

Fig. 8. The output current when the ambient temperature is 25°C, where the current of warm-up step and steady step is 320 mA and 150 mA, respectively.

imaging equipment is shown in Fig. 9. It is observed that the temperature of Heater 2 is around 95°C.

#### IV. CONCLUSION

In this paper, we develop a high-stability miniaturized OCXO in the size of 9.7 mm x 7.5 mm. Thermal analysis according to the FEM simulation is utilized to optimize the ovenized structure. It has shown that the proposed double-heater structure could enhance the oven stability. Therefore, the experimental result shows a highly stable oven performance less than  $\pm 1^\circ\text{C}$  variation from -40 to 85°C, indicating that a high frequency stability less than  $\pm 20$  ppb can be achieved if an AT-cut crystal is used.

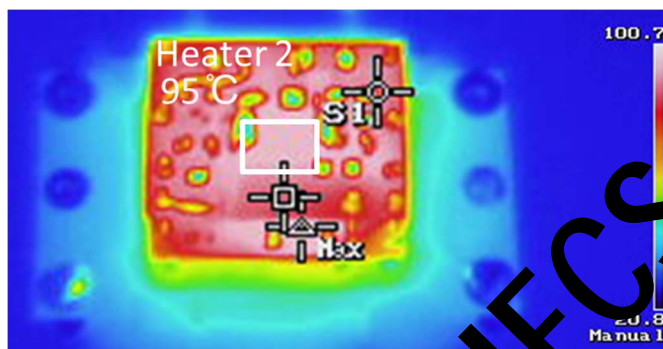


Fig. 9. Thermal distribution captured by the infrared thermal imaging equipment. The temperature of Heater 2 is around 95°C.

#### REFERENCES

- [1] Yasuto Ishii, Kaoru Kobayashi, Tsukasa Kobata, Manabu Ito, Shigenori Watanabe, Shinichi Sato, Kazuo Akaike, "A New Generation DSP-OCXO Using Crystal Temperature Sensor," International Frequency Control Symposium, IEEE, pp.1-4, 2012.
- [2] Kaoru Kobayashi, Yoshiaki Mori, Tsukasa Kobata, Manabu Ito, Shigenori Watanabe, Shinichi Sato, Kazuo Akaike, "High-Performance DSP-TCXO Using Thin-Crystal Oscillator," International Frequency Control Symposium, IEEE, pp.1-4, 2014.
- [3] COMSOL Multiphysics Version 4.3a User Guide, October, 2012.
- [4] Yoshinori R. "Introduction to quartz frequency standards," No. SLCET-92-1, ARMY LAB COMMAND FORT MONMOUTH NJ ELECTRONICS TECHNOLOGY AND DEVICES LAB, 1992.

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