Teensy Logic Analyzer User's Guide
5/27/2016

There are 3 modes to run in:

1. Basic (default) – hey, I just want to record up to 8 signals, up to about 1 MHz
2. Hardware – I only have 1 or 2 signals, and want to sample at up to 24 MHz (LC) or 72 MHz (3.x) with full simple triggering capability
3. Advanced – I like to read instructions before using, and I have 3-8 signals and need as fast a speed or as many samples as possible

For Advanced and Hardware mode capabilities, see tables at end of document.

Quick Setup – see installation.md

1. Download code (or just the hex file(s))
2. Install the PC client (see below – will try to make easier someday)
3. Choose mode and set #defines appropriately (if not Basic)
4. Compile and load in Teensy
5. Select Device Type based upon mode and Teensy type
6. Connect signals to record

Basic/Advanced modes:

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

Hardware mode:

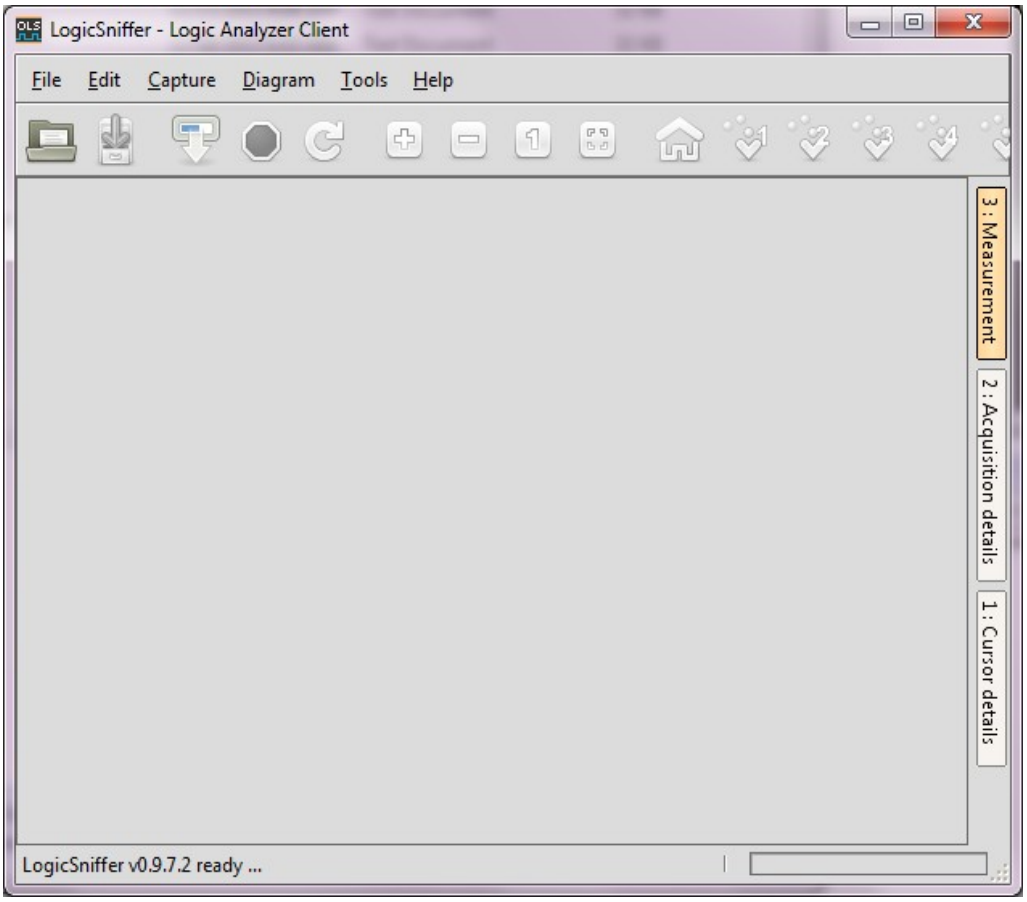
Channel	Pin
0	1
1	8

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 www.lxtreme.nl/ols. See installation.md for instructions on installing all applications.

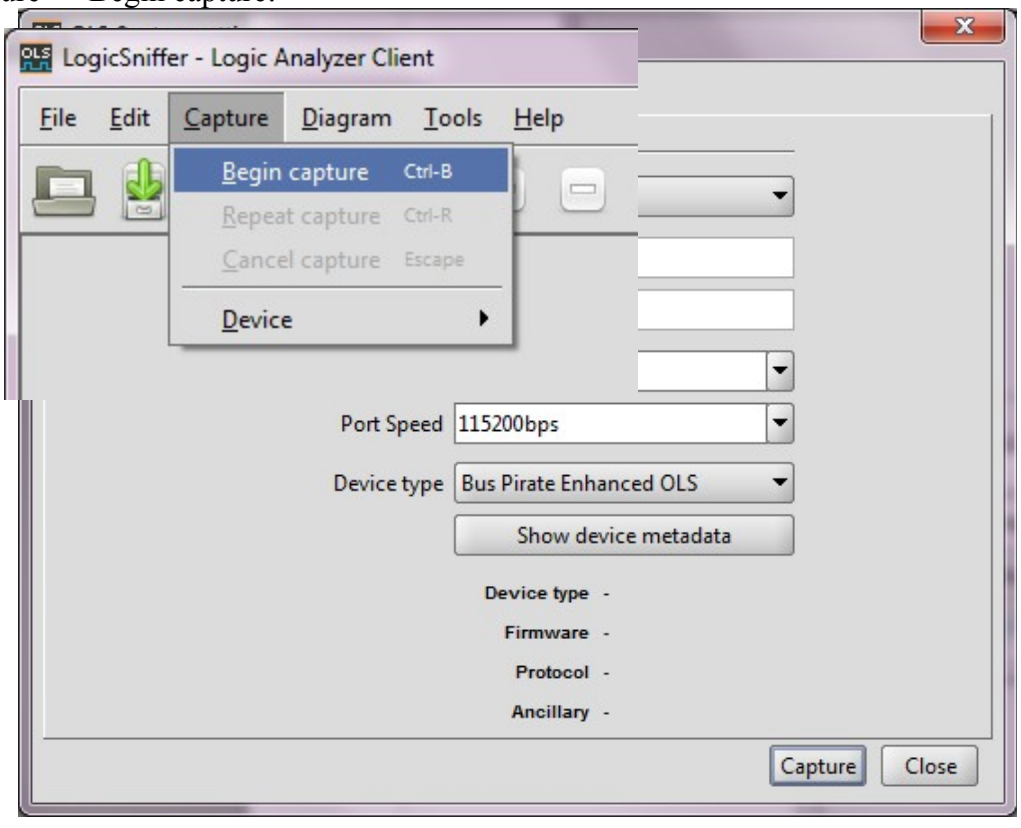
Setting up OLS

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



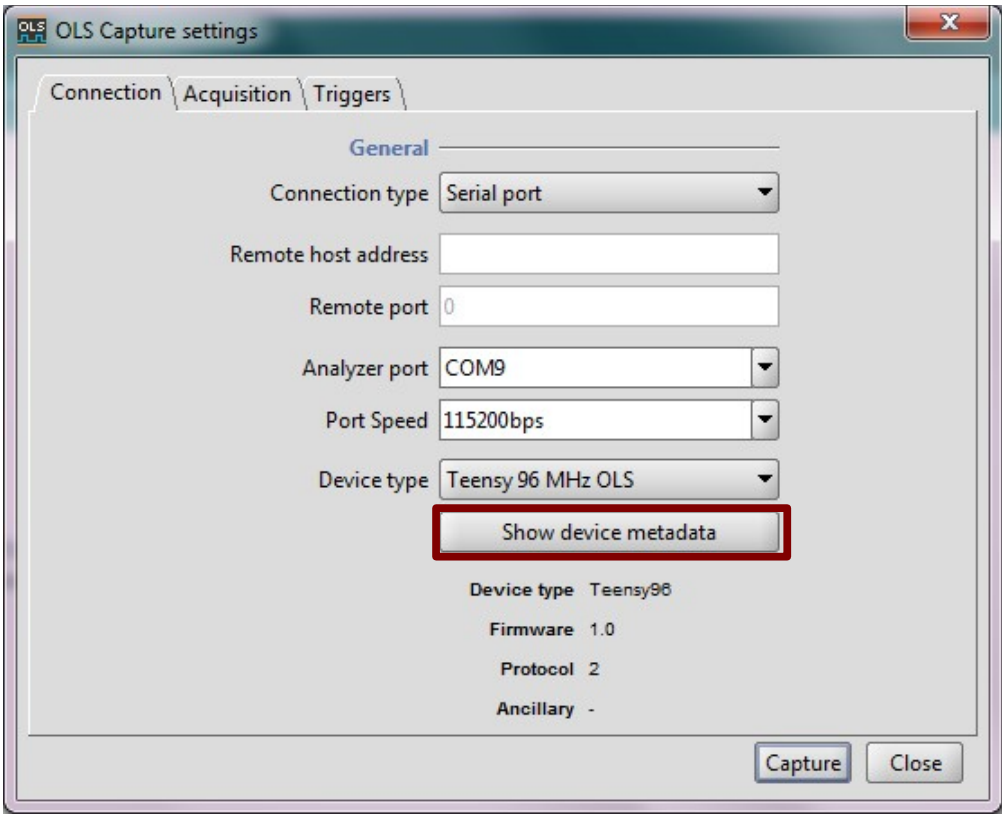
Initial Screen

Select Capture → Begin capture:



Select Analyzer port if necessary.

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).

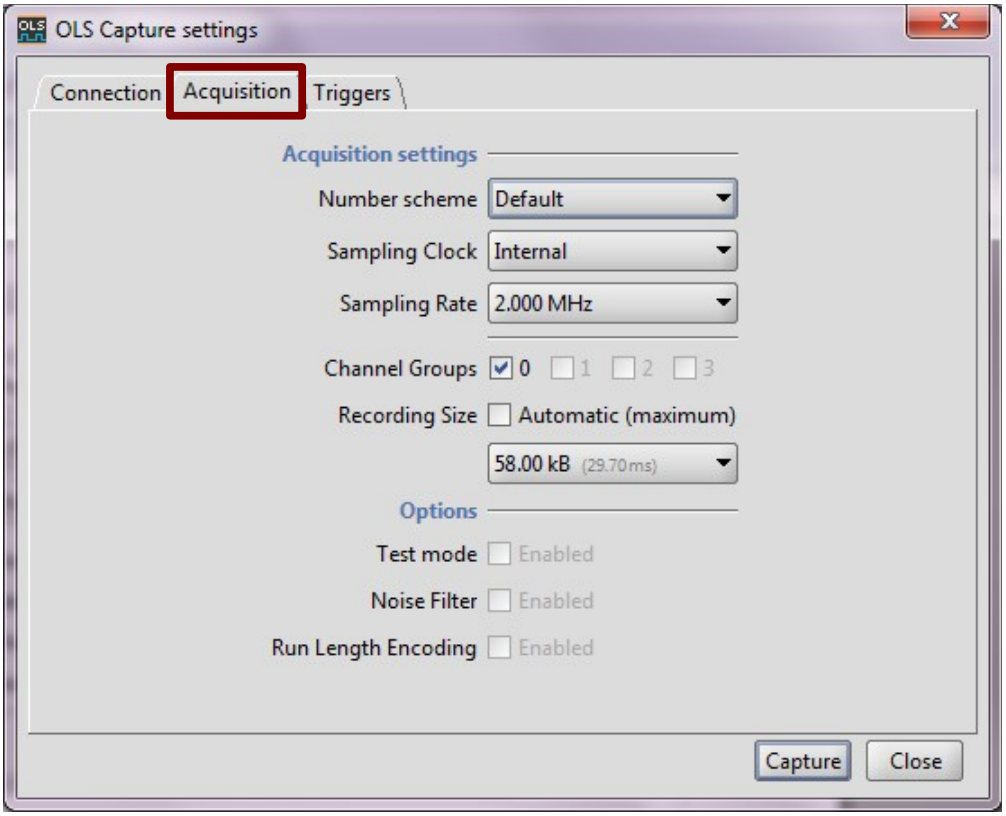


Device type lists various configurations that the Teensy can be built for. Default for Teensy 3.1/3.2 is Teensy96, and default for Teensy LC is Teensy48.

Firmware is the version of the Teensy software.

Protocol is the SUMP protocol and is always 2.

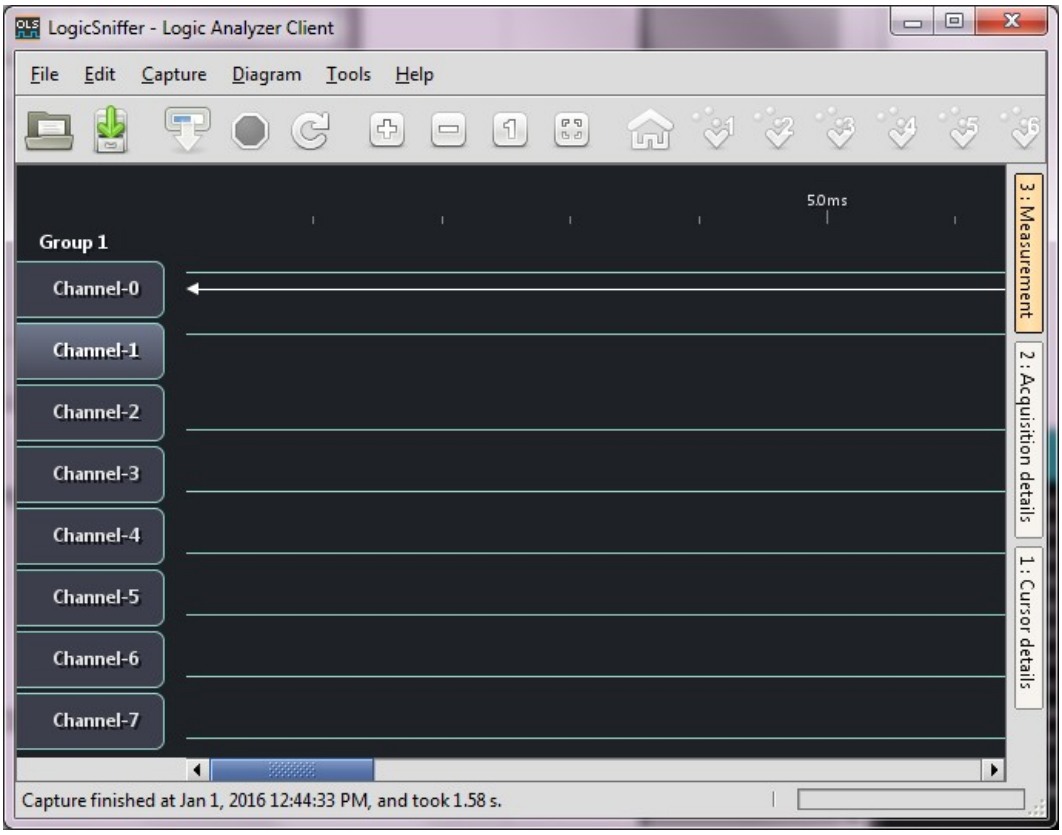
Select the Acquisition tab.



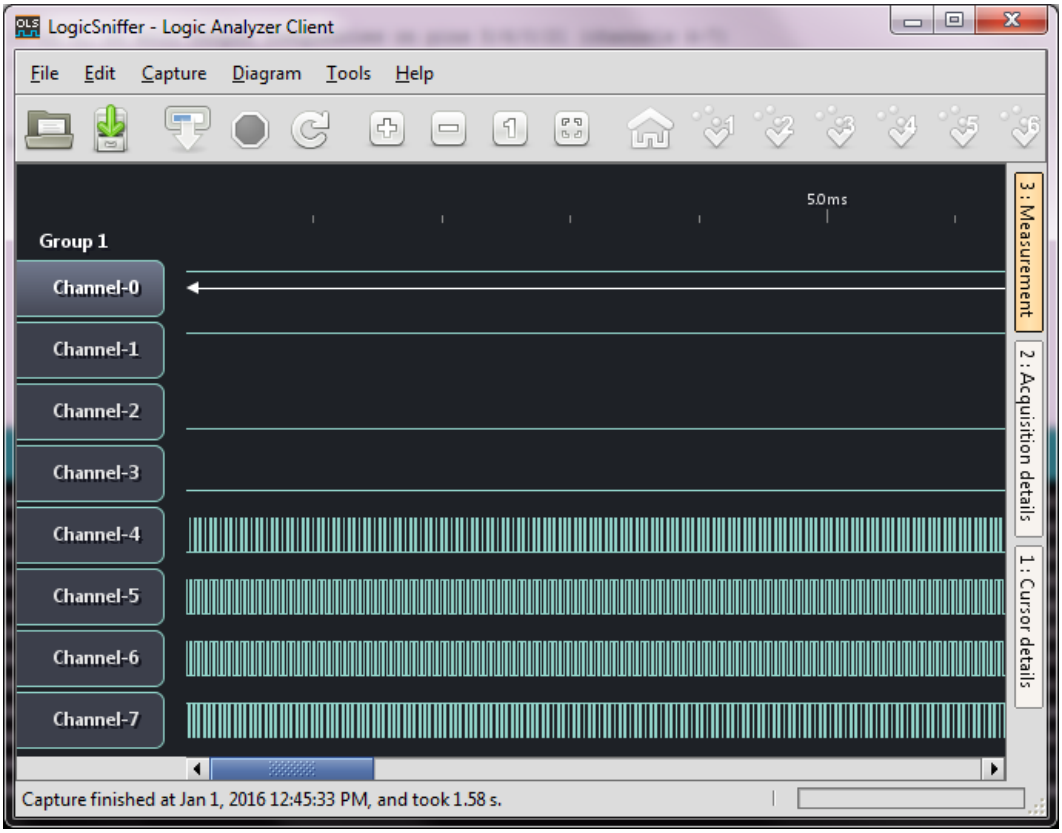
For the basic Teensy 3.1 configuration, the defaults are Sampling Rate of 2 MHz and Recording Size of 58k samples.

Select Capture to start recording.

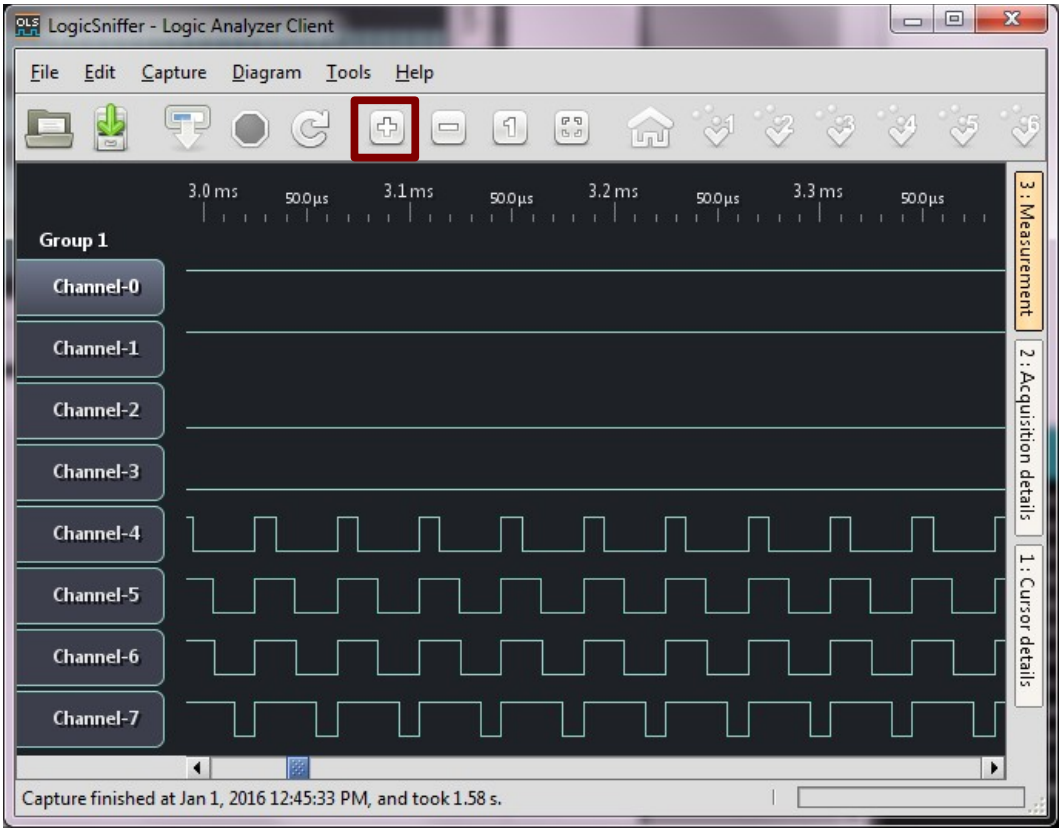
No inputs:



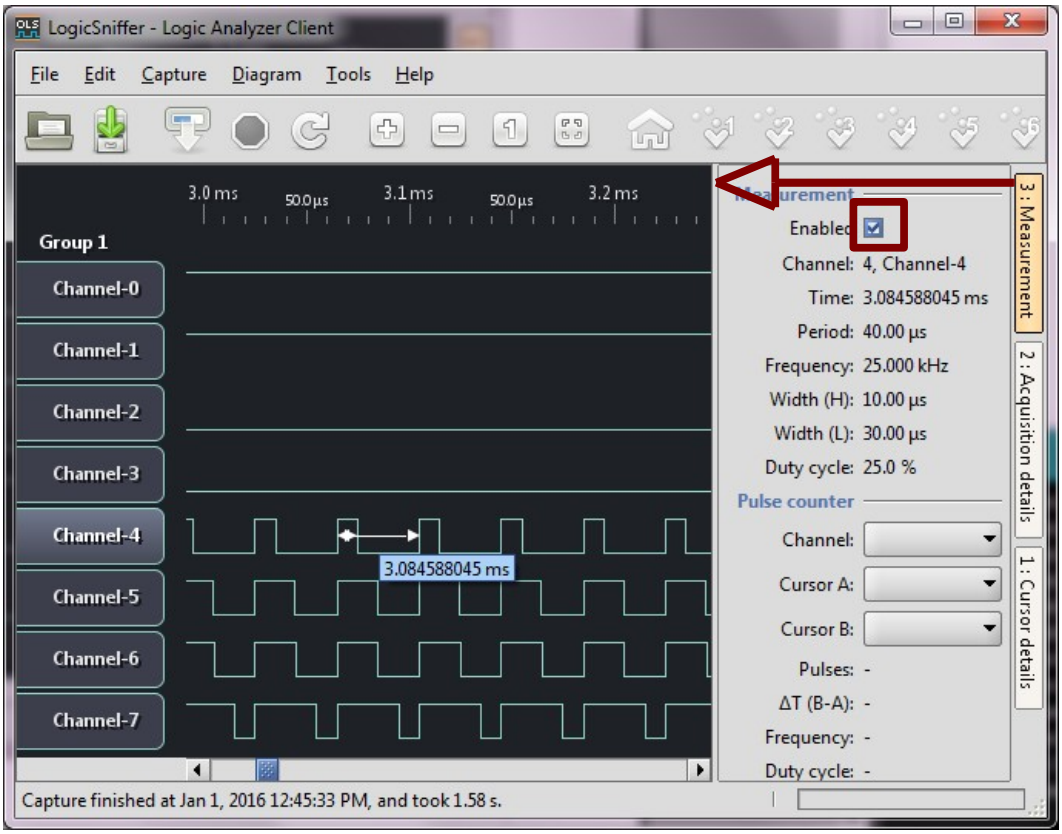
If you compile with #define CREATE_TEST_FREQUENCIES 1, you will see capture data like this:



Zoomed in:

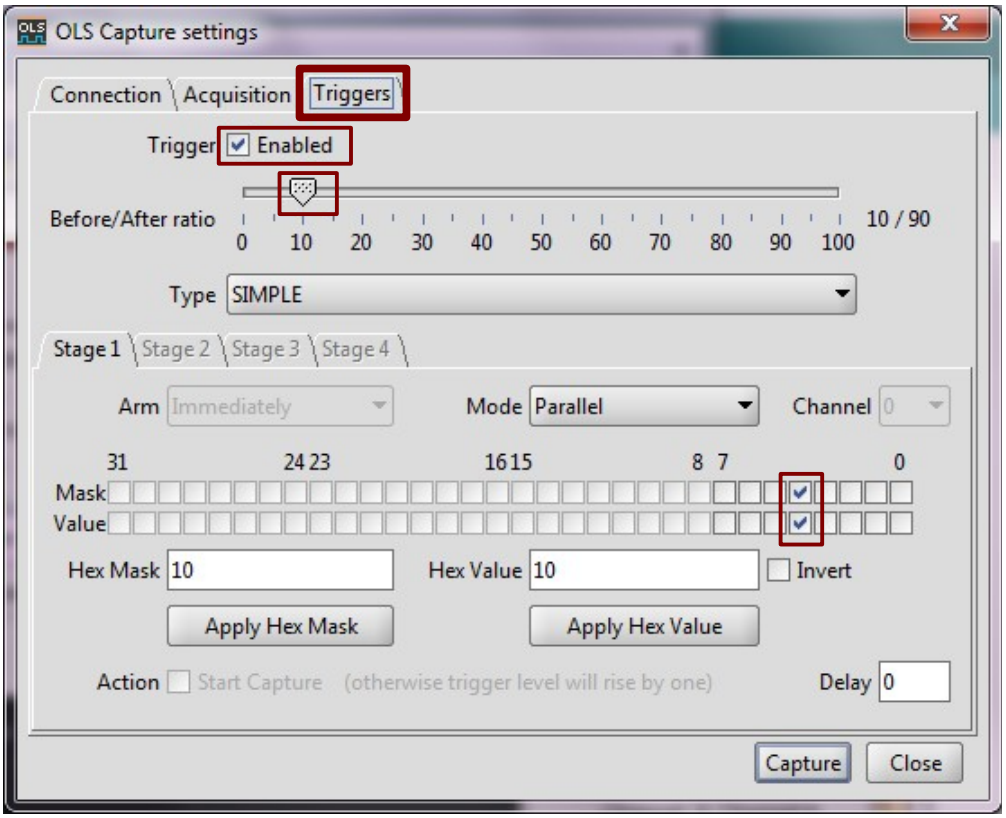


Time measurement – drag right border to the left:

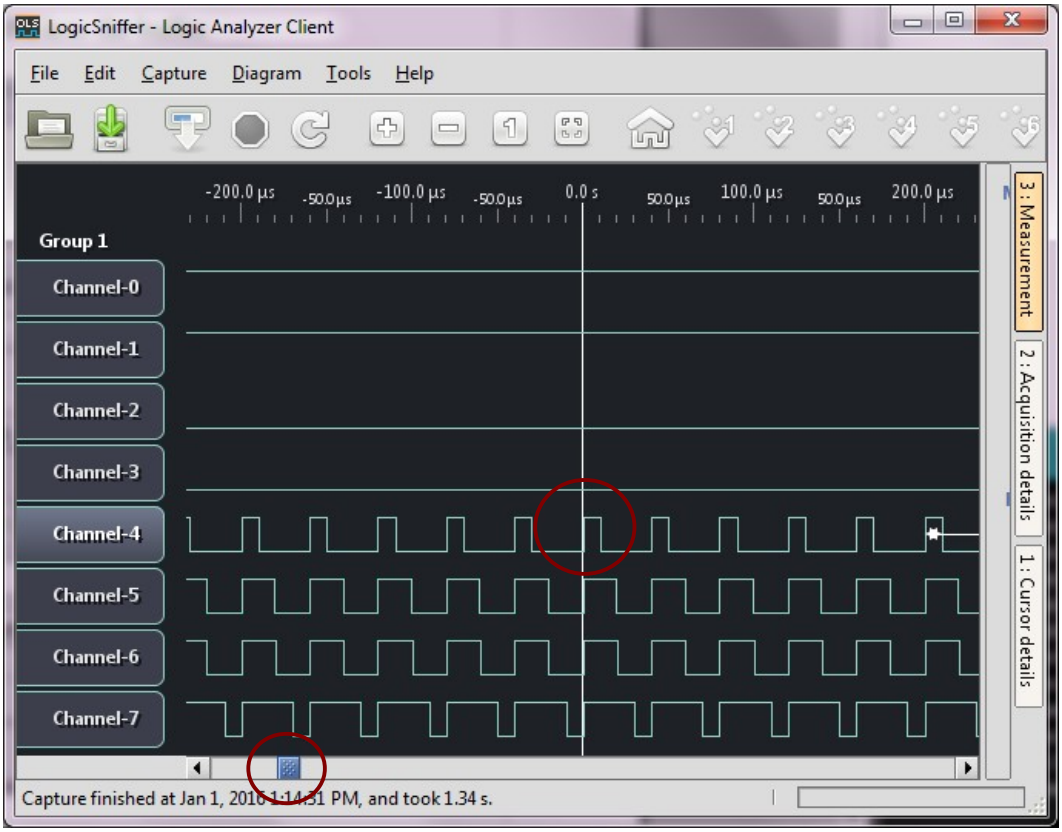


Trigger setup:

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



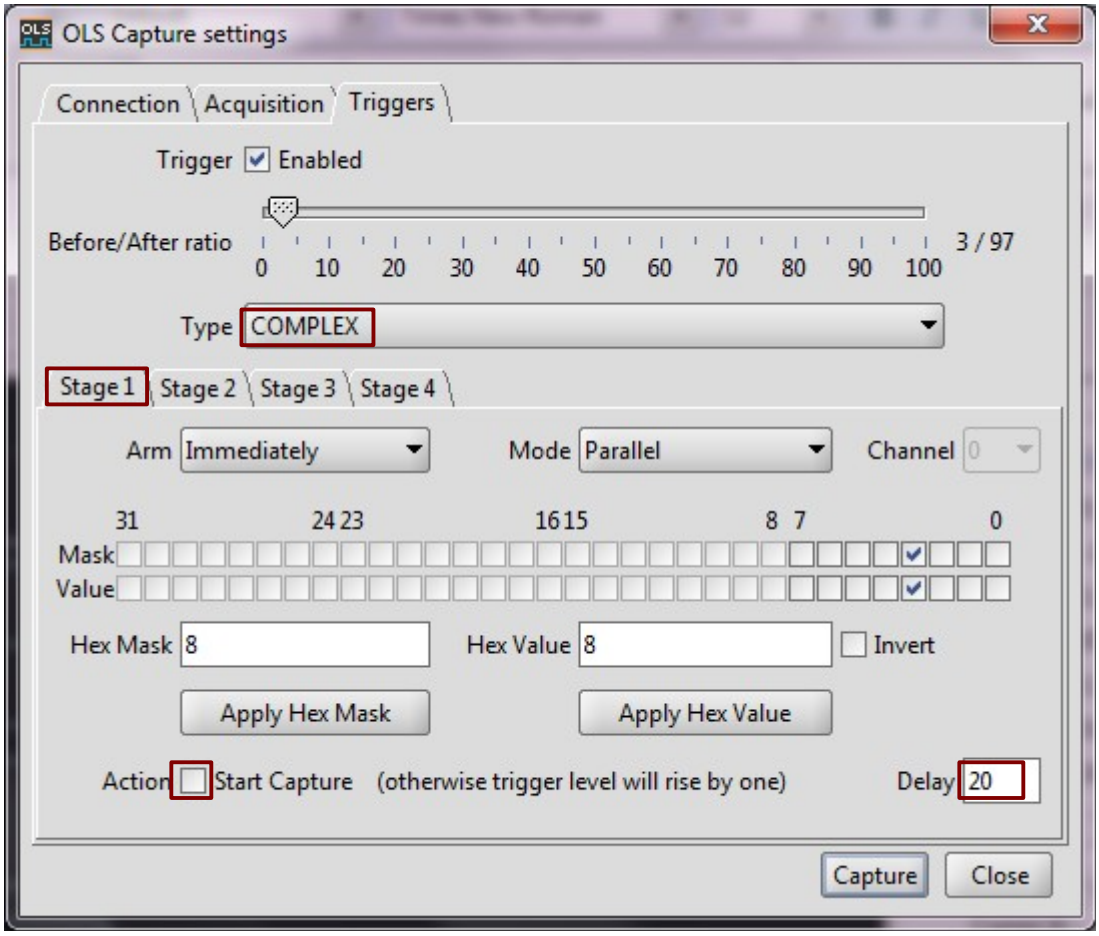
Capture looks like this:



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.

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.

Advanced Configurations

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

```
#define ADVANCED_CONFIGURATION 1
```

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

There are also 120 MHz and 144 MHz Advanced configuration files. You need to compile for 120 MHz (optimized) or 144 MHz (optimized) to use them (if you don't know how, google it, just use 96 MHz, or use the pre-built Hex files).

However, all combinations of speed and samples are not valid in Advanced configuration (that's why it's called Advanced). 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.x 96 MHz	**2 MHz and below Complex Trigger**	**12 MHz Simple Trigger**	**19.2 MHz Pre-Trigger Only**
58k samples and below	8 channels	8 channels (Note 1)	8 channels (Notes 1, 3)
116k samples	4 channels	Note 2	Note 2
232k samples	2 channels	Note 2	Note 2
464k samples	1 channel (Note 4)	Note 2	Note 2

Teensy 3.x 120 MHz	**2.5 MHz and below Complex Trigger**	**15 MHz Simple Trigger**	**24 MHz Pre-Trigger Only**
58k samples and below	8 channels	8 channels (Note 1)	8 channels (Notes 1, 3)
116k samples	4 channels	Note 2	Note 2
232k samples	2 channels	Note 2	Note 2
464k samples	1 channel (Note 4)	Note 2	Note 2

Teensy 3.x 144 MHz	**3 MHz and below Complex Trigger**	**18 MHz Simple Trigger**	**28.8 MHz Pre-Trigger Only**
58k samples and below	8 channels	8 channels (Note 1)	8 channels (Notes 1, 3)
116k samples	4 channels	Note 2	Note 2
232k samples	2 channels	Note 2	Note 2
464k samples	1 channel (Note 4)	Note 2	Note 2

Note 1: Timing data is valid up to about 28k samples, then is 10% too fast (upper SRAM?)
Note 2: Limited to 58k samples. No advantage over 58k setting.
Note 3: Trigger Before/After Ratio is not used. Trigger, if selected, is always at the beginning.
Note 4: Trigger position is incorrect due to a limitation of the client for large sample sizes

Teensy LC	1 MHz and below Complex Trigger	8 MHz Pre-Trigger Only
4k samples and below	8 channels	8 channels (Note 1)
8k samples	4 channels	Note 2
16k samples	2 channels	Note 2
32k samples	1 channel	Note 2

Note 1: Trigger Before/After Ratio is not used. Trigger, if selected, is always at the beginning.
Note 2: Limited to 4k samples. No advantage over 4k setting.

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.

There is also a 120 MHz Hardware configuration file. It is the same as below for Teensy 3.1/3.2, but 25% faster.

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.x 96 MHz	48 MHz and below Simple Trigger
232k samples and below	2 channels
464k samples	1 channel (Note 1)

Teensy 3.x 120 MHz	60 MHz and below Simple Trigger
232k samples and below	2 channels
464k samples	1 channel (Note 1)

Teensy 3.x 144 MHz	72 MHz and below Simple Trigger
232k samples and below	2 channels
464k samples	1 channel (Note 1)

Note 1: Trigger position is incorrect due to a limitation of the client for large sample sizes

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.