AN 0968

Package and Assembly Guideline for the UCODE G2XM / G2XL

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Document information

Info	Content
Keywords	UCODE EPC G2, G2XM, G2XL, Assembly
Abstract	This application note outlines the assembly behavior of the NXP UCODE G2XM / G2XL IC. It covers assembly parameter recommendations for aluminum, copper and silver ink based label antennas, including measurement results.

Revision history

Rev	Date	Description
1.0	20071023	First, initial release; Author: BarRib

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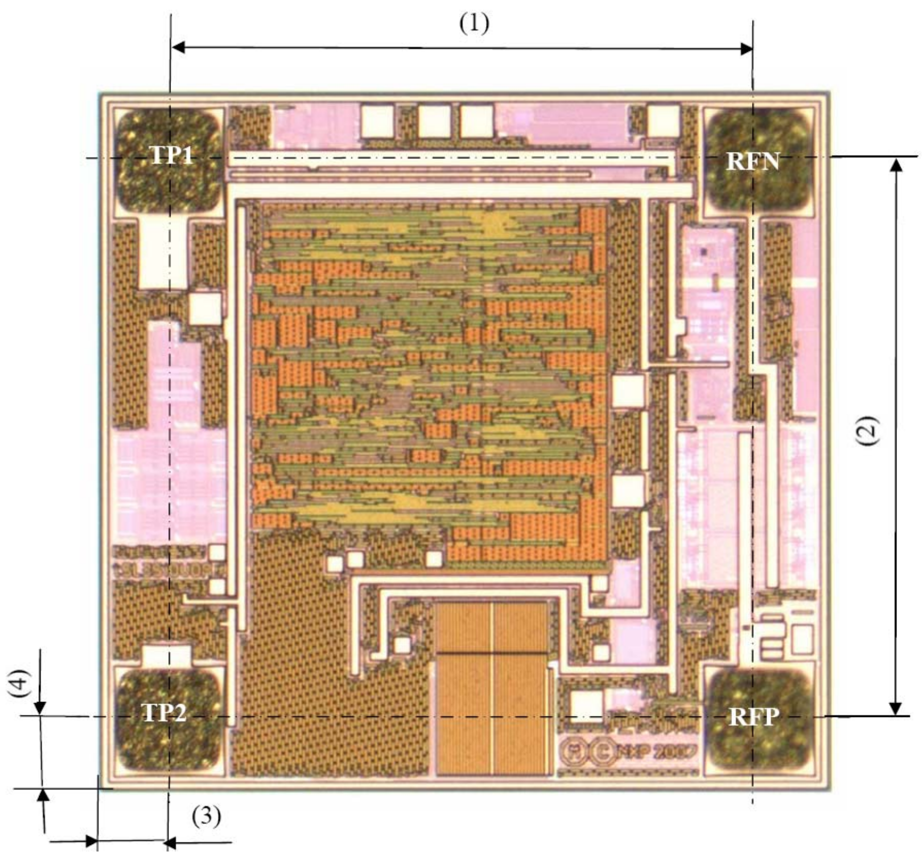
1. Introduction

This application note shows the assembly behavior of NXP's UCODE G2XM and UCODE G2XL IC. Both ICs show the same characteristics.

The UCODE G2XM /G2XL have been assembled with different pressures on aluminum, copper and silver ink antennas. They show consistent performance in spite of different assembly parameter settings, which is proven by test results.

2. Mechanical Data

The following section describes the geometry of the UCODE G2XM /G2XL IC.



(1) bump to bump distance X (TP1 – RFN): 351.0µm
(2) bump to bump distance Y (RFN – RFP): 333.0µm
(3) distance bump to metal seal ring X: 40.3µm
(4) distance bump to metal seal ring Y: 40.3µm

Fig 1. Chip dimensions

2.1 Wafer

Each wafer is scribed with batch number and wafer number and has a diameter of 200 mm (8”) as well as a thickness of 150 µm ± 15 µm. One pad is localized in each corner of the chip. A batch consists of 25 wafers.

2.2 Chip Dimensions

Die size of the IC is 0.470 x 0.488 mm with scribes, corresponding to 0.229 mm^2.

Scribe line width:

-x-dimension: 56.4 µm (scribe line width is measured on top metal layer)

-y-dimension: 56.4 µm (scribe line width is measured on top metal layer)

2.3 Gold Bumps

Parameters of the gold bumps:

- Bump material: > 99.9% pure Au
- Bump hardness: 35 – 80 HV 0.005
- Bump shear strength: > 70 MPa
- Bump height: 18 µm
- Bump height uniformity:
  within a die: ± 2 µm
  within a wafer: ± 3 µm
  wafer to wafer: ± 4 µm
- Bump flatness: ± 1.5 µm
- Bump size: 60 x 60 µm
- Bump size variation: ± 5 µm
- Under bump metallization: sputtered TiW

3. Assembly

The assembly process is split into two phases:

- Placement of the die with an Fineplacer
- Bonding of the die with a Thermode Test Station

In order to evaluate the influence of assembly process parameters like pressure, placement and temperature, the IC was mounted onto copper, aluminium and silver ink antennas.

3.1 Procedure

A Fineplacer Pico (Fig 2) from Finetech was used for die placement on the antennas.

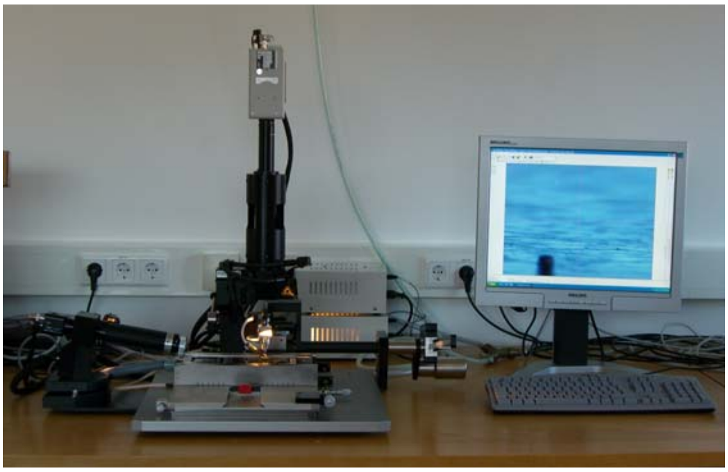
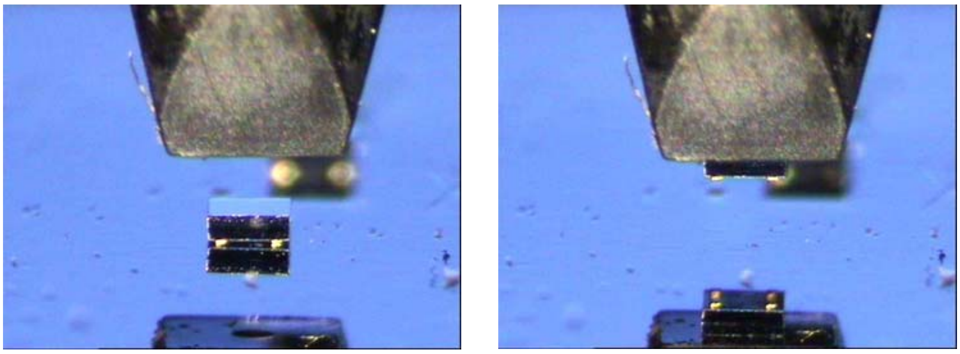


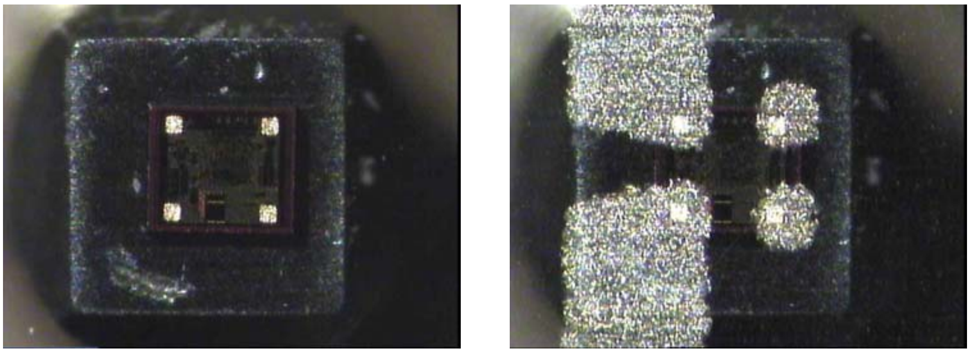
Fig 2. Fineplacer Pico from Finetech

3.2 Placement

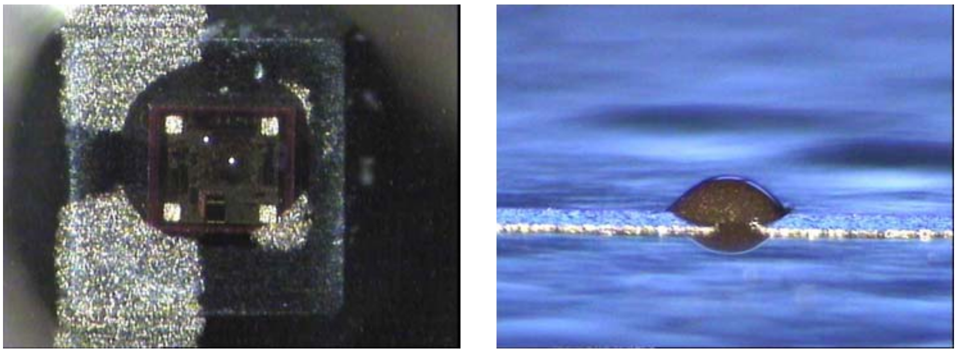
a) Pickup of the die from a gel pack



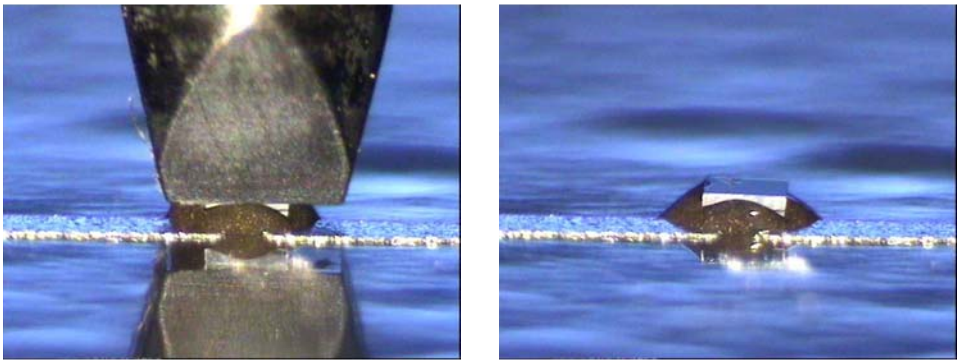
b) Alignment of the die with the antenna



c) Applying of the glue



d) Placement of the die



3.3 Bonding

For the bonding process a Thermode Test Station TTS 300 (Fig. 3) from Mühlbauer is used. The temperature of the upper and the lower thermode can be regulated independently. Also the bonding time is adjustable. For a precise control of the bonding force a low force thermode (Fig. 4) is used. The bonding force is measured with a force indicator.

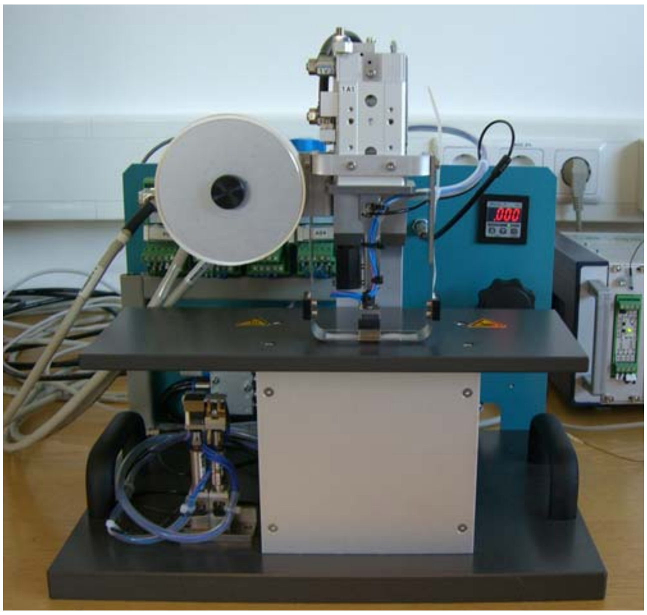


Fig 3. Thermode Test Station TTS 300

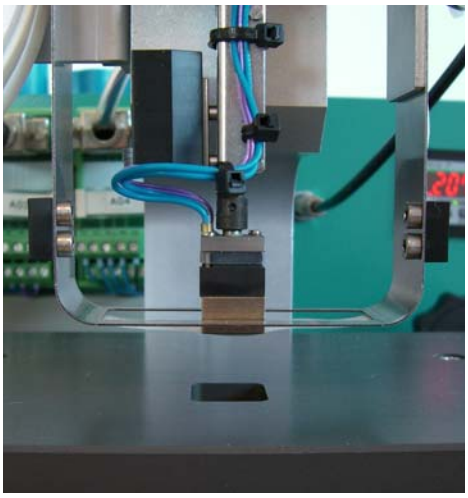


Fig 4. Low force thermode

3.4 Bonding Parameters

The temperature profile (Fig. 5) is measured between the two thermodes with a thermocouple. The bonding time amounts to 2 seconds heat-up time for reaching the recommended 185 °C bonding temperature (Fig 5), plus the recommended curing time of the glue (specified in the datasheet of the glue), and additionally 2 seconds to assure that the glue is fully cured.

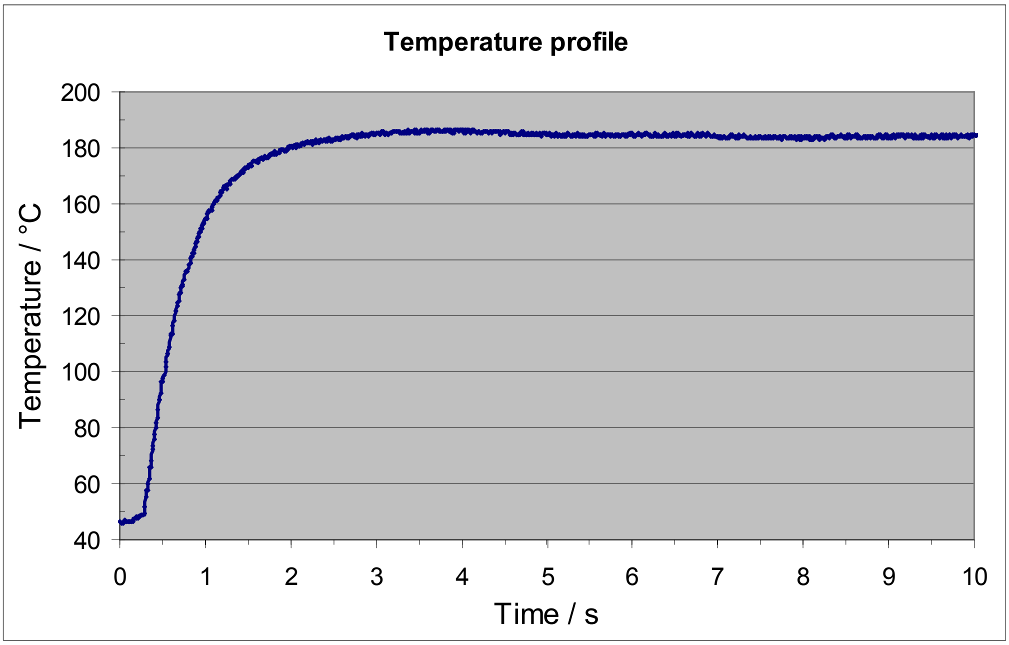


Fig 5. Temperature profile

3.5 Parameter Recommendations

3.5.1 Copper antenna

- Antenna: 12 µm etched copper (Toyo Aluminum KK)
- Substrate: 50 µm PET
- Glue: Kyocera TAP0604F
- Temperature
  - Upper thermode: 185 °C
  - Lower thermode: 180 °C
- Bonding time: 10 s
- Bonding pressure: 1,9 N

3.5.2 Aluminum antenna

- Antenna: 20 µm etched aluminum (Toyo Aluminum KK)
- Substrate: 50 µm PET
- Glue: Kyocera TAP0604F
- Temperature
  - Upper thermode: 185 °C
  - Lower thermode: 180 °C
- Bonding time: 10 s
- Bonding pressure: 1,9 N

3.5.3 Silver ink antenna

- Antenna: 5 µm silver ink (Parelec)
- Substrate: 74 µm PET
- Glue: Delo MK055
- Temperature
  - Upper thermode: 170 °C
  - Lower thermode: 150 °C
- Bonding time: 20 s
- Bonding pressure: 1,2 N

4. Tests and Measurements

4.1 Assembled Antennas

Variants of the far field reference design were used for the characterizations.

4.1.1 Impedance measurements

To measure the capacitance, straps are cut out of the antennas to avoid shorts caused by the loop - structure of the antenna. The capacitance was measured with a differential measurement setup. The total capacity consists of the IC capacitance and the parasitic assembly capacitance.

		Measured at -6 dBm		
	Pressure [N]	Real-Part [Ω]	Imaginary-Part [Ω]	Capacitance [pF]
Copper	1.9	22	-132	1.31
Aluminum	1.9	16	-119	1.46
Silver Ink	1.2	20	-126	1.40

4.1.2 P_{min} Measurement

4.1.2.1 Test Setup

The information gained from this measurement method is the minimal power level the label needs in order to send a backscatter signal. During this far field measurement the minimum power of a reader signal powering the IC of the label is recorded. This minimal power (P_{min}) is measured for a defined frequency range from 840 to 990 MHz.

Fig 6. Measurement setup for UHF labels

4.1.3 Reliability tests

4.1.3.1 Test Setup

To evaluate reliability of the assembled antennas, four of them are put in a Vötsch VC 7034 climate chamber (Fig 7) for 168 hours at 85 °C and 85 % relative humidity, after a P_{min} measurement has been conducted.

Fig 7. Vötsch VC 7034 climate chamber

After 168 hours the samples are taken out of the climate chamber and P_{min} is measured again.

4.1.4 Results - Copper

4.1.4.1 P_{min} at 0 h

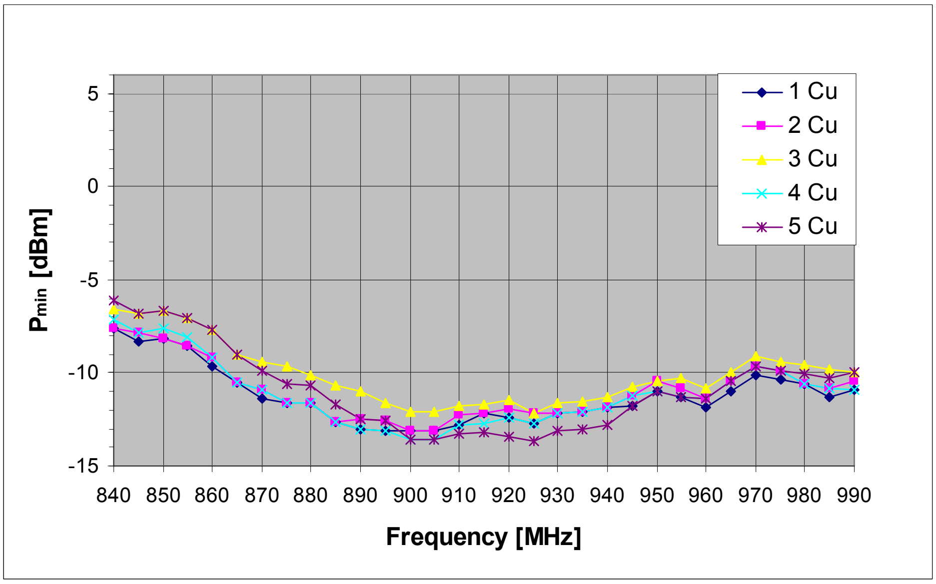


Fig 8. : P_{min} of copper antennas at 0 hour (before the climate chamber)

4.1.4.2 P_{min} after 168 h in the Climate Chamber

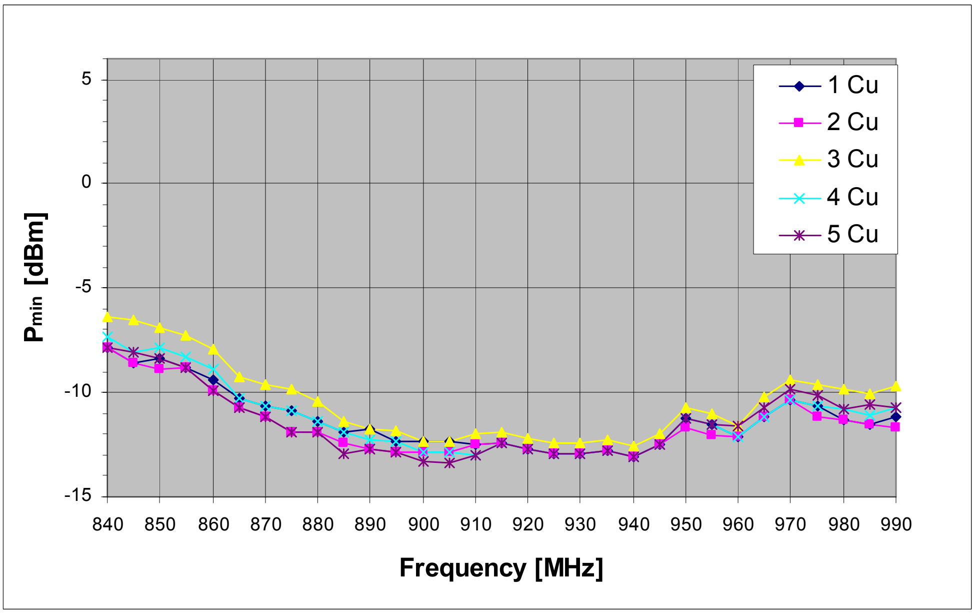


Fig 9. : P_{min} of copper antennas after 168 hours in the climate chamber

4.1.5 Results – Aluminum

4.1.5.1 P_{min} at 0 h

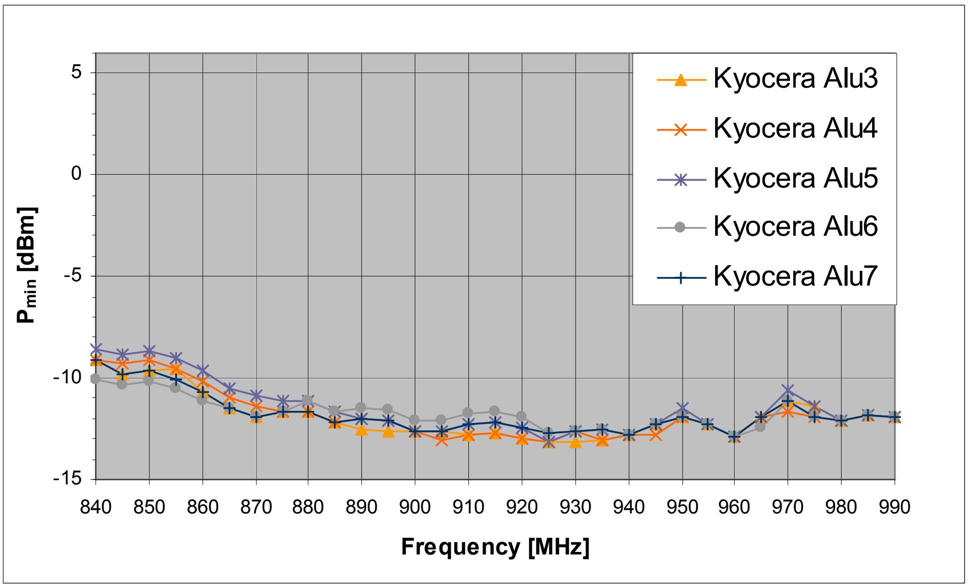


Fig 10. : P_{min} of aluminum antennas at 0 hour (before the climate chamber)

4.1.5.2 P_{min} after 168 h in the Climate Chamber

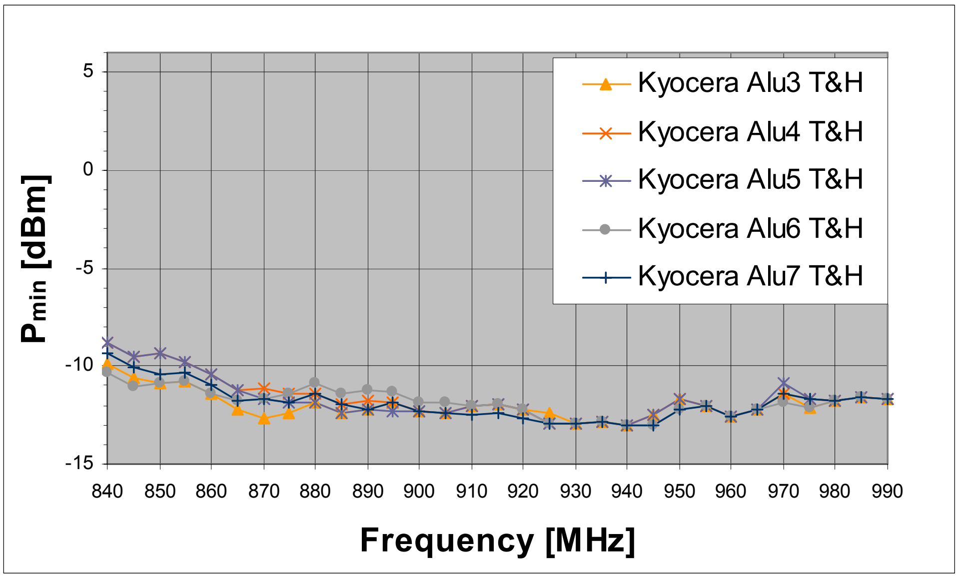


Fig 11. : P_{min} of aluminum antennas after 168 hours in the climate chamber

4.1.6 Results – Silver Ink

4.1.6.1 P_{min} after 0 h in the Climate Chamber

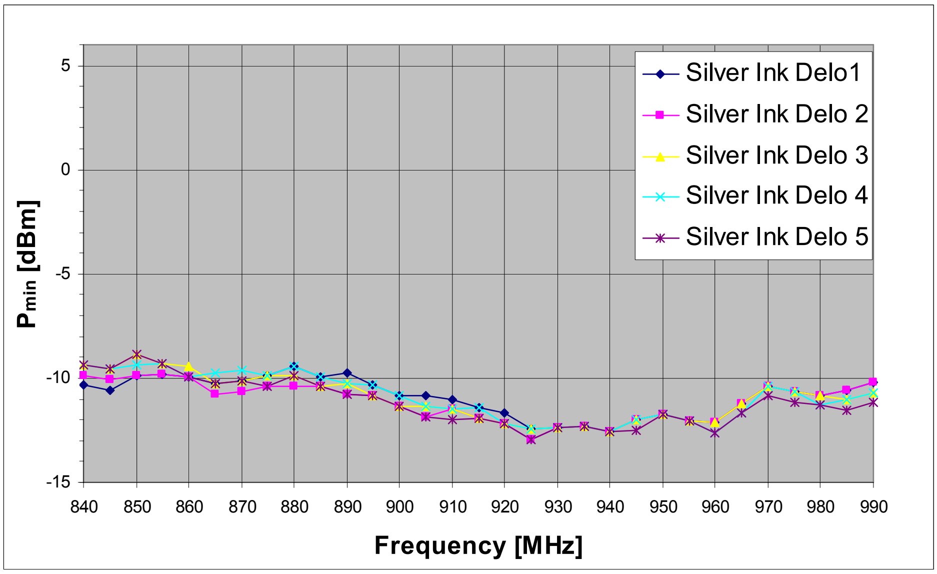


Fig 12. : P_{min} of silver ink antennas at 0 hours (before the climate chamber)

4.1.6.2 P_{min} after 168 h in the Climate Chamber

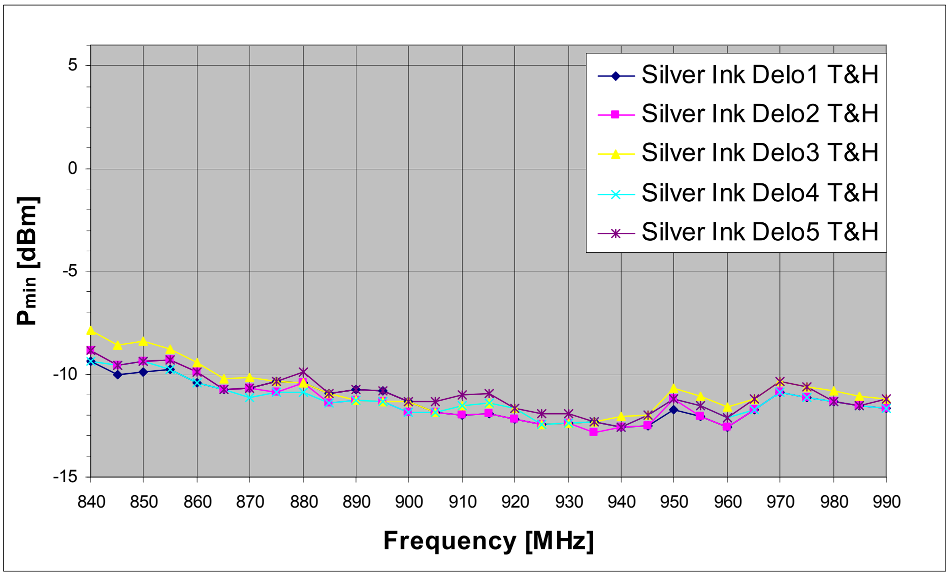


Fig 13. : P_{min} of silver ink antennas after 168 hours in the climate chamber

5. Conclusions

The UCODE NXP G2XM IC was assembled with three different antenna conductor materials with appropriate assembly parameter settings. For each of the three cases, the stability of the bonding connections (IC bumps – antenna) was proven. The minimum power values showed stable results on all substrate materials after THNB tests in the climate chamber.

The performance of the IC with respect to different label technologies could be proven. Depending on the used label antenna material, the optimum parameters were recommended. If different materials are used, the optimum parameters have to be adapted.

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7. Contents

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