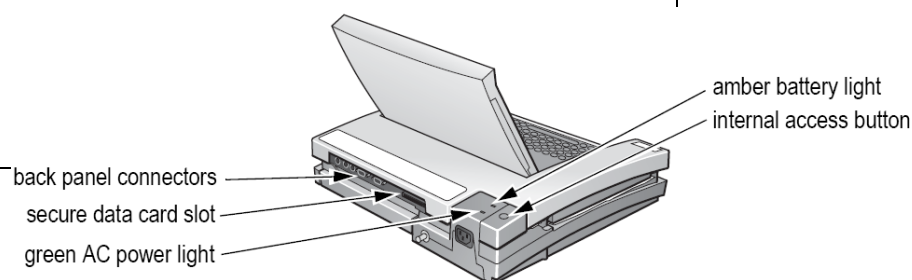
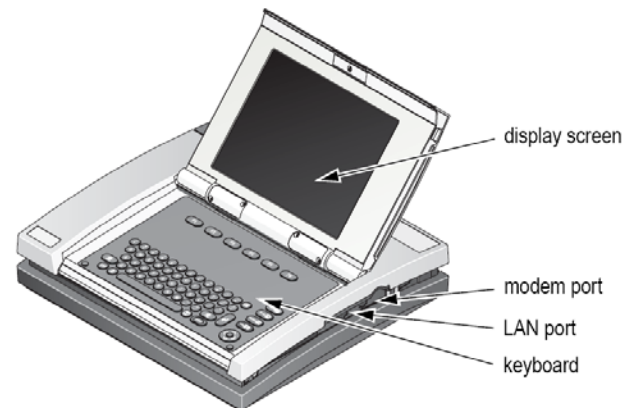
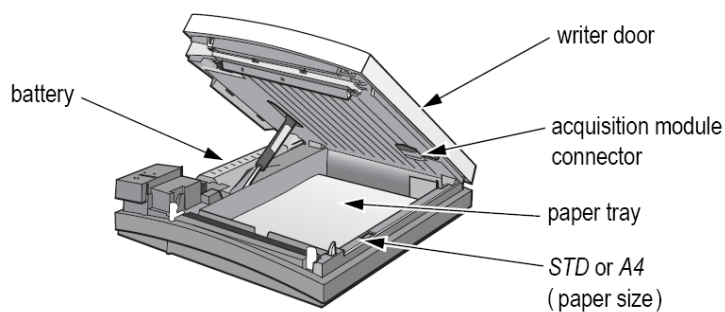

GE Healthcare MAC 5500 ECG Machine Training Module

1. Equipment Overview

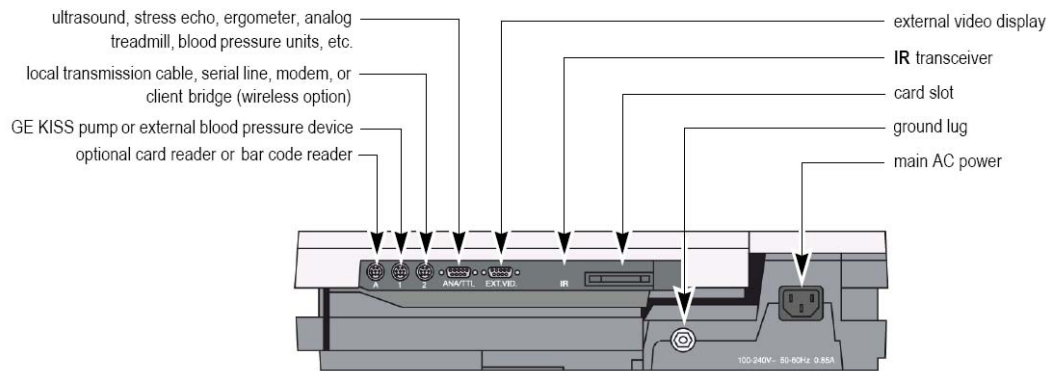
The MAC 5500 ECG machine is a portable electrocardiograph used at MGH for the recording, printing and transmitting of 12-lead ECGs. It features a built-in display, a keyboard, an internal modem, connections for an acquisition module and other related devices, a modem port and a LAN port. Most MAC 5500s at MGH are mounted on trolleys (like the one at right). Twelve-lead ECGs recorded on the Mac 5500 are typically transmitted via modem to MGH's MUSE ECG archiving system. The device can run on battery power, but it should be kept plugged in wherever possible.

Ten electrodes are connected to the patient. Leadwires are attached to the electrodes on one end, and to an acquisition module on the other end. The acquisition module measures voltage differences between the electrodes (12 measurements in total, referred to as leads) and converts these differences to serialized, digital information which is passed to the MAC 5500. The MAC 5500 then displays this information on screen as waveforms.



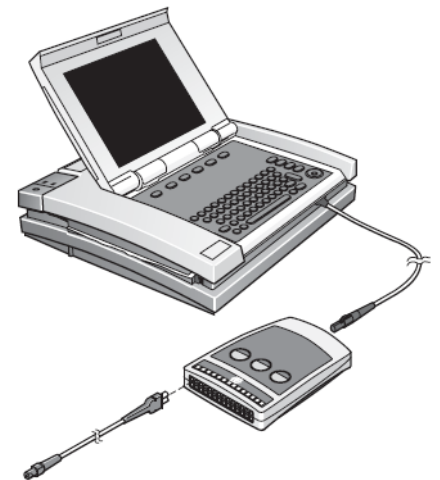
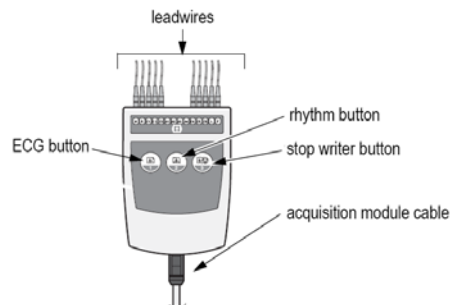
1.1 Connectors

There are several back panel connectors for connecting peripheral devices such as treadmills, blood pressure devices or data acquisition systems, however these are not used in typical practice.



1.2 Acquisition module

The CAM-14 acquisition module is a small data acquisition device that connects to the front of the MAC 5500 via a cable. Its function is to measure voltages across the electrodes attached to the patient, convert the voltages into digitized, serial information, and transmit the information to the MAC 5500. The three buttons (ECG, rhythm and stop writer) provide a means of running a test instead of using the keyboard.



1.3 Leadwires

MAC 5500s at MGH use the 10-leadwire AHA (American Heart Association) convention. Note that the MAC 5500 can accommodate up to 14 leadwires, so in this configuration there will be four empty ports on the acquisition module.

1.4 Modem

All MAC 5500s come with an internal modem as a standard feature. This is different than the MAC 5000, which uses an external modem. External modems *can* be used on the MAC 5500, but this is not typically done in practice.

1.5 Secure data (SD) card

Each MAC 5500 comes with a 64 MB secure data (SD) card that is inserted into the back of the machine. The SD card is used to store ECG recordings. It can also be used to store system settings, but in practice these are saved to the machine's internal memory ("to system"). The SD card is also used for downloading software upgrades to the MAC 5500.

1.6 Main menu/software

A reproduction of the MAC 5500's main menu is shown at right. When leads are connected to the patient the waveforms will appear next to their labeled locations.

The software version is visible only for a few seconds upon startup.

The user prompts help guide the clinician through recording an ECG.

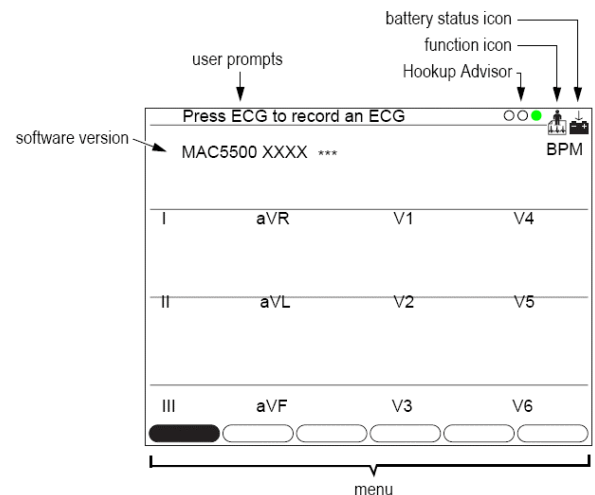
The HookUp Advisor is an optional feature which monitors the quality of ECG signals (red indicates a 'leads fail' condition, yellow indicates some artifact, and green indicates a good quality signal).

The function icon indicates the function the machine is currently using; the icon shown indicates a resting ECG, which is the most common function used at MGH.

The battery status icon indicates how much charge the battery has available – if it is solid then the battery has substantial charge remaining; if it is flashing then the battery is low and the machine should be plugged in.

The menu buttons at the bottom of the screen provide access to additional functions.

10 Leadwire AHA



1.7 File Manager

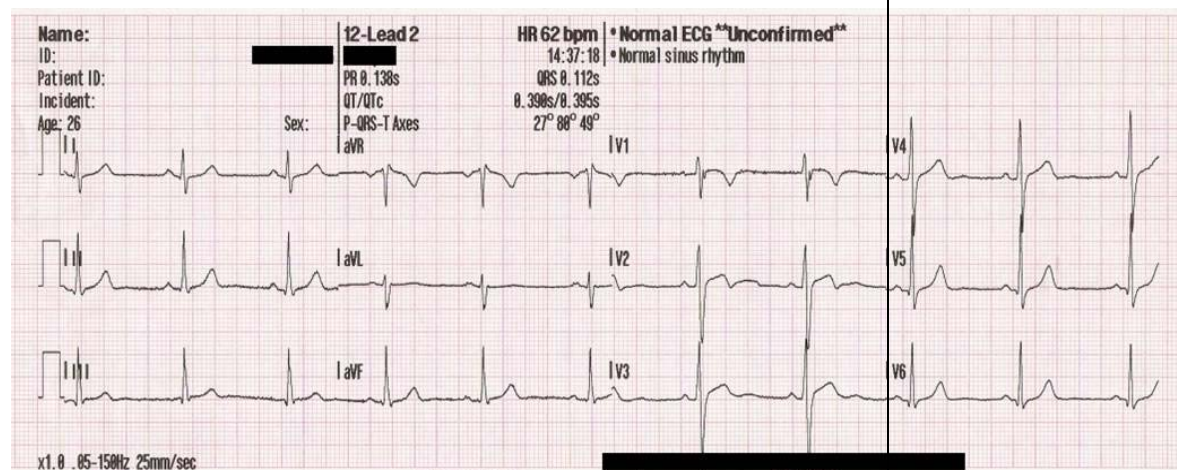
After the Main menu, the File Manager is the most important menu in the MAC 5500. Whenever an ECG report is stored, it can be accessed later through the File Manager. From this menu one can select older reports for viewing, printing, transmission or deletion. The File Manager can be accessed from the Main menu by using the menu buttons at the bottom of the screen.

2. Basic Operations

To record a 12-lead ECG, the clinician must prepare the patient's skin and apply the electrodes, attach the leadwires to the electrodes, enter the patient's information into the MAC 5500, and run the test, typically a 12-lead resting ECG.

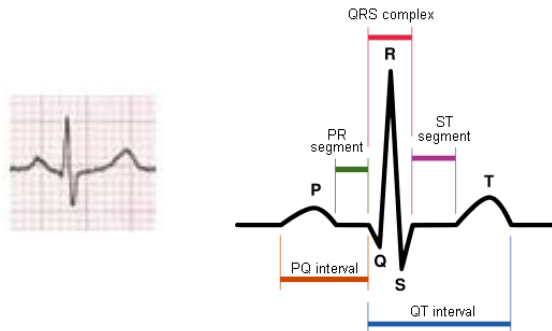
There are several options for entering patient information (bar code reader, infrared, LAN, modem, etc.) however currently at MGH all patient information is entered manually by the clinician.

The test is run by pressing the ECG button on either the keyboard or the acquisition module. The recording takes about 10 seconds and will print a report once it is finished. Depending on the machine's setup it will then either transmit and/or store the report. A report printout will look something like this:

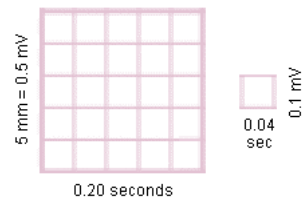


Each row shows waveforms for four different leads (the top row has leads I, aVR, V1 and V4). By looking at each lead separately or in combination with other leads, a clinician can make inferences about a patient's condition.

The report above is an example of a heart exhibiting normal sinus rhythm, in other words, a normal heartbeat. The beats are evenly spaced, not too slow or too fast (between 60-100 cycles per minute), and the waveforms show the normal components, the P wave, the QRS complex, and the T wave.



By measuring the size of the various segments and intervals of the wave, clinicians can further assess the health of the patient. They can do this because of the markings on the ECG paper, which is divided into large and small square blocks. A large block is made up of 25 small blocks (5 rows by 5 columns). Each small block is 1 millimeter (mm) squared and when the paper is run through the machine at 25 mm per second (the typical speed), it means that each small block is equal to 0.04 seconds (horizontally) and each large block is 0.20 seconds. In the vertical direction each small block represents 0.1 millivolts (mV), so a large block is 0.5 mV.



3. Other Functions

3.1. Printing, transmitting and deleting ECG reports

These functions are all accomplished through the File manager menu, in basically the same way. First, select *File Manager* from the Main menu to display the list of stored ECGs. Next press *Select* and then highlight one or more ECG reports. Finally, press *Print*, *Transmit* or *Delete*. If you press *Delete*, the screen will prompt you for a password then ask you to confirm or cancel the request.

4. Installation

The MAC 5500 service manual contains a full installation procedure which should be followed exactly. Default settings should be obtained from your team leader. The basics of the installation are (1) assembling the trolley, (2) attaching the MAC 5500 to the trolley, (3) attaching the acquisition module

pole and holder, (4) connecting the leadwires, (5) inserting the paper, (6) programming defaults, (7) labeling the machine, and (8) running a test report and transmission to the MUSE system.

4.1 Label

Each machine should be labeled with the name of the unit (using 3/4-in. red letters, if possible), for example

MGH / BLAKE 7 / MICU

The label should be applied to the top of the MAC 5500 as shown on the right.

4.2 Acquisition module pole bend

For most ECG machines in *inpatient units only* we do a custom bend of the acquisition module pole so that the assembled machine and trolley will fit under the countertop. When installing a new ECG machine in an inpatient unit the CAD drawing at the end of this document should be given to the Model Shop, along with the pole, so they can make the bend.

4.3 Test transmission

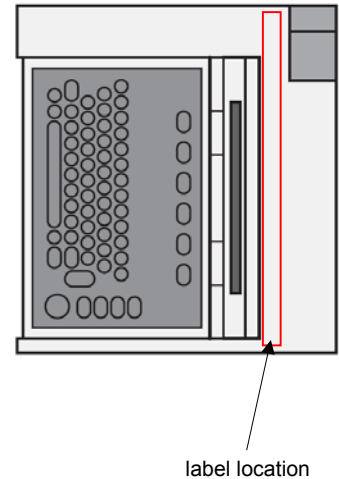
Before deploying the machine we need to verify that it will correctly transmit to the MUSE system, since many of our service calls are due to transmission errors. To do a transmission test, you will need the following:

1. A phone cord
2. An analog phone line (ask your TL if you are not sure where to find one)
3. A patient simulator

The operator manual contains the procedure for doing the transmission. For the patient name use BIOMED TEST (so that the ECG Lab will know to delete the test from the MUSE archives once you are finished).

5. Maintenance

The full SM procedure is located in the service manual, and it should be followed exactly. The SM interval is one year. Battery replacement interval is three years.



During rounds you should perform a visual inspection of the machine – check the case and display for any signs of cracks, inspect cords for fraying, and check that all cords and connectors are properly seated.

GE recommends cleaning the printhead every three months, which is much more frequent than the SM schedule, so this should be done any time you get a chance. The printhead should be wiped with an alcohol-based solution on a soft cloth. Do not use paper towels, since they could scratch the printhead.

6. Troubleshooting

According to data from AMM the most common problems associated with the MAC 5500s are printing problems, transmission problems and poor quality ECGs.

6.1 Printing

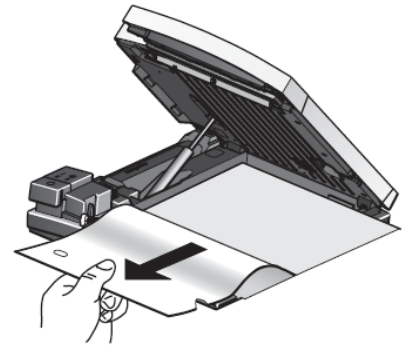
If a clinician reports that s/he is having problems printing or has a paper jam, try the following:

1. Reload the paper, remembering to advance the first sheet out of the machine (see image at right).
2. Clean the printhead – the printheads sometimes become slick during operation, causing the paper to misfeed.

6.2 Transmitting

Most clinicians transmit their ECG reports to the MUSE archiving system via the MAC 5500's internal modem, which connects to an analog phone line.

1. Check that the phone cord is plugged into the modem port on the MAC 5500, not the LAN port. The modem port is the smaller of the two ports and is closer to the back of the machine.
2. Replace the phone cord.
3. Check the phone line to see if it is active.



4. Check how many ECG reports the clinician is trying to transmit – sometimes “batch” transmissions (say, 10 or more reports) do not go through correctly. Transmit one report at a time to see if that works.

5. The MUSE system may be busy – ask the clinician to wait several minutes then try to transmit again.

6.3 Poor quality ECGs

1. If a single lead is giving a bad signal, get a simulator and see if that resolves the problem. If so, the cause is probably due to the electrode not being properly attached to the patient’s skin. Ask the clinician to reapply the electrode. If this still does not solve the problem, try replacing the leadwire.

2. If several or all leads are bad, check that the cable from the acquisition module is securely connected to the MAC 5500.

6.4 Disk full

If the clinician reports that they cannot save an ECG report, bring up the File Manager and delete the oldest records.

6.5 Diagnostic tests

There are diagnostic tests that can be run to verify the operation of many different components of the MAC 5500, including the display, keyboard, speakers, writer, battery, modem and SD card. Full test procedures can be found in the service manual.

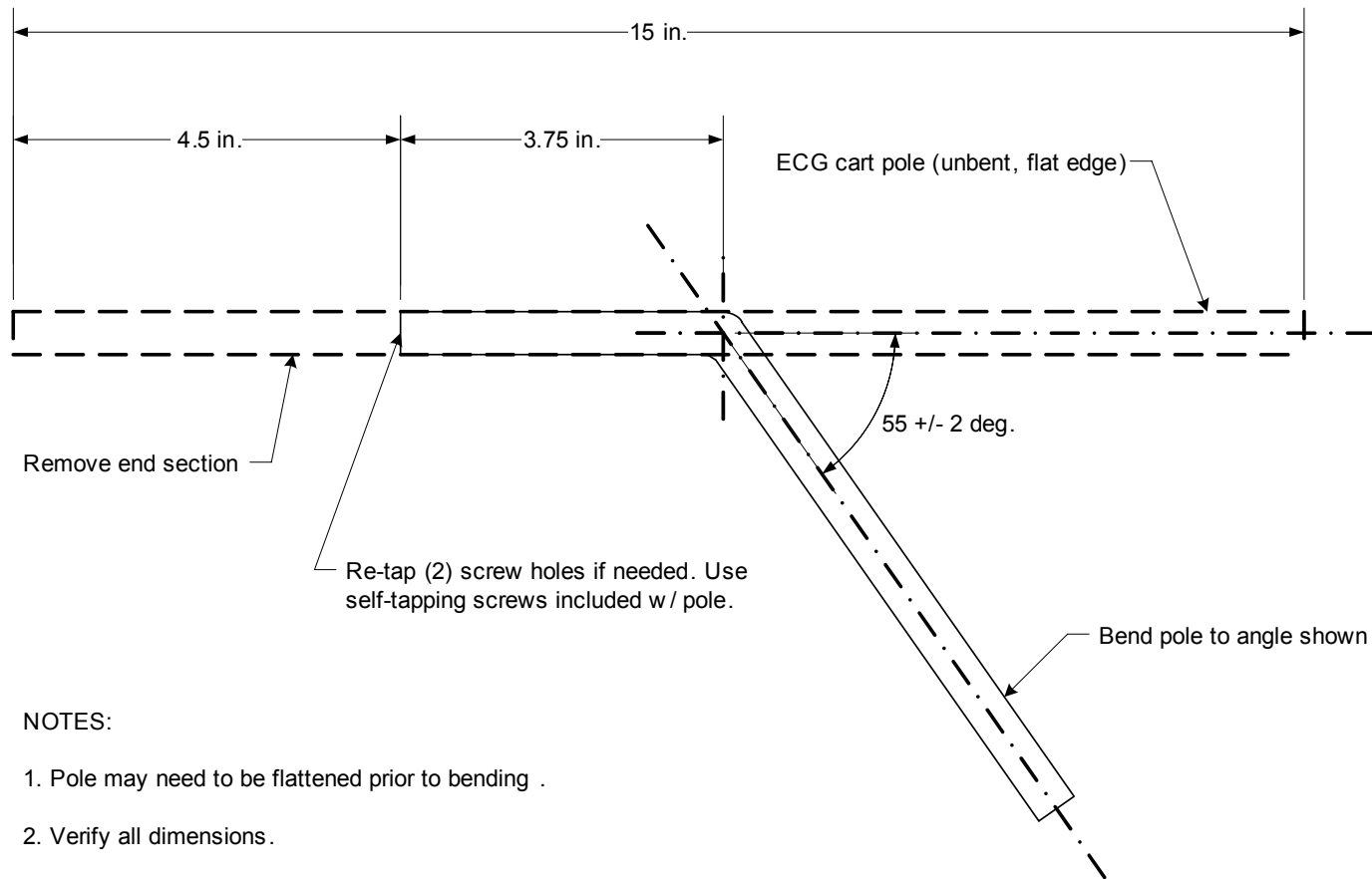
Quiz

Print this sheet, write your name, today's date, and return it to you team leader with your answers. You may use separate sheets of paper if you like.

Name _____

Date _____

1. Write down the steps or button presses you would do (starting from the Main Menu) to set up the MAC 5500 to automatically transmit all ECG reports.
2. Describe in as much detail as you can, how ECG signals are recorded from the patient.
3. A clinician reports that they cannot transmit an ECG report to the MUSE system. List three possible causes of this problem.
4. A clinician shows you an ECG printout and asks you whether or not you think the report shows a normal sinus rhythm – what do you tell them?
5. Obtain a loaner MAC 5500 (ask your team leader about this) and use it to record a resting ECG report from a patient simulator, obtain a printout, and transmit the report to the MUSE system.



NOTES:

1. Pole may need to be flattened prior to bending .
2. Verify all dimensions.