Deney 3 Isıl Dönüştürücüler

Chapter 4

AD590 TEMPERATURE TRANSDUCER

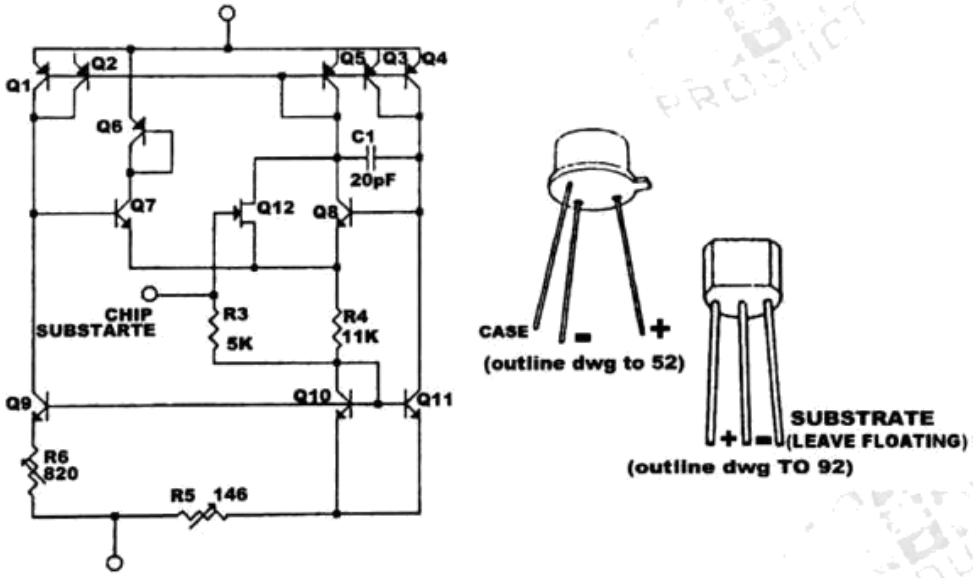
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4.1 OBJECTIVES

1. Study the construction of an AD590.
2. Understanding the characteristic of an AD590.
3. Study the transduction principle of an AD590.
4. Study the applications of an AD590.

4.2 DISCUSSION OF FUNDAMENTALS

The AD590 (Analog Devices Co.) is a monolithic integrated circuit temperature transducer IC that produces an output current proportional to absolute temperature. Figure 4-1 shows its internal schematic diagram and packages.



(a) (b)

Figure 4-1 Schematic diagram and pin configurations

The AD590 has the following features:

1. Linear current output: 1μA / °K
2. Wide temperature-sensing range: -55℃ to +150℃
3. Small volume: two-terminal device, voltage in/current out
4. High accuracy

5. Wide power supply range: the output characteristics are not changed in the power range +4V to +30V, as shown in Figure 4-2.

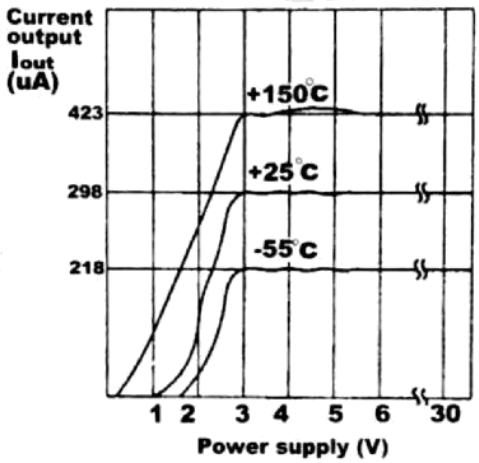


Figure 4-2 Output current vs. power supply

The AD590 is useful in remote temperature sensing applications. The device is insensitive to voltage drops over long lines due to its high-impedance current output. A simple way for converting the current output into a voltage output is to connect the 1KΩ load resistor to the AD590 in serial. To achieve high accuracy in the circuit of Figure 4-3, a 910Ω fixed resistor and a 200Ω semi-pot connected in series is used in place of the 1KΩ.

$V_T = I \times R = 1\mu A / °K \times 1K\Omega$

$= 1mV / °K$

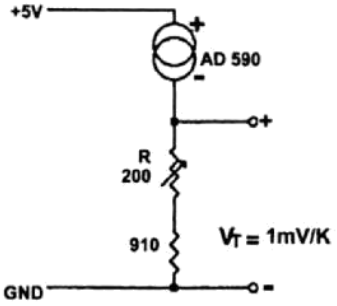


Figure 4-3 Temperature to voltage output circuit

With appropriate application circuits, the AD590 can be used for temperature measuring and control purposes. Here are a few examples.

4.2.1 Lowest-temperature measurement

Each of the AD590 shown in Figure 4-4 is installed at different temperature sensing point and then connected in series. Due to the serial connection, the output current is determined by the AD590, which measures the lowest temperature.

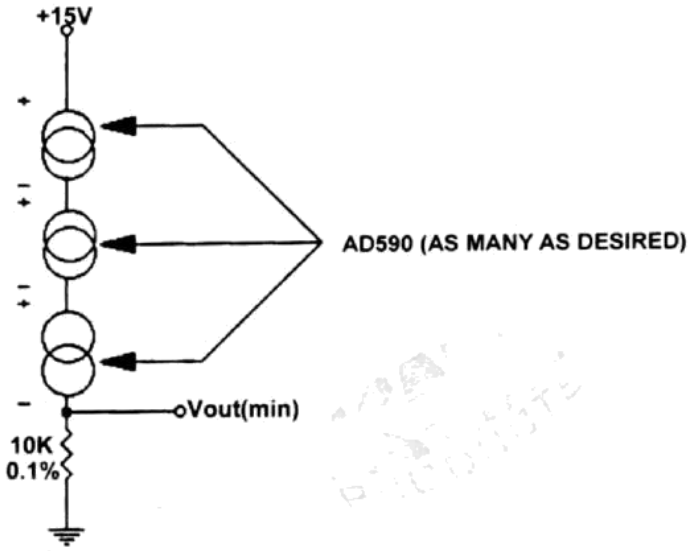


Figure 4-4 Lowest-temperature measurement

4.2.2 Average-temperature measurement

In Figure 4-5, the AD590s' are connected together in parallel. The average temperature can be had if the load resistance R=10KΩ/n (n=total number AD590) is known.

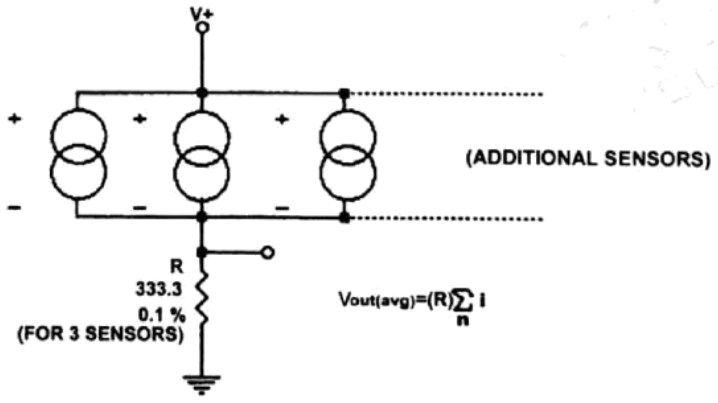


Figure 4-5 Average-temperature measurement

4.2.3 Differential temperature measurement

To measure the temperature difference between points A and B, it is made by connecting two sensors and support parts as shown in Figure 4-6. The 50KΩ potentiometer trims offsets in the devices, so it can be used to set the size of the difference interval.

$$
\begin{aligned}
Vo &= -(I_B - I_A)\,R_3 \\
&= -(T_B \times 1\mu A / {}^\circ K - T_A \times 1\mu A / {}^\circ K) \times 10K\Omega \\
&= (T_A - T_B) \times 1\mu A / {}^\circ K \times 10\ K\Omega \\
&= (T_A - T_B) \times 10mV / {}^\circ K
\end{aligned}
$$

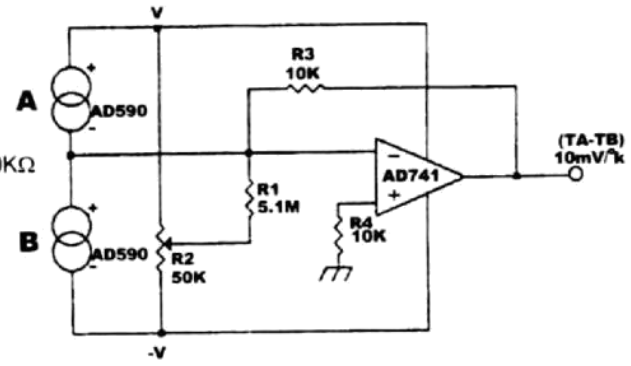


Figure 4-6 Differential temperature measurement

4.2.4 Temperature controller

Figure 4-7 shows a temperature controller circuit. The AD590 provides a 10V reference voltage to the temperature-setting network, which consists of RH, Rset, and RL. The AD590 produces a temperature-dependent voltage 10mV/°K across the 10KΩ resistor. When this voltage is lower than the setting voltage, the comparator AD311 outputs a high potential to turn on the heater. When the sensing temperature reaches the setting temperature, the AD311 outputs a low potential to turn off the heater. C1 is for filtering high-frequency noise.

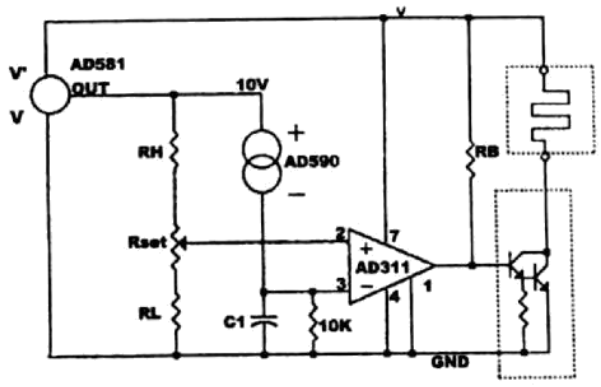


Figure 4-7 Temperature controller

4.3 DESCRIPTION OF EXPERIMENTAL CIRCUITS

The AD590 is an excellent sensor for temperature-to-current conversion due to its good linearity with a transduction ratio of 1μA/°K.

The circuit of Figure 4-8 is the AD590 transduction circuit with two different transduction outputs, the 10mV/°K at U1 pin6 and the 100mV/℃ at Vo15. The U1 acts as a voltage follower. The output of U1 can obtain the voltage of 10mV/°K by adjusting the R2 for R2+R3=10KΩ.

In many applications, the Celsius scale is more convenient than absolute temperature. The relationship of these two temperature scales is °K =°C+273.2, and 273.2°K =0°C. In other words, if the temperature is at 273.2°K (0°C), the output voltages at Vf1 and U1 pin6 should be 2.732V and 0V, respectively. In order to yield the 2.732V-stabilized voltage, a voltage regulator that consists of R6, CR1, R7, R8, R9 and U3 is used.

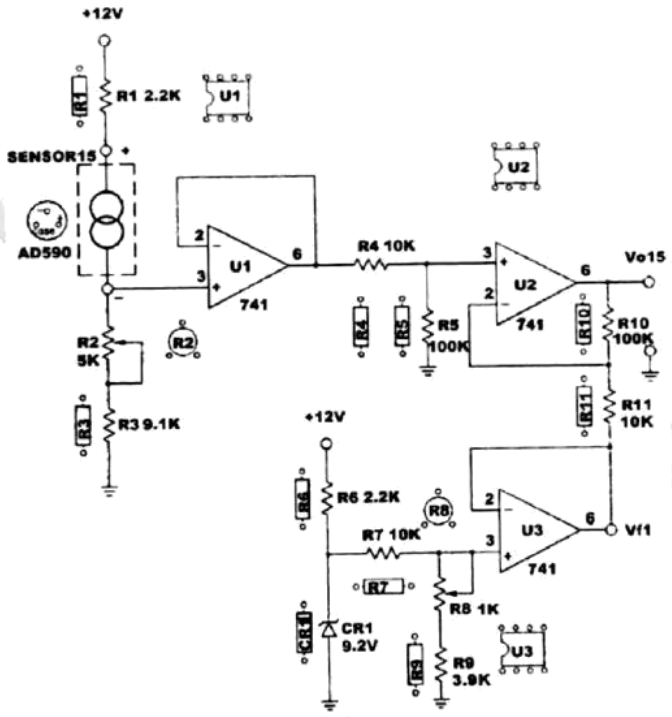


Figure 4-8 AD590 transducer circuit

A digital thermometer shown in Figure 4-9 is built with the AD590 transducer module and the 7135 A/D converter. Since the transduction output of the AD590 transducer is 100mV/℃, such that the full-scale voltage of the A/D converter must be set to 20V.

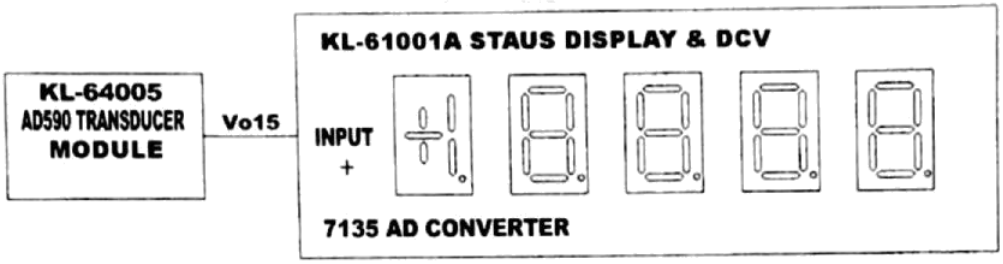


Figure 4-9 Digital thermometer

4.4 EQUIPMENT REQUIRED

1 - Module KL-64005
2 - KL-61001A Trainer
3 - DMM (option)
4 - Soldering Iron (option)

4.5 EXPERIMENTS AND RECORDS

4.5.1 Characteristics and transduction circuit of the AD590

1. Place Module KL-64005 Block 15 on the Trainer KL-61001A.
2. Measure the resistance between U1 pin3 and GND with the DMM(option) and adjust the R2 for the resistance value of 10KΩ.
3. Adjust the R8 to make Vf1=2.732V. The transduction output U1 pin6 is 10mV/°K, Vo15 is 100mV/°C.
4. Preheat the soldering iron(option). As the tip of soldering iron approaches the AD590 sensor, regulate the circumstance temperature. (To avoid a potentially hazardous situation, the soldering iron will not touch the surface of AD590. Use great care when making measurements.) Measure and record the change of Vo15 and U1 pin6 for each setting in Table 4-1.

Table 4-1

The soldering Iron approaches AD590 time(s)	0	5	10	15	20	25	30
U1 pin6							
Vo15 (V)							

5. From Table 4-1 the voltage difference between U1 pin6 and Vo15 = _____V.

4.5.2 Digital thermometer

1. Place module KL-64005 on KL-61001A.
2. Repeat Steps 2 to 5 from section 4.5.1.

3. Set the MODE switch to the SENSOR position, the RANGE switch to the °C position and connect MANUAL (SELECT area) to GND on the Module KL-61001A.
4. Connect the Vo15 on KL-64005 to the DCV INPUT+ on KL-61001A.
5. Preheat the soldering iron. As the tip of soldering iron approaches the AD590 sensor, regulate the circumstance temperature. Measure the Vo15 and readout several times and then record in Table 4-2.

Table 4-2

Vo15 (V)								
KL-61001A Readout								

6. Compare the Voltages of Vo15 with the readouts.

4.5.3 Computer interface and control

Figure 4-10 shows the functional blocks of module KL-61001A. The transducer output (0 to +5VDC) applies to inputs of the 12-bit A/D converter, and then is converted to digital signals to the single-chip microcomputer 89C51 according to control signals. The USB is a communication-interface for communication between the single-chip 89C51 and USB ports of the personal computer. Refers to the KL-61001A USER'S MANUAL for details.

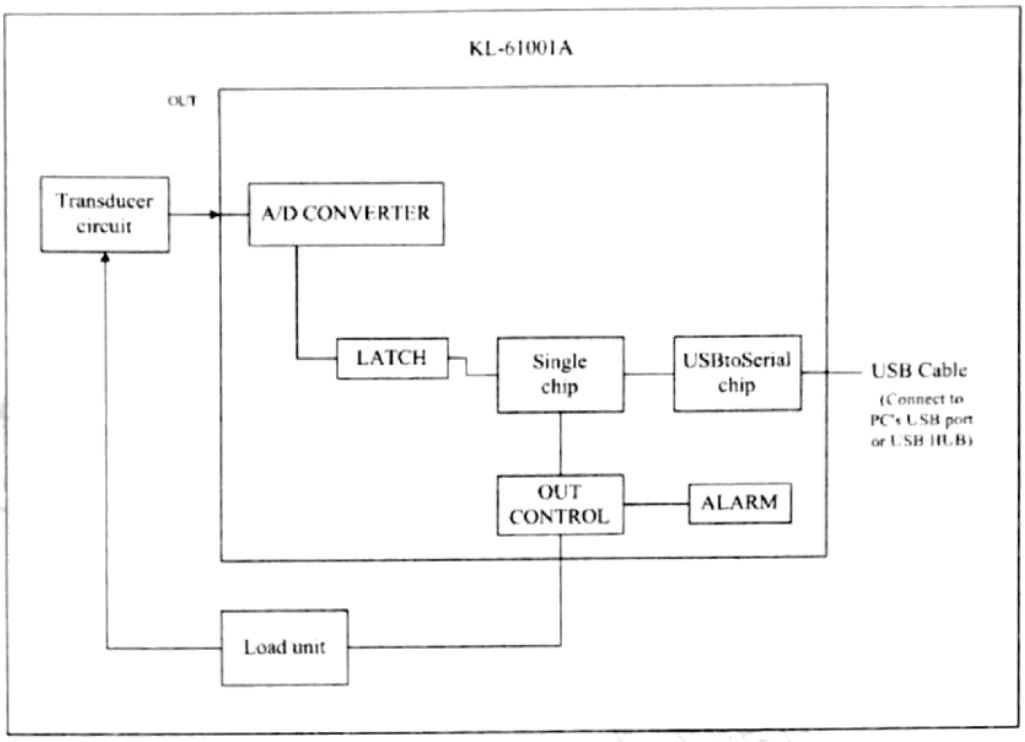


Figure 4-10 Functional diagram of KL-61001A

1. Complete the connections as follows:

SECTION	AREA	SIGNAL TO SECTION		AREA	SIGNAL
SELECT	MANUAL / SINGLE CHIP	CHIP	→ SELECT	MANUAL / SINGLE CHIP	GND
SINGLE CHIP	OUT CONTROL	1	→ AMPLIFIER	ALARM AMPLIFIER	SIN IN
A / D CONVERTER	CONTROL	A/D IN	→ KL-64005	TEMPERATURE SENSOR	Vo15
A / D CONVERTER	CONTROL	GND	→ KL-64005	TEMPERATURE SENSOR	GND

2. Using the USB(B to A Type) cable connect KL-61001A's USB port to the PC's USB interface port.
3. Set the AD590 Transducer Module KL-64005 on the Trainer KL-61001A.
4. Repeat Steps 2 to 3 from section 4.5.1.
5. Set the THUMBWHELL SW. to the value of "4095".
6. Turn on KL-61001A. The alarm buzzer should be turned on if the temperature of AD590 Transducer is higher than the setting value of THUMBWHEEL SW.

7. Refer to Table 4-3. Turn the value of thumbwheel switch in order. Increase temperature and record values when alarm buzzer turned on. Discuss it if you can not complete the table.

Table 4-3

THUMBWHEEL SW.	0819 (10°C)	1638 (20°C)	2457 (30°C)	3276 (40°C)	4095 (50°C)
KL-61001A Readout					
OUT CONTROL pin1					
OUT CONTROL pin4					
KL-64005 Vo15 volts					

8. When the temperature exceeds the setting, the potential at OUT CONTROL pin4 should be LOW and the potential at OUT CONTROL pin1 should be HIGH that turn on the alarm buzzer. Previous Steps are used to display the temperature values of the AD590 transducer through the single-chip microcomputer.
9. Connect the SINGLE CHIP, OUT CONTROL, CTRL to the GND.
10. Execute the KL-600 Series to start the program.
11. Select the correct COM port address.
12. Set "500" into Delay(ms), "3600" into Acqu num. It's able to record 30 minutes.
13. Select TEMP from the pull down table of Option filed.
14. Click Acquire button from the control panel of KL-600 Series. Change the temperature values and observe the temperature curve on the screen.
15. Press Power button of KL-600 Series to exit.