CTU Streaming Demo User Guide

Description

CambridgeIC's Central Tracking Unit (CTU) chips work with sensors built from PCBs to measure the position of contactless targets using resonant inductive sensing technology.

CTU chips are designed to be embedded inside electromechanical products, and communicate with a host system processor over an SPI interface.

To assist demonstration, evaluation and development, CambridgeIC provides hardware and software that works with a PC. A Streaming Adapter enables a PC to communicate with CTU chips by converting between SPI and USB interfaces at high speed.

Features

- Supports CAM312, CAM204 and CAM502 CTU chips
- Collects measurements at maximum rate for CTU
- Flexible number of active sensors
- Animates position results as rotary or linear scale
- Analyse data in a sampling window e.g. average
- Supports CAM502 Pipeline Mode for highest speed
- Save measurements to file
- Save and load set-up to and from file

System Requirements

- Windows 10 or 11 PC
- Available USB port
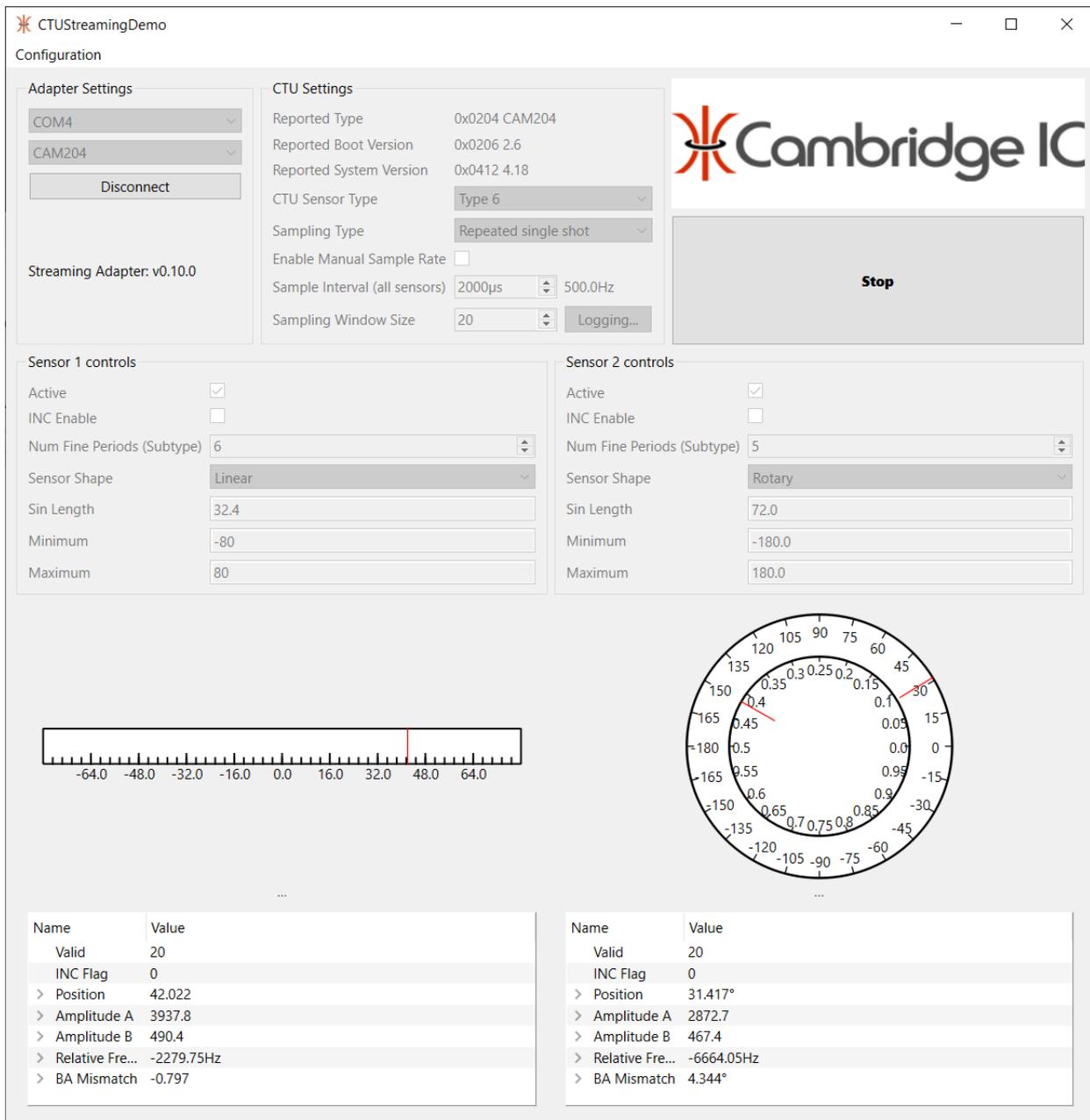
Figure 1 CTU Streaming Demo connected to CAM204 chip measuring precision linear and rotary sensors

1 Hardware Configuration

This section explains what hardware is required to run CTU Streaming Demo, and how to connect it together.

1.1 Streaming Adapter

CTU Streaming Demo requires a Streaming Adapter to work. The Streaming Adapter communicates with the PC over USB, and with a CTU chip over SPI. It includes a processor that acts as a host device for the CTU chip. This processor configures the CTU chip and takes measurements at high speed, streaming results to the PC over USB at high speed.

The processor's firmware can be updated from the PC. Please refer to its datasheet for how to do this.

CTU Streaming Demo does NOT work with CambridgeIC's CTU Adapter. The CTU Adapter is an older part that acted as a bridge between SPI and USB. The Streaming Adapter is more intelligent and higher speed, and is required to achieve high data transfer speeds.

1.2 Connections to CTU Development Board

CambridgeIC offers a range of CTU Development Boards which include the CAM312, CAM502 or CAM312 chip together with external circuitry for processing one or more sensors. They are connected to the Streaming Adapter and to one or more sensors as illustrated in Figure 2.

The Streaming Adapter connects to a CTU Development Board using a 14-way SPI cable whose pinout is shown in Table 1.
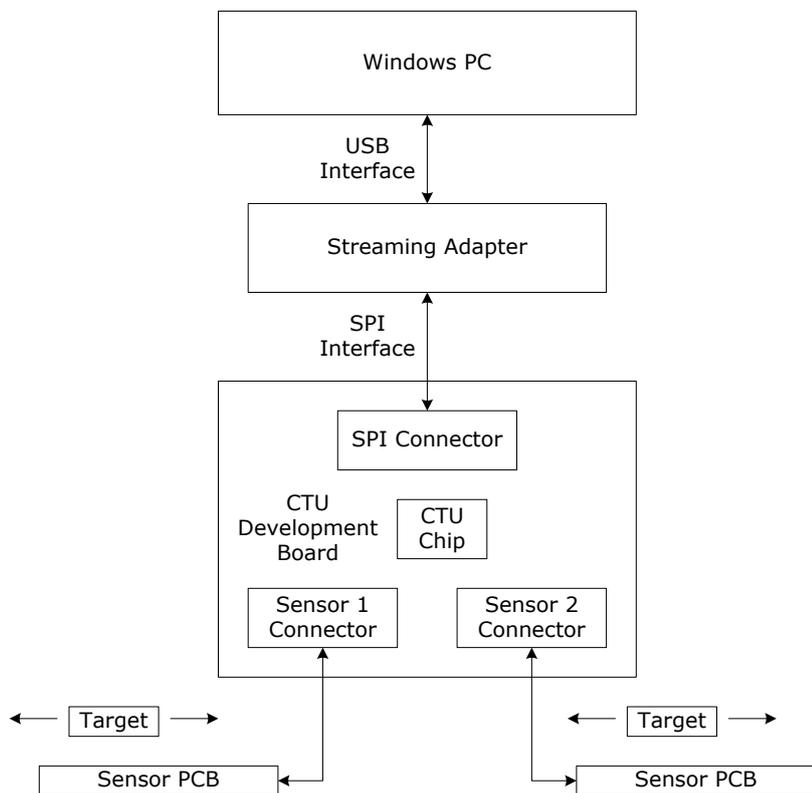
Figure 2 Hardware Connections

1.3 Connections to Customer PCB

The Streaming Adapter can alternatively be connected to a CTU chip located on a customer's PCB. Table 1 lists the Streaming Adapter's SPI connector pinout, including which connections are optional and which must be connected to the CTU circuitry.

Table 1 Streaming Adapter SPI Signals and Mapping

Pin	Signal	Description	Comments
1	VSUPPLY	+3.3V supply out	Optional, do not connect if the CTU chip is powered from a different source
2	GND	Supply voltage return (0V)	Must be connected
3	IO1	User IOs	Must be connected
4	IO2		Optional
5	IO3		
6	IO4		
7	GND	Supply voltage return (0V)	Must be connected
8	MOSI	Master Out Slave In output	Must be connected
9	nSS	Slave Select output	Must be connected
10	SCK	Serial Clock output	Must be connected
11	MISO	Master In Serial Out input	Must be connected
12	IO5	User IOs	
13	IO6		
14	nRST	Reset output, active low	Must be connected

The VSUPPLY signal is a 3.3V output from the Streaming Adapter. It may be used to power CTU and other circuitry providing they draw less than 100mA.

If the CTU chip is powered by other means, VSUPPLY must not be connected, otherwise the Streaming Adapter is likely to become damaged.

All 4 of the CTU chip's SPI lines must be connected to the Streaming Adapter.

The CTU chip's IO1 signal must also be connected to the Streaming Adapter, because it is used as a sample indicator. A sample indicator signals to the host device when each measurement is complete.

The CTU chip's nRST signal must be connected to the Streaming Adapter, so that the Streaming Adapter can reset the CTU chip when that is needed.

If the customer PCB including the CTU chip also includes a host microcontroller connected to the SPI lines and nRST, then these lines must be disconnected or made high impedance any time the Streaming Adapter is connected. This avoids interference and/or damage to circuitry.

2 Download and Installation

2.1 Downloading from Web Site

CTU Streaming Demo is available as a download from CambridgeIC's web site. It is only visible once a user is logged in – visit https://www.cambridgeic.com/modal-login-modal?ml=1.

To obtain a login, please visit https://www.cambridgeic.com/register. Select a user name and password and submit. An email will be sent to the address provided. Please check spam folders. If it does not arrive in a few minutes then please email info@cambridgeic.com and request a manual activation.

Once logged in, CTU Streaming Demo is available as a download from https://www.cambridgeic.com/products/dev-tools/streaming-adapter.

Download and save the CTU Streaming Demo zip file to the target PC. Extract its contents to a local drive on the PC. These contents include an executable file named CTUStreamingDemo-v0.5.1.exe or similar, depending on software version.

2.2 Installation

No installation is required – just launch the executable file to run.

2.3 Connecting the Streaming Adapter to the PC

The Streaming Adapter should install automatically when connected to a Windows PC over USB for the first time. It appears as a COM Port. CTU Streaming Adapter should automatically detect which COM Port to use.

If it is necessary to check that the Streaming Adapter has installed correctly then please refer to its datasheet for detailed instructions.

3 Set-Up

CTU Streaming Demo must be configured to work with the CTU chip that is connected, and for the sensor(s) that it is connected to.

3.1 Set-Up From File

CTU Streaming Demo can be configured from a .cic file. File contents include what type of CTU chip is connected, what sensor(s) are connected, what sampling method to use and how to display results . If a suitable .cic file is available then click Configuration → Load. Navigate to the location of the .cic file and select Open. CTU Streaming Demo's User Interface appearance should change to match the settings given in the .cic file.
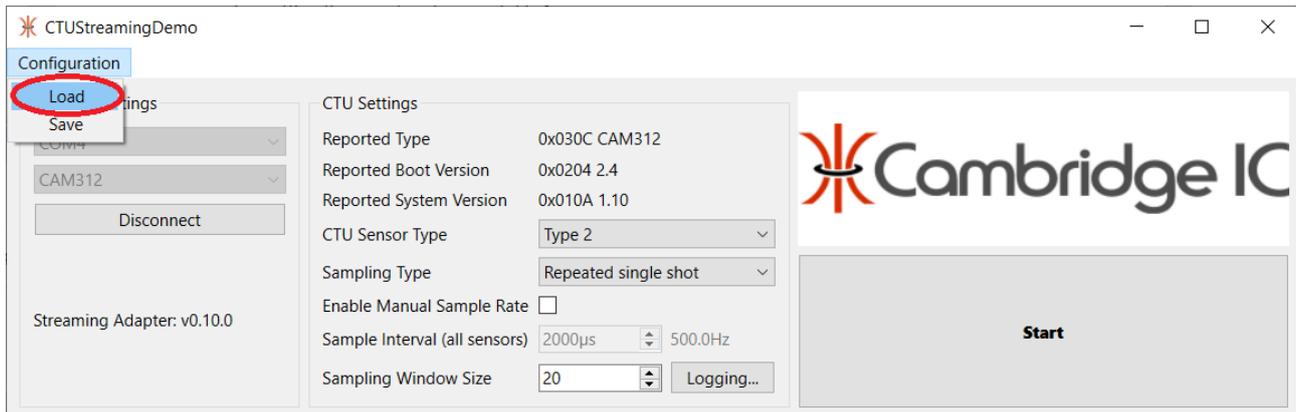
Figure 3 Location of Load

Click Connect to initiate a connection between the Streaming Adapter and the CTU chip, highlighted in Figure 4.
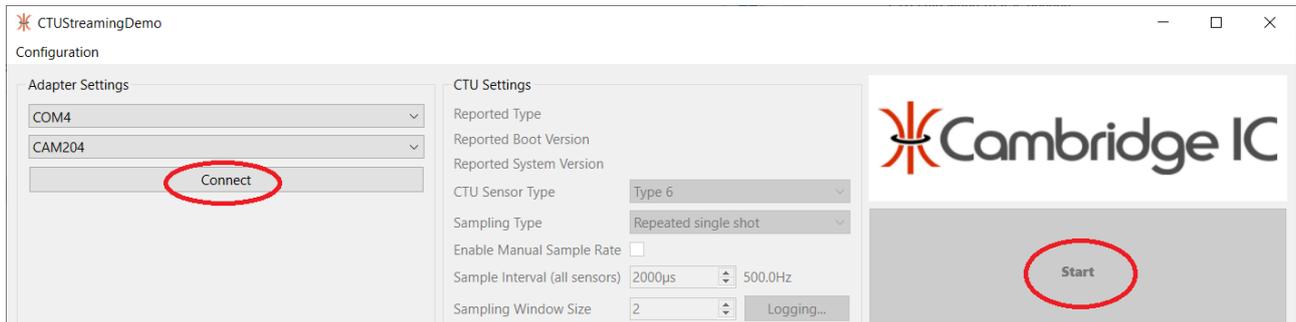
Figure 4 Location of Connect and Start

CTU Streaming Adapter should then display version numbers for the Streaming Adapter's firmware, the type of CTU chip, and its Bootloader and Application Code (System) versions. These are highlighted in Figure 5.
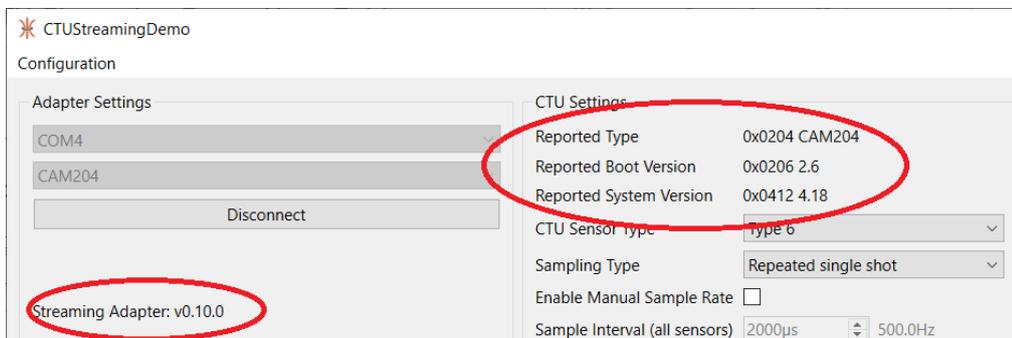
Figure 5 Location of version information.

Then click Start to start measurements, highlighted in Figure 4. Expand CTU Streaming Demo's window so that the linear sliders and/or rotary dials are clear, as shown in Figure 1. These should display the position of target(s) relative to sensors that are connected and Active.

3.2 Set-Up using User Interface

This section is relevant if a .cic file defining the required configuration is not available, or in case it is necessary to make changes.

First select a CTU chip (e.g. CAM204, CAM312, CAM502) from the drop down list and click connect, as highlighted in Figure 6.
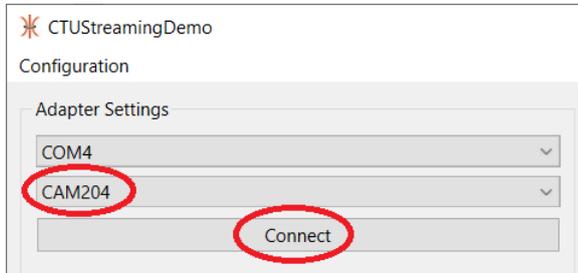
Figure 6 Location of CTU chip selection and Connect

CTU Streaming Adapter should then display version numbers for the Streaming Adapter's firmware, the type of CTU chip, and its Bootloader and Application Code (System) versions. These are highlighted in Figure 5.

Next select the Sensor Type from the drop down list as shown in Figure 7. This must match the Sensor Type of the sensor(s) connected.
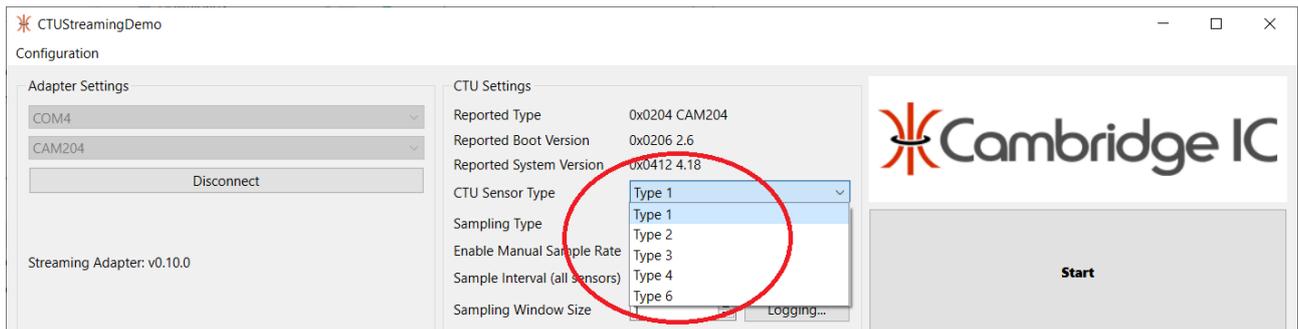
Figure 7 Location of Sensor Type selection

CTU Streaming Demo will now display controls for each sensor that it can process of the selected Type. For example it will display 2 sets of sensor controls when Sensor Type = 6, as shown in Figure 8.
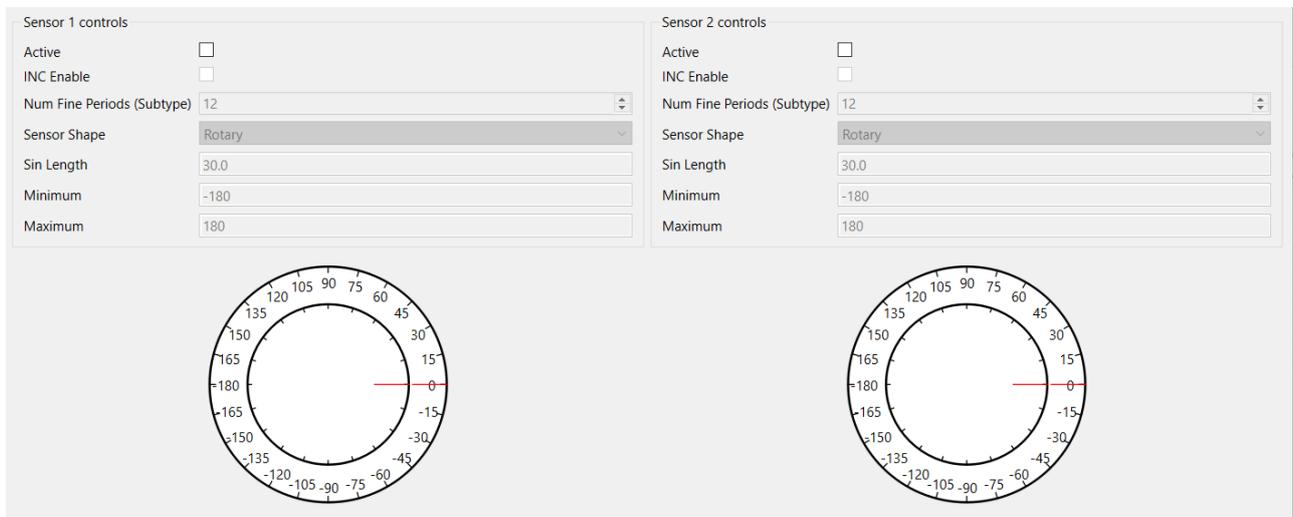
Figure 8 Sensor Controls (rotary)

At least one sensor must be set to Active in order to take measurements. More than one sensor may be set to Active.

Once set to Active, other sensor controls may be modified to suit the connected sensor and how it will be used.

Sensor Shape may be changed to Linear, which displays a linear slider in place of a rotary dial. In this case the minimum and maximum values displayed by the slider can be adjusted. CTU Streaming Demo also works with arc sensors; either the rotary dial or linear slider may be used.

The SinLength parameter may be modified to scale the position result into appropriate units, usually degrees for a rotary sensor or mm for a linear sensor. The SinLength parameter can not be changed when the Sensor Shape is rotary. It is fixed at 360°/Subtype.

When Sensor Type is set to 2, 3 or 6 the Num Fine Periods (Subtype) control must be changed to match the connected sensor's Subtype. For example a Type 2.12 sensor has Subtype = 12, and a Type 6.3 sensor has Subtype 3.

When Sensor Type is set to 2 or 6 it is possible to select Activate INC Enable to allow the sensor to be measured in incremental mode. This yields a higher maximum sample rate and reported position remains absolute. Please refer to the sensor's datasheet for more details. This is not available for Type 3 sensors.

Once these sensor controls have been updated, click Start (shown to the bottom right of Figure 4). If the target is in range of a sensor the VALID indicator should activate and the linear slider and or dial indicator(s) should now move to match the position of each target relative to its sensor. Expand the CTU Streaming Demo window horizontally and vertically to make space for larger displays if required.
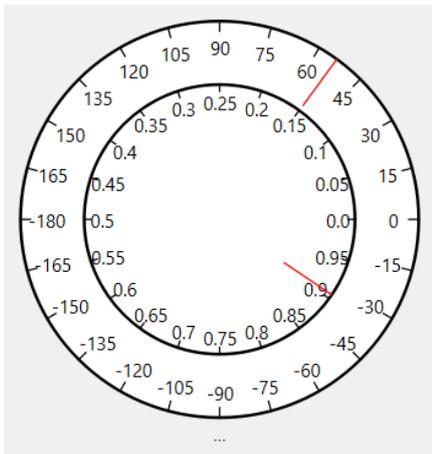
Figure 9 Rotary dial detail

Figure 9 shows a rotary dial. There are two pointers. The outer pointer indicates full absolute position in degrees around a circle. The inner dial indicates fractions of a degree, with one complete revolution equal to 1°. This is helpful for observing small changes in position, for example small movements or noise.

Digital displays underneath the linear slider or rotary dial display reported position and diagnostic data. The diagnostic data available depends on Sensor Type. Basic sensors (Type 1 or 4) include Amplitude and Relative Frequency readings. Precision sensors (Type 2, 3 or 6) include Amplitude A, Amplitude B, Relative Frequency and BA Mismatch readings. Please refer to the CTU chip's datasheet for details of diagnostic data.

The set-up may be saved by clicking Configuration → Save, highlighted in Figure 10.
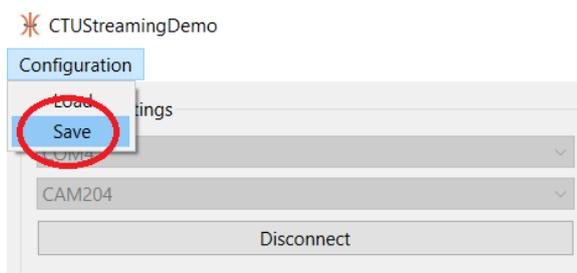
Figure 10 Location of Save set-up

4 Sampling Types

By default CTU Streaming Demo performs Repeated Single Shot measurements at the maximum possible sample rate. Other options are available, controlled by the Sampling Type, Enable Manual Sample Rate and Sample Interval controls highlighted in Figure 11.
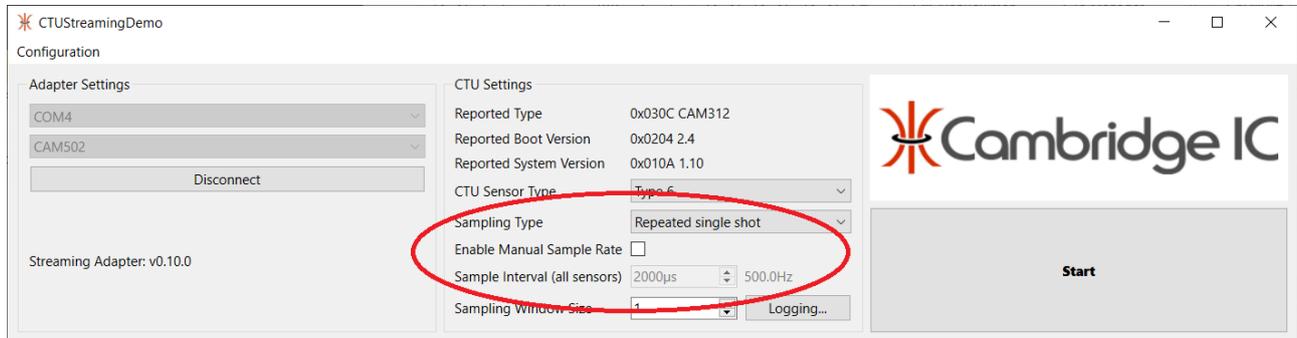
Figure 11 Location of Sampling Type control

4.1 Repeated Single Shot at Maximum Rate

This mode is active when Sampling Type is set to Repeated Single Shot and Enable Manual Sample Rate is not selected.

The Streaming Adapter initiates each measurement with a single SPI transaction that sets the CTU chip's GO bit and reads back the results of the preceding measurement. The CTU chip activates a sample indicator (IO1) once the measurement has completed. The Streaming Adapter detects the sample indicator activation, and immediately initiates the next measurement. This process means that there is no delay between a measurement and the following SPI transactions, so that the CTU chip is sampling as fast as possible.

For CTU chips that support multiple sensors, the Streaming Adapter measures each active sensor in turn.

4.2 Manual Sample Rate

When Manual Sample Rate is enabled, the Streaming Adapter controls the interval between measurements. The Sample Interval control specifies the intended sample interval.

The Streaming Adapter checks that the CTU chip's sample indicator output (IO1) has activated before initiating the SPI transaction that sets the CTU chip's GO bit. If the sample indicator has not activated in time then then the SPI transaction will be skipped. This means that the Streaming Adapter will not attempt to initiate measurements faster than the CTU chip can manage. If the user sets a manual Sample Interval that is too short for the CTU chip, sensor and operating mode, the actual sample interval may be longer than intended.

Manual Sample Rate is useful for simulating host devices that perform control functions in a regularly timed cycle, for example motion control loops. In this case the host will normally initiate CTU chip measurements once per cycle, so CTU chip measurements are synchronized to the host.

When there are more than one active sensors, the Sample Interval controls the time between measurements on the first sensor. Subsequent sensors are measured immediately after the first. For example if Sample Interval is set to 1000µs and there are two active sensors then there will be 2000 measurements per second, 1000 on each of the two sensors.

4.3 CAM502 Pipeline Mode

The CAM502 chip can perform measurements in Pipeline Mode, which maximises sample rate. From a host's perspective Pipeline Mode is very similar to Repeated Single shot. The main difference is that the host's SPI transactions must be regularly timed so that the CAM502 chip can prepare each measurement result in time for it to be read out in the next SPI transaction. This means that Manual Sample Rate is required, and it is always enabled when Sampling Type is set to Pipeline Mode.

The CAM502 is specified with a minimum Sample Interval of 195µs in Pipeline Mode. CTU Streaming Demo allows a user to select slightly a slightly shorter Sample Interval than this for testing purposes.

4.4 CAM312 Low Power Mode

The CAM312 chip includes a power down mode. When Sampling Type is set to Low Power the Streaming Adapter uses this mode to reduce the average power drawn by the CAM312 chip. After each measurement the host initiates this power down mode, and it then wakes the CAM312 chip up again in preparation for the next measurement.

Please refer to the CAM312 datasheet for details of low power operation.

In Low Power mode the host controls sample timing, so Manual Sample Rate is required for this mode.

5 Analysing Data in a Sampling Window
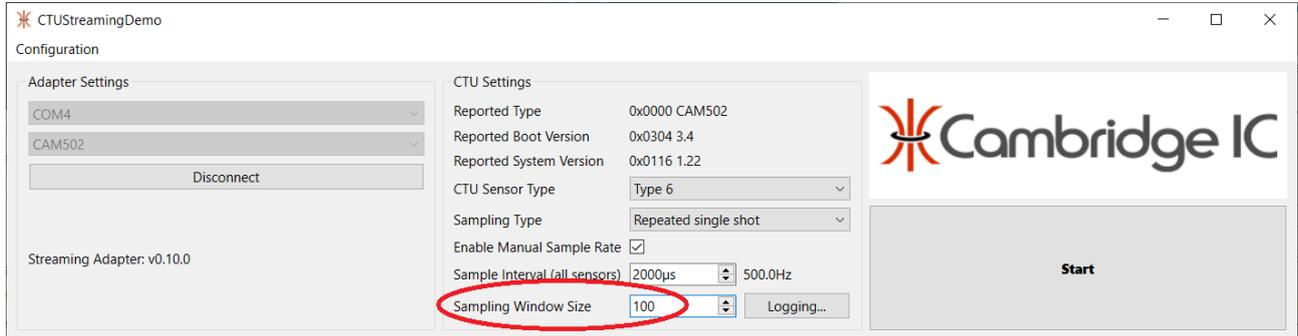
Figure 12 Location of Sampling Window Size control

By default Sampling Window Size is 1 and CTU Streaming Demo displays results of individual measurements.

If instead Sampling Window Size is set to 2 or more then CTU Streaming Demo analyses data from the selected number of measurements, and displays statistics instead of individual measurement results.

Rotary dials and linear sliders display average position. The digital read-outs below display statistics appropriate to each named variable. Please see Figure 13 for an example.
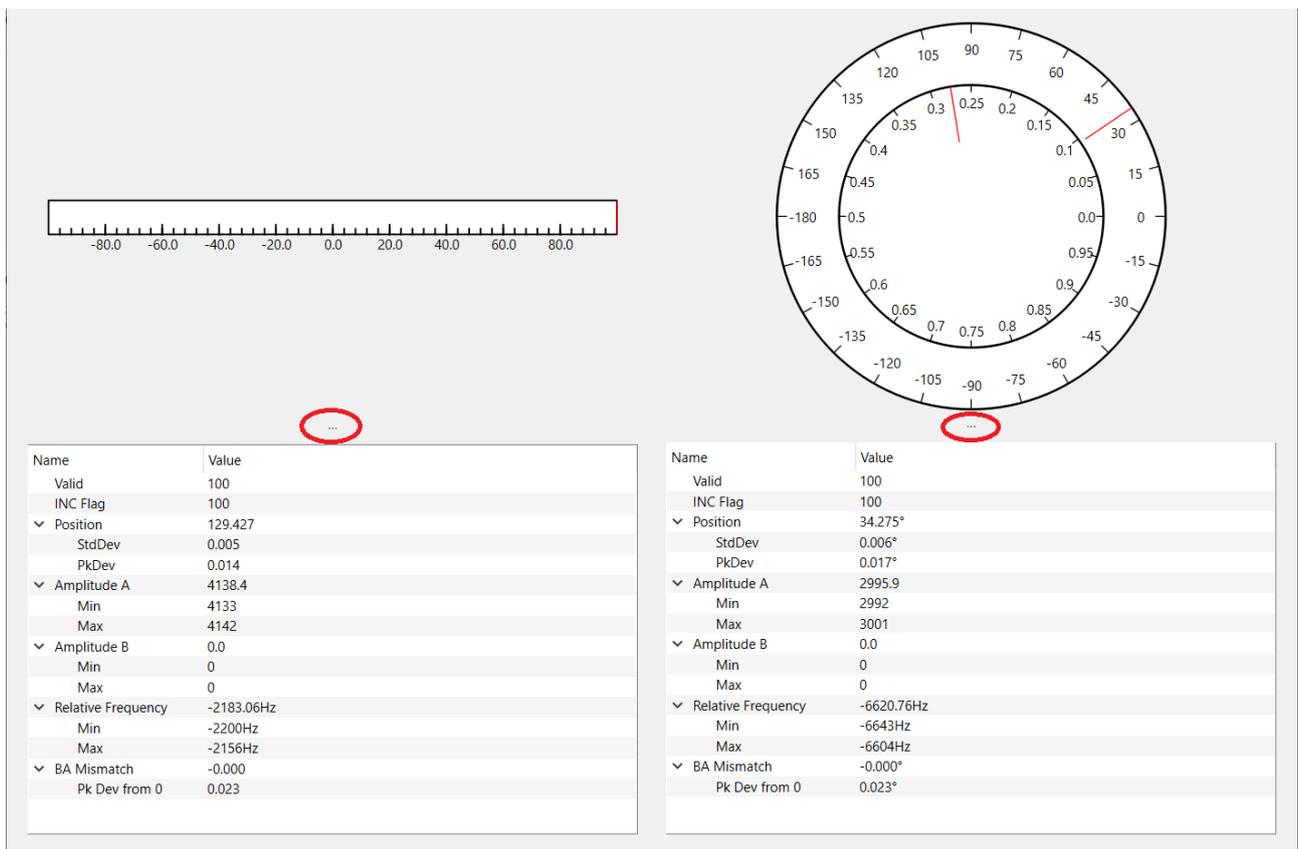
Figure 13 Digital read-outs with location of grips highlighted

By default, the digital displays show average values. Expand each variable by clicking on > to its left, and further statistics become visible. For example Standard Deviation (StdDev) and Peak deviation from average (PkDev) are available for Position measurements.

When expanded in this way there may not be enough space to display all statistics at once like this by default. There are grips above each digital display highlighted in Figure 13. Click and drag the grip upwards to make space for the display.

6 Logging Measurement Data to File

CTU Streaming Demo can save measurement results to file to allow them to be analysed.

6.1 What to Save

If Sampling Window Size is set to 1 then CTU Streaming Demo will save individual measurement results to file, one per result row. It is usually best to use this mode to capture fast transient events where the application of averaging and other analysis may obscure the data.

If Sampling Window Size is set to 2 or more (see section 5) then CTU Streaming Demo will save statistics for each active sensor. In this case each row is based on a number of samples, equal to the Sampling Window Size. This mode is best for analysing measurement data when the target is stationary while each measurement is taken. For example when comparing measurements taken in different metal environments. By saving statistics including average values, the recorded measurements allow greater measurement precision than recording individual measurements.

Results for each active sensor are saved.

6.2 Logging Setup

Set up CTU Streaming Demo as detailed in section 3. Before clicking Start, click on Logging as highlighted in Figure 14.
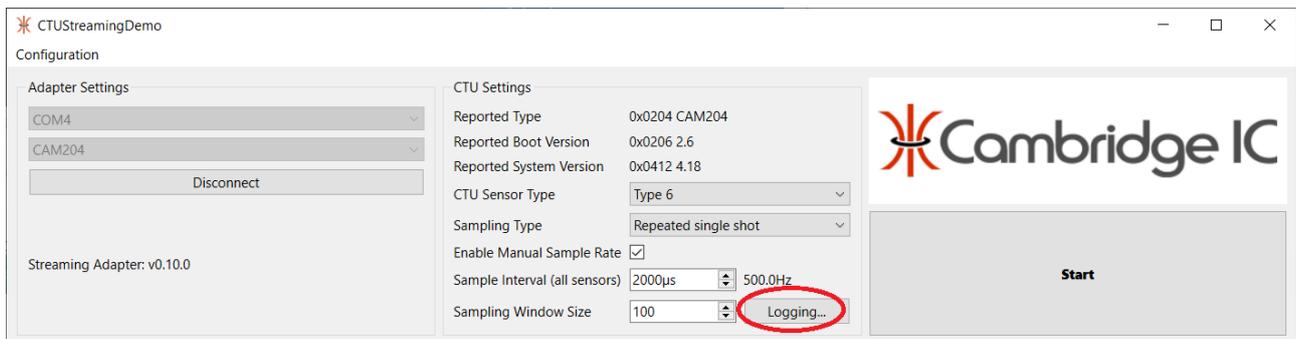
Figure 14 Location of Logging control

A Logging Setup window will appear, as in Figure 15.
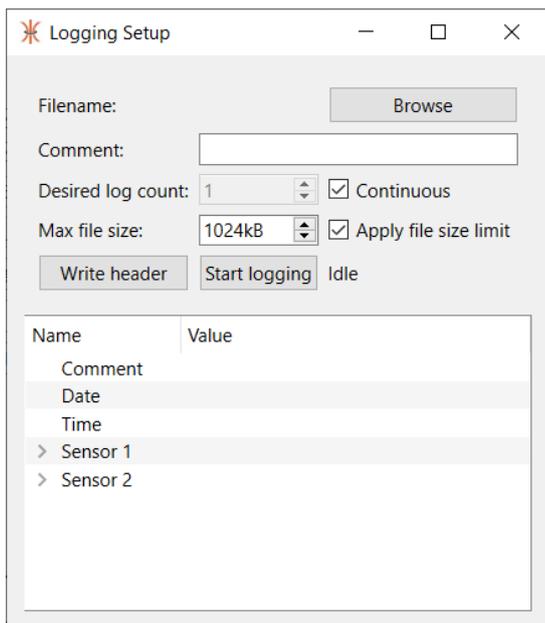
Figure 15 Logging Setup window

Click Browse and select a directory location and file name for the log file. Measurements can be saved to a new or existing file.

If it is a new file then it is strongly recommended to click Write Header. This will save configuration data to file followed by a row of column headings suitable for the data being taken and the number of active sensors.

Now click Start to start measurements.

6.3 Logging Operation

By default Continuous is selected, which means data will be written to file as they become available once Start logging is clicked. This button will then read Stop logging. Click to stop logging. Logging will also stop when the specified Max file size is reached, to avoid excessive data being collected by mistake.

To save a selected number of data rows, deselect Continuous and enter the number in the Desired log count control. Click Start logging to save this number of data points to file.

The most recently saved data appears in the Logging Setup window, and an example is shown in Figure 16. To view all sensor data click the > control next to each sensor.

A comment may be entered for each measurement or set of measurements. It will be saved in the first column of each data row. Adding comments is helpful for documenting tests undertaken with CTU Streaming Demo, to help match test situation with the corresponding data.

Figure 16 Logging Setup window configured for a Sampling Window Size of 100 saving one row at a time

7 Troubleshooting Guide

Symptom	Possible cause	Rectification
Error: Invalid serial port	Streaming Adapter not plugged into USB port	Plug it in
	Adapter driver disabled	Re-Enable driver
	Adapter not yet enumerated	Wait 5 seconds between plugging in the Adapter and running any application that uses it
		Connect PC to internet and try again
Reported versions all 0xFFFF or 0x0000	CTU chip's SPI interface not connected to Streaming Adapter	Plug it in
	CTU chip's SPI interface line(s) stuck	Check wiring for short circuits to supply or ground
	CTU chip's SPI interface lines stuck high	Check wiring for short circuits to supply or ground
Reported Type of CTU chip doesn't match CTU chip selection	Did not make CTU chip selection correctly	Disconnect, update CTU chip selection and Connect again
Unable to select CAM312 Low Power mode		
Unable to select CAM502 Pipeline Mode		
Measurements do not start when expected		
Reported position scaled wrongly	Wrong value of SinLength	Check SinLength value for connected sensor
Precision sensor's position jumps around	Wrong value of Num Fine Periods (Subtype)	Check Subtype value for connected sensor
Can't see linear slider or rotary dial properly	Window too small to display properly	Expand window
Can't see sensor's digital display	Window too small to display properly	Expand window
	Grip set too low	Move grip (Figure 13)

8 Document History

Revision	Date	Description
0001	10 May 2023	First draft based on CTU Streaming Demo 0.5.1

9 Contact Information

Cambridge Integrated Circuits Ltd
21 Sedley Taylor Road
Cambridge
CB2 8PW
UK

Tel: +44 (0) 1223 413500

info@cambridgeic.com

10 Legal

This document is © 2023 Cambridge Integrated Circuits Ltd (CambridgeIC). It may not be reproduced, in whole or part, either in written or electronic form, without the consent of CambridgeIC. This document is subject to change without notice. It, and the products described in it ("Products"), are supplied on an as-is basis, and no warranty as to their suitability for any particular purpose is either made or implied. CambridgeIC will not accept any claim for damages as a result of the failure of the Products. The Products are not intended for use in medical applications, or other applications where their failure might reasonably be expected to result in personal injury. The publication of this document does not imply any license to use patents or other intellectual property rights.