

BIOPAC SOP

DBIC Standard Operating Procedure for BIOPAC MP160

This manual describes standard operating procedures (SOP) for collecting physiological data during fMRI scanning at the Dartmouth Brain Imaging Center (DBIC) using the BIOPAC MP160 system. It is meant to serve both as an instructional guide and as a reference. However, it is not intended as a comprehensive tool for operator training. All users should have hands-on training in the DBIC scan suite prior to using the BIOPAC system.

For training on how to use the BIOPAC system and for technical support, contact:

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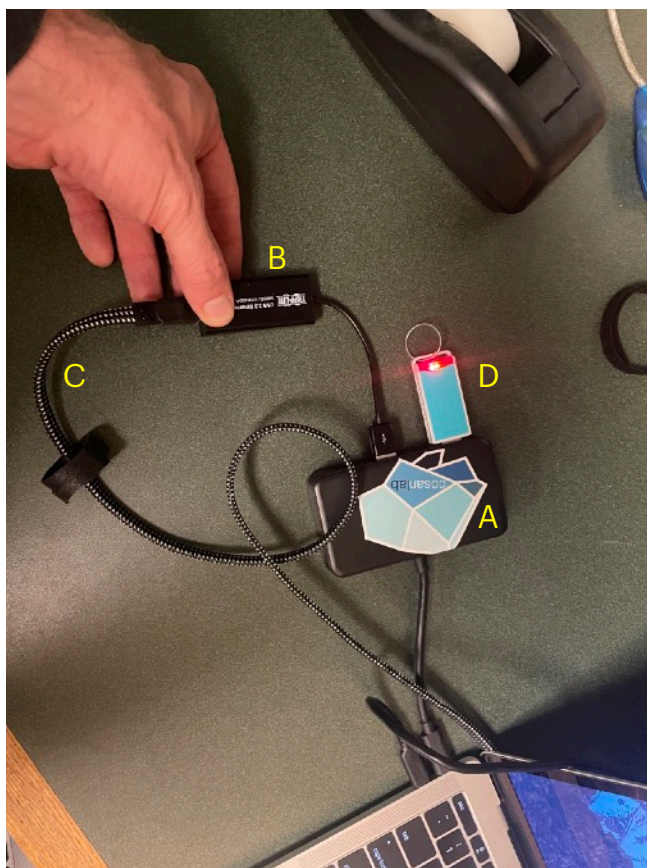
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1. Quick Start

This section provides a step-by-step overview of standard procedures for using the BIOPAC System.

Step 1: Connect the BIOPAC MacBook to the MP160

The software package called AcqKnowledge is used to collect data from the BIOPAC system. This software runs on the MacBook located in the cabinet at the far end of the MRI control room. Set the MacBook on the counter near the MP160 and plug in the power supply for the MacBook. There are two dongles needed to connect the MacBook to the MP160. One is a multi-connection adapter (A in image below) labeled with the Cosan-Lab logo. Plug this dongle into the MacBook. The other dongle is a simple ethernet-to-USB adapter (B). Plug the USB end of this dongle into one of the USB sockets on the first dongle. Then, connect the ethernet cable labeled "BIOPAC" (C) into the ethernet end of the adapter. This ethernet cable is connected to the back of the MP160, and it lives on a hook on the far wall. Finally connect the USB software license key (D) into the multi-connection adapter. When connected it should look something like this:



Next, turn on the MP160 (turn it off and on again if already on). After a few seconds a new ethernet connection should be established between the MacBook and the MP160. Check the network status on the laptop, and there should be a an active network interface with the ip address: 169.254.111.111

If you are having trouble getting this connection up and running, you can refer to the MP160 Communication trouble shooting guide and flow chart here:

<https://www.biopac.com/wp-content/uploads/Troubleshooting-MP160-Communications.pdf>

And here:

<https://www.biopac.com/knowledge-base/mp160-troubleshoot>

Step 2: Connect experimental computer to the LabJack

Your experiment computer (usually a lab or personal work laptop) also needs to communicate with the MP160 through the USB cable labeled “BIOPAC USB” which lives on a hook on the wall that faces the scanner room. This connection allows you to send digital markers into a recoding channel set up in AcqKnowledge so that your physiological data time-courses can be synced in time with your fMRI and behavioral data. This USB cable is connected to the red LabJack U3-LV device, which in turn is connected to the back of the STP100C isolated digital interface module. When the BIOPAC USB cable is connected, an LED on the LabJack will indicate that it is turned on as it gets power through the USB.

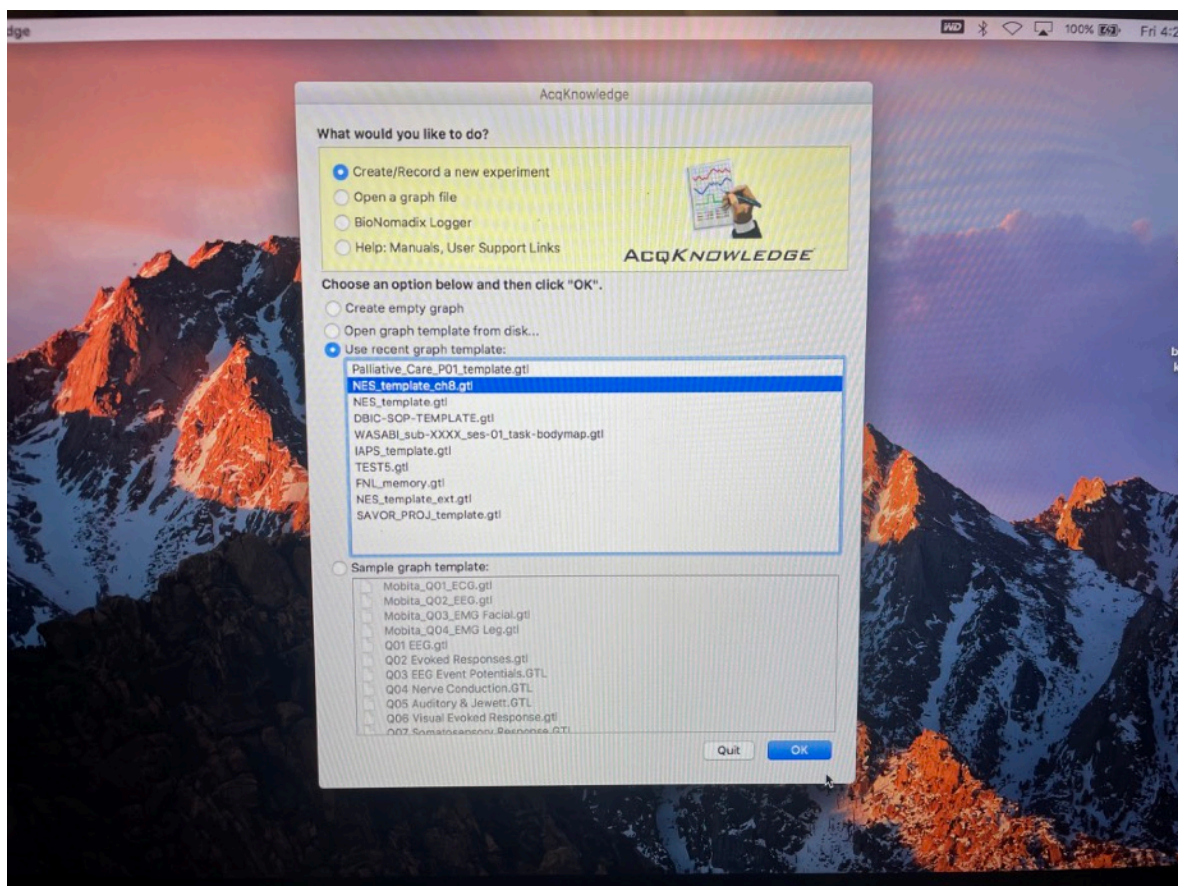
Regardless of what software you use to run your experiments, i.e. MATLAB PsychToolbox, PsychoPy, etc., your program must include code to communicate with LabJack. See the section below Coding for BIOPACK via LabJack U3-LV for an example in Python.

Step 3: Start a new recording session using AcqKnowledge

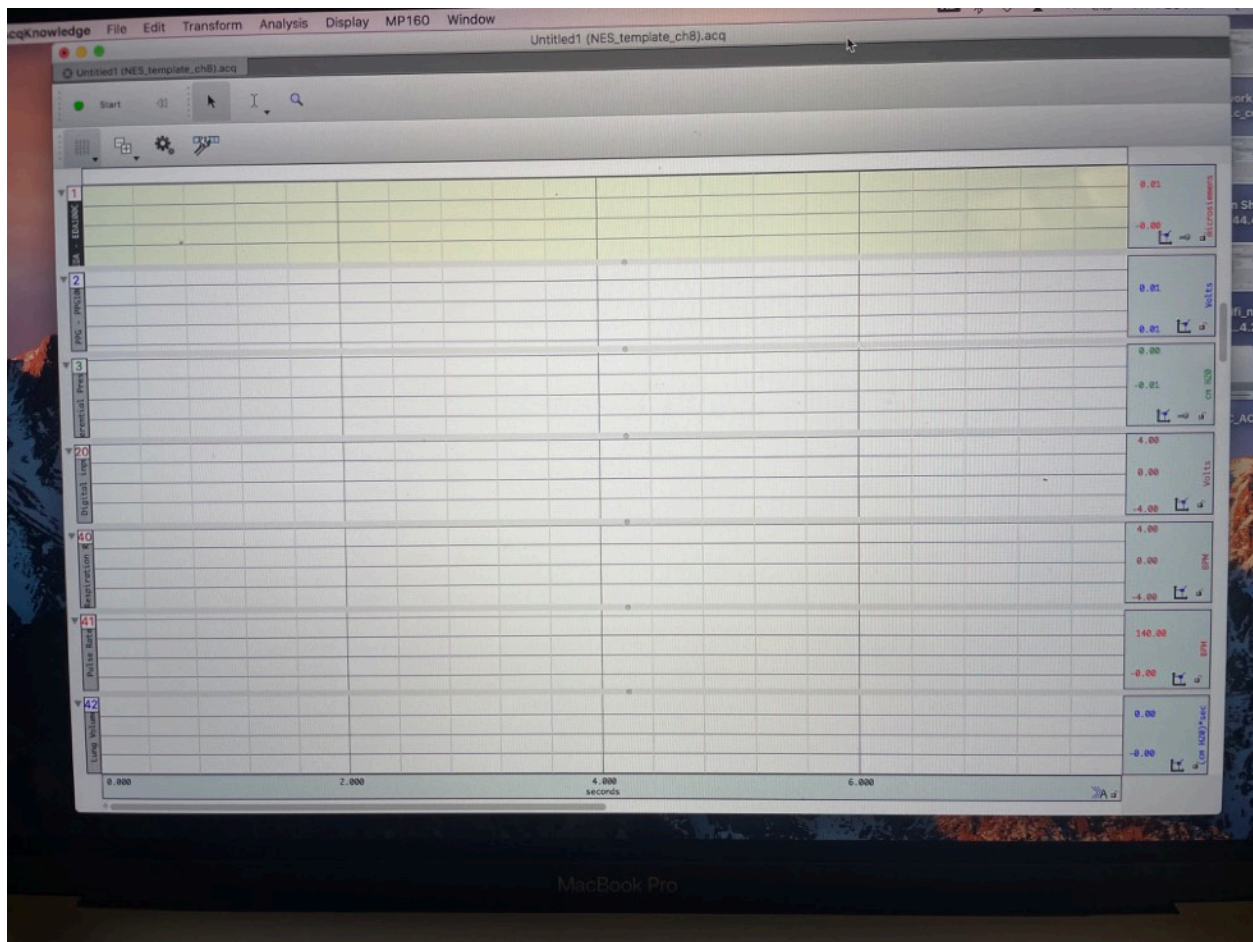
Once everything is connected, click on the AcqKnowledge icon on the dock at the bottom of the screen on the Macbook:



You will be prompted to start a new recording session (see screen shot below). Click the radio button to “Use recent graph template”. And then chose the template called “NES_template_ch8.gtl”. Click OK.

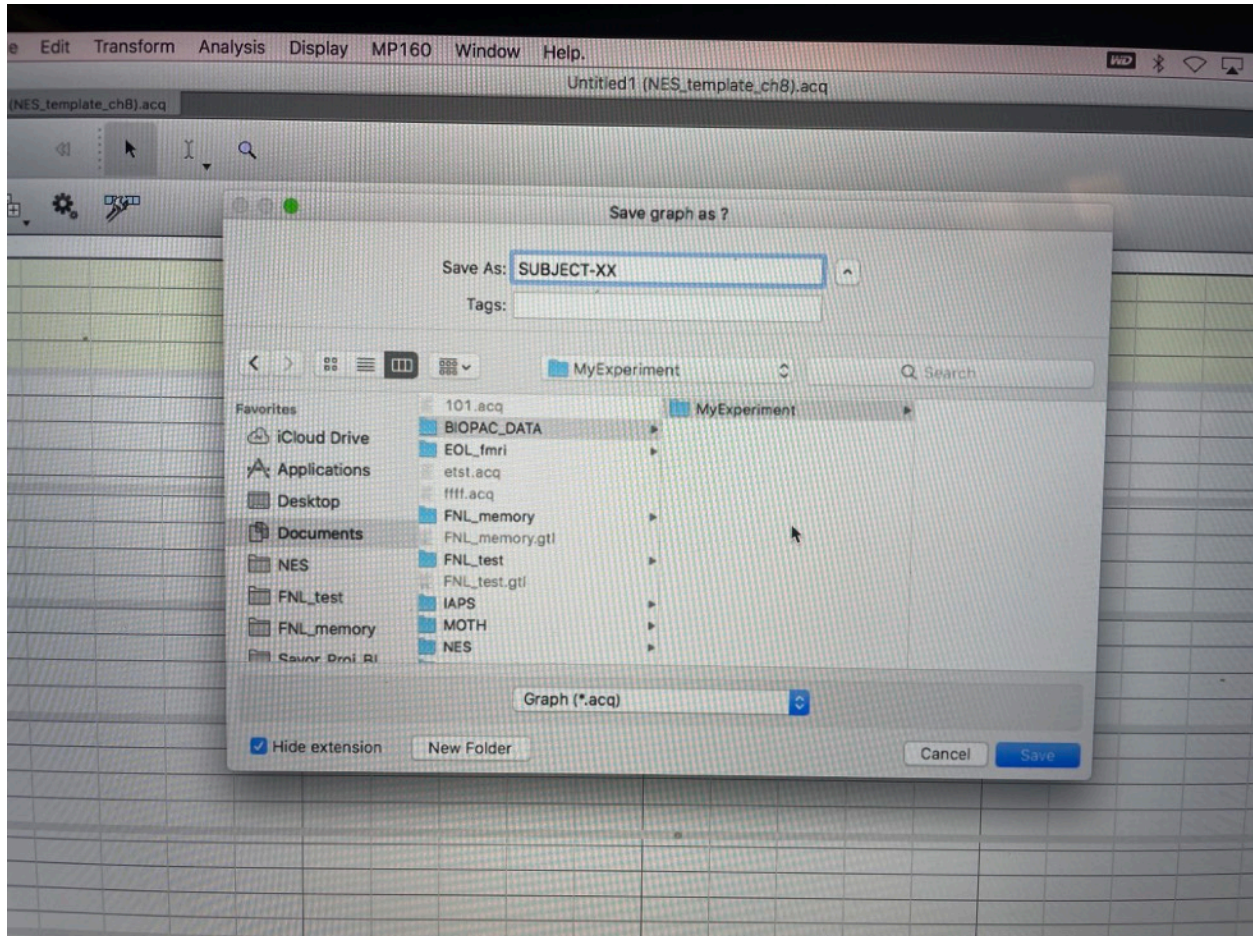


You should now see a new acquisition grid like this:



This grid has 7 channels labeled: 1, 2, 3, 20, 40, 41, 42. The first three channels collect the raw data from your subject. Channel 1 records electrodermal activity (EDA) from the EDA100C-MRI. Channel 2 records photoplethysmogram data from the PPG100C-MRI module for deriving pulse rate. And the Channel 3 records from the DA100C/TSD160A transducer for deriving respiration rate and lung volume. Channel 20 records digital input from the STP100C module for recording signals sent from your experiment laptop, which is needed for marking your data for timing synchronization. The last three channels — 40, 41, and 42 — show time-courses for respiration rate, pulse rate and lung volume derived from the raw data channels.

Before hitting the “Start” button at the top of the grid, choose File -> Save as ... Choose a name for your data (i.e., something that indicates the study name and subject ID), and a location to save the data to on the MacBook’s local hard drive:



Then click Save.

Step 4: Connect Subject to recording equipment

Connect your subject to recording equipment.

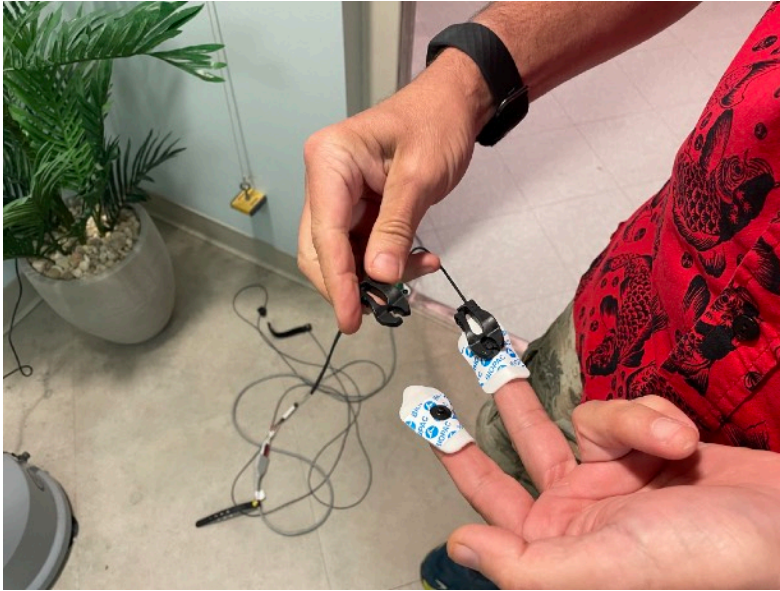
For recording electrodermal activity (“EDA”, also known as galvanic skin response or “GSR”), connect electrode contacts to two of the subjects’ fingers. To do this first apply contact gel to two fresh finger contact pads, like this:



Then attach the contacts to the subject’s fingers:



Next connect the wires to the contacts:



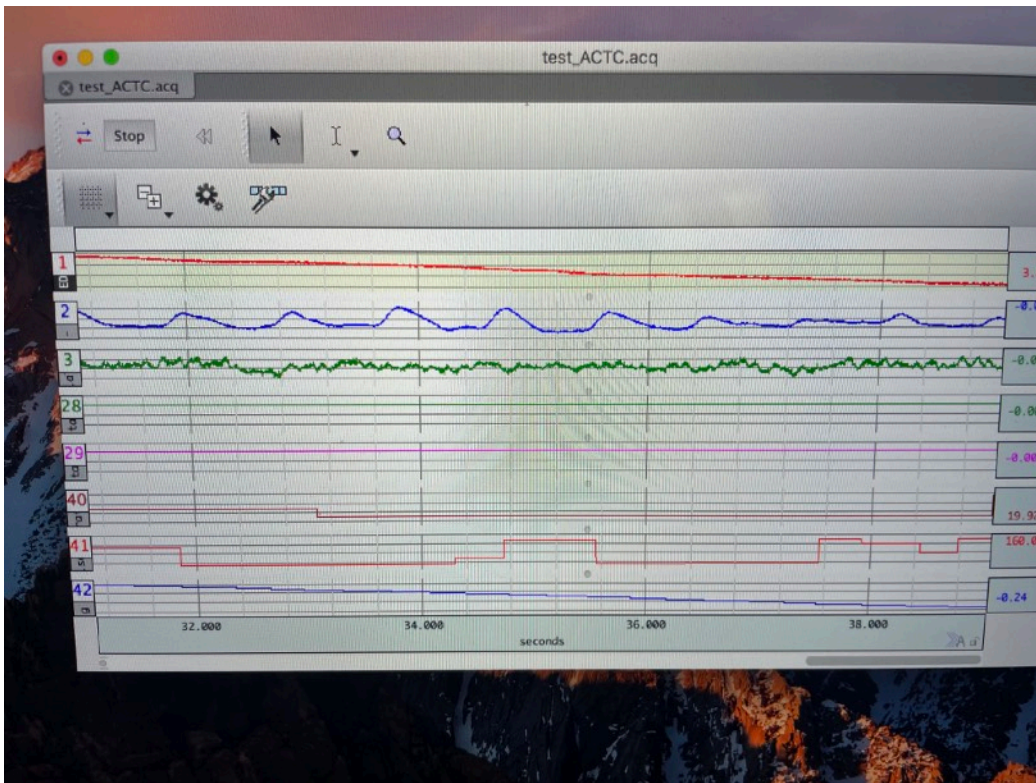
To connect the photoplethysmogram, connect a single finger contact like this:



If collecting respiration rate, connect the torso pressure cuff to the subject (photo not yet available).

Step 5: Run experiment and collect data

When everything is set up and your subject is connected to all equipment, press the “start” button on the AcqKnowledge recording grid. When you do this, you will notice that Channel 20 has disappeared from the grid and has been replaced by two new channels labelled 28 and 29:



This is strange but OK. These channels will be used to mark your data for start and stop times as controlled in your experiment program. Note however, to change the state of Channel 28, you will send signals of FIO20 and for Channel 29 you need to send signals to FIO21 (See coding example below). Once it's started, you can let the AcqKnowledge program run until the end of your session, i.e., the entire time the subject is in the scanner.

Run your fMRI session as usual. Press stop in AcqKnowledge when completed.

Step 6: Retrieve data and shut down BIOPAC

You can use a USB stick to get the data off of the MacBook. Exit all AcqKnowledge windows, return the MacBook to the cabinet along with its dongles, and then shut down the MP160 by pressing the power button on the back.

2. Coding for BIOPACK via LabJack U3-LV

In order to sync your physiological data with your MRI and behavioral data, your experimental code (i.e., MATLAB PTB or PsychoPy scripts that run your experiment) should send signals to the BIOPAC via the LabJack U3-LV device connected to the USB cable marked “BIOPAC USB” hanging on the wall behind the projector computer.

The Python package called u3 can be used to interface with the LabJack U3-LV. Conveniently, this package comes with PsychoPy, which can be installed using pip:

```
$ pip install psychopy
```

If you have a working version of Psychopy, then you can control the LabJack device by using something like the following:

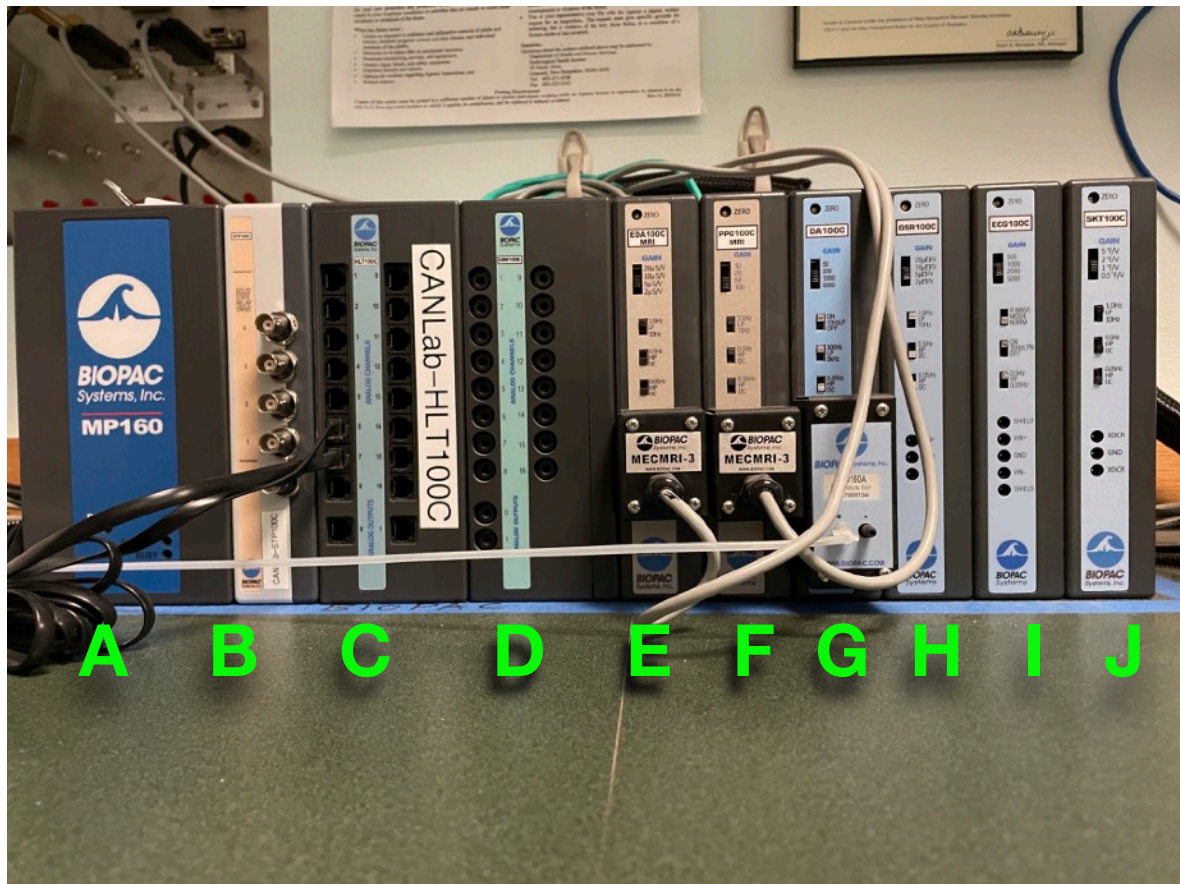
```
>>> import u3  
>>> labJ = u3.U3()
```

The U3 object labJ can be manipulated and configured to conform to your needs.

3. System Overview

The BIOPAC Systems MP160 installed in the scan suite currently supports simultaneous recording of skin conductance, pulse rate, and respiration rate.

This is a picture of the BIOPAC system in the control room:



The blue tape provides a designated home for the system. Operators should not arbitrarily move the BIOPAC system from this location for any reason other than maintenance or trouble shooting of the BIOPAC system itself. The BIOPAC system is free standing and can easily be slid forward to access the connections and switches on the back panels of the units. The system should always be returned to this home position after it is moved for any reason. It is important that the unit rest in the exact footprint of the blue tape and not be pushed back toward the wall. This is because there is equipment plugged-in to the back panels that could become damaged or disconnected if they were to come into contact with a massive object, such as a wall, with any significant kinetic force.

The system comprises ten horizontally interconnecting units labelled A through J. The unit A to the far left labelled “BIOPAC Systems MP160” is the central computing device necessary for the system to function. I will refer to this unit simply as the “MP160” when individuating it from the other components, but note that the phrase “MP160 System” — interchangeably with “BIOPAC” or “BIOPAC System” — might also refer to the entire collection of units as a whole. The three units immediately to the right of the MP160 support different types of input interfaces that allow for connecting arbitrary data collection devices as inputs to the system provided that compatible hardware and signaling have been configured. The six remaining units E through J are input modules each designed to collect different types of physiological data. Note that the first three modules (E, F, and G) have connections attached to their front panels. These connections are MRI-safe (non-ferrous) inputs from the scan room. The final three modules (H, I, and J) have no such connections and are not currently set up to receive any data.

The names and functions of each unit of the BIOPAC system are listed below.

A. MP160

This is the main component of the BIOPAC system. It coordinates all data from the other modules connected to it. Importantly, the MP160 unit needs to be turned on for the system to function. The “ON” state is indicated by the status of a green LED on the front panel, which is illuminated if the system is turned on.

The power button is on the rear panel of the MP160. Operators are responsible for turning the system on and off as required. The system should be turned off when not in use, and should be powered down at the completion of each data collection session.

B. STP100C Isolated Digital Interface

This module provides an interface for digital inputs and outputs. It is needed for for synchronization of the biophysical data to the other experimental data. The STP100C interfaces with a red LabJack U3-LV device which is connected to the parallel port on the back of the module. The LabJack device in turn connects the experiment computer (i.e., a laptop running your experiment software such as PsychoPy or MATLAB PsychToolbox) to the system via USB connection. Note that the connections to the back of the STP100C are wired by hand and are delicate. Please handle the BIOPAC system with care to avoid damaging these connections.

More details can be found here:

<https://www.biopac.com/wp-content/uploads/STP100C.pdf>

C. HLT100C High-level Transducer Interface

This module is used to interface high level output transducers to the MP160 system. It is currently used to interface with the Medoc heat and pain stimulator machine.

More details can be found here:

<https://www.biopac.com/wp-content/uploads/HLT100C.pdf>

D. UIM100C Universal Interface Module (for MP150)

This module is designed for use only with the previous BIOPAC version MP150, which was recently replaced by the MP160. This module is therefore obsolete and can be removed.

More here:

<https://www.biopac.com/wp-content/uploads/UIM100C.pdf>

E. EDA100C-MRI Electrodermal Activity Transducer Module

The EDA100C-MRI is for recording Electrodermal Activity (EDA), also known as Galvanic Skin Response (GSR). This MRI-compatible version of the EDA100C (link below) is part of the standard operating procedure use at DBIC for recording EDA. It requires that the experimental participant be attached to two contacts, usually one on each of two fingers (or toes?) of the same extremity.

For diagrams and more information see here:

<https://www.biopac.com/wp-content/uploads/EDA100C.pdf>

F. PPG100C-MRI Photoplethysmogram Amplifier

The PPG100C-MRI is for recording General Pulse Rate. It requires a single connection to the experimental participant's finger.

More here:

<https://www.biopac.com/wp-content/uploads/PPG100C.pdf>

G. DA100C with TSD160A High Sensitivity Differential Pressure Transducer

This module is configured to record breathing rate measured using a pressure cuff that attaches around the subject's torso. See:

<https://www.biopac.com/wp-content/uploads/TSD160-Series.pdf>

<https://www.biopac.com/wp-content/uploads/DA100C.pdf>

H. GSR100C

This module is not currently configured for use, and might be removed. It is for recording GSR in a non-MRI environment and is unnecessary because we have the EDA100C-MRI.

<https://www.biopac.com/wp-content/uploads/GSR100C.pdf>

I. ECG100C

This module is for recording Electrocardiograms, but it is not currently configured for use. More info:

<https://www.biopac.com/wp-content/uploads/ECG100C.pdf>

J. SKT100C

This module is for recording skin temperature, but it is not currently configured.

<https://www.biopac.com/wp-content/uploads/SKT100C.pdf>