Application Note

Design Considerations for CC1312PSIP FCC and IC Certified RF Module

ABSTRACT

This application note shows how to re-use the CC1312PSIP FCC Modular Certification. The Federal Communications Commission (FCC) and Industry Canada (IC) certification covers the frequency band of 902MHz to 928MHz, but the CC1312PSIP can also operate in the 863MHz to 876MHz ISM band. To re-use the FCC and IC Certification, you must verify that you use the certified software PHYs and copy the hardware reference design as much as possible.

The software section covers all of the various PHYs that have been tested and the maximum power that can be transmitted for each particular PHY. Several PHYs are supported and the benefits of each particular PHY are covered.

The hardware section covers the recommended layouts for a two-layer design and a four-layer design. There are differences between certified antennas and non-certified antennas in the requirements for the reuse of the modular approval for use in Canada and the United States. The last section covers the recommended testing of the CC1312PSIP when assembled onto a main board.

This document walks through software and hardware related questions and how to re-use the FCC or IC certification that enables a quicker time-to-market.

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1 Introduction

The SimpleLink™ CC1312PSIP [4.1] device is an RF certified System-in-Package (SiP) Sub-1GHz wireless module supporting Wi-SUN®, Wireless M-Bus, IEEE 802.15.4, IPv6-enabled smart objects (6LoWPAN), mioty, proprietary systems, including the TI 15.4-Stack. The CC1312PSIP microcontroller (MCU) is based on an Arm® Cortex® M4F main processor and optimized for low-power wireless communication and advanced sensing in grid infrastructure, building automation, retail automation, and medical applications.

The CC1312PSIP [4.1] has a low sleep current of 0.9µA with RTC and 80KB RAM retention. In addition to the main Cortex® M4F processor, the device also has an autonomous ultra-low power Sensor Controller CPU with fast wake-up capability. As an example, the sensor controller is capable of 1Hz ADC sampling at average 1µA system current.

The CC1312PSIP [4.1] has low soft error rate (SER) failure-in-time (FIT) for long operational lifetime. Always-on SRAM parity minimizes risk for corruption due to potential radiation events. Consistent with many customers 10 to 15 years or longer life cycle requirements, TI has a product life cycle policy with a commitment to product longevity and continuity of supply including dual sourcing of key components in the SIP.

The CC1312PSIP [4.1] device is part of the SimpleLink MCU platform, which consists of Wi-Fi™, *Bluetooth®* Low Energy, Thread, Zigbee™, Wi-SUN, Amazon Sidewalk, mioty, Sub-1GHz MCUs, and host MCUs. CC1312PSIP [4.1] is part of a portfolio that includes pin-compatible 2.4GHz SIPs for easy adaption of a wireless product to multiple communication standards. The common SimpleLink Low Power F2 SDK and SysConfig system configuration tool supports migration between devices in the portfolio. A comprehensive number of software stacks, application examples and SimpleLink Academy training sessions are included in the SDK.

By utilizing 3D assembly packaging with the SMD components placed on the CC1312PSIP [4.1] laminate and then placing the chip die directly above, the package volume is fully utilized. For the CC1312PSIP block diagram, see Figure 1-1. The RF filtering section has been was reduced to two singular components from 25 components by making two Integrated Passive Components (IPC). One IPC for the 14dBm Tx / Rx port and another for the 20dBm Tx port. This resulted in a final package size of 7 x 7mm with all components fully integrated.

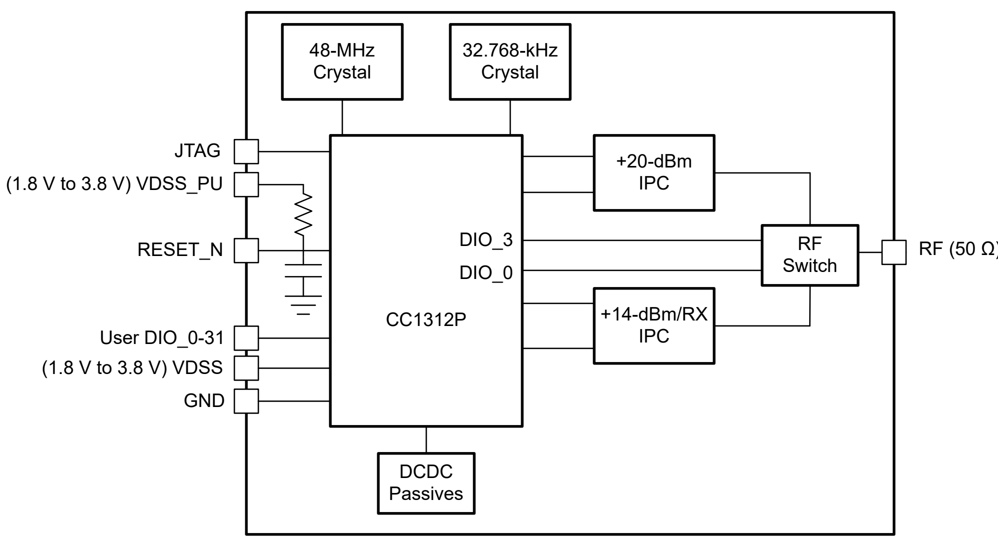

Figure 1-1. CC1312PSIP Block Diagram

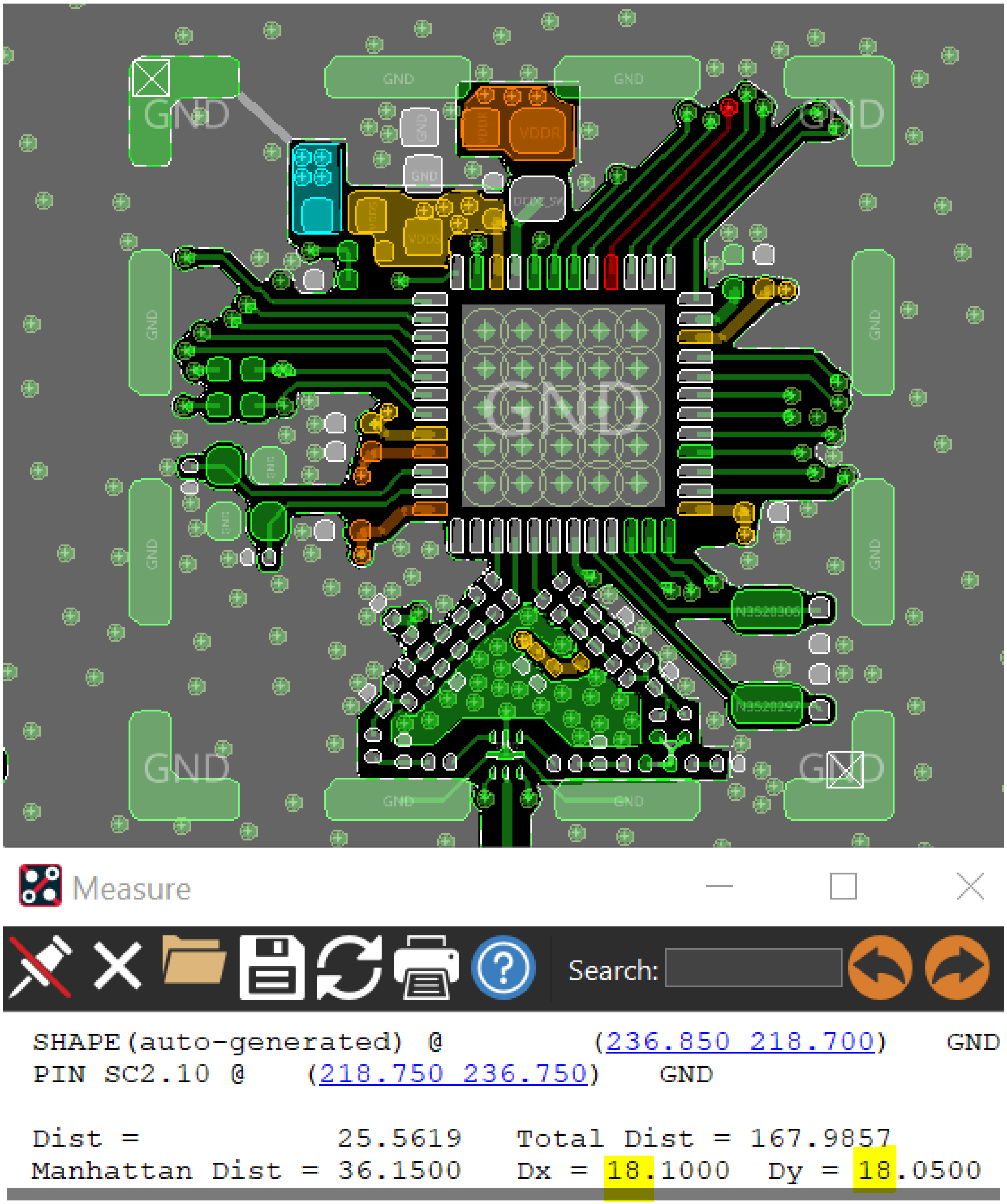

Figure 1-2. Traditional Design With a QFN Chipset

With the traditional design shown in Figure 1-2, this has a PCB floor space of approximately 324mm (18 x 18mm); with the CC1312PSIP [4.1] this was reduced to just 49mm (7 x 7mm). That is an 85 % size reduction.

In addition, to the size reduction, fully certified PHYs and FCC / IC modular certification that enables the option just to re-use the certification. There are also new features such as SW-TCXO that provide TCXO accuracy.

1.1 RF Function and Frequency Range

The CC1312PSIPMOT is designed to operate in the 902MHz to 928MHz band where the FCC modular certification can be re-used. CC1312PSIPMOT can also be used for the 868MHz ISM band but this is not covered by the FCC modular certification. The maximum RF power transmitted is 20dBm but this is dependent on the PHY.

For ETSI operation within 863MHz to 876MHz ISM band. The output power does not exceed 14.0dBm between 863MHz to 870MHz. If greater than 14.0dBm is required, then the operating frequency has to be within 869.400MHz to 869.650MHz. Then 20dBm can be transmitted at 869.525MHz. 20dBm can also be used in the frequency region of 870MHz to 876MHz for certain countries in Europe but not all countries support this frequency region in the EU.

1.2 LP-EM-CC1312PSIP

To evaluate the CC1312PSIP, there is a LaunchPad available LP-EM-CC1312PSIP [4.2] and this must be plugged into a LP-XDS110 or LP-XDS110ET. Figure 1-3 shows a LP-XDS110 on the left side and a LP-EM-CC1312PSIP [4.2] on the right side.

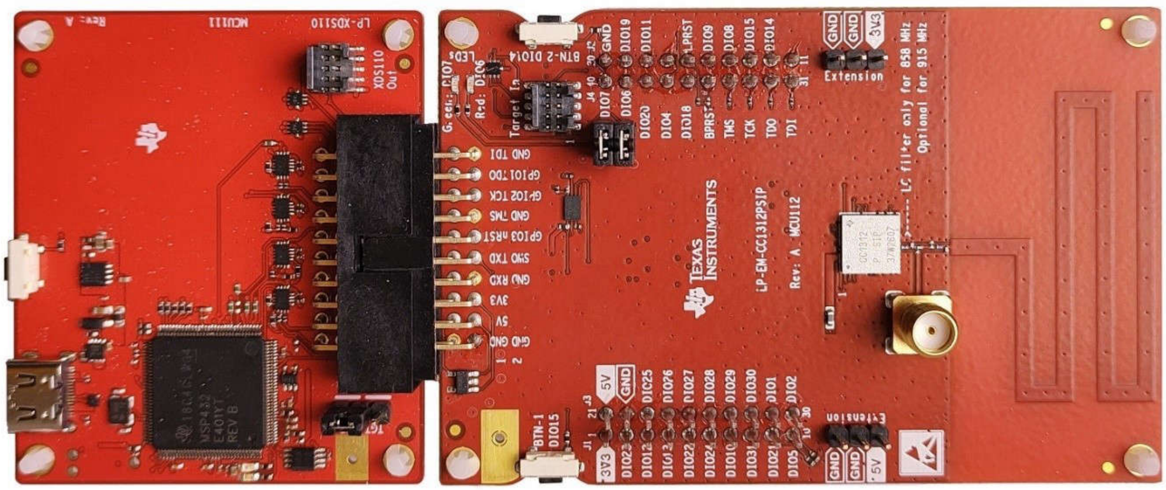

Figure 1-3. LP-EM-CC1312PSIP

The FCC certification covers the frequency band of 902MHz to 928MHz but the CC1312PSIP [4.1] can also operate in the 863MHz to 876MHz ISM band.

The schematic of the radio section is shown in Figure 1-4. The components L1 and C1 are only required for operation at 20dBm at 869.525MHz or 870MHz to 876MHz, L1 must be 3.9nH and C1 must be 3.6pF.

Note

For usage at 902MHz to 928MHz and re-use of the FCC modular certification, L1 must be 100pF or 0ohm and C1 must be DNM.

If L1: 3.9nH and C1: 3.6pF are used at 902MHz to 928MHz, the output power is affected and the recommended output power settings in the SDK are invalid. Adding additional filtering on the RF output implies a Class 2 permissive change (C2PC); refer to section 3.3.2.2 for more information.

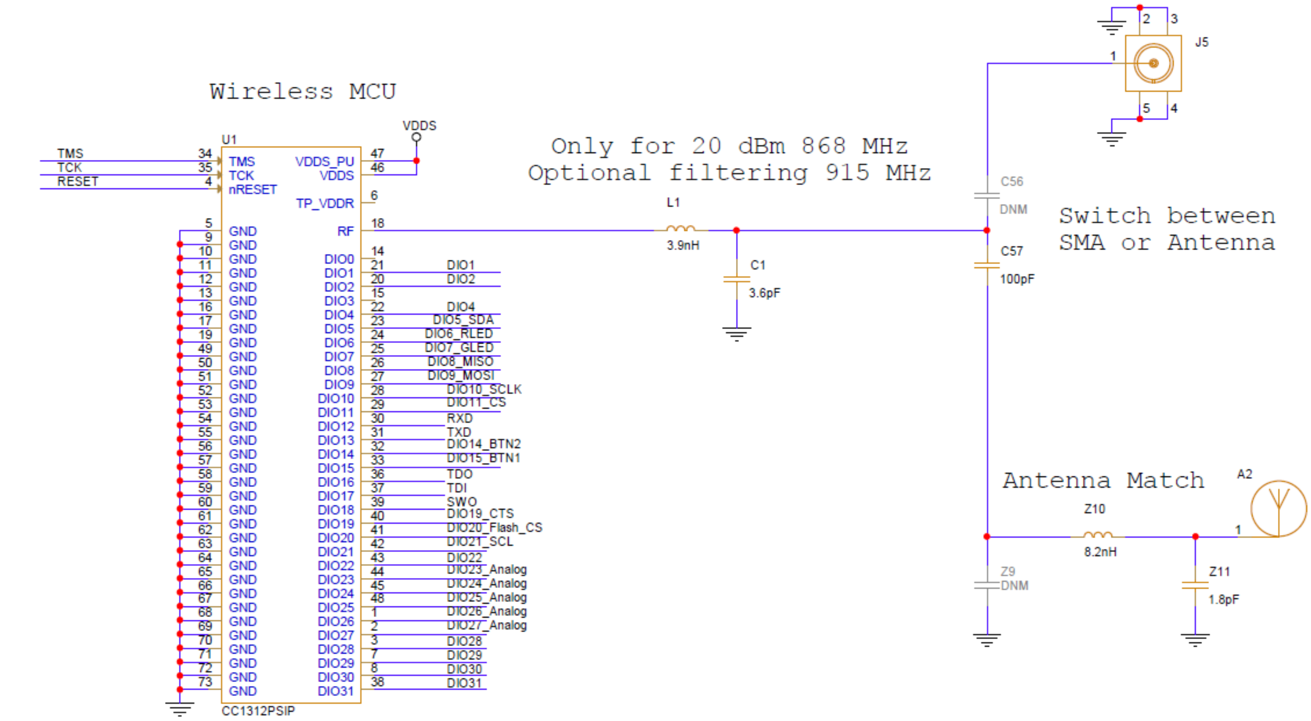

Figure 1-4. Schematic of the LP-EM-CC1312PSIP Radio Section

When matching the antenna, a low-pass or high-pass topology of match can be used. For the CC1312PSIP [4.1] we always recommend to use a low-pass antenna match as shown in Figure 1-4 by the antenna match components of Z10 and Z11.

There is no DC block in the CC1312PSIP [4.1] so component C57 acts as a DC block if required for the antenna section. In the LP-EM-CC1312PSIP [4.2] C57 is also used to switch to the integrated PCB antenna section. If we just required connection to the SMA, then the DC block is assembled at C56 instead and C57 is DNM.

2 Software – Certified PHYs

There is a selection of PHYs available that have been certified with the CC1312PSIP. Refer to the Software Development Kit (SDK) in 4.4 for more information for a particular PHY. These PHYs include WB-DSSS, TI 15.4, MIOTY, WiSUN and PowerG. The MIOTY and PowerG allow up to 20dBm, TI 15.4 allows 19dBm, WiSUN allows 17dBm, and WB-DSSS allows 15dBm. Refer to Table 2-1 for an overview of the different PHYs that are FCC certified. There are additional PHYs supported by the CC1312 and have been validated but not all are FCC certified.

Table 2-1. Overview of Link budget Summary of the Different Certified PHYs

PHY	Mode	Tx_max (dBm)	Rx_min (dBm)	Link Budget (dB)
WiSun	Mode #1b, 50kbps, 25kHz Deviation, 2-GFSK, 98kHz RX, 200kHz Channel Spacing, Min-Max Frequency: US 902.2-927.8 MHz	17	-104	121
WiSun	Mode #2a, 100kbps, 25kHz Deviation, 2-GFSK, 137kHz RX Bandwidth, 200kHz Channel Spacing, Min-Max Frequency: US 902.2-927.8MHz	17	-101	118
WiSun	Mode #3, 150kbps, 37.5kHz Deviation, 2-GFSK, 273kHz RX Bandwidth, 400kHz Channel Spacing, Min-Max Frequency: 902.4-927.6MHz	17	-96	113
WiSun	Mode #4a, 200kbps, 50kHz Deviation, 2-GFSK, 273kHz RX Bandwidth, 400kHz Channel Spacing, Min-Max Frequency: 902.4-927.6MHz	17	-97	114
WiSun	Mode #5, 300kbps, 75kHz Deviation, 2-GFSK, 285kHz RX Bandwidth, 600kHz Channel Spacing, Min-Max Frequency: 902.6-927.2MHz	17	-94	111
WB-DSSS	30kbps (480ksps), DSSS = 1:8	15	-106	121
WB-DSSS	60kbps (480ksps), DSSS = 1:4	15	-105	120

Table 2-1. Overview of Link budget Summary of the Different Certified PHYs (continued)

PHY	Mode	Tx_max (dBm)	Rx_min (dBm)	Link Budget (dB)
WB-DSSS	120kbps (480ksps), DSSS = 1:2	15	-103	118
WB-DSSS	240kbps (480ksps), DSSS = 1:1	15	-101	116
TI 15.4	SimpleLink Long Range, 5kbps (20ksps), 5kHz Deviation, 2-GFSK, 34kHz RX Bandwidth, FEC = 1:2, DSSS = 1:2	19	-117	136
TI 15.4	50kbps, 25kHz Deviation, 2-GFSK, 98kHz RX Bandwidth	19	-108	127
TI 15.4	200kbit/s 100kHz Deviation, 2-GFSK, 273kHz RX Bandwidth	19	-103	122
PowerG	50kbps, 25kHz Deviation, 2-GFSK, 98kHz RX Bandwidth	20	-108	128
MIOTY	2.38kbps, 915.257-916.658MHz, 28.6kHz channel spacing	20	-119	139

The default settings in the SDK must be used when selecting the CC1312PSIP. Deviating from these default settings can impact the FCC Certification when operating in the frequency band of 902MHz to 928MHz. If the settings are changed then the FCC Certification is not valid and new tests are required at an official FCC test house.

In order not to jeopardize the re-use of the FCC certification, then the following settings for the output power should not be exceeded.

2.1 14dBm Tx and Rx Port

This is the standard RF port to transmit up to 14dBm output power and also the RF receiver port.

2.1.1 WB-DSSS

- Maximum RF power transmitted *without* duty cycling is:
  - 14.0dBm and antenna gain less than 2.69dBi

2.1.2 TI 15.4

- Maximum RF power transmitted *without* duty cycling is:
  - 12.5dBm and antenna gain less than 2dBi; or
  - 12.0dBm and antenna gain less than 2.69dBi
- Maximum RF power transmitted *with* duty cycling of 60ms_max is:
  - 14.0dBm and antenna gain less than 2.69dBi

2.1.3 PowerG PHY

- Maximum RF power transmitted *without* duty cycling is:
  - 12.5dBm and antenna gain less than 2.0dBi
  - 12.0dBm and antenna gain less than 2.69dBi
- Maximum RF power transmitted *with* duty cycling of 60ms_max is:
  - 14dBm and antenna gain less than 2.69dBi

2.1.4 mioty PHY

- Maximum RF power transmitted *without* duty cycling is:
  - 12.5dBm and antenna gain less than 2.0dBi
  - 12.0dBm and antenna gain less than 2.69dBi
- Maximum RF power transmitted *with* duty cycling is:
  - 14dBm and antenna gain less than 2.69dBi

2.1.5 WiSun PHY

- Maximum RF power transmitted *without* duty cycling is:
  - 12.5dBm and antenna gain less than 2dBi; or
  - 12.0dBm and antenna gain less than 2.69dBi
- Maximum RF power transmitted *with* duty cycling of 60ms_max is:
  - 12.5dBm and antenna gain less than 2.69dBi

2.2 20dBm Tx Port

This is the high-power Tx port that can send up to 20dBm output power.

2.2.1 WB-DSSS PHY

- Maximum RF power transmitted *without* duty cycling is:
  - 15dBm and antenna gain less than 2.69dBi

2.2.2 TI 15.4 PHY

- 902.2MHz (CH1) – 908.0MHz (CH30)
  - Maximum RF power transmitted *without* duty cycling is:
  - 16dBm and antenna gain less than 2.69dBi
  - Maximum RF power transmitted *with* duty cycling is:
  - 19dBm and antenna gain less than 2.69dBi
- 908.2MHz (CH31) – 927.8MHz (CH129)
  - Maximum RF power transmitted *without* duty cycling is:
  - 19dBm and antenna gain less than 2.69dBi

2.2.3 PowerG PHY

- Maximum RF power transmitted *without* duty cycling is:
  - 19dBm and antenna gain less than 2.69dBi
- Maximum RF power transmitted *with* duty cycling of 60ms_max is:
  - 20dBm and antenna gain less than 2.69dBi

2.2.4 mioty PHY

- Maximum RF power transmitted *without* duty cycling is:
  - 19dBm and antenna gain less than 2.69dBi

2.2.5 Wi-SUN PHY

- Maximum RF power transmitted *without* duty cycling is:
  - 17dBm and antenna gain less than 2.69dBi
- Maximum RF power transmitted *with* duty cycling of 60ms_max is:
  - 19dBm and antenna gain less than 2.69dBi

3 Hardware

3.1 Recommended Layout

Even if the CC1312PSIP [4.1] is certified, a poor RF layout causes increased radiated emissions that can cause increased harmonic emissions or degradation in RF performance. The following layout recommendations must be followed for optimum performance.

3.1.1 4-Layer Design

The LP-EM-CC1312PSIP [4.2] is available for evaluation of the CC1312PSIP [4.1] and is a 4-layer design. The function of the LP-EM-CC1312PSIP [4.2] has been shown in Figure 1-3. This is the design that has been tested at FCC test house. LP-EM-CC1312PSIP [4.2] has also been tested at 868MHz to sell the evaluation board in Europe.

The 4-layer layout has been designed to minimize the emissions from the board. The top layer is the component layer which the CC1312PSIP [4.1] is soldered and assembled, refer to Figure 3-1. Directly underneath the top layer, is the second layer that is mostly the GND layer, refer to Figure 3-2. The third layer is the layer where the majority of the routing is performed, refer to Figure 3-3. The bottom layer there is minimum routing and the majority of this layer is a GND plane, refer to Figure 3-4.

By enclosing the majority of the routing on the third layer, between the GND on the second and fourth layers. The GND layers with the GND vias then form a Faraday cage effect on the majority of the routing performed on the third layer which helps to minimize unwanted emissions from the routing of the signals from the CC1312PSIP [4.1]. As can be seen in Figure 3-1 and Figure 3-4, the routing on the top and bottom layers are kept to a minimum.

A 4-layer design is the preferred choice for a robust and low emission design.

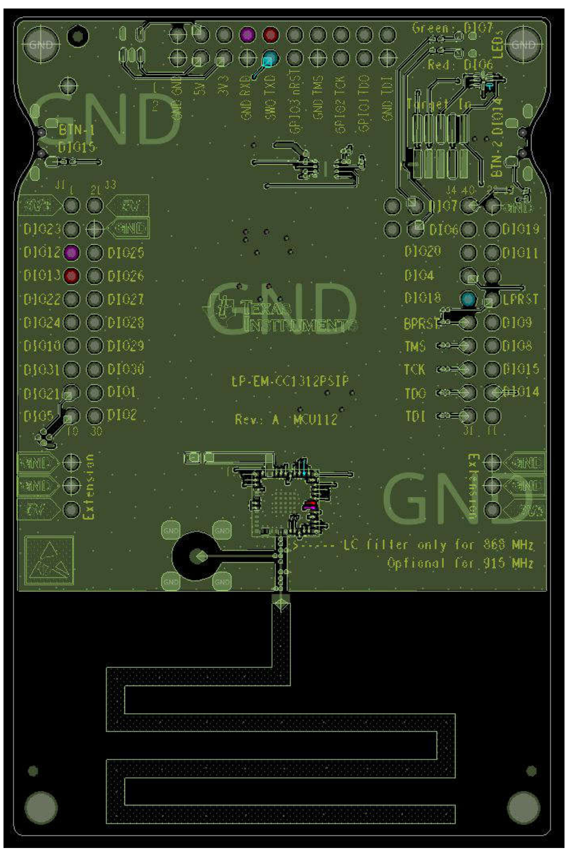

Figure 3-1. Top Component Layer of the 4-Layer PCB Design

Figure 3-2. Second Layer of the 4-Layer PCB Design

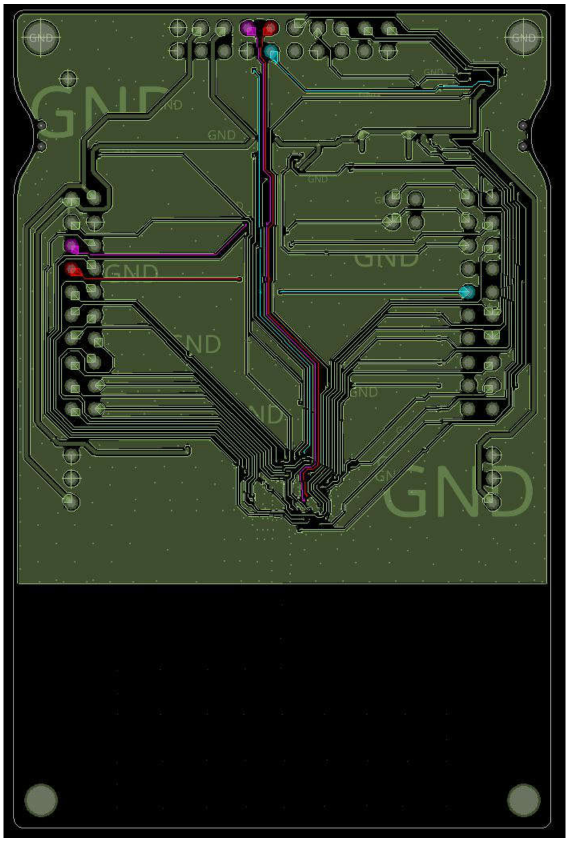

Figure 3-3. Third Layer of the 4-Layer PCB Design

Figure 3-4. Bottom Layer of the 4-Layer PCB Design

3.1.2 2-Layer Design

Since the CC1312PSIP [4.1] has integrated all the components inside the package. The routing requirements to the CC1312PSIP are simplified and this opens up the option to produce a 2-layer PCB design instead of a 4-layer PCB design to save PCB costs.

Since there is only 2 layers of the PCB, the more IO routing inherently decreases the amount of GND on the PCB. Not only does the GND plane reduce, but the Faraday cage effects are also reduced compared to a 4-layer design.

Figure 3-5 shows the top layer of a 2-layer PCB design and Figure 3-6 shows the bottom layer of the 2-layer PCB design. The Faraday cage concept is still tried to be maintained despite having just two layers. Making a 2-layer design is more challenging than making a 4-layer design since the design has greater requirements that a good RF layout concept must be followed. *If good RF layout practice is not followed on the end-product, then the unintentional radiated emissions increase which can cause failures at the certified test lab when proving the level of unintentional radiators is within the regulatory limits.*

The top layer shown in Figure 3-5 is the component layer with the main routing layer. The bottom layer shown in Figure 3-6 is for minor routing and mostly GND plane layer. The bottom layer which is mostly a GND layer is important for the Faraday cage effects and also to maintain a large GND plane as possible for the antenna.

A smaller GND plane naturally gives a lower antenna efficiency and a smaller bandwidth. This is one of the reasons why there must be as little as possible routing on this layer to maintain a highly efficient antenna for a GND plane size that is much smaller than a quarter-wave. The quarter-wave at 915MHz is 8.2cm so GND planes that are less than this distance have a reduced efficiency and bandwidth. The antenna must see as large as possible GND plane for best antenna efficiency. If the GND plane is effectively divided up due to routing, the antenna efficiency is lower.

Figure 3-7 shows the top and bottom layer of the 2-layer PCB design directly underneath the CC1312PSIP. The GND vias and the distance between the GND vias are essential to maintain a good Faraday cage effect whilst just having a 2-layer design.

Note

Directly underneath the CC1312PSIP on the bottom layer, there must be GND to attenuate any unwanted radiation. The majority of the routing on the top layer, must be covered by GND directly underneath on the bottom layer. This creates a Faraday cage effect whilst just using a 2-layer design. This is important to follow otherwise the radiated emissions increase.

Making a 2-layer design requires more caution in the RF layout stage of the design. By not having a good GND plane or using enough GND vias, then the design has increased emissions. If there is uncertainty or if the previous guidelines cannot be followed, then a 4-layer design can be used.

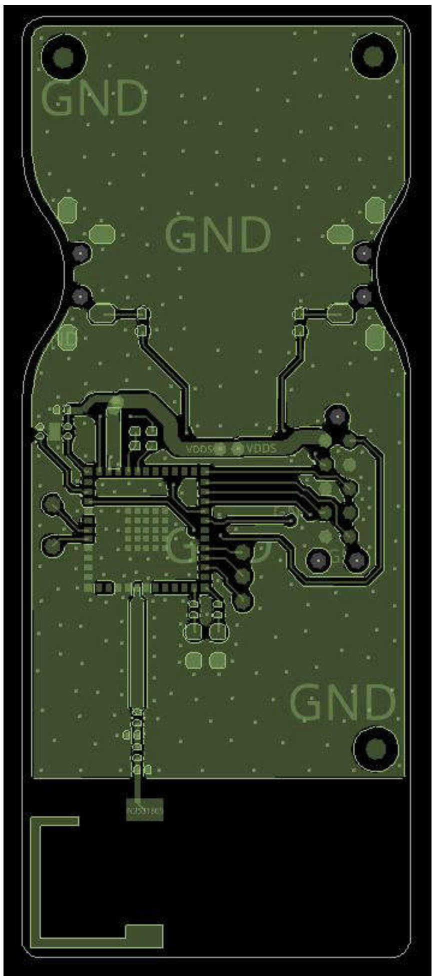

Figure 3-5. Top Layer of 2-Layer PCB Design

Figure 3-6. Bottom Layer of 2-layer PCB Design

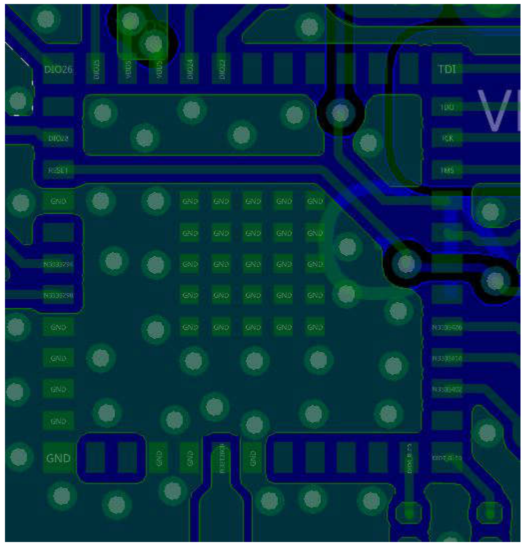

Figure 3-7. Top and Bottom Layer of 2-Layer PCB Directly Underneath the CC1312PSIP

3.1.3 GND Vias

Each GND pad must have a GND via. However, this is difficult to follow when using just through-hole via technology due to the routing on the other layers. As can be seen in Figure 3-7 and Figure 3-8, the maximum GND via distance is approx. 1.5mm from each other for the GND vias that are in close-proximity of the CC1312PSIP.

1.5mm_max distance is based upon Faraday cage attenuation up to the 5^{th} harmonic of 915MHz in a FR4 substrate with a dielectric constant of 4.5. Increasing the distance between the GND vias has less attenuation for the higher harmonics.

Note

1.5mm_max distance must be maintained from each GND pad to a GND via and also the separation between the GND vias that are in close-proximity of the CC1312PSIP. This must also be followed for the grounding of the GND plane around the 50-ohm trace to the SMA or antenna.

The distance between the GND vias is especially important for the 2-layer design since a 2-layer design inherently has less GND than a 4-layer design.

3.1.4 Maximum Track Length

For a 4-layer design, the maximum track length on the top and bottom layers that are outside the Faraday cage can not be longer than 8mm since the majority of the routing can be done on the third layer.

Note

For a 2-layer design, the maximum track length recommendation of 8mm can be difficult to follow since the main routing is done mainly on the top layer. If the tracks on the top layer exceed 8mm in length, then these tracks must have a GND directly underneath on the bottom layer to minimize the unwanted radiation of the long tracks that exceed 8mm.

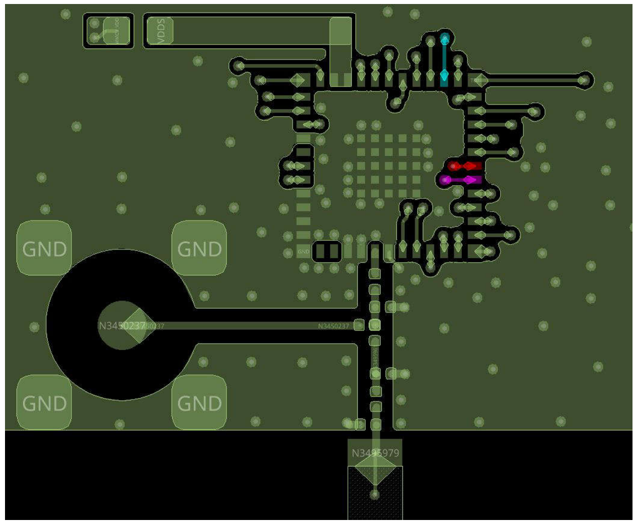

Figure 3-8. Maximum Track Length on Top Layer of a 4-Layer PCB and GND Via Placement

3.2 Antennas

Use a certified antenna that has already been listed in the original FCC filing. By using a certified antenna, then the end-user using the FCC IC label does not need to prove the antenna gain since this is a known antenna and known antenna gain.

If a non-certified antenna is used, then the end-user must prove the antenna gain does not exceed 2.69dBi. Section 3.2.2 covers the items required when filing a new antenna and how to prove the antenna gain so this is accepted by the FCC. A class II permissive change is only required when the antenna gain exceeds 2.69dBi.

3.2.1 Certified Antennas

In all cases, assessment of the final product must be met against the Essential requirements of the Radio Equipment Directive Article 3.1(a) and (b), safety and EMC respectively, as well as any relevant Article 3.3 requirements. Refer to 4.3 for the official and complete CC1312PSIP Manual Information for the End User and OEM Installation Guide.

The antennas shown in Table 3-1 were verified in the conformity testing. A separate approval process is required for any other configurations. This is covered in Section 3.2.2.

Table 3-1. Antenna Specifications of all Certified Antennas

Brand	Antenna Type	Model	915MHz Gain
TI	Integrated PCB antenna	LP-EM-CC1312PSIP	+2.69dBi
Kaadas	Flexi PCB antenna	K1	-5.82dBi
Leedarson	Integrated PCB antenna	L1	-4.51dBi
Leedarson	Integrated PCB antenna	L2	-1.83dBi
Leedarson	Stanced antenna	L3	-9.48dBi
Leedarson	Stanced antenna	L4	+0.37dBi
Leedarson	Integrated PCB antenna	L5	-1.74dBi
Pulse	External whip antenna	W5017	+0.90dBi
Johanson Technology	Chip antenna	0900AT43A0070	-0.50dBi
Johanson Technology	Chip antenna	0915AT43A0026	+1.0dBi
Pulse	Wire antenna	W3113	+0.80dBi

The certified antennas to Kaadas and Leedarson are unique to these particular designs so for other designs, the list of certified antennas is shown in Table 3-2.

Table 3-2. Antenna Specifications of all Certified Antennas for the Broad Market

Brand	Antenna Type	Model	915MHz Gain
TI	Integrated PCB antenna	LP-EM-CC1312PSIP	+2.69dBi
Pulse	External whip antenna	W5017	+0.90dBi
Johanson Technology	Chip antenna	0900AT43A0070	-0.50dBi
Johanson Technology	Chip antenna	0915AT43A0026	+1.0dBi
Pulse	Wire antenna	W3113	+0.80dBi

The 4-layer design of LP-EM-CC1312PSIP [4.2] has an excellent efficiency and antenna gain. This is the recommended certified antenna for the CC1312PSIP [4.1] when there is space to implement a large PCB antenna design.

The external whip antenna is best for usage with a SMA connector. The chip antennas and wire antenna offer a more compact antenna design with a lower gain due to a smaller physical size. Antenna 0915AT43A0026 is used in the compact 2-layer design shown in Figure 3-5

3.2.2 Cross-Linking Certified Antennas

If the exact antenna specified in Table 2-1 cannot be used, then the existing antenna gains for each antenna type can be crossed linked providing that the maximum antenna gain is not exceeded. Therefore, an antenna gain up to +2.69dBi is allowed for the CC1312PSIP [4.1] without violating the certification.

If the antenna gain of 2.69dBi is exceeded, then the antenna must be re-filed and a class II permissive change (CP2C) is needed. To file an antenna, the following must be provided in the antenna measurements report:

- Test Hardware Setup
- Test Software Setup
- Table of Calibrated Equipment
- Test Site Information
- Completed Test Dates
- Test Personnel
- Test Setup Photos
- Antenna Measurement Data showing how the Antenna Gain is derived

Alternatively, if an established antenna vendor is used, the data sheet must be sufficient to prove the maximum antenna gain but the data sheet must contain or link to the above information.

The end-customer is responsible that radiated emissions (unintentional) is still met at the product level. The certified RF measurement data can be re-used but with other clocks and end equipment the measurement can have other interferences. Thus, when changing to a new antenna, three requirements need to be met:

- must be one of the types listed (PCB antenna, stanced antenna, chip antenna, whip antenna or wire antenna)
- must be lower than the max gain of 2.69dBi
- out of band performance must be similar (thus covered by unintentional radiator at the product level)

3.3 Reusing of FCC ID and IC

Correspondence with the Federal Communications Commission (FCC) is normally through a Telecommunication Certification Body (TCB). Many certified test labs who perform the compliance regulatory testing provide the test results to the TCB.

3.3.1 Documentation Supplied to the TCB

1. Signed Letters
    a. Confidential Request Letters – defines what is publicly available on FCC site
    b. Modular Approval Letters
2. Radio Test Reports (Part 15C) from official lab tests for each PHY
3. RF Exposure Reports from official lab tests for each PHY
4. Installation Manual
    a. Antenna Installation and Certified Antennas
    b. FCC Interference Statement

   c. Industry Canada Statement
   d. Radiation Exposure Statement
   e. End Product Labeling
5. Tune-up Procedure Maximum Rated Output Power (Confidential Document)
6. Operational Description (Confidential Document)
7. Block Diagram (Confidential Document)
8. Schematic (Confidential Document)
9. BOM (Confidential Document)

Upon the approval, all the files are available on the https://fccid.io/ZAT-1312PSIP-3 homepage. Please refer to references 4.7 to 4.23 for the documents listed on the FCC homepage. Documents that are shown above marked as Confidential Document are provided to end-customer via the CC1312PSIP Certification homepage [4.6]: https://www.ti.com/tool/CC1312PSIP-CERTIFICATION

Note

In addition to these requirements the end-customer must also verify that there are no other unintentional emission radiators (FCC Part 15B) on the design.

This guideline recommends the software and hardware parameters required to re-use the FCC ID on the end-user product. If these guidelines are not followed, the risk of emissions increases and these are discovered when performing the unintentional radiator measurement tests at the test house. Refer to 4.3 for the official and complete CC1312PSIP Manual Information for the End User and OEM Installation Guide.

The CC1312PSIP has a full FCC grant which implies that the certification can be re-used. Then the FCC test reports from the CC1312PSIP can be provided to the FCC test lab. Besides the host labeling and updating of end-product documents, a change in the FCC ID is needed since the ownership of the end-product cannot be transferred to Texas Instruments Inc. and are maintained by the end-product manufacturer (see also FCC 2.933).

3.3.2 Permissive Change Policy

Copying the modular certified hardware design cannot always be fully possible in an end-user product. Several end products have various different hardware designs or even software changes. In this case when deviating from the original hardware or software testing or ownership of responsibility (change in ID filing), then FCC regulations (2.1043) denote the rules for changes to original certification.

- PCB / Hardware Alterations
- Antenna Alterations
- Software Alterations
- RF Exposure Alterations
- Other Alterations

If there are large changes in the end-user product then a new certification is required. This is determined by the test house when submitting all documentation to the TCB. However, permissive changes do not require a new certification.

For the hardware alterations, the frequency of operation must be maintained that was performed in the original tests. Changing the operating frequency requires a new certification. Modifications on the hardware that does not affect the RF emissions can by implemented by a permissive change.

For the antenna alterations, as previously mentioned, if the antenna gain of 2.69dBi is exceeded, then the antenna must be re-filed and a class II permissive change (CP2C) is needed.

For the software alterations, changes are allowed just as long as the emissions are not increased and still operating within the original frequency band of certification. If the software change does permit a greater output power or emission, then a new certification is required.

3.3.2.1 Class 1 Permissive Change (C1PC)

These include modifications that do not corrupt the RF performance compared to the original listing when the certification was granted. *This does not require any submission of data to the FCC. However, if the FCC requests this data then this must be presented.*

3.3.2.2 Class 2 Permissive Change (C2PC)

These include modifications that degrade the RF performance compared to the original listing when the certification was granted. A degraded RF performance must still meet the regulatory rules. When a CP2C is made, all information must be provided and the new test results that have been affected by this change.

3.3.2.3 Class 3 Permissive Change (C3PC)

These include modifications include a new frequency range, modulation type, increased conducted or radiated output power compared to the original listing when the certification was granted. When a CP3C is made, all information must be provided and the new test results that have been affected by this change.

Note

All testing that require a permissive change must be performed at an approved test lab by the FCC.

3.3.3 Changes in the FCC ID or IC

When the CC1312PSIP is integrated into an end-product, there are two options for the CC1312PSIP certification. The ownership can be transferred to Texas Instruments Inc. or is transferred to the end-user manufacturer. *Since Texas Instruments cannot have the certification ownership of the end-user product this has to be transferred to the end-user manufacturer* (FCC 2.933).

For an end-user manufacturer to access the certification ownership for the CC1312PSIP, this requires them to obtain a FCC ID for that module which involves the following steps:

- Signed approval letter from Texas Instruments Inc. allowing permission to file the ID change. This is achieved by applying for a signed permission letter via the CC1312PSIP Certification homepage [4.6]: https://www.ti.com/tool/CC1312PSIP-CERTIFICATION
- End-user manufacturer must submit a change in ID to a TCB with the following info:
  - A statement that there is no change in the design, circuitry, or construction, and that the original test results continue to be representative of and applicable to the end-user product.
  - Original FCC ID used on the product prior to the change in ID
  - Date of the original grant of product authorization
  - The deltas in design between the end-product with the updated ID and original design
  - If the original test results continue to be representative of and applicable to the end- product with the updated ID
  - Updated Documentation:
    - End-user Manual
    - Label
    - Updated Operating Manual
    - Photos

If the end-user manufacturer obtained a FCC ID, the FCC ID can apply to the TCB for permissive changes without asking the module manufacturer for a signed approval letter.

Where both a permissive change and a change in FCC ID are required, the change in ID application must be processed first, followed by the permissive change filing.

3.3.4 Re-use of FCC ID and IC Certifications Step-by-Step

- Change the FCC ID for the module
  - Request for a signed approval letter via https://www.ti.com/tool/CC1312PSIP-CERTIFICATIONthat grants the right to apply to the FCC for a change in FCC ID for the CC1312PSIP.
  - Request a change in FCC ID and IC for the module from the TCB
- Go to an accredited test lab and perform all remain certification testing for unintentional radiators for the end-product with the CC1312PSIP. The accredited test lab uses the certification test reports and finalizes the certification towards the TCB for the end-customer.
- File a C2PC application to authorize the module in specific end-devices.
- Label the end-product correctly with the updated FCC ID

3.4 Recommended Production Testing

When the CC1312PSIP [4.1] is assembled onto a main board, then the following tests are recommended as a minimum:

- Standby Current
- Static Tx Current when sending a constant Tx carrier wave
- 12dBm conducted output power when sending a constant Tx carrier wave
- 20dBm conducted output power when sending a constant Tx carrier wave

In the Software Development Kit (SDK), there is an example how to send an RF carrier wave. Additionally, SmartRF studio can also be used as a test platform. SmartRF studio is frequently used as a test platform when testing at FCC and CE test houses.

Alternatively, if production time permits and a radio link needs to be established in the final testing then the following must be tested:

- Standby Current
- Static Tx Current when sending a constant 20dBm Tx carrier wave
- Conducted output power when sending a constant 20dBm Tx carrier wave
- Sensitivity of Rx/Tx port using the PER test example in the SDK.

Generally, for production testing the Tx is just tested since this has a short test time. If the performance of the Tx is OK, the Rx performance is assumed to be sufficient since the Insertion Loss has been tested on the Tx side.

Crystal frequency offset is not required to test since this is tested in the CC1312PSIP [4.1] production. If this is required to be tested, then the test must be done whilst sending a constant Tx carrier wave.

4 References

- Texas Instruments, *CC1312PSIP Data sheet*
- Texas Instruments, *LP-EM-CC1312PSIP Reference Design*
- SWRA784 - End User Manual and OEM Installation Guide
- SDK
- SmartRF Studio
- CC1312PSIP-CERTIFICATION
- ZAT-1312PSIP-3_cvrltr_FCC POA
- ZAT-1312PSIP-3_cvrltr_FCC Modular Approval Letter
- ZAT-1312PSIP-3_cvrltr_FCC Confidentiality Request
- ZAT-1312PSIP-3_Attestation_Covered List_2.911d5
- ZAT_Attestation_US Agent_2.911d7
- Peder Rand DOA from Marian Kost September 2021_Signed
- Label information
- FR341305-02E_R01_Part15C_Texas Instrument_CC1312PSIP_Phase2c_PowerG
- FR341305-02D_R03_Part15C_Texas Instrument_CC1312PSIP_Phase2c_MIOTY
- FR341305-02C_R02_Part15C_Texas Instrument_CC1312PSIP_Phase2c_Wi-Sun
- FR341305-02B_R03_Part15C_Texas Instrument_CC1312PSIP_Phase2c_TI 15.4
- FR341305-02A_R03_Part15C_Texas Instrument_CC1312PSIP_Phase2c_WB-DSSS
- FA341305-02_R02_RF Exposure_Texas Instrument_CC1312PSIP_Phase2c
- Pulse_Wire Antenna_W3113
- Pulse_External whip antenna_W5017-3071801
- Johanson Technology_Chip Antnenna_0900AT43A0070
- Johanson Technology_Chip antenna_0915AT43A0026
- AUT Certified Antennas for CC1312PSIP_June

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Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265