

# Temperature Monitoring Using dSPACE Card

**Shanmugavalli M<sup>1</sup>, Pranav Kumar S<sup>2</sup>, Suriya Prakaash D<sup>3</sup>, Kabilleshwaran R<sup>4</sup>, Sathish Kumar M<sup>5</sup>**

Professor, Instrumentation and Control Engineering, Saranathan College of Engineering, Trichy, India<sup>1</sup>

Student, Instrumentation and Control Engineering, Saranathan College of Engineering, Trichy, India<sup>2-5</sup>

**Abstract:** Temperature monitoring in the industrialized and domestic applications is important and many complications can occur due to absence of improper temperature monitoring method. In this project we will monitor the temperature by using the MATLAB & dSPACE Card. In many industries where heaters and coolers are used so in order to measure the temperature man resources is utilized as the major drawback. In this project we are using the digital Storage Oscilloscope the data can be accessed via real time graphical representation. This project model will continuously measure and monitor the temperature level of the room or any device which is operated. In Digital Storage Oscilloscope the data can be viewed in graphical representation and display format is also viewed. This project can be implemented in various industrial sectors such as automotive industries, air conditioning, power plant and other industries that need the data to be saved and analyzed.

**Keywords:** Temperature, Continuous Monitoring, dSPACE, MATLAB, Simulink, Digital Storage Oscilloscope (DSO)

## I. INTRODUCTION

There's a lot at stake when it's about managing high-value equipment, assets, or any other perishable products. The need for remote temperature monitoring systems is critical for numerous applications like maintaining optimal temperatures, ranges of temperature, and humidity. It is now being used in almost every industry. The range of applications of temperature monitors is vast – they are even used in the geotechnical monitoring fields. From a bird's eye view, a temperature sensor is used to compute the degree of cold or hot in an area and convert it into a readable unit. dSPACE stand for "Digital Signal Processing and Control Engineering" flexible hardware systems are in widespread use in the automotive industry and are also employed in drives, aerospace and industrial automation, use dSPACE tools throughout the entire process or individual stages, you can rely on dSPACE to make a real impact on the efficiency of your development cycle. Using the dSPACE to measure and analysis the temperature. Using the MATLAB, Simulink and sensor to measure the process parameter as a temperature in the real time environment and analyze the output of the process parameters in the graphical representation via **controlDesk 7.2** software.

dSPACE based real time implementation of predictive current control scheme for grid connected two level voltage source converters, the cost function evaluates the error between reference and predicted grid currents and selects an optimal switching state based on the minimum error value.[1]

Application of dSPACE microprocessor platform for the study of electric generators using renewable energy sources (RES), integration with MATLAB/Simulink RTI, which enables the rapid prototyping of control algorithms that are developed and simulated in Simulink.[2]

This paper presents a photovoltaic system with maximum power point tracking facility. An intelligent Sliding mode controller method is proposed in this paper to achieve the maximum power point tracking of PV modules.

The system consists of a photovoltaic solar module connected to a DC-DC boost converter. The system is modeled using MATLAB/SIMULINK. The simulation results show that the proposed maximum power tracker tracks the maximum power accurately and successfully in all tested conditions. In this work, temperature monitoring by two methods. In first method to create a program in MATLAB simulink for temperature monitoring and output view in the scope and second method view the output response in real time using dSPACE Card & Digital Storage Oscilloscope (DSO).[3]

The synchronous machine with permanent magnets is a very interesting solution for the generation of electrical energy in isolated and autonomous wind turbine applications, but the stability of the voltage remains a major problem in its use. that's why we're proposing in this paper the analysis of a control scheme for keeping the RMS voltage output constant, the system is supplying by a permanent magnet synchronous generator (PMSG) with variable speed and load.

A comparison is examined between experimental results using dSPACE board. The results are provided to verify the effectiveness of this approach and gives very high performance.[4]

This paper deals with the simulation of a Dynamic Voltage Restorer (DVR) for compensating electric power grid disturbances, in order to guard sensitive loads. The DVR consists for Power Electronics converters (AC-DC and DC-AC converters), a series transformer and a Control System. This management system is capable of detecting the disturbances and compensating them. The complete system (grid model, DVR and sensitive load) was simulated on Real-Time Digital Simulator (RTDS), with Hardware in the Loop (HTL) on dSPACE. In RTDS, the power circuits was modeled, and already on dSPACE, the control logic was implemented. In order to investigate the DVR's dynamic behavior, simulation tests are performed, inserting disturbances with variable amplitude, characterizing a voltage sag, swell and interruption. And finally, the simulation results show a successful compensation for the disturbances inserted in grid, protecting the load.[5]

Implementation of a grid connected smart inverter using the dSPACE system as a rapid prototyping solution for laboratory implementation. [6]

In this paper to create a simulink program for temperature monitoring using the simulink library blocks, in this method using blocks are Constant, Sum, Scope, PID Controller, Simulink-PS converter , PS- Simulink converter, Ideal temperature sensor, Ideal temperature source, Thermal reference, Solver configuration, Use in this blocks temperature monitoring & control and finally output view in the graphical representation using scope function. In this method temperature monitoring output view in the real time using Digital Storage Oscilloscope (DSO), already created the temperature monitoring simulink program in the first method, that simulink program to be build and after building supporting files are added in the given root path or file location, and open the software as control desk 7.2 and created a file, import the builded temperature monitoring simulink file. Additionally added simulink blocks as Master Input/output because to connect the DSO through the dSPACE card and also set the channel it is user defined. dSPACE card have an analog and digital channels which channel to be given in simulink program (example: ADC channel 5 or DAC channel 7) in the channel to connect the Digital Storage Oscilloscope (DSO) using the probes and adjust the x and y rays view the response in the real time.

## II. BLOCK DIAGRAM

The block diagram of temperature monitoring system is shown below.

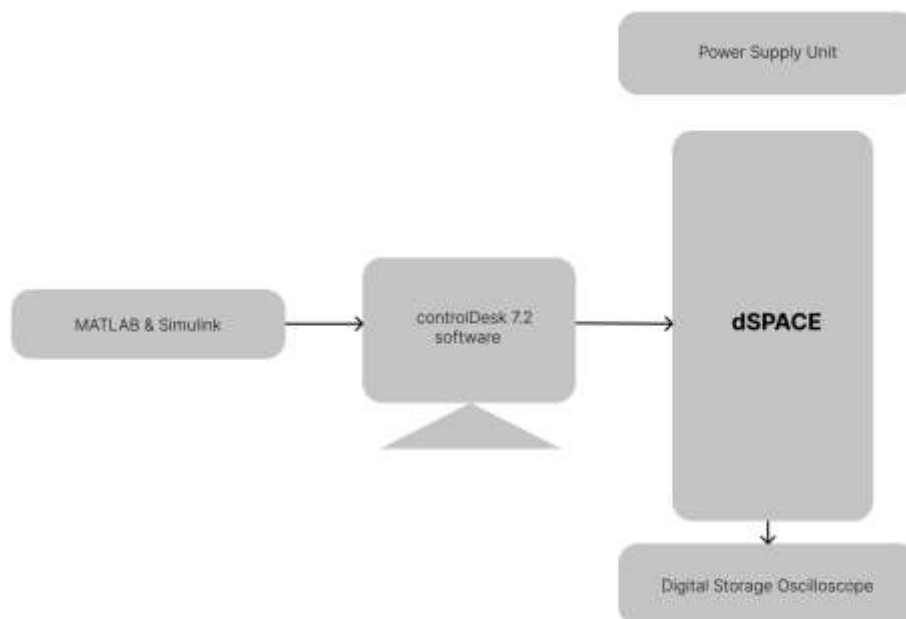


Fig.1 Block diagram of the system

### **III. TEMPERATURE MONITORING**

To put it simply, a monitoring system of temperature is a resistance temperature detector that helps get the measurement of temperature in a readable form. This is done via an electrical sign. Since these systems are designed for a wide variety of needs, you have to decide the type you will use. The top three are thermocouples, thermistors, and RTDs.

With the right temperature monitoring system, you can track critical temperatures at sites, server rooms, and data centers that include important gear. Instead of installing a new distributed control system, you can use intelligence to figure out temperature-related problems. The role of a Resistance Temperature Detector is of prime importance here as it changes electrical resistance in direct proportion with the temperature change.

It does it in a repeatable and precise manner. The remote monitoring IOT measures the temperature through electrical signals. The temperature sensor comprises two types of metals. These metals generate electric voltage or resistance when it experiences temperature change. The voltage that goes across the diode terminals plays a critical role in working a temperature monitoring system. The temperature rises whenever there is an increase in voltage. A drop then follows it in voltage between the base's transistor terminals and the diode's emitter. An accurate measurement is of extreme importance in making sure that this process is successful. There are different kinds of temperature sensors – they depend on the type of temperature that needs to be measured. The two primary types of temperature sensors are contact and non-contact sensors. Places of hazard usually use contact sensors.

- Contact temperature Sensors: Certain temperature sensors need to be in direct contact with the object or person to measure temperature increases or decreases. These kinds of sensors are used to detect gases, solids, liquids varying over a wide range of temperatures. The range includes Resistance Temperature Detector (RTD), Thermocouple, thermistors, and thermometer.
- Non-Contact Temperature Sensors: These are sensors that do not come in direct contact with the object to measure temperature. The degree of hot and cold is measured through radiation that is emitted through the source of energy. Thermal imaging and Infrared sensors are the most types of non-contact temperature sensors.

### **IV. HARDWARE DESCRIPTION**

#### **1. dSPACE:**

The MATLAB Simulink tools depend on the dSPACE controller board in real-time implementation, which is a popular platform in academic research. dSPACE is a famous controller board, offering many advantages in terms of monitoring, controlling, and automating experiments and making the improvement of controllers more efficient. The DS1104 controller board with the best response in terms of a high memory space and faster implementation process was considered in this study.

The properties of the DS1104 controller board are explained in Fig.2. This figure shows the general connection of the controller board with the personal computer and the converter (hardware). A photo of the DS1104 controller board is shown in Fig.3, and the implementation flow of the dSPACE-based converter system is presented in Fig.4. Real-time interface (RTI) is the real-time adoption software for the dSPACE scheme that enhances the real-time C-code automation, faultlessly effects the dSPACE system and input/output hardware structure, and automatically creates, accumulates, connects, and performs the real-time C-code from the Simulink structure. Moreover, RTI produces a variable file corresponding to signals and parameters, and ControlDesk will contact this file and update the parameters.

With RTI, one may simply run the function models on the DS1104 controller board. It configures each I/O graphically by pulling RTI blocks and decreases the implementation time to a minimum. The DS1104 enhances personal computers (PCs) with a strong improvement scheme for faster control implementation. RTI produces Simulink blocks for the graphical structure of an analog-to-digital converter (ADC), a digital-to-analog converter (DAC), I/O lines, and PWM. Generally, the board may be installed in each PC with a free 5-V peripheral component interconnect (PCI) slot.

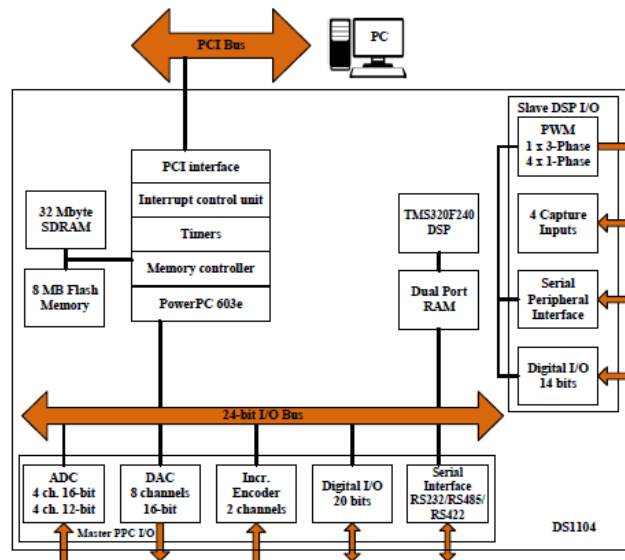


Fig.2 Block diagram of the DS1104 controller board.



Fig.3 Photo of the DS1104 controller board.

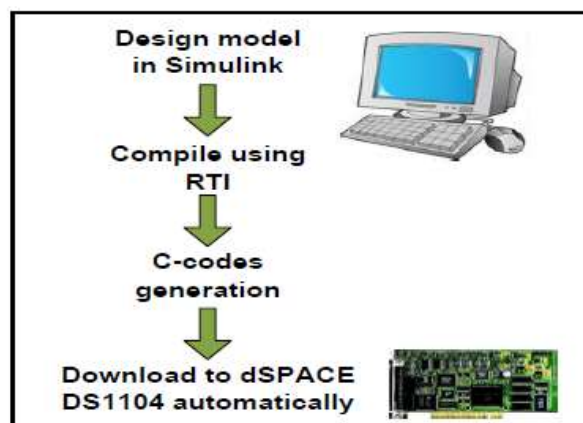


Fig.4 Flow of the implementation of the dSPACE-Based Converter System

There is a requirement for the signal conditioning circuits to be processed via the dSPACE controller board before feeding the signal. This requirement ensures that the voltage and current signals are specified in such a way that the levels match the ADC input range of the controller. Depending on the level condition of the input, the signal undergoes the process of reduction, amplification or current-to-voltage conversion. The signal conditioning consists of AC voltage and current conditioning circuits, and DC voltage conditioning, as depicted in Fig.5

The computer must be prepared with the dSPACE-associated software and hardware, namely, the ControlDesk (dSPACE 2008) software and the DS1104 controller board. Some of the parameters must be measured or tested properly to be set as inputs to the controller. For this purpose, the measurement and dissipation circuits are required.

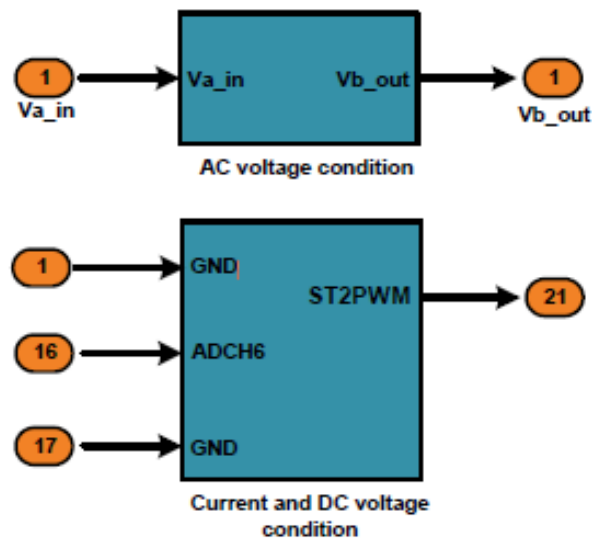


Fig.5 Signal Conditioning.

The implementation of the MATLAB/Simulink converter control technique simulated in real time is proficient with the use of the dSPACE DS1104 RTI. In doing so, the required dSPACE input-output library blocks are involved in the control technique. Fig. 4.1.5 shows the dSPACE 1104 card.



Fig.6 dSPACE 1104.

**V. SOFTWARE DESCRIPTION****1. SIMULINK:**

Simulink is a graphical extension to MATLAB for modeling and simulation of systems. One of the main advantages of Simulink is the ability to model a nonlinear system, which a transfer function is unable to do. Another advantage of Simulink is the ability to take on initial conditions. When a transfer function is built, the initial conditions are assumed to be zero. In Simulink, systems are drawn on screen as block diagrams. Many elements of block diagrams are available, such as transfer functions, summing junctions, etc., as well as virtual input and output devices such as function generators and oscilloscopes.

Simulink is integrated with MATLAB and data can be easily transferred between the programs. In these tutorials, we will apply Simulink to the examples from the MATLAB tutorials to model the systems, build controllers, and simulate the systems. Simulink is supported on Unix, Macintosh, and Windows environments; and is included in the student version of MATLAB for personal computers.

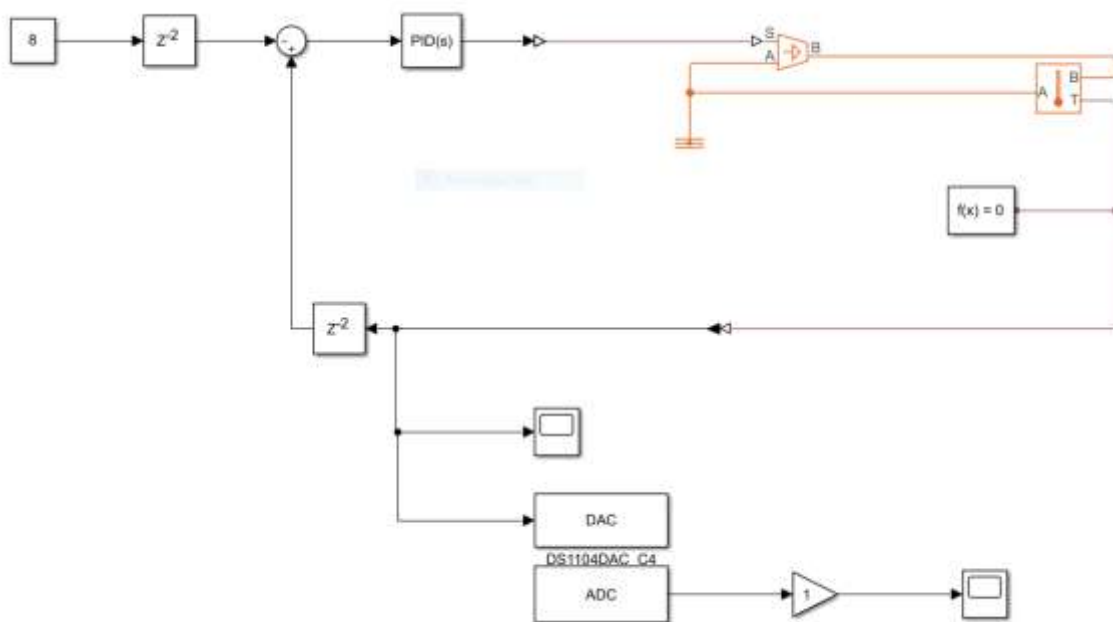


Fig.7 Simulink model of temperature monitoring.

Above the simulink diagram to monitor the temperature using the simulink library blocks such as constant, time delay, sum, PID controller, Temperature sensor, PS converter, scope. In constant block give the set point value according to set point value PID controller, PS Converter and temperature sensor to measure the temperature and scope to generate the output response.

In RTI (real time interface) Master PPC using to get the real time output in Digital Storage Oscilloscope, to convert the digital output to analog output using DAC and to set the solver configurations and build the file.

**2. CONTROLDESK 7.2:**

ControlDesk is the dSPACE experiment software for seamless ECU development. It performs all the necessary tasks and gives you a single working environment

- Integrated ECU calibration, measurement and diagnostics access
- Synchronized data capture across ECUs, RCP and HIL platforms, and bus systems
- Powerful layouting, instrumentation, measurement and post-processing (ASAM MDF)

ControlDesk unites functionalities that often require several specialized tools. It provides access to simulation platforms as well as to connected bus systems and can perform measurement, calibration and diagnostics on ECUs, e.g., via standardized ASAM interfaces.

Its flexible modular structure provides high scalability to meet the requirements of specific application cases. This gives you clear advantages in terms of handling, the amount of training needed, the required computing power, and costs.

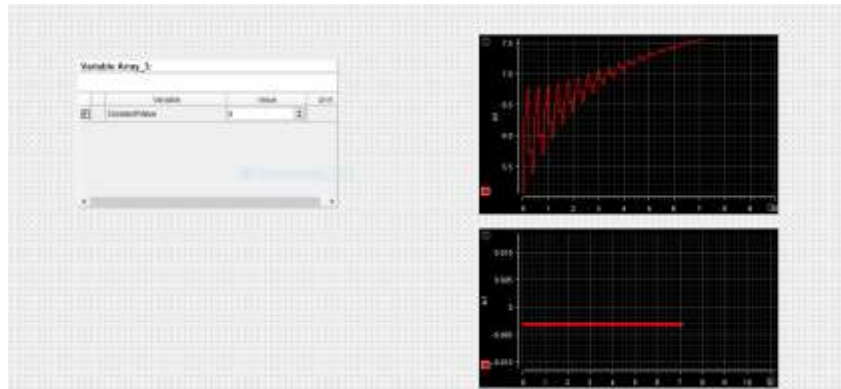


Fig.8 Controldesk Temperature Monitoring.

To create the controldesk program to import the built simulink that file must be a “.sdf” extension and the variables tab have an input & outputs to select the Inputs/outputs and drag & drop to controldesk workspace and also is to be select the output plot in this case using the time plotter, save the file and go to the online to find the run to click it to measure the temperature in the time plotter above diagram as shown as Fig .8

## VI. EXPERIMENTAL SETUP / HARDWARE PROTOTYPE

The below figure depicts the hardware prototype that has been developed to realize the proposed methodology. The tests were conducted using the below experimental setup.

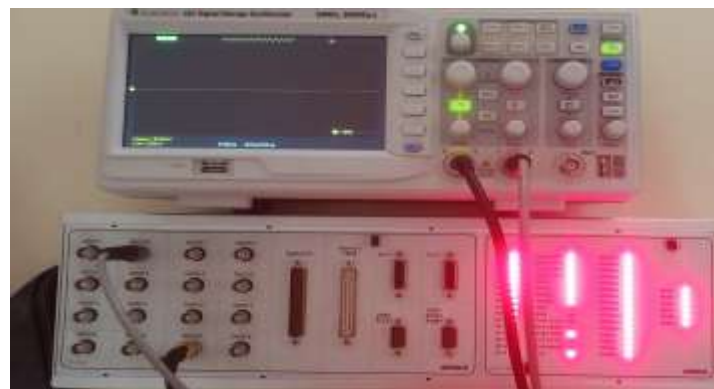


Fig.9 Experimental Setup.

## VII.PROCESS DESCRIPTION

To create a simulink program for temperature monitoring using the simulink library blocks, in this method using blocks are Constant, Sum, Scope, PID Controller, Simulink-PS converter , PS- Simulink converter, Ideal temperature sensor, Ideal temperature source, Thermal reference, Solver configuration, Use in this blocks temperature monitoring & control and finally output view in the graphical representation using scope function. In this method temperature monitoring output view in the real time using Digital Storage Oscilloscope (DSO), already created the temperature monitoring simulink program in the first method, that simulink program to be build and after building supporting files are added in the given root path or file location, and open the software as control desk 7.2 and created a file, import the builded temperature monitoring simulink file.

Additionally added simulink blocks as Master Input/output because to connect the DSO through the dSPACE card and also set the channel it is user defined. dSPACE card have an analog and digital channels which channel to be given in simulink program (example: ADC channel 5 or DAC channel 7) in the channel to connect the Digital Storage Oscilloscope (DSO) using the probes and adjust the x and y rays view the response in the real time.

Open the project Temperature monitor.slx proj in the MATLAB simulink and import the builded file of temperature monitor controldesk 7.2 software is must be a sdf extension. Confirm that dSPACE 1104 is connected to your computer and also connect the DSO which channel to be given in simulink program (example: ADC channel 5 or DAC channel 7) in the channel to connect the Digital Storage Oscilloscope (DSO) using the probes. To go online and run the program either by clicking the Run button on the toolbar or by pressing Ctrl+R. channels and adjust the x and y rays in the DSO view the response in the real time.

### VIII.RESULT

In temperature monitoring output response view in the scope and dSPACE controldesk7.2 software shown as Fig10 and also view the output response in real time using dSPACE Card & Digital Storage Oscilloscope as shown in Fig.11.

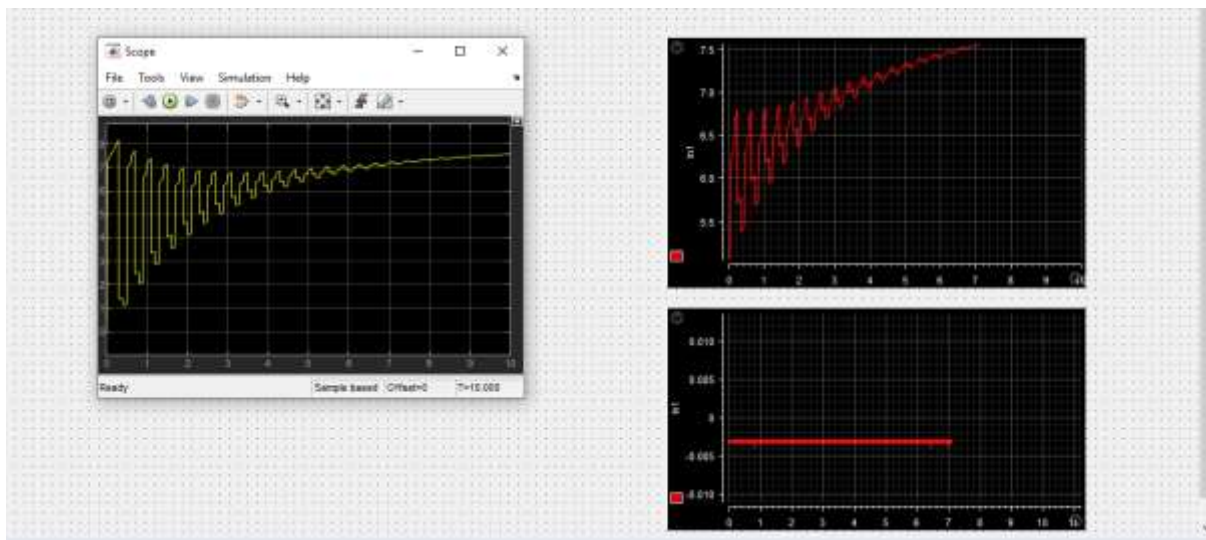


Fig.10 MATLAB scope response & controldesk 7.2 output .

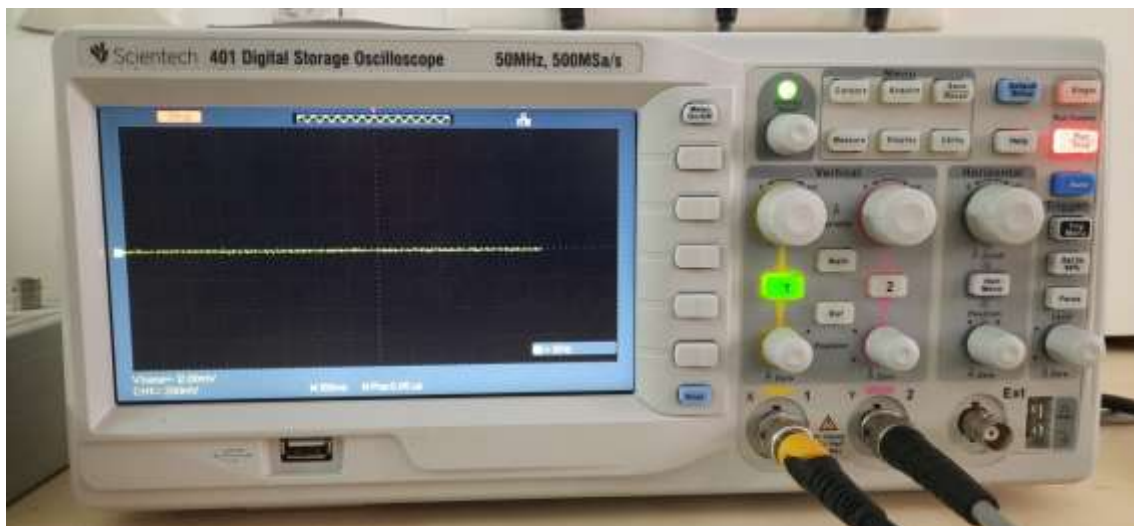


Fig.11 Realtime output in Digital Storage Oscilloscope (DSO).



**XI.CONCLUSION**

As a conclusion, the Real Time Temperature Monitoring System has successfully been developed which shows an alternative to ease the monitoring process, in this system temperature monitoring by two methods. In first method to create a program in MATLAB simulink for temperature monitoring and output view in the scope and second method view the output response in real time using dSPACE Card & Digital Storage Oscilloscope (DSO), this system is very efficient and also validate the output response to compare the first method MATLAB scope function output and second method real time DSO response.

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