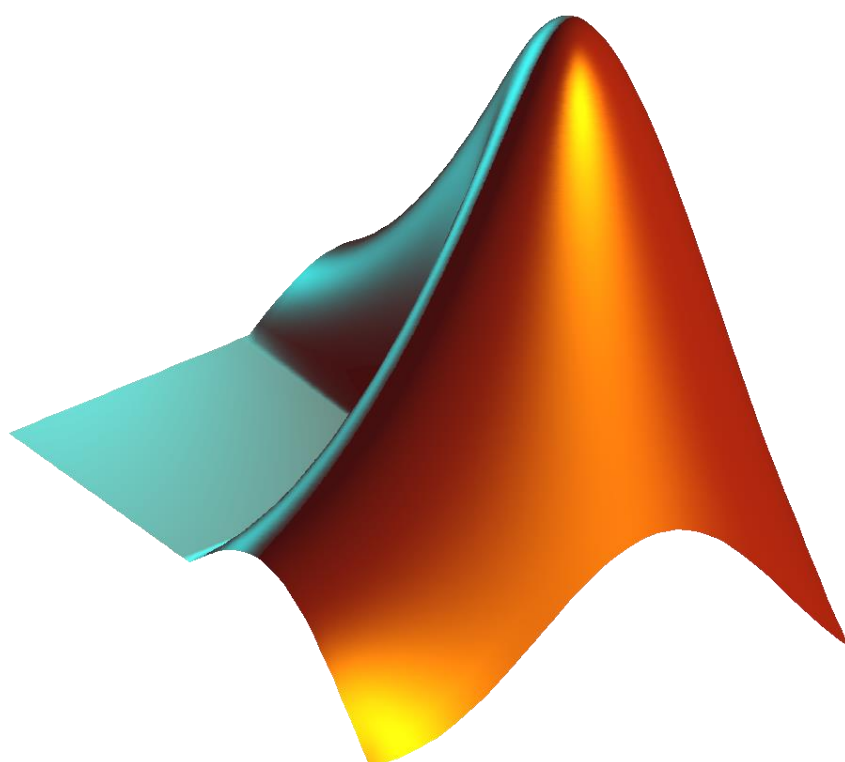


# TMSi MATLAB Interface

## User Manual



REVISION 1



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**SoftPro**

## INTRODUCTION

### About this document

This document describes the TMSi MATLAB Interface, what it does, how it should work and what you can and cannot expect from TMSi regarding this interface. Please read carefully through this document.

### TMSi MATLAB Interface

The TMSi MATLAB Interface is a library for MATLAB written by TMSi to interface the TMSi PC Driver to MATLAB. This interface allow you to acquire data, write and read .poly5 files via MATLAB and/or export data to EEGLAB (<http://sccn.ucsd.edu/eeglab/>).

Functionality that is included in the TMSi MATLAB Interface is limited to the signal acquisition part of the driver and loading data from previously recorded data in TMSi Polybench or the TMSi MATLAB Interface. All functionality needed to perform on-board memory recordings (so-called ambulatory measurement) as present in the Mobita, Mobi and Porti is **NOT** implemented.

### License and Support

The TMSi MATLAB interface is **free of charge** and distributed under MIT License. In short this means that you can do what you want with the MATLAB interface. The complete text of the MIT license is included in the LICENSE.txt in the package, as well as in this document.

The fact that this interface is free of charge has implications for the level of support you can expect from TMSi. TMSi has tested the interface, but cannot guarantee that it works under any circumstance, let alone that it will function in the experimental setup that you have in mind.

### TMSi Support Forum

The TMSi MATLAB interface can be downloaded from our TMSi Support Forum. The Forum can be found on the website under 'Support' ([www.tmsi.com](http://www.tmsi.com)). The forum can be used to post remarks, questions, report bugs or algorithms that you developed for the TMSi MATLAB Interface. TMSi cannot and will not support you in writing MATLAB code. We can give some hints towards a possible solution or where to look in the code, but that is how

far we can go with this. However, there may be users of the forum and TMSi MATLAB Interface who may be able to help you, so do not hesitate to ask your questions. We hope that you as a researcher are also willing to help us, helping others on the usage and implementation of new algorithms, tools etc.

In summary, the support on the interface itself will be limited, but we support the usage of the device itself, the PC Driver and the raw code of the TMSi MATLAB interface.

### **TMSi Polybench or the TMSi MATLAB Interface?**

TMSi Polybench is our toolbox based software package which we continue to support and sell. The MATLAB interface will not, in any way, replace TMSi Polybench. Researchers who want to easily measure signals in a simple graphical environment, where you can create your own measurement configurations using symbolic programming without coding or scripting skills: TMSi Polybench is the way to go. TMSi Polybench is licensed software and not free of charge. Please contact [sales@tmsi.com](mailto:sales@tmsi.com) for more information.

The TMSi MATLAB Interface is to be used by engineers and researchers who are familiar or willing to become familiar with MATLAB and scripting. There are many tutorials, videos, webinars and examples on the web available to learn to use MATLAB. The TMSi MATLAB Interface code is easy to understand and well-documented with comments in the code. You probably do not have to change the more complex aspects of the implemented functions of the TMSi PC Driver.

## DESCRIPTION OF THE TMSi MATLAB INTERFACE

### Installation requirements

The TMSi MATLAB Interface requires:

- A computer with Windows 7, 8.1 or 10, 32-bit or 64-bit.
- TMSi PC Driver 7.2.144 (older versions will not work!)
- MATLAB 2010a or later. (64-bit is recommended)

The TMSi MATLAB interface does not require special toolboxes, although the Signal Processing Toolbox is recommended.

### Getting started

Copy the +TMSi/ folder to your working directory and reference the classes according to TMSi/<class>. The easiest way to start using the interface is follow the examples in the +TMSi folder. With the examples you will be guided through the main features of the TMSi MATLAB interface. Connect a TMSi device to the PC as you would normally do and follow the steps on screen.

### Features

The code in the TMSi MATLAB Interface is a MATLAB library for sampling TMSi devices. The goal of this library is to give an easy programmable interface to TMSi devices.

Currently the library provides:

- Sampling from USB, Wi-Fi, network and Bluetooth TMSi devices.
- (Limited) Real-Time plotting of sampled data.
- Directly saving sampled data to .Poly5 file format.
- Offline export of .Poly5 data to EEGLAB.
- Support for sampling using SynFi and Fusbi.

This library has been tested on:

- MATLAB 2016a (Windows 7 / 64-bit)
- MATLAB 2015a (Windows 8 / 64-bit)
- MATLAB 2012b (Windows 8 / 64-bit)
- MATLAB 2010a (Windows XP / 32-bit)

## Recommendations

A few recommendations and things to keep in mind when using this code.

- Make sure that `TMSi.Sampler.stop()` and `TMSi.Sampler.disconnect()` are always called, even in case of an error: see examples.
- `TMSi.Data` object is not very efficient with memory, because it will append data and extend the array continuously. If you are measuring for extended period of times and you want to save the data use `TMSi.Poly5` class.
- Limit the channels that are shown in a `RealTimePlot`.
- Limit the window size of `RealTimePlot` to ~30 seconds.

## Content

The library contains the following:

### +TMSi/

Contains all the classes used in the library. Should be copied to working directory of MATLAB in order to work correctly.

### +TMSi/Data

Class that represents data retrieved from the TMSi devices. This class can be used for storage of data for short measurements (~10 minutes). This class also provides means to export data to EEGLAB.

### +TMSi/Device

Class that describes the features and properties of a TMSi device such as the serial number, configuration and firmware versions.

### +TMSi/HiddenHandle

This file can be ignored as it only reduces clutter in documentation.

### +TMSi/Library

The Library is the communication channel to the driver. It uses the `TMSiSDK.dll` to connect to and retrieve information for TMSi devices.

### +TMSi/Poly5

The Poly5 class provide means to stream data to and store the data in .Poly5 files. It also allow offline reading Poly5 files. These files can be made using TMSi Polybench, Portilab or the TMSi MATLAB Interface.

### +TMSi/RealTimePlot

Class that allows a basic real-time plotting of sampled data. The RealTimePlot adds data and shows it in realtime. Closing the figure used for plotting will also close the connection to the device. The RealTimePlot allows user input when you press 'a' (AutoScale, 'q' (Quit) or 'r' (Input field to set all signal ranges to a different value).

### +TMSi/Sampler

The Sampler is the class that is used for online streaming of data in signal mode or, if supported, impedance mode. It also controls the driver functions to do average reference calculation, or set the device to a different sample rate.

### +TMSi/TMSiHeader

A generated file by MATLAB required for interacting with TMSiSDK.dll file. It is recommended not to change anything here.

### +TMSi/TMSiSDK\_thunk\_pcwin64

Files required for 64-bit systems. Do not change.

### Example\*

Examples of how to use the library.

## Examples

### **Example01.m: Basic Sampling**

A very basic measurement setup to give an overview of the steps to be taken: open the library, connect to the device, setup the data acquisition connection and settings such as reference calculation and sampling rate and sample 10 times. After that, the connection is closed properly as should be done every time when you use the interface.

### **Example02.m: Sampling including safe closing in case of an error**

The same steps as in example01.m are performed. In case an error (for example in additional code) the interface closes the connection to the device properly.

### **Example03.m: RealTime Plot**

This example plots the data in realtime as long as the figure is visible. When the figure is closed, the connection will be closed.

### **Example04.m: Plotting and write to .Poly5**

The acquisition is started and the data will be written into .Poly5 file. This file can later be used for offline processing or be opened in Polybench for example.

### **Example05.m: Reading a Poly5 file and export to EEGLAB**

This example uses the Poly5 reader from the library to load a previously recorded file. After reading the data, it is converted into EEGLAB format and saved as EEGLAB readable dataset.

### **Example06.m: Impedance measurement**

Refa devices support impedance measurement. In this case the device is set into Impedance Mode and the impedance values are sampled 10 times.

### **Example07.m: Subset of channels for showing and saving**

Imagine that you do not want to store all channels, but just a small subset. This example shows you some first steps into what you should do to change the code to your needs. A small subset is now plotted and shown.



## FAQ

### Does the TMSi MATLAB Interface work in Octave?

**A:** No. Unfortunately not. The 'loadlibrary' call that imports the TMSi driver into a MATLAB environment is not supported by Octave. We would encourage and support you where we can in case you are willing to find a workaround for this in Octave. We are not pursuing the compatibility in Octave unless a `loadlibrary` or similar function is implemented in Octave. If you know a workaround, please let us know.

### Can I use the TMSi MATLAB Interface to program my device to record to a flash card?

**A:** No, we did not implement direct control for recording to flash disk. This requires TMSi Polybench. Contact TMSi Sales ([sales@tmsi.com](mailto:sales@tmsi.com)) for more information.

### What is reference calculation?

**A:** Reference calculation is a driver call that handles the average reference calculation for TMSi devices. In short: it takes the mean of all connected electrodes and subtracts that from each electrode. The default setting is 'true', unless you want to see the 50 Hz/ 60 Hz noise in the environment, or in case of using the Synfi we suggest that you keep it that way.

### The sampling rate is different from what I set in the code. Why is that?

**A:** TMSi has devices with different 'base sampling rates', depending on the configuration of the device. The device will always scale down to the highest available sampling rate. If the base sampling rate of your device is for example 2048 Hz, the setting 2000 Hz will scale down to 1024 Hz.

### I used to read my data using the 'tms\_read.m' script. Do I still need this script?

**A:** No. We made a complete new, much more efficient (in both speed and memory usage), .Poly5 reader. This reader covers all files recorded in TMSi Polybench or the TMSi MATLAB Interface. See `example05.m`

### What do I need to do if I get "Cannot open device" after an error?

**A:** First thing to do is to turn off your TMSi device, disconnect it from the computer and try again. If this does not work, restart MATLAB, else restart computer. Also make sure you have followed the steps mentioned in the User Manual of your device for correct installation.

### How can I identify loss of samples?

**A:** You can check loss of samples through inspection of the SAW channel. If there are inconsistencies in the SAW channel there was most likely some loss of samples.

**Why does RealTimePlot not show a correct saw sometimes?**

**A:** To ensure that RealTimePlot can keep up with the amount of data points sampled, the data is downsampled dynamically. This will cause loss of visual cues if window size of plot is too large. It downsamples to 4 several samples per pixel on screen. This can cause distorted 'saw' signals without you losing samples.

**Am I allowed to distribute the interface to my colleagues?**

**A:** Yes you are. However, we hope that you also mention to register on the TMSi Support Forum.

**How can I add online algorithms to the TMSi MATLAB interface?**

**A:** Please refer to available examples on the TMSi Support Forum.

**How much processing can I do before the TMSi MATLAB interface crashes?**

**A:** This is impossible to answer, as it will depend on your PC, memory, other processes and in general: because we don't know. We did some testing with Filtering, online spectrograms, and they worked fine.

## MIT License

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## Changelog

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*[www.tmsi.com](http://www.tmsi.com)*