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# Design and Development of Digital Passive Transducer

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**Abstract—***The paper presents the application of ohm's law in measurement of physical and mechanical variables such as pressure, temperature, level, etc., and conversion into electrical variable in mV as output of the digital passive transducer (DPT). The variable resistance is the output of the most of the sensors used in industrial measurements. The External excitation- voltage source is applied to the resistance circuit. The output of the electrical signal is measured according to the ohm's law.*

**Keywords:** *DPT, ADC, LED, RTD, LVDT, RVDT, FOP, PVT and SGT*

## 1. INTRODUCTION

### A. Transducer

Definition of transducer: A broad definition of a transducer is as follows: "A transducer is a device which converts the energy from one form to another". Most of the transducers either convert electric energy into mechanical displacement and /or convert some non-electrical energy-physical quantity (e.g., force, sound, temperature etc.) to an electrical signal.

### B. Sensor

The sensor is defined as "it is a device that detects and converts one form of energy into same form of energy or other form of energy in non-electrical form".

A transducer performs the following functions in an electronic instrumentation system:

- Detects or senses the presence, magnitude and changes in physical quantity being measured.
- Provides a proportional electrical output signal

### C. Classification of Transducers

The Classification of the transducers are classified according to the external power supply requirements

1) **Active Transducers:** They are also known as self-generating type transducers. These transducers develop their own voltage or current.

Examples:
- Thermocouples
- Piezoelectric pick-up
- Photovoltaic cell (Solar Cell), etc.

**2) Passive Transducer:**

They are also known as externally-powered transducers. These transducers derive the power required for the energy conversion from an electrical power source.
Examples:

- Resistance thermometers
- Thermisters
- Potentiometric devices
- Differential transformer
- Photoemission cell etc.

### D. Digital Transducers

Whereas in analog transducers the output varies continuously according to the input, the output in digital transducers is discrete and may give frequency type output or digitally coded output, of binary or some other type.

### E. Ohm's Law

The physicist George Ohm described in 1827 measurements of applied voltage and current passing through electrical circuits containing various length of wire.

Ohm's law states that the current (I) passing through a conductor between two points is directly proportional to the voltage (V) & inversely proportional to the resistance(R).

**The mathematical equation for this relationship is:**
$I = V / R$
Where
I is the current in amperes
V is the voltage in volts
R is the resistance in ohms

## 2. WORKING OPERATION

### A. The Digital Passive Transducer (DPT)

The potentiometer is used as a passive transducer. The selector switch with resistor of 1 k ohm is made as stepwise variable potentiometer. The resistance is the physical variable that is converted to electrical variable in mV. The external voltage source is applied by using 9 V DC battery.

The digital passive transducer is consists of external supply of 9 V DC battery is connected to Potentiometer. The potentiometer is a variable resistance. The potentiometer is made in the form of selector switch and connected with resistors. The range of the variable resistor is from 0 ohms to 6 k ohms. The Voltage source is kept constant and resistance of selector switch is varied step of 1 k ohms. The output of the transducer is observed on digital display. The digital display consists of integrated circuit (IC) ICL 7107 and 7-segment light emitting diode (LED) display. The ICL 7107 is analog to digital converter (ADC) with 7-segment decoder for 4-digit digital display.

## 3. METHODOLOGY

### A. Components & Devices used

The list of components used in this project is as follows

- Selector switch with resistors as Potentiometer – 1 No.
- External 9 V DC supply – 1 No.
- Digital Display Module – 1 No.

**The Digital Display Module consists of**

a) ICL 7107 - ADC with 7-segment decoder IC -1 No.
b) 7-segment LED display – 4 Nos.
c) 7805 – 5 V voltage regulator – 1 No.
d) Supporting analog circuit with
i. Resistors (7 Nos)
ii. Capacitors (8 Nos)

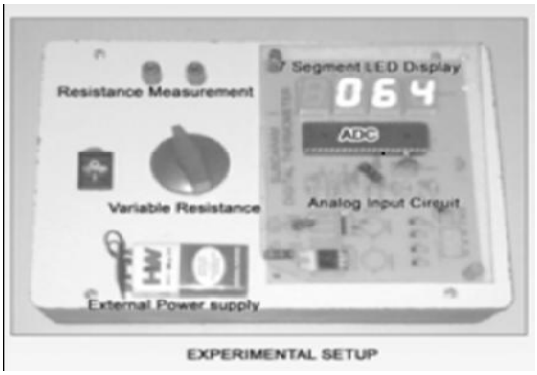


**Fig. .2: Image of Experimental Setup**

## 4. APPLICATIONS

The Passive transducers are used in measurement of process variables in various industries. The common variables are used in automotive and aeronautical industries are mentioned below.

i. Float operated potentiometer for level measurement of fuel.
ii. Temperature measurement of engine using resistance temperature detector (RTD).
iii. Pressure voltage transducer for pressure measurement.
iv. Strain gauge transducer for strain/force measurement.
v. Measurement of linear or rotary displacement.

**Table I: Variable Measurement vs Passive Transducers**

| Sl. No. | Variable Measurement In Automotive & Aeronautical | Passive Transducer |
|---|---|---|
| 1 | Level of fuel, Hydraulic Oil, etc,. | Float Operated Potentiometer (FOP) |
| 2 | Temperature | Resistance Temperature Detector (RTD) |
| 3 | Pressure | Pressure Voltage Transducer (PVT) |
| 4 | Strain / Force | Strain Gauge Transducer (SGT) |
| 5 | Displacement (Linear/Rotary) | Variable Differential Transformer (Linear-LVDT & Rotary-RVDT) |

Applications are summarised in Table 1 with reference to variables measurement and passive transducers.

## 5. RESULTS

The practical results are observed on the digital display module. The variable input resistance is converted into electrical signal in the form of mV.

The practical circuit is made ON by switch. The 9 V DC battery is connected as external voltage supply. The resistance is given 1 k ohms step by step up to 6 k ohms. The electrical signal mV is observed as output from o mV to 130 mV.

Results are observed and tabulated in Table 2

**Table 2**
**Results**

| Sl. No. | Input Resistance in Ohms | Transducer Output In mV |
|---|---|---|
| 1 | 0 | 0 |
| 2 | 1k | 21 |
| 3 | 2k | 42 |

| | | |
|---|---|---|
| 4 | 3k | 64 |
| 5 | 4k | 86 |
| 6 | 5k | 102 |
| 7 | 6k | 129 |

## 6. CONCLUSION

The output in mV is an increase according to input resistance varies.

Accordingly the current flow through the circuit is inversely proportional to resistance as per the *ohm's law.*

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