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1. STARR-Link™ Packaged Parts

The following is a list of parts that should be included in your STARR-Link™ shipping box:

   STARR-Link™ Analog Data Output Module Control Box
   2-meter STARR-Link ™ USB Cable
   STARR-Link ™ User Manual

Please check to see that you have all of these parts before proceeding to installation. If you find any part missing, please contact STARR Life Sciences® at 1-866-978-2779, or by e-mail at <u>support@starrlifesciences.com</u>.

2. Device Requirements

The STARR-Link™ has the following use and interface requirements:

Hardware
   You must have a functioning STARR Life Sciences® MouseOx® Plus device.

Software
   The STARR-Link™ does not require special software since all drivers and controllers are contained within the MouseOx® Plus software.

Computer Hardware
   Your computer must have at least one 2.0 USB port to accommodate the STARR-Link™.

Electrical Requirements
   Your external recording device must have high-impedance inputs.

3. Device Specifications

The STARR-Link™ provides analog outputs of 8 channels and 10 parameters of data obtained from the STARR Life Sciences® MouseOx® Plus. The STARR-Link™ allows you to electronically record those parameters to your own recording device.

The outputs provide analog voltages in a 0-5 VDC range, but they are not true analog voltages. They are real-time analog voltages proportional to digital data calculated by the measuring device, and they update at a 12.5 Hz rate. Each channel provides a specific parameter only for that channel. All voltages are scaled values of the actual parameters as measured by the MouseOx® Plus. The actual values of the parameters can be back-calculated from the analog voltages using simple proportional scale factors, individual for each channel. Other specifications are given below.

Device Compatibility

This STARR-Link™ can be used with the STARR Life Sciences® MouseOx® Plus.

Channel Configuration

The STARR-Link™ provides output for 8 channels of data. These are:

- Oxygen Saturation   - File Marker
- Heart Rate   - Error Code
- Breath Rate   - Breath Distention
- Pulse Distention (or Activity)[*]   - Temperature (or Mouse #)[**]

[*] When measuring Conscious Subjects, Activity replaces Pulse Distention
[**] When using a Multiplexer™, Mouse # replaces Temperature

Output

The STARR-Link™ transmits analog voltage representations of digital data in a range of 0 to 5 VDC, updated at a rate of 12.5 Hz. When using the MouseOx® Plus, signal updates are delayed by 0.7 seconds from real-time, due to the method by which data are collected and the parameters are calculated. However, no delay is added by the STARR-Link™, and the current value delivered from the MouseOx® Plus will be immediately sent out on each channel at a 12.5 Hz (or 80 msec) update rate.

Accuracy

Accuracy of STARR-Link™ analog outputs from each channel is +/- 3 mV.

4. Warnings, Cautions and Operational Notes

WARNING   Replace unit if housing is broken or cracked.

WARNING   DO NOT substitute the USB cable. Use only parts that are packaged with the STARR-Link™ device.

WARNING   Investigational device only.

WARNING   NOT for use on humans.

WARNING   DO NOT place control box in an environment with oxygen fraction greater than 30%.

WARNING   DO NOT immerse control box in liquids.

WARNING   DO NOT short the ground and signal lines as this will permanently damage the internal electronics.

WARNING   DO NOT directly expose control box to flammable or explosive gases.

WARNING   DO NOT use STARR Life Sciences® STARR-Link™ USB cable with any other device.

WARNING   Clean by wiping external surfaces of box and leads with light detergent and water.

WARNING   Avoid spilling fluids on control box.

OPERATIONAL NOTE   This STARR-Link Analog Data Output Module should only be used with the MouseOx® Plus.

OPERATIONAL NOTE   Signal noise that exceeds ±3 mV is likely due to the computer.

5. Using the STARR-Link™ Module

5.1 Device Description

The STARR-Link™ Analog Data Output Module provides you with real-time analog voltage outputs of your MouseOx® Plus data. The STARR-Link™ can transmit up to 8 parameters at a 12.5 Hz update rate, in a 0-5 VDC range. It connects to your computer with a USB cable. A table in Section 5.4 details how to convert the voltage values to the units of the given physical parameter for each channel.

BNC Cable Connectors
The STARR-Link™ device is equipped with 8 BNC connectors. Each connector is labeled with the output parameter assigned to that channel.

Power LED Indicator
When lit, the lower **green** LED indicates that appropriate power has been applied to the module via the USB cable. If this indicator does not light, there is no power going to the STARR-Link™.

USB LED Indicator
When lit, the upper **green** LED indicates that USB communications with the computer are ongoing. This LED may blink while data are being transferred, but it should not go completely dark.

5.2 Output Parameters

The STARR-Link™ transmits analog outputs at an update rate of 12.5 Hz for the following parameters:

Oxygen Saturation (S_pO_2)
Real-time percent oxygen saturation of arterial hemoglobin. The output analog voltage on this channel is proportional to oxygen saturation.

Heart Rate
Real-time cardiac pulse rate. The output analog voltage on this channel is proportional to heart rate.

Pulse Distention

A measurement of the distention of the arterial blood vessels residing between the sensors due to the cardiac output pulse. Changes in its value are proportional to changes in local blood volume. For given vascular resistance and compliance, this parameter can be proportional to blood pressure. This channel will output Pulse Distention, unless you are operating the MouseOx® Plus system using Conscious Subjects software, in which case it will output Activity. The output analog voltage on this channel is proportional to pulse distention.

Respiratory Rate

Breath rate updated every few seconds. Note that this parameter is actually derived from respiratory effort, and will be present even if the animal is experiencing an obstructive apnea, as long as breathing effort is present. The output analog voltage on this channel is proportional to breath rate.

File Marker

File markers are user-selected flags available in the MouseOx® data collection system that indicate the location of up to 50 significant events per data set. It is up to the user to make note of the significance of each marker. The marker numbers start at 0, and proceed sequentially with each entry by the user. The STARR-Link™ provides an analog voltage on this channel that is proportional to the most recent file marker integer.

Error Code

Error codes are given in the table just below. More detail on their significance is provided in the MouseOx® Plus User Manual. The output analog voltage on this channel must be converted to the error code listed in the table.

Error Codes	Error Description	S_pO_2	Heart Rate	Breath Rate	Pulse Distention	Breath Distention
0	No Error	Good	Good	Good	Good	Good
2	Lost Pulse	Good	Unsure	Unsure	Unsure	Unsure
3	Lost Breath Rate	Good	Good	Unsure	Good	Unsure
4	Lost S_pO_2	Unsure	Good	Good	Good	Good
6	Lost Signal	Unsure	Unsure	Unsure	Unsure	Unsure
7	Lost Breath Rate & Lost S_pO_2	Unsure	Good	Unsure	Good	Unsure
8	Breathing Artifact	Unsure	Unsure	Unsure	Unsure	Unsure
9	Signal Optimization	Unsure	Unsure	Unsure	Unsure	Unsure

In this table, each of the error codes is defined for the physiological parameters listed on the right-hand side. For a given error code, the parameter at

that location will be either **Good** or **Unsure**.

Good means that the given measurement satisfies all of our acceptance criteria.

Unsure means that the given measurement does not meet our acceptance criteria during the presence of that particular code.

Breath Distention

A measurement of the distention of the arterial blood vessels residing between the sensors due to changes in intra-thoracic pressure associated with breathing. Changes in its value are proportional to changes in local blood volume. Breath Distention can be correlated with breathing effort, or specifically, intra-thoracic pressure. The output analog voltage on this channel is proportional to breath distention.

Temperature

Real-time measurement of Rectal Temperature when you purchase the MouseOx® Plus Body Temperature Option. Temperature can be output in either °C or °F and the conversion factor is the same for both unit. Thus, you must record what units you are using, although this should be discernable based on the magnitude of the numbers.

This channel will output Temperature unless a Multiplexer™ is detected by the MouseOx® Plus system, in which case it will provide Subject #. The output analog voltage on this channel is proportional to temperature in either unit.

Activity

Activity is a binary-valued parameter that indicates when the animal is moving versus sitting still. It provides a value of 1 when the animal is moving, and 0 when it is still. It is provided as part of the MouseOx® Plus Conscious Subjects Option, and appears in place of the Pulse Distention parameter on the given STARR-Link™ channel, when you measure conscious subjects. The output analog voltage on this channel is proportional to activity.

Subject

Subject # is the number of the animal active on the Multiplexer™. Note that Subject # and Temperature are provided from the same channel. The system will automatically replace the Temperature output with Subject # when it detects the presence of a Multiplexer™. The output analog voltage on this channel must be converted to the numerical value of the Subject # number active at the time data are being passed through the STARR-Link™.

5.3 Operating Your STARR-Link™

Before you begin to operate your STARR-Link™, make sure that you have downloaded the latest Microsoft Windows® updates.

For first time operation, please do the following in the order given! Also, make sure that you have loaded the latest software for your MouseOx® Plus.

Connecting the USB Cable

Connect the USB cable to your STARR-Link™ control box, then to the computer. Note that power to your STARR-Link™ is provided through the USB cable. When you first connect the USB cable, you should see the lower LED on the STARR-Link™ control box illuminate.

The first time that you connect the USB cable, a popup balloon or dialog box will appear that says "Found New Hardware," to identify the presence of the newly detected control board residing within the STARR-Link™. You must wait until your computer indicates that the drivers have been installed, at which point another balloon or dialog box will appear saying "Your new hardware is installed and ready to use."

When using the STARR-Link™, the USB LED Indicator will light whenever data are being transferred. If the light shuts off during data transfer, you have lost communication with the computer. To re-establish communication, simply disconnect the USB cable from the computer, then reconnect it. Be sure to wait about 10 seconds after both actions before continuing. This should restore communication with the computer, and the USB LED Indicator should be lit again. Note that during operation, the USB LED Indicator will blink while data are being transferred. This is normal, and is not a cause for concern.

Calibration of the STARR-Link™

Your STARR-Link™ was calibrated at the factory, and will be fully calibrated when you receive it. Calibration constants are contained in the FLASH memory of the device. If a change in calibration is suspected, please contact STARR Life Sciences® customer service at 1-866-978-2779, or by e-mail at support@starrlifesciences.com.

Connecting to the Recording Device

The channel connectors on the STARR-Link™ are 50 Ω BNC-type. Connections to your recording device can be made with any standard BNC cables. You can also use any number of conversion jacks that allow you to

switch to another connection standard (*e.g.,* banana jacks), but **it is imperative that the voltage outputs not be shorted for > 100 ms. Shorting the voltage outputs can permanently damage the control board in the STARR-Link™ control box!**

If for some reason you use multiple recording devices simultaneously, make sure that the devices have a common ground. This can be achieved by using devices that receive AC power from a plug that has an active earth grounding pin. If you suspect that the ground on a device might be floating, make a direct connection between that device and your other measurement devices before connecting cables to the STARR-Link™.

5.4 Voltage-to-Parameter Scale Factors

All of the STARR-Link™ parameters are transmitted as voltages within the range 0-5 VDC. To convert back to the actual value of the parameter, use the conversion factors given in the following table.

Parameter	To Convert Voltage to Correct Units (see right column), Multiply Parameter Voltage by:	Units after Conversion
S_pO_2	24	%
Heart Rate	200	bpm
Breath Rate	120	brpm
Pulse Distention	360	μm
File Marker	10	#
Error Code	4	#
Breath Distention	360	μm
Temperature	30	°C or °F
Activity	1	#
Subject #	4	#

6. Cleaning the STARR-Link™

The STARR-Link™ device and all accompanying cables should be cleaned using only light detergent and water.

7. Contacting Technical Support

STARR Life Sciences® values its customers and is dedicated to providing quality products and solutions to meet your needs. For technical support, please call or email STARR Life Sciences® at: 1-866-978-2779, or support@starrlifesciences.com.

8. Warranties and Liabilities

Limited Warranty & Disclaimer

STARR-Link™ ("SLS") warrants its non-disposable hardware and sensors (the "Non-disposable Products") against defects in material, workmanship, and performance for a period of one (1) year from the date of shipment by SLS (the "Warranty Period"). SLS warrants that the Non-disposable Products will meet the electronic and mechanical specifications stated in the SLS user manual, although the specifications are subject to change without notice. SLS, at its option, will repair or replace a Non-disposable Product that is found to be defective during the Warranty Period. Defective Non-disposable Products must be received at STARR Life Sciences Corp., 333 Allegheny Ave., Suite 300, Oakmont, PA 15139 no more than thirteen (13) months from the original date of shipment by SLS. All shipments must include a Return Authorization Number (RMA #), obtainable from SLS, and must be sent freight prepaid by the sender.

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