life.augmented

AN5620

Application note

B-UWB-MEK1 filter adjustment

Introduction

B-UWB-MEK1 boards compute distances and positions with powerful location algorithms embedded in the B-UWB-MOD1 module. Relying on extended Kalman filters, their solver works on multiple equations using the incoming measurements to compute a location estimation. The output is then either the 3D-location estimation or a distance between a fixed device and a mobile device.

The default values are adapted to multiple cases and provide robust positioning results. However, some specific environments may require a smoother or more reactive output.

The application MOD1/MEK1 programming tool offers many possibilities to fine-tune the filter and post-process parameters in 1D-filtered, 3D-single self-positioning, and 3D GPS-like modes.

This application note complements the information available in the SDK. It is intended for advanced users already familiar with the quick start guide. It is based on system version 3.x.

UWB

1 General information

B-UWB-MEK1 embeds the B-UWB-MOD1, which features the STM32L476JE 32-bit microcontroller based on the Arm® 32-bit Cortex®-M4 processor.

Note: Arm is a registered trademark of Arm Limited (or its subsidiaries) in the US and/or elsewhere.

Definitions

Table 1 presents the definition of acronyms that are relevant for a better understanding of this document.

Table 1. List of acronyms

Term	Definition
3D_SELF	3D single self-positioning
BLR	Beacon-listening rate
HF	Hyperframe
PHS	Protocol hyperframe size
PSN	Protocol slot number
PSS	Protocol slot size
RTLS	Real-time locating system
RV	Rendez-vous (slot and zone)
SF	Superframe
SFI	Superframe information
TDMA	Time-division multiple access
UWB	Ultra-wideband

References

Refer to the following documents for an introduction to the B-UWB-MEK1 and B-UWB-MOD1 products in indoor location systems:

- Ultra-wideband module for high-precision indoor location (DB4404)
- Evaluation kit for the B-UWB-MOD1 ultra-wideband module (DB4392)
- B-UWB-MEK1 quick start guide (UM2798)
- SDK advanced documentation

Demonstration software

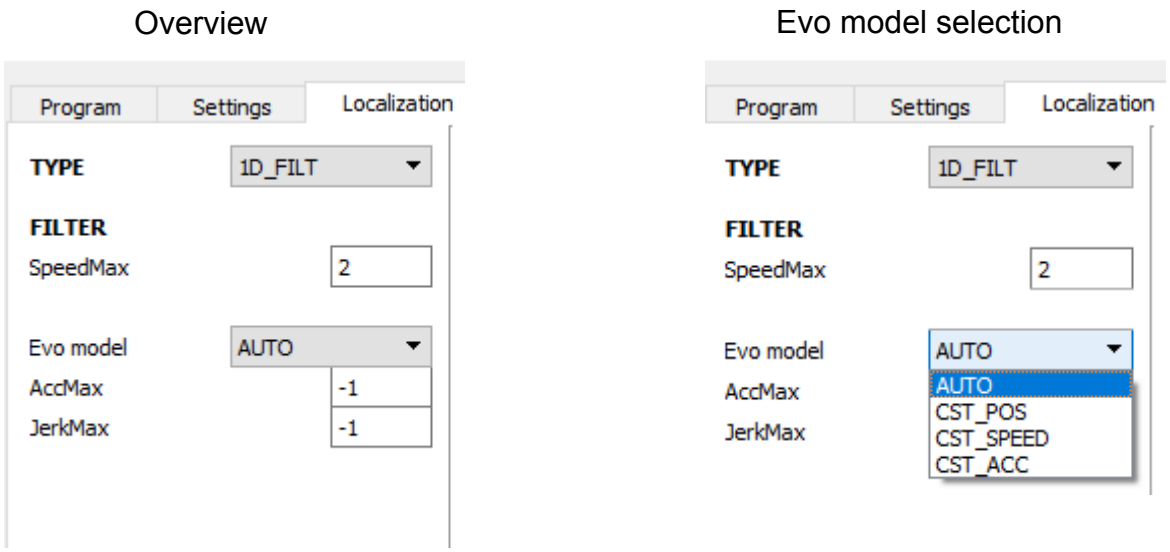
Contact the local STMicroelectronics sales office or distributor (refer to *www.st.com*) for the latest software and associated documentation.

2 Filter parameters

2.1 Motion parameters (1D-filtered and 3D modes)

Three evolution models may apply to the device motion: constant position, constant speed, and constant acceleration. Each of them is linked to the motion parameters speed, acceleration, and jerk.

Figure 1. Display in MOD1/MEK1 programming tool - advanced settings



SpeedMax is the maximum speed that can be reached by the mobile device, expressed in $m.s^{-1}$.

AccMax (advanced setting) is the maximum acceleration rate that can be reached by the mobile device. The value set at -1 means automatic adjustment.

JerkMax (advanced setting) is the maximum rate of change in acceleration versus time which can be reached by the mobile device. The value set at -1 means automatic adjustment.

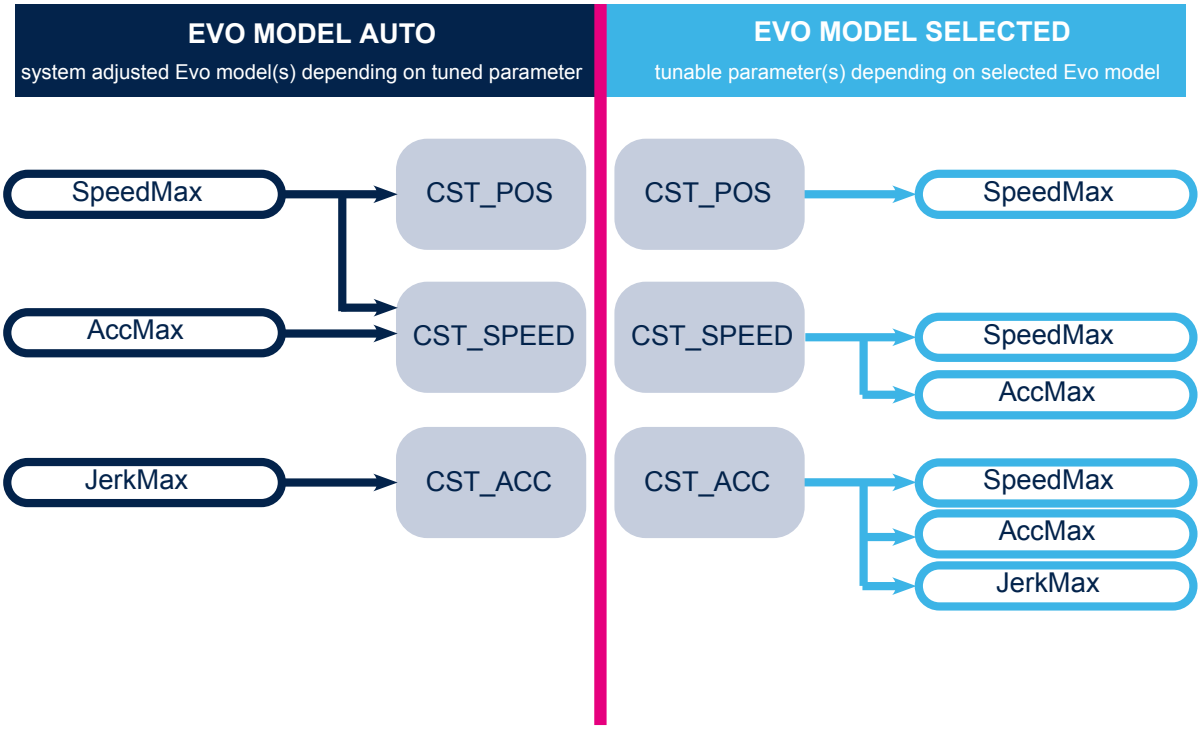
AUTO sets the automatic adjustment of the Evolution mode, depending on the parameter tuned by the user

CST_POS (constant position) concerns devices with seldom motions.

CST_SPEED (constant speed) concerns devices with constant speed.

CST_ACC (constant acceleration) concerns devices with a constant acceleration rate.

Figure 2. **Tuning rules**



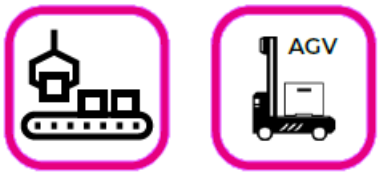
Typical values

There is no rule of thumb to tune these parameters. However, functional tests and practical deployment experience reveals the following principles:

- Dynamic and fidgety systems often need high values for the major part of the parameters
- On the opposite, smooth systems rather need low values

Note: *Human walk speed is 2 $m.s^{-1}$. Human run speed is 10 $m.s^{-1}$.*

Table 2. **A few examples**

Use case	Evo model	Parameter tuning
	Constant position	SpeedMax 1 $m.s^{-1}$
	Constant speed	SpeedMax 2 $m.s^{-1}$
	Constant speed	SpeedMax 3 $m.s^{-1}$
	Constant speed	SpeedMax 5 $m.s^{-1}$
	Constant acceleration	JerkMax 10-50 $m.s^{-2}$

2.2 Minimum number of fixed devices (3D modes only)

The parameter [**Min anchor nb**] defines the minimum set of measurements needed to launch the algorithm in 3D Single Self-Positioning and 3D GPS-like modes. The higher the amount, the more system robustness is ensured.

Typical values

The default value, set at 3, enables 2D location. A minimum of 4 is needed for a 3D-location estimation.

3 Postprocess parameters

3.1 Sliding average (1D-filtered and 3D modes)

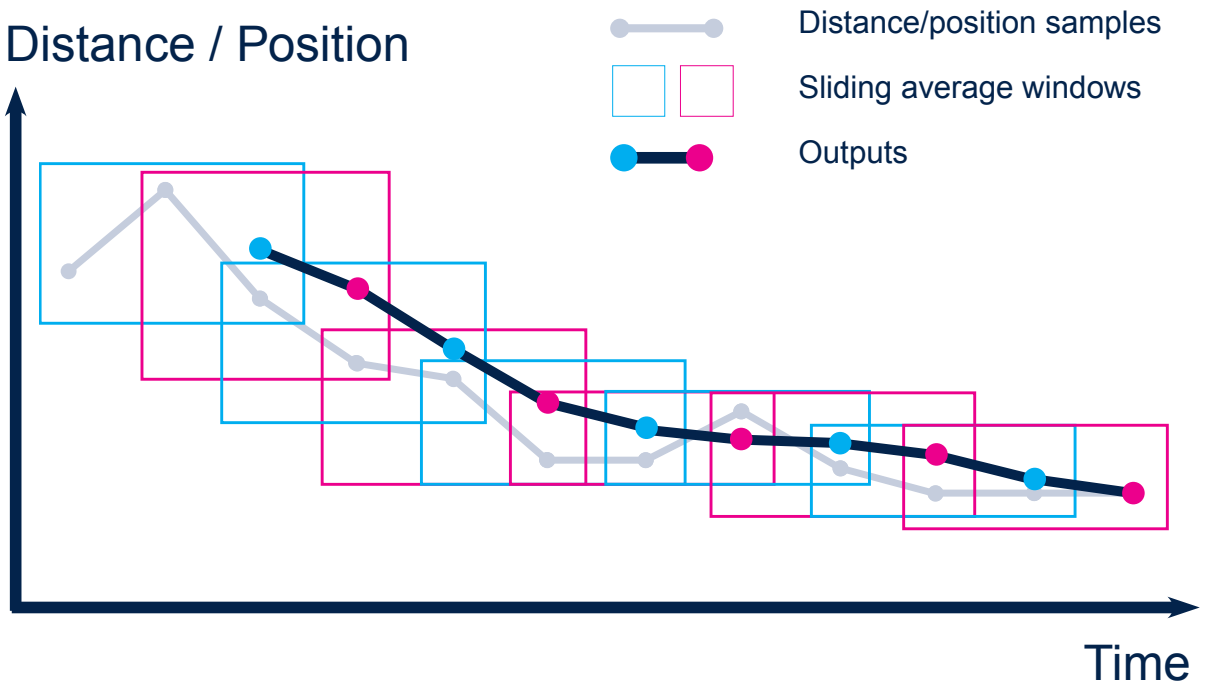
Sliding smoothens the output trajectory by computing an average value based on a sample of the most recent distances or positions. This parameter can be visualized as a sliding window containing a sample, as illustrated in Figure 3 with an average computed from 3 distances per position.

The parameter is activated if values are higher than 1.

Increasing the value makes the output smoother, but adds a constant delay:

$$Delay = Window\_size \times Sampling\_period \div 2$$

Figure 3. Sliding average



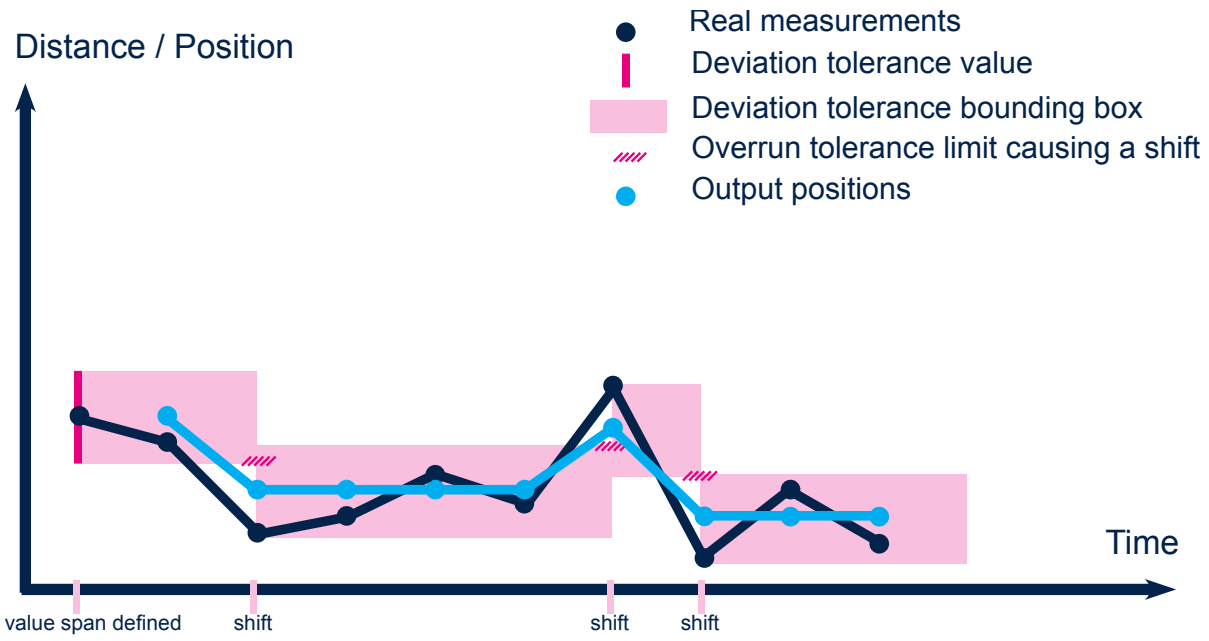
3.2 Accuracy filter (1D-filtered and 3D modes)

The accuracy filter smoothens the output positions by setting aside the position noise which occurs within a defined interval of tolerated deviation.

The interval is expressed in millimeters and includes positive and negative variations around the real measurement. The smoothed output is set at the center of the interval.

Figure 4 illustrates the feature as a bounding box that shifts along the distance/position axis, as soon as the real measurement moves outside of the defined interval.

Figure 4. Accuracy filter



3.3 Forced coordinates (3D modes only)

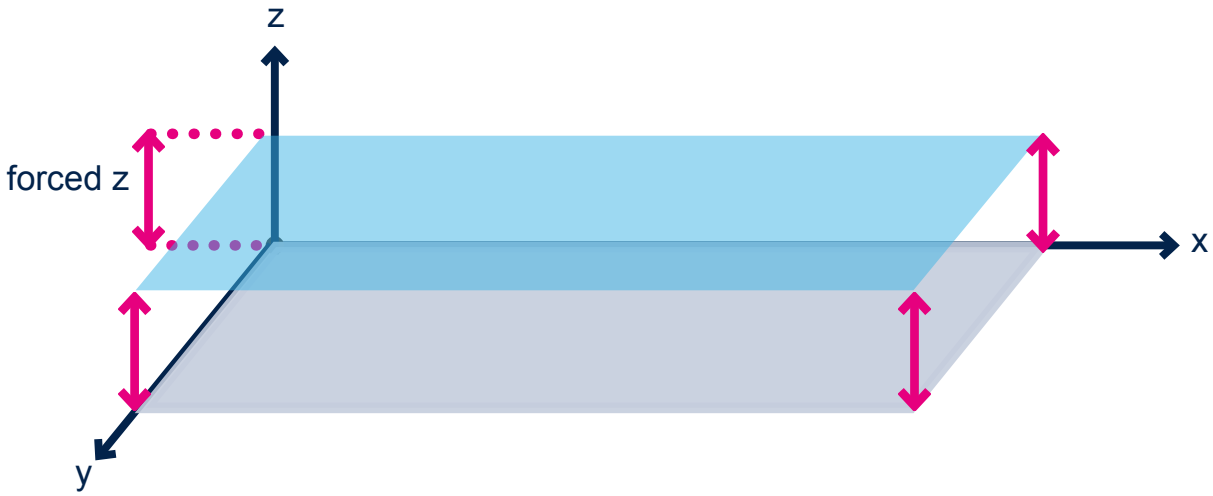
The checkboxes [**Force X Coord**], [**Force Y Coord**], and [**Force Z Coord**] lock the coordinates on one or two axes. This feature contributes to decreasing the margin of error.

Example 1

Z-axis is forced, as the height of the tracked device(s) is supposed to be constant. The system computes the positions on a fixed X/Y plane.

Possible use case: Automated guided vehicle (AGV) moving on an even ground.

Figure 5. Forced Z

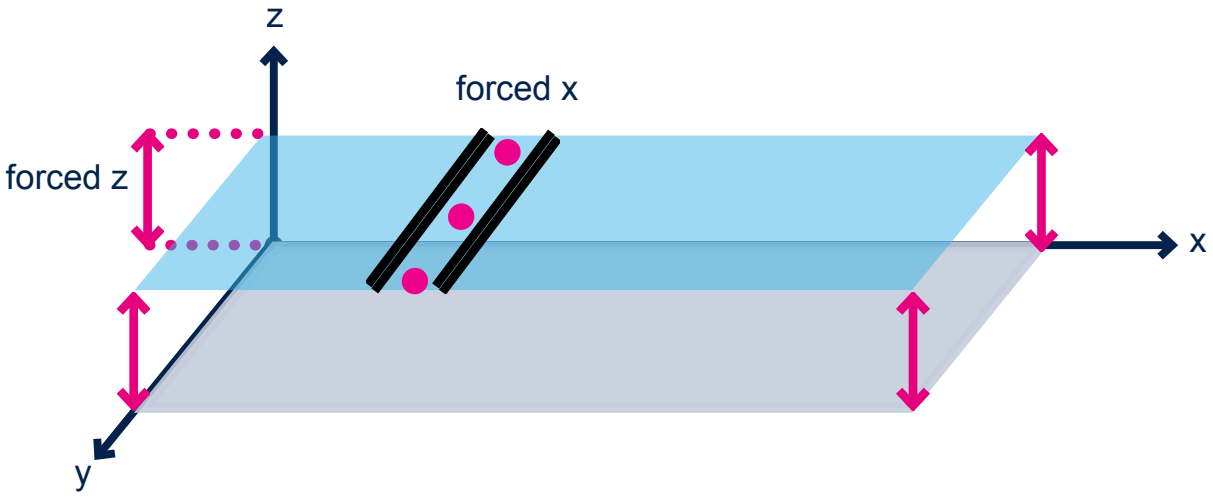


Example 2

X and Z axis are forced, as only 1D positioning of the tracked device(s) on Y is needed.

Possible use case: Device moving on a rail.

Figure 6. Forced X and Z



4 Customization procedure

Caution: The parameters are based on complex equations. Take into account all environment parameters that may impact the algorithmic computation.

The customization procedure is valid for all kinds of filter tuning.

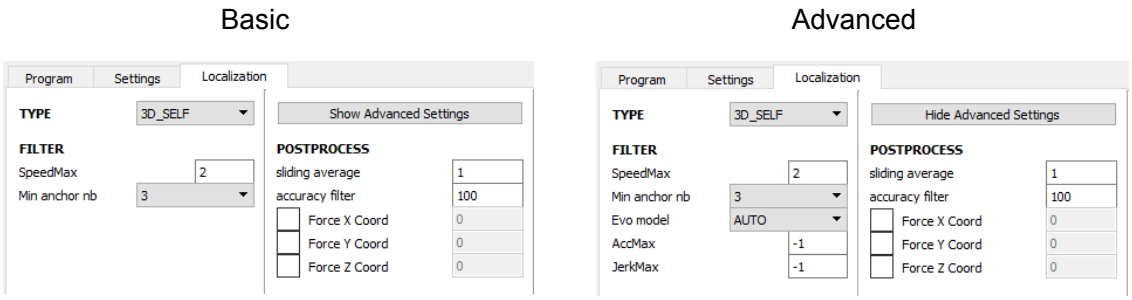
Apply it to the [**master board**] of your setup:

Step 1. In the MOD1/MEK1 programming tool, open the [**Localization**] tab and select your location mode in the [**TYPE**] menu.

Step 2. Remain on the basic setting display or select [**Show Advanced Settings**], depending on the parameter(s) to be tuned:

Figure 7 Example:

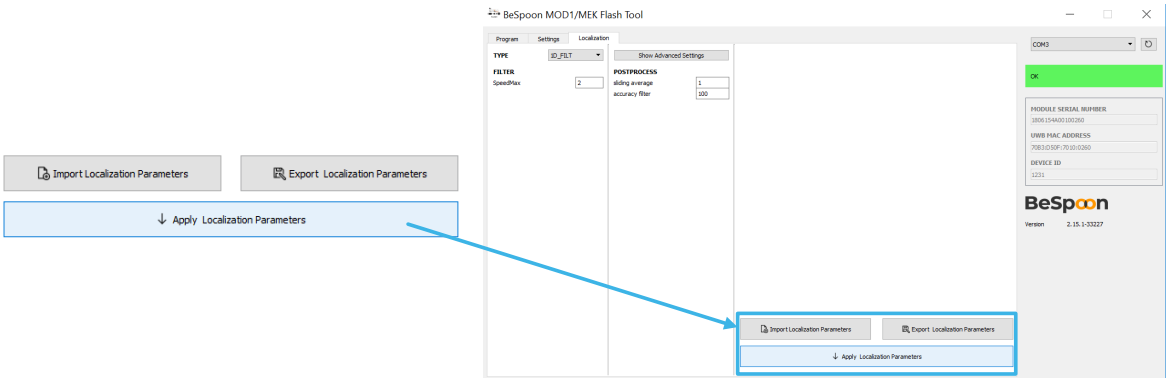
Figure 7. Basic versus advanced settings in 3D_SELF mode



Step 3. Modify the parameter(s) according to the rules described in the Introduction and Filter parameters.

Step 4. Click on [**Apply localization parameters**].

Figure 8. Apply localization parameters



Step 5. Wait until the progress bar displays OK.

The filter is customized.

5 Ask for support

Additional information is available from the documents listed in References. All documents may be updated without notice to individual users beforehand.

For up-to-date support or information about standardized as well as customized solutions, refer to the UWB and product pages on *www.st.com*, or to the nearest STMicroelectronics office.

Revision history

Table 3. **Document revision history**

Date	Revision	Changes
20-Apr-2021	1	Initial release.

Contents

List of tables

List of figures