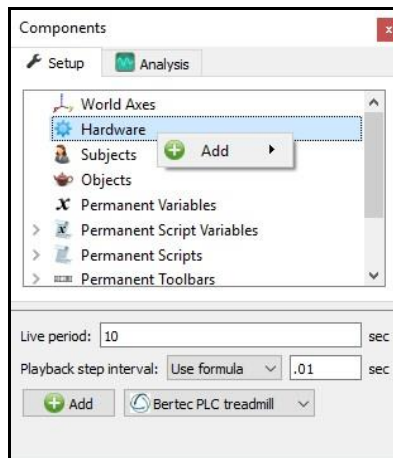


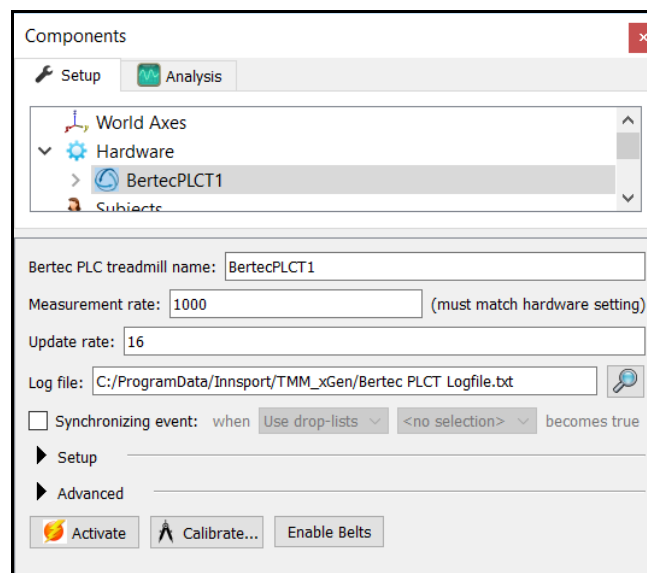
## **The MotionMonitor xGen Hardware Guide: Configuring Bertec PLC Instrumented Treadmill and Controls**

This document reviews the procedures for configuring the Bertec PLC instrumented treadmill and controls in The MotionMonitor xGen.

1. From the Hardware node in the Setup Components window add the Bertec PLC component through the Add button at the bottom of the Components window or right-click on the Hardware node to add the device.



2. From the Bertec PLC parameters panel, a name can be specified for your Bertec PLC device. The Measurement rate is the rate that data are received from the Bertec PLC treadmill, which is fixed at 1,000Hz. The Update rate is the rate that data are sent to the Bertec Treadmill controller. A log file and directory path can be specified for logging any diagnostic messages that are received from the PLC Treadmill. The log file would typically only be needed for troubleshooting if any issues were to arise with the hardware. The synchronizing event can be used for defining an event in the Bertec PLC data stream to align with events in other hardware data streams. This would override the default synchronization methods.



Expanding the Setup node shows the controls for the treadmill belts. Belts on controls whether the belts will be on or off when the Bertec PLC device has been activated and is expecting a Boolean value. Two commonly used variables for this setting are TRUE and Capturing. After the Bertec PLC device has been activated, a Belts on value of TRUE would result in the belts always being on, so they would continue to run in between recordings. Whereas Capturing would only turn the belts on while an activity is being recorded, so the belts would turn off in between recordings. Alternatively, any user defined Boolean variable can be assigned.

The Setup configuration window contains the following elements:

- Belts on:** A dropdown menu with a 'Use drop-lists' button and a '<no selection>' dropdown.
- Left belt speed:** A dropdown menu with a 'Use drop-lists' button and a '<no selection>' dropdown. Below it are two text input fields for 'Minimum value' and 'Maximum value', both containing the number '0'.
- Right belt speed:** A dropdown menu with a 'Use drop-lists' button and a '<no selection>' dropdown. Below it are two text input fields for 'Minimum value' and 'Maximum value', both containing the number '0'.
- Acceleration:** A dropdown menu with a 'Use drop-lists' button and a '<no selection>' dropdown.
- Deceleration:** A dropdown menu with a 'Use drop-lists' button and a '<no selection>' dropdown.
- Inclination angle:** A dropdown menu with a 'Use drop-lists' button and a '<no selection>' dropdown.

The Left and Right Belt Speed, Acceleration, Deceleration and Inclination angle will control the treadmill belts performance. These entries can be by formula, named variable or constants, but all need to be defined. The Minimum and Maximum values for the Left and Right belt speed will override the Left and Right belt speed settings and limit the speed sent to the Bertec Treadmill controller. **Note:** The inclination angle will not update while the belts are running. This process will be explained later.

Expanding the Advanced node shows the “Live data decimation” and “Suspend live data” features. When “Live data decimation” is enabled, the decimation factor will reduce the real time sampling frequency by the specified factor, however, data for the specified measurement rate will be available in post processing. **Note:** A default decimation factor of 10 should be used in order to reduce the real time processing demands of the computer. The “suspend live data” checkbox will suppress any data from the Bertec PLC device from being used in the Live Window, including any graphs, equations or sending updates to the device. However, the data will immediately be available and presented in a recorded activity. This is a means for limiting the computer resources being used while running in the Live Window. **Note:** This feature should not be enabled if any of the Setup parameters are being used to control the Bertec PLC device. Any of these settings should be set to their desired state before enabling the “Suspend live data” feature. The “Track with rigid body” feature allows for the Right and Left belt force plates to be aligned relative to a rigid body affixed to the treadmill. This feature must be enabled before aligning the force plates and allows for the proper interpretation of force plate data in the world reference frame when using the inclination feature. When enabled, the user would not be required to perform force plate alignments after adjusting the treadmill inclination angle.

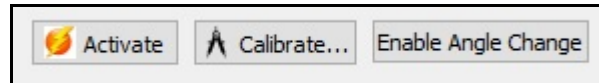
The Advanced configuration window contains the following elements:

- Live data decimation:** A checked checkbox followed by the text 'Factor: 10' and a text input field containing the number '10'.
- Suspend live data:** An unchecked checkbox followed by the text '(reduces CPU requirements by making data only available in pos'.
- Track with rigid body:** An unchecked checkbox followed by a dropdown menu with a 'Use drop-lists' button and a '<no selection>' dropdown.

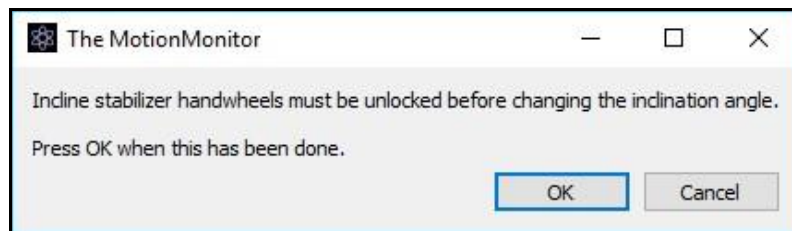
Click on the “Activate” button or the “Activate/Deactivate Hardware” toolbar icon to activate the Bertec PLC device. However, the belts will only “run” when the specified “Belts on” condition is TRUE. To deactivate the Bertec PLC device, click on the “Deactivate” button or the “Activate/Deactivate Hardware” toolbar icon. The hardware emergency stop button will always override these controls.

The “Calibrate” button will zero both Left and Right belt force plates.

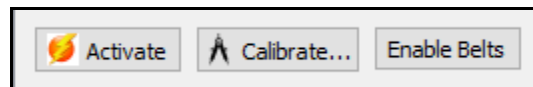
After the Bertec PLC device has been activated, click the “Enable Angle Change” button to apply the Inclination angle setting from the Setup node. During this process the belts will turn off and the subject should not be on the treadmill.



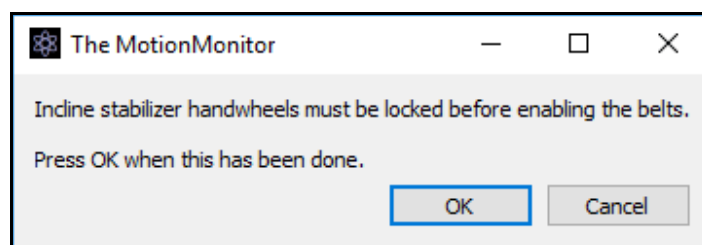
The stabilizer handwheels also need to be unlocked before changing the inclination angle. The following dialog will be presented before the adjustment is initiated.



After the inclination angle has been adjusted the belts can be turned back on by clicking the “Enable Belts” button.



The stabilizer handwheels will need to be locked after adjusting the inclination angle. The following dialog will be presented before the adjustment is initiated.

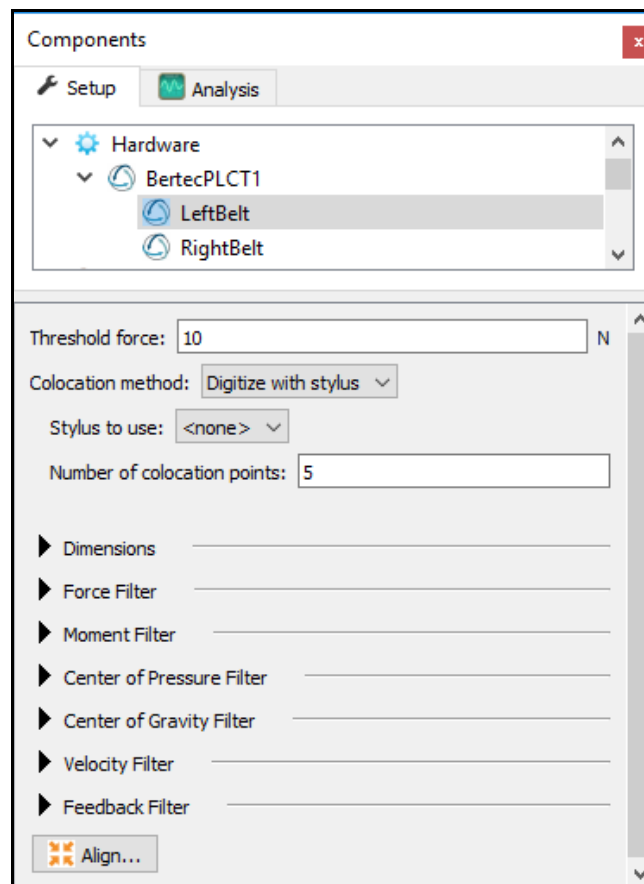


After adjusting the inclination angle, the force plates will need to be re-zeroed using the “Calibrate” button. If the “Track with rigid body” feature was not enabled through the Advanced node, an alignment for each force plate would also be required.

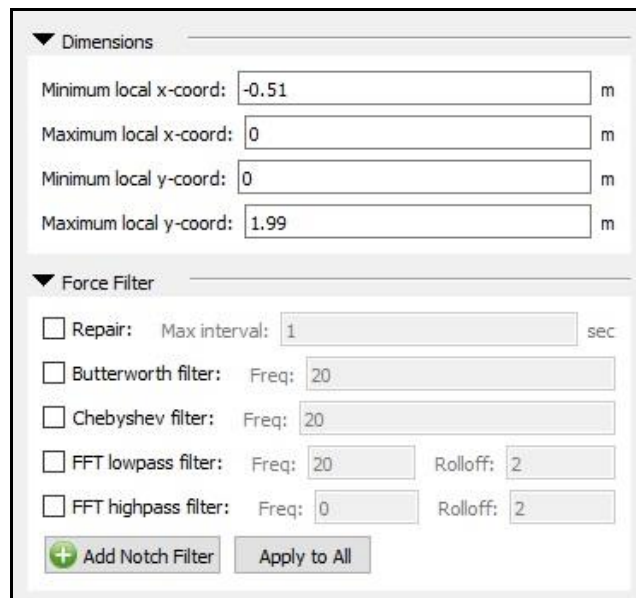
When setting up an experiment, the user should begin with very low constants for the belt speeds, acceleration and deceleration values. The use of any formulas should first be vetted through graphs in the Live window or previously recorded activities and then thoroughly tested without a subject on the treadmill. The use of Minimum and Maximum values for the Left and Right belt speed will also help ensure safe usage of the Bertec PLC device.

Using the Remote Control Features of the Treadmill is very dangerous. Poorly defined settings created by the user or interruption in Communication protocols can have unexpected results in the behavior of the treadmill. Precautions should always include the use of safety harnesses and safety rails as well as thorough testing before involving human subjects.

3. Expand the Bertec PLC node to view the Left and Right Belt force plates and select a Belt to bring up the parameters panel for that force plate. The “Threshold force” sets the minimal allowable force to be used in the software for computing force derived and Center of Pressure data. The “Colocation method” can be selected as either “Digitize with Stylus” or “Use Expressions”. The preferred and recommended method for alignment is the “digitize with Stylus” option. This method requires that a stylus be configured using a kinematic tracking system. Select the stylus from the “Stylus to use” drop-list and specify the number of points to use in the colocation points.



Expand the Dimensions node to show the settings for defining the dimensions which are used to show the footprint in the Animation window. The min/max x and y coordinates refers to the dimensions for the plate, relative to its origin. While standard force plate origins are in the center of the force plate, the treadmill origins are in the back corner.



The screenshot shows a software interface with two main sections: "Dimensions" and "Force Filter".

**Dimensions:**

- Minimum local x-coord: -0.51 m
- Maximum local x-coord: 0 m
- Minimum local y-coord: 0 m
- Maximum local y-coord: 1.99 m

**Force Filter:**

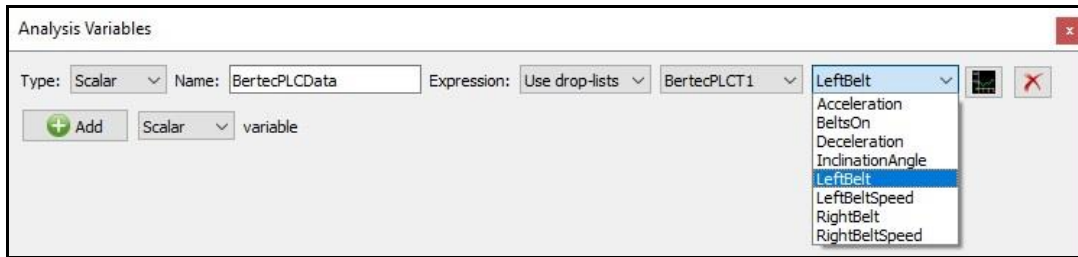
- Repair: Max interval: 1 sec
- Butterworth filter: Freq: 20
- Chebyshev filter: Freq: 20
- FFT lowpass filter: Freq: 20, Rolloff: 2
- FFT highpass filter: Freq: 0, Rolloff: 2

Buttons: + Add Notch Filter, Apply to All

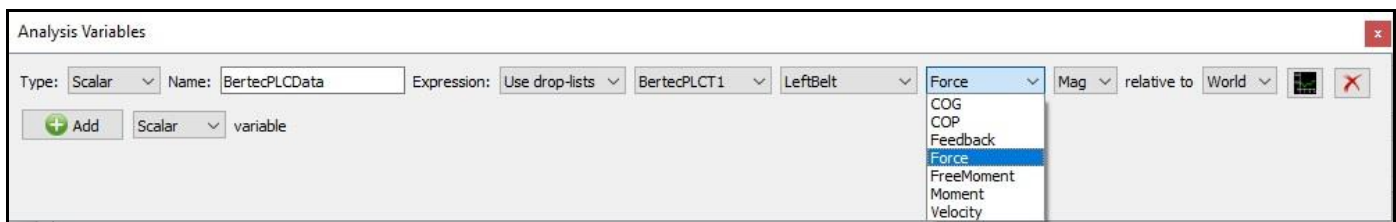
Expand the node for each data type (Force, Moment, Center of Pressure, Center of Gravity, Velocity and Feedback) to control their filtering parameters. Each data type can be filtered independently, and filters can be applied either before data collection or in post processing. The "Apply to All" button will apply the filter settings to both Right and Left Belts for that data type.

Click the "Align" button and follow the prompts to align the force plate. Update these settings and perform the alignment process for each force plate.

- Bertec PLC data can be defined as Analysis Variables and plotted in Graphs as seen in the image below. Tutorial videos for adding variables and graphs can be found at <https://themotionmonitor.com/support/>.

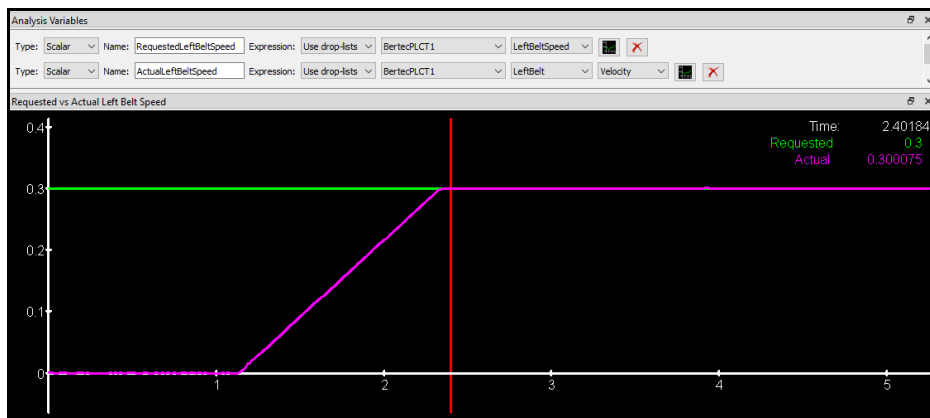


The BeltsOn, Acceleration, Deceleration, Left/RightBeltSpeed and Inclination Angle data types will report the specified values from the Setup Parameters panel for the Bertec PLC device.

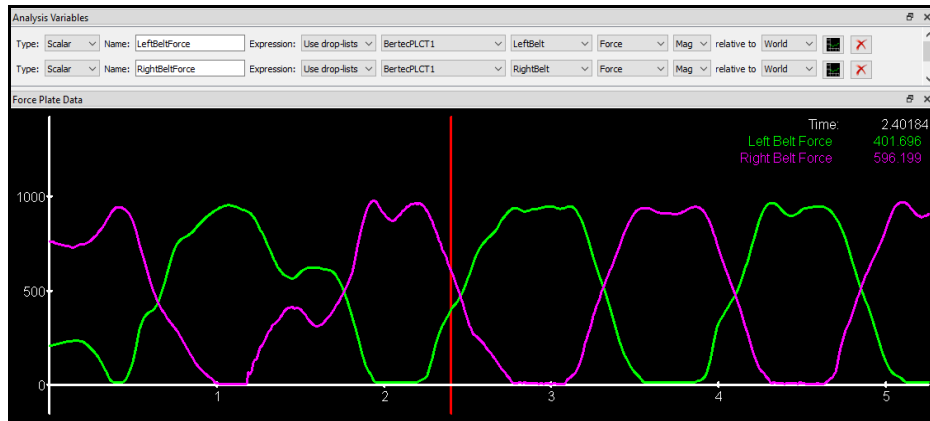


The Left/RightBelt drop-list selection provides data received from the force plate, including COG, COP, Feedback, Force, FreeMoment, Moment and Velocity data.

The graph below displays a plot for the requested (BertecPLCT1.LeftBeltSpeed) and actual speed (BertecPLCT1.LeftBelt.Velocity) of the Left Treadmill Belt.



The graph below displays the plots for the left and right forces that are applied to the treadmill belts.



The image below shows the force plate foot prints and ground reaction force vectors in the Animation window after the alignment procedure was performed for both force plate treadmill belts.

