



Technical Note - Thermal Mitigation

EM/MC74XX



SIERRA
WIRELESS®

4118119
4
May 26, 2021

Important Notice

Due to the nature of wireless communications, transmission and reception of data can never be guaranteed. Data may be delayed, corrupted (i.e., have errors) or be totally lost. Although significant delays or losses of data are rare when wireless devices such as the Sierra Wireless modem are used in a normal manner with a well-constructed network, the Sierra Wireless modem should not be used in situations where failure to transmit or receive data could result in damage of any kind to the user or any other party, including but not limited to personal injury, death, or loss of property. Sierra Wireless accepts no responsibility for damages of any kind resulting from delays or errors in data transmitted or received using the Sierra Wireless modem, or for failure of the Sierra Wireless modem to transmit or receive such data.

Safety and Hazards

Do not operate the Sierra Wireless modem in areas where cellular modems are not advised without proper device certifications. These areas include environments where cellular radio can interfere such as explosive atmospheres, medical equipment, or any other equipment which may be susceptible to any form of radio interference. The Sierra Wireless modem can transmit signals that could interfere with this equipment. Do not operate the Sierra Wireless modem in any aircraft, whether the aircraft is on the ground or in flight. In aircraft, the Sierra Wireless modem **MUST BE POWERED OFF**. When operating, the Sierra Wireless modem can transmit signals that could interfere with various onboard systems.

Note: Some airlines may permit the use of cellular phones while the aircraft is on the ground and the door is open. Sierra Wireless modems may be used at this time.

The driver or operator of any vehicle should not operate the Sierra Wireless modem while in control of a vehicle. Doing so will detract from the driver or operator's control and operation of that vehicle. In some states and provinces, operating such communications devices while in control of a vehicle is an offence.

Limitations of Liability

This manual is provided "as is". Sierra Wireless makes no warranties of any kind, either expressed or implied, including any implied warranties of merchantability, fitness for a particular purpose, or noninfringement. The recipient of the manual shall endorse all risks arising from its use.

The information in this manual is subject to change without notice and does not represent a commitment on the part of Sierra Wireless. SIERRA WIRELESS AND ITS AFFILIATES SPECIFICALLY DISCLAIM LIABILITY FOR ANY AND ALL DIRECT, INDIRECT, SPECIAL, GENERAL, INCIDENTAL, CONSEQUENTIAL, PUNITIVE OR EXEMPLARY DAMAGES INCLUDING, BUT NOT LIMITED TO, LOSS OF PROFITS OR REVENUE OR ANTICIPATED PROFITS OR REVENUE ARISING OUT OF THE USE OR INABILITY TO USE ANY SIERRA WIRELESS PRODUCT, EVEN IF SIERRA WIRELESS AND/OR ITS AFFILIATES HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES OR THEY ARE FORESEEABLE OR FOR CLAIMS BY ANY THIRD PARTY.

Notwithstanding the foregoing, in no event shall Sierra Wireless and/or its affiliates aggregate liability arising under or in connection with the Sierra Wireless product, regardless of the number of events, occurrences, or claims giving rise to liability, be in excess of the price paid by the purchaser for the Sierra Wireless product.

Customer understands that Sierra Wireless is not providing cellular or GPS (including A-GPS) services. These services are provided by a third party and should be purchased directly by the Customer.

SPECIFIC DISCLAIMERS OF LIABILITY: CUSTOMER RECOGNIZES AND ACKNOWLEDGES SIERRA WIRELESS IS NOT RESPONSIBLE FOR AND SHALL NOT BE HELD LIABLE FOR ANY DEFECT OR DEFICIENCY OF ANY KIND OF CELLULAR OR GPS (INCLUDING A-GPS) SERVICES.

Patents

This product may contain technology developed by or for Sierra Wireless Inc.

This product includes technology licensed from QUALCOMM®.

This product is manufactured or sold by Sierra Wireless Inc. or its affiliates under one or more patents licensed from MMP Portfolio Licensing.

Copyright

© 2019 Sierra Wireless. All rights reserved.

Trademarks

Sierra Wireless®, AirPrime®, AirLink®, AirVantage®, WISMO®, ALEOS® and the Sierra Wireless and Open AT logos are registered trademarks of Sierra Wireless, Inc. or one of its subsidiaries.

Watcher® is a registered trademark of Netgear, Inc., used under license.

Windows® and Windows Vista® are registered trademarks of Microsoft Corporation.

Macintosh® and Mac OS X® are registered trademarks of Apple Inc., registered in the U.S. and other countries.

QUALCOMM® is a registered trademark of QUALCOMM Incorporated. Used under license.

Other trademarks are the property of their respective owners.

Contact Information

Sales information and technical support, including warranty and returns	Web: sierrawireless.com/company/contact-us/ Global toll-free number: 1-877-687-7795 6:00 am to 5:00 pm PST
Corporate and product information	Web: sierrawireless.com

Document History

Version	Date	Updates
1	Nov 2015	Creation
2	Jan 2016	Updated recommended operating temperature upper limit in Thermal Limits topic.
3	Oct 2019	Updated Thermal Limits topic temperature to enter low power mode (to match Product Technical Specification)
4	May 2021	Updated Figure 1 Recommended Heatsink Locations (MC74xx copper pad update)



Contents

1. OVERVIEW	6
1.1. Heatsink / Active Cooling	6
1.2. Thermal Limits	7
2. DL THERMAL MITIGATION	7
3. UL THERMAL MITIGATION	7
3.1. UL Data Throttling	7
3.2. UL Power Throttling.....	8
4. LOW POWER MODE	8

>> 1. Overview

Sierra Wireless AirPrime EM/MC74xx modules are based on Qualcomm's MDM9x30 chipset, supporting up to CAT6 data rates of 300 Mbps/50 Mbps by aggregating two receive carriers.

These modems operate faster than previous-generation modules. Due to the increased data rate afforded by dual carriers, more heat is generated in the same small package than before.

1.1. Heatsink / Active Cooling

As described in the module's PTS document, Sierra Wireless recommends heatsinking the module, or allowing airflow across the modem if there are existing fans in the host device.

The majority of the heat is channeled to the backside of the module on the large ground pad shown below.

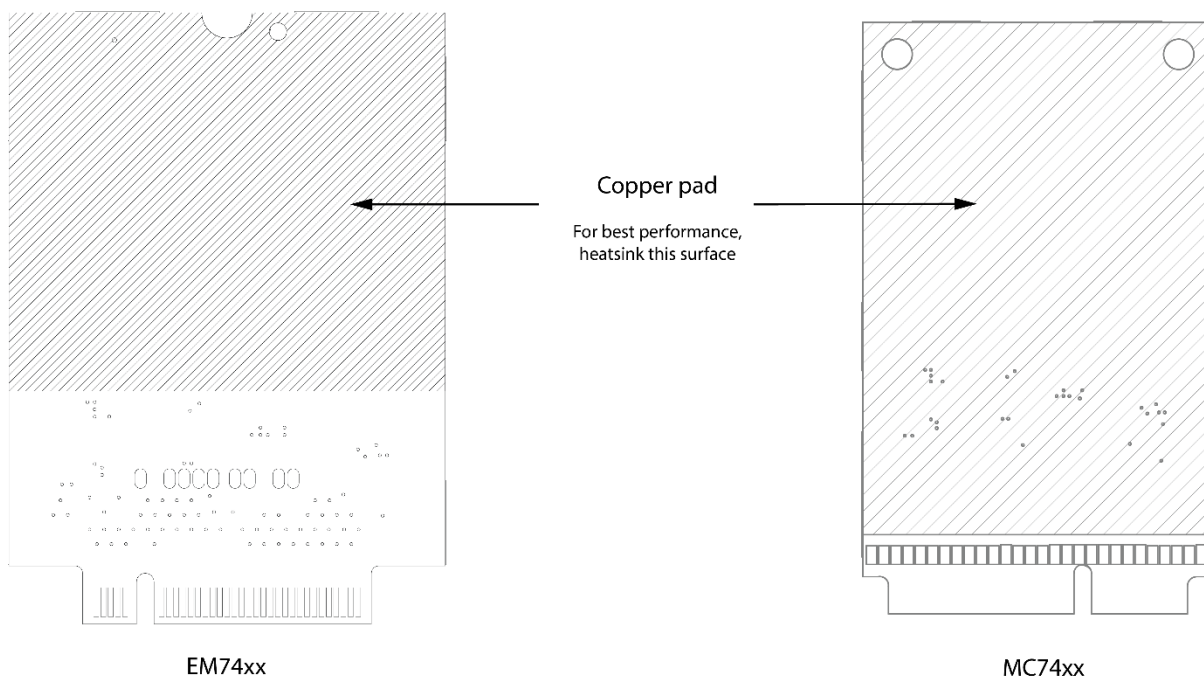


Figure 1. Recommended Heatsink Locations

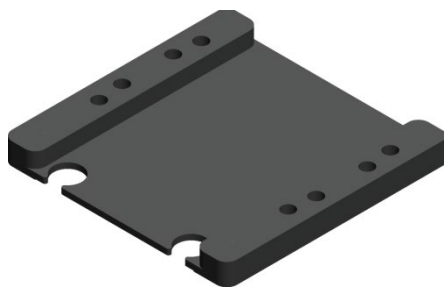


Figure 2. Sample Heatsink (MC74xx)

1.2. Thermal Limits

The module's temperature can be read using the **AT!PCTEMP?** command, which returns the overall board temperature.

In general, the reported temperature should be kept below 80°C, and the module will enter low power mode if it reaches 93°C. The module will not exit low power mode until the temperature drops below 80°C.

As the temperature gets close to these thresholds, the module will reduce performance to cool the unit and prevent further overheating, preserving the end-user experience. This performance reduction is called 'thermal mitigation'.

2. DL Thermal Mitigation

The two carriers in the downlink heat up the module's main processor, which is responsible for processing the data from both carriers and handling two separate receive paths. If the module detects that its overall temperature is getting close to the thermal limit, it cuts back the secondary carrier to save current and reduce heat generation. There is hysteresis on this value; after cooling sufficiently, the module will re-enter its normal operating mode.

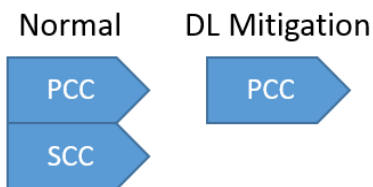


Figure 3. Downlink Thermal Mitigation

3. UL Thermal Mitigation

On the uplink side, the amount of heat generated is a factor of output power and the transmission's duration/duty cycle.

There are two types of uplink thermal mitigation — data throttling and power throttling. There is some hysteresis on these states as well.

3.1. UL Data Throttling

Data throttling acts to reduce the transmission's duration/duty cycle. UL data throttling begins when either of the module's PAs is getting too close to the thermal limit — the module slowly steps down the maximum throughput from 50 Mbps to 10 Mbps as shown below.



Figure 4. Uplink Thermal Mitigation Via Data Throttling

3.2. UL Power Throttling

If downlink throttling and uplink throttling are not able to control the module's temperature, the last thing the module will do is slowly reduce the maximum transmit power from maximum power to 10 dBm, as shown below.



Figure 5. Uplink Thermal Mitigation Via Power Throttling

Depending on RF coverage, this power throttling would reduce the signal quality the base station sees and, in fringe coverage areas, the base station might drop the call if the coverage shrinks to the point where the link can no longer be kept up.

4. Low Power Mode

If the module exceeds the maximum temperature (93°C), it drops the current data session and enters low power mode. It remains in this mode until the temperature drops to 80°C to regain the normal state.

Note: This has always been the behavior for extreme temperature events.
