Adding Neuroscan Integration to Existing Non-EyeLink Experiments: A Quick Tutorial (EB Version 2.2.1)

This tutorial covers the steps required to add Neuroscan EEG support to an existing experiment using version 2.2 or later of SR Research Experiment Builder. This example (Neuroscan_NonEyeLink_Stroop) is based on the "STROOP" example provided with Experiment Builder. Users who are new to the software are encouraged to re-create the STROOP example by following the step-by-step instructions provided in the Experiment Builder User Manual ("15 Creating Non-EyeLink Experiments: Stroop Effect"). This example illustrates using Experiment Builder for Neuroscan experiments without recording eye tracker data. If you are looking for an example that illustrates running experiments with simultaneous EEG and eye tracking recordings, please check out the "Neuroscan_EyeLink_Simple" example and the accompanying tutorial.

Experiment Builder has built-in functionality to support communication between the Display PC and EEG computer via TTL. The new BIOMETRIC_TTL action introduced in version 2.2 of Experiment Builder offers more flexibility than the existing SET_TTL action, and simplifies integration with Neuroscan EEG. This example uses the parallel port of the Display PC to send TTL signals, but the BIOMETRIC_TTL action also supports sending TTL signals through a supported USB device, or though the EyeLink Host PC in an EyeLink project.

1) The BIOMETRIC_TTL Control action implements the "Start Recording" and "Stop Recording" options, which can be used to send signals to control the start and stop of the recording for the Neuroscan EEG if running on the Curry software (but not on the older Scan software). Users will need to configure the trigger values for the "Start Recording" and "Stop/Pause Recording" event actions in the Curry software (see section 4 "Configuring Trigger Settings for the Neuroscan Curry Software").

2) The Biometric TTL Control also allows users to easily control the duration of a signal by sending a clearing signal (typically 0x0) shortly after the initial signal (instead of having to use two SET_TTL actions connected with a Timer trigger).

This current tutorial will demonstrate how to unpause and pause EEG recordings and add event markers to an example experiment that mark the critical events that occurred in a trial. Although the discussion is based on the Stroop example, steps covered here can be easily applied to any non-eyetracking experiments programmed with Experiment Builder.

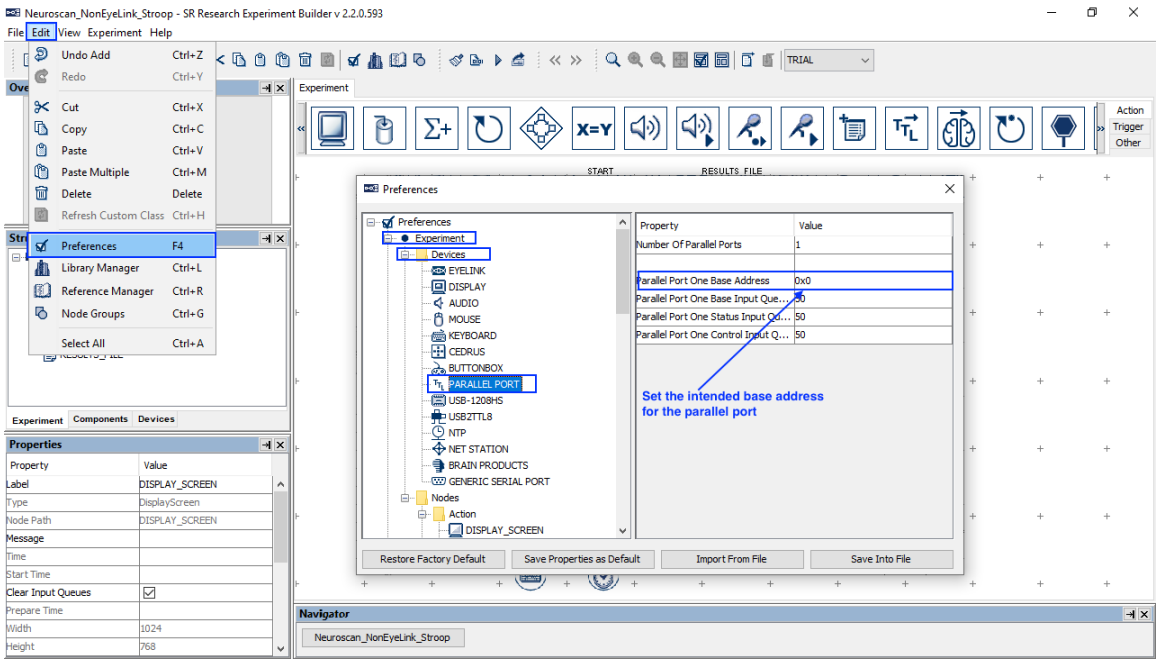
Please report all functionality comments and bugs to support@sr-research.com.

1 Configuring Experiment Builder Preferences

This section illustrates how to configure Experiment Builder to communicate with the Neuroscan EEG. In this example, TTL signals are sent through the parallel port on the Display PC.

1) Select “Edit -> Preferences” from the application menu bar or press the shortcut key “F4” on Windows.

2) Navigate to the “Parallel Port” menu under “Experiment -> Devices” and look for the “Parallel Port One Base Address”. Enter 0x0 in the value field so that Experiment Builder automatically detects the parallel port device installed on the display computer and resolves its base address.



For display computers without a parallel port, users have other options to send TTL signals. For example, the USB-1208 HS by Measurement Computing and the USB2TTL8 by LabHackers are USB-based TTL devices that can be used on both a Mac and Windows PC. In an EyeLink experiment, users may send TTL signals through the devices installed on the EyeLink Host PC (configured through the “EyeLink_Host_TTL” Device).

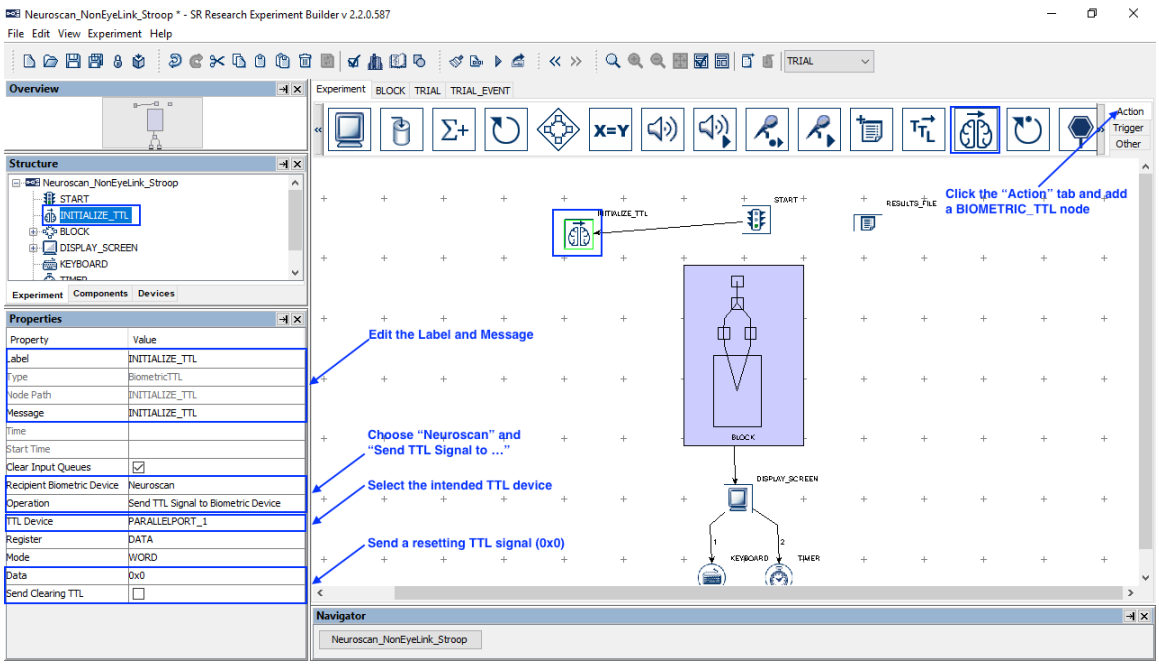
2 Setting the Default TTL Value and Controlling EEG Recordings

One important aspect of integrating eye tracking and EEG data is to ensure that critical events, such as display screens, and/or participants' responses, are marked in both the Experiment Builder results file and the EEG data file. For the Neuroscan EEG system, a default TTL value (typically 0) needs to be set at the beginning of the project. To mark critical events (e.g., stimulus onsets, participant responses) in the EEG data, we can send a brief trigger immediately after the event, then reset the TTL value back to 0 so the EEG can receive the next event marker.

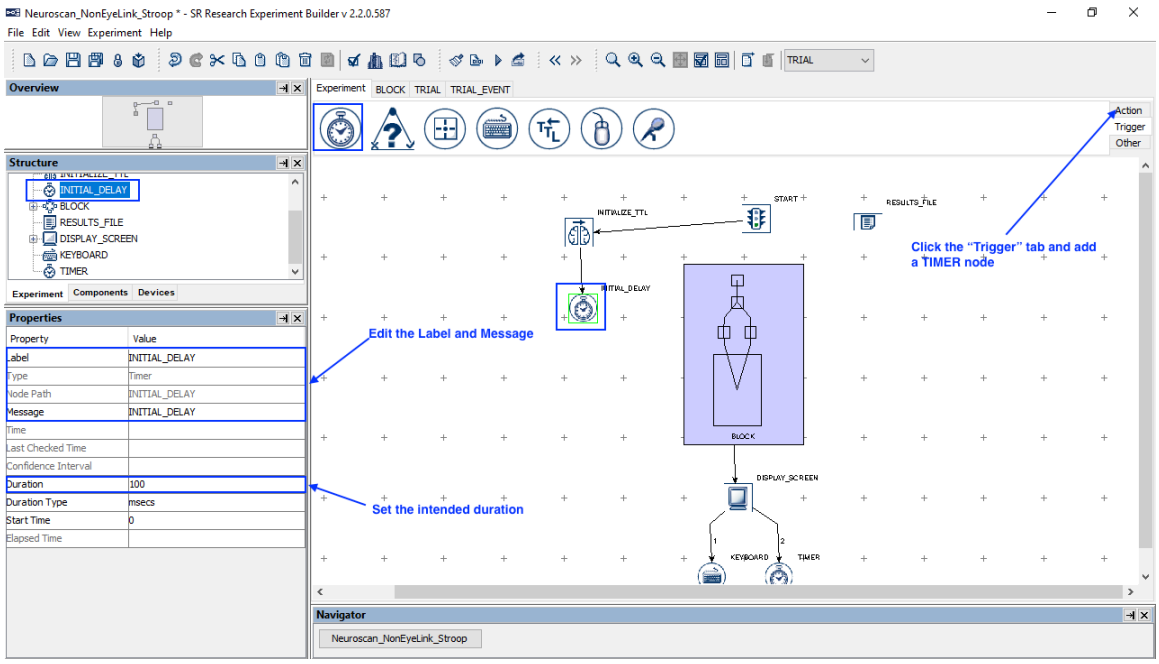
Neuroscan EEG systems running the latest Curry software allow the user to start and stop the EEG recording by sending TTL triggers from Experiment Builder—please see section 4 for information on how to configure the EEG computer to use TTL signals to trigger EEG recording. In this example, we send a single Start Recording command at the beginning of the experiment, and a single Stop Recording at the end of the experiment. Users may also choose to start and stop the EEG recording multiple times within the project, for instance, by sending the start and stop commands at the beginning and end of each block of trials, or more rarely at the beginning and end of each individual trial. Make sure to include a short (1000 msec) delay after sending a Start Recording command, or before sending a Stop Recording command, to ensure the recording has stabilized.

1) Go to the topmost layer of the experiment.

2) Select the "Action" tab of the Component Toolbox and add a BIOMETRIC_TTL action. Set the Label and Message of the action to "INITIALIZE_TTL". Set the "Recipient Biometric Device" to "Neuroscan", and set the "Operation" to "Send TTL Signal to Biometric Device". Use the TTL Device as discussed in section 1 – in this example, we are going to use the parallel port on the Display PC ("PARALLELPORT_1"; if another device is chosen, a prompt will allow the user to set that as the default TTL Device for all Biometric TTL nodes). Set the Register to "DATA", set the Data to "0x0", and uncheck the "Send Clearing TTL" box. Now connect the START node to the INITIALIZE_TTL node.

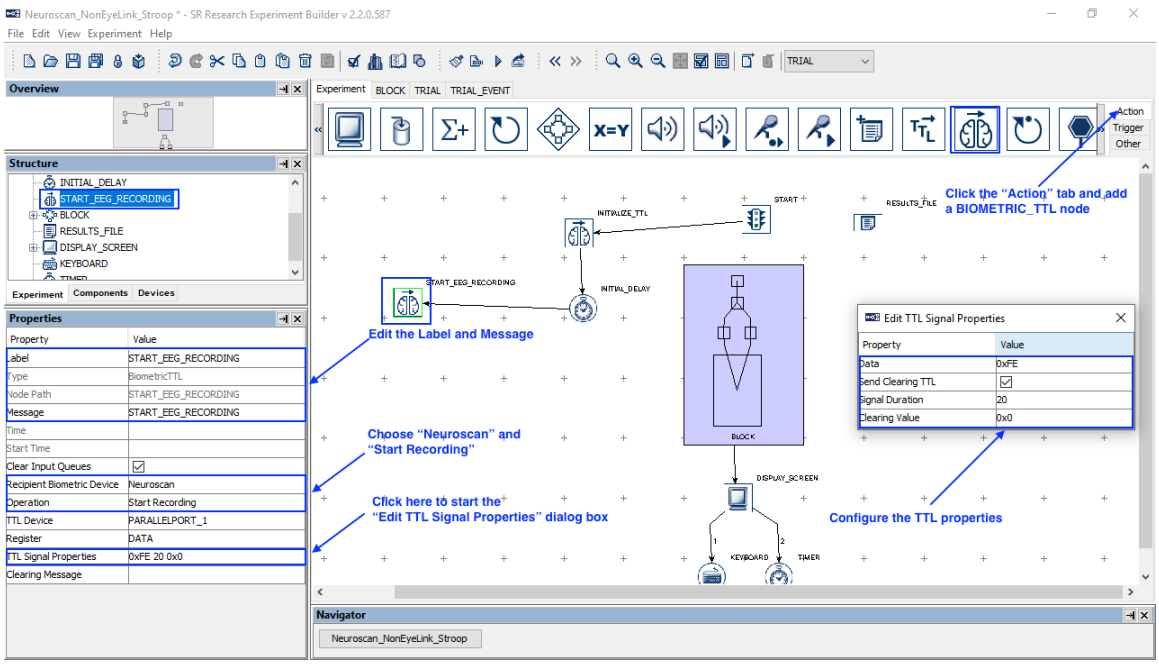


3) Select the "Trigger" tab of the Component Toolbox and add a TIMER node to the graph. Edit the "Label" and "Message" properties of the node to "INITIAL_DELAY". Set the "Duration" to be 100 (msecs). Draw a connection from the INITIALIZE_TTL node to the TIMER node.

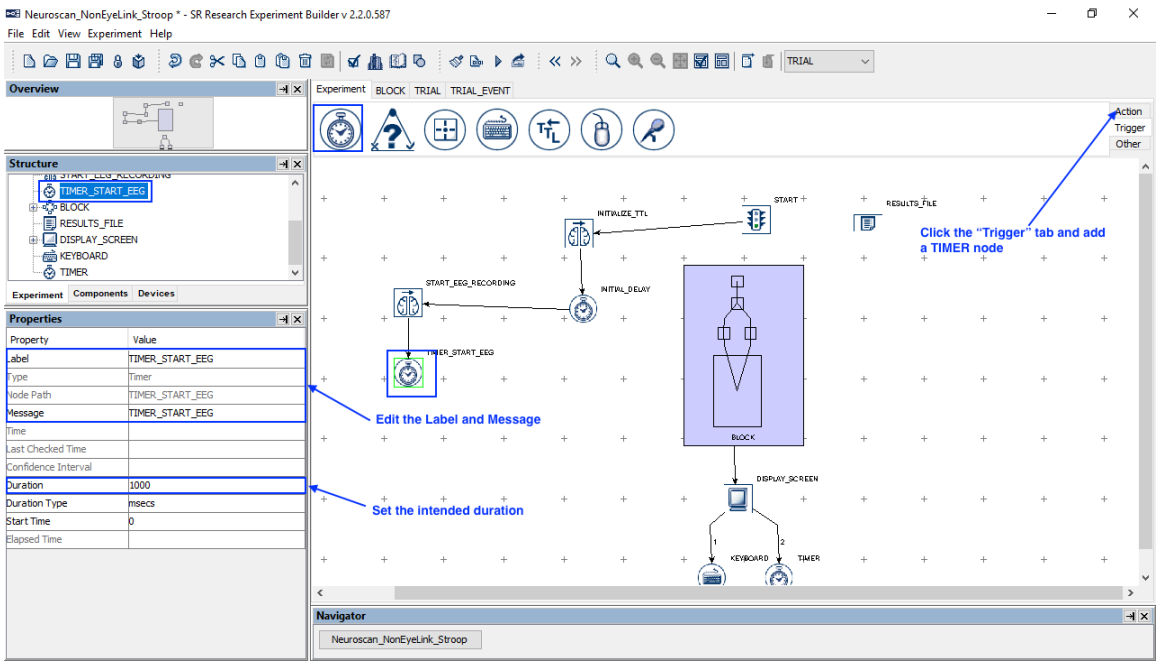


4) At the beginning of the experiment, the EEG recording is started. Select the "Action" tab of the Component Toolbox and add a BIOMETRIC_TTL node to the graph. Edit the "Label" and "Message" properties of the node to "START_EEG_RECORDING". Set the "Recipient Biometric Device" to

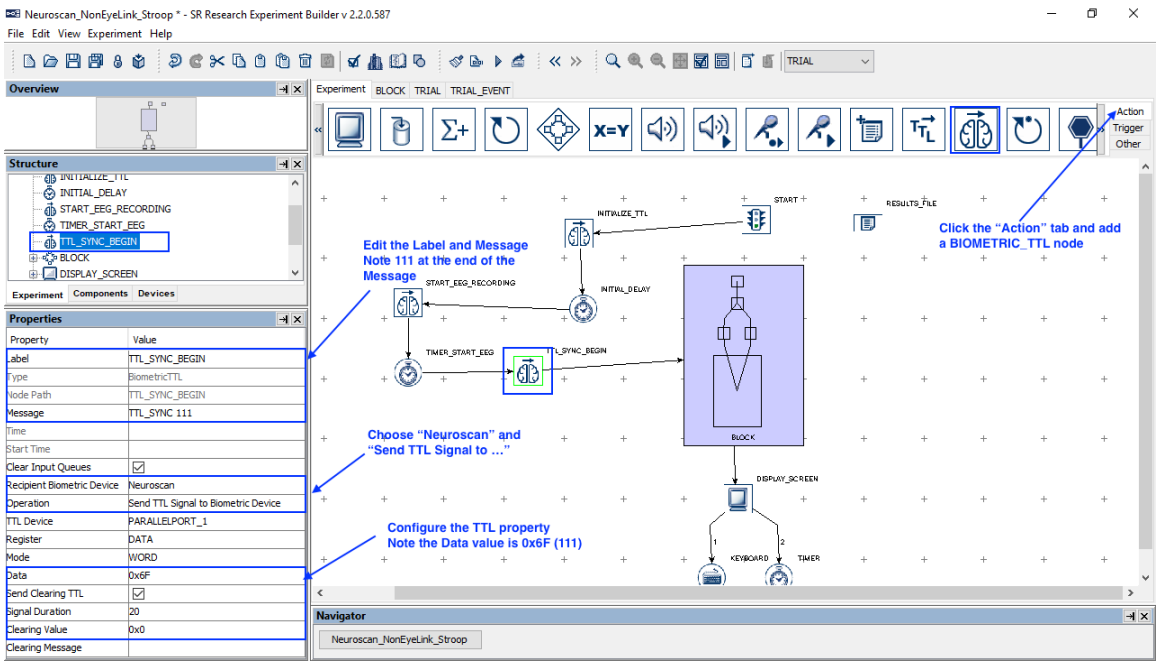
"Neuroscan". Set the "Operation" to "Start Recording". Keep the same TTL Device and Register as in the previous BIOMETRIC_TTL action. By default the "TTL Signal Properties" is set to "0xFE 20 0x0". Click the value field to bring up the "Edit TTL Signal Properties" dialog box to review the settings. The "Data" is set to "0xFE" (254 in decimal)—this is the unique trigger value that will be specified for "Start Recording" in Section 4 (e.g., "254" or the hex code "0xFE"). The "Send Clearing TTL" box is checked, the Signal Duration is set to 20 (ms) and a clearing value of 0x0 is used. Note that the duration required here depends on the sampling frequency used for the EEG recording and will need to be at least one sample period. A 20 msecs pulse duration is typically appropriate to use for most recordings but consult your EEG system's User Manual for the desired duration. Draw a connection from the PREPARE_SEQUENCE node to START_EEG_RECORDING.



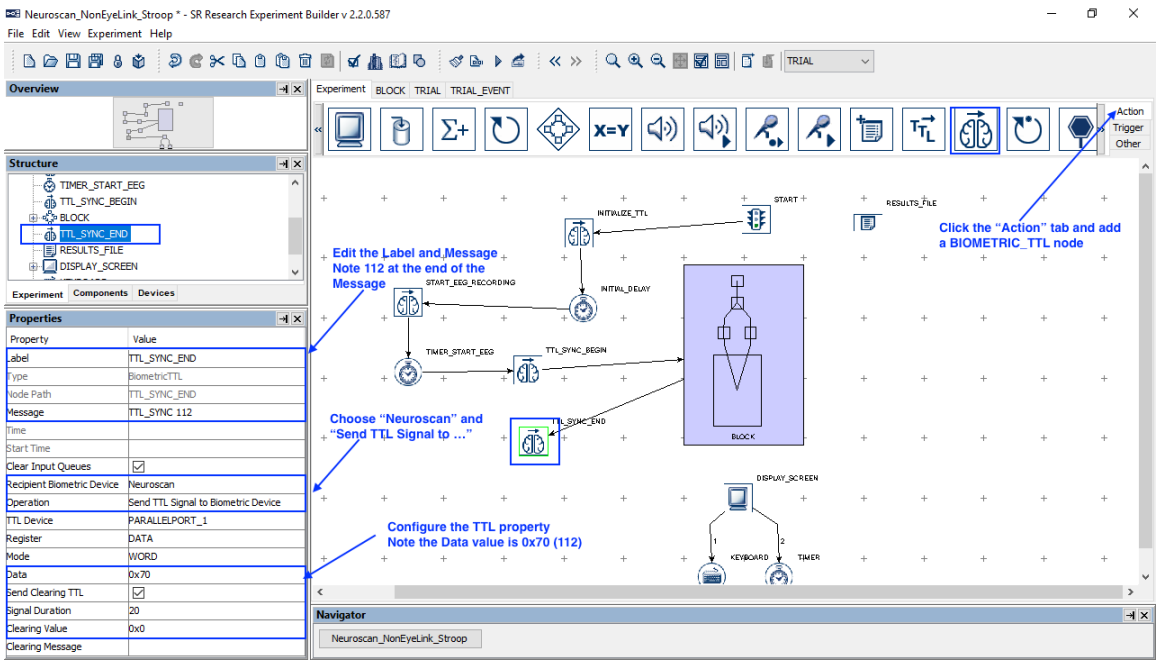
5) Now that the TTL signal has been sent, we will add a delay of 1000 milliseconds to ensure the recording has stabilized. Select the "Trigger" tab of the Component Toolbox and add a TIMER node to the graph. Edit the "Label" and "Message" properties of the node to "TIMER_START_EEG". Set the "Duration" to be 1000 (msecs). Draw a connection from the START_EEG_RECORDING node to the TIMER_START_EEG node. Note this extra delay is completely optional for Neuroscan EEG systems – users can use a shorter TIMER duration or choose to remove this trigger altogether.



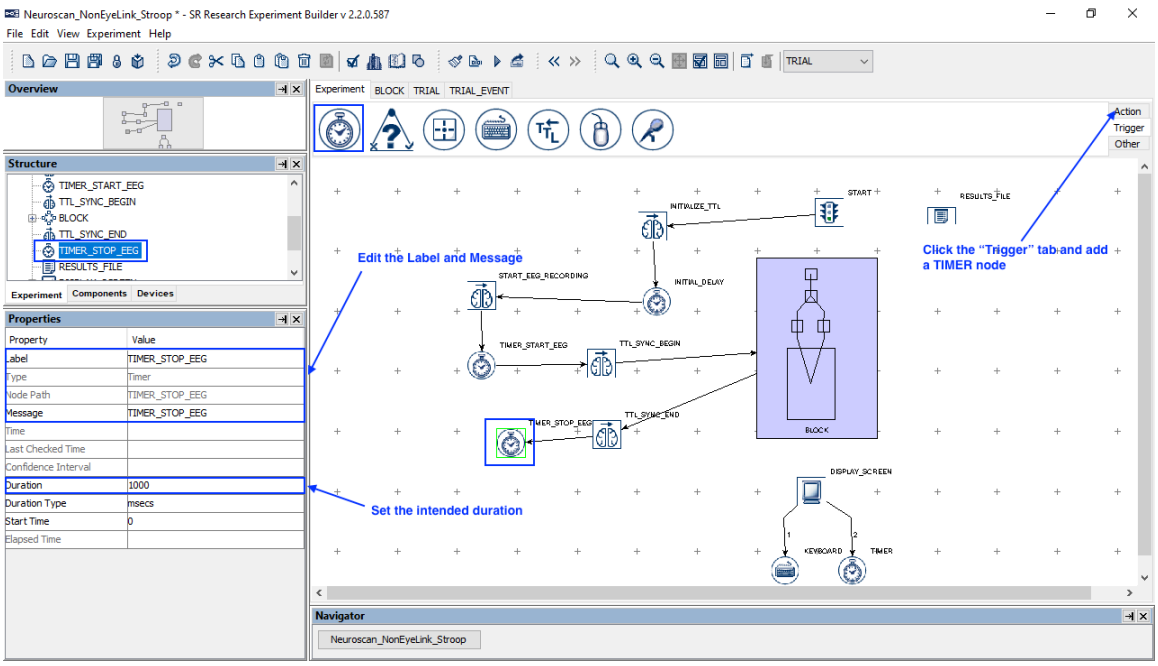
6) To help align the Experiment Builder events and EEG data, we will send a pair of synchronization pulses to the EEG recorder, one at the beginning of the experiment, and one at the end. The same events will be marked as Messages in the messages.txt file. Select the "Action" tab of the Component Toolbox and add a BIOMETRIC_TTL action. Set the Label of the action to "TTL_SYNC_BEGIN" and the message of the action to "TTL_SYNC 111". Note the number at the end of the message, this corresponds to the TTL value that will be sent. Set the "Recipient Biometric Device" to "Neuroscan". Set the "Operation" to "Send TTL Signal to Biometric Device". Use the TTL Device as discussed in section 1 – in this example, we are going to use the parallel port on the Display PC ("PARALLELPORT_1"). Set the "Data" to 0x6F (111 in decimal). The "Send Clearing TTL" box is checked, the Signal Duration is set to 20 (ms) and a clearing value of 0x0 is used. Draw a connection from the TTL_SYNC_BEGIN node to the BLOCK sequence.



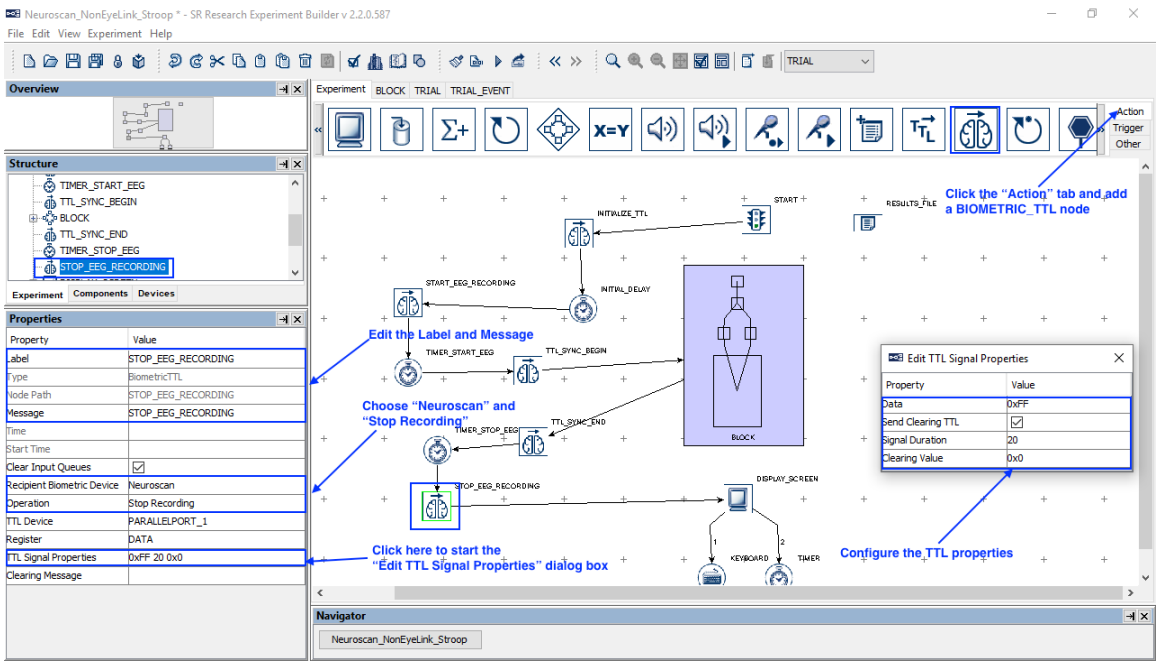
7) A sync signal will be sent at the end of the experiment. Select the "Action" tab of the Component Toolbox and add a BIOMETRIC_TTL action. Set the Label of the action to "TTL_SYNC_END" and the message of the action to "TTL_SYNC 112"—as before, the "112" corresponds to the TTL value that will be sent. Set the Data to "0x70" (112). The "Send Clearing TTL" box is checked, the Signal Duration is set to 20 (ms) and a clearing value of 0x0 is used. Draw a connection from the BLOCK sequence.



8) Before we stop the EEG recording, we will first add a delay to ensure that the recording has finished processing. Select the "Trigger" tab of the Component Toolbox and add a TIMER node to the graph. Edit the "Label" and "Message" properties of the node to "TIMER_STOP_EEG". Set the "Duration" to 1000 msec. (This recording stabilization period is added to be consistent with other examples, but is completely optional for Neuroscan EEG systems—users can set a shorter TIMER duration or choose to remove the TIMER trigger altogether.) Draw a connection from the TTL_SYNC_END node to the TIMER_STOP_EEG node.



9) Select the "Action" tab of the Component Toolbox and add a BIOMETRIC_TTL node to the graph. Edit the "Label" and "Message" properties of the node to "STOP_EEG_RECORDING", and set the "Operation" is set to "Stop Recording". When the Operation is set to Stop Recording, the "TTL Signal Properties" will be set to "0xFF 20 0x0"—the data 0xFF (255) will be specified for "Stop / Pause Recording" in Section 4 (e.g., "255" or the hex code "0xFF"). Draw a connection from TIMER_STOP_EEG to STOP_EEG_RECORDING, and from STOP_EEG_RECORDING to DISPLAY_SCREEN.


Click the "Action" tab and add a BIOMETRIC_TTL node
Edit the Label and Message
Choose "Neuroscan" and "Stop Recording"
Click here to start the "Edit TTL Signal Properties" dialog box
Configure the TTL properties
Edit TTL Signal Properties

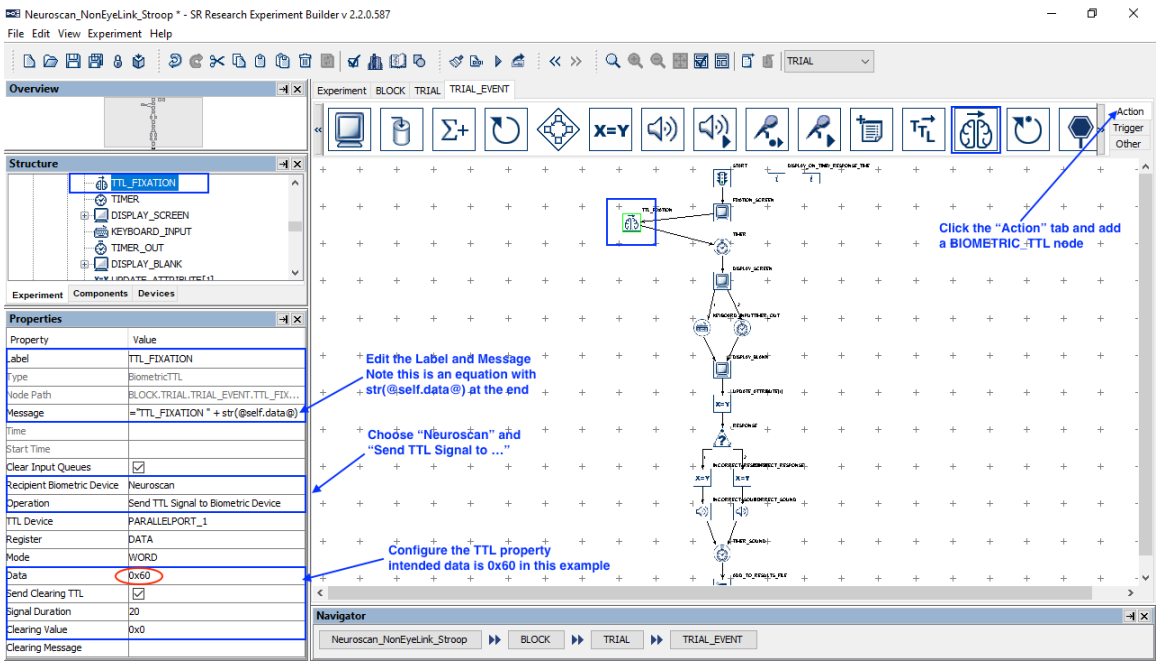
3 Sending Event Markers to EEG Recordings

To make sure events recorded in Experiment Builder are synchronized with the EEG data collected by the Neuroscan EEG, users can send TTL signals from Experiment Builder to mark the critical events in the experiment such as display and audio stimulus onsets, participant responses, etc. In this example, we will illustrate how to use a BIOMETRIC_TTL action to mark the onset of the DISPLAY_SCREEN actions and send the participant's response data to the EEG data stream. It is important to set the "Data" property of the BIOMETRIC_TTL actions to a unique value for each type of critical event. Users may sometimes also use the TTL signal to encode the trial condition information. Note that the values that can be used for the "Data" property may be dependent on the allowable values that can be set based on the EEG system being used. For the purposes of this example, we will use the hex value 0x60 (96 in decimal) for the DISPLAY_SCREEN, 0x61 (97) for the TIMER, 0x62 (98) for the EL_BUTTON, 0x63 (99) for the EL_KEYBOARD, and 0x64 (100) for the DISPLAY_BLANK. To simplify data alignment between the EEG and EyeLink recordings, the unique trigger value should also be written to the Message text of the BIOMETRIC_TTL actions.

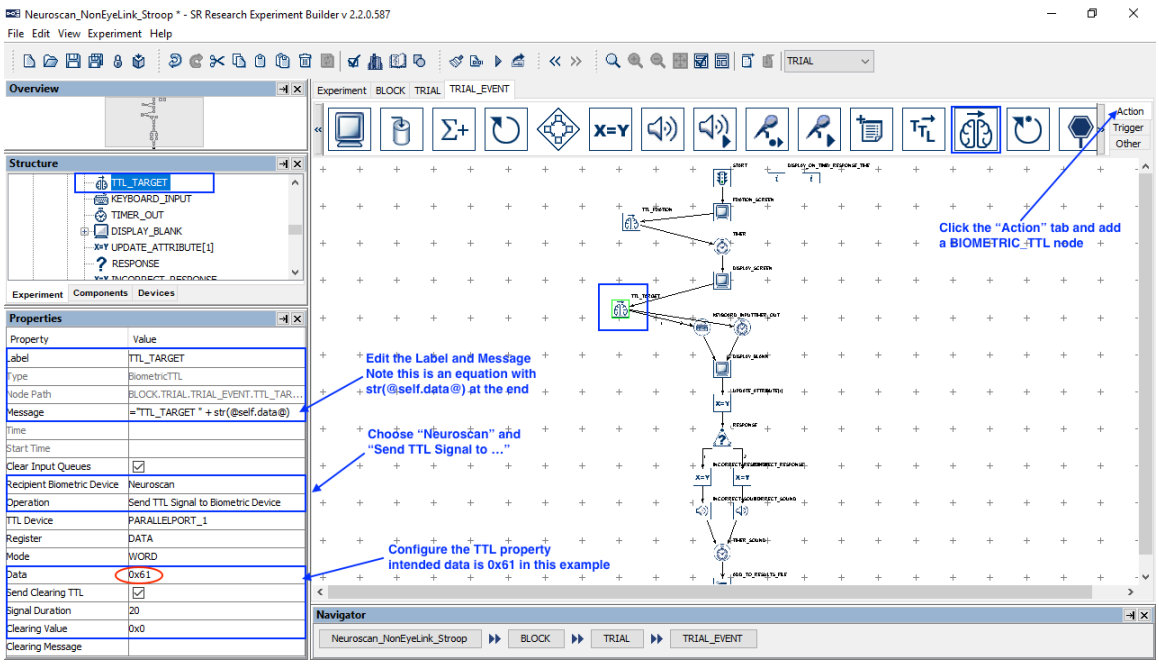
1) Double click the innermost TRIAL_EVENT sequence to show events in the trial.

2) Select the "Action" tab of the Component Toolbox and add a BIOMETRIC_TTL action. Set the Label and message of the action to '="TTL_FIXATION" + str(@self.data@)' (note that the expression must begin with an "="). The reference str(@self.data@) will record the TTL value in the message text. Set the "Recipient Biometric Device" to "Neuroscan", and set the "Operation" to "Send TTL Signal to Biometric Device". Keep the same TTL Device as in other Biometric TTL actions discussed previously. Set the "Data" to 0x60. Check the "Send Clearing TTL" box, and set the Signal Duration to 20 (ms) and clearing value to 0x0. Draw a connection from the FIXATION_SCREEN action to the newly added TTL_FIXATION node. From the TTL_FIXATION node, draw connections to the TIMER node.

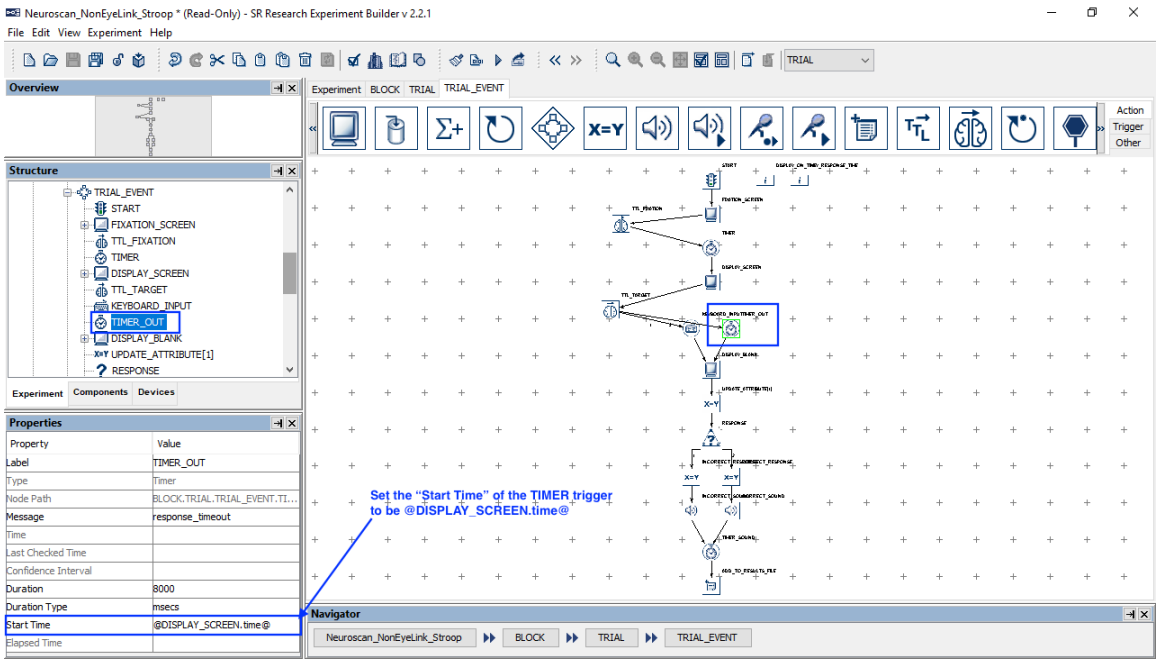
   Important! For proper data alignment between the behavioral data and EEG recordings, please make sure the "Message" field of the BIOMETRIC_TTL action contains a uniquely identifiable string with the TTL value at the end of the text. Please also make sure the BIOMETRIC_TTL node is placed immediately after the event you want to mark in the EEG data.



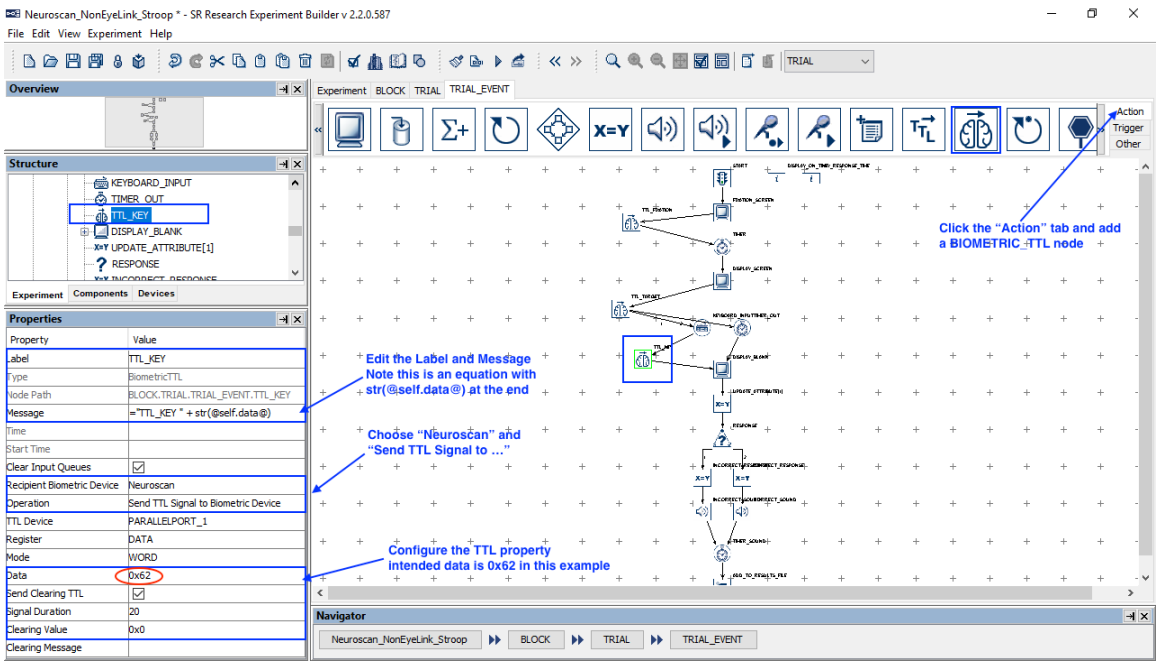
3) Now send a TTL signal following on the onset of the target display. Select the "Action" tab of the Component Toolbox and add a BIOMETRIC_TTL action. Set the Message of the action to ="TTL_TARGET"+str(@self.data@). Use the exactly same properties as in the above-mentioned TTL_FIXATION except that the "Data" will now be 0x61. Draw a connection from the DISPLAY_SCREEN action to the TTL_TARGET node. From the TTL_TARGET node, draw connections to the KEYBOARD_INPUT and TIMEOUT nodes.



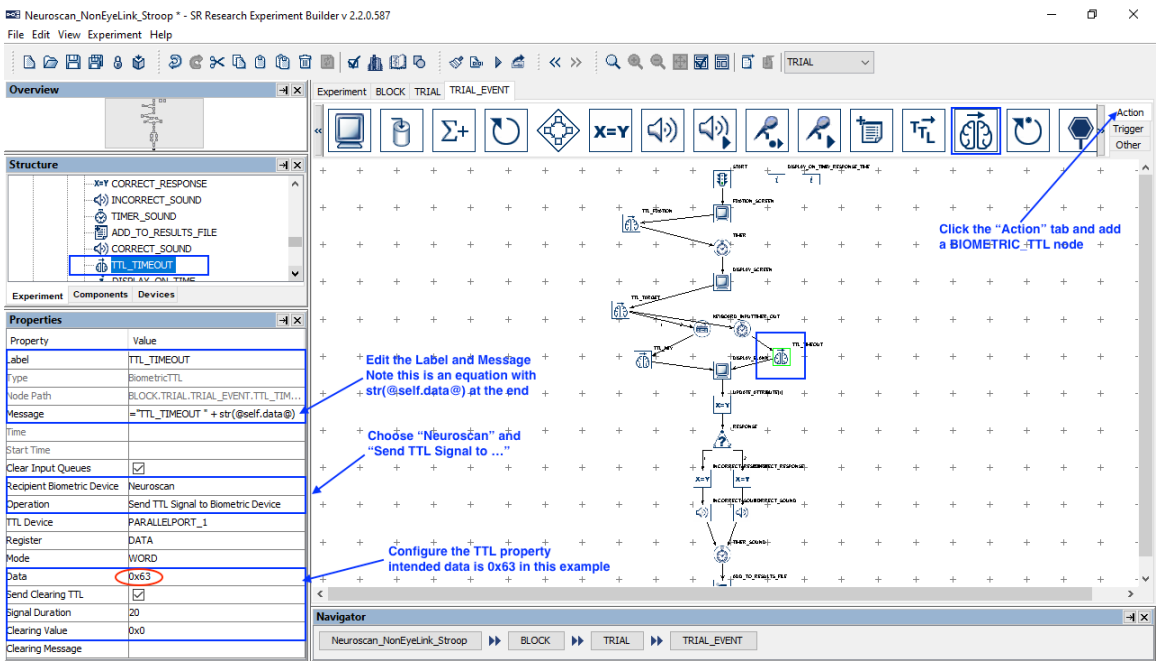
4) For the TIMER trigger that follows the TTL_FIXATION node, set the Start Time to be @FIXATION_SCREEN.time@ instead of the default value of 0, and for the TIMER_OUT trigger that follows TTL_TARGET, set the Start Time value to @DISPLAY_SCREEN.time@. This ensures that the elapsed time of the Timer triggers start at the onset of the Display Screen actions—if left at the default time of 0, the elapsed time would be measured from when the BIOMETRIC_TTL action returns (after the clearing signal is sent).



5) Next, send a TTL signal following each of the possible response methods. Let's start with the keyboard response. Select the "Action" tab of the Component Toolbox and add a BIOMETRIC_TTL action. Set the Message of the action to = "TTL_KEY" +str(@self.data@). Use the same property settings as in the previous BIOMETRIC_TTL actions except that the "Data" will be 0x62. Draw a connection from the KEYBOARD_INPUT to TTL_KEY, and from TTL_KEY to DISPLAY_BLANK.

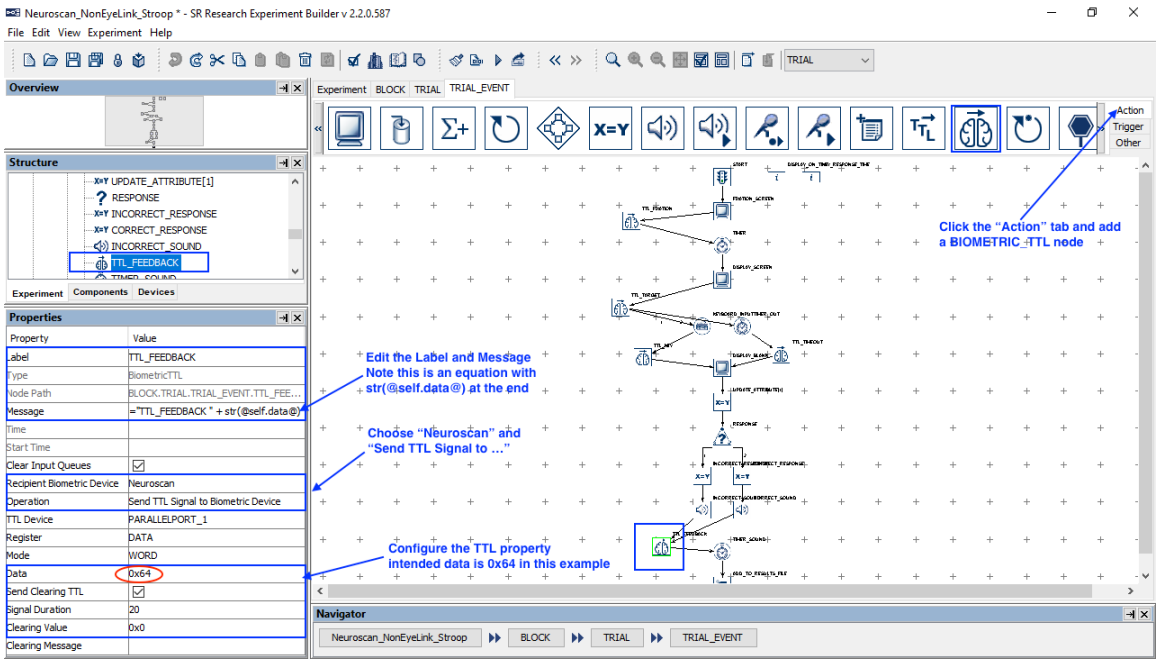


6) Now select the "Action" tab of the Component Toolbox and add a BIOMETRIC_TTL action. Set the Message of the action to = "TTL_TIMEOUT" + str(@self.data@). Use the same TTL settings except that the "Data" is set to 0x63. Draw a connection from the TIMEOUT to TTL_TIMEOUT.



7) Finally, send a TTL signal when the feedback audio is played. Select the "Action" tab of the Component Toolbox and add a BIOMETRIC_TTL action. Set the Message of the action to ="TTL_FEEDBACK" +str(@self.data@), and "Data" to 0x64. Draw a connection from the INCORRECT_SOUND and

CORRECT_SOUND nodes to TTL_FEEDBACK, and from TTL_FEEDBACK to TIMER_SOUND.

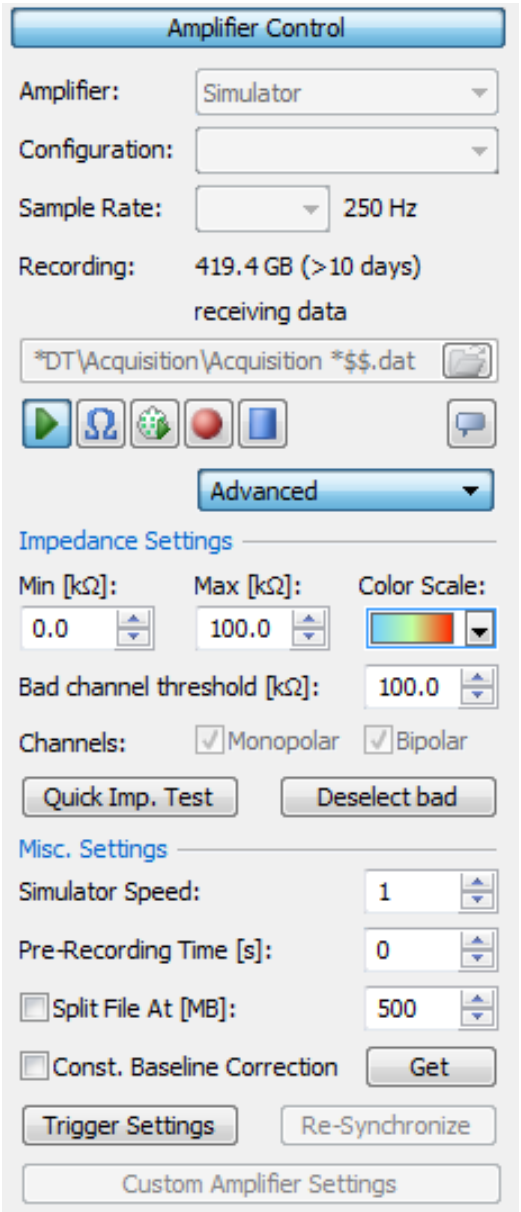


4 Configuring Trigger Settings for the Neuroscan Curry Software

For some EEG systems, trigger commands can be sent or received in order to start and stop the EEG recording (or to "pause" the EEG file) to ensure that unnecessary information is not being recorded. The following section covers how to enable this functionality on the Neuroscan EEG system when running on the Curry software (this is not supported on the older SCAN software).

To edit event codes in the Curry software:

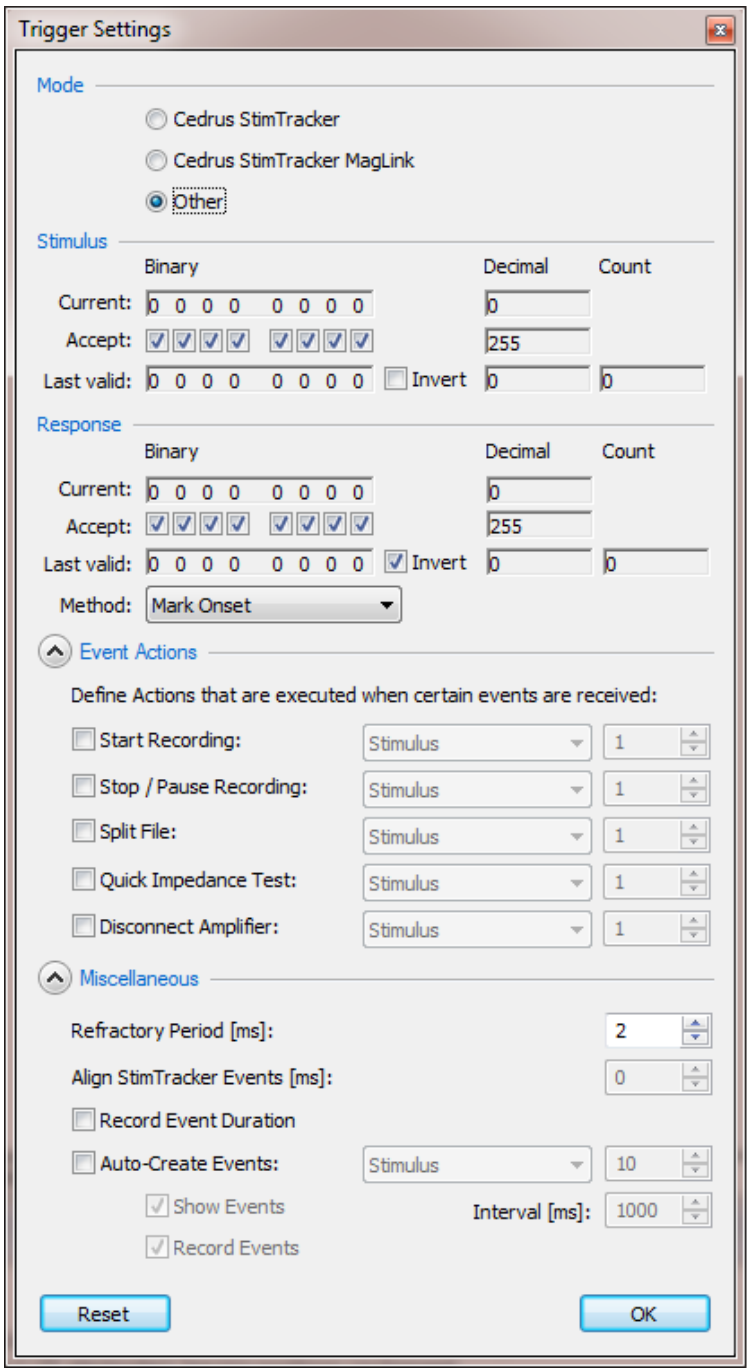
1) Click on the Amplifier Control button and then click on the Advanced button.



2) Click on the Trigger Settings button to open the Trigger Settings dialog window.

3) Under “Event Actions”, check the “Start Recording” and “Stop / Pause Recording” boxes, and then enter the intended trigger value. For the purposes of this example, set the trigger value to the following:

    Start Recording =254
    Stop/Pause Recording =255



The EEG computer should now be set up to receive these trigger commands from the Display PC in order to start and stop the EEG recording. Note that the above triggers only control the pausing of the EEG data file during the experiment. The experimenter will still need to manually start a new data file at the beginning of data collection.