Ultra low power DASH7 Sub-GHz / UWB Localization Tag

Description
- Combined DASH7-FSK/LoRa/UWB & LoRaWAN battery powered localization tag with years-long lifetime.
- Fully integrated off-the-shelf options and motion detection sensor.
- Functions over long-range LoRaWAN, mid-range DASH7-FSK/LoRa or short range D7A-UWB networks.
- Identification & configuration over NFC
- Beaconing & configuration over BTLE
- FOTA over DASH7.
- Operating temperature: -40 °C to 85 °C

Sub-GHz modem
- Murata CMWX1ZZABZ hardware
- FCC & CE / RED certification
- Operates in the 868-915 MHz ISM band
- Embedded chip antenna.

UWB modem
- Bi-directional DASH7-FSK/LoRa v1.2 Industrial IoT connectivity with 1s latency (www.dash7-alliance.org)
- Bi-directional LoRaWAN connectivity (uplink driven).
- IoT modulation schemes GFSK 9.6 / 55.6 / 167.7 kbps or LoRa™ SF8 to SF12.
- Output power up to +14 dBm (with the embedded chip antenna).

Applications
- Combined indoor / outdoor assets localization
- Security systems
- Industrial monitor and control
- Internet of things (IoT)
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- WizziLab product line at
  www.wizzilab.com/products

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1 Hardware specification

1.1 Recommended operating conditions

Table 1. Recommended operating conditions

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>$T_A$</td>
<td>Operating ambient temperature range</td>
<td>-40</td>
<td>-</td>
<td>85</td>
<td>°C</td>
</tr>
</tbody>
</table>

1.2 Absolute maximum ratings\(^{(1)}\)

Table 2. Absolute maximum ratings

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>$T_{STG}$</td>
<td>Storage temperature range</td>
<td>-40</td>
<td>-</td>
<td>85</td>
<td>°C</td>
</tr>
</tbody>
</table>

\(^{(1)}\) Stresses beyond those listed under absolute maximum ratings may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions beyond those indicated under recommended operating conditions is not implied. Exposure to absolute–maximum–rated conditions for extended periods may affect device reliability.

1.3 Sensors and Actuators

Accelerometer

On board ultra low power 3 axis accelerometer.

Temperature

On board temperature sensor.

Battery

On board battery measure circuit.

Buttons

On board hardware reset and general purpose button.

LED

On board RGB LED with integrated controller.
1.4 Battery

Table 3. Lifetime on 3.0V LiMnO$_2$ with 2300mAh capacity

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Min.</th>
<th>Typ.($^1$)</th>
<th>Max.</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>T$_{LIFE}$</td>
<td>Motion sensor ON D7A downlink with 1s latency UWB localization</td>
<td>-</td>
<td>3</td>
<td>-</td>
<td>years</td>
</tr>
</tbody>
</table>

(1) 60 s per day cumulative transmission time (40 LoRaWAN uplink messages with SF12 LoRa modulation or 1500 D7A uplink messages with GFSK modulation at 55 kbps). 10 localization (10 x 4 two-way ranging) per day.
2 Casing and Battery

2.1 Off-the-shelf Option

The WOLT is proposed off-the-shelf in a transparent 78 x 39 x 14 mm blue casing respecting the IP65 specification of IEC 529 (Dust and Hose-proof) and powered with a flat LiMnO2 battery with 2300 mAh capacity.

2.2 Custom Options

The WOLT can be fitted into custom transparent or non transparent casing and supports input voltages from 2.4V to 5V (DC-DC option) allowing to adapt the battery capacity to the use case. For more information, please contact us at: contact@wizzilab.com
3 Sub-GHz modem

3.1 Certifications

**ECC/RED**
If deployed in Europe, the WOLT is provided with ECC/RED certified DASH7/LoRaWAN (TTN) network profiles.

**FCC**
If deployed in North America, the WOLT is provided with FCC certified DASH7/LoRaWAN (TTN) network profiles.

3.2 Data rates
The DASH7 modem has several data rates and modulation scheme available to better fit any kind of application.

Table 4. DASH7 sub-GHz data rates

<table>
<thead>
<tr>
<th>Modulation scheme</th>
<th>Parameter</th>
<th>Rate</th>
<th>Data Rate</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>GFSK</td>
<td>ECC and FCC</td>
<td>High</td>
<td>166700</td>
<td>bps</td>
</tr>
<tr>
<td></td>
<td>ECC and FCC</td>
<td>Normal</td>
<td>55600</td>
<td>bps</td>
</tr>
<tr>
<td></td>
<td>ECC and FCC</td>
<td>Low</td>
<td>9600</td>
<td>bps</td>
</tr>
<tr>
<td>LoRa</td>
<td>ECC and FCC</td>
<td>SF8</td>
<td>3125</td>
<td>bps</td>
</tr>
<tr>
<td></td>
<td>ECC and FCC</td>
<td>SF10</td>
<td>980</td>
<td>bps</td>
</tr>
<tr>
<td></td>
<td>ECC only</td>
<td>SF11</td>
<td>440</td>
<td>bps</td>
</tr>
<tr>
<td></td>
<td>ECC only</td>
<td>SF12</td>
<td>250</td>
<td>bps</td>
</tr>
</tbody>
</table>
3.3 Transmitting power

Table 5. DASH7 sub-GHz transmission power

<table>
<thead>
<tr>
<th>Condition</th>
<th>Max TX power</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECC/RED regulations</td>
<td>+14</td>
<td>dBm</td>
</tr>
<tr>
<td>FCC regulations</td>
<td>+14</td>
<td>dBm</td>
</tr>
<tr>
<td>Non regulated</td>
<td>+14</td>
<td>dBm</td>
</tr>
</tbody>
</table>

3.4 Receiver sensitivity

Table 6. DASH7 sub-GHz reception sensitivity

<table>
<thead>
<tr>
<th>Modulation scheme</th>
<th>Rate</th>
<th>Typical Sensitivity</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>GFSK</td>
<td>High</td>
<td>-105.0</td>
<td>dBm</td>
</tr>
<tr>
<td></td>
<td>Normal</td>
<td>-110.0</td>
<td>dBm</td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td>-117.5</td>
<td>dBm</td>
</tr>
<tr>
<td>LoRa</td>
<td>SF8</td>
<td>-125.5</td>
<td>dBm</td>
</tr>
<tr>
<td></td>
<td>SF10</td>
<td>-131.0</td>
<td>dBm</td>
</tr>
<tr>
<td></td>
<td>SF11</td>
<td>-133.5</td>
<td>dBm</td>
</tr>
<tr>
<td></td>
<td>SF12</td>
<td>-135.5</td>
<td>dBm</td>
</tr>
</tbody>
</table>

3.5 Ranging

Table 7. Ranging error

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>$E_{DIST-D7A}$</td>
<td>Power attenuation (link budget) ranging error (1)</td>
<td>-</td>
<td>30</td>
<td>-</td>
<td>m</td>
</tr>
<tr>
<td>$E_{DIST-LWAN}$</td>
<td>Power attenuation (link budget) ranging error (1) with TDOA enhancement</td>
<td>-</td>
<td>1000</td>
<td>-</td>
<td>m</td>
</tr>
</tbody>
</table>

(1) Highly depends on anchor / gateway density, line-of-sight conditions, operator.
4 UWB modem

4.1 Certifications
Certification-ready firmware based on DWM1001 hardware.

4.2 Data rates
The DASH7 modem has several data rates and modulation scheme available to better fit any kind of application.

Table 8. DASH7-UWB data rates

<table>
<thead>
<tr>
<th>Modulation scheme</th>
<th>Parameter</th>
<th>802,154a channel</th>
<th>Data Rate</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>UWB</td>
<td>ECC and FCC</td>
<td>#5 (6.4 GHz)</td>
<td>110000</td>
<td>bps</td>
</tr>
<tr>
<td></td>
<td>ECC and FCC</td>
<td>#5 (6.4 GHz)</td>
<td>850000</td>
<td>bps</td>
</tr>
</tbody>
</table>

4.3 Transmitting power

Table 9. DASH7-UWB transmission power

<table>
<thead>
<tr>
<th>Condition</th>
<th>Max TX power</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECC/RED regulations</td>
<td>+16 dBm</td>
<td></td>
</tr>
<tr>
<td>FCC regulations</td>
<td>+16 dBm</td>
<td></td>
</tr>
<tr>
<td>Non regulated</td>
<td>+31 dBm</td>
<td></td>
</tr>
</tbody>
</table>

4.4 Ranging

Table 10. DASH7-UWB ranging error

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>$E_{DIST-TWR}$</td>
<td>Two-way ranging error (1)</td>
<td>-</td>
<td>30</td>
<td>-</td>
<td>cm</td>
</tr>
<tr>
<td>$E_{DIST-TDOA}$</td>
<td>Time difference of arrival ranging error (2)</td>
<td>-</td>
<td>30</td>
<td>-</td>
<td>cm</td>
</tr>
</tbody>
</table>

(1) two-way ranging by time of flight estimation without preliminary clock synchronization between the tag and the anchor, according to Decawave’s application note APS013. (2) Depends on inter-anchors’ synchronization accuracy.
5 NFC & BTLE connectivity

TBD
6 Application

6.1 Indoor / Outdoor Tracker

The WOLT can be used for efficient combined indoor-outdoor tracking due to the combination of long / mid / short range connectivity. It is also useful for identification due to its NFC & BTLE connectivity. The UWB ranging provides high localization accuracy up to 10 cm.

6.2 Ready to deploy

The WOLT is suited for proof of concept, pilot and volume applications. By default, it is provisioned with LoRaWAN credentials for TTN (www.thethingsnetwork.org). For DASH7 communication, WizziLab provides infrastructure for easy D7A network deployment. The WOLT-D7A-UWB seamlessly connects to the WizziLab’s DASH7 Industrial IoT platform.

For details visit our website: www.wizzilab.com/products
DASH7 Access Point (gateway) and Network Management Platform
(https://dash7board.wizzilab.com)
6.3 Firmware

The WOLT is provided with highly configurable firmware, allowing to select beacon rates, beacon conditions (motion detection, …) and beacon networks (LoRaWAN and/or D7A). Downlink access over D7A and LoRaWAN is available for static / dynamic configuration, FOTA and actuation (LED blinking). Identification over NFC and BTLE beaconing are available as well.
7 The WOLT Family

The WOLT trackers family also includes an ultra wide band tracker, WOLT-UWB and a dual mode UWB/FSK/LORA tracker.

For details visit our website: [www.wizzilab.com/products](http://www.wizzilab.com/products)
8 Ordering information

Contact us at: contact@wizzilab.com

Or visit our website: http://www.wizzilab.com/products
9 Revision history

Table 11. Document revision history

<table>
<thead>
<tr>
<th>Date</th>
<th>Revision</th>
<th>Changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>2019-09-12</td>
<td>1.0</td>
<td>Document creation.</td>
</tr>
</tbody>
</table>