ANR015 FROM 868 MHZ TO 915 MHZ

REPLACING 868 MHZ RADIO MODULES BY THEIR 915 MHZ COUNTERPARTS

VERSION 1.0

JULY 24, 2019
# Revision history

<table>
<thead>
<tr>
<th>Manual version</th>
<th>Notes</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>• Initial version</td>
<td>July 2019</td>
</tr>
</tbody>
</table>
## Abbreviations and abstract

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>FCC</td>
<td>Federal Communications Commission</td>
<td>American authority for radio certification.</td>
</tr>
<tr>
<td>FEC</td>
<td>Forward Error Correction</td>
<td>Correction method for recovering of erroneous received radio frames</td>
</tr>
<tr>
<td>FSK</td>
<td>Frequency shift keying</td>
<td>Frequency modulation technique</td>
</tr>
<tr>
<td>GFSK</td>
<td>Gaussian frequency shift keying</td>
<td>Frequency modulation technique</td>
</tr>
<tr>
<td>ISED</td>
<td>Innovation, Science and Economic Development</td>
<td>Canadian authority for radio certification.</td>
</tr>
<tr>
<td>ISM</td>
<td>Industrial, Scientific and Medical</td>
<td>Unlicensed frequency bands.</td>
</tr>
<tr>
<td>LRM</td>
<td>Long range mode</td>
<td>Special radio profile for large transmission ranges.</td>
</tr>
<tr>
<td>Payload</td>
<td></td>
<td>The intended message in a frame / package.</td>
</tr>
<tr>
<td>RF</td>
<td>Radio frequency</td>
<td>Describes wireless transmission.</td>
</tr>
<tr>
<td>SRD</td>
<td>Short Range Device</td>
<td>Unlicensed frequency bands.</td>
</tr>
</tbody>
</table>
## Contents

1. **Introduction** ............................................. 4  
   1.1 Other markets ........................................... 4  

2. **Replacing 868 MHz radio modules by their 915 MHz counterparts** ..... 5  
   2.1 Thebe-II ............................................... 5  
      2.1.1 915 MHz counterpart: Themisto-I .................. 6  
   2.2 Tarvos-III .............................................. 9  
      2.2.1 915 MHz counterpart: Telesto-III .................. 10  
   2.3 Tarvos-II ................................................ 13  
      2.3.1 915 MHz counterpart: Telesto-I ................... 14  
      2.3.2 915 MHz counterpart: Telesto-II ................... 17  
   2.4 Overview for replaceable modules .......................... 19  

3. **Important notes** ........................................ 20  
   3.1 General customer responsibility .......................... 20  
   3.2 Customer responsibility related to specific, in particular safety-relevant applications .................................. 20  
   3.3 Best care and attention .................................... 20  
   3.4 Customer support for product specifications .................. 20  
   3.5 Product improvements ....................................... 21  
   3.6 Product life cycle ......................................... 21  
   3.7 Property rights ........................................... 21  
   3.8 General terms and conditions ............................... 21  

4. **Legal notice** ........................................... 22  
   4.1 Exclusion of liability ..................................... 22  
   4.2 Suitability in customer applications ....................... 22  
   4.3 Trademarks ............................................... 22  
   4.4 Usage restriction ......................................... 22  

5. **License terms** ........................................... 24  
   5.1 Limited license ........................................... 24  
   5.2 Usage and obligations ..................................... 24  
   5.3 Ownership ............................................... 25  
   5.4 Firmware update(s) ....................................... 25  
   5.5 Disclaimer of warranty .................................... 25  
   5.6 Limitation of liability .................................... 26  
   5.7 Applicable law and jurisdiction ............................ 26  
   5.8 Severability clause ....................................... 26  
   5.9 Miscellaneous ............................................ 26
1 Introduction

The radio frequency spectrum is regulated by designated regulatory authorities that define how specific spectrum bands can be used. The ISM (Industrial, Scientific and Medical) and SRD (Short Range Device) bands are free to use without license costs. As there is no single worldwide regulation, national authorities define which of the frequency bands are open for access in each specific country.

The 2.4 - 2.5 GHz band can be used worldwide, but has specific disadvantages. Besides the poor transmission range due to the bad penetration of this frequency, the 2.4 GHz band is really noisy and crowded due to the vast number of Wi-Fi and Bluetooth devices around.

To overcome these issues, in Europe the frequency band 868 - 870 MHz is very common, as it provides data transmission ranges and speeds that are sufficient for many industrial applications.

Companies developing radio products for the European market often look out to non-European markets to expand their business volume. Most often the American as well as the Canadian markets are faced due to their huge potential. Unfortunately, in northern America the 868 MHz frequency band is not permitted by the Federal Communications Commission (FCC) USA and the Innovation, Science and Economic Development (ISED) Canada, such that the 902 - 928 MHz frequency band is taken as appropriate counterpart.

This application note describes which key facts have to be considered, when replacing a proprietary Würth Elektronik eiSos 868 MHz radio module by it’s 915 MHz radio module counterpart.

1.1 Other markets

The European, American and Canadian markets are the first markets that have been regulated concerning the frequency spectrum. In between, other foreign markets have been regulated as well. These markets bring additional sales potential. Due to this historic aspect, most of the foreign radio regulations are based on European or North American regulations, such that at least parts of the 868 - 870 MHz or 902 - 928 MHz frequency band are allowed in most of the countries. Keeping that in mind underlines why having both, 868 and 915 MHz radio products, in the portfolio is important when planning to take advantage of Sub-1-GHz radio.
2 Replacing 868 MHz radio modules by their 915 MHz counterparts

This chapter describes which Würth Elektronik eiSos 868 MHz radio modules can be replaced by their 915 MHz counterparts with low effort. Furthermore, the steps to be done for the replacement are considered afterwards.

2.1 Thebe-II

The Thebe-II is a proprietary 868 MHz (Band P) 500 mW radio module, that is available with a 50Ω antenna pad to connect an external antenna. The Thebe-II provides the following radio profiles:

<table>
<thead>
<tr>
<th>Radio profile</th>
<th>Data rate (gross) [kbps]</th>
<th>Modulation</th>
<th>Max packet size [Byte]</th>
<th>Max packet duration [ms]</th>
<th>Max range¹ [m]</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>38.4</td>
<td>(G)FSK</td>
<td>128</td>
<td>40</td>
<td>3000</td>
</tr>
<tr>
<td>2</td>
<td>100</td>
<td>(G)FSK</td>
<td>128</td>
<td>20</td>
<td>2300</td>
</tr>
<tr>
<td>3 (LRM)</td>
<td>10 (=0.625 kbps net)</td>
<td>DSSS + FEC</td>
<td>48</td>
<td>1000</td>
<td>8000</td>
</tr>
<tr>
<td>4 (LRM)</td>
<td>20 (=2.5 kbps net)</td>
<td>DSSS + FEC</td>
<td>64</td>
<td>300</td>
<td>6000</td>
</tr>
<tr>
<td>7</td>
<td>50</td>
<td>(G)FSK</td>
<td>128</td>
<td>35</td>
<td>2300</td>
</tr>
</tbody>
</table>

Table 1: Radio profiles of the Thebe-II

Profile 0, 2 and 7 provide medium speed and range data transmission, where profile 3 and 4 allow higher range data transmission.

¹Using two Thebe-II with external antenna, 2m antenna height, 0 dB antenna gain and 6 dB link margin. The Range Estimator Tool, which is part of the REDEXPERT, allows to calculate the transmission ranges also for other antenna setups.
2.1.1 915 MHz counterpart: Themisto-I

The Themisto-I has been designed as a counterpart for Thebe-II for the North American market. The Themisto-I is a proprietary 915 MHz 500mW radio module, that is also available with a 50Ω antenna pad to connect an external antenna. The Themisto-I provides the following radio profiles:

![Themisto-I: proprietary 915 MHz radio module](image)

Figure 2: Themisto-I: proprietary 915 MHz radio module

<table>
<thead>
<tr>
<th>Radio profile</th>
<th>Data rate (gross) [kbps]</th>
<th>Modulation</th>
<th>Max packet size [Byte]</th>
<th>Max packet duration [ms]</th>
<th>Max range [m]</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>400</td>
<td>GFSK</td>
<td>224</td>
<td>15</td>
<td>1700</td>
</tr>
<tr>
<td>8 (LRM)</td>
<td>480 (= 240 kbps net)</td>
<td>DSSS with FEC</td>
<td>224</td>
<td>15</td>
<td>2500</td>
</tr>
<tr>
<td>9 (LRM)</td>
<td>480 (= 30 kbps net)</td>
<td>DSSS with FEC</td>
<td>224</td>
<td>75</td>
<td>3500</td>
</tr>
</tbody>
</table>

Table 2: Radio profiles of the Themisto-I

To conform with the FCC Part 15.247 and ISED, the Themisto-I uses a wide band digital modulation technique. This allows a high data rate for fast data transmission.

---

1Using two Themisto-I with external antenna, 2m antenna height, 0 dB antenna gain and 6 dB link margin. The Range Estimator Tool, which is part of the REDEXPERT, allows to calculate the transmission ranges also for other antenna setups.
In case, the Thebe-II is replaced by a Themisto-I radio module, the following facts have to be considered:

<table>
<thead>
<tr>
<th>Feature</th>
<th>Information</th>
<th>Actions needed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Form factor &amp; footprint</td>
<td>Both modules have the same form factor and footprint.</td>
<td>None</td>
</tr>
<tr>
<td>Pinout</td>
<td>Both modules are pin compatible.</td>
<td>None</td>
</tr>
<tr>
<td>Antenna</td>
<td>Both modules are available with a 50Ω antenna pad to connect an external antenna.</td>
<td>Check whether the connected 868 MHz antenna can be also used for 915 MHz.</td>
</tr>
<tr>
<td>UART protocol</td>
<td>Both modules provide a command interface using the same commands and functions.</td>
<td>None</td>
</tr>
<tr>
<td>Radio configuration</td>
<td>• The radio profiles of the Themisto-I provide a faster radio transmission at the cost of range.</td>
<td>• Check the range and timing requirements of your application.</td>
</tr>
<tr>
<td></td>
<td>• The channel numbering changes from 129 - 132 (869.45 - 869.6 MHz) to 200 - 252 (902 - 928 MHz).</td>
<td>• Use the new channel numbers in your application code.</td>
</tr>
<tr>
<td>Certification</td>
<td>The 915 MHz range is regulated in North America by the FCC USA and ISED Canada.</td>
<td>Re-testing(^1) of the end-device is needed to determine unwanted emissions.</td>
</tr>
</tbody>
</table>

Table 3: Replace a Thebe-II with a Themisto-I

\(^1\)See FCC 996369 D04 Module Integration Guide V01.
Summary

The Thebe-II and Themisto-I can be considered from the beginning of your design, being aware that in case of selling to countries with 915 MHz a solution is available almost instantly. As the footprint, pinout and UART protocol of both modules is the same, switching from Thebe-II to Themisto-I can be performed very quickly without any hardware re-design.
2.2 Tarvos-III

The Tarvos-III is a proprietary 868 MHz radio module, that is available with integrated antenna as well as with a 50Ω antenna pad to connect an external antenna. The Tarvos-III provides the following radio profiles, that allow fast as well as long range data transmission:

<table>
<thead>
<tr>
<th>Radio profile</th>
<th>Data rate (gross) [kbps]</th>
<th>Modulation</th>
<th>Max packet size [Byte]</th>
<th>Max packet duration [ms]</th>
<th>Max range1 [m]</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>38.4</td>
<td>FSK</td>
<td>128</td>
<td>40</td>
<td>1500</td>
</tr>
<tr>
<td>2</td>
<td>100</td>
<td>FSK</td>
<td>128</td>
<td>20</td>
<td>1100</td>
</tr>
<tr>
<td>3 (LRM)</td>
<td>10 (=0.625 kbps net)</td>
<td>FSK (with FEC)</td>
<td>48</td>
<td>1000</td>
<td>4000</td>
</tr>
<tr>
<td>4 (LRM)</td>
<td>20 (=2.5 kbps net)</td>
<td>FSK (with FEC)</td>
<td>64</td>
<td>300</td>
<td>3000</td>
</tr>
<tr>
<td>5</td>
<td>400</td>
<td>GFSK</td>
<td>224</td>
<td>10</td>
<td>800</td>
</tr>
</tbody>
</table>

Table 4: Radio profiles of the Tarvos-III

Profile 0 and 2 provide medium speed and range data transmission, where profile 3 and 4 allow high range and profile 5 allows high speed data transmission.

1Using two Tarvos-III with external antenna, 2m antenna height, 0 dB antenna gain and 6 dB link margin. The Range Estimator Tool, which is part of the REDEXPERT, allows to calculate the transmission ranges also for other antenna setups.
2.2.1 915 MHz counterpart: Telesto-III

The Telesto-III has been designed as a counterpart for Tarvos-III for the North American market. The Telesto-III is a proprietary 915 MHz radio module, that is also available with integrated antenna as well as with a 50Ω antenna pad to connect an external antenna. The Telesto-III provides the following radio profile:

![Telesto-III](image)

Figure 5: Telesto-III: proprietary 915 MHz radio module

<table>
<thead>
<tr>
<th>Radio profile</th>
<th>Data rate (gross) [kbps]</th>
<th>Modulation</th>
<th>Max packet size [Byte]</th>
<th>Max packet duration [ms]</th>
<th>Max range(^1) [m]</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>400</td>
<td>GFSK</td>
<td>224</td>
<td>10</td>
<td>800</td>
</tr>
</tbody>
</table>

Table 5: Radio profile of the Telesto-III

To conform with the FCC Part 15.247 and ISED, the Telesto-III uses a broad radio spectrum. This allows a high data rate for fast data transmission.

---

\(^1\)Using two Telesto-III with external antenna, 2m antenna height, 0 dB antenna gain and 6 dB link margin. The Range Estimator Tool, which is part of the \textit{REDEXPERT}, allows to calculate the transmission ranges also for other antenna setups.
In case, the **Tarvos-III** is replaced by a **Telesto-III** radio module, the following facts have to be considered:

<table>
<thead>
<tr>
<th>Feature</th>
<th>Information</th>
<th>Actions needed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Form factor &amp; footprint</td>
<td>Both modules have the same form factor and footprint.</td>
<td>None</td>
</tr>
<tr>
<td>Pinout</td>
<td>Both modules are pin compatible.</td>
<td>None</td>
</tr>
<tr>
<td>Antenna</td>
<td>Both modules are available with integrated antenna and a 50Ω antenna pad to connect an external antenna.</td>
<td>In case of external antenna, check whether the connected 868 MHz antenna can be also used for 915 MHz.</td>
</tr>
<tr>
<td>UART protocol</td>
<td>Both modules provide a command interface using the same commands and functions.</td>
<td>None</td>
</tr>
<tr>
<td>Radio configuration</td>
<td>• The radio profile 6 of the Telesto-III is comparable in range and speed with the radio profile 5 of the Tarvos-III. In case, the Tarvos-III uses another radio profile, the range of the Telesto-III is lower, but data rate is higher, such that the data can be transmitted much faster. • The channel numbering changes from 100 - 140 (868 - 870 MHz) to 200 - 252 (902 - 928 MHz).</td>
<td>• Check the range requirements of your application. • Use the new channel numbers in your application code.</td>
</tr>
<tr>
<td>Certification</td>
<td>The 915 MHz range is regulated in North America by the FCC USA and ISED Canada.</td>
<td>Re-testing of the end-device is needed to determine unwanted emissions.</td>
</tr>
</tbody>
</table>

Table 6: Replace a Tarvos-III with a Telesto-III

Figure 6: Range vs. data rate
Summary

The Tarvos-III and Telesto-III can be considered from the beginning of your design, being aware that in case of selling to countries with 915 MHz a solution is available almost instantly. As the footprint, pinout and UART protocol of both modules is the same, switching from Tarvos-III to Telesto-III can be performed very quickly without any hardware re-design.

1See FCC 996369 D04 Module Integration Guide V01.
2.3 Tarvos-II

The Tarvos-II is a proprietary 868 MHz radio module, that is available with a 50Ω antenna pad to connect an external antenna. The Tarvos-II provides the following radio profiles:

<table>
<thead>
<tr>
<th>Radio profile</th>
<th>Data rate (gross) [kbps]</th>
<th>Modulation</th>
<th>Max packet size [Byte]</th>
<th>Max packet duration [ms]</th>
<th>Max range(^1) [m]</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>38.4</td>
<td>GFSK</td>
<td>128</td>
<td>40</td>
<td>1400</td>
</tr>
<tr>
<td>1</td>
<td>2.4</td>
<td>GFSK</td>
<td>128</td>
<td>500</td>
<td>2600</td>
</tr>
<tr>
<td>2</td>
<td>100</td>
<td>GFSK</td>
<td>128</td>
<td>20</td>
<td>1000</td>
</tr>
</tbody>
</table>

Table 7: Radio profiles of the Tarvos-II

Profile 0 provides medium speed and range data transmission, where profile 1 allows higher range and profile 2 allows faster data transmission.

\(^1\)Using two Tarvos-II with external antenna, 2m antenna height, 0 dB antenna gain and 6 dB link margin. The Range Estimator Tool, which is part of the REDEXPERT, allows to calculate the transmission ranges also for other antenna setups.
2.3.1 915 MHz counterpart: Telesto-I

The Telesto-I has been designed as a counterpart for Tarvos-II for the North American market. The Telesto-I is a proprietary 915 MHz radio module, that is also available with a 50Ω antenna pad to connect an external antenna. The Telesto-I provides the following radio profiles:

<table>
<thead>
<tr>
<th>Radio profile</th>
<th>Data rate (gross) [kbps]</th>
<th>Modulation</th>
<th>Max packet size [Byte]</th>
<th>Max packet duration [ms]</th>
<th>Max range(^1) [m]</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>38.4</td>
<td>GFSK</td>
<td>128</td>
<td>40</td>
<td>550</td>
</tr>
<tr>
<td>4</td>
<td>100</td>
<td>GFSK</td>
<td>128</td>
<td>20</td>
<td>400</td>
</tr>
</tbody>
</table>

Table 8: Radio profiles of the Telesto-I

To conform with the FCC Part 15.249 and ISED, the Telesto-II uses low transmission power of about -2 dBm. This allows data transmission with low energy consumption, but also results in reduced ranges.

\(^1\)Using two Telesto-I with external antenna, 2m antenna height, 0 dB antenna gain and 6 dB link margin. The Range Estimator Tool, which is part of the REDEXPERT, allows to calculate the transmission ranges also for other antenna setups.
Figure 9: Range vs. data rate

In case, the **Tarvos-II** is replaced by a **Telesto-I** radio module, the following facts have to be considered:

<table>
<thead>
<tr>
<th>Feature</th>
<th>Information</th>
<th>Actions needed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Form factor &amp; footprint</td>
<td>Both modules have the same form factor and footprint.</td>
<td>None</td>
</tr>
<tr>
<td>Pinout</td>
<td>Both modules are pin compatible.</td>
<td>None</td>
</tr>
<tr>
<td>Antenna</td>
<td>Both modules are available with a 50Ω antenna pad to connect an external antenna.</td>
<td>Check whether the connected 868 MHz antenna can be also used for 915 MHz.</td>
</tr>
<tr>
<td>UART protocol</td>
<td>Both modules provide a command interface using the same commands and functions.</td>
<td>None</td>
</tr>
</tbody>
</table>
| Radio configuration      | • The radio profiles 3 and 4 of the Telesto-I are comparable in speed with the radio profiles 0 and 2 of the Tarvos-II. As the Telesto-I uses reduced output powers, the range is lower in comparison to the respective profiles of the Tarvos-II.  
  • The channel numbering changes from 100 - 140 (868 - 870 MHz) to 200 - 252 (902 - 928 MHz). | • Check the range requirements of your application.  
  • Use the new channel numbers in your application code. |
| Certification            | The 915 MHz range is regulated in North America by the FCC USA and ISED Canada. | Re-testing¹ of the end-device is needed to determine unwanted emissions. |

Table 9: Replace a Tarvos-II with a Telesto-I

---

¹Re-testing is the process of verifying the performance and compliance of a device when it is used in a new environment or with new components.
Summary

The Tarvos-II and Telesto-I can be considered from the beginning of your design, being aware that in case of selling to countries with 915 MHz a solution is available almost instantly. As the footprint, pinout and UART protocol of both modules is the same, switching from Tarvos-II to Telesto-I can be performed very quickly without any hardware re-design.

\(^1\)See FCC 996369 D04 Module Integration Guide V01.
2.3.2 915 MHz counterpart: Telesto-II

The Telesto-II has been designed as another counterpart for Tarvos-II for the North American market. The Telesto-II is a proprietary 915 MHz radio module, that is also available with a 50Ω antenna pad to connect an external antenna. The Telesto-II provides the following radio profiles:

<table>
<thead>
<tr>
<th>Radio profile</th>
<th>Data rate (gross) [kbps]</th>
<th>Modulation</th>
<th>Max packet size [Byte]</th>
<th>Max packet duration [ms]</th>
<th>Max range [m]</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>38.4</td>
<td>GFSK</td>
<td>128</td>
<td>100</td>
<td>900</td>
</tr>
</tbody>
</table>

Table 10: Radio profiles of the Telesto-II

To conform with the FCC Part 15.247 and ISED, the Telesto-II uses frequency hopping techniques. This results in more robust data transmissions, but at the cost of transmission time and thus of power consumption.

Using two Telesto-II with external antenna, 2m antenna height, 0 dB antenna gain and 6 dB link margin. The Range Estimator Tool, which is part of the REDEXPERT, allows to calculate the transmission ranges also for other antenna setups.
In case, the Tarvos-II is replaced by a Telesto-II radio module, the following facts have to be considered:

<table>
<thead>
<tr>
<th>Feature</th>
<th>Information</th>
<th>Actions needed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Form factor &amp; footprint</td>
<td>Both modules have the same form factor and footprint.</td>
<td>None</td>
</tr>
<tr>
<td>Pinout</td>
<td>Both modules are pin compatible.</td>
<td>None</td>
</tr>
<tr>
<td>Antenna</td>
<td>Both modules are available with a 50Ω antenna pad to connect an external antenna.</td>
<td>Check whether the connected 868 MHz antenna can be also used for 915 MHz.</td>
</tr>
<tr>
<td>UART protocol</td>
<td>Both modules provide a command interface using the same commands and functions.</td>
<td>None</td>
</tr>
</tbody>
</table>
| Radio configuration   | • The radio of the Telesto-II uses an asynchronous frequency hopping technique. Since each radio packet is transmitted on a different radio channel, the risk of blocked channels is minimized. The receiver itself has to find the radio channel to receive the data. Therefore the transmitter must send a long preamble prepended to the original radio packet. This costs additional transmission time and power. For proper transmission channel detection, the receiver loses a bit of RX sensitivity that is of the expense of range with respect to the Tarvos-II.  
• No fix channel can be selected, as the Telesto-II automatically manages the frequency hopping. | • Check the range, data transmission timing and power consumption requirements of your application.  
• Disable the channel selection in your application code. |
| Certification          | The 915 MHz range is regulated in North America by the FCC USA and ISED Canada. | Re-testing\(^1\) of the end-device is needed to determine unwanted emissions. |

Table 11: Replace a Tarvos-II with a Telesto-II

Summary

The Tarvos-II and Telesto-II can be considered from the beginning of your design, being aware that in case of selling to countries with 915 MHz a solution is available almost instantly. As the footprint, pinout and UART protocol of both modules is the same, switching from Tarvos-II to Telesto-II can be performed very quickly without any hardware re-design.

\(^1\)See FCC 996369 D04 Module Integration Guide V01.
### 2.4 Overview for replaceable modules

<table>
<thead>
<tr>
<th>868 MHz proprietary radio module</th>
<th>915 MHz counterpart</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thebe-II</td>
<td>Themisto-I</td>
</tr>
<tr>
<td>Tarvos-III</td>
<td>Telesto-III</td>
</tr>
<tr>
<td>Tarvos-II</td>
<td>Telesto-I, Telesto-II</td>
</tr>
</tbody>
</table>
3 Important notes

The following conditions apply to all goods within the wireless connectivity product range of Würth Elektronik eiSos GmbH & Co. KG:

3.1 General customer responsibility

Some goods within the product range of Würth Elektronik eiSos GmbH & Co. KG contain statements regarding general suitability for certain application areas. These statements about suitability are based on our knowledge and experience of typical requirements concerning the areas, serve as general guidance and cannot be estimated as binding statements about the suitability for a customer application. The responsibility for the applicability and use in a particular customer design is always solely within the authority of the customer. Due to this fact, it is up to the customer to evaluate, where appropriate to investigate and to decide whether the device with the specific product characteristics described in the product specification is valid and suitable for the respective customer application or not. Accordingly, the customer is cautioned to verify that the documentation is current before placing orders.

3.2 Customer responsibility related to specific, in particular safety-relevant applications

It has to be clearly pointed out that the possibility of a malfunction of electronic components or failure before the end of the usual lifetime cannot be completely eliminated in the current state of the art, even if the products are operated within the range of the specifications. The same statement is valid for all software sourcecode and firmware parts contained in or used with or for products in the wireless connectivity and sensor product range of Würth Elektronik eiSos GmbH & Co. KG. In certain customer applications requiring a high level of safety and especially in customer applications in which the malfunction or failure of an electronic component could endanger human life or health, it must be ensured by most advanced technological aid of suitable design of the customer application that no injury or damage is caused to third parties in the event of malfunction or failure of an electronic component.

3.3 Best care and attention

Any product-specific data sheets, manuals, application notes, PCN's, warnings and cautions must be strictly observed in the most recent versions and matching to the products firmware revisions. This documents can be downloaded from the product specific sections on the wireless connectivity homepage.

3.4 Customer support for product specifications

Some products within the product range may contain substances, which are subject to restrictions in certain jurisdictions in order to serve specific technical requirements. Necessary information is available on request. In this case, the field sales engineer or the internal sales person in charge should be contacted who will be happy to support in this matter.
3.5 Product improvements

Due to constant product improvement, product specifications may change from time to time. As a standard reporting procedure of the Product Change Notification (PCN) according to the JEDEC-Standard, we inform about major changes. In case of further queries regarding the PCN, the field sales engineer, the internal sales person or the technical support team in charge should be contacted. The basic responsibility of the customer as per section 3.1 and 3.2 remains unaffected. All wireless connectivity module driver software “wireless connectivity SDK” and it’s source codes as well as all PC software tools are not subject to the Product Change Notification information process.

3.6 Product life cycle

Due to technical progress and economical evaluation we also reserve the right to discontinue production and delivery of products. As a standard reporting procedure of the Product Termination Notification (PTN) according to the JEDEC-Standard we will inform at an early stage about inevitable product discontinuance. According to this, we cannot ensure that all products within our product range will always be available. Therefore, it needs to be verified with the field sales engineer or the internal sales person in charge about the current product availability expectancy before or when the product for application design-in disposal is considered. The approach named above does not apply in the case of individual agreements deviating from the foregoing for customer-specific products.

3.7 Property rights

All the rights for contractual products produced by Würth Elektronik eiSos GmbH & Co. KG on the basis of ideas, development contracts as well as models or templates that are subject to copyright, patent or commercial protection supplied to the customer will remain with Würth Elektronik eiSos GmbH & Co. KG. Würth Elektronik eiSos GmbH & Co. KG does not warrant or represent that any license, either expressed or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right relating to any combination, application, or process in which Würth Elektronik eiSos GmbH & Co. KG components or services are used.

3.8 General terms and conditions

Unless otherwise agreed in individual contracts, all orders are subject to the current version of the “General Terms and Conditions of Würth Elektronik eiSos Group”, last version available at www.we-online.com.
4 Legal notice

4.1 Exclusion of liability

Würth Elektronik eiSos GmbH & Co. KG considers the information in this document to be correct at the time of publication. However, Würth Elektronik eiSos GmbH & Co. KG reserves the right to modify the information such as technical specifications or functions of its products or discontinue the production of these products or the support of one of these products without any written announcement or notification to customers. The customer must make sure that the information used corresponds to the latest published information. Würth Elektronik eiSos GmbH & Co. KG does not assume any liability for the use of its products. Würth Elektronik eiSos GmbH & Co. KG does not grant licenses for its patent rights or for any other of its intellectual property rights or third-party rights.

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4.2 Suitability in customer applications

The customer bears the responsibility for compliance of systems or units, in which Würth Elektronik eiSos GmbH & Co. KG products are integrated, with applicable legal regulations. Customer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of Würth Elektronik eiSos GmbH & Co. KG components in its applications, notwithstanding any applications-related information or support that may be provided by Würth Elektronik eiSos GmbH & Co. KG. Customer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences lessen the likelihood of failures that might cause harm and take appropriate remedial actions. The customer will fully indemnify Würth Elektronik eiSos GmbH & Co. KG and its representatives against any damages arising out of the use of any Würth Elektronik eiSos GmbH & Co. KG components in safety-critical applications.

4.3 Trademarks

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4.4 Usage restriction

Würth Elektronik eiSos GmbH & Co. KG products have been designed and developed for usage in general electronic equipment only. This product is not authorized for use in equipment where a higher safety standard and reliability standard is especially required or where
a failure of the product is reasonably expected to cause severe personal injury or death, unless the parties have executed an agreement specifically governing such use. Moreover, Würth Elektronik eiSos GmbH & Co. KG products are neither designed nor intended for use in areas such as military, aerospace, aviation, nuclear control, submarine, transportation (automotive control, train control, ship control), transportation signal, disaster prevention, medical, public information network etc. Würth Elektronik eiSos GmbH & Co. KG must be informed about the intent of such usage before the design-in stage. In addition, sufficient reliability evaluation checks for safety must be performed on every electronic component, which is used in electrical circuits that require high safety and reliability function or performance. By using Würth Elektronik eiSos GmbH & Co. KG products, the customer agrees to these terms and conditions.
5 License terms

This License Terms will take effect upon the purchase and usage of the Würth Elektronik eiSos GmbH & Co. KG wireless connectivity products. You hereby agree that this license terms is applicable to the product and the incorporated software, firmware and source codes (collectively, "Software") made available by Würth Elektronik eiSos in any form, including but not limited to binary, executable or source code form. The software included in any Würth Elektronik eiSos wireless connectivity product is purchased to you on the condition that you accept the terms and conditions of this license terms. You agree to comply with all provisions under this license terms.

5.1 Limited license

Würth Elektronik eiSos hereby grants you a limited, non-exclusive, non-transferable and royalty-free license to use the software and under the conditions that will be set forth in this license terms. You are free to use the provided Software only in connection with one of the products from Würth Elektronik eiSos to the extent described in this license terms. You are entitled to change or alter the source code for the sole purpose of creating an application embedding the Würth Elektronik eiSos wireless connectivity product. The transfer of the source code to third parties is allowed to the sole extent that the source code is used by such third parties in connection with our product or another hardware provided by Würth Elektronik eiSos under strict adherence of this license terms. Würth Elektronik eiSos will not assume any liability for the usage of the incorporated software and the source code. You are not entitled to transfer the source code in any form to third parties without prior written consent of Würth Elektronik eiSos.

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5.2 Usage and obligations

The responsibility for the applicability and use of the Würth Elektronik eiSos wireless connectivity product with the incorporated Firmware in a particular customer design is always solely within the authority of the customer. Due to this fact, it is up to you to evaluate and investigate, where appropriate, and to decide whether the device with the specific product characteristics described in the product specification is valid and suitable for your respective application or not.

You are responsible for using the Würth Elektronik eiSos wireless connectivity product with the incorporated Firmware in compliance with all applicable product liability and product safety laws. You acknowledge to minimize the risk of loss and harm to individuals and bear the risk for failure leading to personal injury or death due to your usage of the product. Würth Elektronik eiSos’ products with the incorporated Firmware are not authorized for use in safety-critical applications, or where a failure of the product is reasonably expected to cause severe personal injury or death. Moreover, Würth Elektronik eiSos’ products with the incorporated Firmware are neither designed nor intended for use in areas such as military, aerospace, aviation, nuclear control, submarine, transportation (automotive control, train control, ship control), transportation signal, disaster prevention, medical, public information network etc. You shall inform Würth Elektronik eiSos about the intent of such usage before
design-in stage. In certain customer applications requiring a very high level of safety and in which the malfunction or failure of an electronic component could endanger human life or health, you must ensure to have all necessary expertise in the safety and regulatory ramifications of your applications. You acknowledge and agree that you are solely responsible for all legal, regulatory and safety-related requirements concerning your products and any use of Würth Elektronik eiSos’ products with the incorporated Firmware in such safety-critical applications, notwithstanding any applications-related information or support that may be provided by Würth Elektronik eiSos. YOU SHALL INDEMNIFY WÜRTH ELEKTRONIK EISOS AGAINST ANY DAMAGES ARISING OUT OF THE USE OF WÜRTH ELEKTRONIK EISOS’ PRODUCTS WITH THE INCORPORATED FIRMWARE IN SUCH SAFETY-CRITICAL APPLICATIONS.

5.3 Ownership

The incorporated Firmware created by Würth Elektronik eiSos is and will remain the exclusive property of Würth Elektronik eiSos.

5.4 Firmware update(s)

You have the opportunity to request the current and actual Firmware for a bought wireless connectivity Product within the time of warranty. However, Würth Elektronik eiSos has no obligation to update a modules firmware in their production facilities, but can offer this as a service on request. The upload of firmware updates falls within your responsibility, e.g. via ACC or another software for firmware updates. Firmware updates will not be communicated automatically. It is within your responsibility to check the current version of a firmware in the latest version of the product manual on our website. The revision table in the product manual provides all necessary information about firmware updates. There is no right to be provided with binary files, so called "Firmware images", those could be flashed through JTAG, SWD, Spi-Bi-Wire, SPI or similar interfaces.

5.5 Disclaimer of warranty

THE Firmware IS PROVIDED "AS IS". YOU ACKNOWLEDGE THAT WÜRTH ELEKTRONIK EISOS MAKES NO REPRESENTATIONS AND WARRANTIES OF ANY KIND RELATED TO, BUT NOT LIMITED TO THE NON-INFRINGEMENT OF THIRD PARTIES' INTELLECTUAL PROPERTY RIGHTS OR THE MERCHANTABILITY OR FITNESS FOR YOUR INTENDED PURPOSE OR USAGE. WÜRTH ELEKTRONIK EISOS DOES NOT WARRANT OR REPRESENT THAT ANY LICENSE, EITHER EXPRESS OR IMPLIED, IS GRANTED UNDER ANY PATENT RIGHT, COPYRIGHT, MASK WORK RIGHT, OR OTHER INTELLECTUAL PROPERTY RIGHT RELATING TO ANY COMBINATION, MACHINE, OR PROCESS IN WHICH THE WÜRTH ELEKTRONIK EISOS’ PRODUCT WITH THE INCORPORATED FIRMWARE IS USED. INFORMATION PUBLISHED BY WÜRTH ELEKTRONIK EISOS REGARDING THIRD-PARTY PRODUCTS OR SERVICES DOES NOT CONSTITUTE A LICENSE FROM WÜRTH ELEKTRONIK EISOS TO USE SUCH PRODUCTS OR SERVICES OR A WARRANT OR ENDORSEMENT THEREOF.
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5.7 Applicable law and jurisdiction

Applicable law to this license terms shall be the laws of the Federal Republic of Germany. Any dispute, claim or controversy arising out of or relating to this license terms shall be resolved and finally settled by the court competent for the location of Würth Elektronik eiSos’ registered office.

5.8 Severability clause

If a provision of this license terms is or becomes invalid, unenforceable or null and void, this shall not affect the remaining provisions of the terms. The parties shall replace any such provisions with new valid provisions that most closely approximate the purpose of the terms.

5.9 Miscellaneous

Würth Elektronik eiSos reserves the right at any time to change this terms at its own discretion. It is your responsibility to check at Würth Elektronik eiSos homepage for any updates. Your continued usage of the products will be deemed as the acceptance of the change. We recommend you to be updated about the status of new firmware and software, which is available on our website or in our data sheet and manual, and to implement new software in your device where appropriate.

By ordering a wireless connectivity product, you accept this license terms in all terms.
List of Figures

1. Thebe-II: proprietary 868 MHz radio module .......................................... 5
2. Themisto-I: proprietary 915 MHz radio module .......................................... 6
3. Range vs. data rate ....................................................................................... 7
4. Tarvos-III: proprietary 868 MHz radio module .......................................... 9
5. Telesto-III: proprietary 915 MHz radio module ......................................... 10
6. Range vs. data rate ....................................................................................... 11
7. Tarvos-II: proprietary 868 MHz radio module .......................................... 13
8. Telesto-I: proprietary 915 MHz radio module .......................................... 14
9. Range vs. data rate ....................................................................................... 15
10. Telesto-II: proprietary 915 MHz radio module ......................................... 17
11. Range vs. data rate ....................................................................................... 17

List of Tables

1. Radio profiles of the Thebe-II ...................................................................... 5
2. Radio profiles of the Themisto-I .................................................................. 6
3. Replace a Thebe-II with a Themisto-I ......................................................... 7
4. Radio profiles of the Tarvos-III .................................................................. 9
5. Radio profile of the Telesto-III .................................................................. 10
6. Replace a Tarvos-III with a Telesto-III ....................................................... 11
7. Radio profiles of the Tarvos-II .................................................................. 13
8. Radio profiles of the Telesto-I .................................................................. 14
9. Replace a Tarvos-II with a Telesto-I .......................................................... 15
10. Radio profiles of the Telesto-II .................................................................. 17
11. Replace a Tarvos-II with a Telesto-II ........................................................ 18