RRU 5G 8T8R Heatsink Embedded Vapor Chamber and Heat Pipe Assemblies

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Abstract

Remote Radio Unit-RRU 5G Heatsink systems are using natural convection cooling due to some outstanding advantages such as low cost, high reliability, noiseless operation, and hard environment operation. However, some main disadvantages such as a relatively low heat transfer and low heat dissipation density are to be solved by optimal heat sink fin design. This paper describes an optimal heatsink fin profile design with V shape angle to maximize natural cooling for RRU 5G embedded heat pipe and vapor chamber technology. Several core ICs of RRU 5G with high heat loss sources up to a hundred W are embedded copper plates and heat pipes. Temperature measurements were carried out to validate the RRU 5G 8T8R heatsink modeling and experimental methods.

Keywords
Remote, Radio, Unit-RRU 5G, 8 Transmitter/8, Receiver-2T2R.

1. Introduction
Remote Radio Unit-RRU 5G Heatsink systems are using natural convection cooling due to some outstanding advantages such as low cost, high reliability, noiseless operation, and hard environment operation in S. Shinjo, K 2017. However, some main disadvantages such as a relatively low heat transfer and low heat dissipation density are to be solved by optimal heat sink fin design. The RRU 5G -8T8R, 16T16R, 32T32R, and 64T64R normally have big losses, sizes, volumes, and complexities. Thermal management cannot be neglected due to the reduced feature size and the increased power levels in J. Curtis 2013 The total power of PFGA ICs in RRU 5G is from 800W to 1000W, most of the input power will be converted to heating losses S. Chen 2016. Total heat losses of RRU 4G FPGA and PA is about from 240W to 300W based on operation modes. In order to control the overheat temperature of PA transistors and ICs, a heat pipe and vapor chamber is designed to dissipate the heat loss to air in different cases to avoid overheating. This paper describes an optimal heatsink fin profile design with V shape angle to maximize natural cooling for Active Antenna Unit-RRU 5G. The RRU 5G cooling system is composed vapor chamber and heat plate passive cooling system. Temperature measurement results were carried out to validate the industrial lab experiment. This paper also shows an optimal calculation of RRU 5G housing heatsink fin to minimize manufacturing and material cost of RRU Housing.

2. Thermal simulation
The 3D model and material parameters have been designed to determine the temperature distribution of the RRU heatsink in figure 1. The hotspot is located in the center of heat sources. The maximum temperature must be lower than the temperature limit of IC PA transistor, modeling steps is shown in Figure 1.

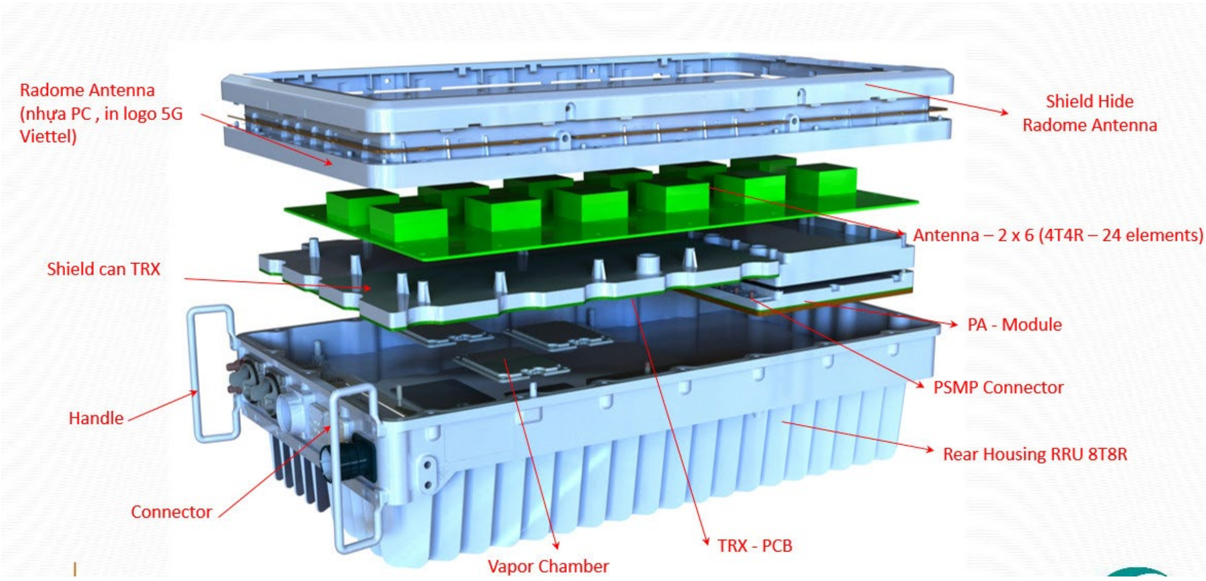

Figure 1. 3D RRU 5G 8T8R Modeling

Material properties of thermal conduction and heat losses are inputs of FEM model and losses were applied to ICs and electronic devices as in Figure 2.

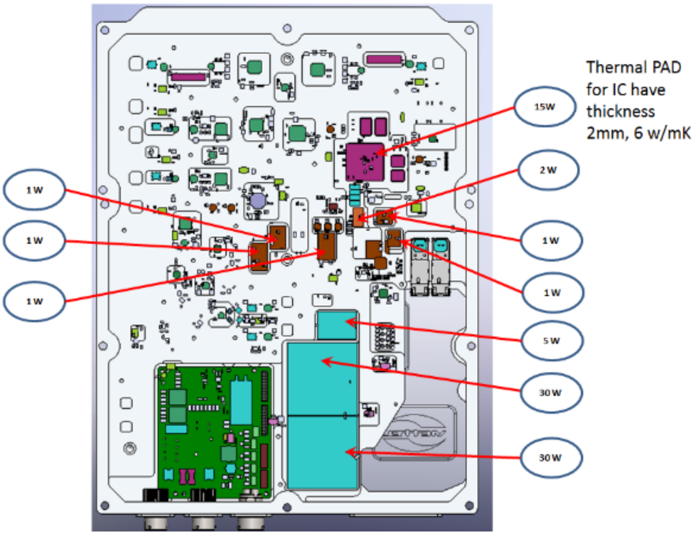

Figure 2. Material properties

The total heat source is 260-300W at an ambient temperature of 25^{0}C and natural convection, Aaluminum conduction AL6061 of 171 W/m.K has set up and applied for the thermal model.

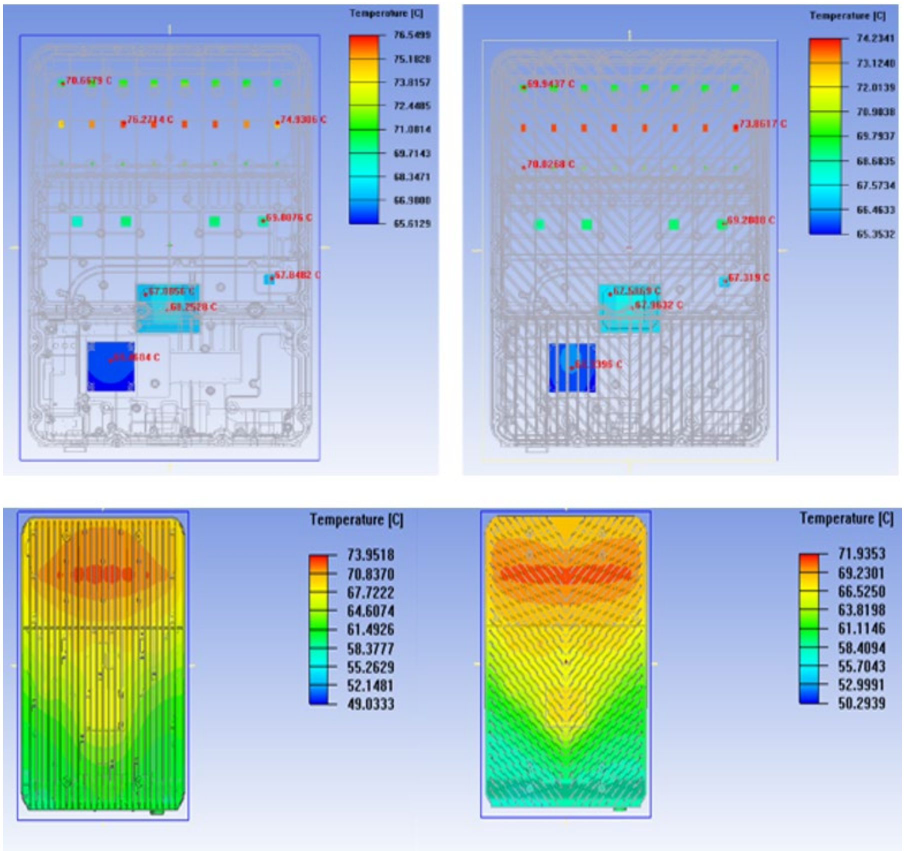

Figure 1. Thermal simulation results of Ics and Heatsink

The maximum temperature of RRU heatsink is 72^0 C in the front side with V heatsink fins and 74 ^{0} C rear side with a straight fin. To evaluate the simulation results, a hardware setup has been built by a temperature sensor, power losses, and PC-data acquisition.

3. Temperature Measurement Setup

The experimental setup includes heatsink, heat source and Data acquisition to record temperature values with a time sample of 30 seconds and total test duration of 3 hours.

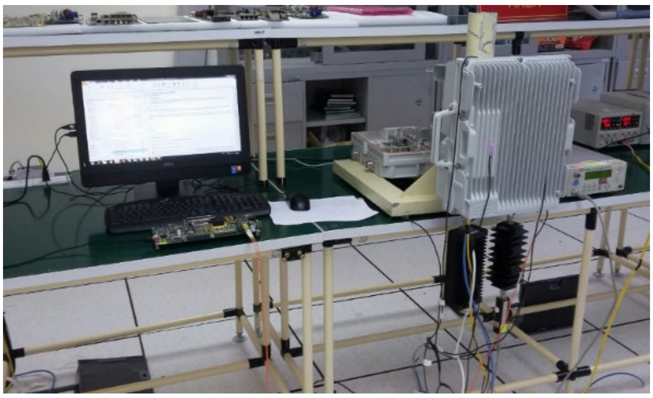

Figure 2. Experimental setup

Figure 4 shows the schematic of experimental setup, which includes the power amplifier of RRU heat sink of 300W (heat source), data acquisition with 6 channels for 6 measure points, and desktop PC. The heat transfer surface of the heat source is attached to the sidewall of heating block, and value of the input power is controlled by the power meter.

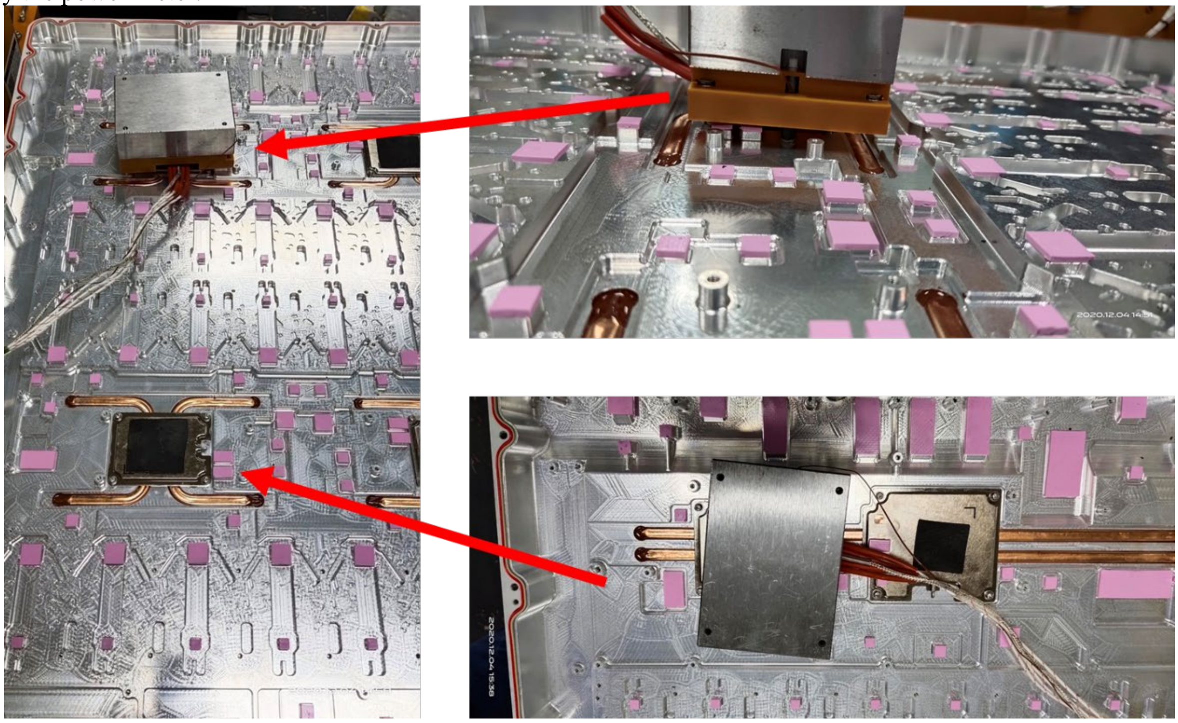

Figure 5. Vapor chamber embedded Heatsink

Input power for RRU heat source is 48V*9.2A=440W and the temperature in PCB and ICs base and heatsink fin are record by data acquisition and PC in fig 5. According to obtain constant temperature values, the experimental test is running in 3 hours. There are five temperature sensors is inserted in several points as vapor chamber, copper plate, housing, front and rear sides.

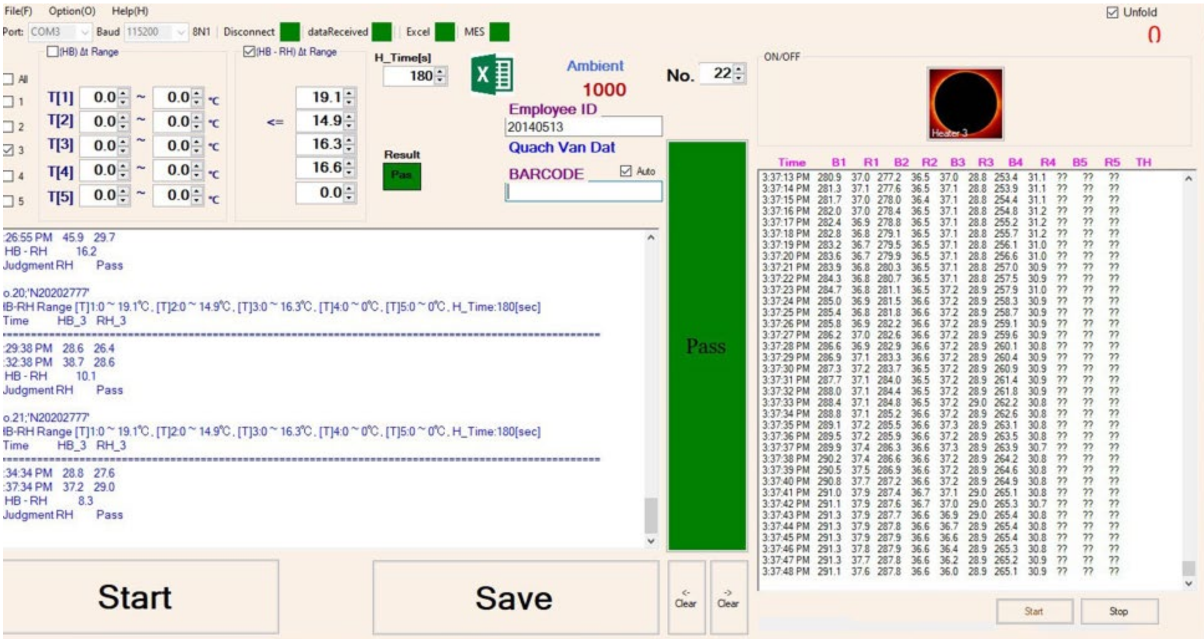

Figure 3. Experimental interface

Temperature results are recorded by data acquisition in Lab. After three hours for heat run test, the maximum temperature in the electronic power transistor is 74^0 C degrees and the temperature base is 68^0C degrees. Each power amplifier circuit has an Aluminum plate coating Ag to improve grounding and heat transfer and two IC transistors were welded in this base plate. Temperatures of IC transistor, base, and ambient are shown in figure 7.

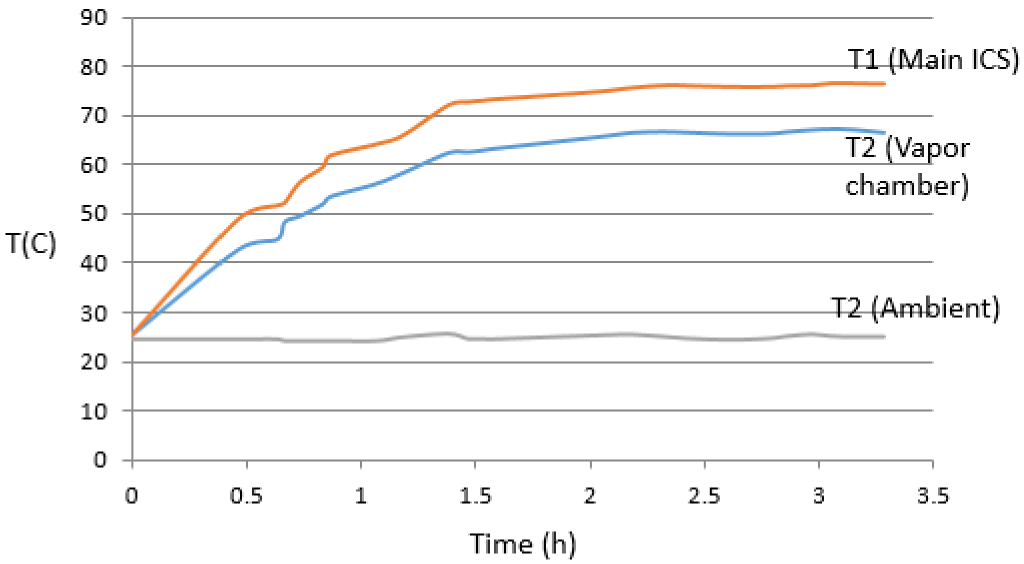

Figure 7. Temperature curves of Main ICs(PA) and Vapor chamber.

The Fluke temperature measurement device has been installed to compare temperature distribution in RRU 5G as figure 8. The temperature in pick point is 67.8 ^{0}C degrees and this point is very close to the vapor chamber plate. It is clear that heat loss was dissipated and the temperature difference between the vapor chamber and heatsink is small. Thus, the vapor chamber and heat pipe embedded is a significant effect.

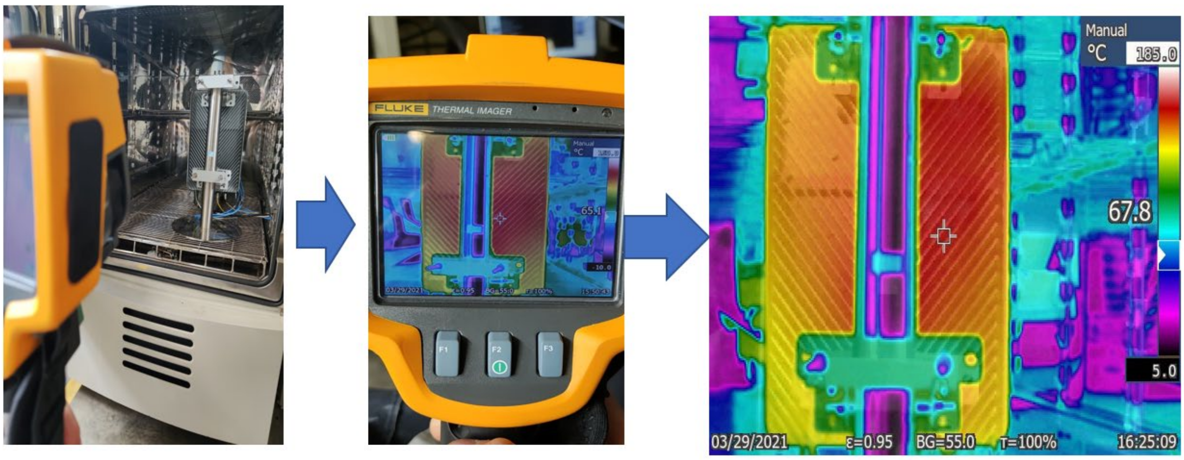

Figure 8. Thermal distribution of RRU 5G 8T8R V heatsink fin

The temperatures in simulation results (figure 3) and temperature image (figure 8) are good agreement and acceptable.

4. Conclusion

This paper has implemented FEM simulation and experiment methods for RRU 5G heatsink embedded vapor chamber and heat pipe to improve heat transfer efficiency. This research illustrated that V shape heatsink fin with vapor chamber and assemblies is potentially applied for the industry. 3D Thermal simulations have been carried out to find out the best V shape angle. Finally, the RRU 5G heat sink with V-shaped fins was applied to fabricate and measure temperatures in the lab by supporting Viettel High Technology Industries Corporation, Vietnam

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