



Single Board Heater Using Adam-4022t PID Controller

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ABSTRACT:The main purpose of the project is to control temperature of single board heater^[8] using DAQ card by ADAM model-4022T. USB to RS485 converter UD2535-U of milestone for interfacing computer with hardware is used. The hardware consists of heater, temperature sensor AD590, signal conditioning circuit ,fan,relay. With an excellent accuracy $\pm 0.15\%$, ADAM-4022T is an ideal controller for temperature and other process variable in heating and cooling application as it has built in PID-Controller. The ADAM is provided with PID values from the temperature response of the heater. These values are then fed to ADAM and it takes the necessary action of controlling the plant temperature. It also provides the trend chart which displays the actual process by taking the real time data.

KEYWORDS: DAQ CARD(Data Acquisition),PID(Proportional Integral Derivative),USB to RS485 converter UD2535-U,AD590 (temperature sensor), real time trend chart.

I. INTRODUCTION

Temperature control is an essential parameter in many industries such as pharmaceutical, beverage, oil and gas, etc. Therefore temperature control is an important factor in many process. Measurement and control of temperature always requires accuracy and precision, if these two aspects are not met then, inappropriate results will be obtained. Considering these two parameters we have designed a temperature control of Single board heater using ADAM 4022T. In this plant we have used temperature sensor AD590 which senses the temperature of the heater and gives output in form of current (milliampere). This current is converted into a standard 4-20 mA and is given as an input to ADAM 4022T. ADAM 4022T has a built in PID controller which maintains the temperature of the plant at given set point.

II. PROJECT FLOW

Fig.1 shows flow of project execution is: The single board heater is heated at 24 VDC the temperature of heater is sensed by AD590 temperature sensor which gives output in mA is given to signal conditioning circuit. This signal conditioning converts the output of AD590 into the standard 4-20mA current signal. This is fed to ADAM input side. As per the PID values provided by the user the ADAM takes the necessary action it also controls the process and maintains the process variable at set point. The ADAM utility software which is present in the Pc is connected to ADAM by USB to RS485 converter UD2535-U.

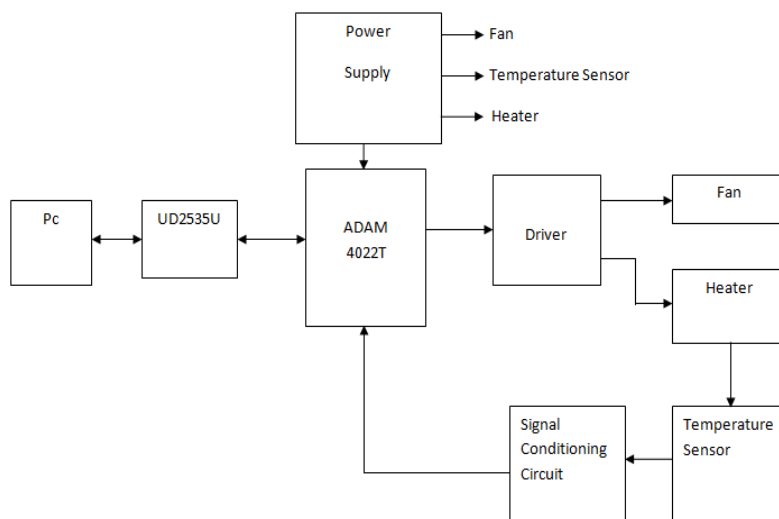


Fig.1 Project Flow Block Diagram

III. SIGNAL CONDITIONING CIRCUIT

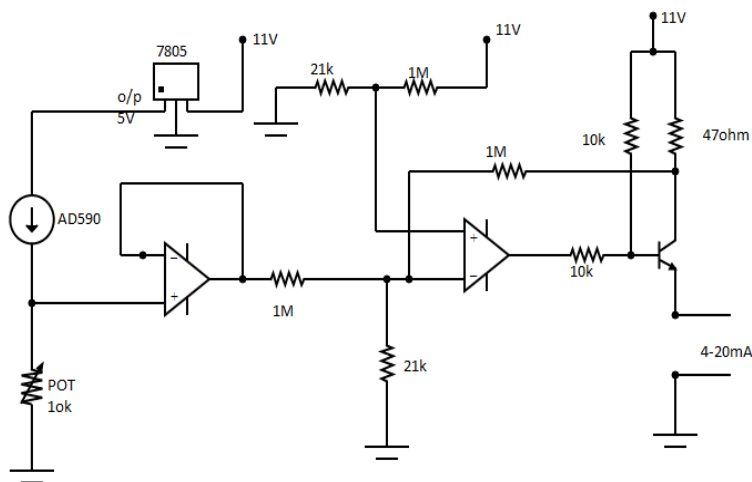


Fig.2 shows the major components of the signal conditioning circuit.

The components are described as follows:

A.AD590: The AD590 is a 2 terminal integrated circuit temperature transducer that produces an output current proportional to absolute temperature. For supply voltages between 4V and 30V, the device acts as a high impedance, constant current regulator passing $1\mu\text{A}/\text{K}$. Laser trimming of the chip's thin-film resistors is used to calibrate the device to $298.2\mu\text{A}$ output at $298.2\text{K}(25^\circ\text{C})$. The AD590 is particularly useful in remote sensing applications. The output characteristics also make the AD590 easy to multiplex^[2].

B.LM324: The LM324 series are low-cost, quad operational amplifiers with true differential inputs. They have several distinct advantages over standard operational amplifier types in single supply applications. The quad amplifier can operate at supply voltages as low as 3.0 V or as high as 32 V with quiescent currents about one-fifth of those associated with the MC1741 (on a per amplifier basis). The common mode input range includes the negative supply,

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(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 4, April 2016

thereby eliminating the necessity for external biasing components in many applications. The output voltage range also includes the negative power supply voltage. In our project we have used only two operational amplifiers^{[11][10]}.

C.BD140: PNP power transistor in a TO-126; SOT32 plastic package. NPN complements: BD135, BD137 and BD139. Products are pre-selected in DC current gain. Features of BD140 are: High current (max. 1.5 A), Low voltage (max. 80 V)

D.LM7805: It is a three terminal device in which it helps to regulate the power. Here, it is used so as to evenly distribute the power supply^[12].

IV. Interfacing between ADAM module and Heater

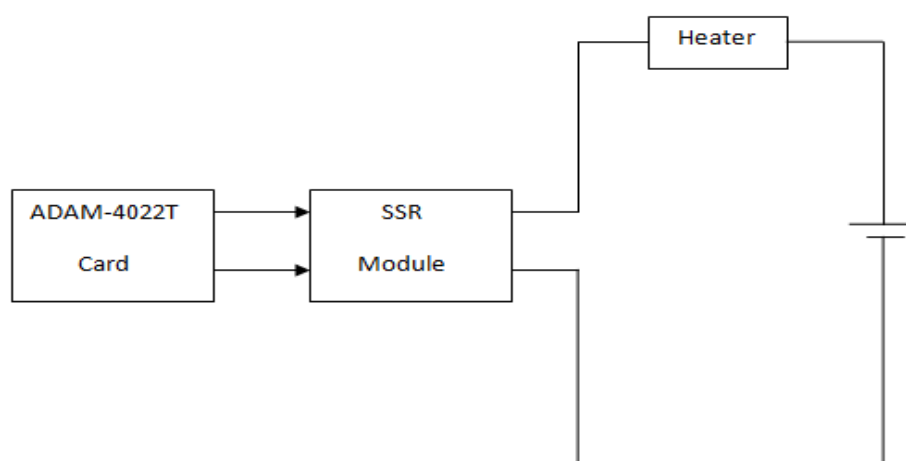


Fig.3. Interfacing between ADAM module and Heater

To regulate the heater temperature the ADAM module is connected with Solid State Relay which regulates the on/off action of the heater. SSR-module has a input which accepts 4 to 20 mA and output is range upto 30V (Ac) which controllers the on/off of the heater.

V. UD2535-U

This device features USB(Universal Serial Bus) interface technology, it is converted to the RS-232 or industrial RS422/485, so it can be easily adopted for industrial machines with RS232 or RS422/485 interfaces. This converter is USB bus powered and does not need any power adapter. Milestone's "UD-25U" is a USB/RS232 to RS485 Converter and designed for high-speed data transmission between computer system through its USB Port or RS232C Port and peripherals or the other devices having RS485 interface over long distance under high noise conditions. The RS232 standard supports handshaking signals (such as RTS, CTS) and full-duplex communication^[15].

VI. ADAM-4022T

ADAM-4022T utility software can help us to select input and range configuration, set the operating parameter (SP, SV, PV..... etc) for your process control needed. ADAM-4022T utility software also integrates the trend chart to help you to monitor and debug your control setting.^[17]

A. Instrument Driver Network for Adam 4022T:

If 3rd party software wants to connect to ADAM series, It can be communicated through OPC sever. For ADAM-4000,5000/485 it may apply ADAM-OPC sever. For ADAM5000/TCP, ADAM-6K series it may need Advantech

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Modbus TCP OPC sever. However this is not free software, customer needs to buy it. The ADAM OPC Servers support three communication protocol servers, including Advantech ASCII Command (AdamOPC),MODBUS/RTU(ModbusRTU),MODBUS/TCP (ModbusTCP) protocol. The servers provide the OPC interface for monitoring the ADAM 4000, ADAM 5000 and ADAM 6000 remote I/O series products. The Modbus TCP OPC Server is used for Ethernet communication and the others are for serial port communication. Therefore the Modbus RTU and Modbus TCPOPC servers could be used for other devices which are supported MODBUS/RTU and MODBUS/TCP protocol. The servers provide several fields for specifying the properties of devices, groups and tags. Those were implemented using advanced programming concepts of the most current version of the OPC specification for use in developing next generation industrial software applications.

B.PID Loop Configuration

ADAM-4022T ,in General connection MODBUS is selected as we have used the modbus for data transmission with the field i.e the single board heater.Input connection channel PV0 is set with 4 to 20mA and channel ch0 is selected.Output connection AO is selected and 4 to 20mA is set.PID configuration setpoint i.e SV is set at 60% of input values.Trend chart is displayed which shows PV,SV,MV values^[17].

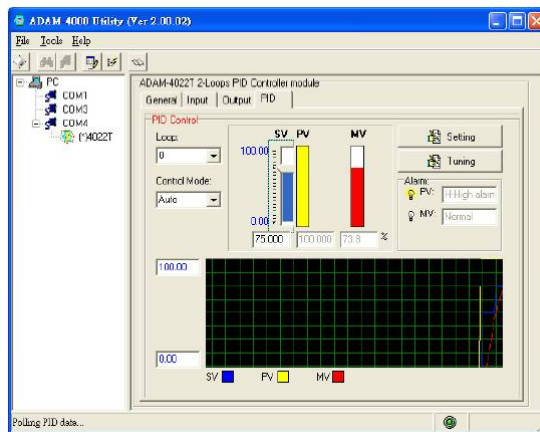


Fig.4. PID Loop configuration

VII. RESULT

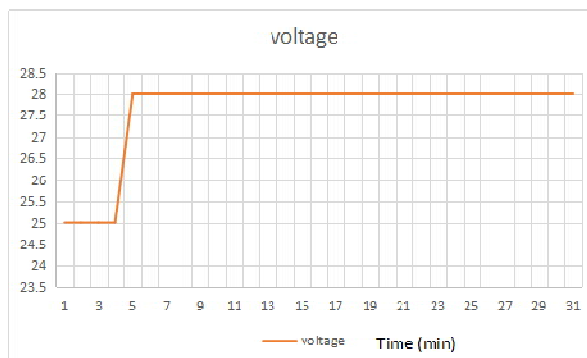


Fig. 5.Step test for Cohen -Coon testing

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Fig.5 shows the step response of the heater when voltage is applied. This readings are obtained when the setup is open loop and fig.6 is also open loop response of the heater. The temperature is obtained by keeping the heater in ice bath and in room temperature and fixed voltage is applied.

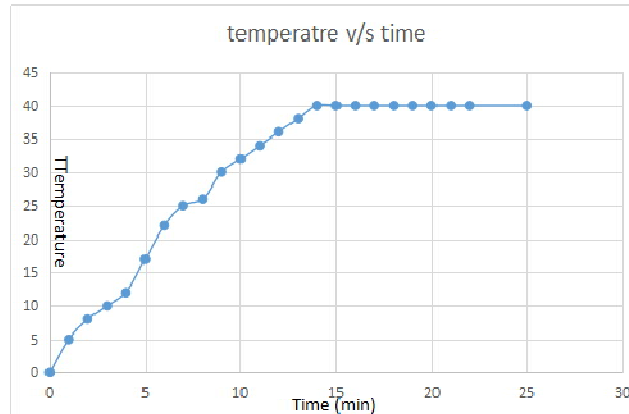


Fig.6. Response of single board heater

As per the Cohen- Coon Technique the PID values are calculated for the response of the heater as shown in fig.6

PID values by calculation (Cohen -Coon technique)

	Kc	τ_i	τ_d
PID	$\frac{\tau}{k * td} \left(\frac{4}{3} + \frac{td}{4\tau} \right)$	$td \left(\frac{32 + 6td / \tau}{13 + 8td / \tau} \right)$	$td \left(\frac{4}{11 + 2td / \tau} \right)$
	7.65	4.705	0.356

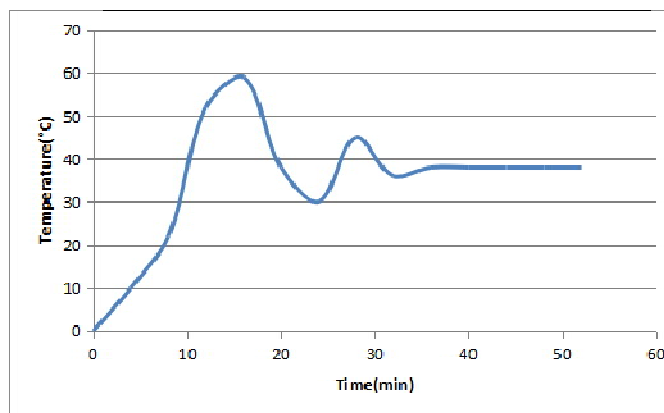


Fig.7. Response of the System

The set point of the system is about 40°C the system shows some overshoot before reaching its setpoint. The transfer

function of the system is $\frac{k e^{-tds}}{\tau s + 1} = \frac{1.6 e^{-2s}}{18s + 1}$.



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VII. CONCLUSION

A proper temperature control is achieved using ADAM 4022T .As we have used the Adam in single loop mode we can only control single parameter i.e temperature.Further we can also modify the system and can use the ADAM as dual loop PID controller. PID controller is easy and fast way to achieve the desired set point. The experiment performed using ADAM-4022T will help the industrial setup . In industries it becomes very difficult to make changes without any prior results this experiment will thus help them to achieve their desired modification.

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