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INFRARED TEMPERATURE SENSING

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7.1 INTRODUCTION

In the field of temperature sensing, there are any ways to measure a temperature on both living and non-living things. Nowadays, temperature was able to be measured by using the infrared radiation. Infrared (IR) is invisible radiant energy, electromagnetic radiation with longer wavelengths than those of visible light, extending from the nominal red edge of the visible spectrum at 700 nanometers (frequency 430 THz) to 1 mm (300 GHz)[1]. Infrared thermography (IRT), thermal imaging, and thermal video are examples of infrared imaging science. Thermo graphic cameras usually detect radiation in the long infrared range of the electromagnetic spectrum (roughly 9,000–14,000 nanometers or 9–14 μm) and produce images of that radiation, called thermograms.

The principle of the infrared thermal imaging was by receiving the invisible infrared radiation energy which emitted by the object into the air. Based on the relationship between the infrared radiation energy and temperature could know the relevant object surface temperature (Stefan-Boltzmann Law)[2][3].

7.2 INFRARED THERMOMETER

An infrared thermometer is a thermometer which differs temperature from a part of the thermal radiation emitted by the object being measured. By knowing the amount of infrared energy emitted or released by the object and its emissivity, the object's temperature can often be determined. Infrared thermometers are a subset of devices known as "thermal radiation thermometers".

Emissivity is a term that is often misunderstood and misused. It represents a material's ability to emit thermal radiation. It is an optical property of matter. Each material has a different emissivity, which may vary by temperature and infrared wavelength[4]. In order to make a temperature measurement of an object using an infrared imager, it is necessary to estimate or determine the object's emissivity. An
infrared thermometer design consists of a lens to focus the infrared thermal radiation on a detector that will convert the received energy from the source to an electrical signal. Then it can be represented in a unit of temperature after being compensated for ambient temperature. Infrared thermometer allows temperature to be measured from a distance (non-contact measurement).

Infrared thermometer are used in some typical circumstances such as measuring a moving object, which the object is covered by electromagnetic field; as in induction heating; where the object is contained in a vacuum or in a controlled atmosphere or environment. It also used for a place where contact sensor could not be used. It can be used in wide variety of temperature monitoring, such as:

- Checking mechanical or electrical equipment for temperature or hot spots
- Checking heater or oven temperature for calibration and control.
- Monitoring materials processes involved in cooling and heating

Based on Stefan-Boltzmann Law, radiant power is proportional to the fourth power of temperature. Thus, when the measurement surface has both cold and hot spot, the indicated temperature may be higher than the actual average temperature, and close to fourth power mean average[2]. Most surfaces have a high emissivity (over 0.9) however reflective surface tend to have lower emissivity than non-reflective surfaces. Some sensor can adjust its emissivity setting according to the surface measured.

The most common infrared thermometer used in industries is Spot Infrared Thermometer or known as Infrared Pyrometer.

7.3 LITERATURE REVIEW

7.3.1 Accuracy of Measurement Temperature by Using Infrared Thermometer

Ling Zeng at el. (2014) used an infrared thermometer (FEI, MWIR-512) to measure the distribution of surface temperature under different environments which contains electric parameter, magnification of object lens and measurement environment. Since infrared thermometer is a non-contact measurement instrument, it will not damage the initial temperature of field of the object.

Generally, the main heat source of DC/DC power module consists of VDMOS, triode, transform and so on. The surface temperature of these components was tested respectively. In this experiment, 28V and 40V (max) power supply is used. The distribution of temperature is as shown in Figure 7.1.
Figure 7.6: Surface temperature distribution of electronic component at different input voltage

The figure 7.2 shows the relationship between the magnification of lens and the temperature.

![Graph showing relationship between magnification of lens and temperature](image)

Figure 7.7: The variability of device temperature with magnification of objective lens

7.3.2 Research On Non-Contact Infrared Temperature Measurement

Ning Bin and Wu Yuchan (2010) state the optical system consists of the Fresnel lens and optical filter forms the beginning of the measuring chain. The lens receives the emitted infrared energy from a measuring object and focuses it onto a detector. They used thermopile sensor in contactless temperature measurement. Figure 7.3 shows the schematic of external structure of the sensor, TS118-3 have four external pins. The so created electric output signal is processed by a preamplifier, to use the A/D converter for signal acquisition, as shown in figure 7.4.[5]

![Schematic of external structure of the sensor, TS118-3](image)

Figure 7.3: Mechanical dimensions of the TS118-3
7.4 RESULTS AND DISCUSSION

Research done by Ling Zeng at el. (2014) give out results such in figure 7.5. Figure 7.5: The relation between surface temperature of key component and dwell time : (a) temperature of triode; (b) temperature of V-MOS; (c) temperature of Transformer.

The temperature of main heat source show different relationship with the input voltage, as shown in Fig.1, the input voltage significantly affects the surface temperature of component, especially for triode, while the surface temperature of transform change is small than others. Therefore different components have different results with the input voltage. Clearly the input voltage has more influence of the measurement temperature accuracy on triode than others. The reason of this result is that different components have different sensitivity to input electrical parameters.
7.5 CONCLUSIONS

Temperature is one of the major reliability concerns in the use of DC/DC power module. In this work, concerning three factors which contain input voltage, the magnification of objective lens and environment condition, the temperature of key components on DC/DC power module under different condition are measured by Infrared Thermometer. The results suggest that:

(1) The input voltage of DC/DC power module significantly influences the surface temperature of component, especially for triode, but the surface temperature change of the transform is smaller than others.

(2) The temperature of key component increases with the magnification of objective lens. The reason of this result is that big magnification of objective lens can get more energy which comes from DC/DC power module and outside.

(3) The effect of environment condition on key component of DC/DC power module in the study is more profound compared to other factors. It is found that the temperature of Triode and VDMOS decreases with the dwell time of incubator chamber, and the temperature of transform is more complicated with that.

Therefore, to get the real temperature of key component of DC/DC module, which is used as the standard of judging thermal property, the input voltage, the magnification of objective lens?

REFERENCES