Chapter 12
Intellective Applied Thermometer Design Based on DS1420

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Abstract The AT89S52 SCM is the core of the entire system. The system includes temperature sensor module, data collection module, data processing module, keyboard number tube module, voice module, and LCD display module. In order to ensure the accuracy of sampling, it uses the temperature sensor's good performance to achieve the temperature and voltage transformation, and high-precision OP amplifier and then 12 bits samples. Later through a sequence of software operation, system realizes the alarm temperature pre-sets, LCD/LED display, voice playback, and other functions to achieve human–computer interaction.

Keywords DS1420 application · Scheme design · Flow chart design · Circuit · Intellective thermometer

12.1 The Overall Design Diagram

Accurate intelligent thermometer of this system first use high-precision temperature sensor, high-precision amplification get 0–5 V changes, then process the data into the microcontroller after A/D conversion. Finally, in the processing of the SCM algorithm to achieve human–computer interaction interface. Figure 12.1 is its overall design diagram.

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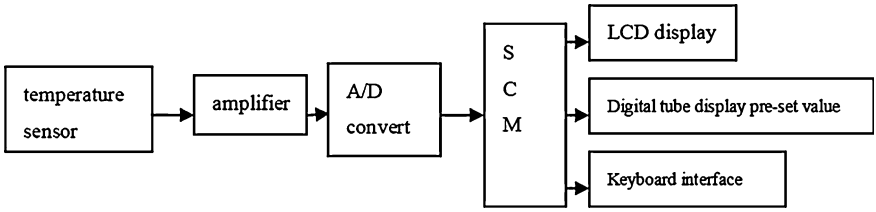


Fig. 12.1 Hardware system diagram

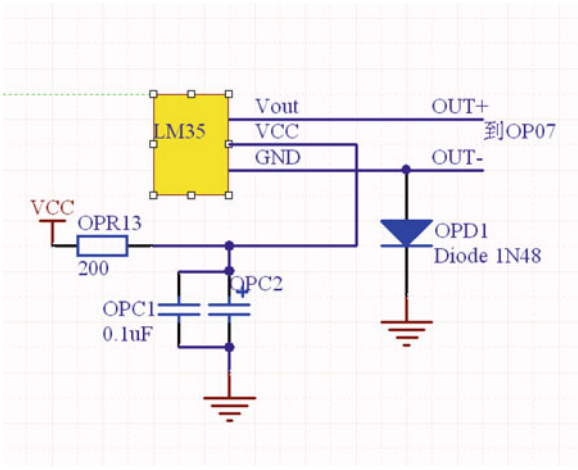
12.2 Comparison of the Sensor Selection and Design

The following is the analysis of the advantages and disadvantages of the two sensor.

12.2.1 Integrated Dedicated Temperature Sensor Design

The integrated temperature sensor, such as the use of AD590, the LM35 which has three pins, power, land-side and voltage output, under such connection 0 °C is undetectable, so the voltage elevation program is being used, which it can detect 0 °C and its output is high-impedance differential output, so an external amplifier needs a double-ended change the single-ended and high-input impedance amplifier (amplifier program will be given a detailed discussion in amplifier part). This program is convenient to debug and easy to control. Output can be adjusted from 0 to 500 mV [1]. Which is shown as in Fig. 12.2.

Fig. 12.2 Schematic diagram of temperature collection chip LM35



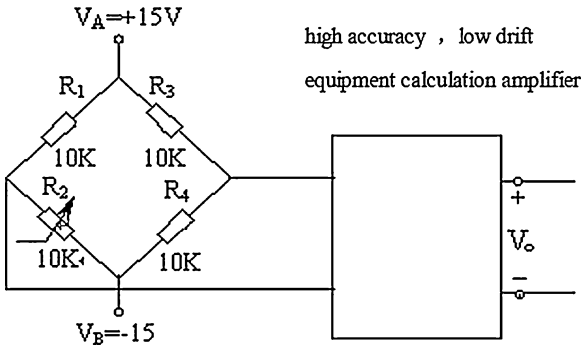


Fig. 12.3 Schematic diagram of thermistor

12.2.2 Thermal Resistance of the Program Design

The accuracy of general thermistor is relatively low which cannot reach the system accuracy requirement. Copper thermal resistance Cu100 is used as the temperature sensor, whose characteristic parameters the linearity is very good and its accuracy is high. It is connected into the bridge measurement circuit which constitutes the $T \rightarrow V$ transformation.

Adjusting this parameter can allow V_0 in the 0–5 V scope, which exactly corresponds to $T = 0$–50 °C. The disadvantage of this method is the accuracy of the request-level signal amplification circuit is very high (Fig. 12.3 is its schematic diagram). So design program one was being choosen which means integrated temperature sensor was selected. Program one is convenient to debug and is not prone to make mistake, besides its linearity is good.

12.3 The Amplifier Circuit Design

As the dynamic range of the integrated temperature sensor is narrow, hence the small-signal amplifier was required. About the accuracy requirements, we choose the precision 0P07 op amp, the differential mode output of LM35 is converted to single-ended output, and 10 times magnified, which allows that 0–5 V changes corresponding to 0–50 °C. As the magnification times are not high, dual single-ended transformation network was choosed.

The amplifier circuit consists of dual end change to single-ended circuit, and 10 times magnified. Adjusting the tone 0 resistance can inhibit 0 drift. To ensure accuracy, the resistance use metal film resistors whose stability is better. Adjustable resistors were used as precision adjustment, which ensures the accuracy of amplification. For example: if the enlarged feedback resistor change more than 1 % per °C, the actual temperature is 10 °C. Under such condition, analysis of two situations:

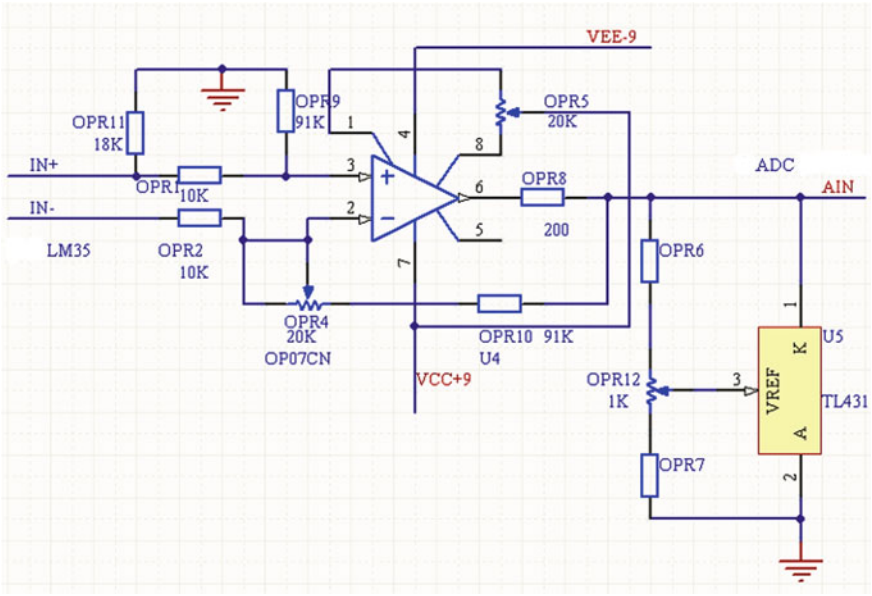


Fig. 12.4 Clipper circuit consist of OP07

Accurate amplification case: 10 °C correspond 100 mV *Magnified* 10 *times* 1 V 10 bits *AD convert* ⇒ 205
Resistance deviation case: 10 °C correspond 100 mV *Magnified* 9.9 *times* 0.99 V 10 bits *AD convert* ⇒ 191

From the above analysis, the value is quite different after the sampling quantify, if through the single-chip computing, plus the calculation error, it is difficult to achieve the requirements of the accuracy which is 0.1 °C. Protection circuit can consist of limiter circuit, using a TL431 precision reference source as a limiter circuit design; by adjusting OPR12 its output threshold can be adjusted. Figure 12.4 is its schematic diagram.

12.4 A/D Sampler Selection

As V_0 in the 0–5 V exactly correspond to $T = 0$–50 °C, and accuracy of 0.10 C required conversion bits $m = \log_2(500\ \text{C} \div 0.1\ ^\circ\text{C}) = 8.96578$, 9 bits A/D converter has been selected. However, due to the conversion problem it produces quantization error, so we choose 12 bits high-precision A/D converter TLC2543. TLC2543 is equipped with a serial control and 11-channel 12-bit ADC. And as this chip use a serial port, it occupied little source of the microcontroller (Fig. 12.5 is

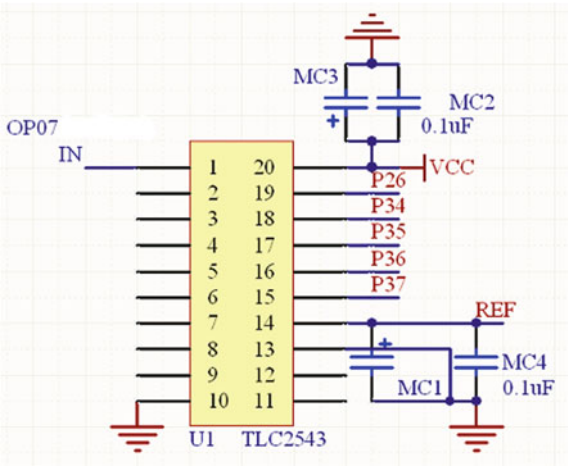


Fig. 12.5 Schematic diagram of 12 bits A/D sample chip TLC2543

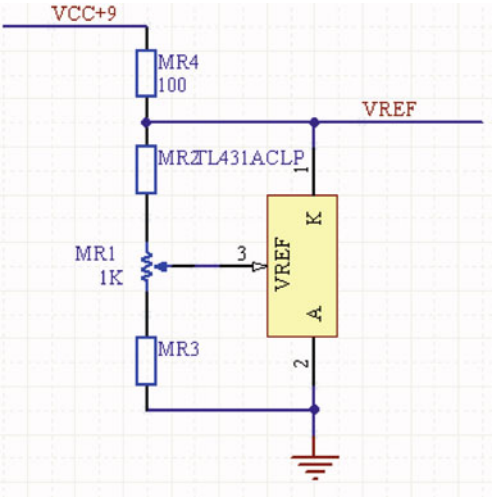


Fig. 12.6 Reference voltage source based on TL431

its connection map of hardware). In order to improve accuracy, we also choose the highly stable reference voltage provided by TL431 as the comparison voltage VREF (Fig. 12.6 is its schematic diagram).

12.5 Human–Computer Interaction Design

In order to increase the human–computer interaction, we added LCD display and voice reporting temperature, in addition to the keyboard and digital tube. You can see the dynamic characteristics of the temperature by watching LCD, and voice broadcast services can serve for the blind which make system more humane.

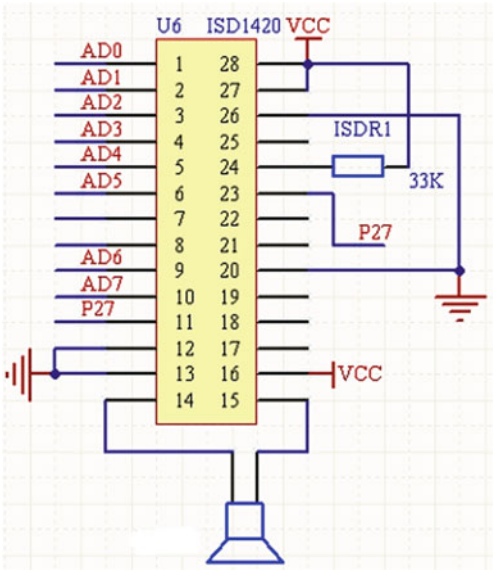


Fig. 12.7 DS1420 schematic diagram

Meanwhile, we also provide a pre-set temperature alarm function to realize automated control. The LCD monitor is 126 × 64 dot matrix and by the LCD module it displays temperature curve during a period of time.

The management of the keyboard LED lights were controlled by 8279 or ZLG7290. In order to spare the microcontroller interface, chip ZLG7290 with I^2C bus interface was used as the digital display which can manage the 64 buttons and 8 digital tubes [2].

12.6 Voice Broadcast System Based on DS1420

Voice broadcast system consist of a lot of chips, here we choose the ISD1420 chip which integrates audio amplification, audio sampling, storage, playback zoom, and automatic level control (AGC). The control is very simple, and the recorded sound (can be stored for 100 years) can be selected to play according to the address. Figure 12.7 is its schematic diagram.

The address assignment for the digit "0–9", ".", "centi degree" which is needed to be broadcasted in the voice broadcast system:

Syllable	Address
“0”	00H
“1”	04H
“2”	08H
“3”	0CH
“4”	10H
“5”	14H
“6”	18H
“7”	1BH
“8”	20H
“9”	24H
“.”(dot)	28H
“centi degree”	2CH

12.7 Block Diagram of the Design of Software Programming

The core of this system is the microcontroller. D/A sample was sent to microcontroller, data conversion by microcontroller produces a lot of outputs which includes alarm, temperature digital display, temperature voice broadcast, LCD waveform display, and so on.

12.8 Conclusion

By analysis and multiple testing, the product system front-end part normalized output (0 to +500 C Linear mapping 0–5 V),and output has protection circuit which make sure output voltage does not exceed 5 V; system collects temperature sample per second and after being filtered and calculating the accuracy is 0.10 C. Each measured once per minute system reports once by voice; system can be set arbitrarily within the range 0–500 C temperature as warning temperature to make sure just as the measured temperature exceeds the warning temperature value system immediately alarm.

Intelligent thermometer can be used to accurately measure human body temperature, which has great significance for real life. Such as “SARS” time, has played a huge role in the area of large flow of people (the railway station, bus station) and accurate measurement of their own technology is also an important way of promoting scientific development.

References

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