Description

CambridgeIC's CAM622 IC inductively detects the position of a resonant target relative to a sensor. They are designed to be embedded inside a customer's electromechanical product, typically for motion control.

CAM622 interface options include SPI, digital quadrature ("ABN"), SENT or BiSS. They are all fully configurable. For example the quadrature interface's number of AB cycles per revolution and position of the N index pulse.

Non-volatile configuration is done either over SPI or BiSS. BiSS communication shares the quadrature ABN signals, allowing CAM622 based sensor modules to omit SPI connections and remain configurable.

To assist demonstration, evaluation and development, CambridgeIC provides hardware and software that works with a PC. A MultiComms Adapter enables a PC to communicate with a CAM622. This connects to a PC USB port, and communicates at high speed with the CAM622 over either SPI, BiSS or SENT.

The CAM622 Read Position Application is for taking and analysing measurements over the CAM622's SPI, BiSS or SENT interface.

The CAM622 Configuration Tool Application is for programming the CAM622 for standalone operation.

CAM622 Read Position

- CAM622 communication over SPI, BiSS or SENT
- Takes measurements at up to 33kHz
- Synchronous or asynchronous operation
- Animates position measurements on scales
- Plots position, velocity, linearity, diagnostic data
- Saves measurements to file

CAM622 Configuration Tool

- Either SPI or BiSS used for configuration
- Configures for BiSS, SENT or quadrature ABN
- Volatile or non-volatile write options
- Reads and displays position and diagnostics
- Reads and displays ABN state over SPI or BiSS
- Saves and loads settings to and from file

Firmware Update Tool

- Updates the CAM622's on-chip Application Code over SPI

System Requirements

- Windows 10 or 11 PC
- Available USB port

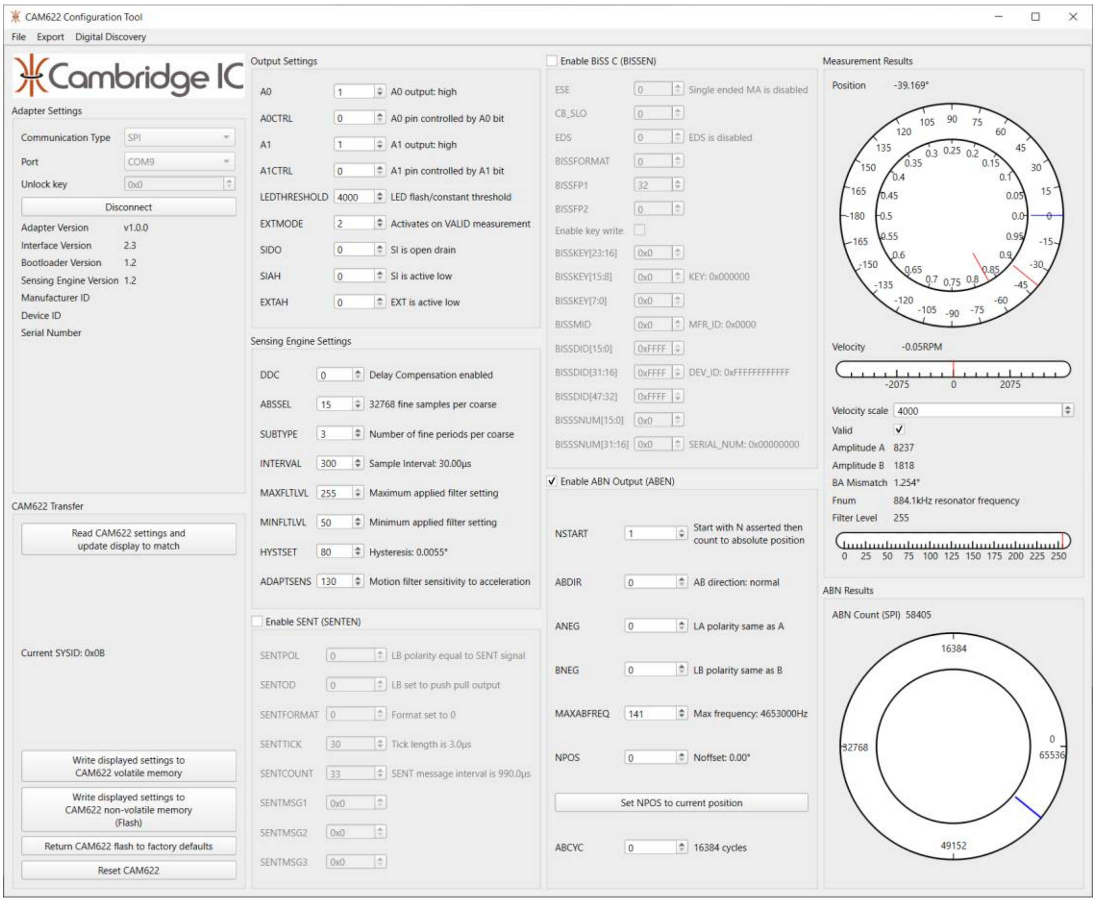

Figure 1 CAM622 Configuration Tool Main Window

1 Hardware Configuration

This section explains what hardware is required to run CAM622 applications.

1.1 MultiComms Adapter

The CAM622 Read Position, CAM622 Configuration Tool and Firmware Update Tool applications connect to a CAM622 using a MultiComms Adapter. The MultiComms Adapter communicates with the PC over USB, and with the CAM622 over SPI, BiSS or SENT. It includes a processor that acts as a host device for the CAM622. This processor configures the CAM622 and takes measurements in real time, streaming results to the PC over USB at high speed.

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

The MultiComms Adapter replaces CambridgeIC's older Streaming Adapter. Streaming Adapters still work with CAM622 Read Position and CAM622 Configuration Tool and Firmware Update Tool applications. However they only support the SPI interface, and lack switched power supplies.

1.2 Connecting the MultiComms Adapter to a CAM622

A CAM622 MultiComms Board is available for evaluating and prototyping with the CAM622. Figure 2 illustrates options for connecting it to a MultiComms Adapter.

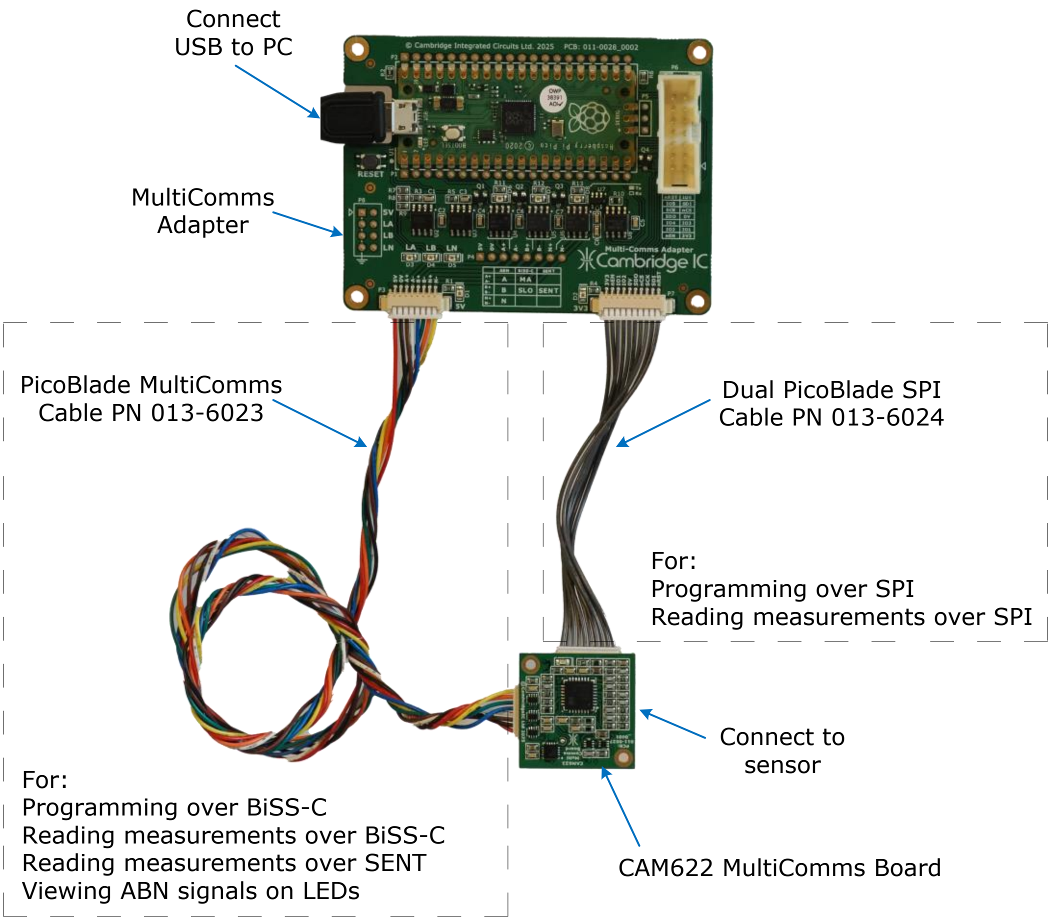

Figure 2 Connection options between a MultiComms Adapter and a CAM622 MultiComms Board

The SPI connection is always required for initial configuration of a CAM622 device. If configuration over BiSS is required then BiSS communication must first be configured over SPI (section 4.5). Once that has been done, it is possible to configure the CAM622 over BiSS alone, using only the MultiComms cable. However it is also possible to keep both MultiComms and SPI cables connected at the same time, which allows for operation over any interface.

The MultiComms Adapter can alternatively connect to a CAM622 mounted on a customer's PCB. The minimum connections for configuration over SPI are 0V, nCS, SCK, SDO, SDI and nRST. The nRST connection allows CAM622

Software to reset the CAM622. If CAM622 Read Position is to be used in synchronous mode (Figure 17) then the SI signal must also be connected.

The MultiComms Adapter includes a switched 5V output to power CAM622 circuitry through the MultiComms cable. When the CAM622 Software needs to reset the CAM622 it switches the 5V rail off and on again. The MultiComms Adapter's 5V output must therefore be used to power the CAM622 circuitry (through a 5V to 3.3V regulator), in order for a reset to be successful.

The MultiComms Adapter includes MultiComms test points that can be used to monitor raw signals such as quadrature ABN signals using an oscilloscope. The MultiComms Adapter converts these signals to single ended 5V logic levels, and these are also available for probing at its LA LB LN Test Points. LEDs reflect the state of the A, B and N signals. Please refer to the MultiComms Adapter's datasheet for details.

The MultiComms Adapter also works with the older CAM622 ABN Board in place of the newer CAM622 MultiComms Board. The CAM622 ABN Board lacks a BiSS interface, so it is usually only connected over SPI.

1.3 Connecting a Sensor to the CAM622 MultiComms Board

Figure 3 illustrates how to connect sensors to the CAM622 MultiComms Board. Rotary sensors usually connect with a 6-way Dual PicoBlade Cable, CambridgeIC part 013-6019. Linear sensors usually connect with a 120mm 6-way PicoBlade-EZMate Cable instead, CambridgeIC part 013-6021.

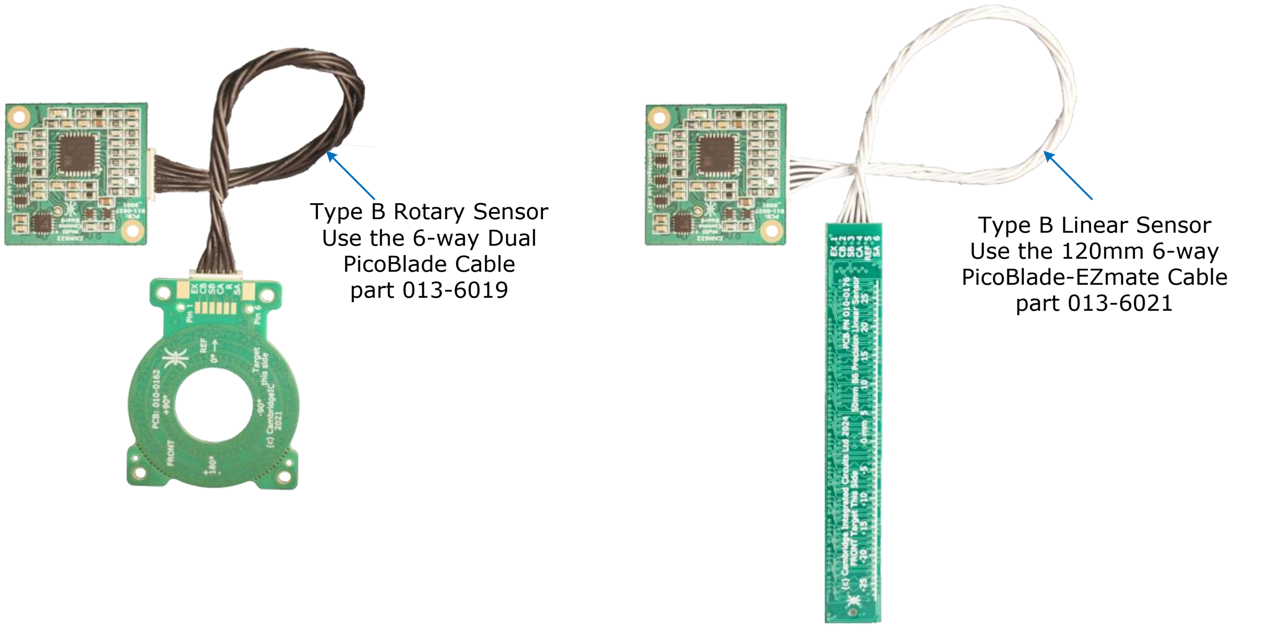

Figure 3 Connections to a Type B Rotary or Linear Sensor

Sensors work in combination with their matching target, not shown in Figure 3. To obtain valid measurements the target should be placed in range of the sensor, according to the sensor's datasheet.

Sensor connections are optional when using the CAM622 Configuration Tool application. However they are recommended, to help check the system is working as expected. A working sensor is required to "Set NPOS to Current Position" (section 4.4).

2 Download and Installation

2.1 Downloading from Web Site

The CAM622 Applications are available as a download from CambridgeIC's web site. They are only visible once a user is logged in – visit the CambridgeIC login page.

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, applications are available as a download from https://www.cambridgeic.com/products/dev-tools/streaming-adapter.

Download and save the zip file to the target PC. Extract its contents to a local drive on the PC.

2.2 Connecting the Streaming Adapter to the PC

The MultiComms Adapter should install automatically when connected to a Windows PC over USB for the first time. It appears as a COM Port. CAM622 applications should automatically detect which COM Port to use.

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

2.3 Installation

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

3 CAM622 Read Position

The CAM622 Read Position application configures the CAM622 for taking measurements, captures measurements at high speed and displays results and analysis. Its main window is illustrated in Figure 4.

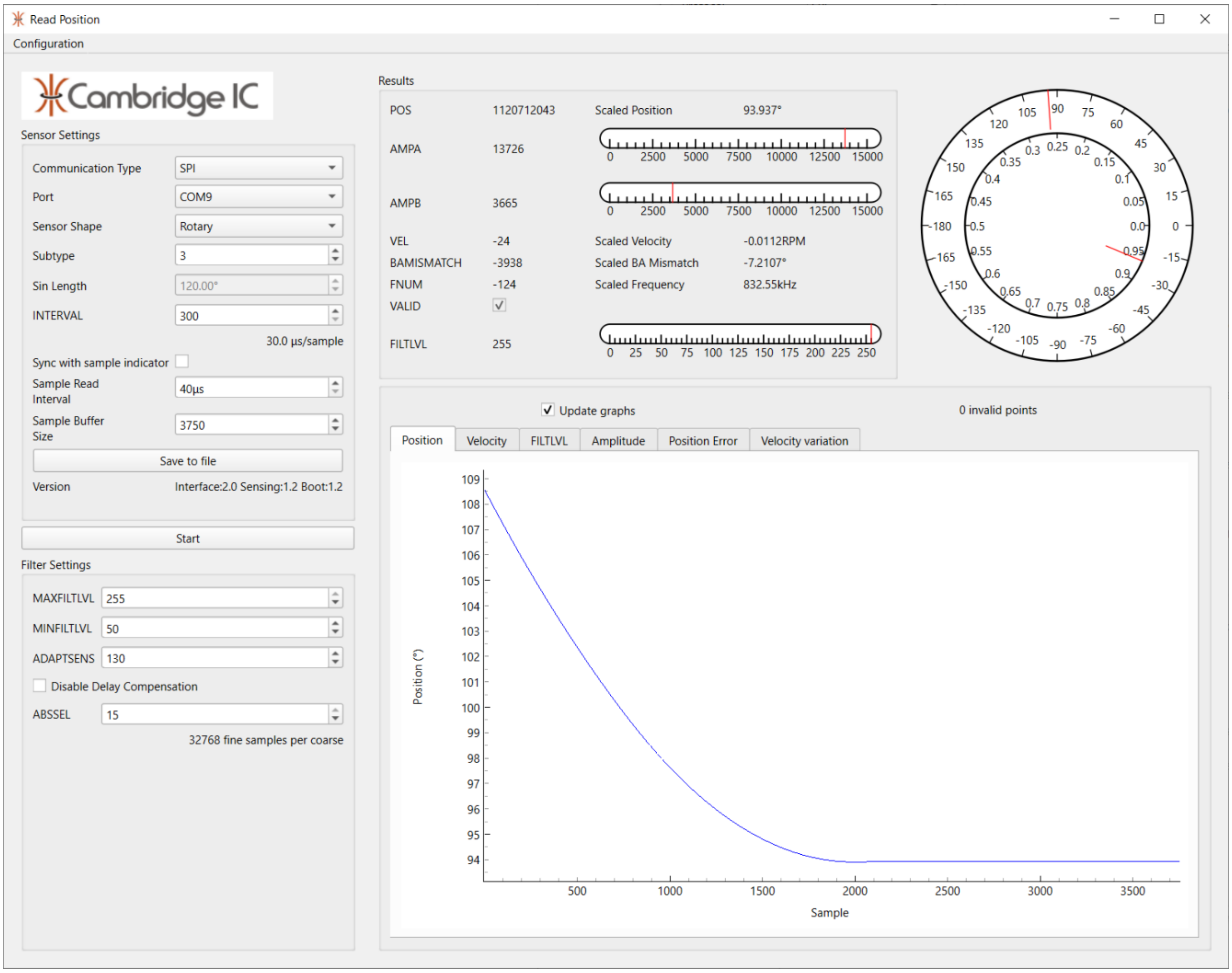

Figure 4 CAM622 Read Position Main Window

3.1 Connecting to a Streaming Adapter

When a Streaming Adapter is plugged into the PC, it should appear as a virtual COM port. CAM622 Read Position should detect this automatically and display the COM port, as illustrated in Figure 5.

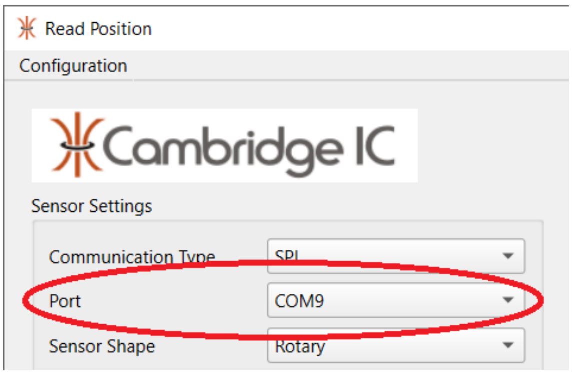

Figure 5 COM Port Display

If the COM Port display is blank, this means CAM622 Read Position has not detected the Streaming Adapter. It may not be connected properly, or a Streaming Adapter firmware update may have failed. Please refer to its datasheet for more assistance with fault finding.

3.2 Setting Communication Type

By default CAM622 Read Position communicates over SPI. This requires the SPI connection illustrated to the right of Figure 2. It is strongly recommended to get started with SPI. The SPI interface delivers comprehensive diagnostic data updated at the same high rate as position data, and provides full access to settings.

CAM622 Read Position can also communicate with a CAM622 over BiSS C or SENT. These are selected using a drop-down menu illustrated in Figure 6. To use these alternative options, the CAM622 must first be configured. For BiSS configuration please refer to section 4.5. For SENT configuration please refer to section 4.7. Note that there are two BiSS C options. Select "BiSS C" if the BISSEN=1 and ABEN=0. Select "BiSS (ABN Enabled)" if BISSEN=1 and ABEN=1 (section 4.6).

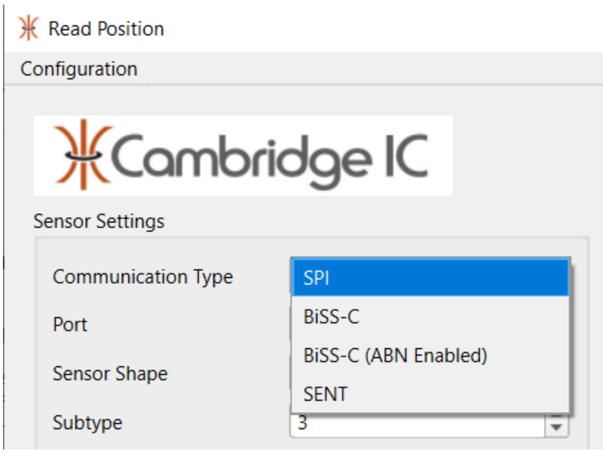

Figure 6 Setting Communication Type

If BiSS or SENT interfaces are selected, a MultiComms cable connection is required between the MultiComms Adapter and CAM622 MultiComms Board, illustrated to the left of Figure 2.

3.3 BiSS Communication Settings

If BiSS is selected, additional configuration options are displayed, as illustrated in Figure 7. BISSFORMAT is reserved for future use and its value is fixed at 0. With BISSFORMAT=0, BiSS Format P1 controls the number of position bits reported each BiSS Frame. A value of 24 is suitable for most needs. Note that the Read Position application controls this parameter (BISSFP1). It does not matter what number is programmed into the CAM622's non-volatile memory; Read Position will override the value.

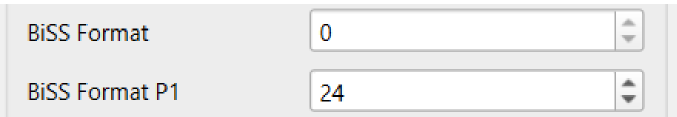

Figure 7 Controls specific to BiSS

3.4 SENT Configuration Settings

SENT is a unidirectional interface, with the CAM622 autonomously transmitting data to the MultiComms Adapter. This means that the CAM622 Read Position application can only display measurement results. It can not make changes to CAM622 settings such as Filter Settings (section 3.12), which are greyed out when SENT is selected.

When SENT is selected, SENT Tick Length and SENT Format must be changed to reflect how the CAM622 is configured. Figure 8 shows the relevant controls. These must be set the same as when the CAM622 was configured for SENT (section 4.7).

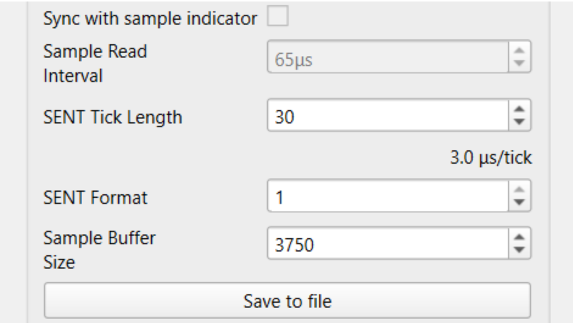

Figure 8 SENT settings

3.5 Setting Sensor Shape, Subtype and SinLength

Check and update the Sensor Shape control to match the sensor. The Subtype control MUST then be set to match the sensor's Subtype.

If a rotary sensor was selected the control appears like in Figure 9. The Subtype is the number of fine COS/SIN periods per coarse COS/SIN period. This corresponds to the number of fine COS/SIN periods around a circle. A Type B sensor's name includes its subtype after "B". For example a 25mm B3 Rotary Sensor has Subtype=3. The SinLength parameter's value is automatically calculated, it equals 360° divided by the Subtype.

If a linear sensor was selected the control appears like in Figure 10. The Subtype is the ratio of the coarse coil's sinusoidal pitch to the fine coil's sinusoidal pitch. A Type B sensor's name includes its subtype after "B". For example a 50mm B6 Linear Sensor has Subtype=6. The SinLength parameter must match the sinusoidal pitch of the sensor's fine coil.

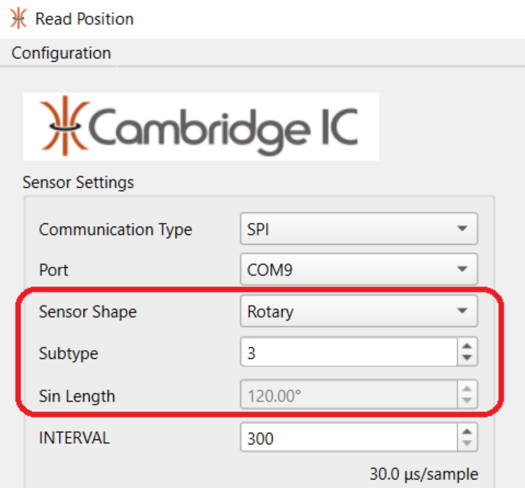

Figure 9 Rotary

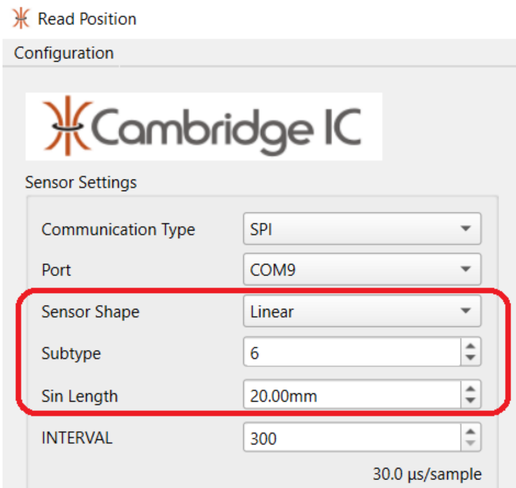

Figure 10 Linear

If Subtype is not set correctly, the reported position will always be wrong, and its value may jump erratically even when the target is stationary or moving slowly. If a linear sensor's SinLength parameter is set incorrectly then reported position values will be scaled incorrectly.

3.6 Basic Measurements

Click “Start” to begin taking measurements, located as shown in Figure 11.

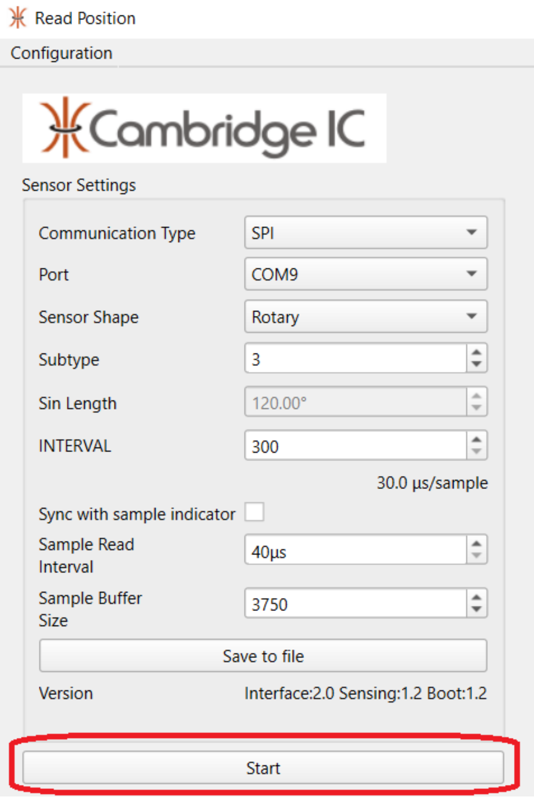

Figure 11 Starting measurements

The CAM622 will start taking regular measurements. The status of those measurements, whether VALID or not, is displayed as shown in Figure 13. Measurements must be VALID (tick in box as shown) for the CAM622 to report position and other data. If the CAM622 does not report VALID when taking measurements, check connections to the sensor, and check the target is present and in range.

It may be necessary to reset the CAM622 before starting CAM622 Read Position. If the software fails to start, for example with a “Please check you have selected the correct COM port and the boards are correctly connected” error message, press the small black button adjacent the incoming USB cable on the MultiComms Adapter, illustrated in Figure 12. Then try clicking “Start” again.

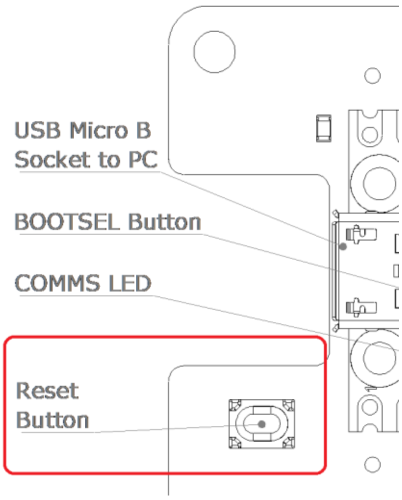

Figure 12 Reset Button location on MultiComms Adapter

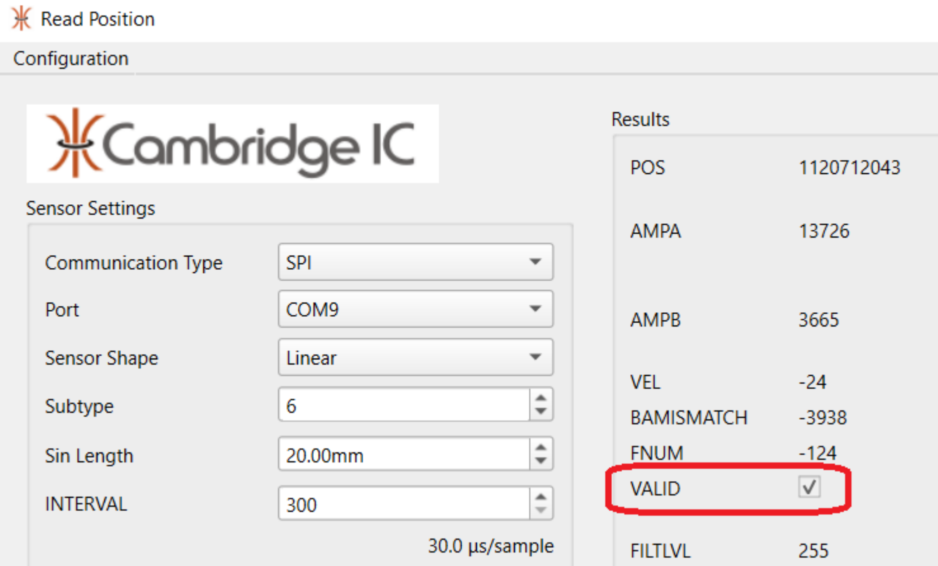

Figure 13 VALID display

If VALID, the position indicators to the top right of the main window should follow the position of the target relative to the sensor.

Figure 14 illustrates position dials indicating rotary position. The outer dial pointer indicates absolute position across 360°. The inner dial pointer rotates once for every 1° of angle change. It is useful for observing small changes in position, including position noise.

Figure 15 illustrates the display length control, and the linear slider and dial indicating linear position. Set the display length to the measurement range of interest, for example 10mm more than the sensor's measuring length. The linear slider pointer indicates position. The rotary gauge pointer rotates once for every mm of linear movement, and is useful for observing small changes in position.

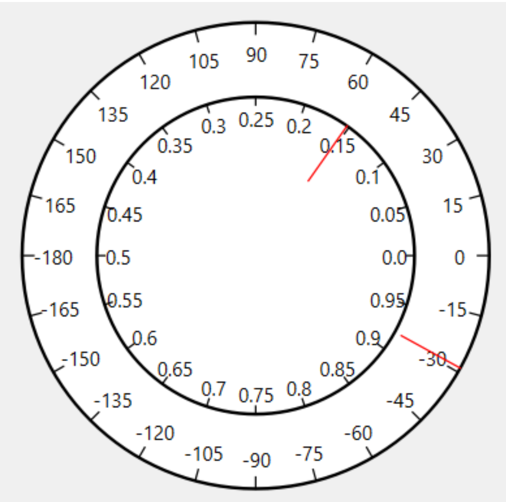

Figure 14 Dial indicator for rotary position

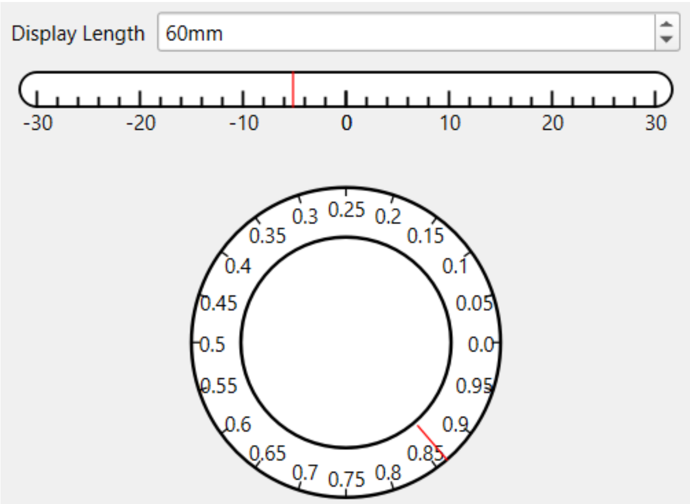

Figure 15 Linear position slider and gauge

3.7 Adjusting Measurement Timing

INTERVAL sets the CAM622's internal measurement interval, in multiples of 0.1µs. For example 300 corresponds to an interval of 30µs between the beginning of successive measurements.

"Sync with Sample Indicator" determines whether the MultiComms Adapter times SPI transactions after each CAM622 Sample Indicator activation (synchronised, Figure 17) or whether SPI transactions are asynchronous (Figure 16). The CAM622 includes Latch Point Compensation (in Application Code V2.0 onwards) which eliminates errors associated with asynchronous operation. The default, asynchronous operation, is therefore recommended for most applications.

When asynchronous is selected the "Sample Read Interval" control sets the interval between the beginning of each SPI transaction. The minimum value is 40µs for SPI communication or 65µs for BiSS, limited by USB bandwidth. For most applications the minimum value is recommended.

When operating synchronously, the default value of INTERVAL is 320, corresponding to 32.0µs. The minimum value is 300 (30.0µs). Depending on a PC's speed and the behaviour of its USB port, operation at this minimum value is not always reliable, and the PC may not capture all results in this case. The default value of 320 is recommended for most applications.

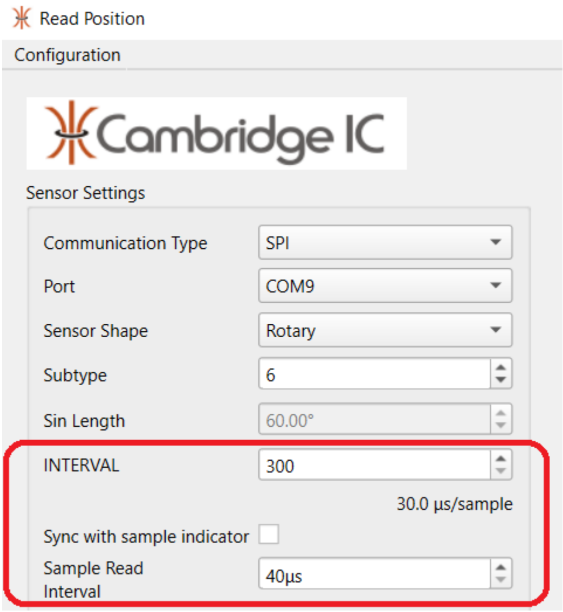

Figure 16 Asynchronous

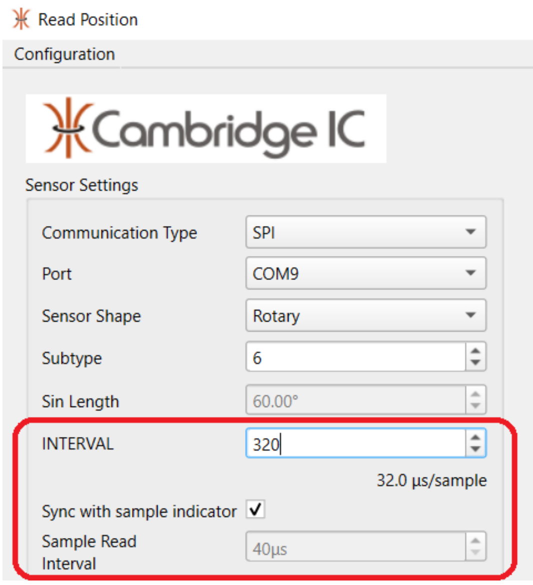

Figure 17 Synchronous

3.8 Measurement Results Detail

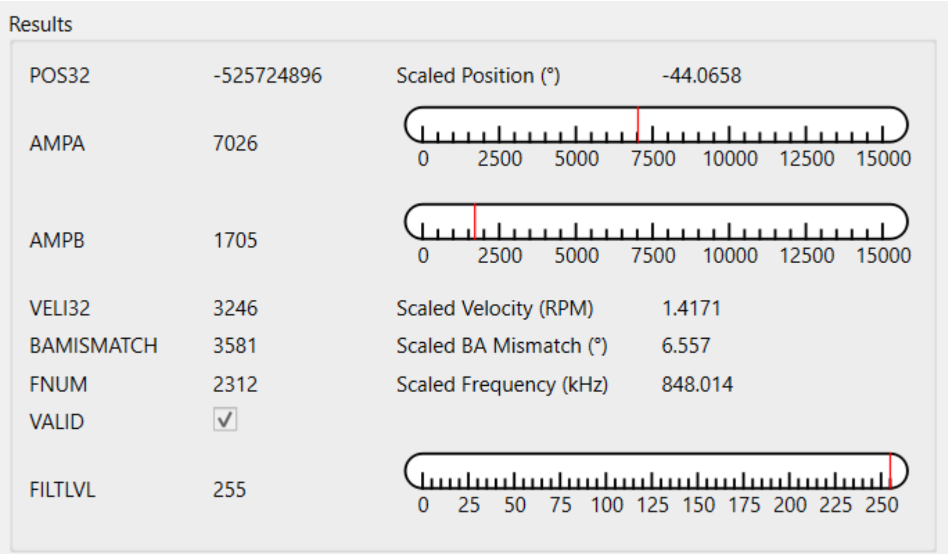

Figure 18 Raw results and their interpretation

The top middle of the results window is illustrated in Figure 18, and shows measurement results in detail. The first column is the name of the CAM622 results register. The second column is the raw data collected from the CAM622. The third column is interpreted results, in physical units where appropriate.

The Scaled Position value reports position in degrees for rotary sensors and in mm for linear sensors.

AmplitudeA is a measure of signal strength measured from the fine COS/SIN sensor coils. It decreases as the gap between sensor and target increases, and with nearby metal. The recommended minimum for design purposes is 3000, while greater values are preferred for higher resolution. AmplitudeB is a measure of signal strength measured from the coarse COS/SIN sensor coils, and is typically 3 to 6 times smaller. AmplitudeB (and BA Mismatch) is updated less frequently than AmplitudeA, under the control of ABSSEL, see section 3.12.

VELI32 is measured velocity, as measured by the CAM622's Motion Filter. Note that it is not calculated from the difference in successive position measurements. It is filtered somewhat more than position readings. It is a signed value.

BA Mismatch is the difference in position reading between the fine and coarse sensor coils. It is a signed value and its nominal value should be close to zero. Small departures caused by errors mainly from the coarse coil are normal. Larger errors can be caused by misalignment or metal placed behind the sensor or target in a highly asymmetric way.

FNUM is a signed value approximately indicating the target resonator's frequency. A raw value of zero indicates the resonator frequency matches the CAM622's centre frequency, nominally 833.3kHz. Resonator frequency is an important measure of signal health. Large departures from zero (scaled frequency far from nominal) can be caused by incorrect resonator tuning and/or metal nearby.

FILTLVL is the current filter level for the CAM622's Motion Filter. Higher values indicate a greater amount of filtering. When adaptive filtering is being used, the reported FILTLVL value will normally vary with acceleration and position noise between MINFILTLVL and MAXFILTLVL. It is reported to allow the behaviour of the Motion Filter to be monitored.

When connected over SPI, all measurement results are updated each transaction, resulting in a high update rate. BiSS and SENT transmit position values each transaction, but it takes many transactions to transmit a full set of diagnostic data, so this is updated at lower rates.

For more details of how measurement results are reported and the significance of the diagnostic data that is reported, please refer to the CAM622 datasheet and to the Type B Sensor Reference Manual.

3.9 Viewing and Adjusting the Position Graph

The CAM622 Read Position application plots position by default. Figure 19 illustrates the plot area during measurements, for the case of a stationary target. Graphs will update continuously as long as "update graphs" is activated, see the highlighted control in Figure 19. Uncheck this box to freeze the current data, for example to examine it in detail.

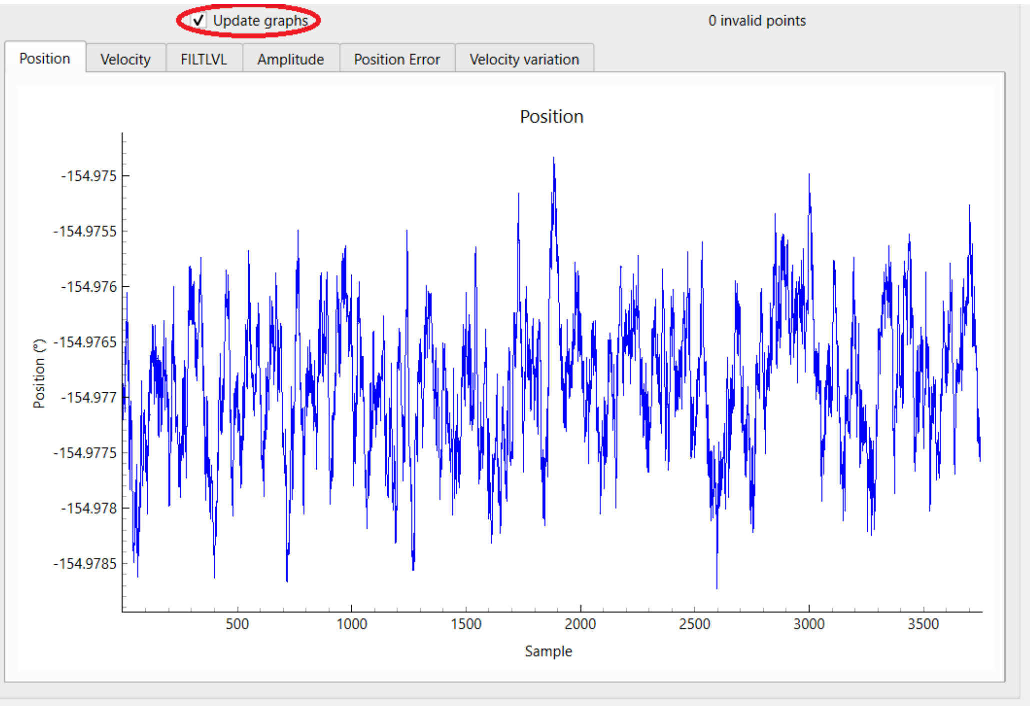

Figure 19 Position plot with static target, autoscaled

The graph's y-axis scaling may be changed using a mouse with a mouse wheel. Position the cursor over the graph and scroll to change scaling. Figure 20 illustrates the effect of scrolling out on Figure 19.

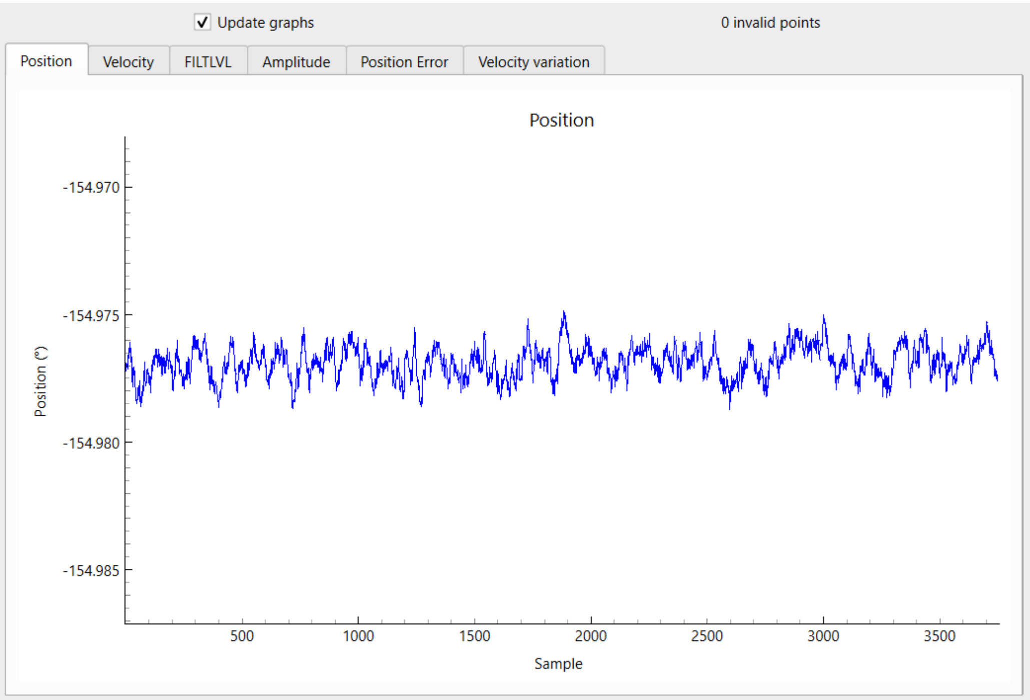

Figure 20 Position plot with static target, scaled

The graph axes may also be scaled manually, by right clicking a mouse over the graph area, selecting the relevant axis, then filling in the desired manual control over minimum and maximum axis values. This is illustrated in Figure 21.

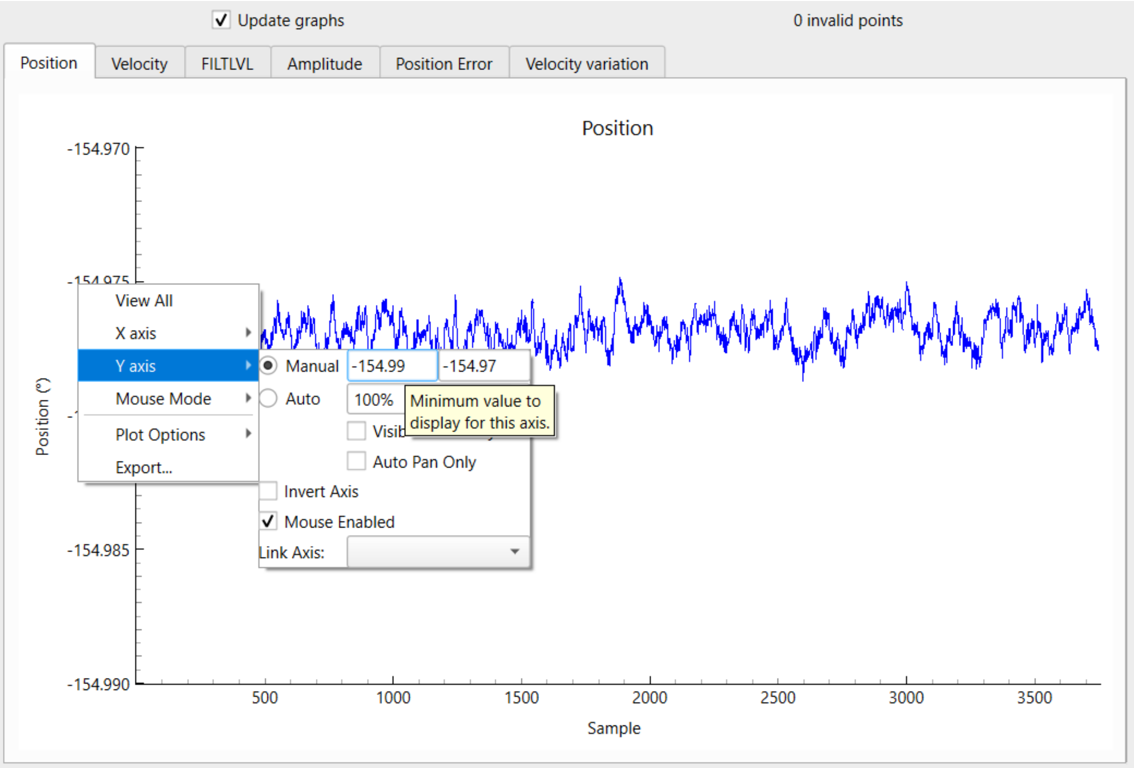

Figure 21 Position plot with static target, manual scaling

To revert to an autoscaled graph, click on the "A" symbol to the bottom left of the graph, highlighted in Figure 22. The "A" only appears when a mouse curor is nearby, so if it is not immediately visible move the cursor to the bottom left of the graph area.

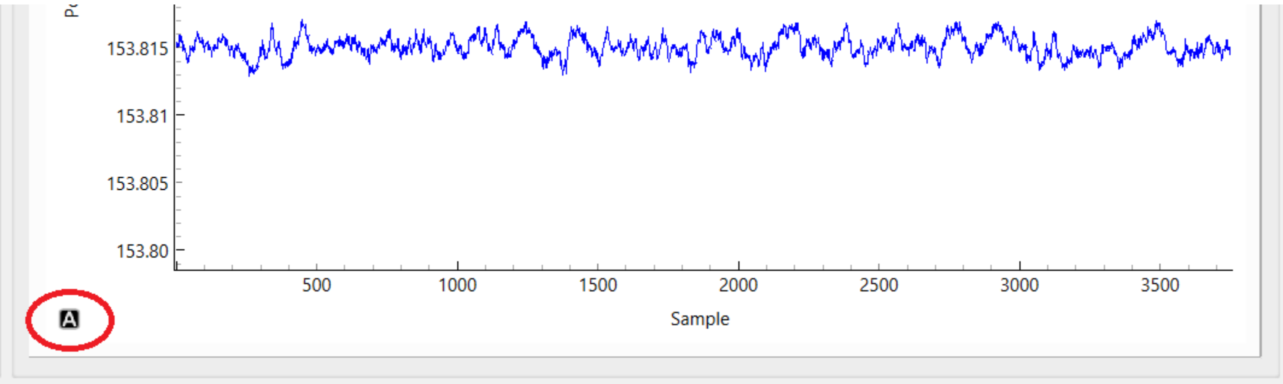

Figure 22 Graph autoscale control

The x-axis of the position graph is sample number. One sample corresponds to one sample reported over SPI, BiSS or SENT.

Note that successive graphs do not necessarily include contiguous data. There may be "missing" data from one graph to the next.

Breaks in a graph's plot line represent either invalid points or points missing due to the PC's USB port being unable to keep up with the data rate. In the latter case, increase the INERVAL value (for synchronous operation) or sample read interval (for asynchronous) to resolve this issue.

3.10 Rotary Sensor Graphs with Rotating Target

This section illustrates how to use graphs to plot position and position error using a target rotating at constant speed. Figure 23 illustrates the position graph when the target is rotated at approximately 4000rpm in the negative direction.

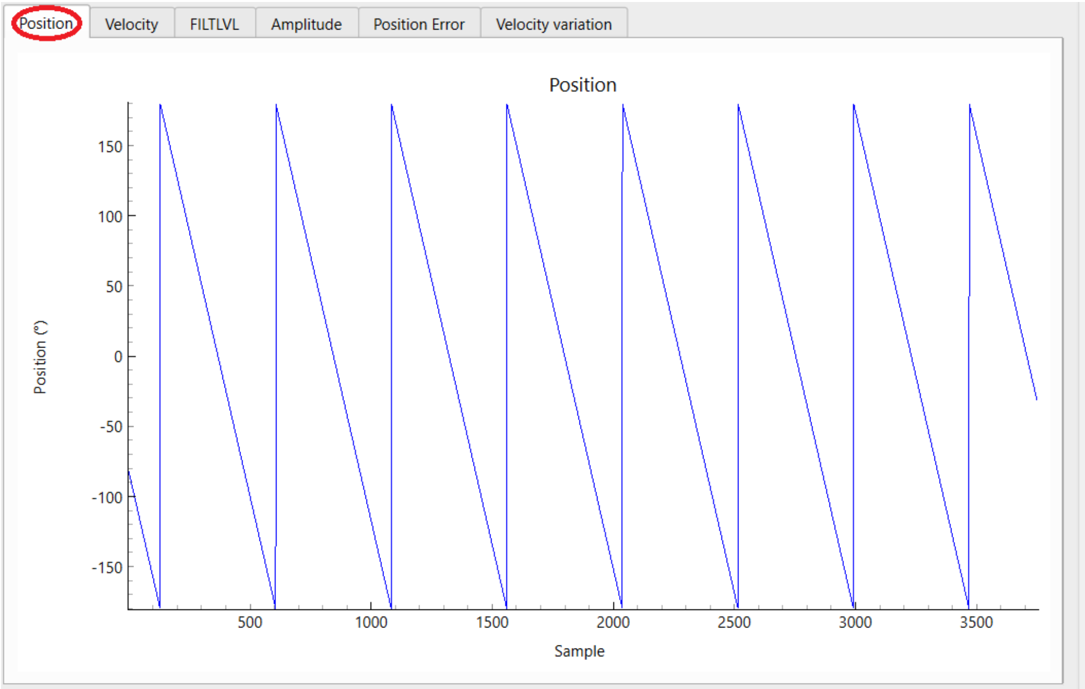

Figure 23 Position graph with target rotating at 4000rpm.

The position value is interpreted as a signed value, hence in the range -180° to +180°.

It is possible to analyse the linearity error of the sensing system by assuming that the target is rotating at constant speed. Click on the "Position Error" tab to view a plot of linearity error against position.

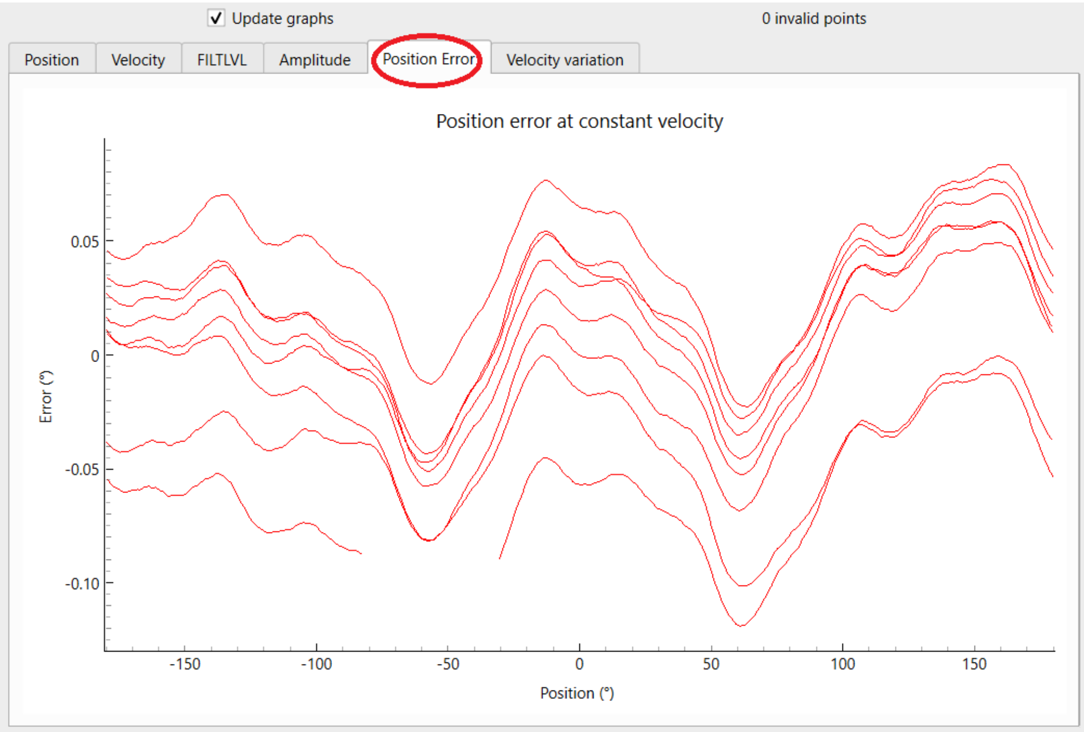

Figure 24 Position Error, overlay of multiple rotations

Note that when Position Error is displayed, the x-axis is now in units of position in degrees. Figure 24 illustrates the Position Error graph corresponding to the position plot of Figure 23. Note how Position Error includes data from multiple rotations of the target, each at a slightly different offset in the y-direction.

When the plots do not overlay, as illustrated here, it is because the rotation speed is not quite constant. To view a clearer position error plot, reduce the sample buffer size as highlighted in Figure 25.

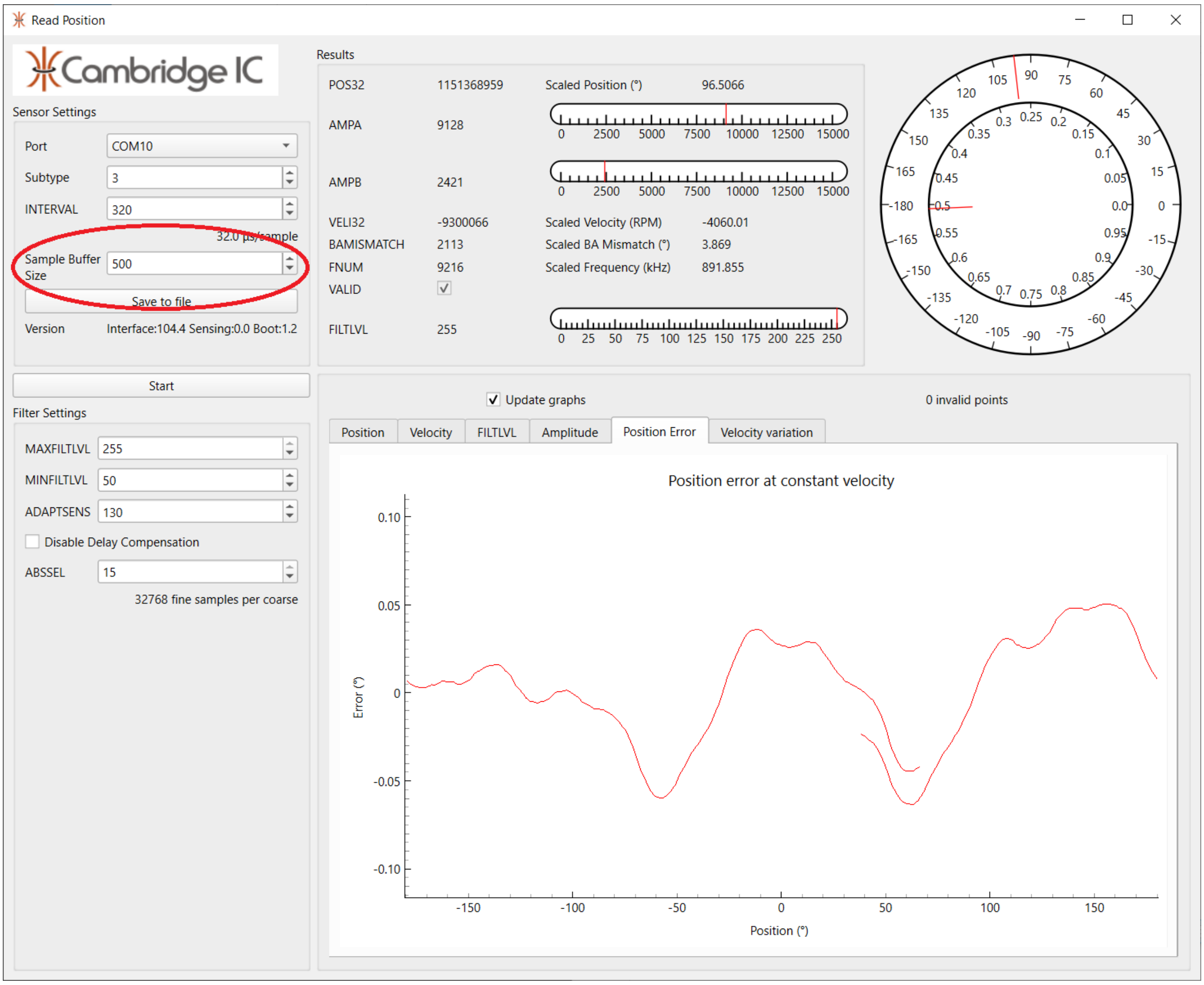

Figure 25 Reducing sample buffer size for clearer position error plot

This can yield a clear position error plot. There is a break in the line between about 40° and 70° above due to motor speed variability, but this is a relatively insignificant artefact compared to the multiple crossings in Figure 24.

Click on the "Velocity" tab to view a plot of velocity measurement against sample number. Figure 26 illustrates a velocity plot with the target spinning at approximately 4000rpm in the reverse direction, scaled to include y=0.

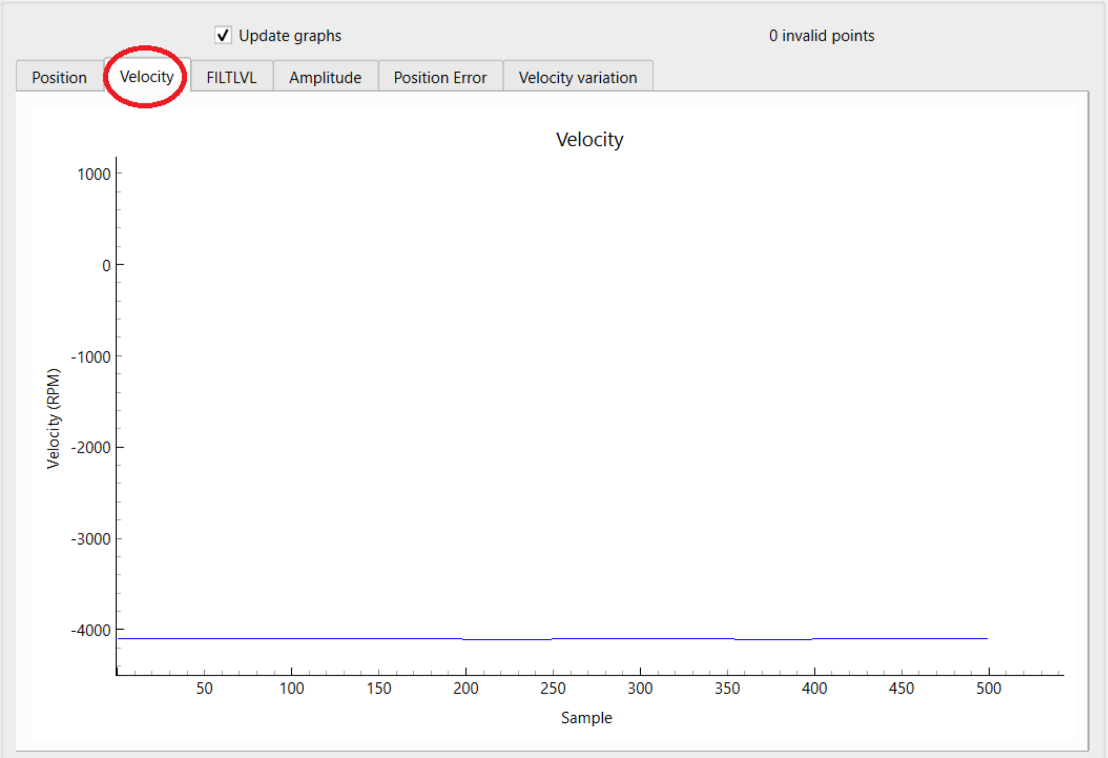

Figure 26 Velocity graph

Figure 27 illustrates the contents of the Velocity Variation graph for the same rotational speed. The y-axis is now in units of % and the x-axis is in degrees (assuming actual velocity is constant). This plot of percentage variation in velocity from average is equivalent to the sensor's differential non-linearity.

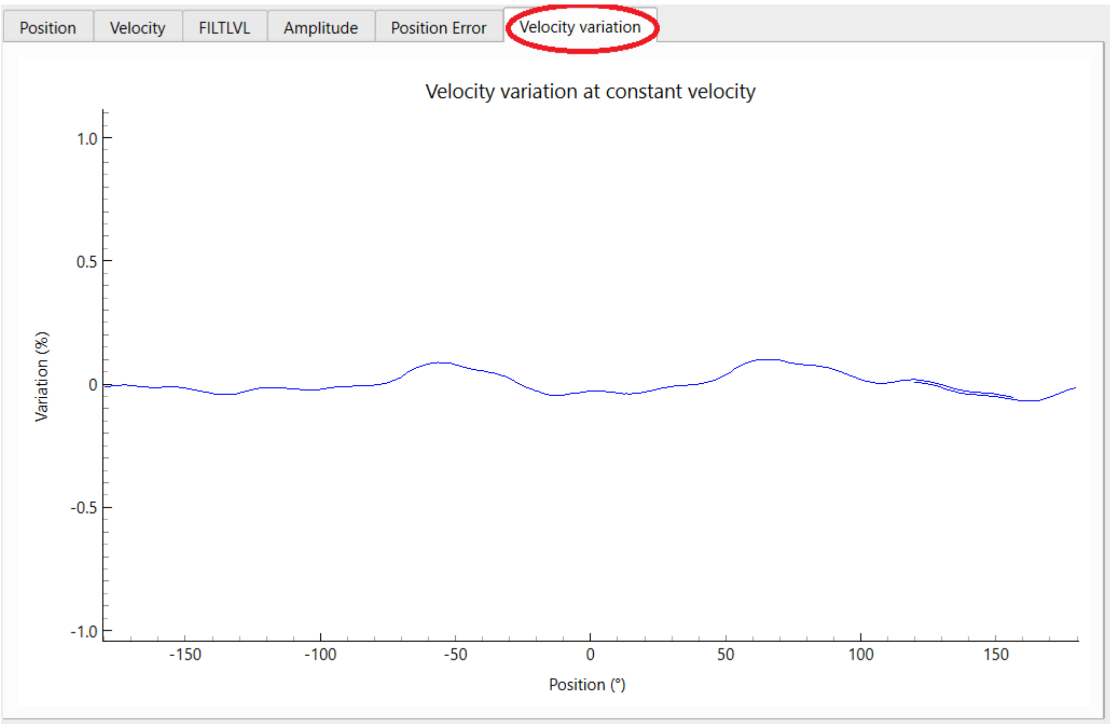

Figure 27 Velocity variation graph

Figure 28 shows how the Motion Filter's FILTLVL value varies with angle for the same speed rotation. Note how FILTLVL is generally 255 (=MAXFILTLVL), but sometimes dips slightly in response to apparent acceleration. In this case there is no actual acceleration. Instead, the Motion Filter is responding to peaks of linearity error as if they were acceleration. In most applications this behaviour is acceptable because it only occurs with a fast moving target, but the Motion Filter's parameters can be adjusted to avoid it, see section 3.12.

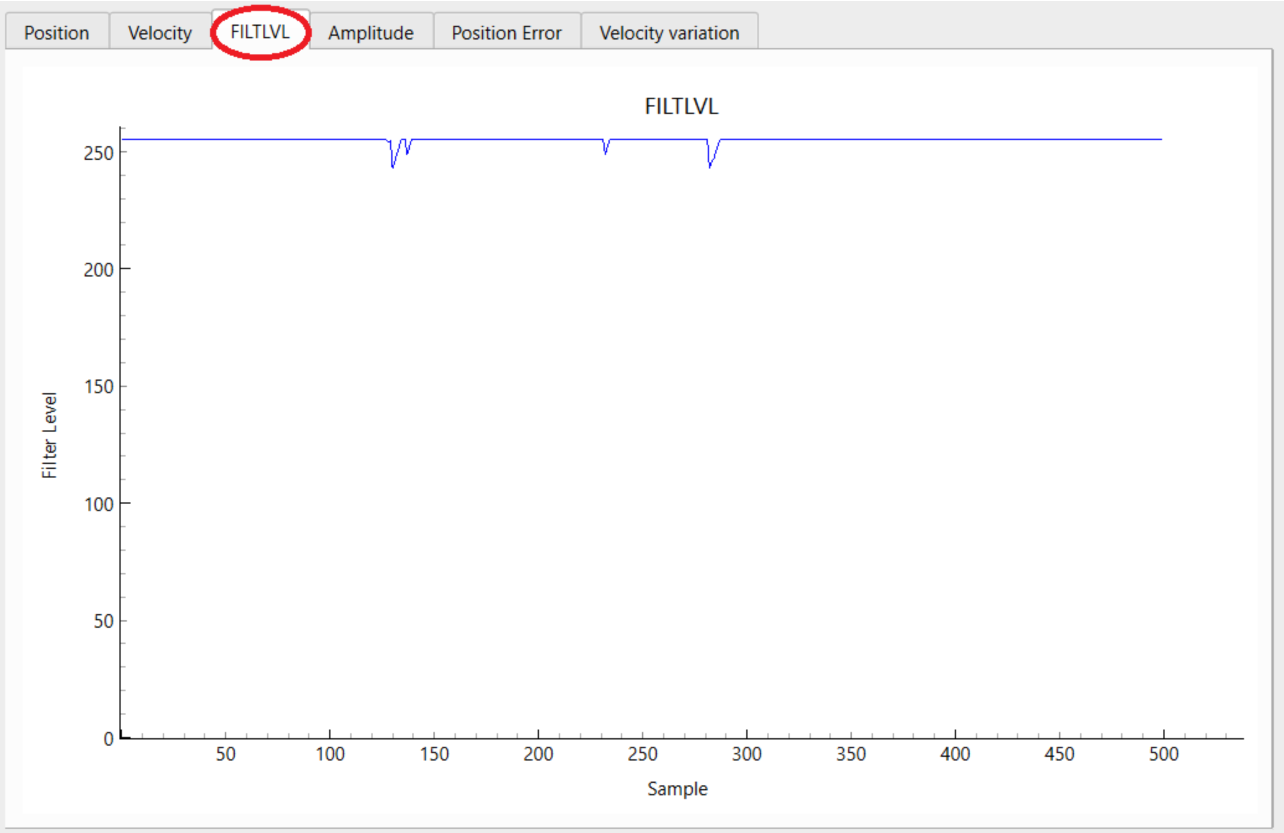

Figure 28 FILTLVL graph

Figure 29 shows the Amplitude (AmplitudeA) graph in the case of a rotating target with good alignment between target rotation axis and sensor axis. Figure 30 shows a similar situation except with target rotation axis misaligned by 1mm. Note how Amplitude varies with angle in the case of Figure 30. This variation is a sign of misalignment. Note that there is a high-frequency "sawtooth" variation in Amplitude which can be ignored.

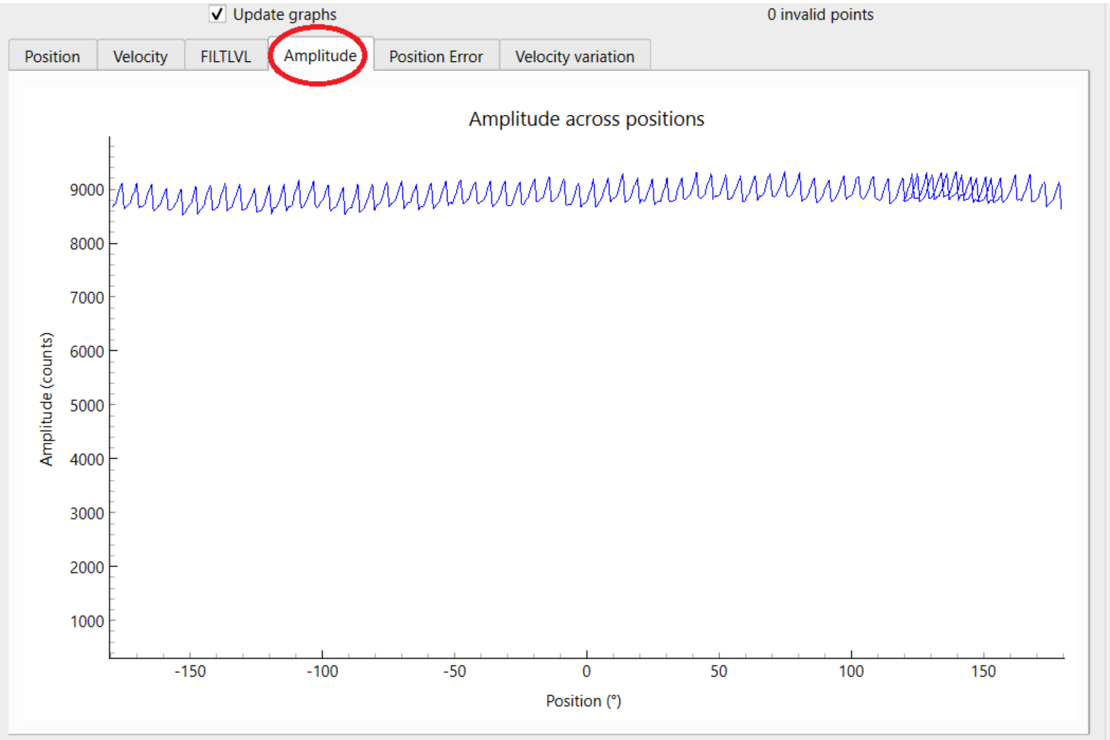

Figure 29 Amplitude plot, aligned

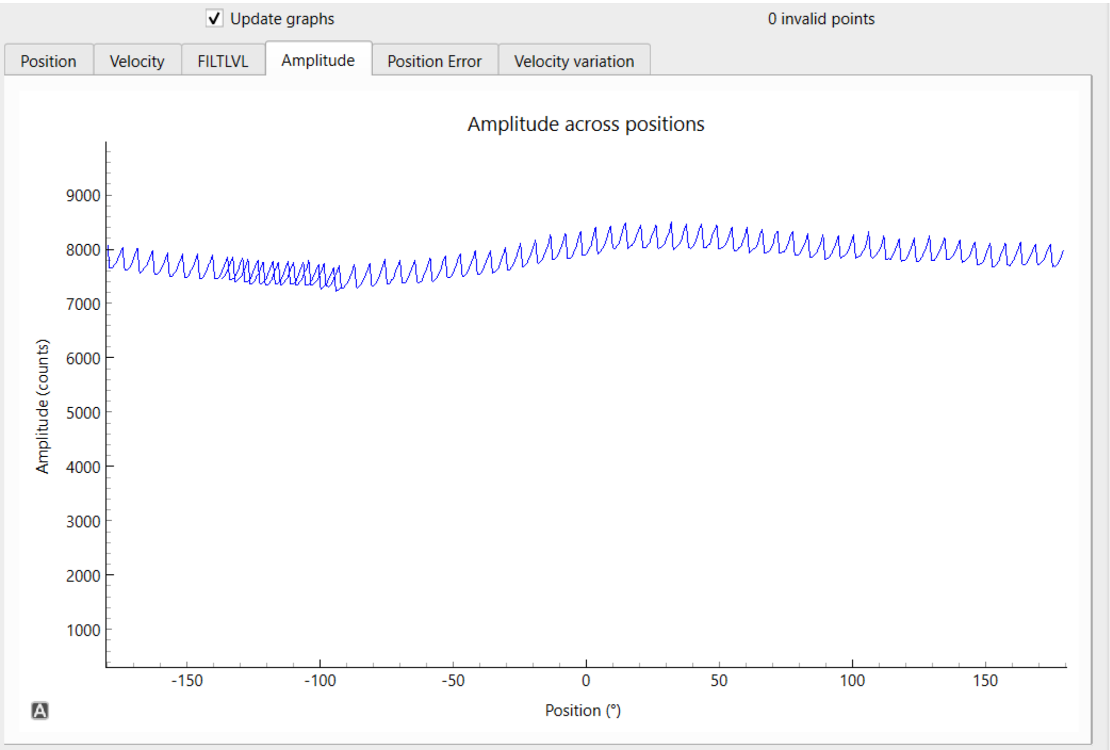

Figure 30 Amplitude plot, misaligned 1mm

3.11 Graphing BiSS and SENT Values

BiSS can deliver position measurements at a similar rate to SPI. CAM622 Read Position can therefore display a Position Error graph in a similar way to SPI, as in Figure 31.

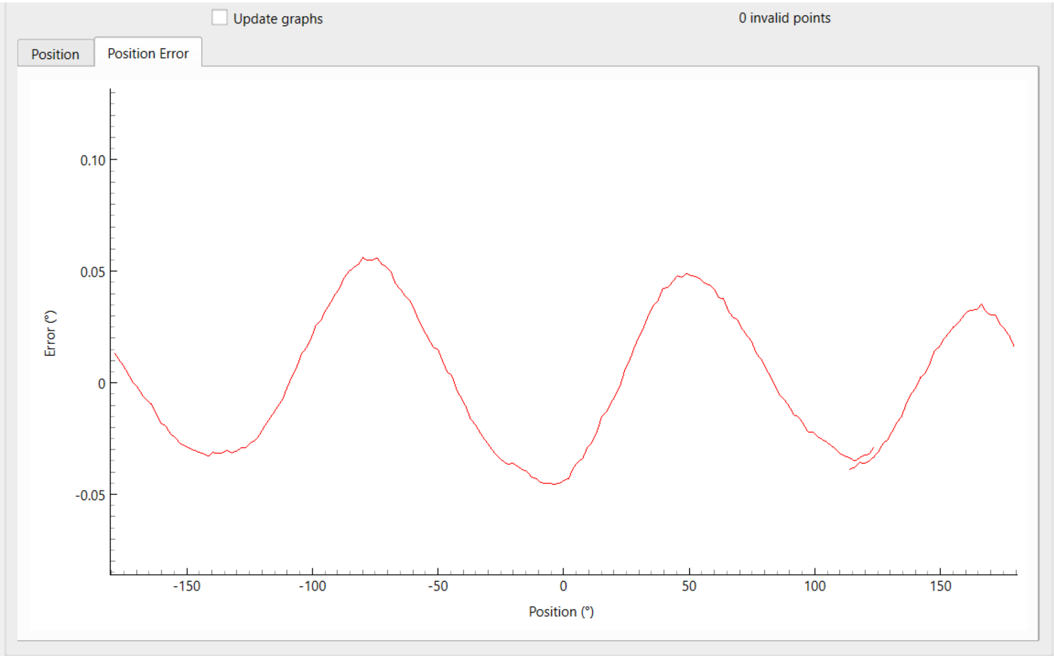

Figure 31 Position Error plot over BiSS

Note, however, that graphs of velocity, FILTLVL and Amplitude are not available over BiSS, because these values are transmitted far less frequently than over SPI. This is a limitation of BiSS.

SENT is far slower than SPI and BiSS. Position Error plots are possible, but require a target to be rotating slowly and at constant speed, which tend to be difficult to achieve together. When SENTFORMAT is set to 1, each SENT packet includes both position and velocity information, so a Velocity plot is available as illustrated in Figure 32. In this case velocity is logarithmically encoded with limited resolution and dynamic range, hence the steps visible in Figure 32.

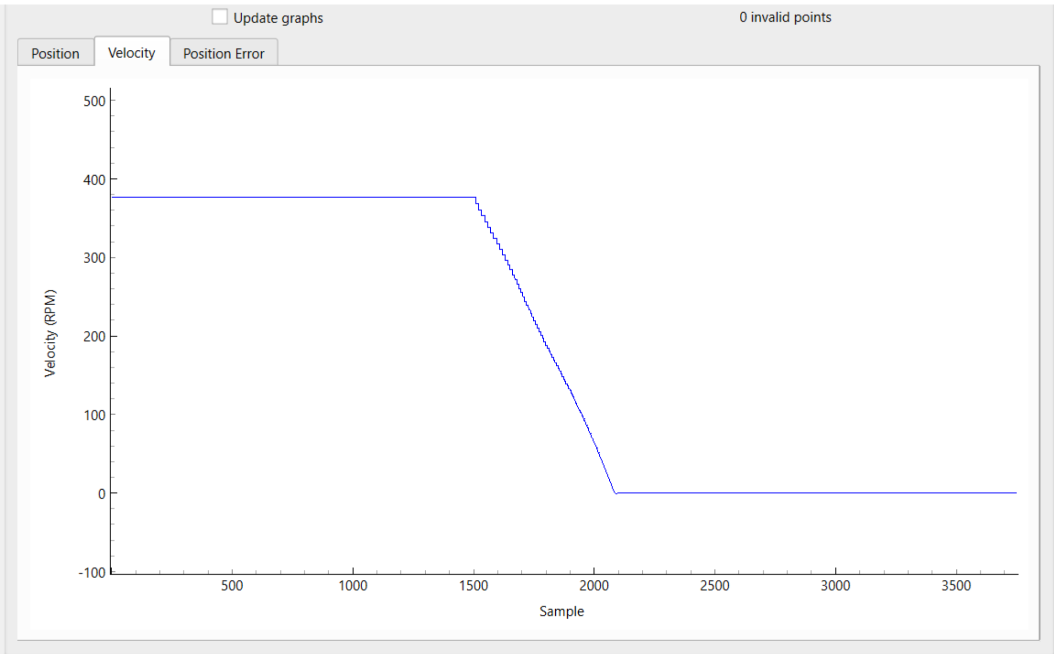

Figure 32 Velocity over SENT, SENTFORMAT=1

3.12 Configuring Motion Filter Settings and ABSSEL

The CAM622 includes a motion filter which reduces reported noise at the expense of a small delay in response to velocity changes. Its parameters may be adjusted to best suit the application. Figure 33 illustrates filter controls set to their default values.

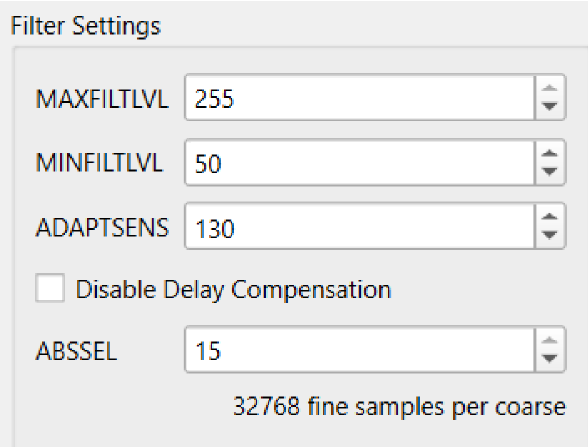

Figure 33 Motion Filter and ABSSEL settings

These default values are suitable for almost all applications. They apply maximum filtering when no acceleration is detected (MAXFILTLVL=255). When acceleration is detected the amount of filtering is reduced (down to a minimum of MINFILTLVL=50). ADAPTSENS sets how sensitive the Motion Filter is to acceleration. Since acceleration and noise are generally impossible to distinguish, a larger value of ADAPTSENS (more sensitivity to acceleration) will tend to make the system more sensitive to noise too, and this may cause unwanted reductions in filtering in systems with high noise. Please refer to the CAM622's datasheet for details of the Motion Filter and its settings.

The Motion Filter includes compensation for delays in the measurement path, so that the apparent delay between actual and reported position is nominally zero. Check the box next to its control to disable this feature.

To disable the Motion Filter completely to view raw measurement data, select Disable Delay Compensation and set MAXFILTLVL=MINFILTLVL=0. To return a value to default, hover over the control, right click and select "Return to default".

Note that if Disable Delay Compensation is set then the CAM622's Latch Point Compensation will be inactive, resulting in errors associated with variable delays between the end of each measurement and when the MultiComms adapter reads it out. In this case synchronous operation is recommended (Figure 17), especially when graphing Position Error like in Figure 25.

The ABSSEL control sets how often a coarse measurement occurs. By default its value is 15, corresponding to 32768 fine measurements in between every coarse. Please refer to the CAM622's datasheet for details.

3.13 Saving Measurement Results

To save the most recent sample buffer's results to file, click "Stop" to stop measurements then click "Save to file". The most recent set of measurement data is saved in a file "sample_data.csv" in the application's directory location. Each row in the data corresponds to one measurement in the measurement buffer. The first column is for diagnostic purposes, and is usually 0. Each subsequent column is raw data collected from the CAM622's registers, starting from CTRL and ending in CRC, in order. The final two columns are position in degrees and velocity in rpm, based on the raw values.

4 CAM622 Configuration Tool

The CAM622 Configuration Tool's main window is shown in Figure 1. It is for configuring the CAM622 to…

- Autonomously generate digital quadrature ABN outputs, which emulate the outputs of an optical encoder
- Autonomously transmit measurement results over a SENT interface
- Interface over BiSS

Please refer to section 1.2 for how to connect hardware. Figure 2 illustrates connections to a CAM622 MultiComms Board.

The CAM622 Configuration Tool may be used with either a rotary or linear target, although reported position is always scaled as if the sensor were rotary. Please use CAM622 Read Position to interpret linear position measurements.

4.1 Starting and Initial Configuration

Launch the CAM622 Configuration Tool executable to get started. When a MultiComms Adapter is plugged into the PC, it should appear as a virtual COM port. The CAM622 Configuration Tool should detect this automatically and display the COM port in a similar way to Figure 5.

By default the CAM622 Configuration tool communicates over SPI. SPI must be used for initial configuration. If the CAM622 is later to be programmed over BiSS, the BiSS interface must first be configured and enabled over SPI (section 4.5). Once this has been done, it is then possible to perform subsequent configuration over BiSS. Select between SPI, BiSS C or BiSS C with ABN Enabled as illustrated in Figure 34. BiSS C requires BiSSEN=1, ABEN=0. BiSS C with ABN Enabled requires BISSEN=1, ABEN=1 (section 4.6).

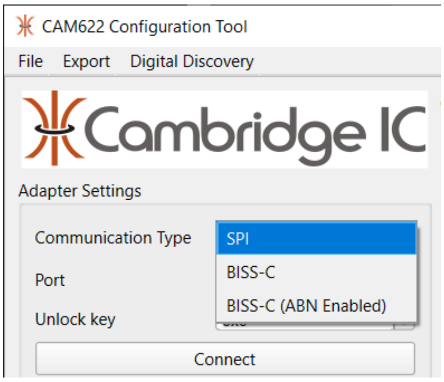

Figure 34 Protocol options

If SPI is selected, an SPI connection is required between the MultiComms Adapter and CAM622 MultiComms Board, illustrated to the right of Figure 2. If BiSS is selected, a MultiComms cable connection is required illustrated to the left of Figure 2. Both may be left connected.

When using SPI to configure the CAM622 for BiSS operation, there is an option to lock the CAM622 against unauthorised configuration using a secret BISSKEY value (section 4.5). In this case subsequent configuration over BiSS requires a non-zero value in the "Unlock key" field matching the secret BISSKEY value.

Once the COM port appears and the communications protocol is selected, click "Connect", illustrated at the bottom of Figure 34. If the connection to the CAM622 is successful the CAM622 Configuration Tool displays version numbers for the Streaming Adapter and CAM622, as in Figure 35.

The Adapter version is for the software in the MultiComms Adapter's processor (or the older Streaming Adapter if that is used instead).

The Interface Version refers to the version of software running in the Interface Core of the CAM622. The Sensing Engine Version refers to the software running in the Sensing Engine core. The Bootloader Version refers to the bootloader in the CAM622.

When connected over BiSS, the Manufacturer ID, Device ID and Serial Number reflect the values previously programmed in the BISSMID, BISSDID and BISSNUM fields respectively. These are all under user control. For their configuration please see section 4.5.

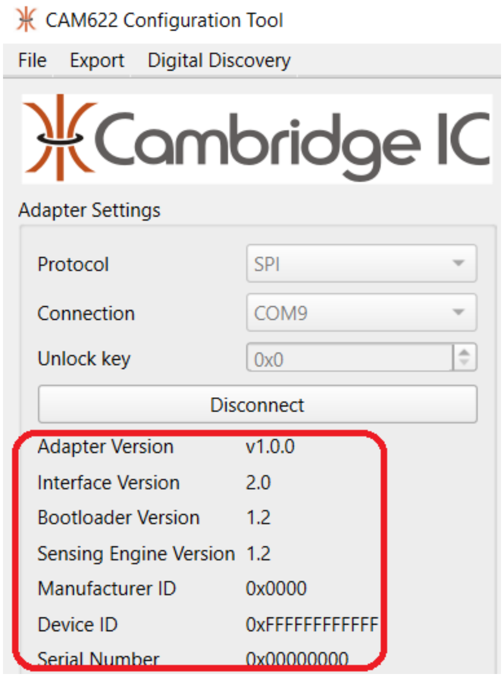

Figure 35 Version numbers

The Subtype control MUST be set to match the sensor's Subtype. Its location is shown in Figure 36. The Subtype is the number of fine COS/SIN periods per coarse COS/SIN period. For a rotary sensor this corresponds to the number of fine COS/SIN periods around a circle. A Type B sensor's name includes its subtype after "B". For example a 25mm B3 Rotary Sensor has Subtype=3.

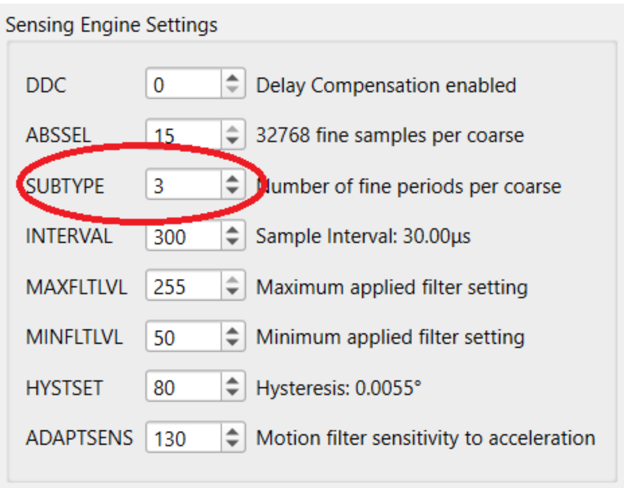

Figure 36 Subtype control

If Subtype is not set correctly, the reported position will always be wrong, and its value may jump erratically even when the target is stationary or moving slowly.

Changes made to controls including Subtype will be highlighted in yellow when they differ from the current CAM622 register settings. The CAM622 Transfer Controls are illustrated in Figure 37. They control the transfer of data between the application window and CAM622.

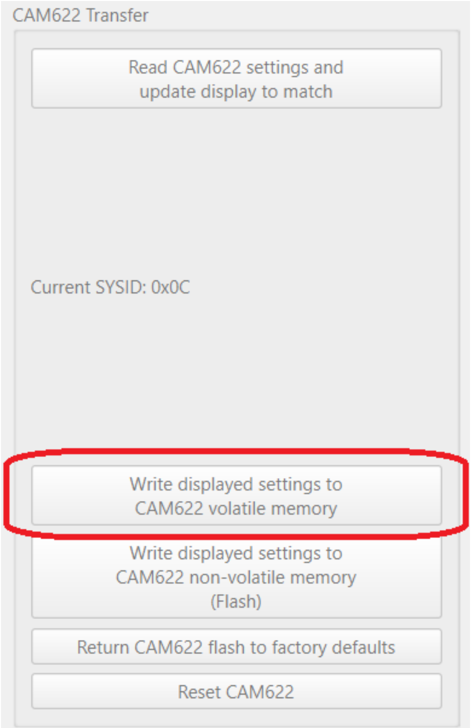

Figure 37 "Write … volatile memory"

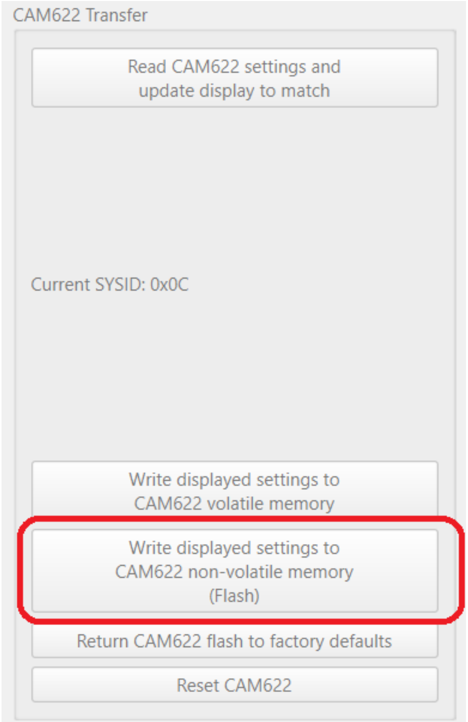

Figure 38 "Write … non-volatile memory"

Click on the highlighted control "Write displayed settings to CAM622 volatile memory" illustrated in Figure 37. This transfers the current settings to the CAM622, including the Subtype setting. Controls previously highlighted in yellow should no longer be highlighted because they now match the CAM622 register settings.

Once all relevant CAM622 settings have been made, it is possible to "Write displayed settings to CAM622 non-volatile memory", as illustrated in Figure 38. It is good practice to do this only when absolutely needed, though, since the CAM622 has a limit to the number of non-volatile writes allowed. The limit is very high, but nevertheless non-volatile writes should be avoided until they are needed.

The CAM622 Configuration Tool reads the CAM622's results registers while connected. To keep SPI or BiSS activity to a minimum, so as not to interfere with any ABN synthesis, results are only captured occasionally. Captured results include position. The Measurements Results indicator shown in Figure 39 should now reflect the position of the target. The outer pointer indicates absolute position across 360°. The inner dial rotates once for every 1° of angle change. It is useful for observing small changes in position, including position noise. Note that there is no option for displaying a linear slider. Please use the CAM622 Read Position application for this, like in Figure 10.

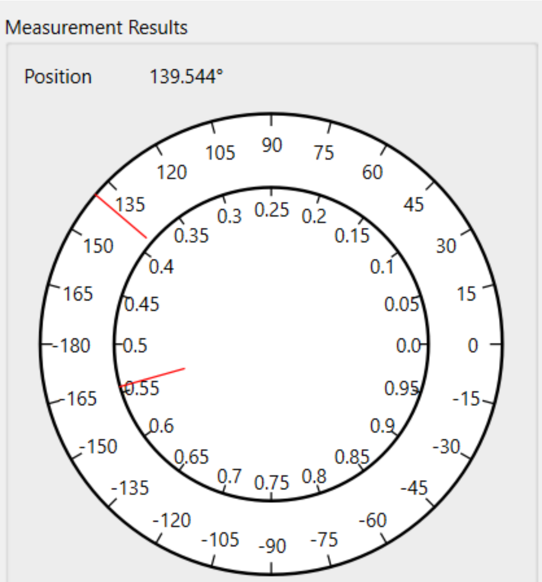

Figure 39 Measurement Results dial display

The CAM622 Configuration Tool reads diagnostic results in addition to position, and displays them below as shown in Figure 40. This diagnostic data is the same as reported by the Read Position application, and is described in section 3.8.

The velocity display is the Motion Filter's estimate of velocity read over SPI or BiSS, and is not derived from reported position readings or AB edge frequency.

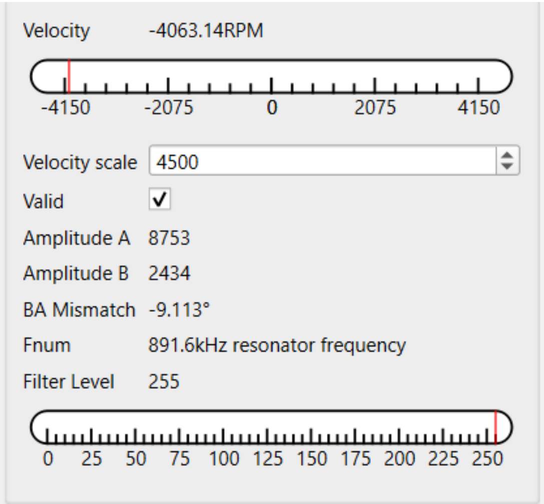

Figure 40 Diagnostic data display

4.2 Sensing Engine Settings

The CAM622 Configuration Tool includes a group of settings that control the CAM622's Sensing Engine, illustrated in Figure 41. Please refer to section 4.1 for how to set Subtype. INTERVAL MUST be set to 300 (30.0µs measurement interval) in order for quadrature ABN and Latch Point Compensation to work successfully. For simplicity, other controls may be left at the default values shown in Figure 41.

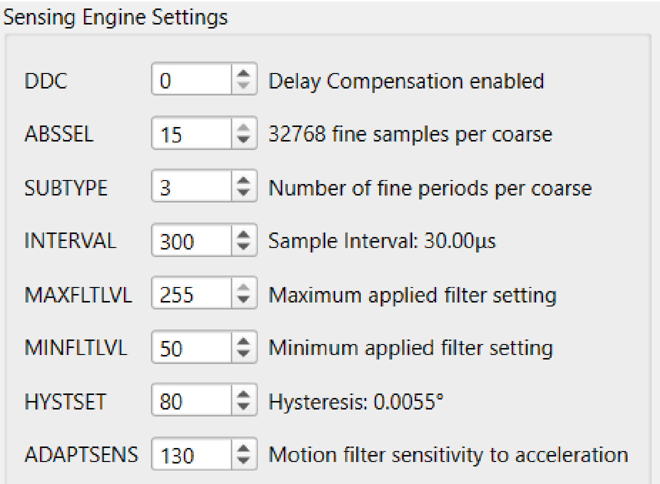

Figure 41 Sensing Engine Settings

The effects of DDC, MAXFILTLVL, MINFILTLVL and ADAPTSENS are described in 3.12, and in more detail in the CAM622 datasheet.

HYSTSET controls the amount of hysteresis deliberately added to position data to reduce noise in the ABN signals, if required. Set this to 0 for zero hysteresis. Please refer to the CAM622 datasheet for more details on hysteresis, including the relationship between HYSTSET and the actual amount of hysteresis added. A value of 80 corresponding to 0.0055° of hysteresis is typically appropriate, corresponding to 1 bit of hysteresis when outputting ABN at 16 bit resolution.

Having made changes to Sensing Engine settings, click on “Write displayed settings to CAM622 volatile memory” to update the CAM622 with the chosen values.

4.3 Output Settings

Figure 43 shows the CAM622 Configuration Tool's output settings.

A0, A1, A0CTRL and A1CTRL control the behaviour of the CAM622's A0 and A1 outputs. When A0CTRL=0, the A0 control sets the state of the output. This enables the user to directly control the state of A0. When A0CTRL=1, the CAM622 takes control of the A0 output, changing its state depending on the operating mode. In this case A0 controls the active state of A0. The same applies to A1 and A1CTRL. Configuration for "BiSS C (ABN Enabled)" (section 4.6) requires A0CTRL=A1CTRL=1 to allow the CAM622 to switch between BiSS communication and quadrature ABN output.

The CAM622 MultiComms Board's A0 signal controls the direction of the B output from differential line transceivers, and should usually be set to 1. The A1 output controls the direction of the A and N outputs of the differential line transceivers, and should be set to 1 for ABN operation and 0 for BiSS C. When both ABN and BiSS C are enabled (section 4.6) it is essential to set A0CTRL=A1CTRL=1 so that the CAM622 takes control of both outputs, enabling it to switch modes as necessary.

EXTMODE controls the behaviour of the CAM622's EXT output. In the CAM622 ABN Board, EXT directly drives an LED. The LED is active with EXT high, so use EXTAH=1. EXTMODE controls the behaviour of EXT, with EXTMODE=1 recommended for driving an LED. In this case the LED lights continuously when the reported Amplitude (AmplitudeA) exceeds the LEDTHRESHOLD value. It flashes when the reported Amplitude is less than the LEDTHRESHOLD value, and is still VALID, as a warning of low signal level. It is off when the CAM622 reports not VALID. The ideal LEDTHRESHOLD value depends on the application and the connected sensor, and a value of 4000 is broadly appropriate for getting started.

SIDO and SIAH control the CAM622's SI Sample Indicator output.

Having made changes to Sensing Engine settings, click on "Write displayed settings to CAM622 volatile memory" to update the CAM622 with the chosen values.

4.4 ABN Settings

Figure 42 illustrates controls for generating quadrature ABN signals. Click to activate "Enable ABN Output" to prepare for ABN synthesis. Note that controls are highlighted in yellow until settings are next transferred to the CAM622.

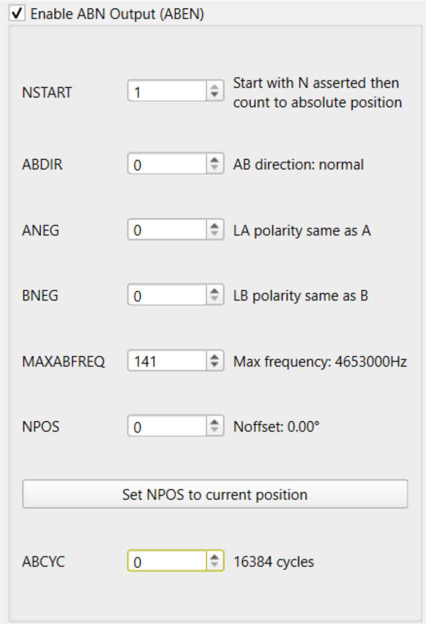

Figure 42 ABN Settings

NSTART controls whether the CAM622's ABN outputs behave like a traditional optical encoder when first started (NSTART=0) or whether the CAM622 starts counting from an N pulse to yield an absolute value after start-up (NSTART=1).

ABDIR controls the direction of the quadrature AB outputs.

ANEG and BNEG control the polarity of the A and B signals respectively, including their states when N is asserted.

MAXABFREQ sets the maximum toggle rate for the AB signals. By default (MAXABFREQ=141) the CAM622's maximum AB edge rate is 4.65MHz. This value can be reduced should a host have a lower limit for its maximum count frequency. Note that the value of MAXABFREQ controls the maximum rotation speed of the target. For example the maximum speed is 4170rpm with MAXABFREQ set to its maximum value of 141 and with ABCYC=0 (65536 edges per revolution).

NPOS controls the position of the index ("N") pulse. It is a 16-bit integer value representing 360° of rotation. Enter a desired value of NPOS, or click "Set NPOS to current position" to set the index pulse to the target's current position.

ABCYC controls the number of AB cycles per revolution, with a value of 0 corresponding to 16384 cycles, which corresponds to 65536 edges per revolution and hence "16 bit".

Figure 43 illustrates the output settings required for generating quadrature ABN signals from the CAM622 MultiComms Board.

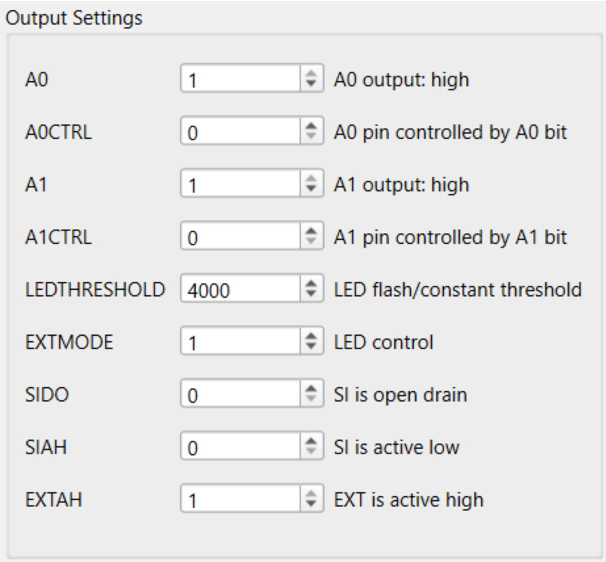

Figure 43 Output Settings for Quadrature ABN from a CAM622 MultiComms Board

For more details on these settings please refer to section 4.3 and the CAM622 datasheet.

Having made the required changes to settings, click on "Write displayed settings to CAM622 volatile memory" to update the CAM622 with the chosen values. Alternatively, to write current settings to non-volatile memory for subsequent autonomous operation, click on "Write displayed settings to CAM622 non-volatile memory" highlighted in Figure 38.

The CAM622 should now be generating ABN signals. When a system is connected as shown in Figure 2, ABN signals and their inverses are available from the MultiComms Adapter's MultiComms test points. The MultiComms Adapter converts these signals to single ended 3.3V logic levels, and these are also available for probing with an oscilloscope at its LA LB LN Test Points. The LA, LB and LN LEDs reflect the state of these signals, for a visual indication. Please refer to the MultiComms Adapter's datasheet for details.

When appropriate settings have been written to non-volatile memory, the ABN signals will operate autonomously following a reset, including when the SPI interface is disconnected.

When the ABN output is enabled and the CAM622 Configuration Tool is connected to a CAM622, it also reads the ABN count value over SPI or BiSS and displays it as a dial, as shown in Figure 44.

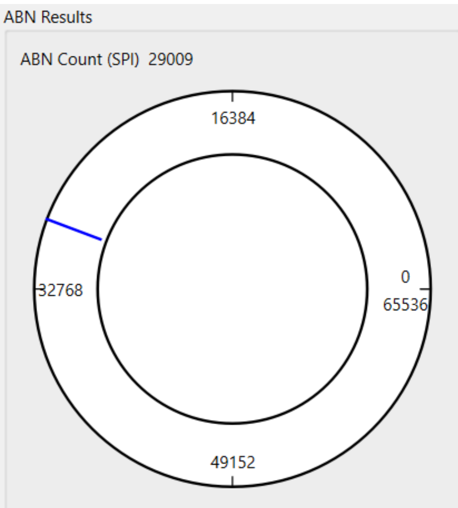

Figure 44 ABN results dial

4.5 BiSS Settings

The CAM622 supports interfacing over BiSS using an external iC-MCB IC from iC-Haus. This part is included on the CAM622 MultiComms Board. Figure 45 illustrates recommended settings for getting started with BiSS when connecting to this board.

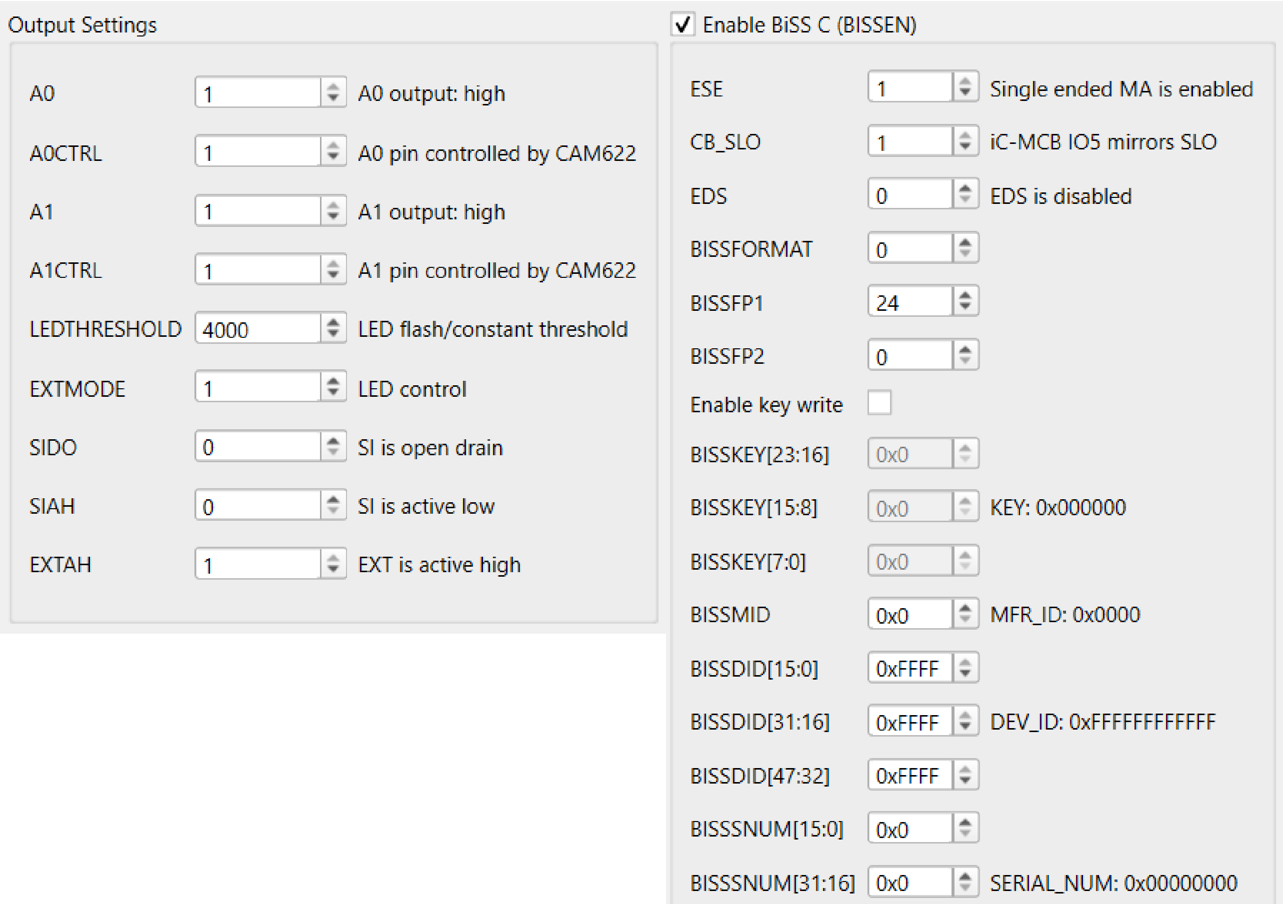

Figure 45 Output Settings and BiSS Configuration for CAM622 MultiComms Board

The output settings illustrated to the left of Figure 45 give the CAM622 control over the CAM622's A0 and A1 outputs, with polarity appropriate for the CAM622 MultiComms Board. Note that the A0, A1, A0CTRL and A1CTRL controls can only be modified when communicating over SPI. They can not be modified over BiSS. This is to protect against updates over BiSS that would otherwise prevent further communication, in case the SPI connections are no longer accessible.

EXTMODE is set for LED control and EXTAH=1 to control the CAM622 MultiComms Board's LED. Please refer to section 4.3 for more details on LED control including the role of LEDTHRESHOLD.

BiSS settings are illustrated to the right of Figure 45. ESE and CB_SLO must both be set to 1 for the CAM622 MultiComms Board to work properly. They configure the iC-MCB for single ended input and output for use with the board's external line transceivers.

The EDS control is to enable an electronic datasheet, and this feature is not implemented. The BISSFORMAT control is intended to select alternative results formatting, and only BISSFORMAT=0 is currently supported.

When BISSFORMAT=0, the BISSFP1 parameter controls the number of position bits reported to a BiSS host. This allows a user to configure the CAM622's BiSS Frame to suit an individual BiSS host. Note that the CAM622 Configuration Tool's measurement results display (Figure 39) uses 32-bit position values obtained from diagnostic data, and its resolution is NOT controlled by BISSFP1. Note also that the CAM622 Read Position Application controls the value of BISSFP1; it is not necessary to configure the same BISSFP1 value with the CAM622 Configuration Tool.

The BISSKEY values are to protect the CAM622 against unauthorised configuration over BiSS in the field. To enable protection, activate "Enable key write" and enter secret BISSKEY values. Then when subsequently connecting over

BiSS, enter the same secret BISSKEY value in the "Unlock key" field to the top left of the CAM622 Configuration Tool window before clicking "Connect". When the CAM622 is not protected in this way (BISSKEY=0x000000), "Unlock key" must be set to the default, 0x0. Key protection is not recommended until it is needed, since it compromises usability.

The BISSMID, BISSDID and BISSNUM fields control the Manufacturer ID, Device ID and Serial Number reported over BiSS. A manufacturer of BiSS devices should have their own Manufacturer ID obtained from the BiSS Association. Device ID is used to uniquely identify a manufacturer's BiSS products. The Serial Number is typically used to uniquely identify each part that includes the CAM622. Note that these fields do not need to be populated for initial evaluation.

Please refer to the CAM622 datasheet for more details on BiSS settings.

4.6 Configuring for BiSS and ABN

The CAM622 is designed to work with hardware supporting both quadrature ABN and BiSS interfacing, with configuration done in software alone. This allows customers to build hardware, hold it in stock and configure later according to customer demand.

In some cases the CAM622 will be built into a sealed module with only ABN signals and power accessible. The SPI interface might be sealed or potted, and hence not available for configuration. In this case the CAM622 can be configured for both BiSS and quadrature ABN, for subsequent configuration over BiSS, which uses the same ABN lines as quadrature ABN output.

To configure the CAM622 for BiSS and ABN, an SPI connection is required initially, typically when hardware is first manufactured. Follow section 4.5 for BiSS configuration and section 4.4 for quadrature ABN programming. Use output settings A0=A1=A0CTRL=A1CTRL=1. Quadrature ABN settings do not need to be finalised, just ABEN=1. The hardware is now ready to configure over BiSS when that is needed, and the SPI connections are no longer required and can be covered and/or potted.

To configure the hardware for its final customer application, connect it to a MultiComms Adapter over BiSS and use the CAM622 Configuration Tool. If the application requires quadrature ABN output, finalise ABN settings according to section 4.4. If the application requires a BiSS interface, change ABEN to 0.

When BISSEN=ABEN=1, the CAM622 performs an ABN/BiSS Selection Process each time it comes out of reset, documented in its datasheet. If it detects the MultiComms Adapter (or another BiSS host specially designed to support the ABN/BiSS Selection Process) then it will operate in BiSS mode until the next reset. If not, it will generate quadrature ABN. This means that hardware configured for quadrature ABN output can still have its configuration updated, for example a change to the number of AB cycles per revolution or a switch to BiSS interfacing. If a customer wishes to prevent an end user from making such changes then updates to configuration can be protected using a key, see section 4.5.

Note that ABEN MUST be set to 0 for the hardware to support normal BiSS hosts, since they will not be designed to perform the ABN/BiSS Selection Process needed to enter BiSS mode when ABEN=1.

4.7 SENT Settings

To configure the CAM622 for SENT output, first ensure BISSEN=ABEN=0. Figure 46 illustrates the controls for SENT configuration. The values shown are suitable for use with the CAM622 MultiComms Board connected to the MultiComms Adapter as shown in Figure 2.

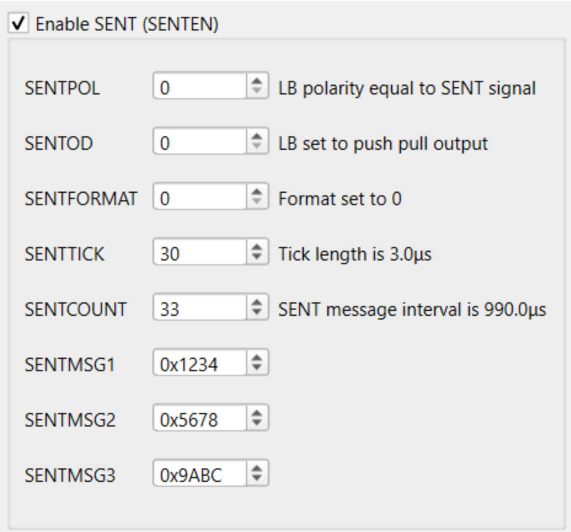

Figure 46 SENT settings with a CAM622 MultiComms Board

SENTPOL and SENTOD control the behaviour of the SENT output on the CAM622's LB pin. SENTFORMAT controls the message format, with 0 corresponding to transmitting 24-bit position. SENTTICK controls the SENT tick length. When CAM622 Read Position is used to receive SENT, its SENT Tick Length control must match the setting used. SENTCOUNT controls the number of measurements between each SENT transmission, and hence the SENT transmission rate. SENTMSG values may be used for identifying the customer's device, for example a product ID and/or serial number. Please refer to the CAM622 datasheet for more details.

Figure 47 illustrates output settings that work with the CAM622 MultiComms Board. A1 must be 1 so that the board's B signal is configured as an output. Please refer to section 4.3 for how to set the LEDTHRESOLD control and the others underneath it.

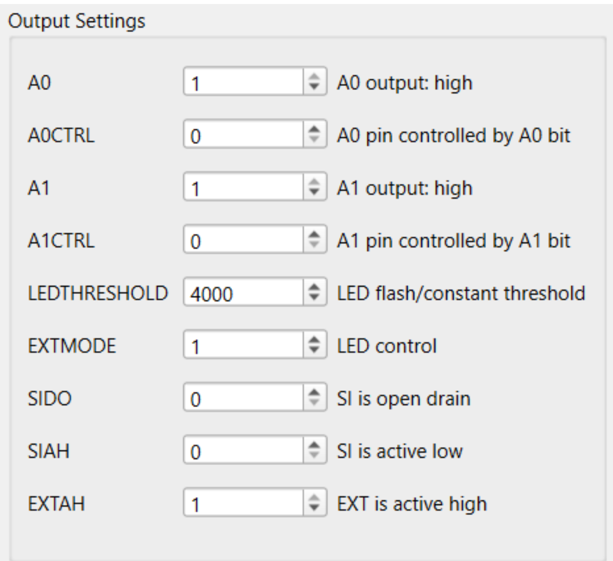

Figure 47 Output Settings for SENT with a CAM622 MultiComms Board

Write the configuration to non-volatile memory (Figure 38) then press the reset button illustrated in Figure 12. It should now be possible to receive SENT measurement data using CAM622 Read Position.

4.8 CAM622 Transfer Operations

Figure 48 illustrates the set of available options for transferring data to and from the CAM622's memory.

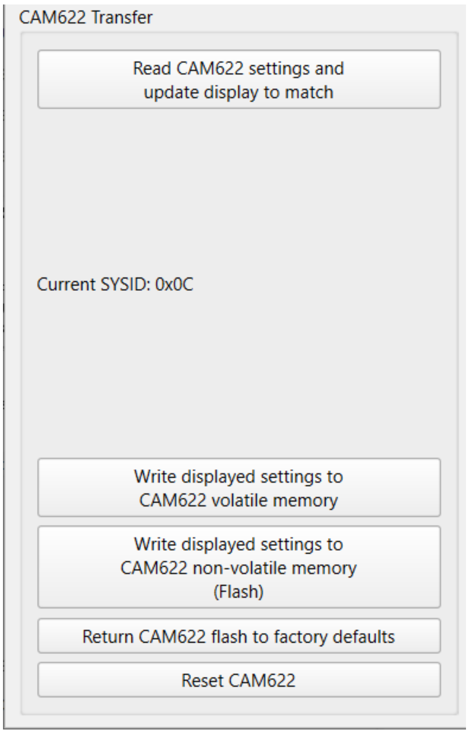

Figure 48 CAM622 Transfer Options

Controls for writing displayed settings to volatile and non-volatile memory are described in section 4.1.

The "Read…" control reads the contents of the CAM622's memory and displays the results. This can be used to display the non-volatile configuration of a CAM622 part that has previously been programmed. Note that the CAM622's contents are always read when "Connect" is clicked to start the CAM622 Configuration Tool running.

Clicking "Return CAM622 flash to factory defaults" restores all factory defaults, including ABEN=0 and BISSEN=0.

"Reset CAM622" performs a reset. When communicating over SPI the MultiComms Adapter toggles the nRST line to perform a reset. When communicating over BiSS it switches off the 5V power rail briefly, then switches it back on again. Note that the CAM622's memory contents are always read back after a reset. The CAM622 Configuration Tool's window will therefore be populated with any settings that have been saved to non-volatile memory.

4.9 Saving and Loading Configurations from File

Click File → Save and select a file name and location to save the current displayed settings to file. By default settings are saved to a file with extension ".cicconfig". This is a human readable text file listing settings.

Once connected, Click File → Load and select a file and location to load displayed settings with values from file. Then click "Write displayed settings to CAM622 non-volatile memory" to write the saved values to the CAM622's non-volatile memory, see Figure 38.

Alternatively, load settings from file and make any necessary adjustments before clicking "Write displayed settings to CAM622 non-volatile memory". Save the updated configuration using File → Save.

4.10 Exporting Configuration as a C Array

Displayed settings may also be exported in the form of a C array suitable for incorporation into customer code such as when a host microcontroller is to be used to apply the configuration. Click Export → C Array → To Clipboard, then paste the resulting text where the code is needed.

5 Firmware Update Tool

The CAM622 includes a bootloader that allows a host to update its internal software ("Application Code") over SPI.

The Firmware Update Tool updates the CAM622's Application Code using the Streaming Adapter for communication between a PC and the CAM622.

If other CAM622 Applications are open then ensure they are disconnected before using the Firmware Update Tool.

When a Streaming Adapter is plugged into the PC, it should appear as a virtual COM port. The Firmware Update Tool should detect this automatically and display the COM port, as shown in Figure 49.

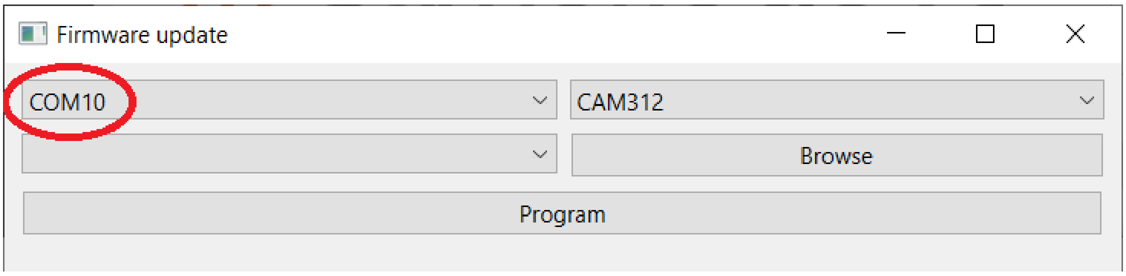

Figure 49 Checking Streaming Adapter COM Port

The Firmware Update Tool supports other CambridgeIC processor ICs. Select the CAM622 as shown in Figure 50.

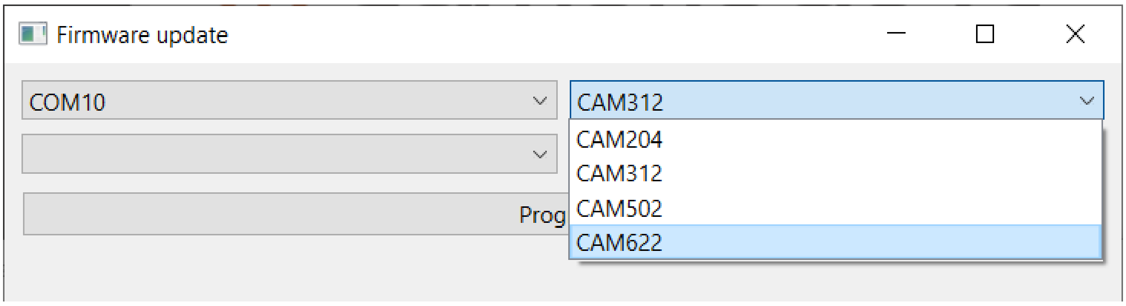

Figure 50 Selecting CAM622

Click "Browse" and navigate to the location of the chosen Application Code. This will have the file suffix ".cff". For example file 020-0020_001-008.cff is V 1.8 Application Code for the CAM622.

Click "Program" to program the CAM622 with the selected Application Code. If successful the window will display previous and new versions and "transfer complete" as shown in Figure 51.

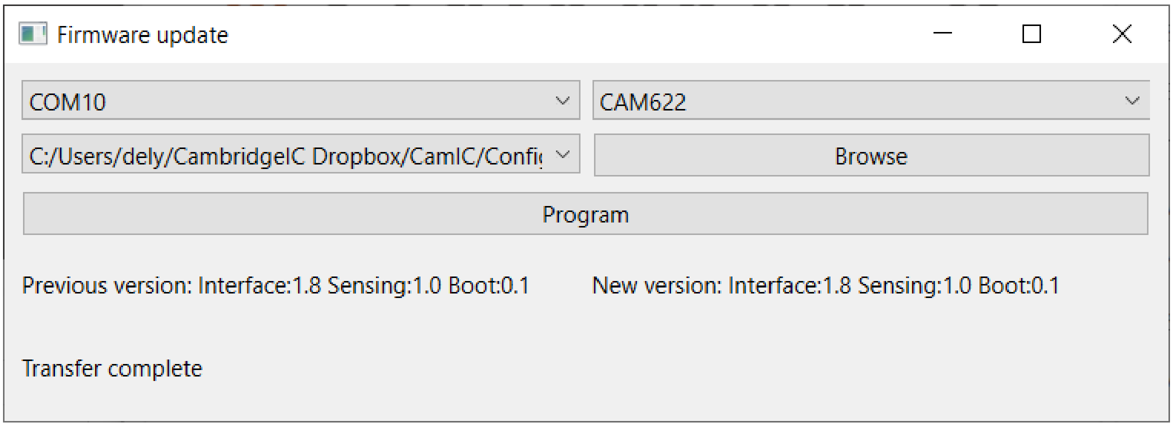

Figure 51 Update Firmware following successful transfer

6 Document History

Revision	Date	Description
0001	15 January 2025	First draft
0002	17 June 2025	Read Position now also supports linear sensors, updated accordingly
0003	16 January 2026	Documented CAM622 MultiComms Board in place of CAM62 ABN Board Documented MultiComms Adapter in place of Streaming Adapter Updated to include configuration for and use of BiSS and SENT interfaces
0004	23 February 2026	Added control over the number of position bits reported over BiSS (CAM622 Application Code 2.4 onwards).

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8 Legal