13.56MHz RFID
Japan radio regulations and testing methods

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(Unofficial translation and interpretation: In case of inconsistency, the original text in Japanese shall prevail)
13.56MHz RFID in Japan Radio Regulations

• 13.56MHz RFID is categorized as an inductive reading and writing radio communication equipment in Article 44 of the Enforcement Regulations.

• License is exempted for inductive reading and writing radio communication equipments 1) whose electric field strength is less than 500uV/m at 3m 2) with type certificate defined in the Enforcement regulation Article 46 clause 2.

• Inductive reading and writing radio communication equipment is a sub-category of high frequency based equipments defined in the Radio Law Article 100
### 13.56MHz RFID Type certificate requirements in regulations

<table>
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<th>Requirement Details</th>
<th>Description</th>
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<td>13.56MHz RFID Type certificate</td>
<td>Requires compliance</td>
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<tr>
<td>Enforcement Law Article 44 clause 2</td>
<td>Equivalent to Ordinance for Regulating Radio Equipment, Article 61</td>
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Industrial standard


- Relevant standards
  - STD-T82: Inductive reading and writing communication equipment (13.56MHz RFID)
  - STD-T89: 950MHz Premise radio station (UHF 4W EIRP RFID)
  - STD-T90: Specified radio station (UHF 20mW EIRP RFID)

http://www.arib.or.jp/english/index.html
Section 3 Technical requirement = Same to radio regulation
Section 4 Communication control = No special requirement
Section 5 Measurement method = TELEC “Measurement method for inductive reading and writing radio communication equipment” applies
Section 6 Nomenclature
TELEC does the test and type certificate the equipment.
http://www.telec.or.jp/eng/Index_e.htm

Measurement conditions (excerpt)
1. Measurement site: Flat open site which can secure at least 20m x 17.3m elliptic area within which there is no metallic object. A 10m measurement anechoic chamber can be used.
2. Device under test (DUT): DUT shall be capable to transmit a standard encoded test signal (ITU-T O.150 9th PN or 15th PN).

If measurement at 10m distance is difficult, a longer distance measurement is valid. Calibrate the measured value with the following.

$$E_1 = \left( \frac{D}{10} \right) \times E_2$$

Calibrated field strength (uV/m) | Distance(m) | Measured field strength (uV/m)
Outband emission measurement
1) electric field strength is less than 500uV/m at 3m

Testing condition
1. DUT shall modulate with standard encoded test signal and transmit continuously.

Testing procedure
1. Set DUT vertically on the pedestal
2. Measure the field power
3. Rotate the rotary table and record the maximum value
4. If possible, change the orientation of DUT to Y or Z direction, repeat (2) and (3)
5. Choose the maximum level through 1 – 4 and record

Remarks
1. If the RBW of the measurement receiver is 9kHz, the receiver can be used but record the fact as a measurement condition.
Outband emission measurement

2) type certificate defined in the Enforcement regulation Article 46 clause 2.
Outband emission measurement
2) type certificate defined in the Enforcement regulation Article 46 clause 2. (continued)

Testing condition
1. DUT shall modulate with standard encoded test signal and transmit continuously.

Testing procedure
1. Set DUT vertically on the pedestal
2. Set the loop antenna plane facing to DUT
3. Set spectrum analyzer
   1. Carrier frequency 13.56MHz
   2. RBW 10kHz, Sweep 1MHz
4. Rotate the rotary table and record the maximum value and the angle
5. Set the loop antenna horizontally
6. Rotate the rotary table and record the maximum value and the angle
7. Set DUT horizontally on the pedestal and repeat (2) – (6)
8. Choose the configuration at which the maximum level is achieved through (2)-(6)
9. Switch from spectrum analyzer to the measurement receiver. Search the maximum value in the defined band by quasi-peak detection. The defined band and the maximum allowed values are followings (same to page3).
   (1) 13.553-13.567MHz 47.544mV/m
   (2) 13.41-13.553MHz, 13.567-13.71MHz 1.061mV/m
   (3) 13.11-13.41MHz, 13.71-14.01MHz 316uV/m
10. For the defined band (2) and (3), the center frequency of the measurement receiver shall be set to the following range to avoid the inclusion of carrier component
    1. 13.56MHz ± 12kHz in (2), ± 145kHz in (3)
    2. 13.56MHz ± 155kHz in (3)
    3. 13.56MHz ± 455kHz above and below 13.56MHz ± 450kHz
11. For the outband emission measurement outside 13.56MHz ± 450kHz, evaluate the level within ± 2MHz with spectrum analyzer. Switch to the measurement receiver if necessary.
Outband emission measurement
2) type certificate defined in the Enforcement regulation
Article 46 clause 2.

- Remarks
  - If the RBW of the measurement receiver is 9kHz, the receiver can be used but record the fact as a measurement condition.
  - If the measurement result at 13.56MHz ± 12kHz does not conform the technical requirement because of the carrier leakage, a spectrum analyzer measurement with RBW 1kHz and MAXHOLD can be used. For the calibration from 1kHz to 10kHz, add 20dB to the measurement result. If the sideband of the carrier is believed to be a random noise, the calibration (addition) could be 10dB.

Annotation by Auto-ID Lab
If the noise is wide band (AWGN), the correction from 1kHz RBW to 10kHz entails 10dB correction. This totally makes sense.

When we fail to pass the outband emission mask with 10kHz RBW because of a pulse (peaky) noise, we can use 1kHz RBW. In the case of 1kHz RBW measurement, we can avoid the frequency, at which the peak noise is observed. Otherwise we still observe the same peak value with 10kHz RBW. By eschewing the frequency, our measured outband emission will be significantly smaller than the previous peak value. That is why we add 20dB correction, which is the correction value for coherent combination.
Carrier frequency measurement

Setup

- **Testing condition**
  - Frequency counter or spectrum analyzer shall be used as the measurement equipment. The frequency accuracy shall be better than 5ppm.
  - Matching circuit can be used between DUT and the attenuator if needed.
  - Attenuator shall protect excessive input to the measurement equipment.
  - If DUT only has embedded antenna, an measurement antenna, probe or loop antenna for example, which is placed against the embedded antenna shall be connected to the measurement equipment.
  - If there is momentary cessation of the transmissions, a spectrum analyzer shall be used.

- **DUT condition**
  - Continuous transmission of CW shall be used. If DUT cannot transmit CW, a continuous standard encoded test signal shall be used.

- **Measurement**
  - In case of a frequency counter, read the measurement
  - In case of a spectrum analyzer, set the maker to the carrier frequency and read the frequency.

- **Report**
  - Measurement result shall be described in MHz. The difference from 13.56MHz shall be indicated in terms of plus or minus ppm.
Harmonics measurement (cable connection is available)

Setup

- Testing condition
  - Matching circuit can be used between DUT and the attenuator if needed.
  - Attenuator shall protect excessive input to the measurement equipment
- DUT condition
  - Continuous transmission of CW shall be used. If DUT cannot transmit CW, a continuous standard encoded test signal shall be used.

- Measurement
  - Spectrum analyzer shall be set up to measure up to at least 3rd harmonics. RBW shall be 10kHz. Detection mode shall be positive peak. MAXHOLD can be used to search for the spectrum.
  - If the maximum value of harmonics complies the requirement, the level and the frequency shall be used as the measured data.
  - If the maximum value of the harmonics exceeds the requirement, the average level, obtained by zero span and sample detection, shall be used as the measured data.

- Report
  - The measured harmonics and the corresponding frequency shall be recorded in uW and MHz, respectively.
Harmonics measurement (in case DUT only has embedded antenna)

- Setup

- Testing condition
  - Measurement antenna shall have frequency bandwidth incorporating harmonics. The frequency characteristics of the measurement antenna shall have been measured before the test.
  - When the carrier power is measured, the antenna factor of measurement antenna shall have been measured at 13.56MHz before the test.

- DUT condition
  - The absolute gain of DUT antenna at 13.56MHz shall have been declared by the applicant.
  - Continuous transmission of CW shall be used. If DUT cannot transmit CW, a continuous standard encoded test signal shall be used.

- Measurement
  1. Measurement antenna shall be placed in front of the DUT antenna at 0.4m distance. Adjust the orientation of DUT and measurement antenna such that the measured data is maximized at 13.56MHz
  2. Calibrate the measured power level E(dBm) to magnetic field strength H (dBuA/m) according to the following equation.

\[
H = E + 107 + A_f - 51.5
\]

where \(A_f\) represents the antenna factor of the measurement antenna. The carrier power \(P\) (dBm) shall be computed from \(H\) (dBuA/m) such that

\[
P = H - A_i + 40 \log f + 60 \log r - 126.35
\]

where \(A_i\) is the gain of DUT antenna, \(f = 13.56\) (MHz), \(r\) represents the distance (m) between DUT and measurement antenna.

3. Change the distance from DUT antenna and measurement antenna from 0.3m to 1m with 0.1m resolution. Identify the range of position where the computed carrier power \(P\) (dBm) is constant. Choose an appropriate measured data within the range.
(4) Spectrum analyzer shall be set up to measure up to at least 3rd harmonics. RBW shall be 10kHz.

(5) Place the measurement antenna in an appropriate position in the vicinity of DUT. Adjust the spectrum analyzer to display the carrier and either lower or higher harmonics. Avoid excessive input, which causes distortion, to the spectrum analyzer. MAXHOLD can be used if necessary.

(6) Record the relative power between the maximum harmonics and the carrier. Record also the frequency of the maximum harmonics. Calibrate the relative power with the frequency characteristics of the measurement antenna.

(7) Translate the relative power obtained in (6) to the absolute power using the absolute power of the carrier. Record the data as the measured data.

(8) If the measured data complies the requirement, the level and the frequency shall be used as the measured data.

(9) If the measured data exceeds the requirement, the average level, obtained by zero span and sample detection, shall be used as the measured data.

Report

- The measured harmonics and the corresponding frequency shall be recorded in uW and MHz, respectively.