A CUSTOMIZABLE PLATFORM FOR REMOTELY TEACHING & LEARNING LVDTs

THE RELEVANCE OF USING THE IEEE1451.0 STD. TO FACILITATE ITS DESIGN AND ACCESS

ISEP/CIETI / LABORIS

Ricardo Costa (rjc@isep.ipp.pt)
Samuel Fernandes (samuel54@gmail.com)
Joni Jorge (joni.pin.jor@gmail.com)
Gustavo R. Alves (gca@isep.ipp.pt)

REV2016 - 13th International Conference on Remote Engineering and Virtual Instrumentation
24-26 February 2016, UNED, Madrid, Spain
INDEX

1. Introduction

2. Teaching & Learning the LVDT sensor
   2.1 LVDT overview
   2.2 Educational considerations

3. Example of a customizable platform with a LVDT

4. Using the IEEE1451.0 Std. to design and access the platform
   4.1 Overview of the IEEE1451.0 Std.
   4.2 Considerations for its adoption in the LVDT laboratory

5. Conclusions and perspectives
1- INTRODUCTION

Electrical Engineer

Well designed engineering course curricula (theoretical and practical components)

Good competences

Create, design and innovate!

Practical component is fundamental in engineering courses.
- it should include experimental activities using laboratory infrastructures;
- it is important for teaching and learning analogue transducers (LVDT sensor!).

LVDT
Linear Variable Differential Transformers

A real remotely accessible infrastructure (remote laboratory) is a good solution to include LVDT experimental activities in all engineering courses!

A standard design of the remote laboratory is important!
2. Teaching & Learning the LVDT Sensor

2.1. LVDT Overview

- **Core**
- **Chassis**
- **Electrical wires**

Diagram:
- One coil (primary winding)
- Two coils (secondary windings wound out of phase)
- AC
- $V_a$
- $V_b$
- $V_{a-b}$

Parts:
- Tip
- Spring
- Coils
- Cable
- Shaft
- Core
### 2- Teaching & Learning the LVDT Sensor

#### 2.1- LVDT Overview

**LVDT**

![LVDT Diagram](image)

**Conditioning circuit**

![Conditioning Circuit Diagram](image)

Some characteristics:
- Highly reliable sensors;
- Good accuracy;
- Good Linearity;
- Good sensitivity;
- Infinite resolution;
- Ruggedness (frictionless operation).

Some applications:
- Flight control feedback systems;
- Position feedback of servomechanisms;
- Automated measurements in machine tools;
- ....and many other industrial and scientific electromechanical applications.
2- **Teaching & Learning the LVDT Sensor**

2.2- **Educational Considerations**

- Engineering schools should provide well-structured curricula with appropriated educational resources to fulfill the learning outcomes;

- The experimental component is required to practice learned theories (specially for teaching and learning analogue sensors, such as the LVDTs);

- LVDTs involve many physical principles very much influenced by the environment conditions, requiring the use of *real experiments* (simulations are not sufficient);

- Two possible solutions: traditional or *remote labs*;

  - Remote labs overcome the lack of resources (laboratories and technical infrastructures) giving a more flexible access to the conduction of real experiments;

  - Remote labs are an important educational technology to the current and future of the education landscape (report published by educational specialists of the New Media Consortium “Horizon Report Europe: 2014 Schools Edition”);

- Therefore...

  ...it was idealized and designed a *remotely accessible infrastructure with a customizable platform integrating a LVDT with a basic conditioning circuit*
3- **Example of a Customizable Platform**

- **Users**
- **WEB**
- **Server**
- **Stepper motor**
- **LVDT**
- **Serial interface**
- **Webcam**
- **Function generator**
- **Oscilloscope and Multimeter**
- **Remote interface & web server**
- **Customizable platform**
- **Instruments** (Power supply; Function generator; Oscilloscope and Multimeter)

**EXAMPLE OF A CUSTOMIZABLE PLATFORM**
3- Example of a Customizable Platform

Sx - switch
Cx - connection
(represent the nodes able to be attached to an instrument)
R - resistor (10k)
C - capacitor (10µF)
D - diode (1N4148)

Supply circuit
LVDT
Signal conditioning circuit

oscilloscope
Function generator
multimeter

S4 S5 S6 S7 S8 S9 S10 S11 S12 S13 S14 S15 S16
Ch1 Ch2 Ch3 Ch4 Ch5 Ch6 Ch7 Ch8 Ch9 Ch10 Ch11 Ch12 Ch13 Ch14 Ch15 Ch16
GND OUT GND (+) (+)
3- Example of a Customizable Platform

But... it was implemented without any standard approach!

A solution is the adoption of some issues described in the IEEE1451.0 Std.
4- **THE IEEE1451.0 Std.** TO DESIGN AND ACCESS THE PLATFORM

4.1 - **Overview of the IEEE1451.0 Std.**

- Defined in 2007 and it aims to network transducers (sensors and actuators) using standardized interfaces.

---

**NCAP**

*APIs*

*commands*

**IEEE1451.x**

**TIM**

*TEDS*

---

**TLV structure**

- **Type (1 octet)**
- **Length** (tipically 1 octet)
- **Value**
  - (the number of octets depends on the length indicated in the length field)

---

**Number of octets in the data block + 2 octets of the checksum**

---

**Success / fail flag (1 octet)**

**Length (2 octets)**

**data (variable octets)**
4- THE IEEE1451.0 Std. to design and access the platform

4.2 - Considerations for its adoption in the LVDT lab.

- The NCAP:
  - can act as a master implemented in a webserver, since it provides the web interface to enable remote users sending commands to the platform (the TIM);
  - sends commands to the TIM using any type of physical interface, such as the RS-232 or USB serial connections;

- The TIM (is the platform) and it can adopt a TEDS:
  - the fields document and control the entire behavior of the infrastructure and of the associated platform;
  - implemented inside an internal memory able to be updated using the Read/Write TEDS commands.
5- CONCLUSIONS AND PERSPECTIVES

- **Teaching and learning** analogue transducers is fundamental in electrical engineering (the LVDT is one of those transducers that operates as a sensor);
- The use of **remote laboratories** should be considered to teach and learn the LVDT sensor.

- A **remote laboratory** infrastructure to conduct real experiments with a LVDT **was developed**;
- The laboratory was divided in two distinct parts (hardware + software), whose architecture within the CPU was defined from the scratch (it did not follow any standard approach).

- **A solution based on the IEEE1451.0 Std. was considered**;
- The use of a TEDS memory able to access through the standard commands Read/Write TEDS is suggested to implement the described infrastructure and future ones.

- In the future, developments of remote lab infrastructures based on the IEEE1451.0 Std. will be considered!
Thanks for your attention

Ricardo Costa (rjc@isep.ipp.pt)

http://www.dee.isep.ipp.pt/~rjc