Teensy Logic Analyzer User's Guide
11/25/2018

There are 2 modes to run in:

1. Basic (default) – I just want to record up to 8 signals, up to about 10 MHz
2. Hardware – I only have 1 or 2 signals, and want to sample at up to 24 MHz (LC), 72 MHz (3.2), or 120 MHz (3.6) with full simple triggering capability

The faster speeds tend to have fewer of the bells and whistles. For capabilities at each sample rate, see tables at the end of document.

Quick Setup

1a. Windows - Download OLS .zip (https://github.com/LAtimes2/ols/releases/latest), unzip, and run run.bat

1b. Linux - Download OLS .tar.gz (https://github.com/LAtimes2/ols/releases/latest), extract, and run run.sh

2. Select Capture -> Begin Capture, and set Analyzer port to COM port or /dev/tty for the Teensy

3. Select Device type for your Teensy type and capabilities (Basic/Demo/Hardware), then select Load Firmware

Basic mode:

Channel	Pin
0	2
1	14
2	7
3	8
4	6
5	20
6	21
7	5

Hardware mode:

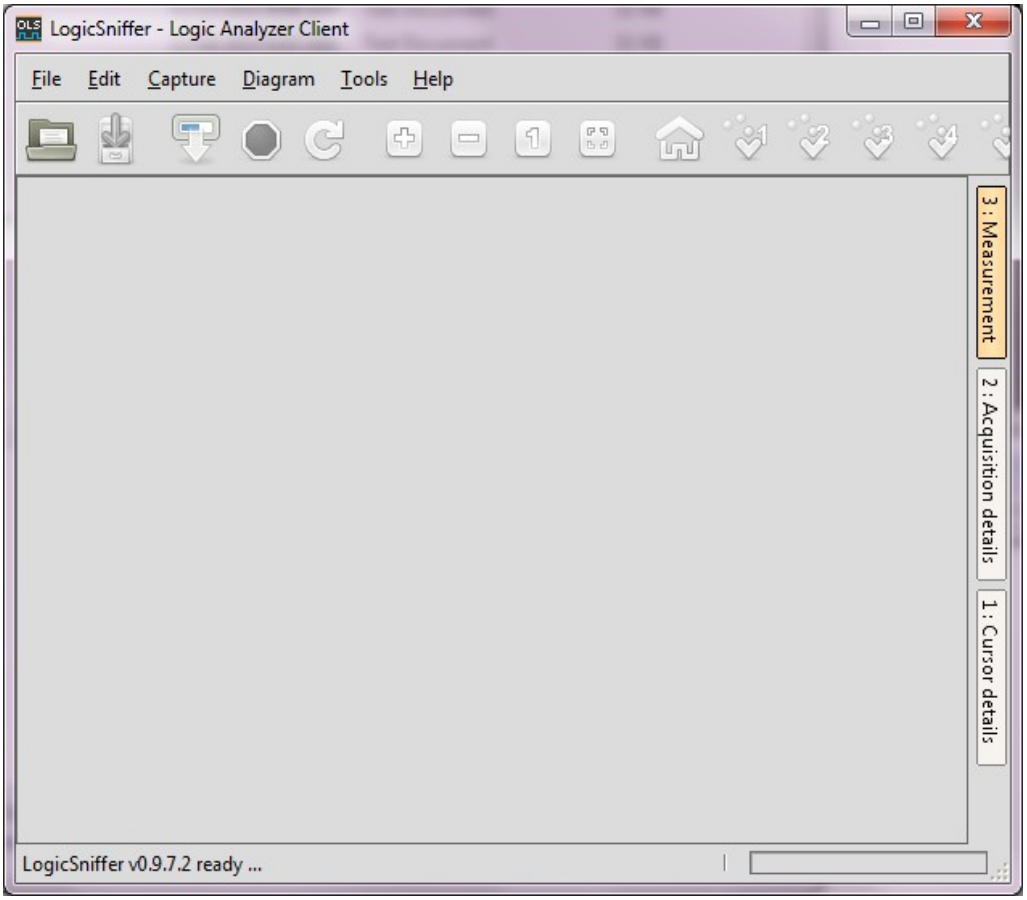
Channel	Pin
0	1
1	8

OLS user interface (PC client)

The Teensy communicates with the PC via a SUMP application. The SUMP protocol is a standard for sending logic analyzer data. This document uses the OpenBench Logic Sniffer PC client for these examples. It runs under Windows/Linux/OSX and is available for download at github.com/LAtimes2/ols/releases or www.lxtreme.nl/ols. See installation.md for instructions on installing all applications.

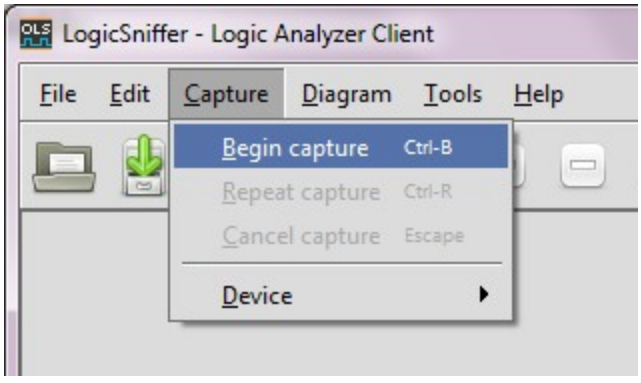
Setting up OLS

OLS will remember the settings between runs. But the first time you must set up a few items.

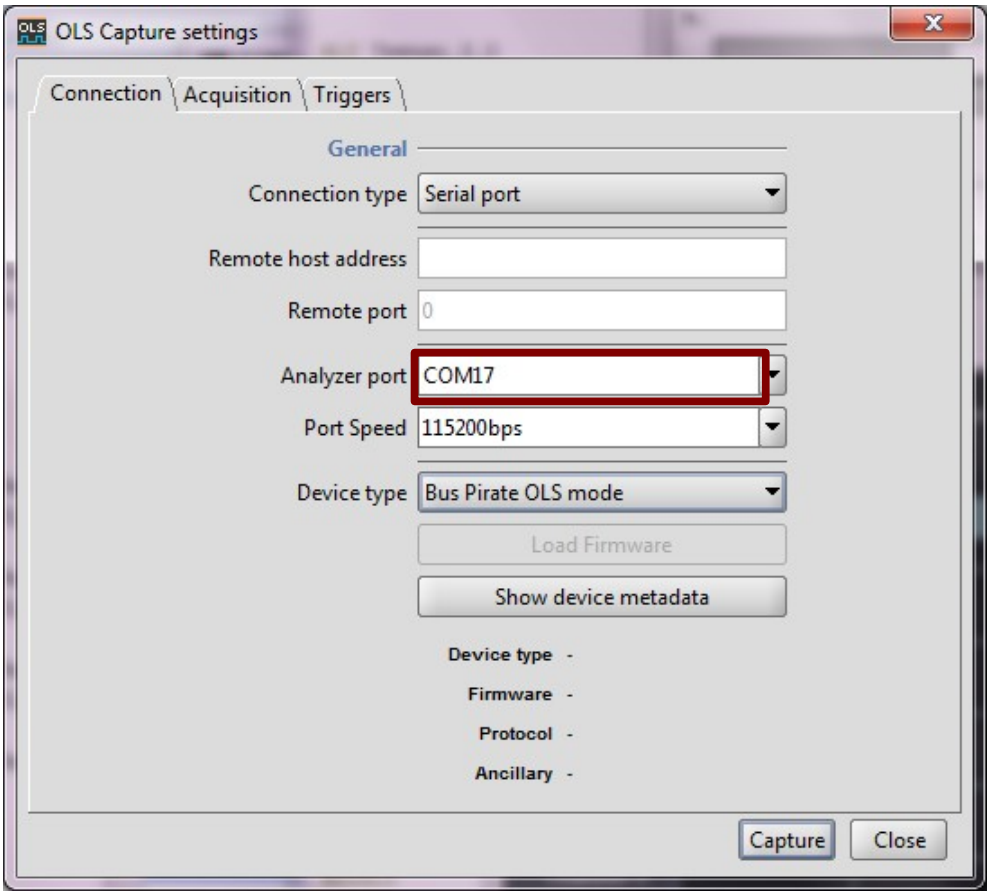


Initial Screen

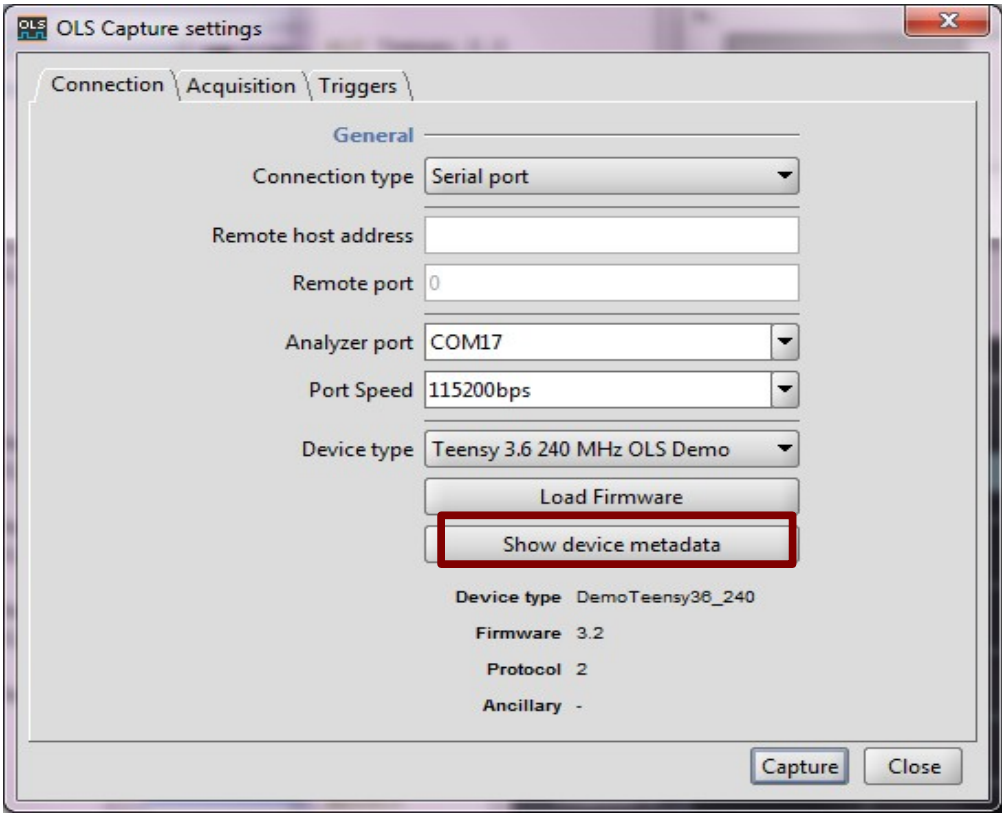
Select Capture → Begin capture:



Select Analyzer port if necessary (ttyACM0 for Linux):



First time - select 'Show device metadata' (this resets all parameters, so only use it if you are not sure of the device type, and check Acquisition and Triggers tabs after selecting).

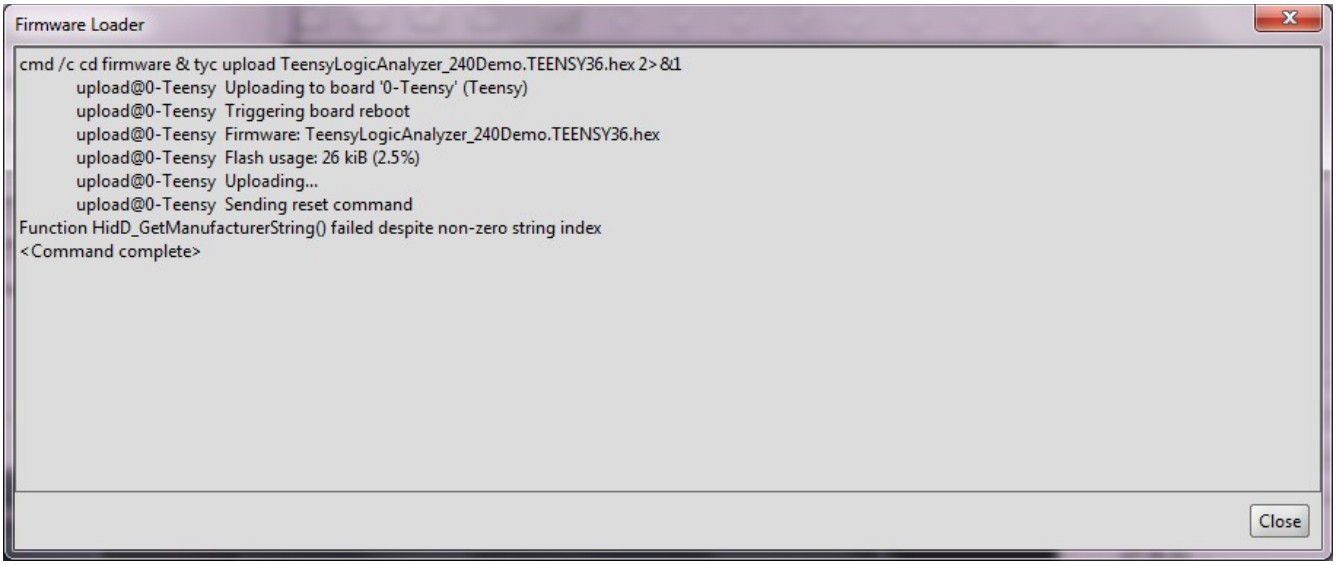


Device type lists various configurations that the Teensy can be built for. Default for Teensy 3.1/3.2 is Teensy96, and default for Teensy LC is Teensy48.

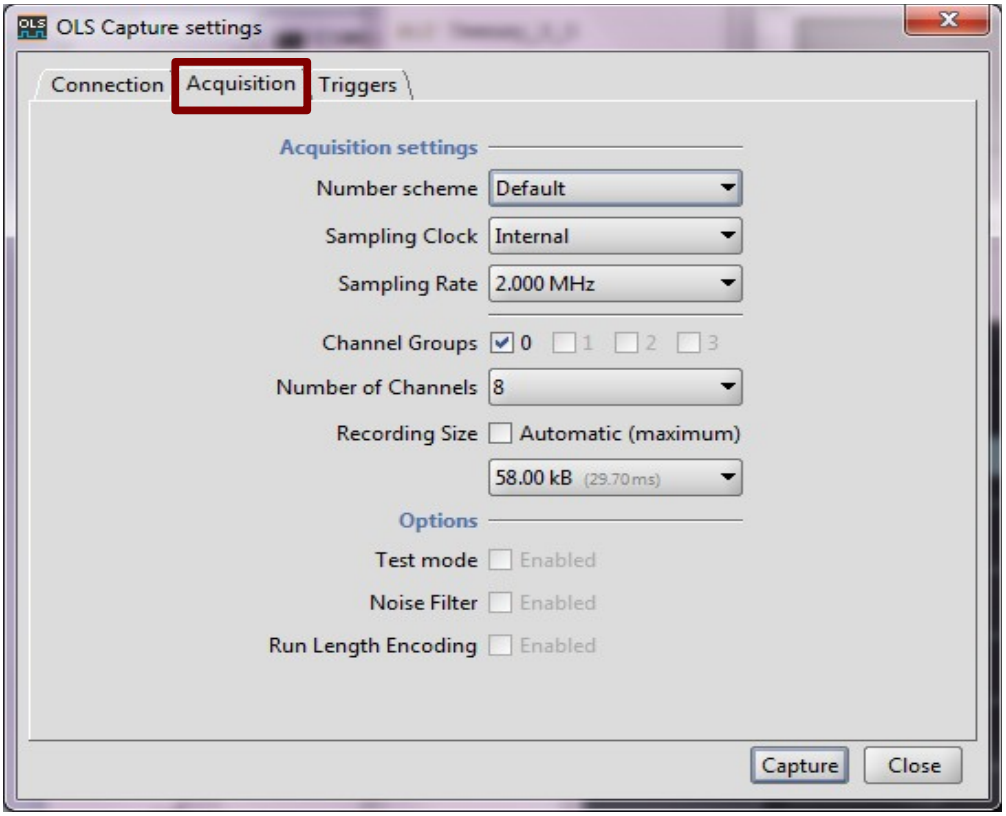
Firmware is the version of the Teensy software.

Protocol is the SUMP protocol and is always 2.

If you have not loaded firmware in your Teensy yet, you can do it by selecting the appropriate Device type, then select Load Firmware. It will display a dialog like this (it will automatically close when complete). If multiple Teensy's are connected at this time, it may get an error, so turn off or remove the other Teensy's.



Select the Acquisition tab.



For the basic Teensy 3.2 configuration, the defaults are Sampling Rate of 2 MHz and Recording Size of 57k samples.

Number scheme - not used

Sampling Clock - not used, always internal

Sampling Rate - set as desired. Higher speeds have some limitations, see tables at end of file.

Channel Groups - keep 0 selected

Number of Channels - Fewer channels allows recording more data. Selecting 4 channels can record twice as much data as 8 channels, 2 channels is 4x, 1 channel is 8x more data.

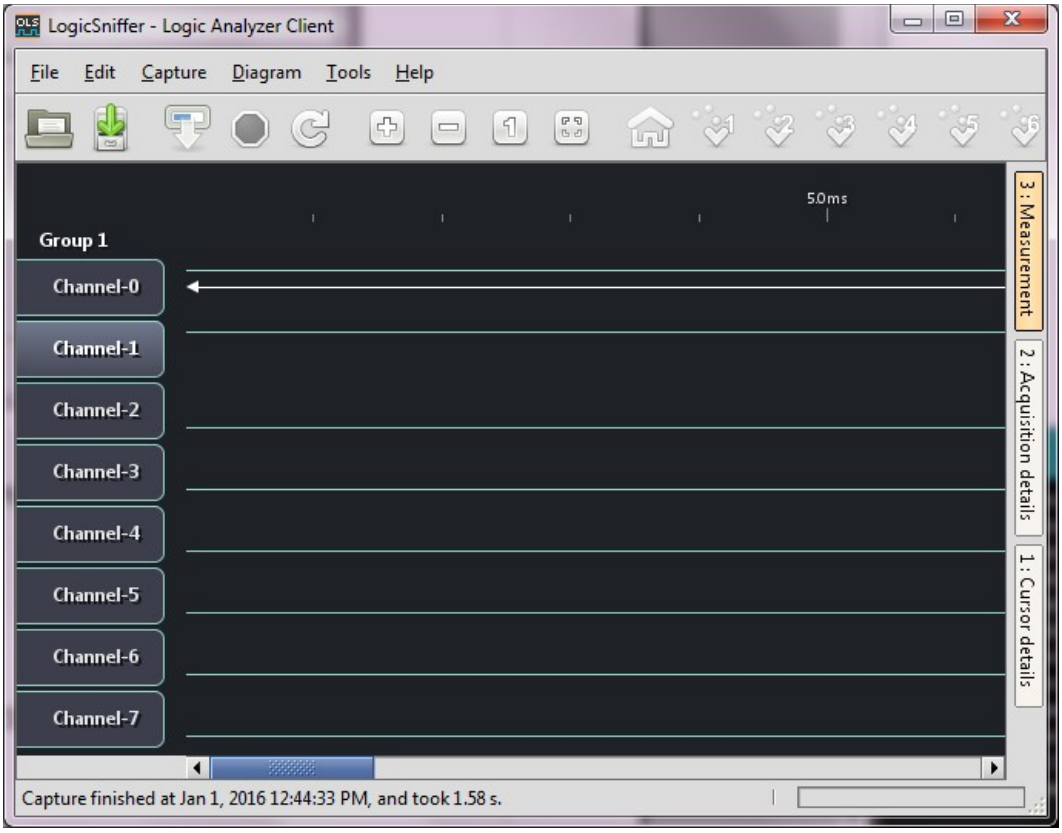
Recording Size - Default value is the maximum for 8 channels. If you set it higher, you also need to reduce the number of channels accordingly. It will give you a message dialog if trying to record too much data for the number of channels.

Run Length Encoding - if selected, it compresses the data to record for longer times. If your data isn't changing very often, Run Length Encoding (RLE) can record up to **100 times longer** when selected. It does not take affect at the 3 highest sample rates since it takes more computing power to record.

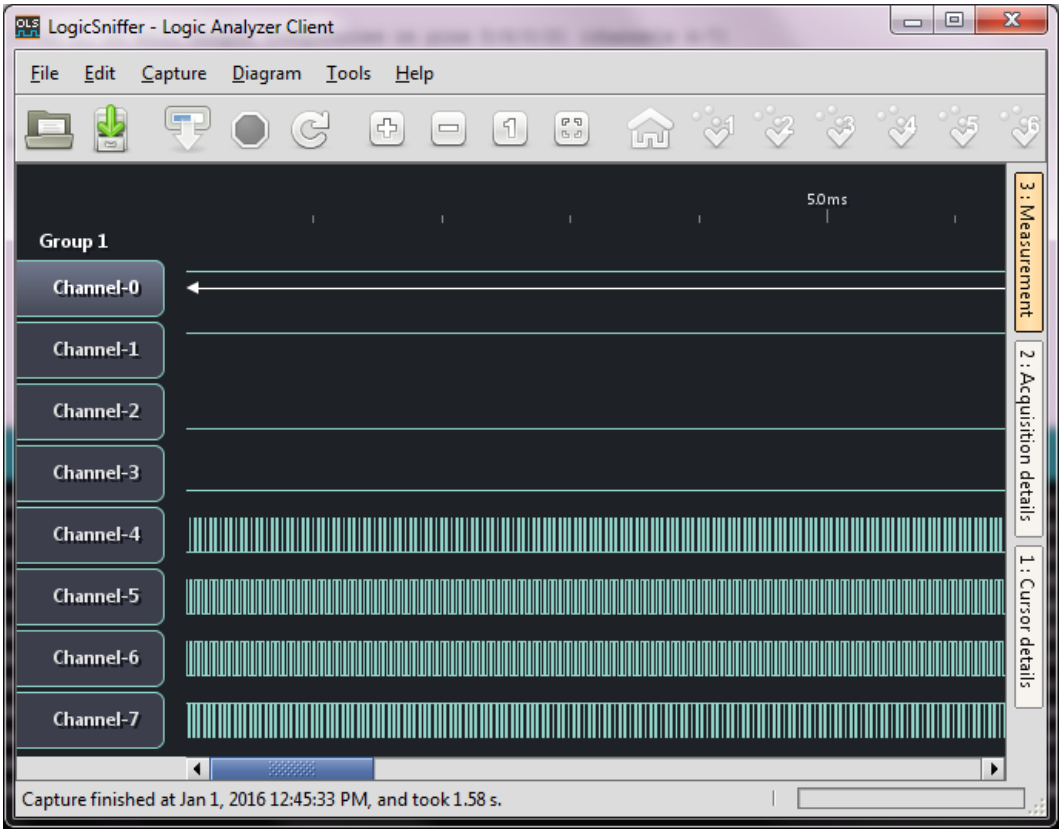
RLE uses the highest channel for internal data, so it can only record 7 channels. RLE cannot be used when recording 1, 2, or 4 channels.

Select Capture to start recording.

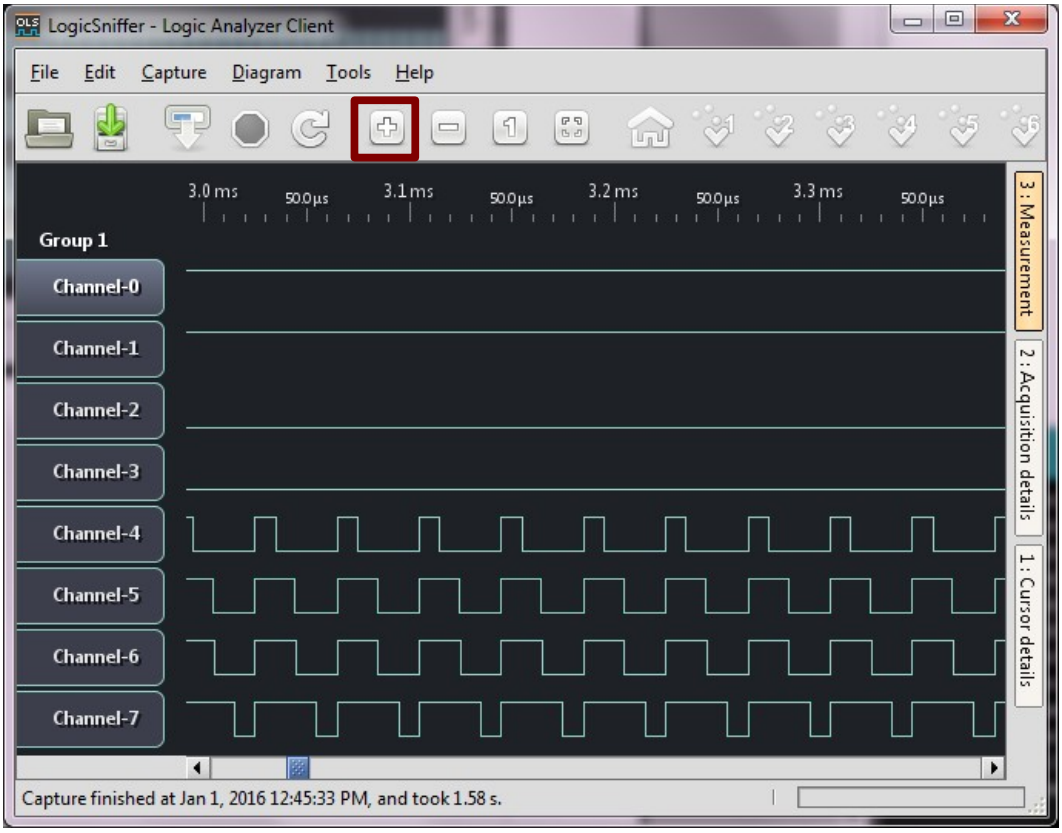
No inputs:



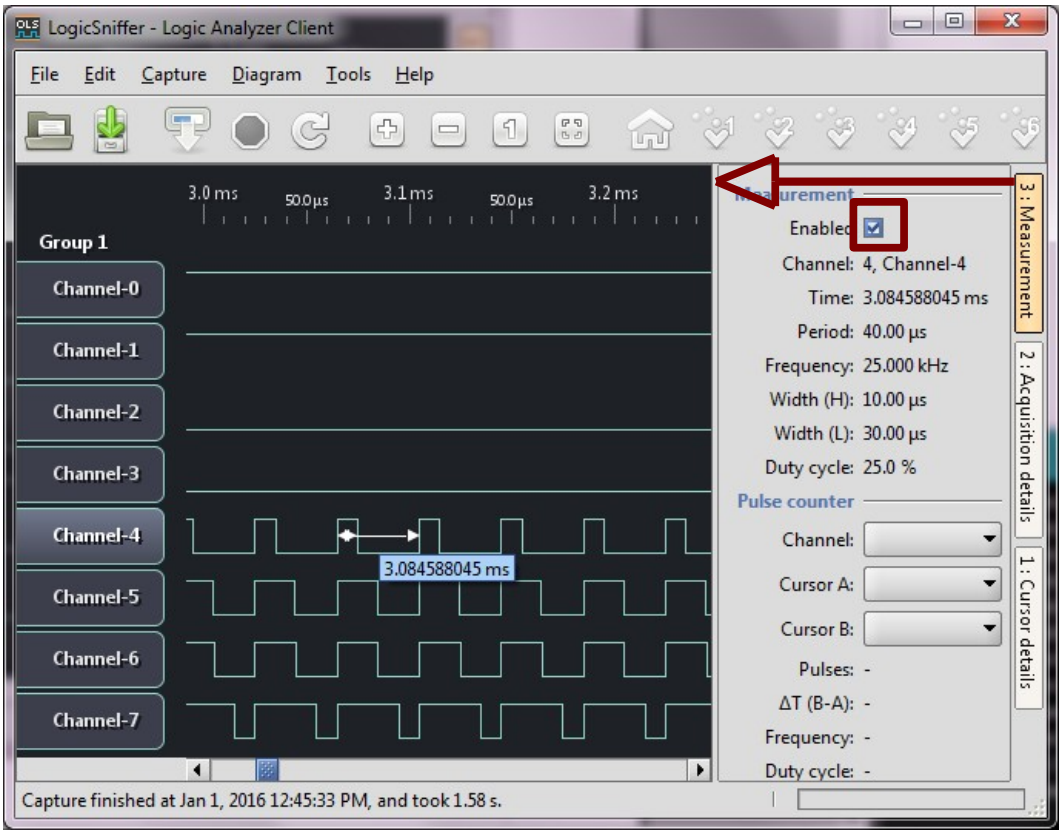
If you are using Demo firmware, you will see capture data like this:



Zoomed in:

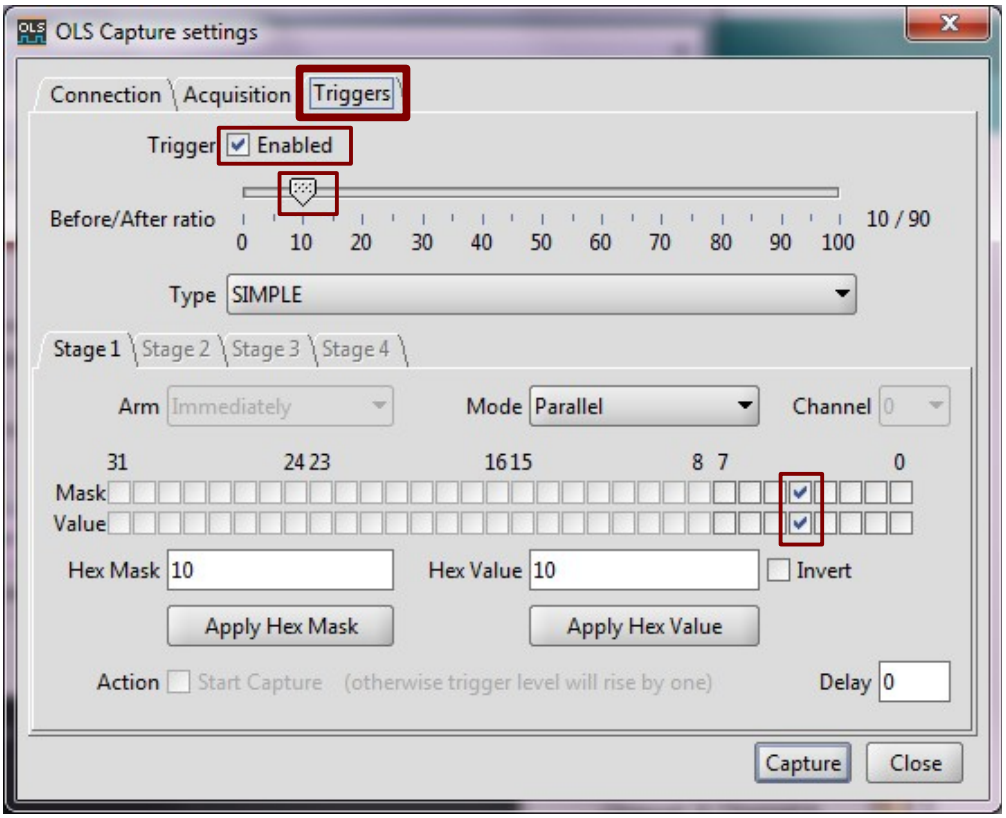


Time measurement – click on 3: Measurement and/or drag right border to the left:

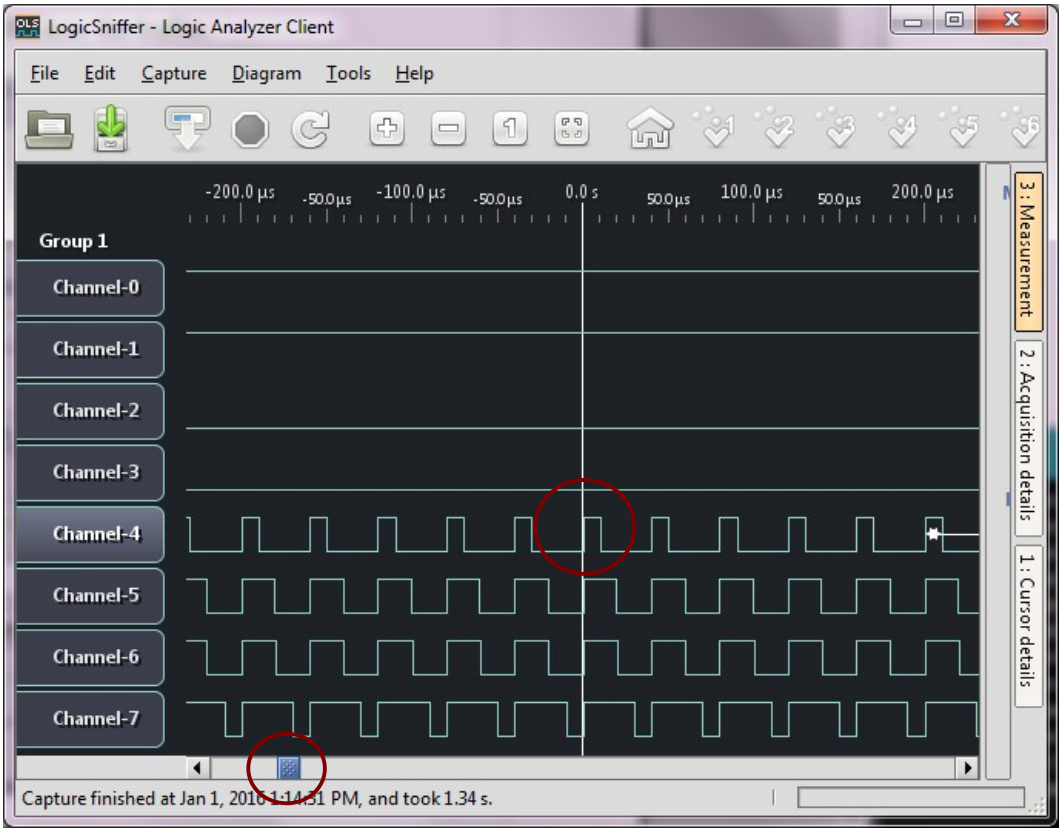


Trigger setup:

This example sets up a trigger on channel 4 being high at 10% into the buffer.



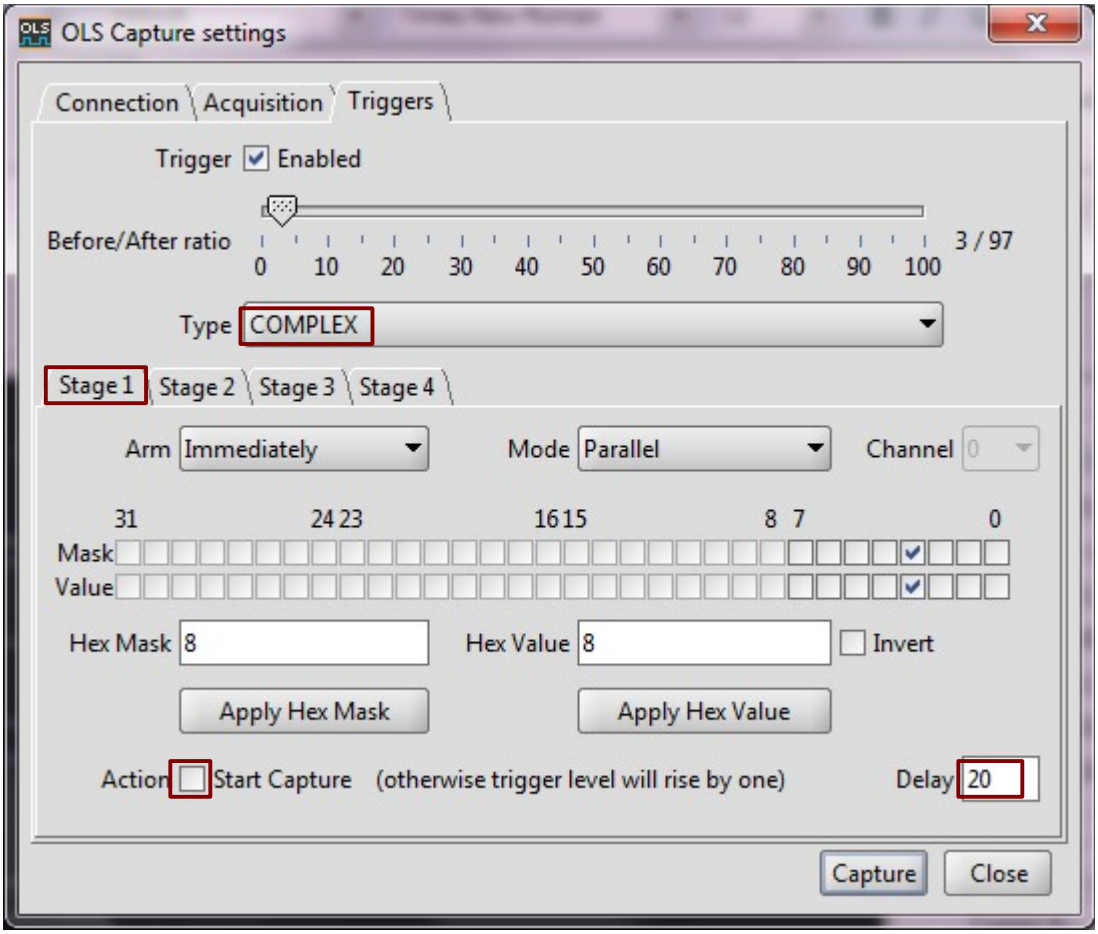
Capture looks like this:



While the logic analyzer is waiting for a trigger, the red Stop button is enabled. To halt the analyzer when no trigger is received, press the button. No data will be sent back from the Teensy unless Run Length Encoding (RLE) is selected, since RLE can go a long time if the data is not changing.

Advanced Trigger Setup:

Some modes allow complex trigger sequencing (up to 4 stages). For example, if a signal is usually high, but you want the low to high transition, you can set up 2 stages, with the first stage triggering on the signal being low, and the second stage triggering on high. There is also a delay between stages, so if you want the fourth clock select on a SPI transfer, calculate the number of samples in each transfer and put that delay (plus a little extra) between stages.



To set up a stage,select COMPLEX type, then select Stage X tab. Set trigger mask and value for each stage, along with any optional delay after the stage is triggered. On the last stage, check the Start Capture box to indicate the trigger is complete.

LED

The LED on the Teensy works as follows:

Blinking every 2 seconds – idle (not recording)
On – recording, waiting for a trigger
Quick flashes – receiving commands from the PC client.

Basic Configurations

Not all combinations of speed and samples are valid. See tables below. When a combination cannot be met, the display will have alternating 1's and 0's in the invalid sections (an entire channel, or a portion of time, or both).

Teensy 3.6 240 MHz	up to 5 MHz	10 MHz	30 MHz	48 MHz	80 MHz
1 channel at 1.92M samples	✓				
2 channels at 984k samples	✓				
4 channels at 492k samples	✓				
Full triggering capabilities	✓				
Run-length encoding	✓				
Simple trigger with before/after	✓	✓	✓		
Simple trigger after	✓	✓	✓	✓	✓
8 channels at 246k samples	✓	✓	✓	✓	
8 channels at 186k samples					✓

Teensy 3.5 120 MHz	up to 2.5 MHz	5 MHz	15 MHz	24 MHz	40 MHz
1 channel at 1.92M samples	✓				
2 channels at 984k samples	✓				
4 channels at 492k samples	✓				
Full triggering capabilities	✓				
Run-length encoding	✓				
Simple trigger with before/after	✓	✓	✓		
Simple trigger after	✓	✓	✓	✓	✓
8 channels at 246k samples	✓	✓	✓	✓	
8 channels at 186k samples					✓

Teensy 3.2 144 MHz	up to 3 MHz	6 MHz	18 MHz	28.8 MHz	48 MHz
1 channel at 456k samples	✓				
2 channels at 228k samples	✓				
4 channels at 114k samples	✓				
Full triggering capabilities	✓				
Run-length encoding	✓				
Simple trigger with before/after	✓	✓	✓		
Simple trigger after	✓	✓	✓	✓	✓
8 channels at 57k samples	✓	✓	✓	✓	
8 channels at 29k samples					✓

Teensy 3.2 96 MHz	up to 2 MHz	4 MHz	12 MHz	19.2 MHz	32 MHz
1 channel at 456k samples	✓				
2 channels at 228k samples	✓				
4 channels at 114k samples	✓				
Full triggering capabilities	✓				
Run-length encoding	✓				
Simple trigger with before/after	✓	✓	✓		
Simple trigger after	✓	✓	✓	✓	✓
8 channels at 57k samples	✓	✓	✓	✓	
8 channels at 29k samples					✓

Teensy 3.0 96 MHz	up to 2 MHz	6.4 MHz	16 MHz
1 channel at 76k samples	✓		
2 channels at 38k samples	✓		
4 channels at 19k samples	✓		
Full triggering capabilities	✓		
Run-length encoding	✓		
Simple trigger with before/after	✓	✓	
Simple trigger after	✓	✓	✓
8 channels at 9.5k samples	✓	✓	
8 channels at 5k samples			✓

Teensy LC	up to 500 kHz	8 MHz
1 channel at 32k samples	✓	
2 channels at 16k samples	✓	
4 channels at 8k samples	✓	
Full triggering capabilities	✓	
Run-length encoding	✓	
Simple trigger with before/after	✓	
Simple trigger after	✓	✓
8 channels at 4k samples	✓	✓

Hardware Configuration

Once you are comfortable with the basic configuration, you can try the hardware configuration to get higher speeds and/or more samples. To use it, compile with

#define HARDWARE_CONFIGURATION 1

and select Device type as Teensy 96 MHz OLS Hardware or Teensy LC 48 MHz OLS Hardware.

At some higher speeds and/or sample sizes, only 1 channel is available. See tables below. When a combination cannot be met, the display will have alternating 1's and 0's in the invalid sections (an entire channel, or a portion of time, or both).

Teensy 3.2 96 MHz	48 MHz and below Simple Trigger
232k samples and below	2 channels
464k samples	1 channel

Teensy 3.2 144 MHz	72 MHz and below Simple Trigger
232k samples and below	2 channels
464k samples	1 channel

Teensy 3.5 120 MHz	60 MHz and below Simple Trigger
984k samples and below	2 channels
1.92M samples	1 channel

Teensy 3.6 240 MHz	120 MHz and below Simple Trigger
984k samples and below	2 channels
1.92M samples	1 channel

LC: Gets you 12 MHz, 2 channels at 16k samples (vs 4k). Pretrigger.
Gets you 6,4,2 MHz, 2 channels at 16k samples with full trigger.
Gets you 24 MHz 1 channel. Pretrigger

Teensy LC	6 MHz and below Simple Trigger	12 MHz Pre-Trigger Only	24 MHz Pre-Trigger Only
16k samples and below	2 channels	2 channels (Note 1)	1 channel (Note 1)
32k samples	1 channel	1 channel	1 channel (Note 1)

Note 1: Trigger Before/After Ratio is not used. Trigger, if selected, is always at the beginning.