



Author	Sierra Wireless		Date	January 26, 2024
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Content Level	BASIC	INTERMEDIATE	ADVANCED	✓	Confidentiality	Public	✓	Private	
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Hardware Compatibility	Product Line	IoT Modules	Series	RC7110	
				RC7120	

Software Compatibility	ALL	Document Type	App Note	✓	Tech Note	
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1 Version

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2 Introduction

This document is provided to Sierra Wireless distributors and clients to aid more rapid development of embedded applications using the Sierra Wireless portfolio of cellular solutions. To request a new application/technical note, contact your regional Sierra Wireless Product Marketing Manager.

Note: In this document:

- RC71xx refers to RC7110 and RC7120.

3 Glossary

Term	Definition
FEM	Finite Element Model
system box	A simulation construct that models a real-world test setup
LGA	Land Grid Array

4 Overview

To use a Sierra Wireless RC71xx module in LTE bands at full transmit power over long periods, thermal energy must be dissipated to keep the module within its operating temperature specifications.

This document provides an overview of the Finite Element Model (FEM) setup used for thermal simulation of an RC71xx module. This thermal model can be used to conduct the customer's product thermal simulation.



5 Test Unit Details

The RC71xx module is an LGA device. All components are located on the top side of the module under the shield. All electrical and mechanical connections are made through the 238 LGA pads and 1 polarity mark on the bottom side of the PCB.

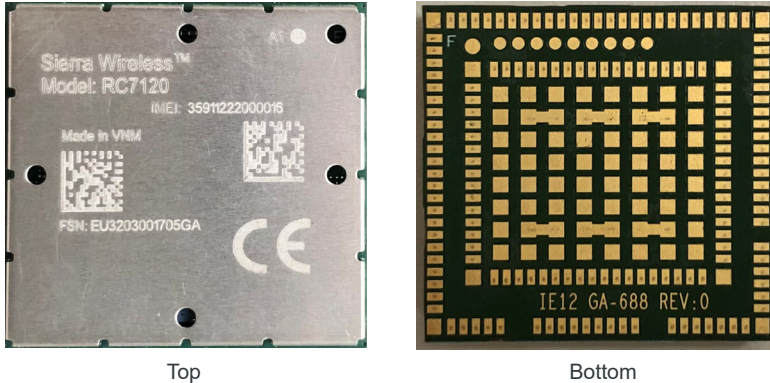


Figure 1: RC71xx Module—Top and Bottom Surfaces

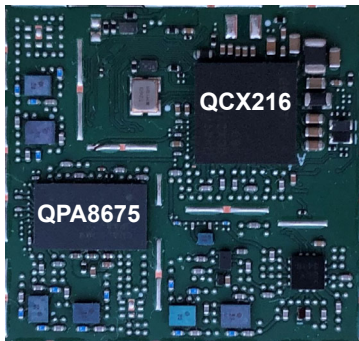


Figure 2: RC71xx Module—Critical Internal Components

Figure 2 shows the critical components inside an RC71xx test unit. All the named components generate heat.

6 FEM Simulation Setup

The RC71xx test unit FEM was set up using the FloTHERM CFD simulation tool which can be directly imported to FloTHERM.

The simulations were conducted with an assembled unit. The assembled unit is a system box (Figure 3) that represents the environment in which the physical experiments were conducted. The system box contains the RC71xx test unit mounted on a host board via the M.2 connector (Figure 4). For reference, Figure 5 shows the actual RC71xx on a host board.

Note: This model does not use a heatsink.

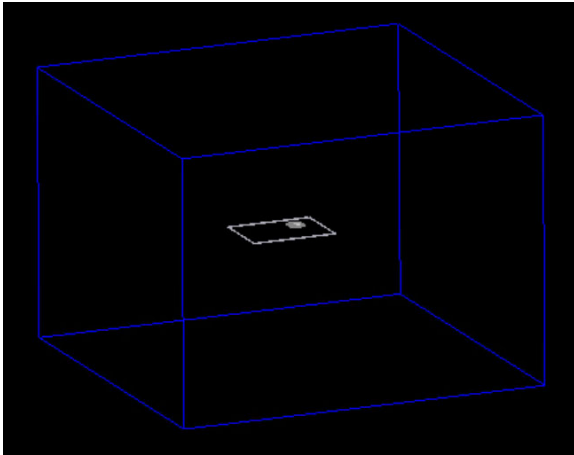


Figure 3: Thermal model full setup in system box

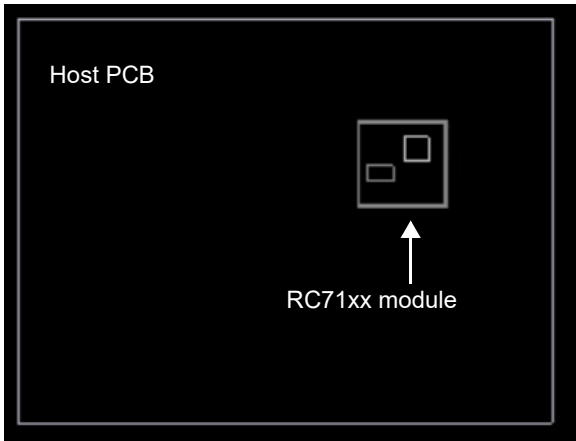


Figure 4: Thermal model full setup with RC71xx on host board

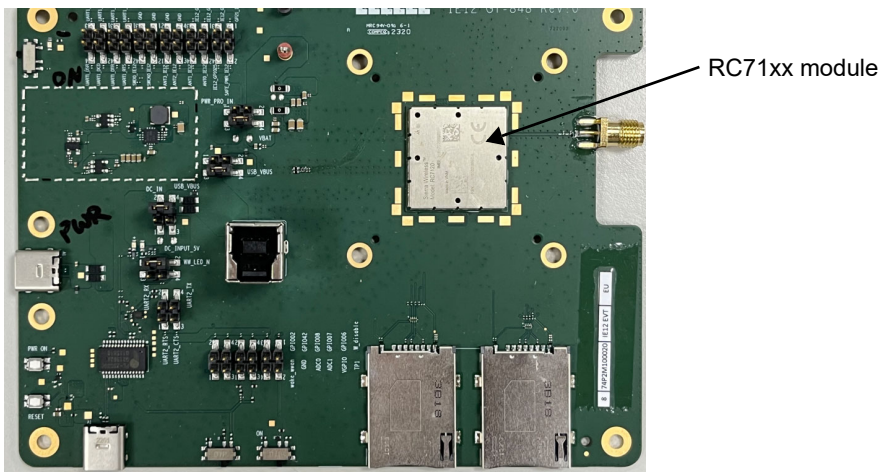


Figure 5: Actual RC71xx setup on host board



7 Material Properties

Table 1 summarizes the material properties entered in the simulation to represent the materials from the actual physical test setup. These material properties control the thermal conduction in the system.

Table 1: Simulation Model—Material Properties

Material	Conductivity k (W/(mK))	Resistivity ($\Omega \cdot m$)	Density (kg/m ³)	Specific Heat Cp ($\frac{J}{kg \cdot K}$)
Copper (Pure)	401	1.7e-8	8960	386
FR4	0.58	>1.0e14	1300~1500	900~1100
Dielectric	0.58	>1.0e14	1300~1500	900~1100
Shielding case (C7521)	23	2.6e-4	8700	375

8 Geometries

Geometry is a block of material in the simulation environment that represents an actual component. Figure 6 illustrates how the RC71xx module geometries are positioned in the simulation, and Table 2 provides the actual geometry sizes.

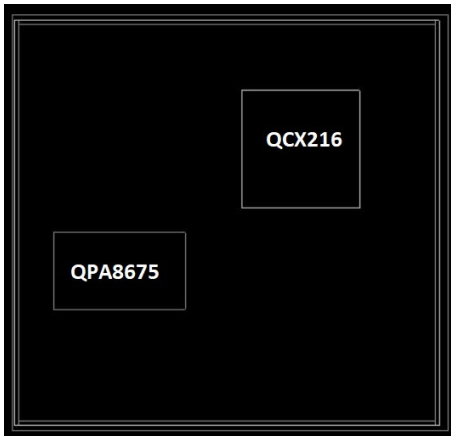


Figure 6: Simulation—Geometry Positioning

Table 2: Simulation—Geometry Dimensions

Item #	Component	Dimensions (mm)		
		X	Y	Z
1	System box	800	800	800
2	Host PCB	135.0	102.0	1.25
3	RC71xx PCB	23.0	21.7	0.79
4	QCX216	6.1	6.1	0.7



Table 2: Simulation—Geometry Dimensions (Continued)

Item #	Component	Dimensions (mm)		
		X	Y	Z
5	QPA8675	6.8	4.0	0.72
14	RC71xx shielding	22.0	21.0	1.7

9 Boundary Conditions & Assumptions

Boundary settings define the environment around the RC71xx unit and influence thermal properties inside the whole system.

9.1 System Box Boundary Parameters

The system box represents the environment in which the physical experiments were conducted.

[Table 3](#) describes the boundary conditions used for the system setup.

Table 3: System Box Boundary Parameters

Attribute	Project Definition	Description
Solution type	Flow & Heat transfer	Attributes that define air and module heat exchange properties.
Dimensionality	3D	Attributes that define coordinate system dimensions.
Ambient	40°C	Attributes that define conditions outside the module.
Fluid	40°C @ 1 atm pressure	Attributes that define surrounding cooling or heating fluid.
Gravity	Normal, -Z	Attributes that define gravitational force direction and angle to the module. The Z-axis is the direction facing the top side of the module.
Grid constraint	Medium with component localization	Attributes that define minimum grid requirements over and near to objects.

9.2 Test Unit Parameters

The RC71xx test unit is mounted on a host board inside the system box.

[Table 4](#) describes the boundary conditions used in the RC71xx thermal model.

Table 4: Test Parameters

Attribute	Project Definition	Description
Thermal model	QCX216	Attributes that define heat sources. The set values are in terms of power.
Source	QCX216, QPA8675	
2-Resistor model	QPA8675	Attributes that define simplified models.



10 Power Distributions

There are two heat sources in the RC71xx module. To get proper heat distribution, a good measurement or assumption of power consumption must be set for each heat source.

For example, the power distribution for LTE cat1 bis full TX configuration with the module mounted on a host board without using a heatsink is shown in [Table 5](#).

Table 5: RC71xx Components — Power Distribution (Full Performance)

Product	Operating Condition	QCX216	QPA8675
RC7110	Cat 1bis, B2, 20 MHz, DL 10.296 Mbps, UL 632 Kbps, Tx power max 23 dBm	0.584 W	2.024 W
RC7120	Cat 1bis, B7, 20 MHz, DL 10.3 Mbps, UL 630 Kbps, Tx power max 23 dBm	0.588 W	2.205 W

11 Temperature Contour Plots

The following figures illustrate heat propagation across the RC71xx module and into its environment.

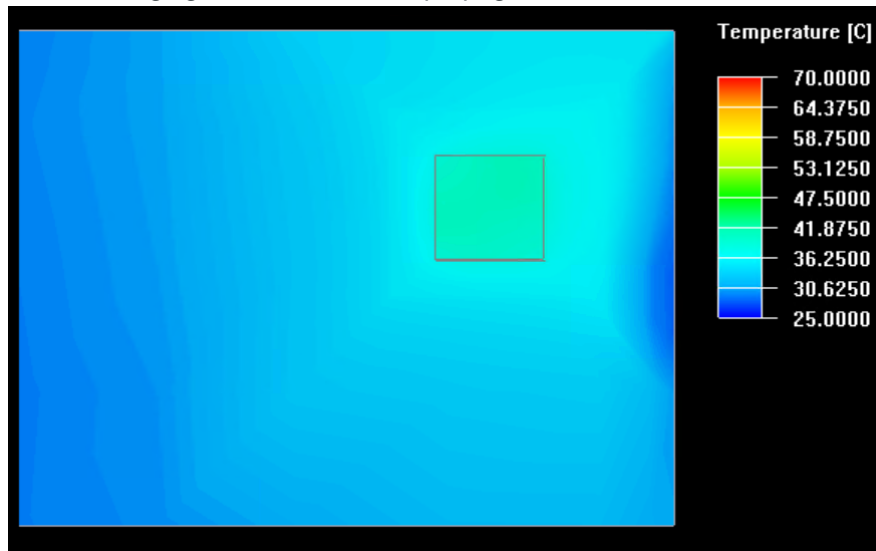


Figure 7: Temperature Contour—Entire model

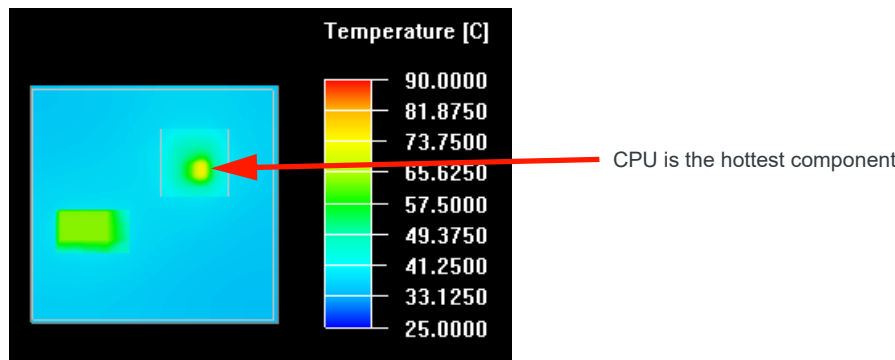


Figure 8: Temperature Contour—RC71xx module

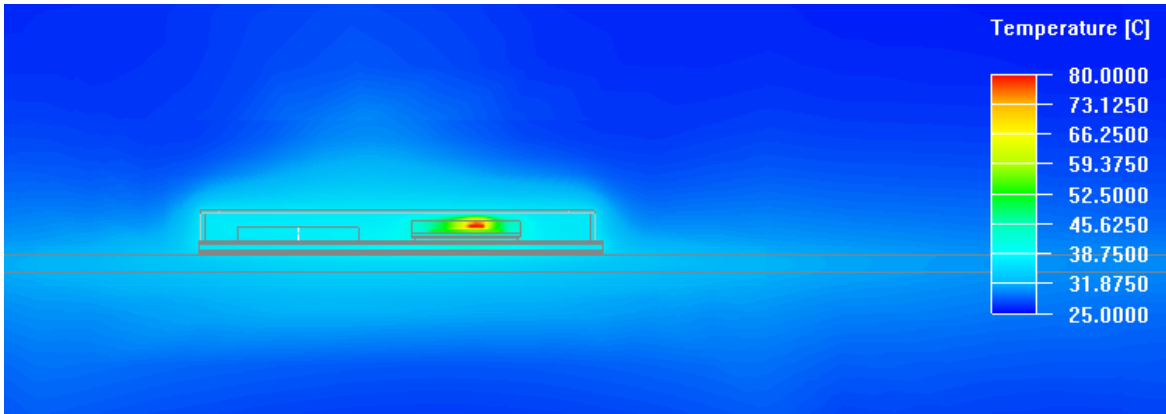


Figure 9: Entire System—Temperature Distribution Cross-Section View

12 Velocity Vectors

Velocity vectors characterize the movement of air. These diagrams show the properties of the air at a given point in the model, including speed, temperature, pressure, etc.

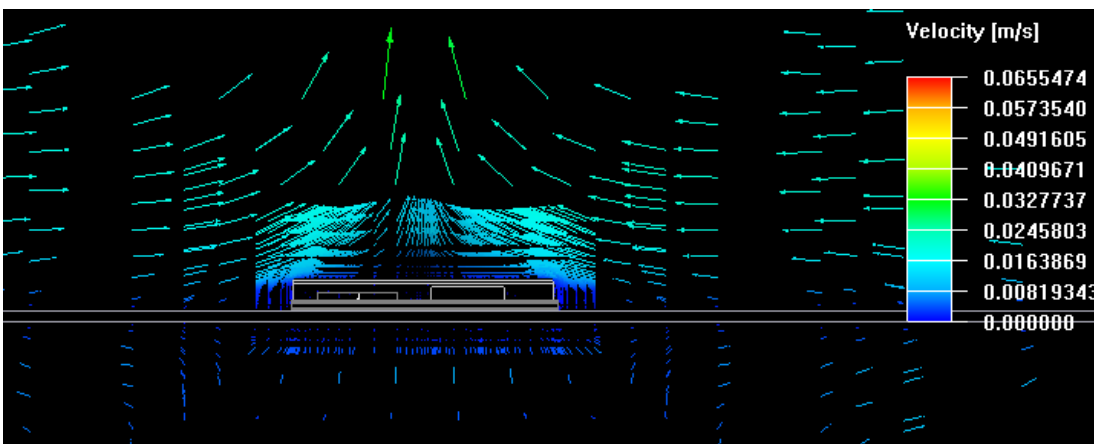


Figure 10: Air Velocity Vectors—Cross-Section View

13 Interpretation of Simulation Results

- Material properties used in these simulations are based on values found in the literature and from vendor data sheets.
- This methodology has correlated well with existing temperature measurements and is deemed to be adequate for predicting thermal performance of RC71xx modules.
- The thermal model design file Sierra Wireless provided is the RC71xx module itself. Actual temperature response will be dependent on host configuration, type of printed circuit board and ambient conditions.



14 Support

For direct clients: contact your Sierra Wireless FAE

For distributor clients: contact your distributor FAE

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15 Document History

Revision	Release Date	Changes
1	January 2024	Creation

16 Legal Notice

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