



The Black Box ToolKit

Serious about science: Serious about timing

The Black Box ToolKit T-Pad v1

Quick Start Guide



Credits:

Author: Dr. Richard R. Plant, C.Psychol, CSci, AFBPsS

Covers the following hardware:

The Black Box ToolKit T-Pad - USB Response Pad with Integral Timing

For the following platforms:

Microsoft Windows XP SP3, Vista SP2 (32/64), Windows 7 SP1 (32/64)
Windows 8 (32/64), Windows 8.1 (32/64), Windows 10 (32/64), Windows 11 (64)
Mac OS 8/9, OS-X
Linux 2.4 and greater

Contact details:

Phone: +44 (0)114 303 00 56

Fax: +44 (0)114 303 46 56

Email: info@blackboxtoolkit.com
support@blackboxtoolkit.com
sales@blackboxtoolkit.com

Web address: www.blackboxtoolkit.com

The Black Box ToolKit Ltd (BBTK) makes no warranty or representation, either express or implied, with respect to this manual, its quality, accuracy, merchantability, or fitness for a particular purpose. In no event will The Black Box ToolKit Ltd be liable for direct, indirect, special, incidental, or consequential damages resulting from any defect or inaccuracy in this manual, even if advised of the possibility of such damage.

Copyright 2023-2025 The Black Box ToolKit Ltd. All rights reserved.

Contents

1. Introduction	5
a. Who	5
b. What	5
c. Where	5
d. When	5
e. Why	6
f. How	6
2. Standard USB HID Keyboard Mode	7
3. Using the T-Pad App Alongside Your own Experiment to Record Accurate Timings	8

Warnings and Cautions

Intended Usage

Unless otherwise labelled, all products offered for sale by The Black Box ToolKit Ltd are for academic study and/or research use only.

The Black Box ToolKit Ltd, instruments, components, and accessories are designed for educational and research oriented life science applications and investigations. The Black Box ToolKit Ltd, does not condone the use of its instruments for clinical medical applications. Instruments, components, and accessories provided by The Black Box ToolKit Ltd, are not intended for the diagnosis, cure, mitigation, treatment, or prevention of disease.

Electrostatic Discharge Instructions



T-Pad system components that are sensitive to electrostatic discharge are marked with the ESD symbol. For these T-Pad components, users should not directly touch any internal pins and should adhere to the following precautions when connecting electrodes or adapters to these components. Users should always ground themselves before handling these T-Pad components. Users should then ground the T-Pad component before connecting to other equipment by touching the screw terminals of the component cable or by touching the metal shell of the component.

Note that the information in this manual is subject to change, without notice. The manufacturer declines responsibility for the safety, reliability, and performance of T-Pad system components if not used in compliance with T-Pad documentation.

1. Introduction

The aim of this Quick Start Guide is to give you a brief overview of the T-Pad response pad and covers who should be using it through to how it can be used to help you improve your timing accuracy and experimental rigor.

Once you have read this short guide you should be able to quickly and easily use the T-Pad to act as your response device and millisecond accurate timing partner in any of your experiments.

For more advanced users a detailed in-depth manual is provided to give more background and concrete examples of how to integrate the T-Pad into your experiments using code and serial communication over USB.

a. Who

If you are a psychologist, neuroscientist or vision researcher who uses a computer to run experiments and report timing accuracy in units of a millisecond, then it is likely your timings are wrong! Anyone who measures and reports response timing accuracy in units of a millisecond using computer delivered experiments should be using the T-Pad to ensure they are reporting true and accurate findings.

b. What

Our advanced USB response pad, the T-Pad, is designed to quickly and easily help you achieve better millisecond accurate timing in your Psychology experiments. It has a hardware based timer that is completely separate from your computer and gives independent timings for visual stimulus onsets, button presses and vocal responses via a voice key microphone.

- USB Response Pad with Integral Timing
- Up to 10x Built-in Buttons, Hand-held buttons or Foot Pedals
- 2x Opto-detectors
- 1x Microphone/Voice Key
- 13x TTL Out
- 1x TTL In
- 1x USB Keyboard HID
- 1x USB Serial VCP

c. Where

You should use the T-Pad in any experiments where you use a computer for presentation of stimulus materials, synchronization, TTL event marking on other equipment, e.g. EEG, eye-trackers etc. and recording of Reaction Times, or RT's, via button presses or voice key. If you record and report timings in units of a millisecond this is critical.

d. When

In short whenever you use a computer to deliver a Psychology experiment. It is recognized that online and cross-platform studies are most susceptible to timing variation regardless of system used. Online systems include: PsyToolkit, Labvanced, Gorilla, Testable, Pavlovia or jsPsych among others. Timing error affects your work even when you use standalone experiment generator software such as: E-Prime, MATLAB, PsychToolbox, PsychoPy, Presentation, Inquisit, Superlab, OpenSesame and PEBL etc. Online and lab-based psychology experiments are equally prone to timing errors.

e. Why

Timing error affects your work even when you use standalone experiment generator software such as: E-Prime, MATLAB, PsychToolbox, PsychoPy, Presentation, Inquisit, Superlab, OpenSesame and PEBL etc. Online and lab-based psychology experiments are equally prone to timing errors. The Black Box ToolKit Ltd specializes in professional measurement and calibration products that help you achieve millisecond accurate stimulus presentation and response timing, synchronization and TTL event marking, or triggering, in your computer-based experiments. Remember poorly controlled psychology experiments can lead to replication failure, spurious results, questionable conclusions and bad science. Without using the T-Pad you can never be 100% confident of your results.

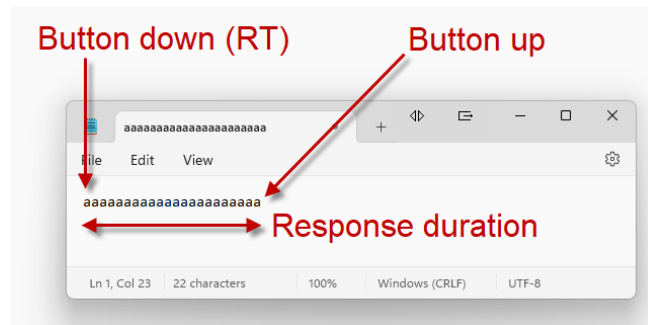
f. How

All activity the T-Pad detects as your experiment runs is streamed to your experiment along with an independent timestamp. That might be the onset, duration and offset of a visual stimulus image, a button press or a vocal response. By using photodiodes, or opto-detectors, that attach to your screen the T-Pad can detect visual stimulus onsets as they happen in the real world, independently timestamp them and send them to your experiment. It also detects responses on up to 10 built-in buttons and provides millisecond accurate reaction times or RTs. Up to 10 external hand-held response buttons and foot pedals can also be used to capture responses along with TTL trigger input and a voice key microphone. Alternatively simply plug a second USB lead into a USB port on your PC/Mac/Linux system and our advanced USB response pad will appear as a second keyboard. The T-Pad also works on any platform including Apple iPads, Android tablets and phones with appropriate adapter. Press a button and a standard keystroke will be sent to your experiment.

2. Standard USB HID Keyboard Mode

To get you up and running as quickly and easily as possible the T-Pad can be used as a standard USB HID keyboard connected via its USB keyboard socket. In this mode it appears as a second USB keyboard and when you press a button it is as though you pressed a key on a standard keyboard. No drivers are required and it should just work when you plug it in! When working as a USB keyboard the T-Pad operates as a full speed USB device running at 1,000 Hz meaning it can send button down data to your PC in 1 millisecond. Internally it checks for button down and other activity around 5,000 times a second (5kHz). However in this mode you should remember that the software you are using to run an experiment may not be able to detect responses in such a timely fashion and may record the wrong timings. In USB keyboard mode all timings are provided by your own software that is administering the experiment and the independent hardware timer within the T-Pad is not used.

As the T-Pad can operate as a standard keyboard you can open Notepad or any other text editor and see the effect of pressing a button. For example, if button 1 was pressed down the letter 'a' would appear in Notepad. If you kept the button pressed down, this would repeat as if you had held the key down on a standard keyboard.



When you let the button up it would be like letting the key up. To the PC this provides two signals, Key Down and Key Up. Your experiment then has access to Reaction Time (RT) and response duration, or how long the button was held down.

By default the T-Pad produces the following HID keyboard keystrokes for buttons (Bx), visual stimuli (Opto 1 & 2), vocal responses (Voice Key) and TTL In, all of which can be recorded by your experiment:

Input	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	Opto 1	Opto 2	Voice Key	TTL In
HID Key	a	b	c	d	e	f	g	h	i	j	k	l	m	n

What's more the T-Pad also features integrated hardware based TTL triggers which automatically event mark activity related to onsets and reaction times in the real world as they occur with sub-millisecond accuracy. This makes the T-Pad an easy to use fit and forget solution for TTL event marking/TTL triggering in Psychology experiments that use EEG, fMRI, Eye Tracking or any study where you need to event mark with sub-millisecond accuracy. Typically it can TTL event mark in around 100 millionths of a second (100 uS) after detecting activity.

3. Using the T-Pad App Alongside Your own Experiment to Record Accurate Timings

An alternative to letting your own software record presentation and response timings alone is to let our partner App record those in parallel. In this mode the T-Pad App runs alongside your experiment and records all activity and timings from the independent hardware timer inside the T-Pad. You just concentrate on standard keyboard key presses and leave the heavy lifting to us! As far as your experiment is concerned the keystrokes outlined in the section above are all you need monitor.

All you need do is use the USB Keyboard Connection for the T-Pad to report keystrokes to your experiment. The second USB Serial connection, or Virtual Communications Port (VCP), sends activity and millisecond accurate hardware based timing data to our App. No need to recode! Works out of the box with E-Prime, SuperLab, Presentation, Inquisit, PsychoPy or any other software that can accept standard keyboard responses. Activity on a photodiode, microphone or TTL trigger input also produces a standard keyboard keystroke alongside button presses.

With both USB leads connected the T-Pad simultaneously sends keyboard key presses to your experiment and timings to our App. At the end of your experiment you have the option to export timing data from our App, analyze activity and timings from within the App or use the App to Synchronize data your experiment recorded with what we captured.

A typical scenario might be where you wish to run your own simple visual stimulus choice reaction time experiment and have inserted opto patch markers into your materials. In this example you might press button 1 when a green smiley face is presented and button 2 when a red sad face is presented.

Welcome to a simple T-Pad experiment

Press button 1 if green
Press button 2 if red
[ESC] will quit

I will debrief you after the experiment.

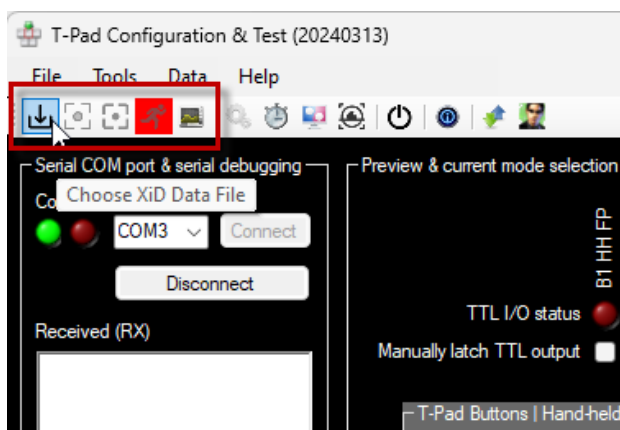
Press [SPACE] to start



When you wish for the onset of a visual stimulus to be recorded you should ensure that a white patch appears under an opto-detector. In this example a white opto marker has been inserted into each stimulus image at the same position on the right. The opto-detector when plugged into the T-Pad would be placed over this spot on the screen. For the duration of the stimulus image you should ensure that the pure white patch is shown (stimulus onset and duration). Prior to and after the stimulus is displayed you should ensure that a pure black opto patch is shown at the same location (stimulus offset and ISI or Inter-Stimulus Interval). To make testing simpler you may choose to set your background to a constant pure black. By using a black (no stimulus) and a white opto patch (stimulus shown) this enables the opto-detector to detect the onset of the visual stimulus when it first appears, its duration and its offset when it is removed. For the green smiley face (target) you would set your response key as the letter 'a' as if the 'a' key had been pressed on a standard keyboard, i.e. button 1 on the T-Pad. For the red sad face button 2, 'b'.

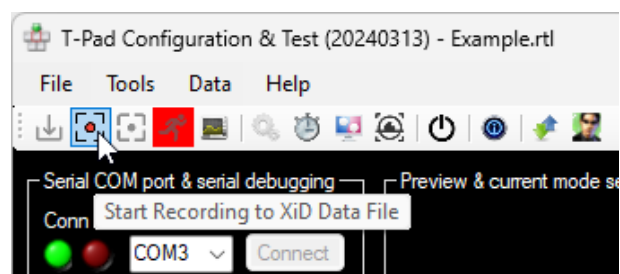
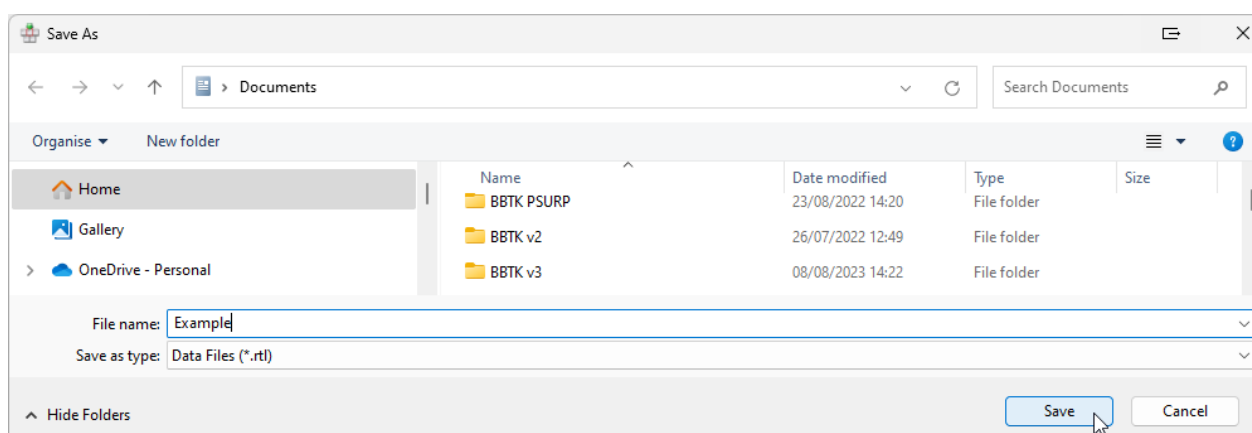
To capture events and timing data you will need to ensure that you are connected to the T-Pad and that your sensor sensitivity and thresholds are set correctly. You also need to be running in Mode 3: XiD protocol.

For information on installing the Configuration and Test App see the Installation Guide.



After starting the App the first thing you need to do this click on the Choose XiD Data File button.

Next choose the folder and filename you wish to save data into. In effect this will save all streamed data from the T-Pad into this file.

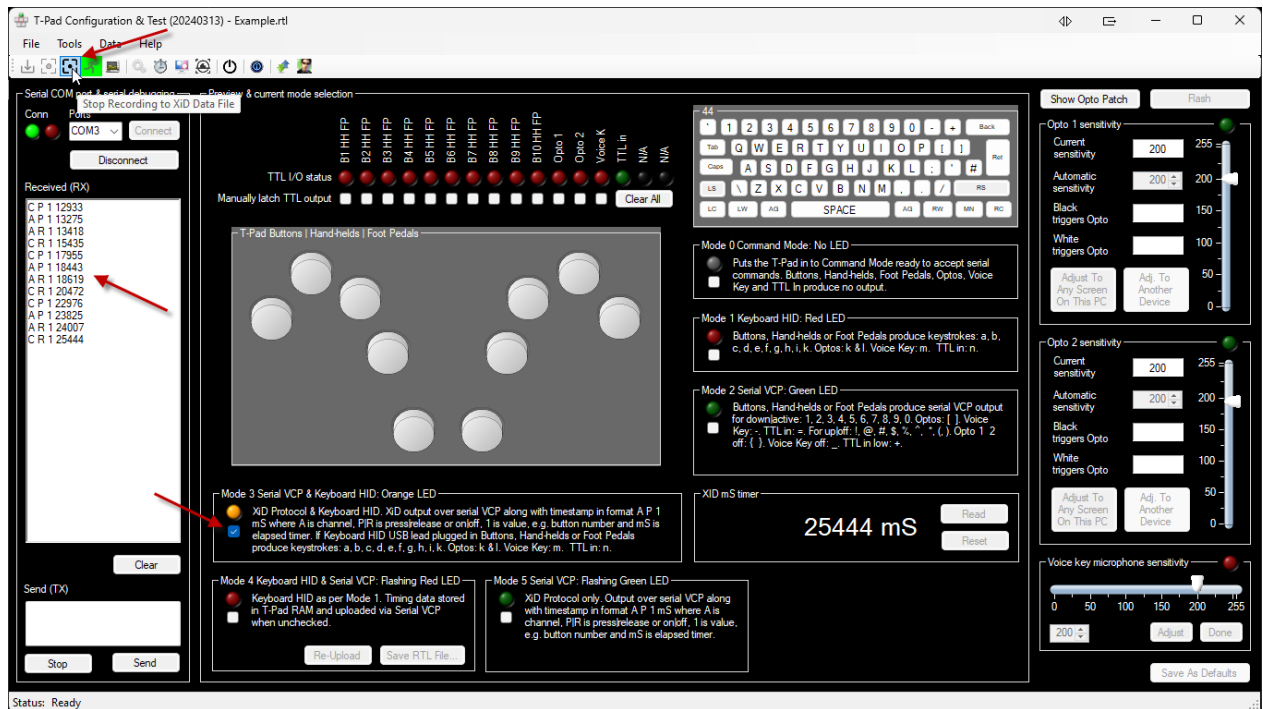


Now that you have chosen the actual filename click on the record button to start recording all activity.



Once you click on the record button the running man icon will turn green.

As data is recorded it will be shown on screen in XiD Mode. Once you have completed your run click on the stop button.

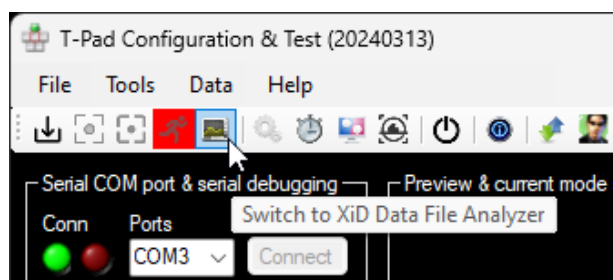


Data will now be written to the chosen .RTL file and can now be analyzed with the T-Pad Data Analyzer.

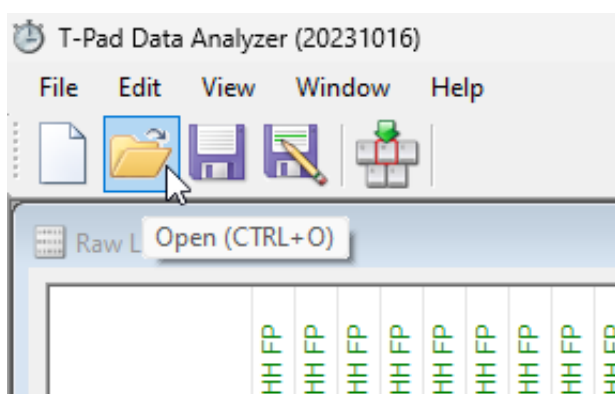
NOTE: DATA will ONLY BE SAVED to the .RTL file once the STOP BUTTON IS PRESSED.

Your own experiment will have recorded event and timing data based on the USB keyboard keystrokes received from the T-Pad. Remember these timings may, or may not, be accurate as they are based on software timings recorded by your experiment and not the independent hardware timings from the T-Pad. Instead independent hardware timings from the T-Pad were simultaneously recorded by our App via the second USB serial connection.

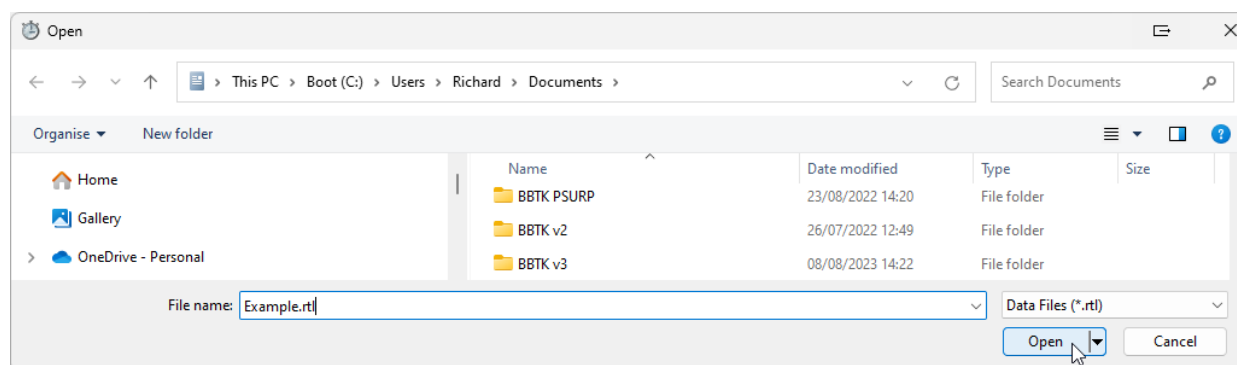
Now that both your own experiment and the T-Pad App have collected all event and timing data you can now analyze the resulting data.



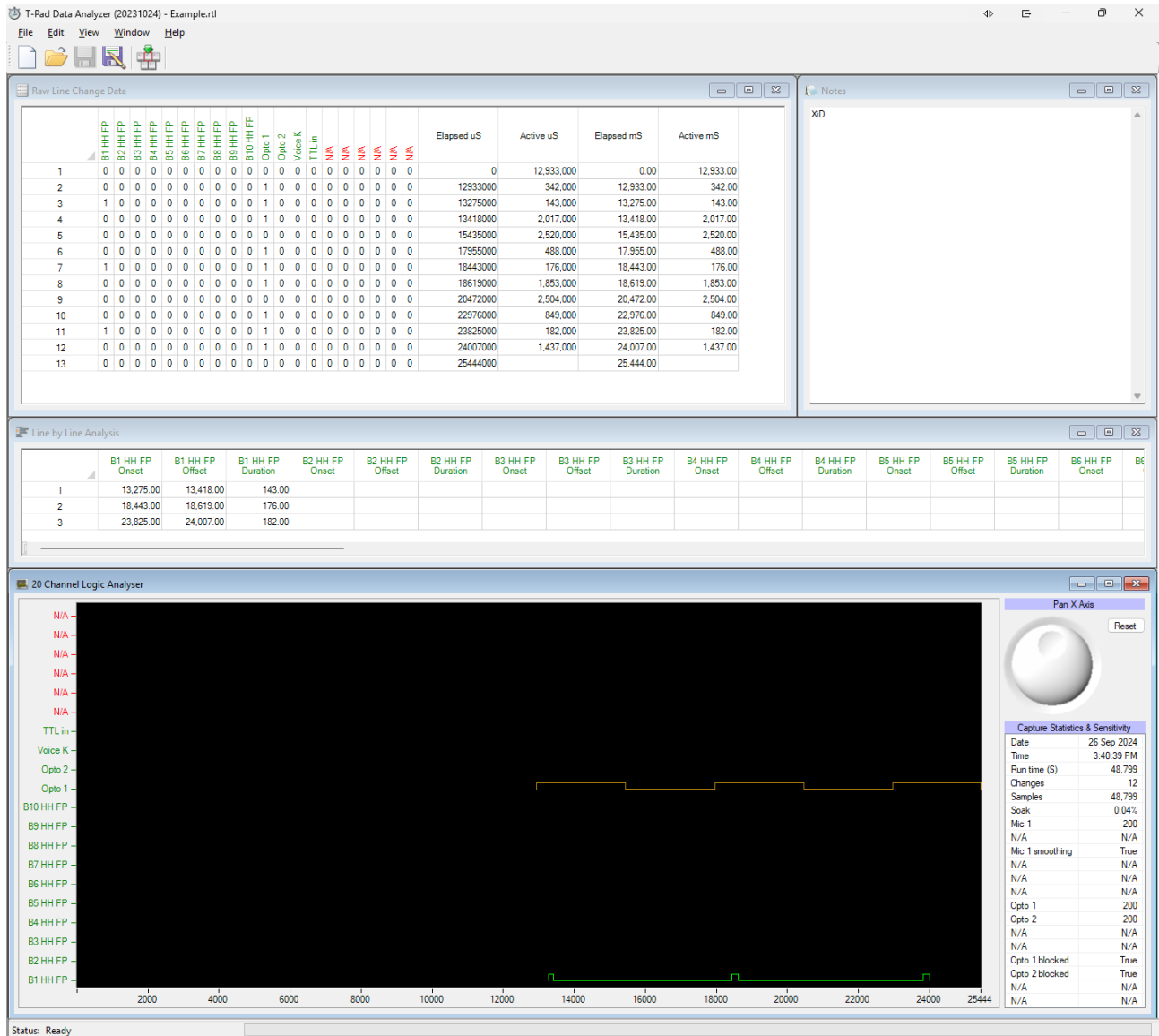
To analyze data you can either use the 'switch to' toolbar button or start the T-Pad Data Analyzer independently.



Once the T-Pad Data Analyzer has started load the chosen .RTL file.



The raw line change data will then be shown, parsed into an easy to use spreadsheet view and plotted on a graphical display against a millisecond timebase.



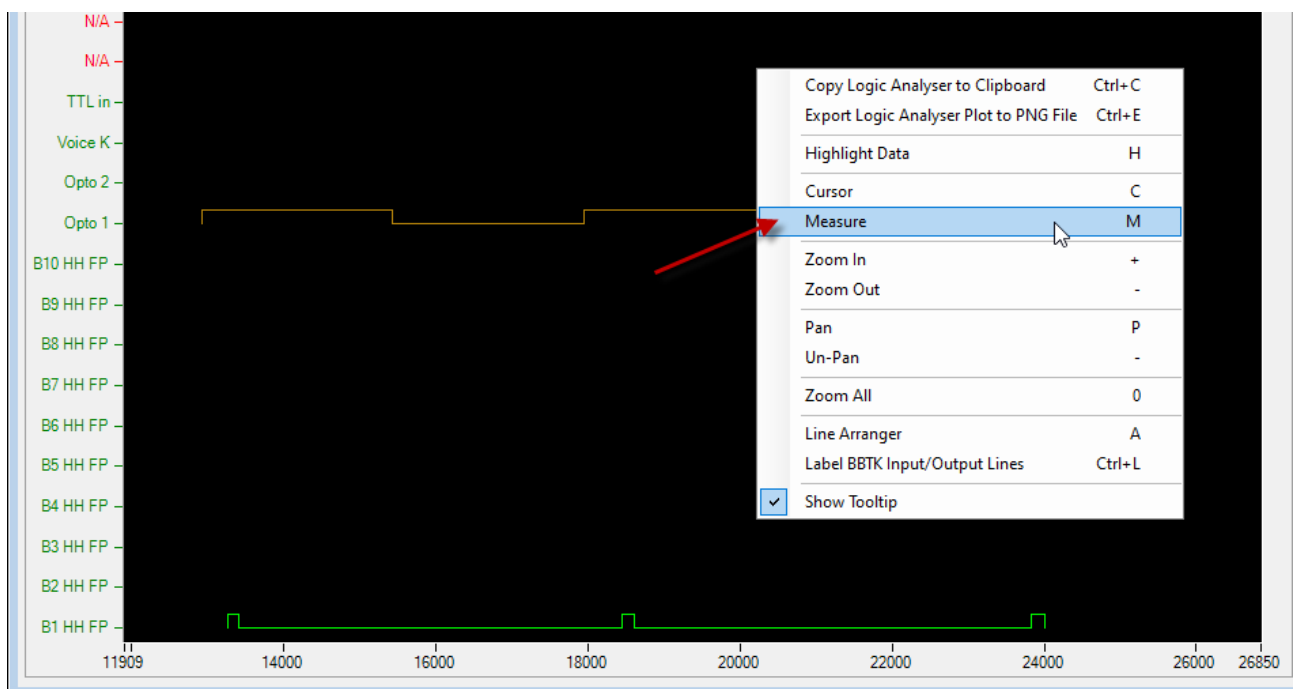
To look at individual line activity you can use the Line by Line Analysis spreadsheet. Here Opto 1, the stimulus image activity is shown:

	Opto 1 Onset	Opto 1 Offset	Opto 1 Duration	Opto 2 Onset	Opto 2 Offset	Opto 2 Duration
1	12,933.00	15,435.00	2,502.00			
2	17,955.00	20,472.00	2,517.00			
3	22,976.00	25,444.00	2,468.00			

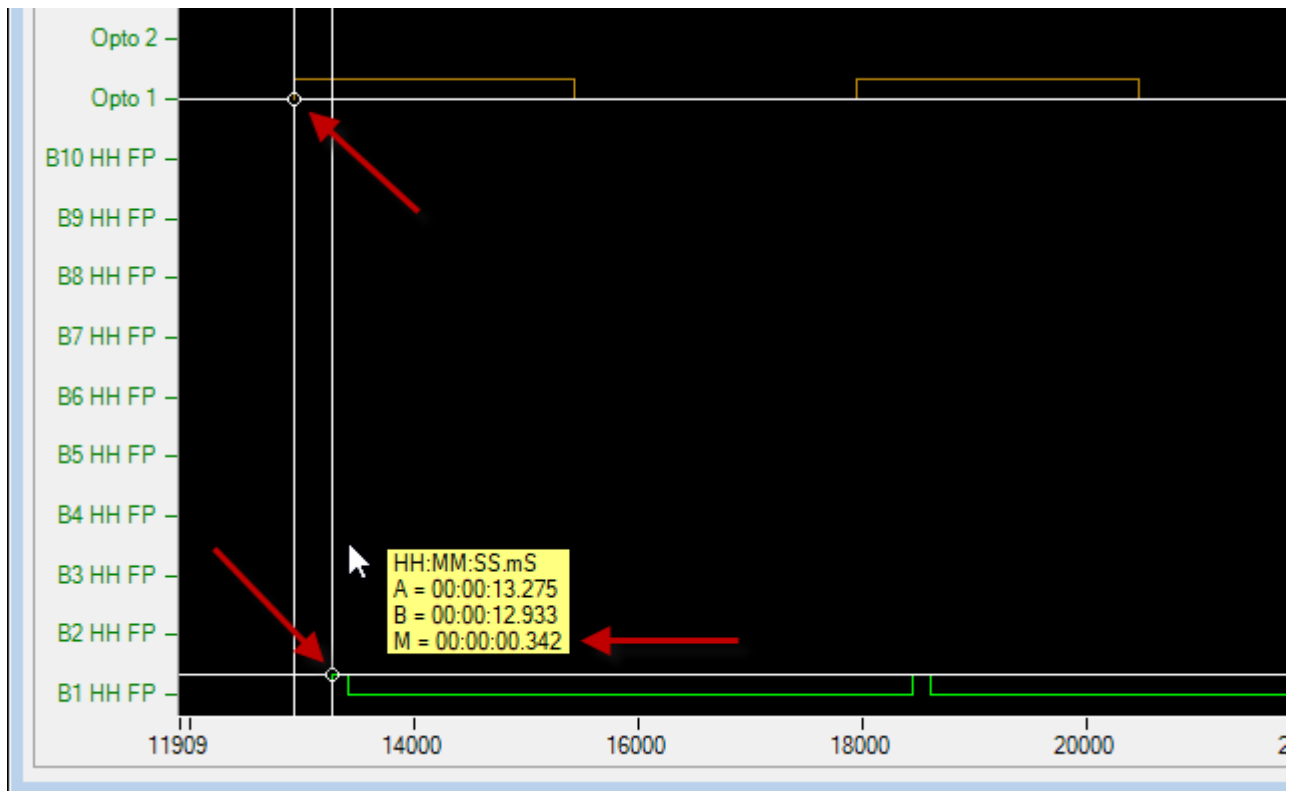
By using the Logic Analyser you can examine things Reaction Time (RT) relative to a visual image onset recorded by the Opto-detector.

Remember all these measures are when stimulus images actually appeared in the real world and when buttons etc. were pressed as they are timings from the internal clock of the T-Pad that is not tied to the accuracy of your PC, Windows or the experiment package you are using.

To check an RT right click on the 20 Channel Logic Analyzer and click on Measure from the context menu or press M on the keyboard:



Two measurement cursors will now appear:



If you drag the first cursor to the onset of Opto 1 when the visual stimulus first appeared and the second to the onset of button 1 being pressed, i.e. going high, you can read off the M value of 342 mS. So we know that the real-world RT relative to that visual stimulus onset is 342 mS. That is, when button 1 was pressed in response to the green smiley face.

By using measurement cursors you can see how you can easily examine stimulus duration (Opto 1) and response duration (B1 HH FP). In short the measurement cursors allow you to measure the millisecond time between any two points on any two events.

To analyze more RT's you have the option to export the Line by Line Analysis spreadsheet for further data analysis in a spreadsheet package like Microsoft Excel.

Whilst you have a cursor highlighted you can also press H on the keyboard to jump to that onset in the spreadsheet view:

