



AirPrime HL Series

Customer Process Guidelines



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Contents

1. INTRODUCTION	7
1.1. Overview.....	7
1.2. Reference Documents.....	7
2. HANDLING.....	9
2.1. Storage and Handling of the AirPrime HL Series Module	9
2.1.1. Storage Condition	9
2.1.2. ESD.....	9
2.1.3. Moisture Sensitivity.....	9
2.2. Component Package	10
2.2.1. Package Description	10
2.2.2. Marking Description	11
2.3. Component Packing	12
2.3.1. Packing Description	12
2.3.2. Packing Label	12
3. SMT ASSEMBLY PROCESS.....	13
3.1. Lead-Free Process	13
3.2. PCB Design Requirements.....	13
3.2.1. PCB Surface Finish	13
3.2.2. Footprint.....	14
3.2.3. Layout Recommendations	15
3.3. Solder Mask.....	15
4. BOARD MOUNTING GUIDELINES	16
4.1. Stencil Design.....	16
4.2. Solder Reflow Profile.....	17
4.3. Washing and Potting	18
5. REWORK GUIDELINES.....	19
5.1. Component Removal.....	19
5.2. Pad Redress.....	19
5.3. Solder Paste Deposit.....	19
5.4. New Component Placement.....	20
5.5. New Component Soldering.....	20



List of Figures

Figure 1.	Different Assembly Technologies on AirPrime HL Series Modules	10
Figure 2.	AirPrime HL Series Shielded Product Label Example	11
Figure 3.	AirPrime HL Series Molded Product Marking Example	11
Figure 4.	AirPrime HL Series Tape and Reel	12
Figure 5.	Packing Label	12
Figure 6.	Recommended Footprint – Copper Layout	14
Figure 7.	Recommended Solder Resist and Paste Mask Layout.....	16
Figure 8.	Recommended Reflow Profile.....	17



1. Introduction

1.1. Overview

This document presents guidelines for the industrial assembly of an AirPrime HL Series Embedded Module on an application.

Note: Sierra Wireless modules are shipped factory-programmed, with industry or mobile operator approved firmware, according to the specific SKU ordered. Periodically, newer firmware versions become available and can include new features, bug fixes, or critical security updates. Sierra Wireless strongly recommends that customers establish their own production capability for updating module firmware on their assembled end platform, in the event that a newer firmware must be installed before deployment. Sierra Wireless also recommends customers design their products to support post-deployment FOTA upgrades using the AirVantage cloud platform.

1.2. Reference Documents

Note: The list of AirPrime HL modules below may be not exhaustive; this document is applicable to all AirPrime HL variants (22x23 and 24x25 mm).

- [1] AirPrime HL3450 Product Technical Specification
Reference number: 4117500
- [2] AirPrime HL6528x Product Technical Specification
Reference number: 4114016
- [3] AirPrime HL6528RDx Product Technical Specification
Reference number: 4117701
- [4] AirPrime HL7518 Product Technical Specification
Reference number: 4115834
- [5] AirPrime HL7528 Product Technical Specification
Reference number: 4116873
- [6] AirPrime HL7538 Product Technical Specification
Reference number: 4118596
- [7] AirPrime HL7539 Product Technical Specification
Reference number: 4118584
- [8] AirPrime HL7548 and HL7588 Product Technical Specification
Reference number: 4116369
- [9] AirPrime HL7549 Product Technical Specification
Reference number: 4117459
- [10] AirPrime HL7618 Product Technical Specification
Reference number: 4117929
- [11] AirPrime HL7618RD Product Technical Specification
Reference number: 4119874
- [12] AirPrime HL7648 Product Technical Specification

- Reference number: 4119069
- [13] AirPrime HL7650 Product Technical Specification
Reference number: 41110363
- [14] AirPrime HL7688 Product Technical Specification
Reference number: 4119272
- [15] AirPrime HL7690 Product Technical Specification
Reference number: 4118552
- [16] AirPrime HL7692 Product Technical Specification
Reference number: 4119631
- [17] AirPrime HL77xx Product Technical Specification
Reference number: 41110555
- [18] AirPrime HL8518, HL8528 and HL8529 Product Technical Specification
Reference number: 4117047
- [19] AirPrime HL8548 and HL8548-G Product Technical Specification
Reference number: 4114663
- [20] AirPrime HL8549 and HL8549-G Product Technical Specification
Reference number: 4115653
- [21] JEDEC standard JESD625-A, Requirements for Handling Electrostatic Discharge – Sensitive (ESDS) Devices
- [22] ANSI/ESD S20.20: Protection of Electrical and Electronics Parts, Assemblies and Equipment
- [23] IPC/JEDEC J-STD-033 – Handling, Packing, Shipping and Use of Moisture / Reflow Sensitive Surface Mount Devices



2. Handling

2.1. Storage and Handling of the AirPrime HL Series Module

2.1.1. Storage Condition

AirPrime HL modules can be stored in their sealed, original packages, for up to 1 year.

They can withstand a storage temperature range between -40°C to $+85^{\circ}\text{C}$, nevertheless when packed into T&R the upper storage temperature is decreased to $+40^{\circ}\text{C}$ due to T&R packaging material.

Tip: *For optimal results, the recommended storage temperature is $+20^{\circ}\text{C} \pm 10$ degrees.*

2.1.2. ESD

The AirPrime HL Series unit is ESD sensitive. For ESD level information, refer to the corresponding Product Technical Specification of each product as listed in section 1.2 Reference Documents.

It is recommended to use standard ESD precautions, as described in the following standards:

- JEDEC standard JESD625-A, Requirements for Handling Electrostatic Discharge-Sensitive (ESDS) Devices
- ANSI/ESD S20.20: Protection of Electrical and Electronics Parts, Assemblies and Equipment

2.1.3. Moisture Sensitivity

The AirPrime HL Series module is sensitive to moisture absorption:

- MSL 3, 245°C , 2 reflows allowed on customer PCB; see additional details in section 4.2 Solder Reflow Profile.

Caution: *Baking conditions differ according to the HL assembly technology (see section 2.2.1).*

For shielded versions, if tape & reel vacuum pack is open for more than 168h, material should be baked at 40°C for 13 days. If parts are on tray, baking conditions are 24 hours minimum at 85°C .

For molded versions, if the vacuum bag is open for more than 168h, material should be baked for 48 hours at 125°C in tray. Nevertheless, it is recommended to store the modules in dry cabinet ($<10\%$ RH) once the vacuum bag is opened.

It is recommended to follow the standard MSL procedure, as described in the following standard:

- IPC/JEDEC J-STD-033 - Handling, Packing, Shipping and Use of Moisture / Reflow Sensitive Surface Mount Devices.

2.2. Component Package

2.2.1. Package Description

The AirPrime HL Series module is a scalable QFN (quad flat no lead) package, 22x23x2.5 mm (except for the HL8549 and HL8549-G being 24x25x2.5 mm), pitch 0.8 mm with 146 terminals.

The terminals include:

- 66 inner signal pads
- 8 mechanical corner pads
- 7 signal pads for JTAG
- 1 polarity mark
- 64 ground pads

The PCB material is FR4. Plating is NiAu ($3\ \mu\text{m} < \text{Nickel} < 8\ \mu\text{m}$ and $0.05 < \text{Gold} < 0.13\ \mu\text{m}$).

Different assembly technologies are used inside the HL Series modules. Some HL modules use Sierra Wireless' standard assembly process with a metallic soldered shielding, while others use an overmolding compound plus metal sputtering. Baking conditions and other parameters may vary depending on the technology used. Refer to sections 2.1.3 Moisture Sensitivity and 4.2 Solder Reflow Profile for specific parameters per assembly technology; and the corresponding product technical specification for the assembly technology used per HL Series module.

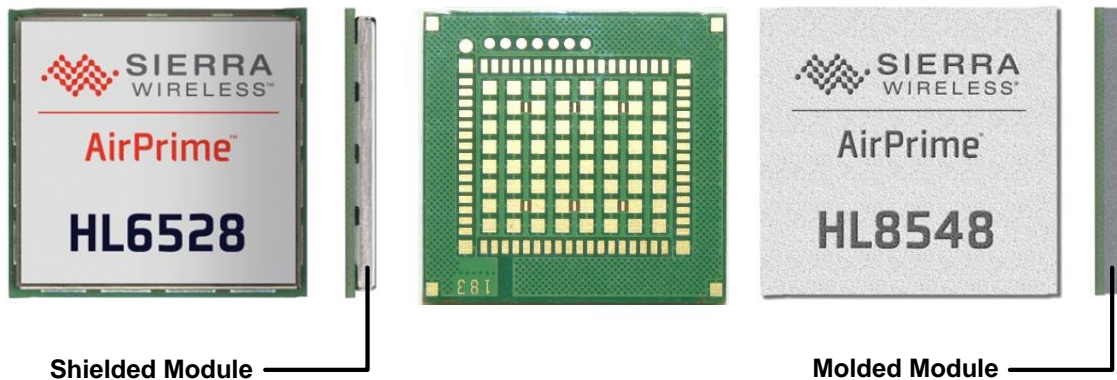


Figure 1. Different Assembly Technologies on AirPrime HL Series Modules

For additional information, refer to the corresponding Product Technical Specification of each product as listed in section 1.2 Reference Documents.

2.2.2. Marking Description

Marking contents and marking methods on the module may differ between each variant of the product family.

The marking method can be via paper label or laser marking. For variants that use laser marking, there are rare instances where these modules are marked with a paper label instead.

Common label content includes:

- Model Name
- Serial Number and IMEI or MEID Number (both letters and data matrix bar code)
- Fabrication Country
- Relevant regulatory compliance markings and identification codes (this may be a CE logo, FCC ID number, IC ID number, etc.)
- Pin 1 indicator for solder-down modules

The examples below are not contractual and do not show exact contents of the label. Label contents may also be rearranged to fit any additional customer-specific need or market segment and can change without notice at the sole discretion of Sierra Wireless.

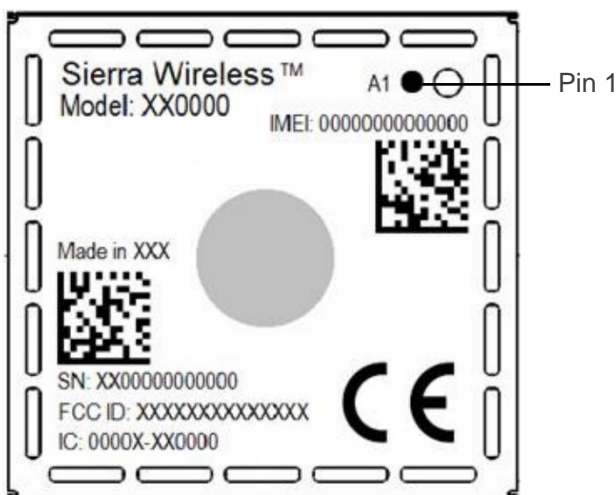


Figure 2. AirPrime HL Series Shielded Product Label Example

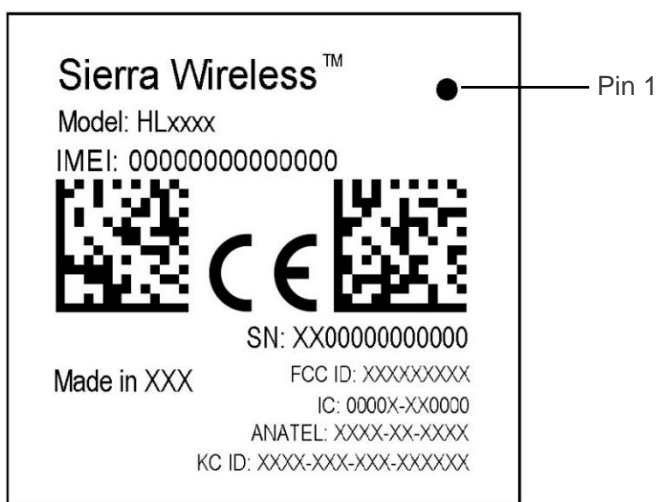


Figure 3. AirPrime HL Series Molded Product Marking Example

2.3. Component Packing

2.3.1. Packing Description

The AirPrime HL Series module is delivered in tape and reel.
 Quantity per tape and reel is 500.

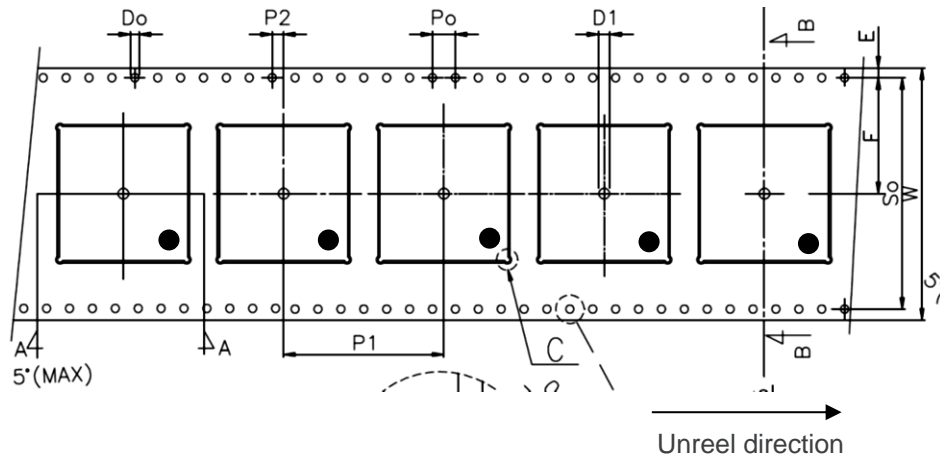


Figure 4. AirPrime HL Series Tape and Reel

P1	P0	W
28.0 mm	4.0 mm	44.0 mm

2.3.2. Packing Label

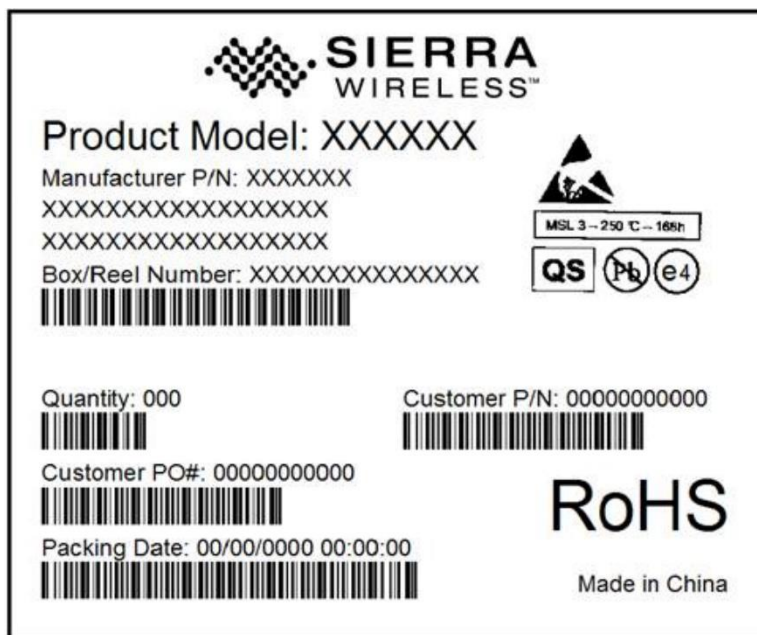


Figure 5. Packing Label



3. SMT Assembly Process

This section presents information and recommendations for the industrial assembly of the AirPrime HL Series module on the application.

Note: *The HL Series products should be assembled by reflow process.*

For customers planning to use both HL78xx (15x18mm – 16 ground pads) and larger HL modules (22x23mm – 64 ground pads), Sierra Wireless advises to use the larger HL footprint (22x23mm) and 2 stencils (one recommended for each product).

Using larger HL modules (64 ground pads) on HL78xx copper footprint (16 ground pads) has not yet been evaluated thermally. This will be confirmed in future document revisions.

3.1. Lead-Free Process

In compliance with directive 2011/65/CE and its amendments, Sierra Wireless products do not contain the following hazardous substances.

Table 1. Restricted Substances

Substance Name	Limit (%)
Lead	0.1%
Mercury	0.1%
Cadmium	0.01%
Hexavalent chromium	0.1%
Polybrominated biphenyls (PBB)	0.1%
Polybrominated diphenyl ethers (PBDE)	0.1%
Bis(2-ethylhexyl) phthalate (DEHP)	0.1%
Butyl benzyl phthalate (BBP)	0.1%
Dibutyl phthalate (DBP)	0.1%
Diisobutyl phthalate (DIBP)	0.1%

The AirPrime HL Series modules are manufactured with RoHS-compliant components and processes.

3.2. PCB Design Requirements

3.2.1. PCB Surface Finish

The PCB surface finish recommended is Electroless Nickel, immersion Gold. Organic Solderability Preservative (OSP) may also be used.

Caution: *Hot Air Solder Leveled finish (HASL) is not recommended because the process does not give consistent solder volumes on each pad because of poor pad flatness.*

3.2.2. Footprint

In order to produce high assembly yields and a reliable solder joint, the footprint on the customer application board should match Figure 6 below.

Note that:

- The 64 inner pads and the 8 corner pads are ground pads.
- For molded versions, the copper pad should not extend out of the module as the PCA edge side is conductive.
- Manufacturing tolerance for copper pads is 30 µm.

Mechanical drawings of the AirPrime HL Series module’s footprint (including dimensions and pitch) are available in the Product Technical Specification of each product as listed in section 1.2 Reference Documents.

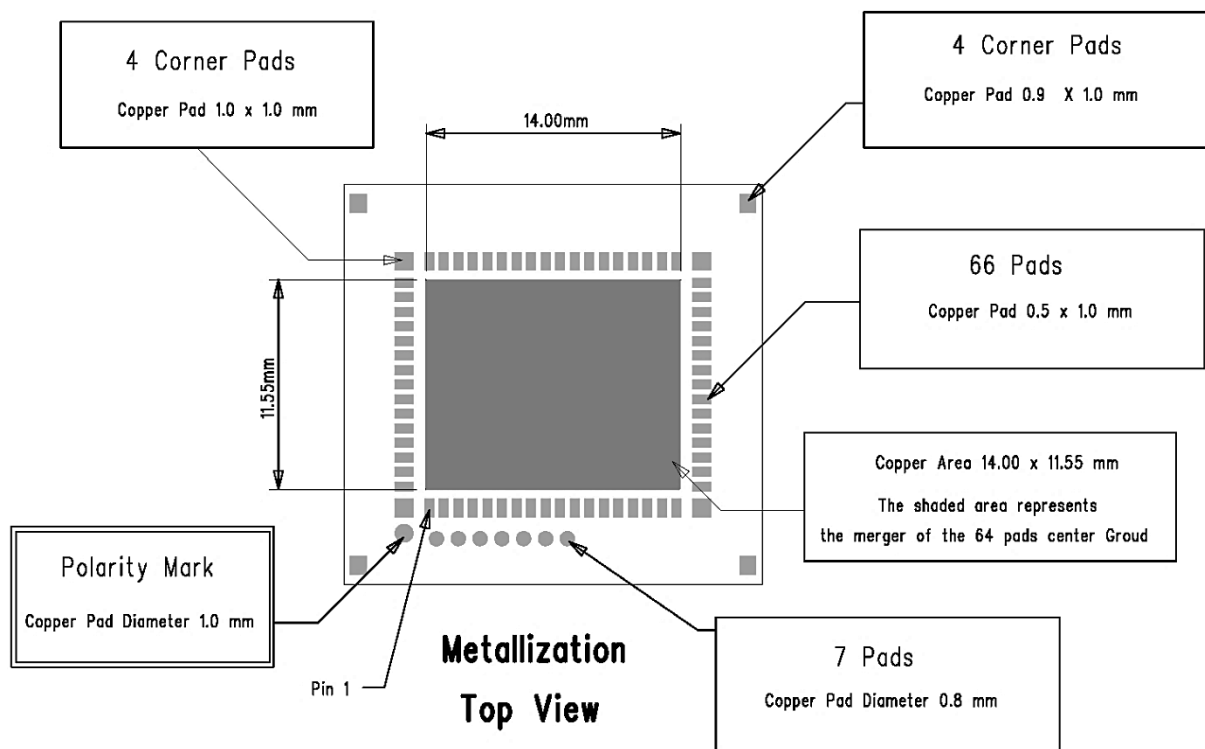


Figure 6. Recommended Footprint – Copper Layout

3.2.3. Layout Recommendations

Sierra Wireless' layout recommendations include:

- A GROUND area under the HL series module. This ground area should be a whole area of copper with proper ground vias to provide a good grounding system between the application and the embedded module and improved thermal dissipation. It should be covered by solder resist on the non-soldered area.

The ground vias may be micro-vias, filled or unfilled. Through-holes can be used in between each of the 64 ground pads (under the solder resist).

- There should not be any SIGNAL trace or hole / micro-via under the AirPrime HL product.
- Customers should place a copper pad under the Polarity mark to avoid any risk of short circuits between it and the customer layout. This mark eases visual confirmation of the module's correct orientation.
- The Polarity mark should not be soldered (there is no stencil aperture for the Polarity mark).
- The antenna pad and its track should be adapted according to RF constraints, based on customer layout. Refer to each corresponding Product Technical Specification for more details.
- Leave a component-free area of 2 mm around the HL Series unit for accessing the surrounding components and for scalability with the HL8549x.

3.3. Solder Mask

The pads on the printed circuit board are either Solder Mask Defined (SMD) or Non-Solder Mask Defined (NSMD).

Since the copper etching process has tighter control than solder masking process, NSMD pads are preferred over SMD pads.

Moreover, NSMD pads with solder mask opening larger than the metal pad size also improve the reliability of solder joints, as this limits the stress concentration at the solder-to mask corner interface.

For external pads, the solder mask opening should be 100 μm to 150 μm larger than the pad, resulting in 50 μm to 75 μm clearance between the copper pad and solder mask. This allows for solder mask registration tolerances, depending upon the PCB fabricator's capabilities.

For ground pads, SMD pads should be used if a copper ground area is under the AirPrime HL Series module as described in section 3.2.3 Layout Recommendations.

The recommended solder mask thickness on the top copper is 10 μm to 30 μm .

Refer to Figure 7 for recommended solder resist and paste mask layout.

4. Board Mounting Guidelines

4.1. Stencil Design

The recommended stencil thickness is 125 µm.

The proposed stencil design is presented in the figure below.

It is highly recommended to monitor the solder paste height, registration and proper placement during the squeegee printing.

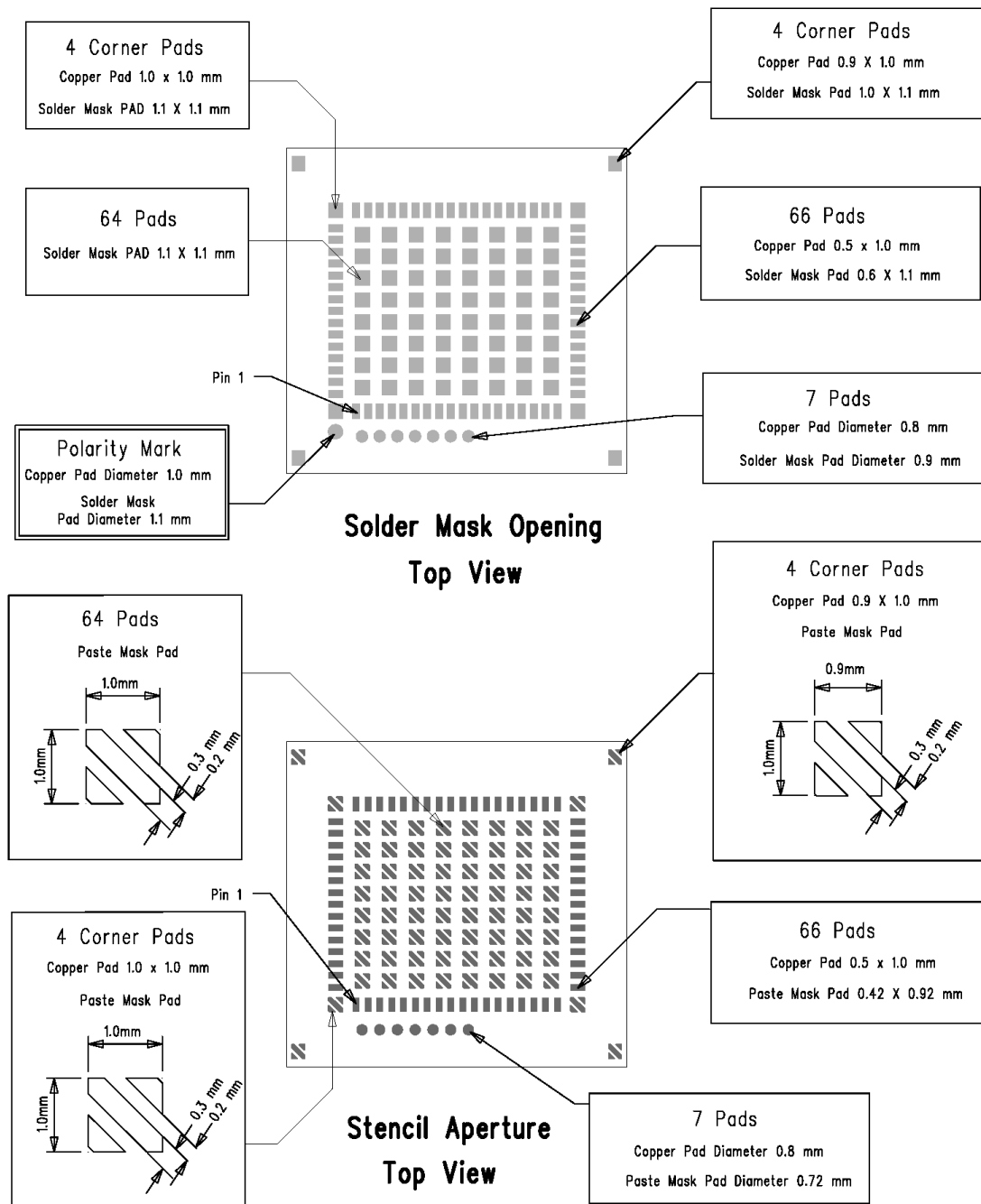


Figure 7. Recommended Solder Resist and Paste Mask Layout

4.2. Solder Reflow Profile

Lead-free SMT reflow profiles should be used to surface mount the AirPrime HL Series module.

The reflow profile depends on PCB density and type of solder paste being used. The paste manufacturer’s recommendation should also be considered to determine the proper reflow profile.

The solder reflow profile specified in Table 2 is a mandatory requirement to ensure reliable assembly.

Table 2. Solder Reflow Profile

Peak Temperature	245°C max
Reflow Time (over 220°C), for molded versions	60 sec max
Number of reflow cycles	2

Caution: *It is recommended to use only one reflow cycle for module assembly.*

If repairs or other rework are performed on the customer board near the HL module, care must be taken to ensure the module is not reflowed.

The figure below is a reflow profile example.

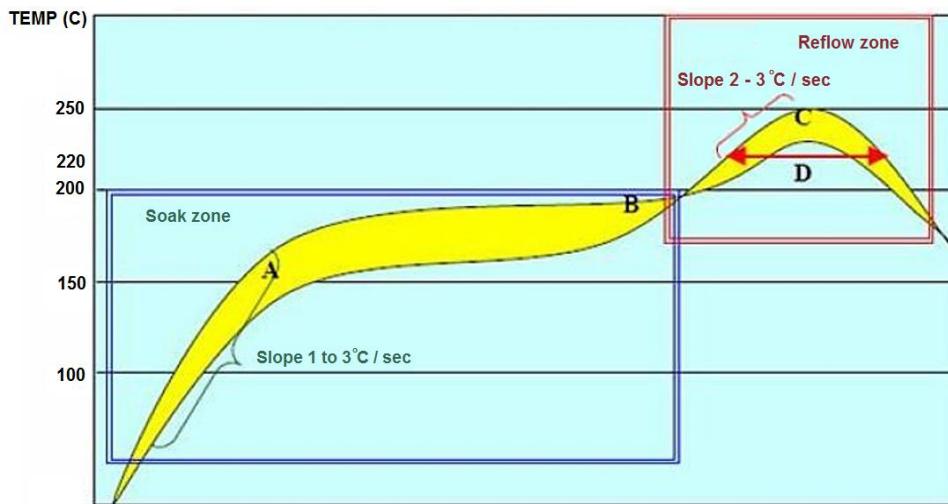


Figure 8. Recommended Reflow Profile

Additional recommendations are presented in the table below for consideration.

Factor	Recommendation
Max slope at soak time	1 to 3°C / sec
Max slope at reflow zone	2 to 3°C / sec
Soak time (between A and B: 150 and 190°C)	60 to 120 sec
Reflow time (D: over 220°C)	40 to 60 sec
Max temperature (C)	235 – 245°C
Cooling down slope	1 to 3°C / sec

Note: *It is recommended to perform reflow in a nitrogen atmosphere.*

4.3. Washing and Potting

Water wash is not recommended with shielded Sierra Wireless embedded modules due to difficulty in ensuring proper drying under the shield.

Use of ultrasonic process should be avoided as it can damage the quartz crystal components.

Sierra Wireless has not performed potting qualification tests on HL modules. Customers should pay attention to RF tracks since the ϵ_{air} (epsilon-air) will be different below the potting compared to an open-air design. After potting a module, RF performance should be re-checked to guarantee that no degradation compared to nominal values occurred.



5. Rework Guidelines

Rework tools and operating parameters are customer/application specific. Rework tools, heating profiles and the rework process should be tailored to these specific needs for optimum results.

Prior to any rework, if the component floor life has been exceeded, it is highly recommended to bake the PCB to remove moisture from the assembly. (See JEDEC J-STD-033 paragraph 6 - Board rework. If possible for the PCB and the other components of the board, apply the same baking conditions as per section 2.1.3).

The pre-baking process will prevent damage to any component due to moisture vapor pressures caused during reflow.

Prior to removal, the metal shielding of the AirPrime HL Series shielded module must be glued to the module substrate, by using glue able to withstand reflow profile.

5.1. Component Removal

The step consists of reflowing the solder joints attaching components to the PCB. Ideally, the reflow profile for part removal should be the same as the one used for part attachment. However, the time above liquidus can be reduced as long as the reflow is complete.

In the removal process, it is recommended that the board should be heated from the bottom side using convective heaters and hot gas, or hot air or IR should be used on the top side of the component. Special nozzles or IR lens should be used to direct the heating in the component area and heating of adjacent components should be minimized.

Excessive hot airflow should also be avoided, as this causes the component to overheat.

Once the joints have reflowed, the vacuum lift-off should be automatically engaged for pick-up during the transition from reflow to cool down.

Warning: *If heating conditions are not properly controlled during manual hot removal from PCB assembly, package integrity can be damaged from overheating.*

5.2. Pad Redress

Once the component has been removed, the site and pads need to be cleaned properly. It is better to use the combination of a blade style conductive tool and a fluxed desoldering braid.

Once the residual solder has been removed, the land pads should be cleaned with a solvent. The solvent is usually specific to the type of solder paste used in the original assembly and the paste manufacturer's recommendations should be followed.

5.3. Solder Paste Deposit

Once the PCB is properly cleaned and inspected, solder paste should be applied on the solder land (on the component itself or on the customer PCB) with a mini-stencil which has same thickness and apertures as the stencil used for original attachment.

5.4. New Component Placement

A slip-beam optical system should be used to align the component to the PCB. This method will display an image of the land pad overlaid on the mating footprint and aid in proper alignment. Similar to paste printing, the alignment should be done under magnification of 50x to 100x.

5.5. New Component Soldering

The reflow profile developed during original attachment or removal should be used to attach the new component.