

## Test plan (Cubeworks)

- **Introduction:**

We hereby request approval for the following C2PC equipment application (limited modular), which has been already submitted:

FCC ID: 2ASD7-S76S

Configuration number (DSS): TC556864

Configuration number (DTS): TC989713

According to the KDB 388624, we summarize the following information for PAG MODLIM:

Approval for the 2ASD7-S76S module has been granted as “Limited Modular” associated with a specific host in order to include the new antenna integrated in the host which is the reason it could not be tested in stand-alone mode. To leverage the FCC grant for a host device, additional testing is required to ensure the host device follows FCC Part 15, Articles 15.247.

The equipment is a Nanotag which uses LoRA (DSS and DTS) and frequency range from 902.3 MHz to 914.9 MHz.

- **Justification:**

The module, by itself, has full functionality. However, with the new antenna it cannot be tested in Standalone mode because the antenna is a PCB print antenna, so the module is tested with the host.

The reason it requires the host is precisely to make use of the antenna and to have a power supply via the included battery.

The requirement can be found in KDB 996369-D01 v04r02 Appendix D, PAG Requirements for LMA.

- **Illustrations:**

On the following photos it is referenced the location of the antenna and the way it is integrated in the host:

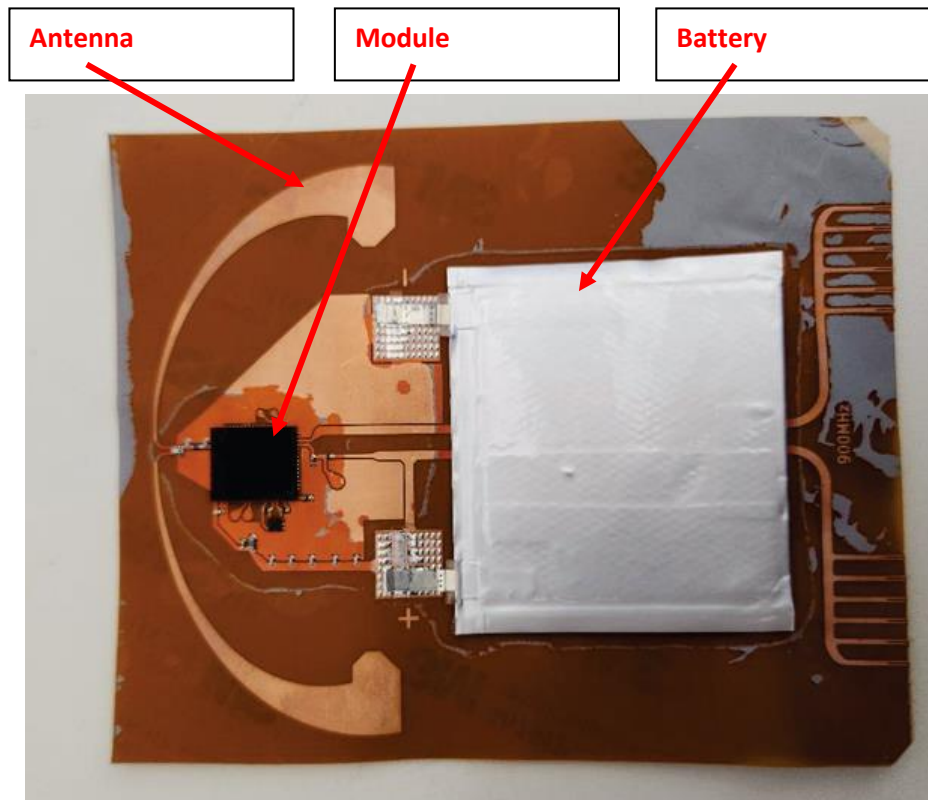


Figure 1: Front side



Figure 2: Back side

- **Test Plan:**

A partial test report has been performed, following the rule **FCC Part 15.247**, including Radiated emissions, as common test case for **DSS and DTS**, in order to guarantee the compliance with the new antenna. The rest of the test cases are re-used from the previous certification of the module.

| Test case                   | Original full modular approval                               | Limited modular approval                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|-----------------------------|--------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Bandwidth                   | Done. Report No.<br>FR730201-4<br><br>Grant date: 12-15-2017 | Leveraged from original modular approval.<br><br>The module remains unchanged except the new antenna which is integrated in the host. There are no modifications in module parameters, modulators, demodulators, amplifiers, signal paths or filters, so the testing performed in the original full modular certification is deemed to remain applicable and representative to this new application.                                                                                                                                       |
| Output power                | Done. Report No.<br>FR730201-4<br><br>Grant date: 12-15-2017 | Leveraged from original modular approval.<br><br>The module remains unchanged except the new antenna which is integrated in the host. There are no modifications in module parameters, modulators, demodulators, amplifiers, signal paths or filters, so the testing performed in the original full modular certification is deemed to remain applicable and representative to this new application. Leveraged from original modular approval.<br><br>The module remains unchanged except the new antenna which is integrated in the host. |
| Radiated spurious emissions | Done. Report No.<br>4733ERM.002A1                            | Performed again. The new antenna may influence on the radiated emissions.<br><br>Testing has been performed while the module is integrated in the host device, so that this testing is only valid and representative to this integration and cannot be extended to another host using the same antenna design. For that reason, this application is for a Limited Modular approval.                                                                                                                                                        |

|                             |                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                             |
|-----------------------------|------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Number of Hopping frequency | <p>Done. Report No. FR730201-4</p> <p>Grant date: 12-15-2017</p> | <p>Leveraged from original modular approval.</p> <p>The module remains unchanged except the new antenna which is integrated in the host. There are no modifications in module parameters, modulators, demodulators, amplifiers, signal paths or filters, so the testing performed in the original full modular certification is deemed to remain applicable and representative to this new application.</p> |
| Channel Separation          | <p>Done. Report No. FR730201-4</p> <p>Grant date: 12-15-2017</p> | <p>The module remains unchanged except the new antenna which is integrated in the host. There are no modifications in module parameters, modulators, demodulators, amplifiers, signal paths or filters, so the testing performed in the original full modular certification is deemed to remain applicable and representative to this new application.</p>                                                  |

The figure 3 shows the tests conditions:

## TEST CONDITIONS

(\*): Data provided by the client.

| TEST CONDITIONS | DESCRIPTION                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| TC#01           | <p><u>Power supply (V):</u><br/>Battery Operated : 3V</p> <p><u>Type of power supply:</u><br/>DC voltage from internal non-rechargeable battery.</p> <p><u>Temperature (°C):</u><br/> <math>T_{nom} = +15</math> to <math>+35</math><br/> <math>T_{min} = N/A</math><br/> <math>T_{max} = N/A</math> </p> <p>The subscript nom indicates normal test conditions.<br/> The subscripts min and max indicate extreme test conditions (minimum and maximum respectively).<br/> N/A: Not Applicable.<br/> (*)Declared by applicant.</p> <p><u>Test Frequencies for Radiated tests:</u><br/> Lowest channel: 902.3 MHz<br/> Middle channel: 908.5 MHz<br/> Highest channel: 914.9 MHz </p> |

Figure 3: Test conditions

The following tables show the results for the worst case:

| Frequency (MHz) | MaxPeak (dBμV/m) | QuasiPeak (dBμV/m) | Pol | Margin - QPK (dB) | Limit - QPK (dBμV/m) | Comment     |
|-----------------|------------------|--------------------|-----|-------------------|----------------------|-------------|
| 37.517500       | 27.4             | 16.6               | H   | 23.4              | 40.0                 |             |
| 111.431500      | 23.3             | 10.8               | H   | 32.8              | 43.5                 |             |
| 408.833500      | 35.1             | 20.5               | V   | 25.5              | 46.0                 |             |
| 610.108500      | 39.1             | 25.5               | V   | 20.5              | 46.0                 |             |
| 902.321000      | 118.3            | 118.2              | H   | ---               | ---                  | Fundamental |
| 962.218500      | 42.8             | 29.2               | V   | 24.9              | 54.0                 |             |

Figure 4: Frequency MHz = 902.30000, Equipment Type = LORA 900 MHz, Frequency Range GHz = [0.03, 1]

| Frequency (MHz) | MaxPeak (dBμV/m) | QuasiPeak (dBμV/m) | Pol | Margin - QPK (dB) | Limit - QPK (dBμV/m) | Comment     |
|-----------------|------------------|--------------------|-----|-------------------|----------------------|-------------|
| 38.051000       | 27.3             | 16.2               | V   | 23.8              | 40.0                 |             |
| 170.892500      | 25.8             | 13.0               | H   | 30.5              | 43.5                 |             |
| 401.510000      | 34.2             | 20.1               | V   | 26.0              | 46.0                 |             |
| 611.951500      | 39.6             | 25.5               | V   | 20.5              | 46.0                 |             |
| 908.432000      | 116.3            | 116.2              | H   | ---               | ---                  | Fundamental |
| 967.359500      | 42.8             | 29.3               | H   | 24.7              | 54.0                 |             |

Figure 5: Frequency MHz = 908.50000, Equipment Type = LORA 900 MHz, Frequency Range GHz = [0.03, 1]

| Frequency (MHz) | MaxPeak (dBμV/m) | QuasiPeak (dBμV/m) | Pol | Margin - QPK (dB) | Limit - QPK (dBμV/m) | Comment     |
|-----------------|------------------|--------------------|-----|-------------------|----------------------|-------------|
| 37.808500       | 27.0             | 16.3               | H   | 23.7              | 40.0                 |             |
| 73.116500       | 21.5             | 9.0                | H   | 31.0              | 40.0                 |             |
| 110.655500      | 22.7             | 10.9               | H   | 32.7              | 43.5                 |             |
| 162.453500      | 25.4             | 13.0               | H   | 30.5              | 43.5                 |             |
| 611.515000      | 39.2             | 25.4               | V   | 20.6              | 46.0                 |             |
| 914.882500      | 116.4            | 116.3              | H   | ---               | ---                  | Fundamental |
| 964.110000      | 42.4             | 29.1               | H   | 24.9              | 54.0                 |             |

Figure 6: Frequency MHz = 914.90000, Equipment Type = LORA 900 MHz, Frequency Range GHz = [0.03, 1]

| Frequency (MHz) | PK+_MAXH (dBμV/m) | AVG_MAXH (dBμV/m) | Pol | Margin - AVG (dB) | Limit - AVG (dBμV/m) |
|-----------------|-------------------|-------------------|-----|-------------------|----------------------|
| 2881.000000     | 49.9              | 41.5              | V   | 12.5              | 54.0                 |
| 15997.00000     | 53.0              | 49.2              | V   | 4.8               | 54.0                 |
| 17856.00000     | 54.5              | 51.4              | H   | 2.6               | 54.0                 |

Figure 7: Frequency MHz = 902.30000, Equipment Type = LORA 900 MHz, Frequency Range GHz = [1, 18]

| Frequency (MHz) | PK+_MAXH (dBμV/m) | AVG_MAXH (dBμV/m) | Pol | Margin - AVG (dB) | Limit - AVG (dBμV/m) |
|-----------------|-------------------|-------------------|-----|-------------------|----------------------|
| 2857.50000      | 50.7              | 41.5              | H   | 12.5              | 54.0                 |
| 16011.0000      | 52.0              | 48.6              | V   | 5.4               | 54.0                 |
| 17785.0000      | 53.0              | 49.3              | H   | 4.7               | 54.0                 |

Figure 8: Frequency MHz = 908.50000, Equipment Type = LORA 900 MHz, Frequency Range GHz = [1, 18]

| Frequency (MHz) | PK+_MAXH (dBμV/m) | AVG_MAXH (dBμV/m) | Pol | Margin - AVG (dB) | Limit - AVG (dBμV/m) | Comment      |
|-----------------|-------------------|-------------------|-----|-------------------|----------------------|--------------|
| 1830.000000     | 48.4              | 43.3              | H   | ---               | ---                  | 2nd Harmonic |
| 2745.000000     | 53.3              | 47.8              | H   | 6.2               | 54.0                 | 3rd Harmonic |
| 16022.000000    | 52.5              | 48.9              | H   | 5.1               | 54.0                 |              |
| 17788.000000    | 54.9              | 50.5              | H   | 3.5               | 54.0                 |              |

Figure 9: Frequency MHz = 914.90000, Equipment Type = LORA 900 MHz, Frequency Range GHz = [1, 18]

A RF exposure report has been included according to FCC 47 CFR Part 2.1091; FCC 47 CFR Part 1.1307 FCC 47 CFR Part 1.1310.

It shows during its normal use, the separation distance between the radiating structures of the device and nearby users will be greater than 20 cm. In order to perform the assessment a conservative evaluation distance of 20 cm has been used.

The following tables show the equipment specifications and the exemption evaluation.

The computed value(s) are below the exemption limit(s), so these modes meet the requirements stated in FCC 47 CFR Part 1.1307.

| Technology / Mode | Operating Band | Frequency under evaluation (MHz) | Maximum Conducted Output Power (dBm) | Antenna peak gain (dBi) | Maximum E.R.P. (dBm) | Maximum E.R.P. (mW) | Maximum E.I.R.P. (dBm) | Maximum E.I.R.P. (mW) |
|-------------------|----------------|----------------------------------|--------------------------------------|-------------------------|----------------------|---------------------|------------------------|-----------------------|
| LoRa              | ISM (USA)      | 902 - 928                        | 17.22                                | -2.82                   | 12.25                | 16.79               | 14.40                  | 27.54                 |

Figure 10: Equipment specifications

| Technology / Mode | Operating Band | Frequency under evaluation (MHz) | Distance (cm) | Maximum E.R.P. (mW) | §1.1307(b)(3).i.(C) Exposure Limit (mW) | Verdict for exemption § 1.1307(b)(3).i |
|-------------------|----------------|----------------------------------|---------------|---------------------|-----------------------------------------|----------------------------------------|
| LoRa              | ISM (USA)      | 902 - 928                        | 20.00         | 16.79               | 461.82                                  | Pass                                   |

Figure 11: FCC Exemption Evaluation Results