CFMRI Physiological Monitoring System (BIOPAC)

Operator's Manual

This manual provides a quick guidance to using the BIOPAC physiological monitoring system during MRI. It is not intended as a substitute for training. All users are required to attend a training session in order to use the physiological monitoring system.

Safety Precautions

Cables and lead wires (MRI compatible) can cause patient heating or burn if not used properly. To minimize the risk of RF current burn:
- **Place cables and lead wires neatly in straight alignment with no looping.**
- **Keep the length of lead wires and patient cable within the bore to a minimum.**

Never use custom wire or leads that are not inspected for MRI safety. Contact Kun Lu (kunlu@ucsd.edu) for an MRI safety check of equipment.

Introduction

At 3.0 Tesla, physiological noise exceeds other sources of noise such as thermal noise. In addition, it has been shown that physiological noise is significantly greater in cortical gray matter than white matter[1]. Therefore, physiological noise estimation and correction are often desired for functional MRI (fMRI) data analysis. At the Center for fMRI (CFMRI), we provide a BIOPAC physiological monitoring system that can accurately monitor a subject's physiological parameters, including Pulse (PPG), CO_2 and respiratory effort.

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[1] Kruger et al MRM 46:631-637 (2001)

The BIOPAC physiological monitoring system is located in the lower cabinet next to the scanner console table in the control room. The system consists of the following functional modules (Figure 1):

- **IPS100C Power Module**
  Supplies power to the attached amplifiers modules.
- **PPG100C module**
  Amplifier module for measuring pulse waveform. Requires a BIOPAC TSD200 pulse plethysmogram transducer (not supplied).
- **CO2100C module**
  Amplifier module for measuring CO_2 waveform. Requires a nasal cannula or face mask assembly with standard male Leur connectors (not supplied).
- **RSP100C module**
  Amplifier module for measuring respiratory effort via chest expansion. Requires a BIOPAC TSD201 respiration effort transducer (not supplied).
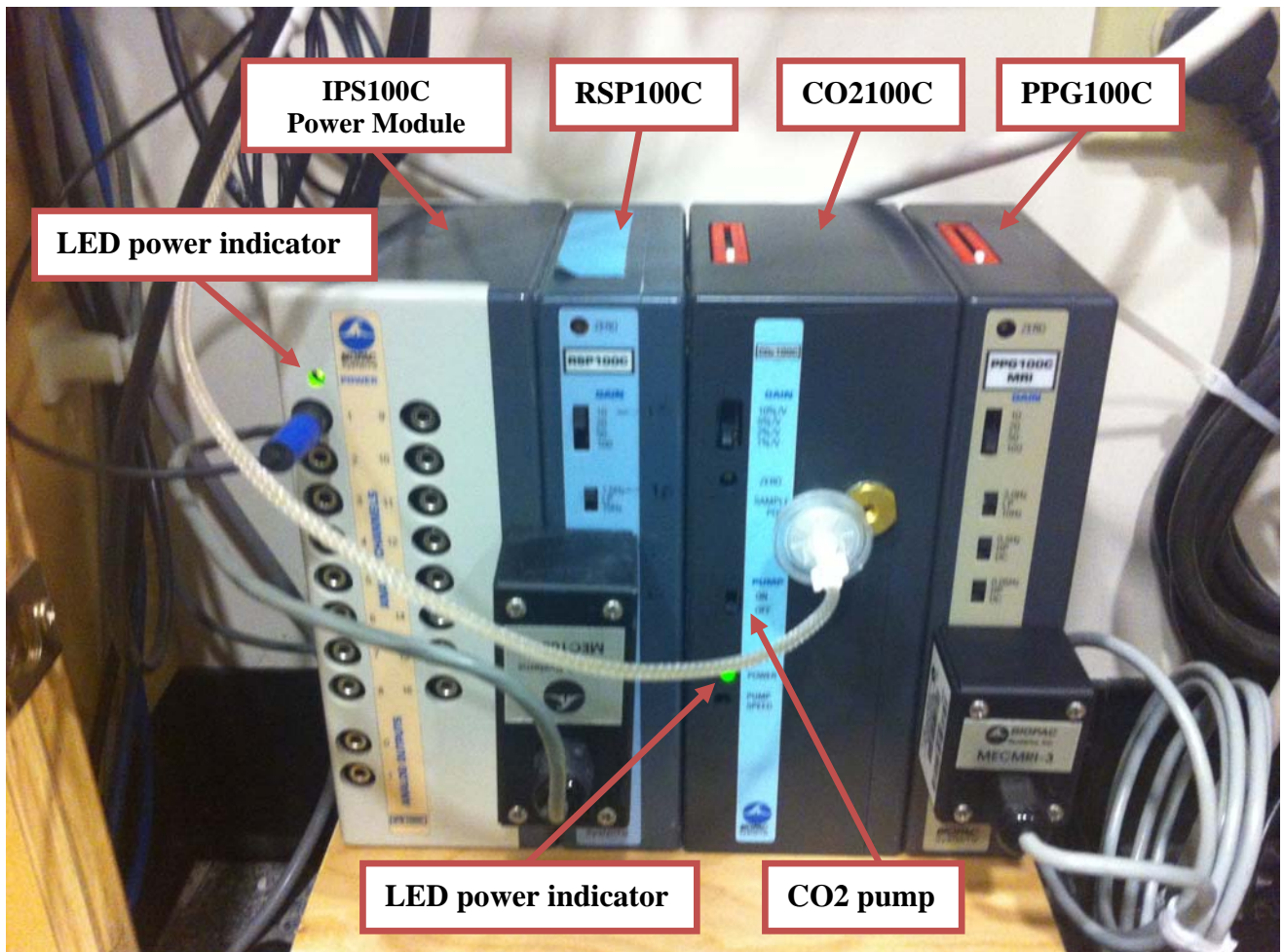

Figure 1: CFMRI BIOPAC Physiological Monitoring System

Preparing for Physiological Monitoring

Follow the steps below to prepare for physiological monitoring:

1. **Make sure that the green LED light on the ISP100C power module is ON.**

   If not, check if the power module is correctly plugged into a power source.

2. **Setting up the PPG transducer (as needed)**

- Remove the PPG cable from the wall mount inside the magnet room and extend it to near the patient table. Connect the PPG transducer by plugging in the three color-coded leads to the socket end of the cable (see Figure 2):

red lead → **VIN+ port**
black lead → **GND port**
blue lead → **VIN- port**

Figure 2. PPG cable lead connection

- Place the transducer on the finger (e.g., index finger tip) and tighten the Velcro strap (Figure 3).To minimize motion artifact, place the sensor on a hand that will remain mostly immobile.
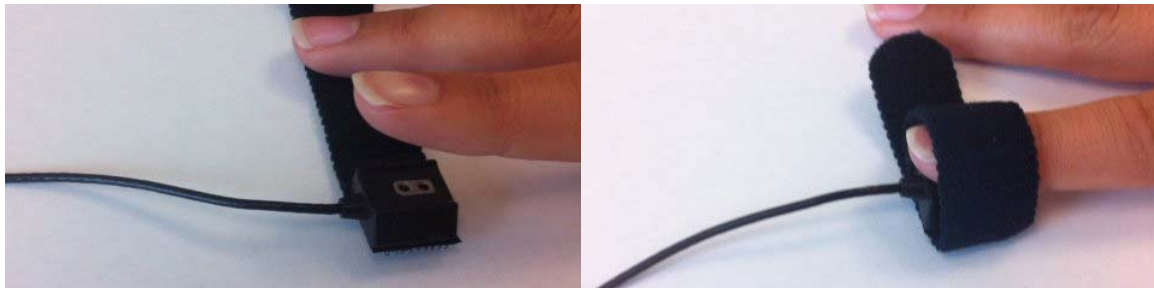

Figure 3. Attaching PPG Transducer

- Check the tension level. If the strap is too tight, blood flow may be constricted, resulting in a flat signal. If the strap is too loose, ambient light could enter the sensor, resulting in a noisy waveform.

3. **Setting up the CO2 sampling line (as needed)**

- Make sure the green LED light on the CO2100C module is ON (See Figure 1). If not, plug in the attached power adapter to a wall outlet.

- Turn the CO2 pump switch ON (see Figure 1, Remember to turn the pump OFF after done!). You should hear a low humming from the box, indicating that the pump is working. DO NOT change any other switch settings on the module.

- Remove the extension CO2 sampling tube from the wall mount inside the magnet room and place it to near the patient table. The sampling tube has a standard male Leur connector and can be connected with a nasal cannula or a face mask assembly. Be sure to attach a 5 micron filter at the connection (Figure 4).

Figure 4. Moisture filter

- Place the nasal pieces gently inside the patient's nose, loop the excess tubing over the patient's ear and then down under the chin.

- Check the EtCO2 readings on the computer screen.

4. **Set up the respiratory effort transducer (as needed).**

- Remove the RESP cable from the wall mount and extend it to near the patient table. Connect the respiratory effort transducer to the socket end of the cable (Figure 5):

Figure 5. RESP cable lead connection

- While the patient is in sitting up position, place the belt around the patient's lower rib cage (approximately the 10th rib). Make sure the sensor buckle is in front of the patient (Figure 6). Adjust the belt so that it feels snug with enough room to fit a finger under the belt.

- Instruct the patient to lay down in supine position and breathe quietly.

Figure 6. Respiratory belt placement

5. **Inspect the positioning of all the cables**
   Arrange the cables in straight alignment with the scanner bore with no kinks or loops and avoid risks of any cable being caught during bed movement.

Collect Physiological Data

You should have logged into the physiological monitoring computer and opened the physio.vi application as shown in Figure 7. Follow the steps below to start acquiring physiological data.

Notes: You are recommended to start an acquisition right before each scan starts, and stop right after the scan finishes. Remember to specify a new Subject ID for each scan so that the previously saved file will not be overwritten.

If you prefer to leave the data acquisition on for multiple scans, you will have large output files, which will need to be parsed into individual scans for post-processing. We provide MATLAB programs for parsing such large files.
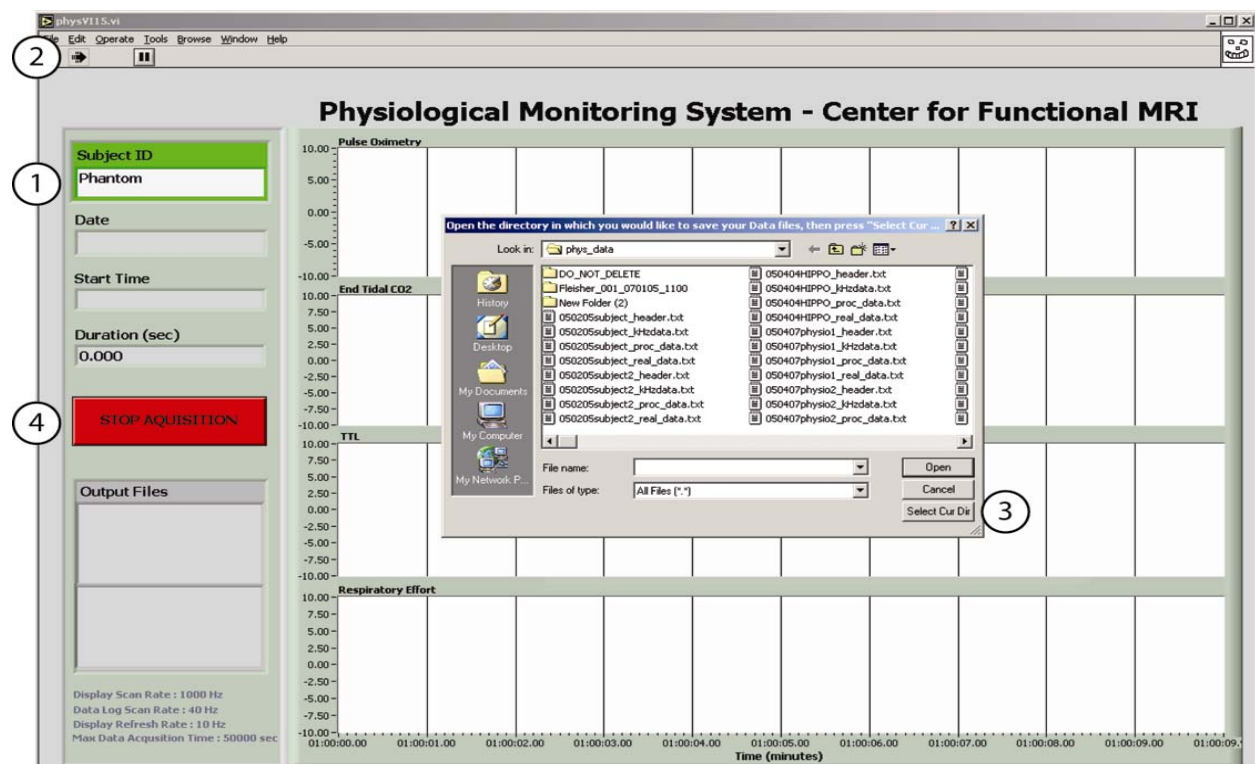

Figure 7. Physio.vi screen shot

1. Type in a Subject ID (the default name is "phantom").

2. Click ⇨ to start data acquisition.

3. In the pop-up window, select a desired folder where you want to save the data files and click "**Select Cur Dir**" button (The default folder is "phys_data" located on the desktop of the computer). Data acquisition should start now.

4. To stop data acquisition, press **STOP ACQUISITION** button

5

Transfer Data and Clean Up

Congratulations. You have now successfully collected physiological data during an MRI scan. However before you leave, please make sure to:

1. Transfer data

   - The name and location of the data files are displayed on the screen. File "*prefix_real_data.txt*" contains physiological data sampled at 40Hz; File "*prefix_kHzdata.txt*" *contains* TTL signal sampled at 1KHz.

   - The physiological monitoring computer is equipped with Secure SSH and a CD-R/W drive for data transferring purpose. <u>No retrieval of data is guaranteed after the user has left the scanner.</u>

2. Clean up

   - <u>Turn OFF the CO2 pump</u> in the CO2100C module if you have used the module. Continuous running of the pump at high speed may damage the pump.

   - The physiological monitoring system consists of many cables and sensor wires and requires extra attention to keep things neat and organized. Please wind up all the cables and hang them on the corresponding wall mounts. Collect all the accessories, including wires, leads, belts, gel and pads and stow them in the cupboards or other proper locations. <u>Failure to do so will result in suspension of the privilege to use the physiological monitoring system.</u>

   - Use the problem report button on the web scheduling page to report any problems or suggestions you may have using the system. THANK YOU!

For questions about this manual, please contact Kun Lu (kunlu@ucsd.edu). 08/01/2013

Appendix: Ordering Information for Supplies

The following supplies are not provided by CFMRI. Groups who need them can purchase from the following vendors:

Product Name: **Pulse Plethysmogram Transducer**
Product ID: TSD 200
Vendor: www.BIOPAC.com

Product Name: **Respiratory Effort Transducer**
Product ID: TSD 201
Vendor: www.BIOPAC.com

Product Name: **Adult Nasal CO2 Sampling Cannula**
　　　　　　　(Cannula CO2 7' Sampling Line)
Manufacture: SALTER LABS
Manufacture Part number: 4007 (male Luer connector with filter)
Supplier Part number: 000834554-CS
Supplier: Professional Hospital Supply, Inc (PHS)
　　　　　41980 Winchester Road
　　　　　Temecula, CA 92590 US
　　　　　Telephone: 1(800)944-3195
　　　　　Fax: 1(951)296-2626
　　　　　www.phsyes.com