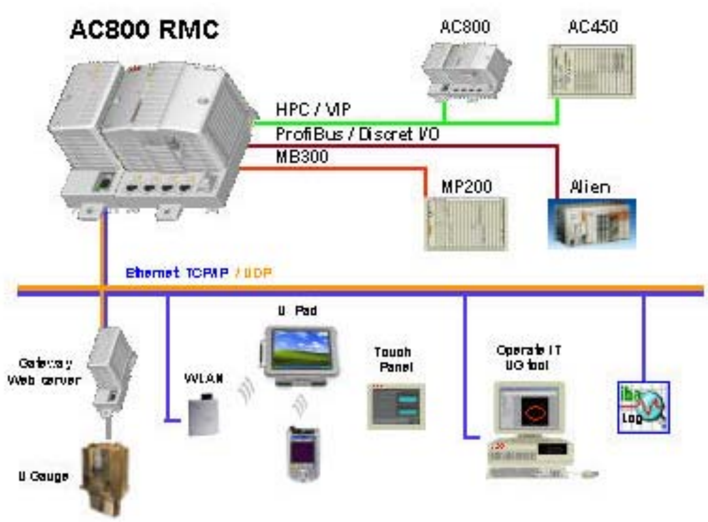

Figure 5. IDC concept components.

3.3 Measuring System

This solution allows an accurate measurement of the width and height and position from head to tail of round long products. By observing the graphical displays the rollers get early warnings of abnormalities in the rolling and can make the necessary adjustments. This operator tool for process understanding will result in more consistence mill setup and improved pass schedules.

A measuring system can measure / identify problems with:

Dimension, due to Tension and Roll gap setup by measuring width and height

Temperature, due to Width variation head to tail by measuring width and height. See Figure 6

Interstand tension, due to Width variation at tail out by measuring width and height. See Figure 7

Grove utilization, by measuring the width

Eccentricity, by height measurement. See Figure 8

Mechanical adjustments, by measuring height and the bar position in pass line

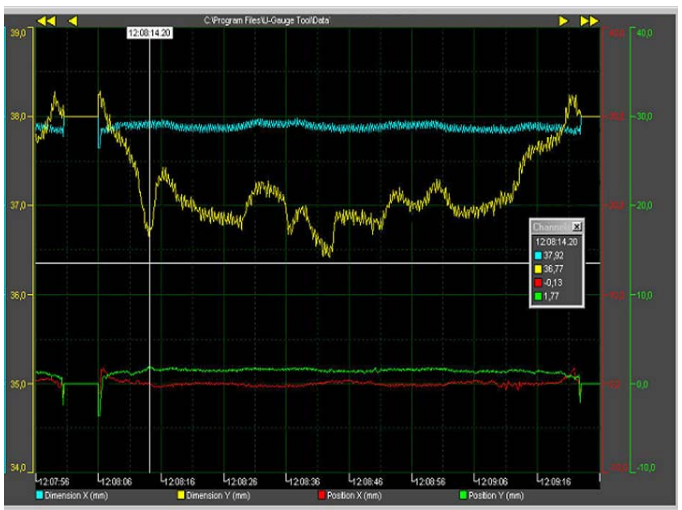

Figure 6. Typical width variation due to temperature profile.

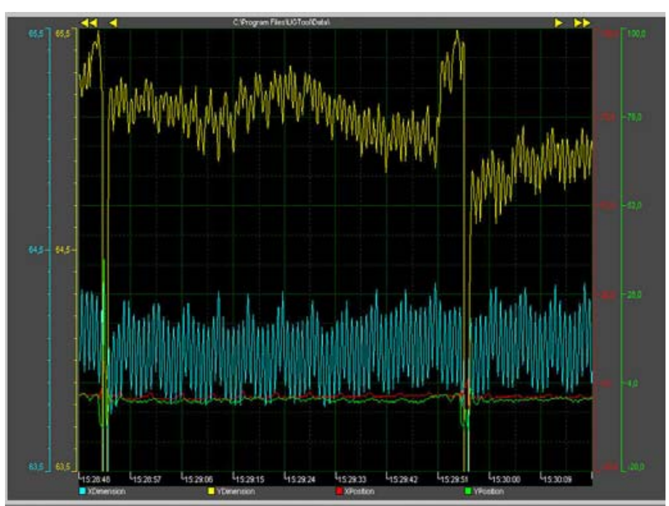

Figure 7. This chart shows problems with Roll eccentricity, Tail out tension and Head end variations.

Figure 8. Roll eccentricity, height and width change in opposite direction. Mass flow constant and height variation corresponds to roll speed.

3.4 IDC Control

The width is controlled from head to tail by means of interstand speed changes, while the height is compensated for roll wear between bars.

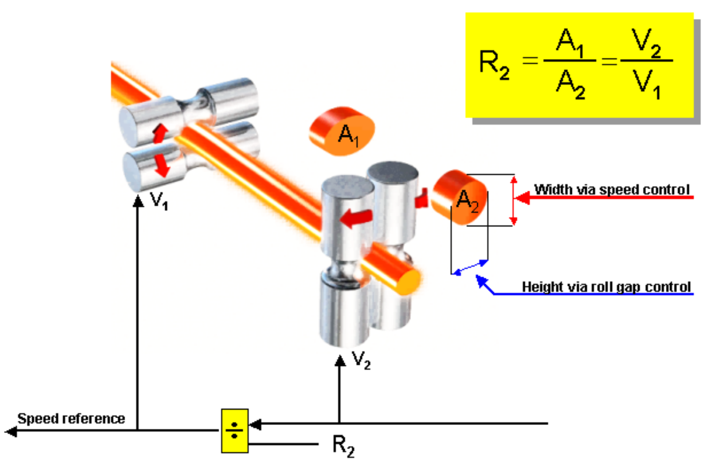

Figure 9. IDC control

The interstand speed is controlled by the R-factor. If the width is too big the R-factor is increased and the speed of the upstream stand is decreased introducing a small tension that reduces the width. In the example below, see Figure 10, a R-factor change of 0.6 % affect the width by 0.7 mm, a traditional minimum tension control allows the R-factor to change 3 to 5 %.

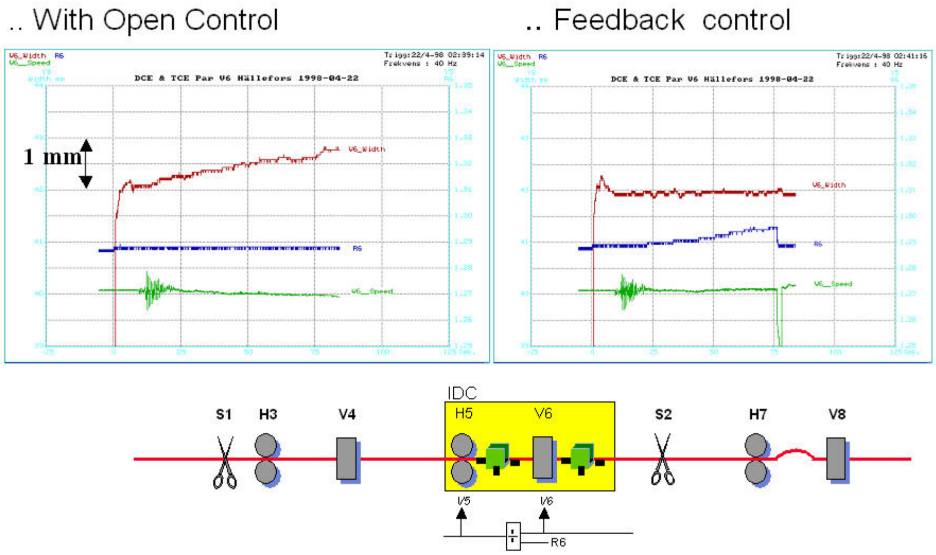

Figure 10. Without IDC control the width variation is approx. 0.7 mm from head to tail due to temperature. IDC is turned on and the R-factor change of 0.006 units to control the width.

3.5 U Gauge sensor

The U Gauge is based on ABB’s patented Pulsed Eddy Current Technology and does not have the limitations and drawbacks associated with conventional eddy current technology. It ensures that measurements are performed with exceptional high accuracy, also under very difficult environmental conditions. Key dimensions like width, height, area, resistivity, temperature and position are measured in less than one millisecond. Width, height, position, temperature and gauge status are communicated via the TCP/IP gateway.

Figure 11. U Gauge in operation

Pulsed Eddy Current Technology measures the voltage pulse induced in the coil when a constant excitation is suddenly interrupted. The coil excitation is a DC source controlled via a switch, see Figure 12.This new technology allows three unique signals to be derived at three different times, Distance, Resistivity and Thickness. As the coil excitation is completely interrupted when the switch is open the measured values are only affected by the eddy current in the material resulting in exceptionally high measurement accuracy.

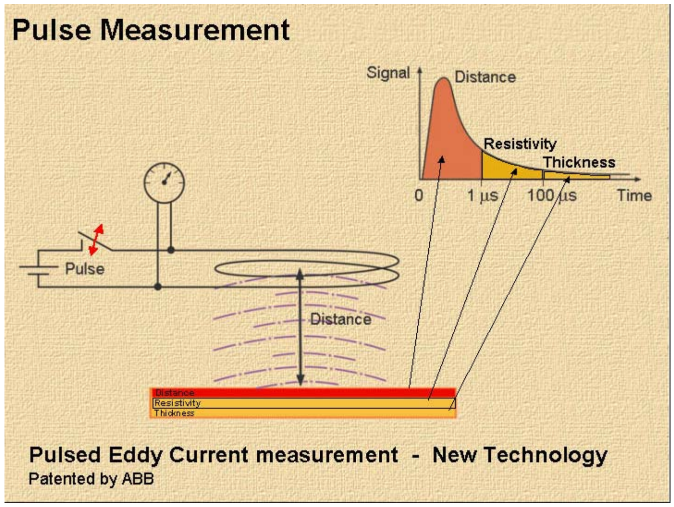

Figure 12. Pulsed Eddy current Technology

The traditional eddy current technology, based on AC excitation of coils can only measure a phase and amplitude change when a material is present. These two measurements are effected by three parameters distance, resistivity (temperature), and thickness, see Figure 13. The coil excitation is never interrupted and the measured value of the eddy current in the material is affected by the excitation eddy current resulting in poor accuracy.

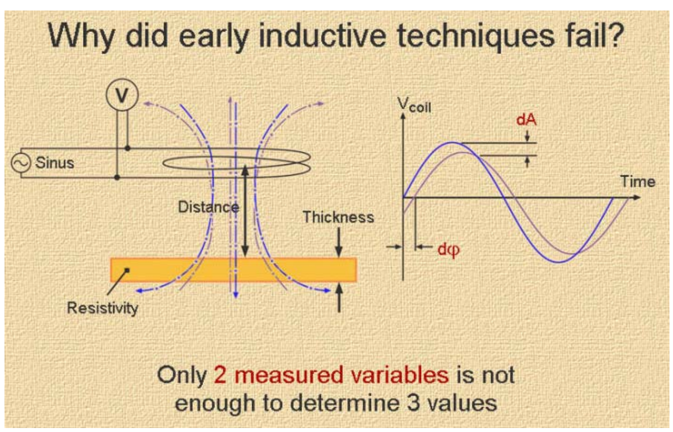

Figure 13. Traditional AC excitation of coils

3.6 TCP/IP gateway

The TCP/IP gateway is used to connect the U Gauge sensor to the TCP/IP UDP network, the gateway allow alien systems to connect to the U Gauge. The gateway also includes a web server for data and maintenance access via standard web browser. The gateway can also be configured over TCP/IP. The simultaneous capacity of the module is one UDP connection, one IBA log connection and 10 TCP/IP sockets.

3.7 Operator Interface

The IDC operator interface is divided into two categories, one for the control room and main operator and one for the mill crew on the floor. The main operator interface includes schedule, setup, analysis and maintenance displays. The mill crew interface can be mounted in local pulpits or be incorporated in hand-held Pocket PC and Tablet PC working with WLAN.

3.8 UG Tool

The UG Tool is a software application to maintain, measure and log data from U Gauges. The UG Tool can run in two different modes, Operator mode and Maintenance mode. The difference between the modes is the extent of toolsavailable to the user.

The UG Tool can also act as server providing U Gauge sensor data to remote clients. There can be up to 10 remote clients connected simultaneously. The UG Tool has several powerful tools to analyze data from the process. The Log and Profile will measure data from selected U Gauge sensors in real-time and present the result graphically. Recorded data can be analyzed using the Historical function of the UG tool. There are also several tools to maintain and upgrade the firmware of the U Gauge sensor.

3.9 AC800 RMC

A measuring system can be extended to a stand-alone control system that gives corrections to an existing control system hosting the mill reference cascade or to an integrated control system, that includes the reference system as well as schedules and configuration of the mill.

4 IDC EXPERIENCE