

MYOGRAPH SYSTEM - 840MD

USER MANUAL, VOL. 3.0



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SAFETY

The 840MD has been designed for use only in teaching and research applications. It is not intended for clinical or critical life-care use and should never be used for these purposes; nor for the prevention, diagnosis, curing, treatment, or alleviation of disease, injury, or handicap.



CAUTION:

- *DO NOT OPEN THE UNIT: THE INTERNAL ELECTRONICS POSE A RISK OF ELECTRIC SHOCK.*
- *DO NOT USE THIS APPARATUS NEAR WATER.*
- *TO REDUCE THE RISK OF FIRE OR ELECTRIC SHOCK, DO NOT EXPOSE THIS APPARATUS TO RAIN OR MOISTURE. OBJECTS FILLED WITH LIQUIDS SHOULD NOT BE PLACED ON THE APPARATUS.*
- *DO NOT BLOCK ANY VENTILATION OPENINGS. INSTALL IN ACCORDANCE WITH THE MANUFACTURER'S INSTRUCTIONS.*
- *ONLY USE SECURE INDUSTRY STANDARD CONNECTORS AND TUBING FOR PRESSURE CONNECTIONS. FAULTS, DEFECTS AND MISTAKES DUE TO WRONG CONNECTIONS VOID WARRANTY. WE ARE NOT LIABLE FOR ERRORS AND MISTAKES DUE TO INAPPROPRIATE PRESSURE CONNECTION.*
- *DO NOT INSTALL NEAR ANY HEAT SOURCES SUCH AS RADIATORS, HEAT REGISTERS, STOVES, OR ANY OTHER APPARATUS THAT PRODUCES HEAT.*
- *ONLY USE ATTACHMENTS AND ACCESSORIES SPECIFIED BY THE MANUFACTURER.*
- *UNPLUG THIS APPARATUS DURING LIGHTNING STORMS OR WHEN UNUSED FOR LONG PERIODS OF TIME.*

The 840MD is delivered with an external 100-240V AC to 24V DC ADAPTER. Protect the power ADAPTER and cord from being walked on or pinched. Particularly at power plugs and at the point where they connect to the apparatus.

Refer all servicing to qualified service personnel. Servicing is required when the apparatus has been damaged in any way, including: the power-supply cord or plug being damaged, liquid spilling onto or objects falling into the apparatus, exposure to rain or moisture, abnormal operation, or the unit being dropped.

EC DECLARATION OF CONFORMITY

DMT A/S

Certify and declare that the following apparatus:

MYODYNAMICS MUSCLE STRIP MYOGRAPH SYSTEM - MODEL 840MD

Restrictive use: Only for laboratory use.

Manufactured by:

DMT A/S

Rho 14

DK-8382 Hinnerup

Denmark

Conforms with the essential requirements of the EMC Directive 2004/108/EC.

Based on the following specifications applied by:

EN 61326-1:2006

EN 61326-2-6:2006

EN 61326-2-6/Corr.:2007

And with the LVD Directive 2006/95/EC. Based on the following specifications applied by:

EN 61010-1:2010

EN 61010-2-030:2010

General warnings regarding EMC:

Do not use this device near sources of strong electromagnetic radiation (e.g. unshielded intentional RF sources), as these may interfere with the proper operation.

CHAPTER 1 - SYSTEM OVERVIEW

1.1 INTERFACE

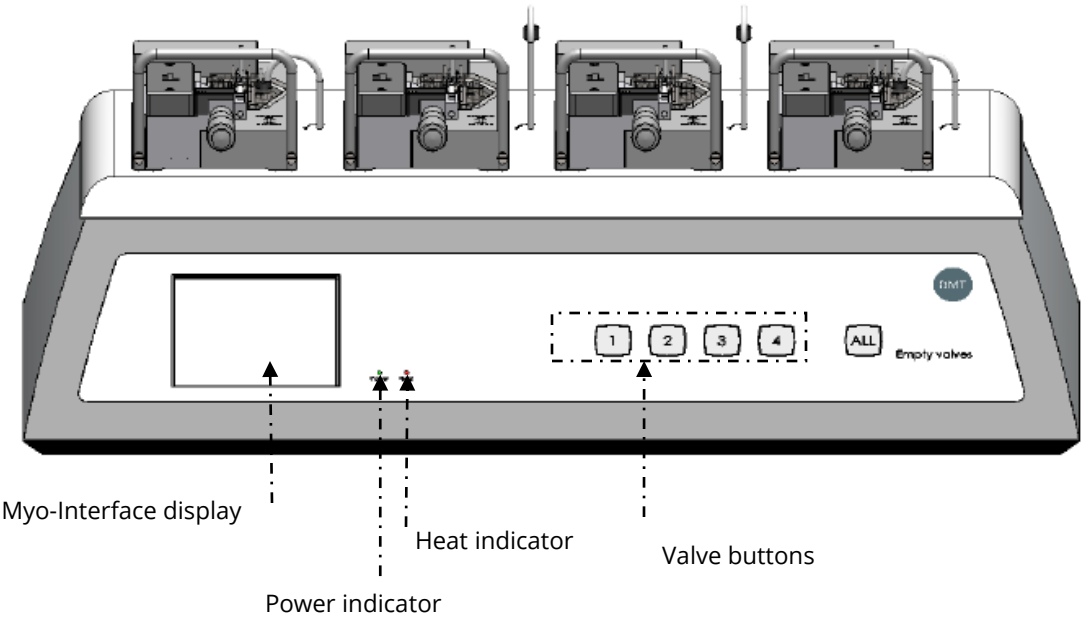


Figure 1.1 Interface Front Panel

1.2 INTERFACE REAR PANEL

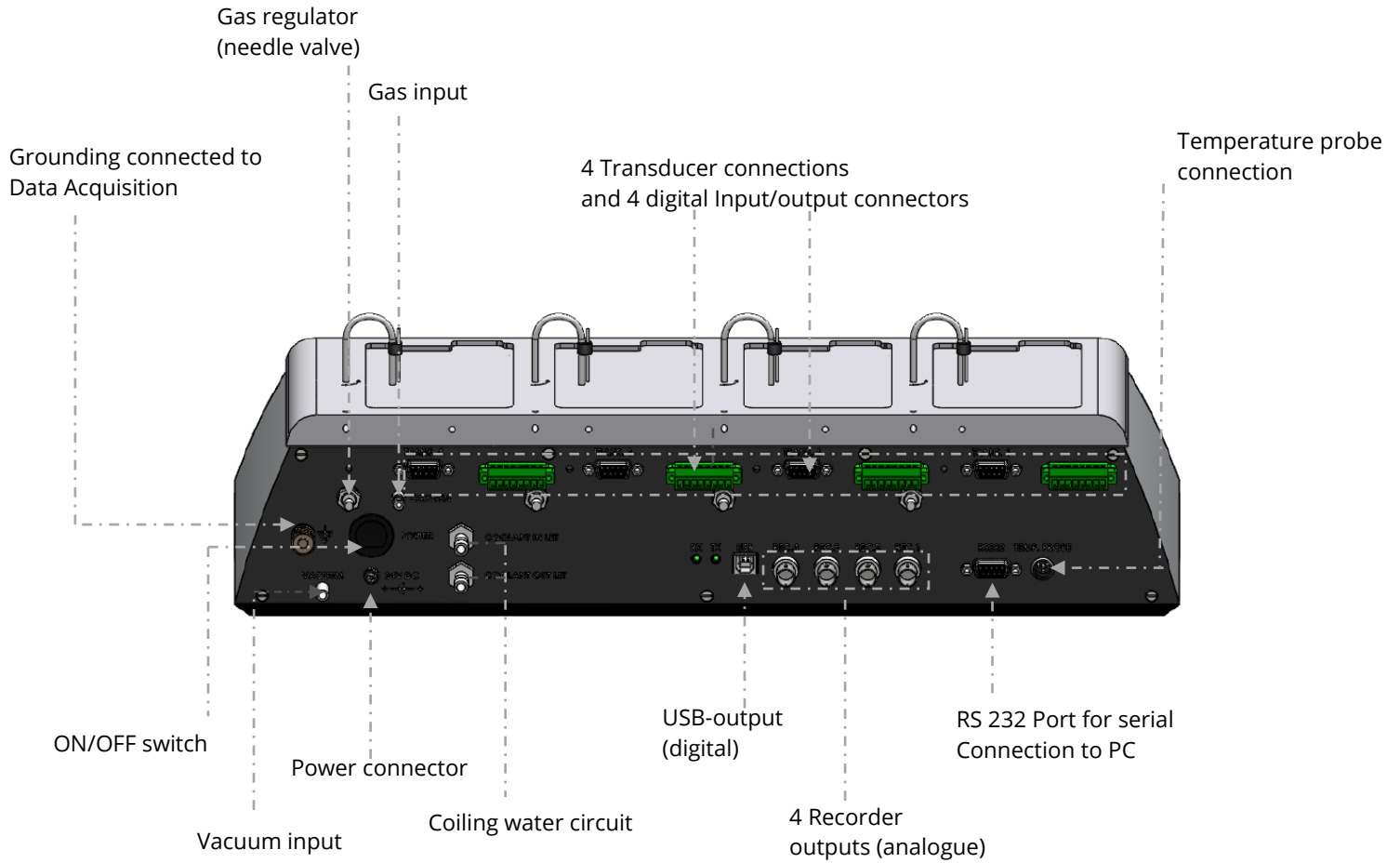


Figure 1.2 Interface Rear Panel

1.3 MYODYNAMICS MUSCLE STRIP MYOGRAPH - 840MD

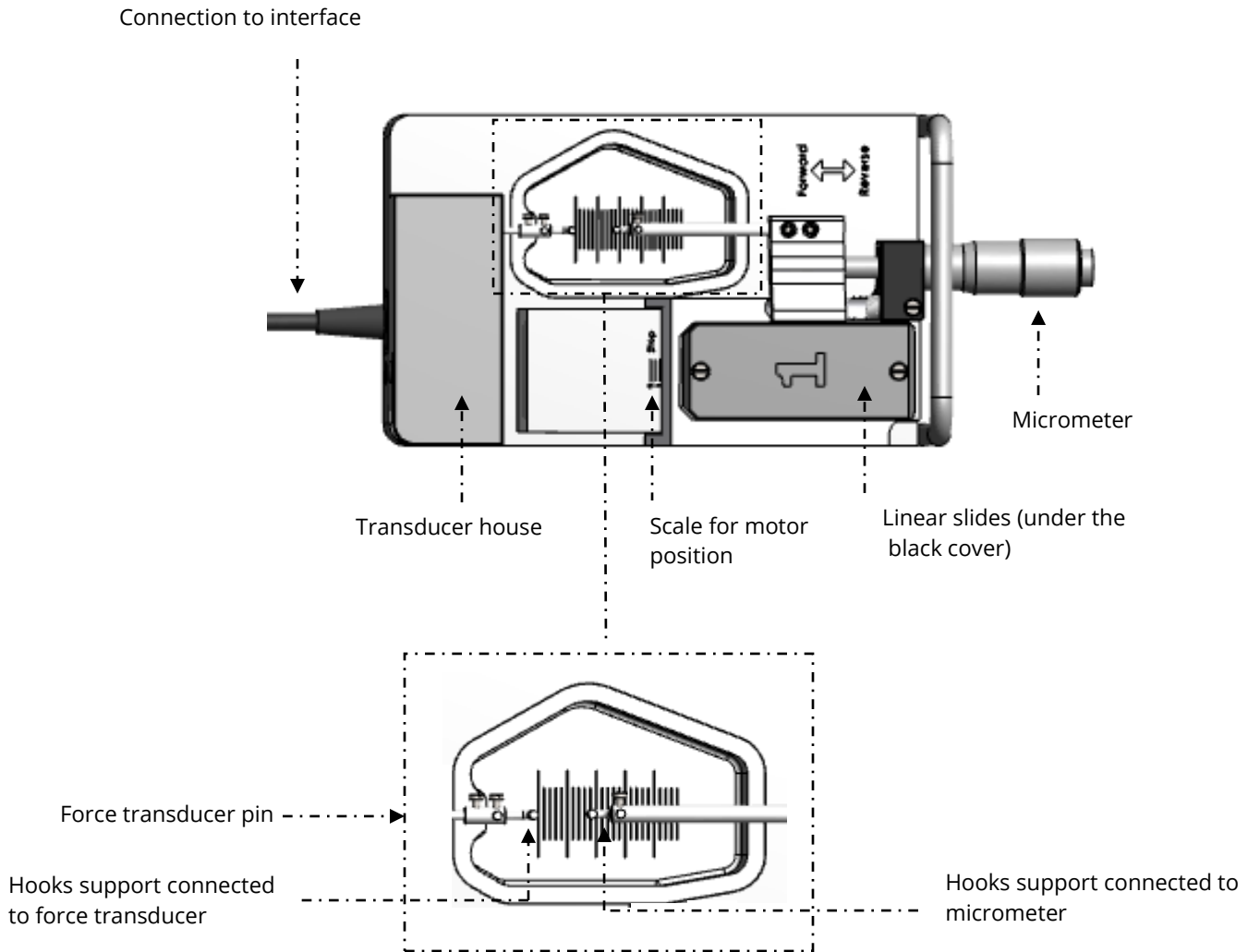


Figure 1.3 MyoDynamics Muscle Strip Myograph - 840MD with close-up of the chamber

CHAPTER 2 - SETTING UP

2.1 SETTING UP THE MYODYNAMICS MUSCLE STRIP MYOGRAPH SYSTEM - 840MD

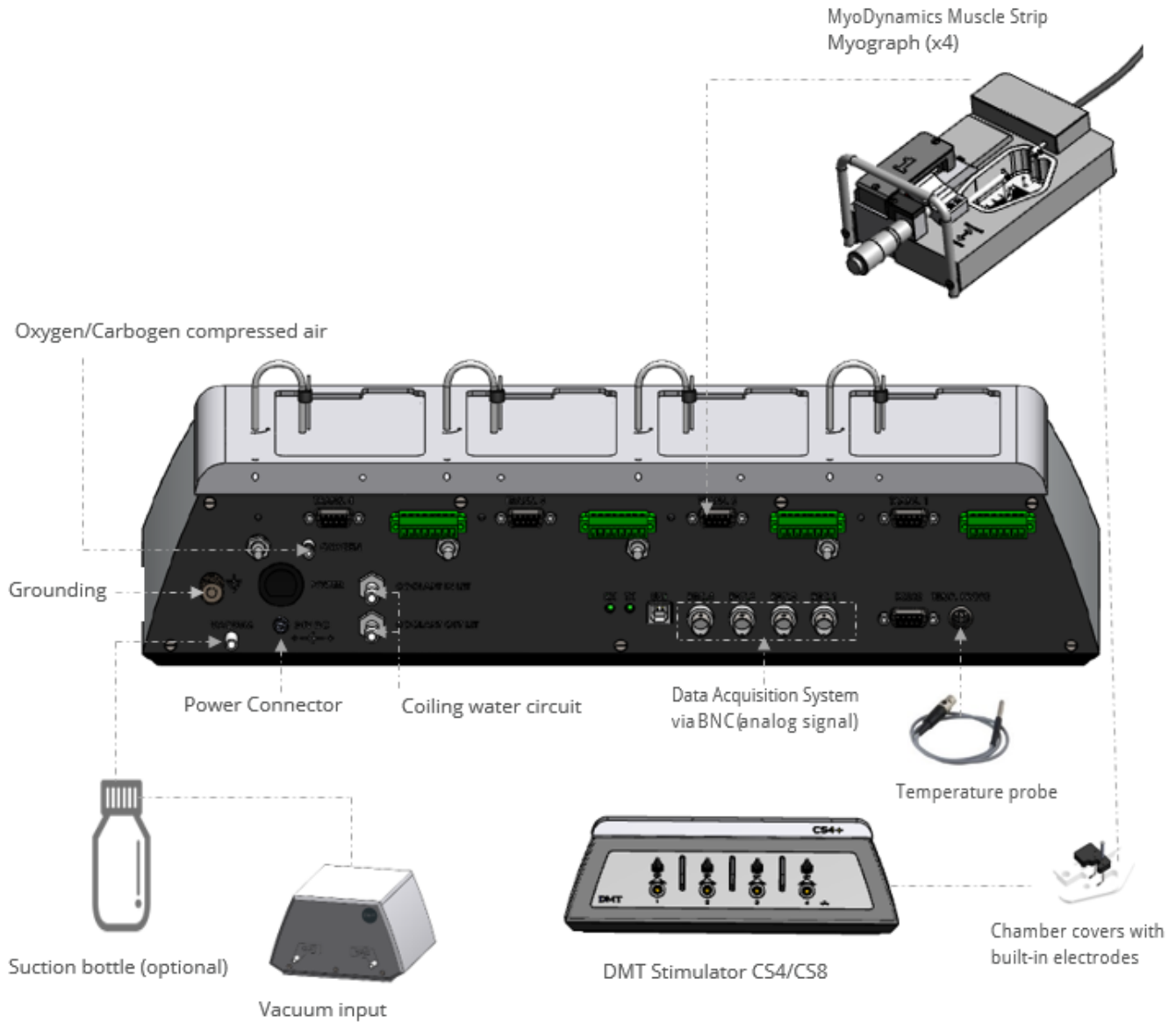


Figure 2.1 Example of complete set-up - MyoDynamics Muscle Strip Myograph System - 840MD

1. Interface – Computer Connection:

Data acquisition is possible by connecting the Interface through a PowerLab data acquisition or similar system (optional).

Connect the Interface to the PowerLab unit using BNC cables. Connect Rec 1 on the Interface to Input 1 on the Power Lab, Rec 2 to Input 2 etc. Connect the PowerLab unit to one of the USB-ports on the computer using the USB cable delivered with the PowerLab system. Follow the “DMT Quick-Start Guide” provided with the PowerLab system to install the PowerLab driver and Chart software on the computer.

2. Oxygen Supply:

Connect the gas supply (95% O₂, 5% CO₂ or 21% O₂, 5% CO₂, balance N₂) with tubing running from the gas supply to the gas inlet marked “OXYGEN” on the back of the Interface. Oxygen is supplied to the chambers by tubing attached to the stainless steel vacuum pipe. The oxygen and vacuum tubing need to be inserted into the chamber to aerate the heated buffer and emptying the chambers respectively. Needle valves on the back of the interface can be adjusted to regulate the amount of bubbling that occurs. Turning the regulator clockwise increases the bubbling while turning it counter-clockwise decreases the bubbling. Each regulator has a lock device attached that can be used when the desired bubbling is achieved (see figure 2.2).

NOTE: THE NEEDLE VALVES NEED TO BE GREASED (USING THE GREASE FOR THE LINEAR SLIDES) AND TURNED AT REGULAR INTERVALS TO PREVENT THEM FROM STICKING OR PERMANENTLY FREEZING.

3. Vacuum Connection:

The system has a built-in manifold with separate valves that allows each chamber to be drained individually. After connecting the vacuum source at the back of the Interface, the vacuum pipes need to be inserted into the chambers for this feature to work properly. The pipes are inserted into the chamber by gently pulling up on the curved part of the pipe, turning it 90° counter-clockwise and gently lowering it into the chamber (see figure 2.2 below). A chamber can then be emptied by pressing the corresponding numbered button on the Interface. Pressing the ALL button at the Interface will empty all the chambers at the same time.

NOTE: WHEN DRAINING THE CHAMBERS USING THE AUTOMATIC VACUUM FUNCTION, PRESS THE APPROPRIATE BUTTON FOR AN ADDITIONAL 3-5 SECONDS AFTER INITIAL EMPTYING. THIS WILL HELP DRAIN RESIDUAL BUFFER AND SOLUTIONS RETAINED IN THE TUBING AND VALVES.

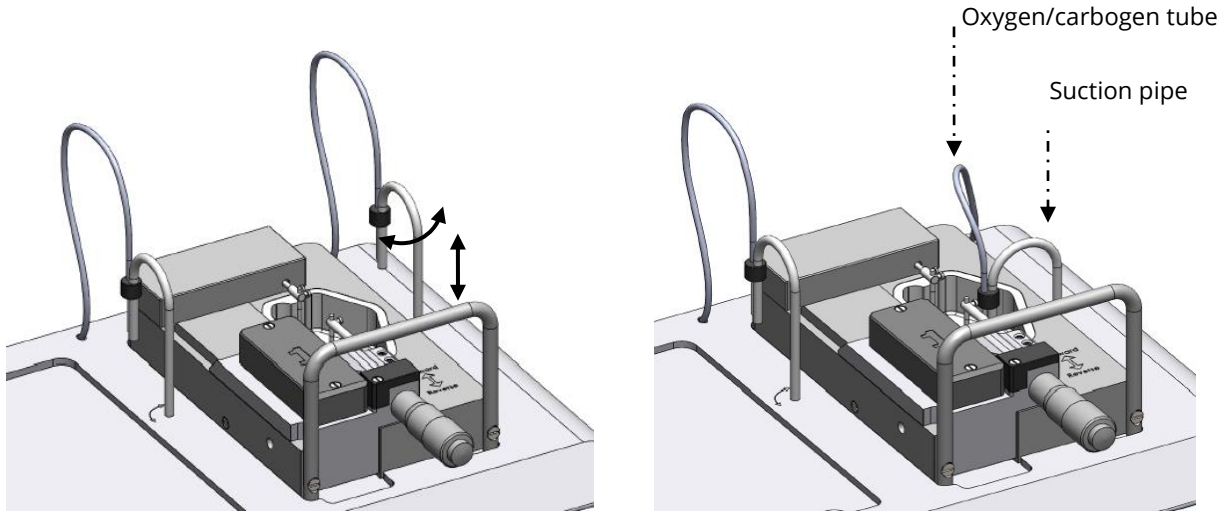


Figure 2.2- Pipes for oxygen supply and suction connection - pipes up (left), pipes down (right)

4. Chamber Covers (optional)

The chamber covers will help maintain the temperature and other buffer conditions (gas tension, pH) fairly constant. Holes in the chamber covers serve different purposes, and they are illustrated in the figure 2.3 below. The slots allow the covers to be placed over the chamber around the support arms and gas/vacuum tubes. The stimulation electrodes are built into the chamber cover and can be used to activate the muscle via field stimulation.

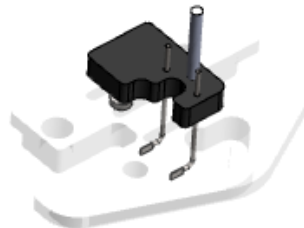


Figure 2.3 - Chamber cover with built-in electrodes for 84UMU (optional)

2.2 THE FIRST FORCE CALIBRATION

Prior to shipping the MyoDynamics Muscle Strip Myograph System is subjected to two days of continuous testing, including a final force calibration. However, DMT recommends that a new force calibration is performed before using the myograph system for the first time. The force calibration procedure is described in detail in chapter 3.6.1.

CHAPTER 3 - EXPERIMENTAL SET-UP

This chapter contains a detailed description of how to navigate the touch screen menus and how to use the special features of the Multi Interface.

3.1 GENERAL DESCRIPTION OF HOW TO NAVIGATE THE TOUCH SCREEN

Menus on the Interface are all accessible by a touch screen. To access a menu, simply touch the screen. When a setting needs to be changed, press SELECT beside the line to be changed.



The line to be modified will turn blue, indicating that the Interface is waiting for input. When ALL is chosen, all lines corresponding to all four channels will turn blue.



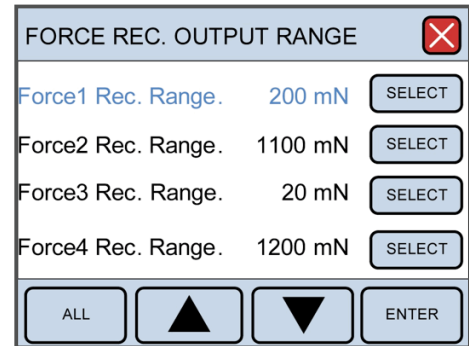
Changing the numeric value for the chosen parameter can be done by touching UP or DOWN arrows.



Once the desired setting has been chosen, pressing ENTER will lock the selection and be stored in memory.



Pressing the white X in the red box will exit the menu and take you automatically to the Actual Force display.



3.2 POWER-UP SCREEN

After turning on the Interface, an introduction screen appears. It displays the product system, model no., software version number, date and the system ID number.

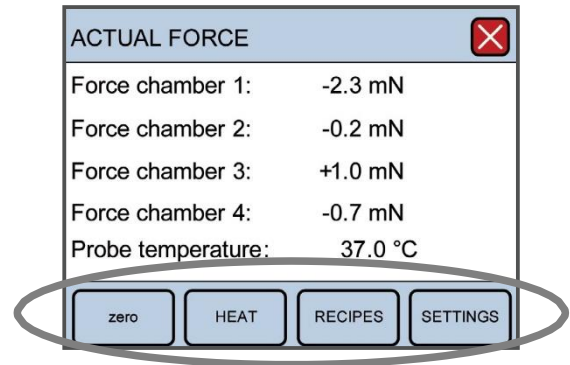
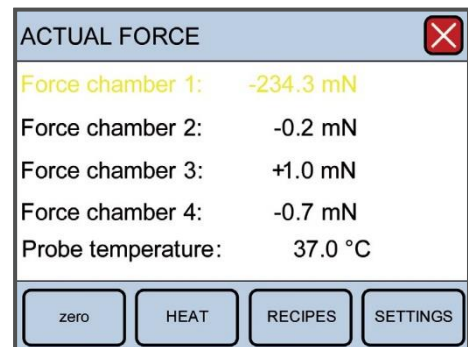
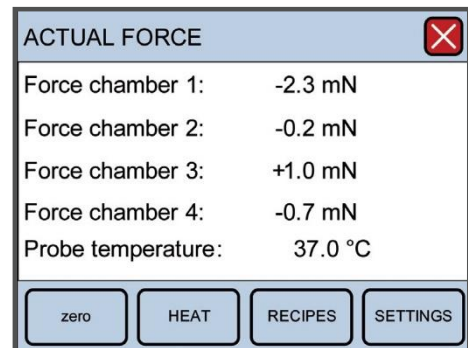
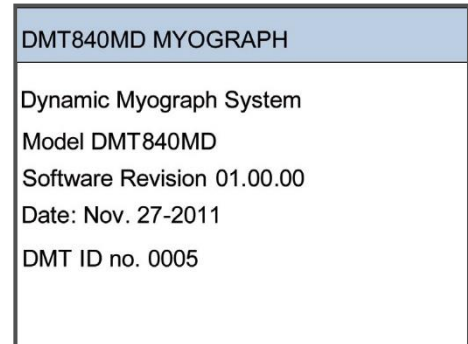
The system is auto-initializing while this screen is displayed.

After a few seconds, the Actual Force display will appear.

At any given time, if the force applied on any channel is out of range, the force reading for the overloaded channel will turn yellow as a warning.

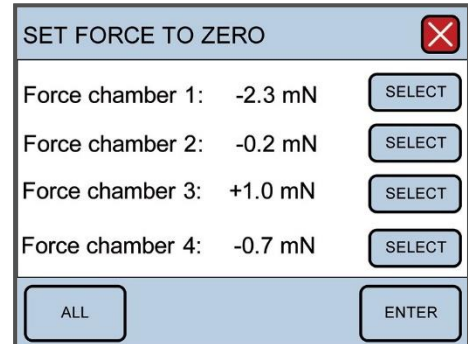
Three menus are accessible from the default Actual Force display. These menus are:

- Zero Menu
- Heat Menu
- Protocols Menu
- Settings Menu



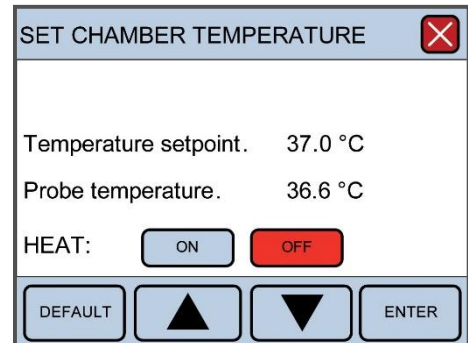
3.3 ZERO MENU

This menu is used to zero the output of the transducers. When using a data acquisition program like LabChart by AD Instruments®, this feature will reset the baseline of the chart traces without affecting the calibrations or physically changing any pre-load tensions placed on the mounted vessels. The channels can be changed individually by pressing SELECT or all at once by pressing ALL. Pressing ENTER will execute the zero function and return the user to the Actual Force display.

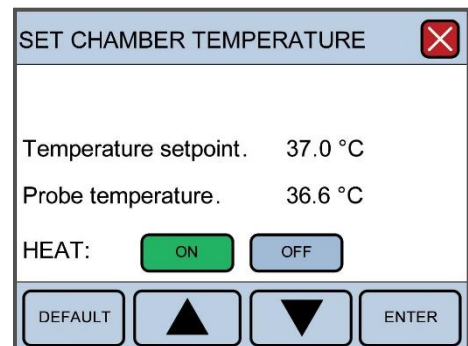


3.4 HEAT MENU

The heating temperatures are controlled from this menu. To turn the heat on, or to change the temperature for the system, press HEAT in the Main Menu. The Heat Menu will be displayed allowing the user to change the system temperature, as well as turn the heat on or off. Pressing DEFAULT will automatically reset the temperature setpoint to 37°C. Manually change the temperature by pressing UP or DOWN arrows. Pressing ENTER will save the new temperature setpoint.



To turn the heat on press ON and it will turn green indicating the heat is on. The system will heat to the designated temperature setpoint. A little red light to the right of the touch screen will turn on when the heat is turned on.



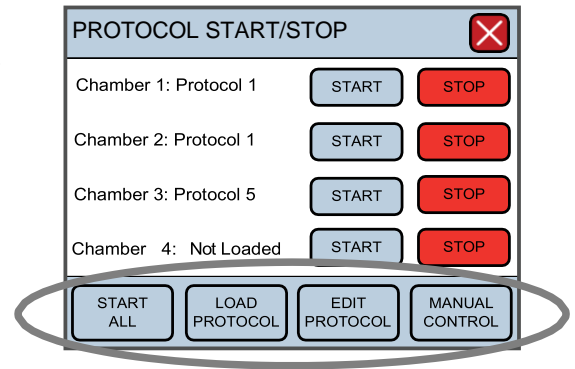
3.5 PROTOCOL MENU

The protocols are used to control the motor in the user- defined sequences. The Protocols Menu contains several sub- menus that can be accessed to change functional aspects of the protocols. These sub-menus include:

3.5.1 LOAD PROTOCOLS

3.5.2 EDIT PROTOCOLS

3.5.3 MANUAL CONTROL

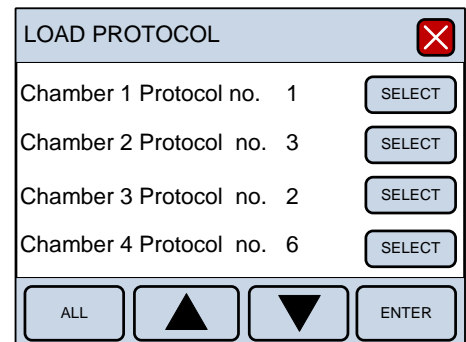


The Protocol Main Menu is used to start/stop the loaded protocols. A protocol must be loaded before it can be started. If a chamber has no protocol loaded the START command will not work, and the display will show “Not Loaded”.

To start all chambers, press, START ALL. This button will then convert to STOP ALL. If only one chamber has to be started or stopped use the START or STOP to the right of each chamber. START turns green when the protocol is started. STOP turns red if the protocol is stopped or not loaded.

3.5.1 LOAD PROTOCOL MENU

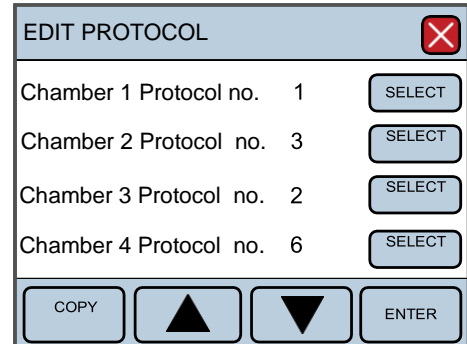
Use the SELECT or ALL to select which chamber to load. After selecting the chamber (the line will turn blue) the protocol number to be loaded can be changed with UP or DOWN arrows. When the protocol number is selected press ENTER to upload the protocol to the motor. The line will return to black.



3.5.2 EDIT PROTOCOL MENU

Press SELECT to select which chamber to edit. After selecting the chamber (the line turns blue) the protocol number to be edited can be changed with the UP or DOWN arrows. When the protocol number is selected, press ENTER which will take you to the programming menu.

The protocols can be copied between the chambers. Press COPY to get to the Copy Menu. See the Copy Menu description in chapter 3.4.2.2.



NOTE: AFTER A PROTOCOL HAS BEEN EDITED IT MUST BE RELOADED BEFORE IT IS ACTIVE.

3.5.2.1 Programming Menu

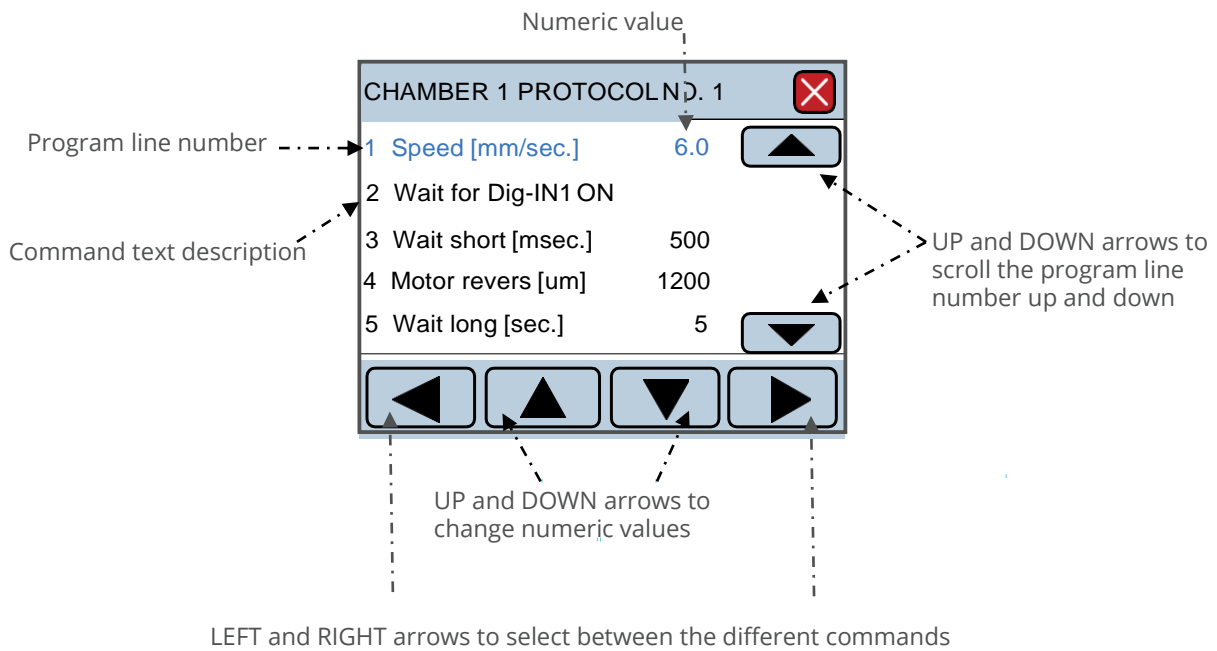
A protocol can have from 1 to 30 program lines. Each program line has a number on the left hand side. After the program line number there is text that describes the command. If the command includes a programmed numeric value, this will be on the right hand side of the text.

Only one line is programmed at a time. To select a line number, use the UP and DOWN arrows on the right hand side of the display. The selected line turns blue.

The LEFT and RIGHT arrows at the bottom of the display are used to scroll between the different commands. The UP and DOWN arrows at the middle are used to change the numeric value in the command.

NOTE: THE NEW COMMAND IS FIRST SAVED IN THE PROTOCOL AFTER YOU SCROLL AWAY FROM THE LINE NUMBER, SO IF LINE NUMBER 1 THAT HAS BEEN CHANGED SCROLL TO LINE NUMBER 2 TO SAVE THE NEW COMMAND IN LINE 1 TO THE PROTOCOL, AND SO ON. IT DOES NOT MATTER IF YOU SCROLL UP OR DOWN.

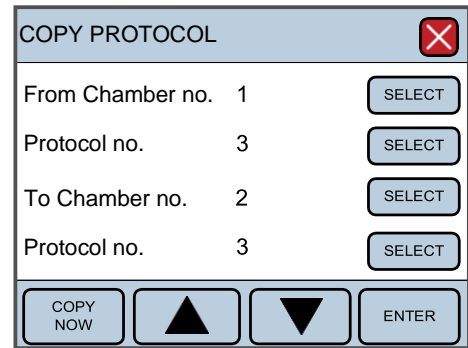
To save changes to a command, simply press UP or DOWN arrows to get to the next line. When the protocol is started it executes from line number 1. The first line is always the first command.



3.5.2.2 Copy Menu

Protocols can be copied between the chambers to reduce programming time. Before a copy can take place, it has to be configured. Press SELECT to select the line that must be changed. The line turns blue. Use the UP and DOWN arrows to change the numeric values. Press ENTER to save the selected value.

When the configuration of chambers and protocols is correct, press COPY NOW. The display will indicate the status of the copy.

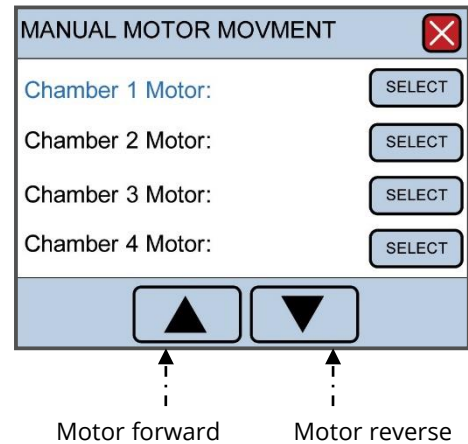


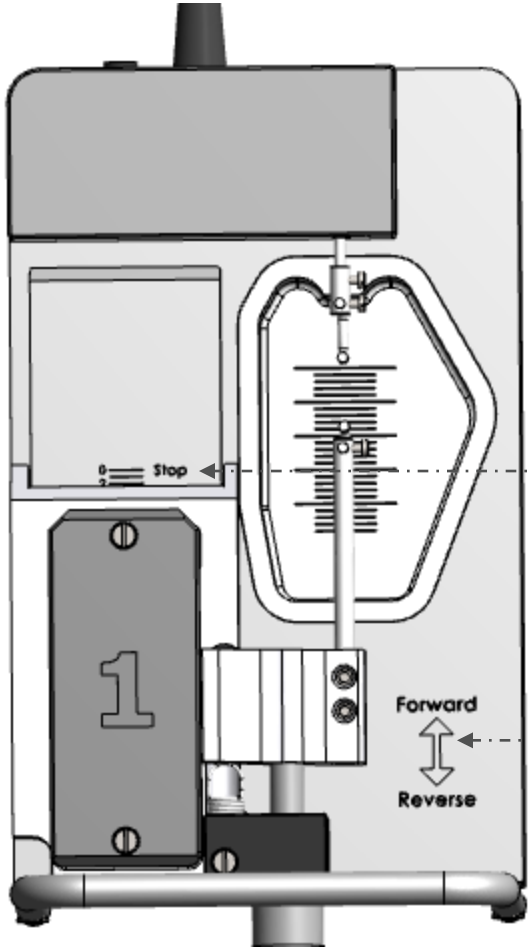
NOTE: BE CAREFUL WHEN USING THE COPY FUNCTION THERE IS NO REGRET FUNCTION.

3.5.3 MANUAL CONTROL MENU

Press SELECT to choose which chamber to control. After selecting the chamber, the line turns blue. The motor position can be changed with the UP and DOWN arrows.

A quick press on the UP or DOWN arrow make the motor move 10µm. If the UP or DOWN arrow is pressed constantly, the motor speed will accelerate.





Motor position scale with maximum travel marked with a STOP line

Motor direction - forward/reverse

3.6 SETTINGS MENU

Settings Menu contains several sub-menus that can be accessed to change functional aspects of the interface. These sub-menus include:

3.6.1 FORCE CALIBRATION

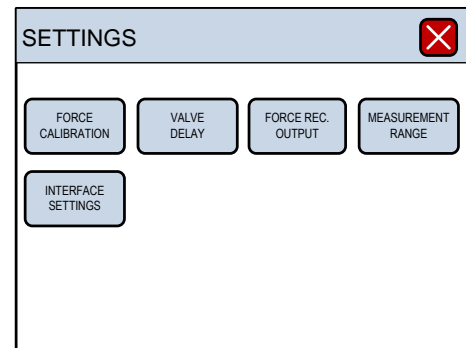
3.6.2 VALVE DELAY

3.6.3 FORCE REC. OUTPUT

3.6.4 MEASUREMENT RANGE

3.6.5 INTERFACE SETTINGS

3.6.6 FORCE CALIBRATION



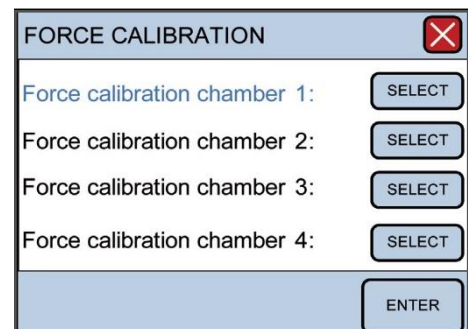
This section contains step-by-step instructions to calibrate the force transducer for 840MD.

NOTE: EVERYTIME A FORCE CALIBRATION IS PERFORMED THE MEASUREMENT RANGE IS SET TO DEFAULT 200MN. SET MEASUREMENT RANGE AFTER THE FORCE CALIBRATION.

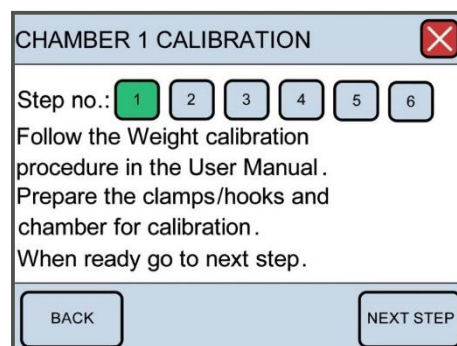
By entering the Force Calibration sub-menu, the transducer calibration procedure will start. Press FORCE CALIBRATION to enter the sub-menu. The sub-menu will list all 4 chambers for calibration.

To begin the calibration, press SELECT for the chamber which the calibration will be performed on. The text for the chamber to be calibrated will turn blue. Pressing ENTER will enter the procedure for calibrating the force transducer on the desired chamber.

The calibration procedure is listed in 6 individual steps and needs to be performed for each channel or transducer when calibrating the system.



1. Involves setting up the chamber for calibration. Make sure the chamber contains the hooks. Fill the chamber with double-distilled water for the volume to be used experimentally. Press “NEXT STEP”.



2. Set up the calibration kit (bridge and T-balance) on one of the Myograph chambers as illustrated in figure 3.1. Make sure that the T-balance pin does not touch the mounting support. The pin should be as close as possible to the mounting support without touching in order to get the most accurate calibration (see figure 3.2 and 3.3). Press NEXT STEP when the calibration kit has been properly placed.

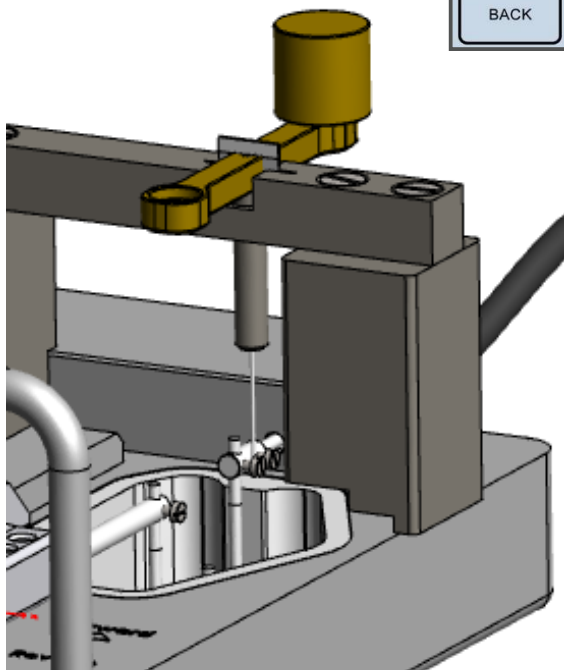
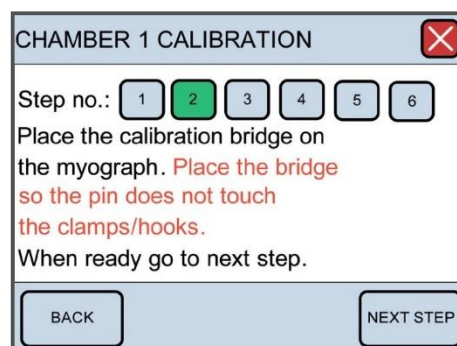


Figure 3.1 – Force calibration kit shown in place on a Myograph chamber.

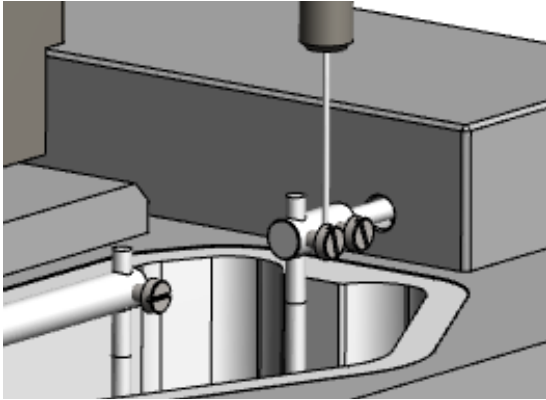


Figure 3.2 - Illustration of the proper placement of the T-balance pin for calibration.

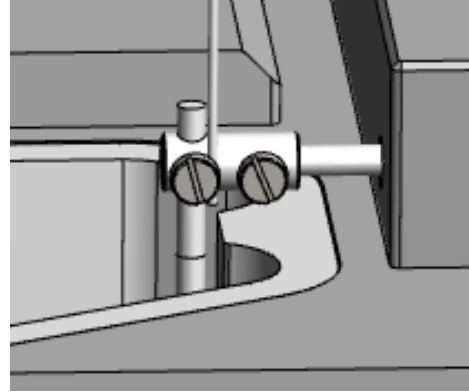


Figure 3.3 - Close-up of the two screws where the T-balance pin should be placed.

- Initiates the heating process for the chambers. In order for the calibration to be accurate, the transducers must be heated to the experimental temperature to be used to accommodate heat-induced expansion of the electronic parts in the transducer. Otherwise, inaccurate readings and transducer drift may occur, introducing large errors into the experiment. To start heating, press "HEAT ON".

The system takes about 20 to 30 minutes to reach 37°C. Make sure adequate time is allowed so that calibration can be performed at the temperature at which the experiments will be performed.

Place the temperature probe into the chamber for the first calibration to monitor when the chamber has reached the target temperature. Once the chamber(s) are heated and have reached the target temperature, press "NEXT STEP".

CHAMBER 1 CALIBRATION
✕

Step no.: 1 2 3 4 5 6

Turn the heat on. Wait until the temperature is stable.

Temperature set-point: 37.0 °C

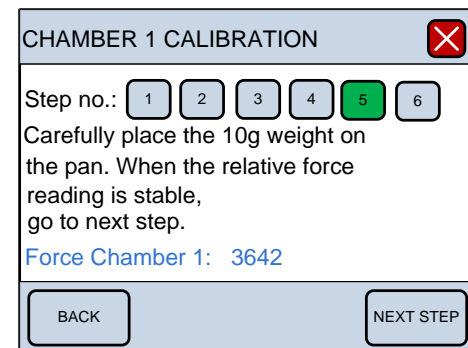
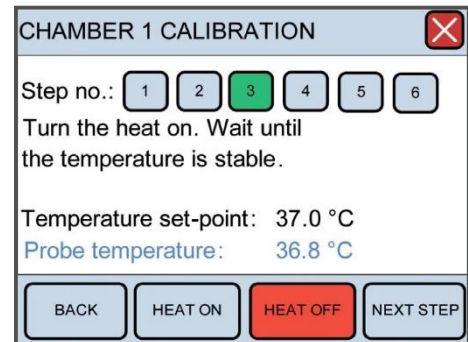
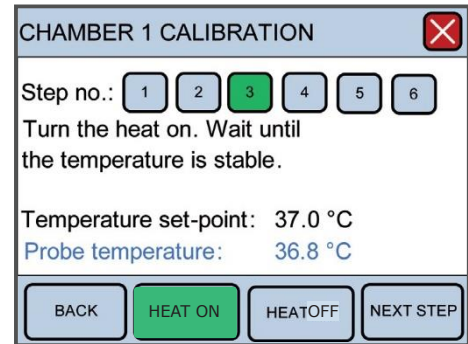
Probe temperature: 36.8 °C

BACK
HEAT ON
HEAT OFF
NEXT STEP

When the system reaches target temperature, adjust the calibration kit so that the tip of the T-balance pin is as close to the mounting support on the transducer side as possible without touching, as illustrated in figure 3.2. One way to do this is to use the following technique. Start with the calibration kit in place so that the T-balance pin of the bridge with the pans is not touching any part of the support. Go to the main menu displaying the forces, and zero the channel being calibrated so the force reads zero. Slowly and gently slide the calibration kit forward toward the micrometer so that the T-balance pin rests on the support, creating a force reading on that channel. Carefully slide the calibration kit back toward the transducer slowly until the force reads zero or very close to zero. As soon as the force reads zero, the T-balance pin will be properly placed for force calibration.

4. Is the first step in the actual force calibration process. A four digit number will be displayed in blue at the bottom of the screen. If nothing has been affected during the heating process, the zero, 0gram, or 0.00mN calibration should be stable as indicated by the four digit number and NEXT STEP can be pressed at this time. If the four digit number is not stable, then wait until the number has stopped fluctuating before pressing NEXT STEP.

5. Is the 10gram force calibration. At this step, place the 10gram weight in the pan closest to the transducer simulating a vessel pulling the hook attached to the transducer. Remember, a 10gram weight in a 90°vector is cut in half, and the transducer will only detect 1 gram or 49.05mN of force. The weight placement should cause a positive increase in the four digit number. Wait at least 30 to 45 seconds for the applied force to stabilize before pressing NEXT STEP. Once the four digit number has stabilized, press NEXT STEP.



- Is to verify that the calibration was performed correctly. The Force Chamber 1 reading should be $49.05 \pm 0.5\text{mN}$. If the Force Chamber 1 reading is off by more than 0.5mN , then remove the weight, press BACK to return to step 4, and repeat the calibration process. If the Force Chamber 1 reading is satisfactory, then press NEXT STEP. Calibrate the other chambers in the same way.

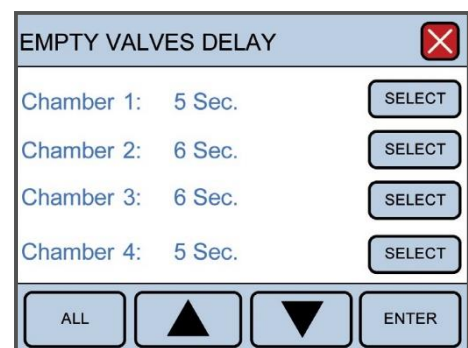
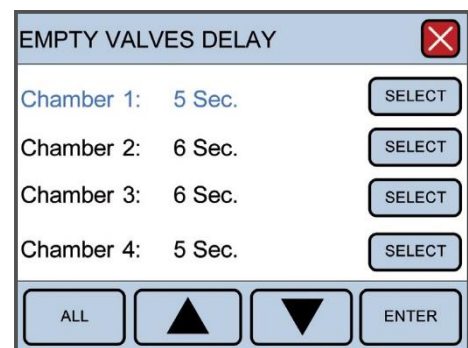
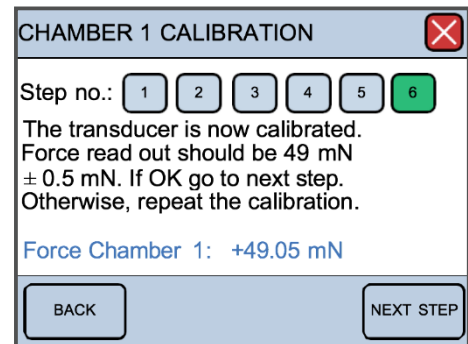
3.6.2 VALVE DELAY

Pressing VALVE DELAY in the Settings Menu will allow the user to modify the time duration that the vacuum valves stay open for washes. Factory default is set at 1 second, but 1 second is not enough time to completely empty a chamber with even as small as volume of 5 ml.

Pressing SELECT next to any given channel will cause the line selected to turn blue. The up and down arrows can then be used to modify the length of time the vacuum valves stay open after the valves have been activated with the push buttons on the front panel of the interface.

Pressing ALL will cause all the lines to turn blue, meaning all chambers can be modified at the same time. Again, the up and down arrows can be used to modify the length of time the vacuum valves stay open.

Pressing ENTER after modifying the value(s) for valve delay will lock in the number(s) and be retained in memory every time the system is turned on.

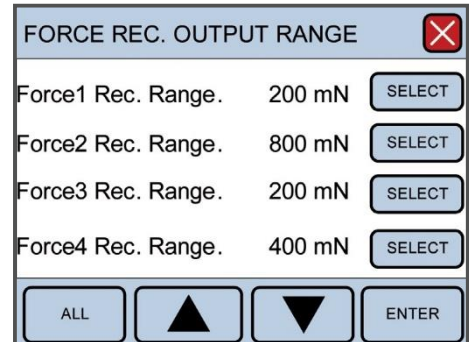


3.6.3 FORCE REC. OUTPUT

The Force Recording Output (or Force Rec. Output) sub- menu determines the upper limit for force sent from the BNC analogue output connectors. This will only affect the data collected from the Interface to a data acquisition system such as AD Instruments PowerLab and LabChart software.

The factory default setting for force recording output is 20mN, meaning that if the force of the mounted vessel exceeds 20mN, the force recorded in the data acquisition software will not record more than 20mN and will appear as a flat-line trace at 20mN, even though the force readings on the Interface may exceed 20mN. Therefore, change the force recording output settings to an appropriate setting to capture any maximal response from the vessel of interest. This value should not exceed the settings for the transducer range, which is defined by the sub-menu, Measurement Range and is explained in the next section.

The SELECT and ALL functions are the same in this menu as previously described for the Valve Delay Menu. Pressing ENTER will store the numbers in memory for future experiments.

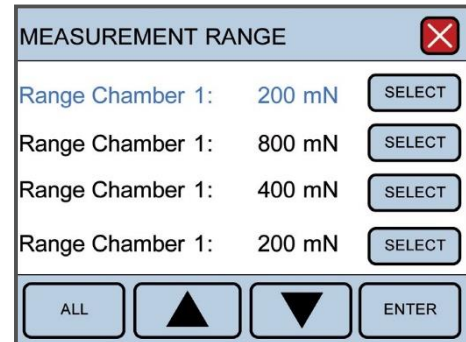


NOTE: ANYTIME THIS FUNCTION IS CHANGED, A NEW FORCE CALIBRATION ON THE TRANSDUCERS SHOULD BE PERFORMED, ENTERING THE NEW VOLTAGE VALUES INTO THE DATA ACQUISITION SYSTEM BEING USED.

3.6.4 MEASUREMENT RANGE

The Measurement Range sub-menu in Settings determines the maximum force capacity of the transducer. The factory setting is 200mN, but the transducer capacity can be changed to 400mN, 800mN or a maximum of 1600mN of force detection, depending on the size of the muscle strip used.

The SELECT and ALL functions are the same in this menu as previously described for the Valve Delay Menu. Pressing ENTER will store the numbers in memory for future experiments.

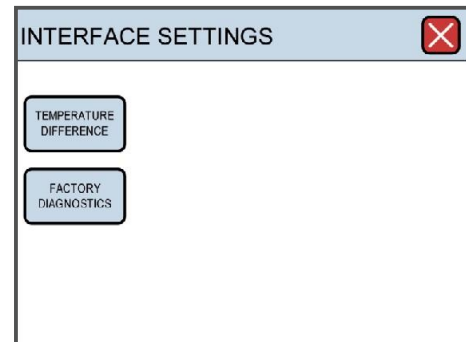


3.6.5 INTERFACE SETTINGS

The Interface Settings sub-menu in Settings has an additional 2 sub-menus. These 2 additional sub-menus are:

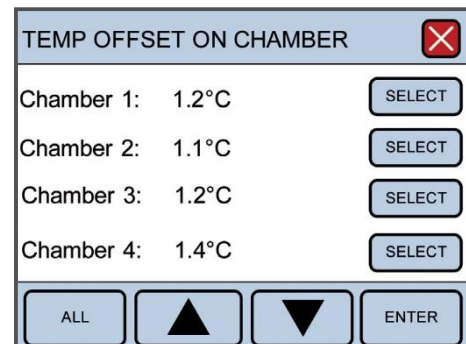
3.6.5.1 Temperature Difference

3.6.5.2 Factory Diagnostics



3.6.5.1 Temperature Difference

The temperature difference function allows the user to finetune the temperature setpoint of the system. Although the temperature setpoint for the system can be set in the Heat Menu, the actual temperature for the system may not heat to the exact defined setpoint. However, it is possible to adjust the temperature of each chamber individually to fine-tune the temperature setting so that exact temperatures can be achieved for any particular chamber. This is referred to as temperature offset (Temp Offset on chamber).



The SELECT and ALL functions are the same in this menu as previously described for the Valve Delay Menu. Pressing ENTER will store the numbers in memory for future experiments.

3.6.5.2 Factory Diagnostics

Entering Factory Diagnostics will display the Login Code to Diagnostics window. This window is for trained technicians and used for diagnostics and troubleshooting purposes. The general user will not have access to this window. Entering the proper five digit login code, will allow the trained technician access to diagnostics panels that will provide information during a malfunction or mechanisms to change other settings controlled by the onboard computer.

LOGIN CODE TO DIAGNOSTICS

Type login code to get acces

1 2 3 4 5
6 7 8 9 0

Code init value . 51761

CLR ENTER

CHAPTER 4 - PROTOCOL COMMANDS

At the moment there are 16 different commands to choose from when making the protocol.

Command shown in the 840MD display	The function of the command
Stop	This is the default command in all protocols when not programmed.
1. Protocol End	The protocol execution is stopped, until a new manual start is done.
2. Wait for Dig-IN1 ON	Wait until the digital input 1 is active "On" before the next protocol line is processed.
3. Wait for Dig-IN1 OFF	Wait until the digital input 1 is inactive "OFF" before the next protocol line is processed.
4. Wait for Dig-IN2 ON	Wait until the digital input 2 is active "On" before the next protocol line is processed.
5. Wait for Dig-IN2 OFF	Wait until the digital input 2 is inactive "OFF" before the next protocol line is processed.
6. Set Dig-OUT1 ON	Set the digital output 1 ON. Active (low impedance).
7. Set Dig-OUT1 OFF	Set the digital output 1 OFF. Active (high impedance).
8. Set Dig-OUT2 ON	Set the digital output 2 ON. Active (low impedance).
9. Set Dig-OUT2 OFF	Set the digital output 2 OFF. Active (high impedance).
10. Speed [mm/sec.]	Speed range on motor 0,5-12mm/sec.
11. Motor forward [μm]	Forward movement of the motor with the clamps moving together - range is 10 to 5000 μm .
12. Motor reverse [μm]	Reverse movement of the motor with the clamps moving away - range is 10 to 5000 μm .
13. Wait long [sec.]	Wait a long time before next line is processed, range is 1-5000 sec.
14. Wait short [msec.]	Wait a short time before next line is processed, range is 10-10000 msec.
15. Jump to line	Jump to line no. And execute the protocol from the new line - range is 1-30
16. Repeat	How many times the protocol has to be repeated. The range is 1 to 250 times.

4.1 EXAMPLE 1

This is an example of how to program a protocol.

1. Start with filling out the protocol schedule as shown here.

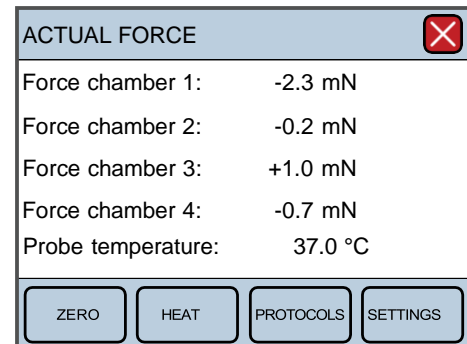
Chamber no. 1

Protocol no. 1

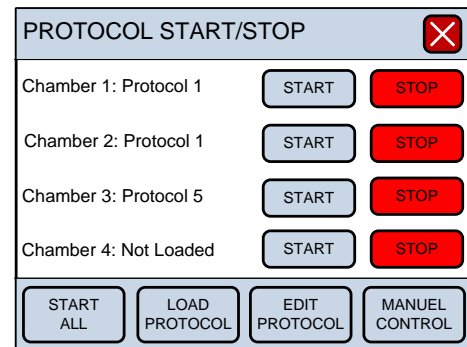
Line no.:	Command:	Value:
1	Speed [mm/sec.]	7.5
2	Motor reverse [μm]	100
3	Wait long [sec.]	3
4	Motor forward [μm]	100
5	Wait long [sec.]	3
6	Motor reverse [μm]	30
7	Wait short [msec.]	100
8	Motor forward [μm]	30
9	Wait long [sec.]	1
10	Repeat	10
11	Jump to line	2
12	Protocol End	

Protocol example 1 - A typical protocol can look like this.

2. Open the protocol display by pressing the protocols button.



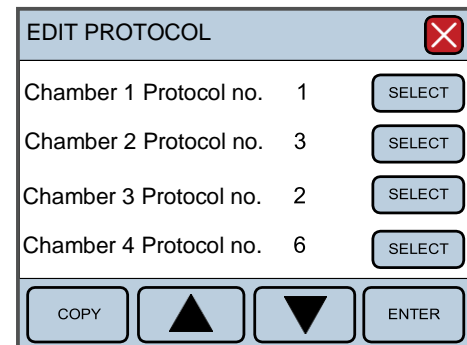
3. Open the edit protocol display by pressing the EDIT PROTOCOL button.



4. Select Chamber 1 with the SELECT button. The text line turns blue when selected.

Use the arrows to select the protocol number.

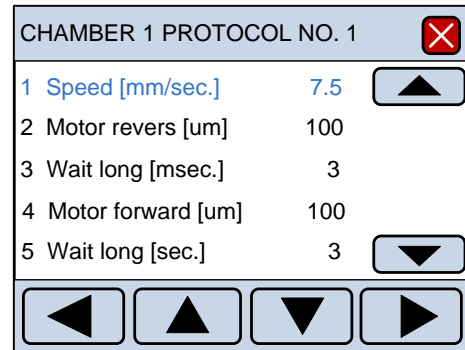
Pres the ENTER button to go to the programming menu.



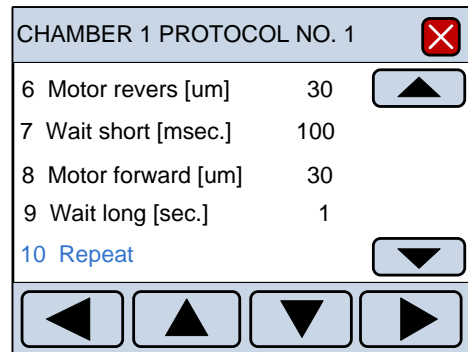
5. The display must look like this after the protocol is programmed.

Look in chapter 3 under Programming Menu: for a description on how to navigate the display.

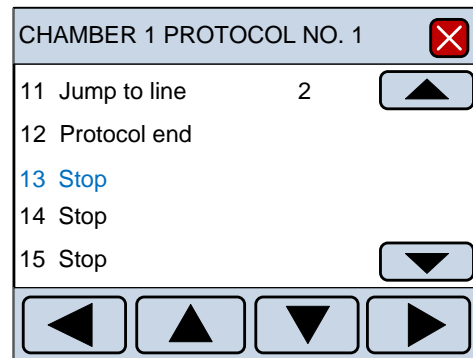
Program no. 1-5



Program no. 6-10



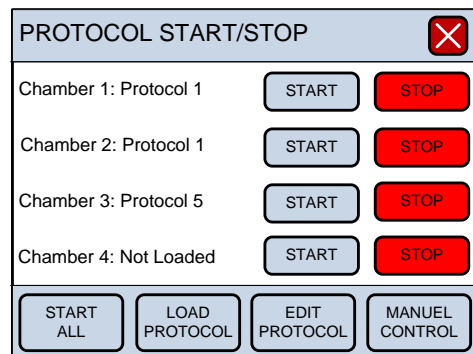
Program no. 11-15



6. After programming, press on the red cross to return to Protocol menu.

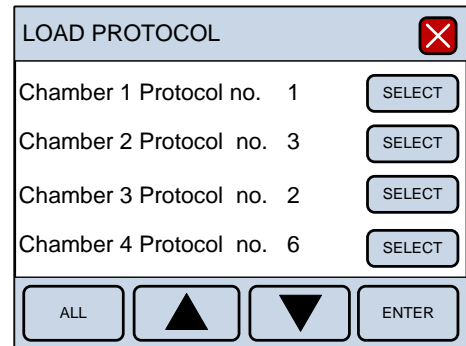


7. To load the program, press the LOAD PROTOCOL button

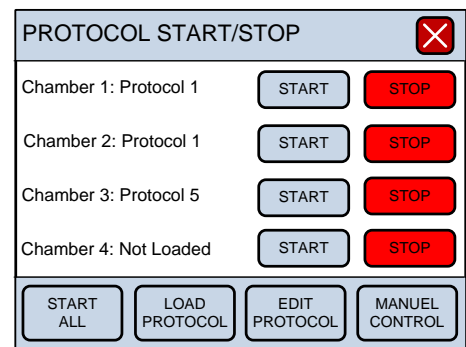


- Select Chamber 1 with the SELECT button. The text line turns blue when selected.

Use the arrows to select the protocol number.
 Press the ENTER button to load the protocol.
 After loading, press the white cross to go back to the protocol start/stop display.



- Protocol number 1 on chamber 1 is ready to start. Press the START button.



DESCRIPTION OF PROTOCOL EXAMPLE 1:

This example is a simple protocol used to illustrate some of the commands.

- Line 1: Speed [mm/sec.]
- Line 2: Motor reverse [μ m]
- Line 3: Wait long [sec.]
- Line 4: Motor forward [μ m]
- Line 5: Wait long [sec.]
- Line 6: Motor reverse [μ m]
- Line 7: Wait short [msec.]
- Line 8: Motor forward [μ m]
- Line 9: Wait long [sec.]
- Line 10: Repeat

NOTE: AFTER A "PROTOCOL" COMMAND, THERE MUST ALWAYS BE A "JUMP TO LINE" COMMAND.

Line 11: Jump to line Set the line number (2) the repeat command will be restarted on.

Line 12: Protocol End Stop the execution of the protocol.

The protocol is ready for a new manual start from the display.

After programming (editing) the protocol, it is ready to be loaded into chamber 1. After loading, the protocol is ready to start.

NOTE: AFTER A PROTOCOL HAS BEEN EDITED IT MUST BE RELOADED BEFORE IT IS ACTIVE.

4.2 EXAMPLE 2

Chamber no. 1

Protocol no. 4

Line no.:	Command:	Value:
1	Speed [mm/sec.]	3.2
2	Wait for Dig-IN1 ON	
3	Motor reverse [μ m]	100
4	Wait long [sec.]	3
5	Motor forward [μ m]	100
6	Wait long [sec.]	3
7	Set Dig-OUT1 ON	
8	Motor reverse [μ m]	30
9	Wait short [msec.]	100
10	Motor forward [μ m]	30
11	Wait long [sec.]	1
12	Set Dig-OUT1 OFF	
13	Repeat	10
14	Jump to line	2
15	Protocol End	

Protocol example 2 - A typical protocol may look like this.

DESCRIPTION OF PROTOCOL EXAMPLE 2:

This is a more complex example with an external digital start trigger. It can be a start pulse from a stimulator or some other external device.

It also uses the digital output which can be used to trigger the data acquisition system or some other external device.

Line 1: Speed [mm/sec.]	Set the speed on the motor to 3.2mm/sec. The speed must be set before the motor is started.
Line 2: Wait for Dig-IN1 ON	The program is waiting on the digital input 1 to go ON (be active).
Line 3: Motor reverse [μm]	Set the distance the motor has to move away from the transducer to 100 μm .
Line 4: Wait long [sec.]	Wait 3sec. before the next command line is executed.
Line 5: Motor forward [μm]	Set the distance the motor has to move towards the transducer to 100 μm .
Line 6: Wait long [sec.]	Wait 3sec. before the next command line is executed.
Line 7: Set Dig-OUT1 ON	Set the digital output ON (Low impedance).
Line 8: Motor reverse [μm]	Set the distance the motor has to move away from the transducer to 30 μm .
Line 9: Waitshort [msec.]	Wait 100msec. before the next command line is executed.
Line 10: Motor forward [μm]	Set the distance the motor has to move towards the transducer to 30 μm .
Line 11: Wait long [sec.]	Wait 1sec. before the next command line is executed.
Line 12: Set Dig-OUT1 OFF	Set the digital output OFF (High impedance).
Line 13: Repeat	Repeat the protocol 10 times.
Line 14: Jump to line	Set the line number (2) the repeat command will be restarted on.
Line 15: Protocol End	Stop the execution of the protocol.

The protocol is ready for a new manual start from the display.

NOTE: AFTER A PROTOCOL, ALWAYS MAKE A TEST RUN WITHOUT ANY TISSUE MOUNTED TO MAKE SURE THE PROTOCOL WORKS AS INTENDED.

4.3 DIGITAL INPUT

On each chamber backplate there is a connector with two digital inputs.

The inputs are galvanically isolated from the 840MD internal power supply. The power to activate the inputs must be delivered from an external device. The voltage required to activate the input is from 5 to 24volt DC. Each input channel is bidirectional.

The input impedance is 1.2 Kilo Ohm.

The minimum pulse length that can be detected is 5ms.

Connector at the backplane

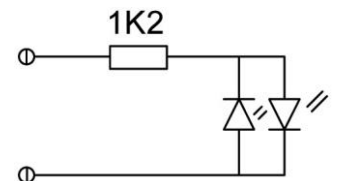
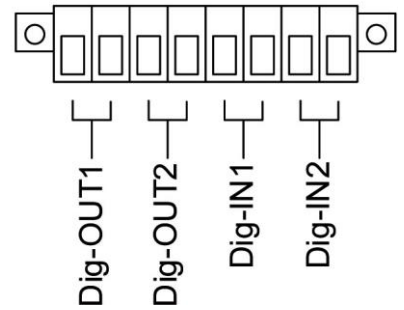


Diagram of the Digital input

4.4 DIGITAL OUTPUT

There is a connector with two digital outputs at the back plate of each chamber. All the outputs are galvanically isolated from the 840MD internal power supply. Each output channel is bidirectional and works like a Relay.

The maximum voltage at the output is 24volts.

The output impedance is 120Ohm.

The minimum pulse length at the output is 10m

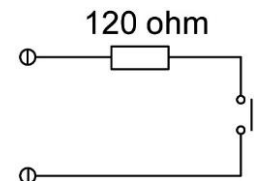


Diagram of the Digital output

Danish Myo Technology A/S

E-mail: sales@dmtd.dk
Tel.: +45 87 41 11 00
Fax: +45 87 41 11 01



DMT-USA, Inc.

E-mail: sales@dmtd-usa.com
Tel.: +1 734 707 0250
Fax: +1 678 302 7013



DMT-China

Tel.: +86 21 6486 9685
Fax: +86 21 5877 0063



DMT-Asia Pacific

Tel.: +61 2 8814 1597

