ERM Test Report: ETSI EN 300 220-2 V3.1.1

Short Range Device (SRD) operating in the frequency range 25 MHz to 1 000 MHz;
Part 2: Harmonised Standard covering the essential requirements of article 3.2 of the Directive 2014/53/EU for non specific radio equipment

Devices tested:
Irwccx-mpcie-868

Customer: n-fuse GmbH
Test Report No.: n-fuse/220/2018/185

IMST GmbH
Frank Tofahrm
Jens Lerner

July 30th, 2018
Administrative Summary

IMST GmbH
Dept. Test Center
Carl-Friedrich-Gauss-Strasse 2-4
D-47475 Kamp-Lintfort
Germany
Tel. +49 2842 981-0

Subject: ETSI EN 300 220-2 V3.1.1
Device: Irwcxx-mpcie-868

Customer: n-fuse GmbH
Ossietzkystrasse 4
70174 Stuttgart, Germany

The devices have PASSED the tests hereunder with limitations.

Test Engineer: Frank Tofahrn, ERM Test Lab
Date: July 30th, 2018

Originator: Frank Tofahrn
Approved: Jens Lerner
Test Engineer
Quality Assurance

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Content
1 Introduction .................................................................................................................. 4
2 General .......................................................................................................................... 4
3 Description of the Device under Test (DUT) ................................................................ 5
   3.1 General ...................................................................................................................... 5
3.2 DUT-Modes of Operation .......................................................................................... 6
   3.2.1 DUT Setup ............................................................................................................ 6
   3.2.2 DUT Peripherals .................................................................................................. 6
   3.2.3 DUT Modifications ............................................................................................... 6
   3.2.4 Supporting Equipment ......................................................................................... 6
   3.2.5 Firmware on the module ..................................................................................... 6
   3.2.6 External software used for the test ...................................................................... 6
4 Overview: Conformance Requirements and Tests Applied ........................................... 7
5 Detailed Test Results .................................................................................................... 9
   5.1 Transmitter Requirements ....................................................................................... 9
      5.1.1 Operating Frequency ......................................................................................... 9
      5.1.2 Frequency Error or Frequency Drift .................................................................. 10
      5.1.3 Unwanted Emissions in the Spurious Domain .................................................... 11
      5.1.4 TX effective radiated power .............................................................................. 12
      5.1.5 TX Duty cycle ................................................................................................... 13
      5.1.6 Occupied Bandwidth ....................................................................................... 14
      5.1.7 TX out of band emissions ................................................................................ 16
      5.1.8 TX Transients ................................................................................................... 20
      5.1.9 TX-Behaviour under Low-Voltage Conditions .................................................. 21
      5.1.10 Blocking ......................................................................................................... 22
   5.2 List of Measurement Equipment used for Testing .................................................... 23
      5.2.1 Hardware ........................................................................................................... 23
      5.2.2 Software .......................................................................................................... 24
1 Introduction

The objective of the investigation hereunder, was to perform testing of the devices “Irwxccx-mpcie-868” for customer n-fuse GmbH, in accordance with the harmonized Standard EN 300 220-2 V3.1.1 covering the essential requirements of article 3.2 of the Directive 2014/53/EU for non specific radio equipment.

The test results herein refer to the tested sample(s) only.

2 General

<table>
<thead>
<tr>
<th>Manufacturer Information</th>
<th>Customer Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Company Name</td>
<td>n-fuse GmbH</td>
</tr>
<tr>
<td>Street Name, No.</td>
<td>Ossietzkustrasse 4</td>
</tr>
<tr>
<td>PLZ/ZIP City</td>
<td>70174 Stuttgart</td>
</tr>
<tr>
<td>Country</td>
<td>Germany</td>
</tr>
<tr>
<td>Contact Person</td>
<td>Thomas Hoppe</td>
</tr>
<tr>
<td>Phone</td>
<td>+49 (0)1601218888</td>
</tr>
<tr>
<td>E-Mail</td>
<td><a href="mailto:Thomas.hoppe@n-fuse.co">Thomas.hoppe@n-fuse.co</a></td>
</tr>
</tbody>
</table>

Table 2.1: General Information about Manufacturer / Customer

Subject: Electromagnetic Radio Spectrum Matters (ERM)

Test Engineer: Frank Tofahrn
IMST GmbH, Germany

Place of test: Testcenter at IMST GmbH, ERM Test Lab, Kamp-Lintfort, Germany

Persons present during testing:

IMST GmbH
Frank Tofahrn

n-fuse GmbH
N/A
3 Description of the Device under Test (DUT)

3.1 General

Device: Irwccx-mpcie-868
Serial No.: n-fuse/220/18/185 (IMST-Marking)
Operating voltage: 5V (USB)
Frequency: 867.1 – 868.5 MHz
Bandwidth: 150 kHz
Modulation: LORA 125

Picture 3.1: DUT Irwccx-mpcie-868 – Sample 1

Picture 3.2: DUT Setup 1: Irwccx-mpcie-868; 2: Raspberry Pi Control Unit
3.2 DUT-Modes of Operation

<table>
<thead>
<tr>
<th>Device Designator:</th>
<th>Irwccx-mpcie-868</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marking of Units:</td>
<td>n-fuse/220/18/185 (IMST Marking)</td>
</tr>
<tr>
<td>Equipment Type:</td>
<td>Wideband</td>
</tr>
<tr>
<td>RF Output Power:</td>
<td>&lt;14 dBm / 868 MHz</td>
</tr>
<tr>
<td>Frequency Range, Operational:</td>
<td>868 MHz Band L &amp; M</td>
</tr>
<tr>
<td>Type of Modulation:</td>
<td>LORA</td>
</tr>
<tr>
<td>Duty Cycle:</td>
<td>N/A</td>
</tr>
<tr>
<td>Listen-Before-Talk Capability:</td>
<td>N/A</td>
</tr>
<tr>
<td>Single Frequency Operation:</td>
<td>N/A</td>
</tr>
<tr>
<td>Spread Spectrum Capability:</td>
<td>N/A</td>
</tr>
<tr>
<td>Receiver Category:</td>
<td>1.5</td>
</tr>
</tbody>
</table>

Environmental Conditions

| Temperature Range, Operational: | 0 °C to +80 °C       |
| Power Supply:                  | USB                   |
| Nominal Supply Voltage:        | 5 V                   |
| Supply Voltage Range:          | N/A                   |
| Test Mode Capabilities:        |                        |

| Test modulation to be used:    | D-M3                  |

Table 3.3: Characteristics of the DUT

3.2.1 DUT Setup

Normal setup

3.2.2 DUT Peripherals

None

3.2.3 DUT Modifications

None

3.2.4 Supporting Equipment

Raspberry Pi

3.2.5 Firmware on the module

None

3.2.6 External software used for the test

util_tx_continuous Version 0.2.2, util_tx_test Version 0.0.2, util_pkt_logger

All located and executed on the Raspberry Pi
### 4 Overview: Conformance Requirements and Tests Applied

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Description</th>
<th>Reference: Clause No.</th>
<th>Requirement Conditionality</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Operating frequency</td>
<td>4.2.1</td>
<td>U</td>
</tr>
<tr>
<td>2</td>
<td>Unwanted emissions in the spurious domain</td>
<td>4.2.2</td>
<td>U</td>
</tr>
<tr>
<td>3</td>
<td>TX effective radiated power</td>
<td>4.3.1</td>
<td>U</td>
</tr>
<tr>
<td>4</td>
<td>TX Maximum e.r.p. spectral density</td>
<td>4.3.2</td>
<td>C</td>
</tr>
<tr>
<td></td>
<td>Applies to EUT using annex B bands I, L. Applies to EUT using DSSS or wideband techniques other than FHSS modulation. using annex C band X.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>TX Duty cycle</td>
<td>4.3.3</td>
<td>E</td>
</tr>
<tr>
<td></td>
<td>Not applicable to EUT with polite spectrum access where permitted in annex B, table B.1 or annex C, table C.1 or any NRL.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>TX Occupied bandwidth</td>
<td>4.3.4</td>
<td>U</td>
</tr>
<tr>
<td>7</td>
<td>TX out of band emissions</td>
<td>4.3.5</td>
<td>C</td>
</tr>
<tr>
<td></td>
<td>Applies to EUT with OCW &gt; 25 kHz.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>TX Transient</td>
<td>4.3.6</td>
<td>U</td>
</tr>
<tr>
<td>9</td>
<td>TX Adjacent channel power</td>
<td>4.3.7</td>
<td>C</td>
</tr>
<tr>
<td></td>
<td>Applies to EUT with OCW &lt; 25 kHz.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>TX behaviour under low voltage conditions</td>
<td>4.3.8</td>
<td>C</td>
</tr>
<tr>
<td></td>
<td>Applies to battery powered EUT.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>TX Adaptive power control</td>
<td>4.3.9</td>
<td>C</td>
</tr>
<tr>
<td></td>
<td>Applies to EUT with adaptive power control using annex C band AA.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>TX FHSS</td>
<td>4.3.10</td>
<td>C</td>
</tr>
<tr>
<td></td>
<td>Applies to FHSS EUT.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>TX Short term behaviour</td>
<td>4.3.11</td>
<td>C</td>
</tr>
<tr>
<td></td>
<td>Applies to EUT using annex C bands Y, Z, AA, AB, AC, AD.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>RX sensitivity</td>
<td>4.4.1</td>
<td>C</td>
</tr>
<tr>
<td></td>
<td>Applies to EUT with polite spectrum access.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Clear channel assessment threshold</td>
<td>4.5.2</td>
<td>C</td>
</tr>
<tr>
<td></td>
<td>Applies to EUT with polite spectrum access.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Polite spectrum access timing parameters</td>
<td>4.5.3</td>
<td>C</td>
</tr>
<tr>
<td></td>
<td>Applies to EUT with polite spectrum access.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>RX Blocking</td>
<td>4.4.2</td>
<td>U</td>
</tr>
<tr>
<td>18</td>
<td>Adaptive Frequency Agility</td>
<td>4.5.4</td>
<td>C</td>
</tr>
<tr>
<td></td>
<td>Applies to EUT with AFA.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4.1: Conformance Requirements
Key to columns:

**Requirement:**

- **No**: A unique identifier for one row of the table which may be used to identify a requirement.
- **Description**: A textual reference to the requirement.
- **Clause Number**: Identification of clause(s) defining the requirement in the present document unless another document is referenced explicitly.

**Requirement Conditionality:**

- **U/C**: Indicates whether the requirement shall be unconditionally applicable (U) or is conditional upon the manufacturers claimed functionality of the equipment (C).
- **Condition**: Explains the conditions when the requirement shall or shall not be applicable for a requirement which is classified "conditional".

Presumption of conformity stays valid only as long as a reference to the present document is maintained in the list published in the Official Journal of the European Union. Users of the present document should consult frequently the latest list published in the Official Journal of the European Union.
5 Detailed Test Results

5.1 Transmitter Requirements

5.1.1 Operating Frequency

5.1.1.1 Reference
EN 300 220-2 V3.1.1, reference clause 4.2.1

5.1.1.2 Test Conditions
Values declared by the provider

5.1.1.3 Measurement Setup
No test

5.1.1.4 Manufacturer Declaration

<table>
<thead>
<tr>
<th>Value</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operational Frequency band or bands</td>
<td>Band L / Band M</td>
</tr>
<tr>
<td>Nominal Operating Frequency or Frequencies</td>
<td>867.1 / 867.9 / 868.1 / 868.5 MHz</td>
</tr>
<tr>
<td>Operating Channel width(s) - OCW -</td>
<td>150 kHz</td>
</tr>
</tbody>
</table>

Table 5.1: Operating Frequency
5.1.2 Frequency Error or Frequency Drift

5.1.2.1 Reference
EN 300 220-1 V3.1.1, reference clause 5.7

5.1.2.2 Test Conditions
Extreme Conditions

5.1.2.3 Measurement Setup
 Modifications to measurement setup: None
 Measurement equipment used: [2]
 Actual measurement uncertainty: N/A

5.1.2.4 Measurement Results

<table>
<thead>
<tr>
<th>Value</th>
<th>Measured Frequency (MHz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measured Operating Frequency / MHz</td>
<td>N/A</td>
</tr>
<tr>
<td>Carrier frequency under lower extreme test conditions / MHz</td>
<td>N/A</td>
</tr>
<tr>
<td>Carrier frequency under higher extreme test conditions / MHz</td>
<td>N/A</td>
</tr>
<tr>
<td>Frequency error (upper) / kHz</td>
<td>N/A</td>
</tr>
<tr>
<td>Frequency error (lower) / kHz</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Table 5.2: Result Table Frequency Error

Remark: No test. Device cannot generate an unmodulated carrier.
Result: N/A
5.1.3 Unwanted Emissions in the Spurious Domain

5.1.3.1 Reference
EN 300 220-2 V3.1.1, reference clause 4.2.2

5.1.3.2 Test Conditions
Operational Modes: TX only mode
Environmental Conditions: Normal

5.1.3.3 Limits

<table>
<thead>
<tr>
<th>State</th>
<th>Frequency/[MHz]</th>
<th>47 to 74</th>
<th>87.5 to 118</th>
<th>174 to 230</th>
<th>470 to 862</th>
<th>Other frequencies below 1000</th>
<th>Frequencies above 1000</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>47 to 74</td>
<td>87.5 to 118</td>
<td>174 to 230</td>
<td>470 to 862</td>
<td>Other frequencies below 1000</td>
<td>Frequencies above 1000</td>
</tr>
<tr>
<td>Operating</td>
<td>4 nW</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>250 nW</td>
<td>1 µW</td>
</tr>
<tr>
<td>Standby</td>
<td>2 nW</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2 nW</td>
<td>20 nW</td>
</tr>
</tbody>
</table>

Table 5.3: Limits for Spurious Emissions

Modifications to measurement setup: None
Test equipment used: [2], [4], [5], [104]
Actual measurement uncertainty: <±2 dB, the Standard requests: ±6 dB.

5.1.3.4 Measurement Results
No relevant spurious detected

Remark: None
Result: The devices PASSED the test without limitations.
5.1.4 TX effective radiated power

5.1.4.1 Reference
EN 300 220-2 V3.1.1, reference clause 4.3.1

5.1.4.2 Test Conditions
Normal conditions

5.1.4.3 Limits
See table B.1 and C.1 in Annex B of EN 300 220-2 V3.1.1

5.1.4.4 Measurement Setup
Measurement setup according to the standard applied hereunder.
Modifications to measurement setup: None
Measurement equipment used: [2], [4], [20], [104]
Actual measurement uncertainty: ±1.5 dB, the Standard requests: ±6 dB

5.1.4.5 Measurement Results

<table>
<thead>
<tr>
<th>Frequency / MHz</th>
<th>0°C / dBm</th>
<th>25°C / dBm</th>
<th>80°C / dBm</th>
</tr>
</thead>
<tbody>
<tr>
<td>867,10</td>
<td>13,40</td>
<td>12,05</td>
<td>10,56</td>
</tr>
<tr>
<td>867,90</td>
<td>13,34</td>
<td>12,09</td>
<td>10,59</td>
</tr>
<tr>
<td>868,10</td>
<td>13,31</td>
<td>12,07</td>
<td>10,62</td>
</tr>
<tr>
<td>868,50</td>
<td>13,29</td>
<td>11,98</td>
<td>10,66</td>
</tr>
</tbody>
</table>

Table 5.4: Result Table

Remark: Conducted test. An antenna gain of 0 dBd is assumed.
Note that in some countries a PSD limit applies for Band L. In this case the output power has to be reduced accordingly.
The program util_tx_continuous has been used for this test with the following parameters:
- [testfrequency] --r1257 --dig 0 --mix 4 --pa 0 --mod LORA --sf 7 --bw 125
The final application has to be operated using the parameters shown above

Result: The devices PASSED the test with limitations.
5.1.5  TX Duty cycle

5.1.5.1  Reference:
EN 300 220-2 V3.1.1, reference clause 4.3.3

5.1.5.2  Test Conditions:
N/A

5.1.5.3  Limits:
See sub clause 4.3.3.2 in EN 300 220-2 V3.1.1

5.1.5.4  Measurement Setup
No test

5.1.5.5  Measurement Results

<table>
<thead>
<tr>
<th>Value</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Declared Duty Cycle</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Table 5.5: Result Table

Note:  Not applicable.
       The duty cycle has to be tested in the final application.

Remark:  No test.
Result:  N/A
5.1.6 Occupied Bandwidth

5.1.6.1 Reference
EN 300 220-2 V3.1.1, reference clause 4.3.4

5.1.6.2 Test Conditions
Tests are performed in a conducted measurement
Environmental conditions: Normal conditions.

5.1.6.3 Limits
See sub clause 5.6. in EN 300 220-1 V3.1.1

5.1.6.4 Measurement Setup
Modifications to measurement setup: None
Test equipment used: [2]

5.1.6.5 Measurement Results

![Spectrum](image)

**Picture 5.6: OBW 867.10 MHz**
Picture 5.7: OBW 868.50 MHz

**Remark:** The program util_tx_continuous has been used for this test with the following parameters:

- \([\text{testfrequency}]\) -r1257 -dig 0 --mix 4 --pa 0 --mod LORA --sf 7 --bw 125

The final application has to be operated using the parameters shown above

**Result:** The devices PASSED the test without limitations.
5.1.7 TX out of band emissions

5.1.7.1 Reference
EN 300 220-2 V3.1.1, reference clause 4.3.5

5.1.7.2 Test Conditions
Modulation: LORA (D-M3)
Equipment Type: Wideband
Operational Modes: TX-only mode
Environmental Conditions: Extreme conditions

5.1.7.3 Limits:
See EN 300 220-1 V3.1.1, sub-clause 5.8

5.1.7.4 Measurement Setup
Modifications to measurement setup: None.
Test equipment used: [2], [105]
Actual measurement uncertainty: < ±1 dB, the Standard requests: ±3 dB.

5.1.7.5 Measurement Results

![Plots of OOB Subbands, Signals, and Spurs](image)

*Picture 5.8: 867.10 MHz*
Picture 5.9: 867.90 MHz
Picture 5.10: 868.10 MHz
Remark: The program util_tx_continuous has been used for this test with the following parameters:
- [testfrequency] –r1257 –dig 0 --mix 4 --pa 0 --mod LORA --sf 7 --bw 125

The final application has to be operated using the parameters shown above.

Result: The devices PASSED the test without limitations.
5.1.8 TX Transients

5.1.8.1 Reference
EN 300 220-2 V3.1.1, reference clause 4.3.6

5.1.7.2 Test Conditions
Modulation: Operation EN 300 220-1 V3.1.1, sub-clause 6.1.2 (D-M3),
Equipment Type: Wideband equipment,
Operational Modes: Single carrier frequency, no channel spacing or plan
Environmental Conditions: Normal

5.1.7.3 Limits
See EN 300 220-1 V3.1.1 sub clause 5.10

5.1.7.4 Measurement Setup
Modifications to measurement setup: None
Test equipment used: [2]
Actual measurement uncertainty: ±1 dB, the Standard requests: ±3 dB.

5.1.7.5 Measurement Results

![Graph showing TX Transients](image)

Picture 5.12: TX Transients

**Remark:** None The program utiltx_test has been used for this test with the
–p parameter set to 8dBm
The final application has to be operated using the parameters shown above

**Result:** The devices PASSED the test without limitations.
5.1.9  TX-Behaviour under Low-Voltage Conditions

5.1.9.1  Reference
EN 300 220-2 V3.1.1, reference clause 4.3.8

5.1.9.2  Test Conditions
Normal conditions

5.1.9.3  Limits
See EN 300 220-1 V3.1.1 sub clause 5.12

5.1.9.4  Measurement Setup
Modifications to measurement setup: None
Actual measurement uncertainty:  N/A

5.10.5 Measurement Results:

**Remark:**  No battery operation.
**Result:**  The devices PASSED the test without limitations.
5.1.10 Blocking

5.1.10.1 Reference
EN 300 220-2 V3.1.1, reference clause 4.4.2

5.1.10.2 Test Conditions
Equipment Type: Receiver category 1.5
Operational Modes: Single carrier frequency, no channel spacing or plan,
Environmental Conditions: Normal.

5.1.10.3 Limits
See subclause 5.3.18 of the standard

5.1.10.4 Measurement Setup
Modifications to measurement setup: None
Test equipment used: [2], [9], [19], [26]
Actual measurement uncertainty: <±1 dB, the Standard requests: ±3 dB.

5.1.10.5 Measurement Results

Picture 5.13: Blocking Levels
Remark: None
Result: The devices PASSED the test without limitations as category 1.5 receivers.
Annex

5.2 List of Measurement Equipment used for Testing

5.2.1 Hardware

<table>
<thead>
<tr>
<th>No.</th>
<th>Type of equipment</th>
<th>Manufacturer</th>
<th>Type / Notifier</th>
<th>Serial Number</th>
<th>Cal due:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Spectrum Analyzer</td>
<td>R&amp;S</td>
<td>FSQ26</td>
<td>200096</td>
<td>2018/1</td>
</tr>
<tr>
<td>2</td>
<td>Spectrum Analyzer</td>
<td>R&amp;S</td>
<td>FSV13</td>
<td>100784</td>
<td>2019/04</td>
</tr>
<tr>
<td>3</td>
<td>Power Supply</td>
<td>Agilent</td>
<td>E3632A</td>
<td>MY40001408</td>
<td>N/A</td>
</tr>
<tr>
<td>4</td>
<td>Anechoic Chamber, small</td>
<td>Siemens-Matsushita</td>
<td>Project No. 007-A34-089/99A</td>
<td>N/A</td>
<td>ANT</td>
</tr>
<tr>
<td>5</td>
<td>Anechoic Chamber, large</td>
<td>Siemens-Matsushita</td>
<td>IMST</td>
<td>N/A</td>
<td>EMC</td>
</tr>
<tr>
<td>6</td>
<td>Shielded Room</td>
<td>EMC</td>
<td>Proj.-Nr 0284</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
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<td>Temperature Chamber</td>
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<td>EMV</td>
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<td>13</td>
<td>Antenna (dual ridged Horn, 0.8 - 12 GHz)</td>
<td>Satimo</td>
<td>SH 800</td>
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<td>ANT</td>
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<td>SMJ 100A</td>
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### 5.2.2 Software

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