ZOLL®

X Series® Service Manual

9650-001356-01 Rev. J

The issue date for the *X Series Service Manual* (**REF** 9650-001356-01 Rev. J) is **April 2022**.

If more than 3 years have elapsed since the issue date, contact ZOLL Medical Corporation to determine if additional product information updates are available.

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Preface

Overview

The ZOLL® X Series™ Service Manual is intended for the trained biomedical equipment technician whose responsibility is to routinely inspect the device, identify malfunctions, andmake repairs at the subassembly level. This Service Manual has five main chapters and two appendices.

Preface—Contains safety warnings and an overview of the manual's contents. Be sure to review this section thoroughly before attempting to use or service the X Series unit.

Chapter 1—Maintenance Tests describes step-by-step procedures for various maintenance tests.

Chapter 2—Troubleshooting provides a listing of error messages to help the service technician detect faults and repair them.

Chapter 3—Disassembly Procedures describes step-by-step procedures for disassembling modules in the X Series unit.

Chapter 4—Replacement Parts List displays a complete list of ZOLL part numbers for field replaceable parts available for the X Series unit, allowing the service technician to identify and order replacement parts from ZOLL.

Chapter 5—Functional Description provides technical descriptions for the X Series major subassembly modules.

Chapter 6—Test After Repair provides information on what tests must be performed after making repairs to the device.

Appendix A—X Series Electrical Hardware Interconnect Diagram and X Series Signal and Power Interconnect Schematic.

Appendix B—Contains simulators and settings that may be used to assess the performance of the NIBP module.

Maintenance Test Checklist—Contains a blank checklist that can be copied and used to record the results of device maintenance tests.

Safety Considerations

The following section describes general warnings and safety considerations for operators and patients. Service technicians should review the safety considerations prior to servicing any equipment and read the manual carefully before attempting to disassemble the unit. Only qualified personnel should service the X Series unit.

Federal (U.S.A.) law restricts this unit for use by or on the order of a physician.

Safety and effectiveness data submitted by ZOLL Medical Corporation to the Food and Drug Administration (FDA) under section 510(K) of the Medical Device Act to obtain approval to market is based upon the use of ZOLL accessories such as disposable electrodes, patient cables and batteries. The use of external pacing/defibrillation electrodes and adapter units from sources other than ZOLL is not recommended. ZOLL makes no representations or warranties regarding the performance or effectiveness of its products when used in conjunction with pacing/defibrillation electrodes and adapter units from other sources. If unit failure is attributable to pacing/defibrillation electrodes or adapter units not manufactured by ZOLL, this may void ZOLL's warranty.

Only qualified personnel should disassemble the X Series unit.

WARNING! This unit can generate up to 2775 volts with sufficient current to cause lethal shocks.

All persons near the equipment must be warned to “STAND CLEAR” prior to discharging the defibrillator.

Do not discharge the unit’s internal defibrillator energy more than three times in one minute or damage to the unit may result.

Do not discharge a battery pack except in a ZOLL *SurePower*™ Charging Station.

Do not use the X Series in the presence of flammable agents (such as gasoline), oxygen-rich atmospheres, or flammable anesthetics. Using the unit near the site of a gasoline spill may cause an explosion.

Do not use the unit near or within puddles of water.

Additional Reference Material

In addition to this guide, there is a *X Series Operator’s Guide*(**REF:** 9650-002355-01) which is a comprehensive reference work that describes all the user tasks needed to operate the X Series.

Conventions

WARNING! Warning statements describe conditions or actions that can result in personal injury or death.

Caution Caution statements describe conditions or actions that can result in damage to the unit.

Note: Notes contain additional information on using the defibrillator.

Service Policy Warranty

In North America: Consult your purchasing agreement for terms and conditions associated with your warranty. Outside of North America, consult a ZOLL authorized representative.

In order to maintain this warranty, the instructions and procedures contained in this manual must be strictly followed. For additional information, please call the ZOLL Technical Service Department 1-800-348-9011 in North America.

Technical Service

If the ZOLL X Series unit requires service, contact the ZOLL Technical Service Department:

Telephone: 1-978-421-9655; 1-800-348-9011

Fax: 1-978-421-0010

Email: techsupport@zoll.com

Please have the following information readily available for the Technical Service representative:

- Unit serial number
- Description of the problem
- Department where equipment is used
- Sample chart recorder strips or electronic log files documenting the problem (if applicable)
- Purchase Order to allow tracking of loan equipmentPurchase Order for a unit with an expired warranty

If the unit needs to be sent to ZOLL Medical Corporation, obtain a service request number (SR#) from the Technical Service representative. Return the unit in its original container to:

ZOLL Medical Corporation
269 Mill Road
Chelmsford, Massachusetts 01824-4105

Attn: Technical Service Department (SR#)

Telephone: 1-800-348-9011; 1-978-421-9655 FAX: 978-421-0010

Technical Service for International Customers

International customers should return the unit in its original container to the nearest authorized ZOLL Medical Corporation Service Center. To locate an authorized service center, contact the International Sales Department at ZOLL Medical at the above address.

Tamper Proof Labels

ZOLL products must be repaired by qualified individuals. The removal of the tamper proof label could result in voiding the factory warranty. Please contact the Technical Service Department if you have any questions or concerns prior to removing the label.

Service Manual Feedback Survey

In an effort to continuously improve the efficacy of our product documentation, ZOLL Medical Corporation invites you to participate in a short survey regarding your experience using this manual. The responses collected from the survey will contribute directly to improving future revisions of this manual. Participation in the survey is voluntary and survey responses are made anonymous by default.

If you would like to participate in the survey, please click or tap on the QR code below, or scan it with your mobile device. Alternatively, you may enter *www.zoll.com/servicemanualsurvey* into the address bar of your preferred web browser.

Chapter 1
Maintenance Tests

X Series Overview

This chapter includes step by step instructions as part of an annual inspection procedure. These tests should be performed by trained biomedical professionals. Use the checklist at the back of this document (*ZOLL X Series Maintenance Tests Checklist*) to record your results of the maintenance tests.

Additionally, it is necessary to perform the maintenance tests after repairs are made to the device to ensure that the functions of the X Series work properly and within specifications. See **Chapter 6: Test After Repair** for more information.

This chapter describes the following maintenance tests:

- 1.0 Physical Inspection of the Unit
- 2.0 Leakage Current Test
- 3.0 Treatment Report Test
- 4.0 Readiness Test
- 5.0 Operational Tests
- 6.0 ECG Test
- 7.0 Shock Test
- 8.0 Synchronized Cardioversion Test
- 9.0 Pacer Test (if applicable)
- 10.0 SpO2 Test (if applicable)
- 11.0 SpO2, SpCO, and SpMet Test (if applicable)
- 12.0 EtCO2 Calibration
- 13.0 EtCO2 Calibration Check
- 14.0 EtCO2 Test
- 15.0 IBP Test (if applicable)
- 16.0 NIBP Calibration Check
- 17.0 NIBP Leak Test
- 18.0 Inflation/Deflation Test
- 19.0 NIBP Functional Test
- 20.0 Temperature Test (if applicable)
- 21.0 Wi-Fi Test (optional)
- 22.0 Audio Recording Test (if applicable)
- 23.0 Real BVM Help Test (if applicable)
- 24.0 CPR Feedback Test (if applicable)
- 25.0 Paddles Test (if applicable)

Before You Begin the Maintenance Tests

- Assemble the tools listed in following section.
- Install a fully charged battery in the device.
- Ensure the correct date and time are displayed on the device.
- Perform the tests in the order presented.
- Perform all the steps of each test procedure.
- Complete all the steps of the procedure before evaluating the test results.
- Review all caution and warning statements to ensure operator safety, especially when discharging energy from the device.
- All tests should be completed within Manual mode operation. If the device starts in AED mode, you must enter Manual mode operation before you begin each test.

Equipment You Need to Perform the Maintenance Tests

The equipment listed below is utilized in the maintenance test procedures in this chapter. Please note that not all simulators and analyzers will produce the same results. Be sure to follow the manufacturer's recommendations for conducting the maintenance tests.

Note: Some equipment may not be required based on device configuration.

- Defibrillator analyzer
- ECG simulator
- IBP simulator with cable
- Temperature simulator with cable
- NIBP simulator
- 5% CO_2 calibration gas cylinder with CO_2 sample line (AirGas P/N: Z03NI748BDC002)*
- CO_2 sampling line airway adapter (P/N: 8300-0520-01)
- Stopwatch
- Adult BVM
- CPR Feedback Test equipment:
    - Universal Adapter Cable (ZOLL P/N: 8000-0804-01) with CPR Connector (P/N: 8000-0370)

Note: * ZOLL recommends purchasing the calibration gas and sample line kit listed above. If sourcing the calibration gas from a different source, ensure the calibration gas you use is medical grade, has a composition of 5% CO_2, 21% O2 Balance N2, and has a flow rate of 0.5 liters per minute.

Required Accessories

Note: Some accessories may not be required based on device configuration.

- AccuVent cable and sensor
- Auxiliary power source
- Battery
- Dual lumen NIBP hose
- ECG cables
- Microstream filterline (EtCO2)
- Paddles
- PC with Windows Media Player and speakers
- Printer paper
- SpO2 cable and sensor
- USB thumb drive

Maintenance Tests

1.0 Physical Inspection of the Unit

		Observe this...	Pass / Fail
Main Housing	1.1	The device is clean and without any obvious signs of damage, cracks, loose housing parts, or excessive wear.	o o
	1.2	The handle is secure and is in good condition.	o o
	1.3	The printer door can open and close properly.	o o
	1.4	The input connectors are clean and undamaged.	o o
	1.5	The protective screen appears clean without significant scratches or cracks which could allow water ingress. Scratches to the device's screen should not impede visibility of clinical data.	o o
Cables	1.6	The Multifunction Cable (MFC) gasket is in place and is intact. If replacement is needed, see Replacing the Multifunction Cable Gasket.	o o
	1.7	All cables (including accessories) are free of cuts, cracks, and exposed wires.	o o
Battery & Power	1.8	Ensure the device's battery is properly secured within the battery well.	o o
	1.9	On the rear case, inspect the AC power connector for signs of damage. Ensure the AC power cord is securely connected.	o o
	1.10	Connect the device to AC power. Ensure the front panel AC and battery indicators are illuminated and not flashing.	o o
Note: If the battery indicator is not illuminated, ensure the battery is properly seated in the battery well and that the battery is not displaying a fault indicator. Inspect the pins and contacts both on the battery and within the battery well to ensure they are not damaged or in need of cleaning. The battery indicator will not illuminate unless the device is connected to AC power.			

2.0Leakage Current Test

Before You Begin

ZOLL X Series® and X Series® Advanced defibrillators have been certified as Class 1 ME externally powered per IEC/EN 60601-1 Standards. The device meets the Class 1 standard when operating on battery as the device is internally powered, and again when operating on AC due to the presence of a protective earth connection.

The design of X Series and X Series Advanced devices complies with IEC standards, which allow for various methods of protection. Subclause 8.6 of IEC 60601-1 states the following:

"Typically, metal ACCESSIBLE PARTS of CLASS I A1E EQUIPMENT are PROTECTIVELY EARTHED. However, they could be separated by other MEANS OF PROTECTION, in accordance with 8.5."

Subclause 8.5.1 details the following example:

"PATIENT CONNECTIONS and other ACCESSIBLE PARIS are separated from parts different from earth potential by DOUBLE or REINFORCED INSULATION"

The X Series and X Series Advanced comply with subclause 8.5.1 as the external power supply is double insulated, and therefore provides protection to the entire rest of the system. Further, an isolation transformer within the external power supply also provides a reduction in voltage from the AC input to 14.5Vdc. The power supply itself remains Class 1 due to the presence of a protective earth; double insulation alone does not mandate that the adapter be classified as Class 2 by the IEC.

Per the standards, a protective earth connection is not required to be carried through to the chassis. Any exposed metal components on the chassis, which carry through the power supply, are functional grounds only and are not to be considered protective. **As the chassis does not require a protective earth due to the electrical system design, measuring protective Earth resistance is Not Applicable per the standard.**

Equipment See the manufacturer's instructions or supplied specifications for the leakage tester you use.

WARNING! SHOCK HAZARD! Do not use anti-static robes, benches, floor mats, or perform the below tests at an ESD station during electrical safety testing. Follow all specified precautions offered by the ESA manufacturer.

WARNING! Do NOT touch the DUT while the testing procedure is underway. Always consider the DUT to be electrified while testing is in progress.

Test Setup See the manufacturer's instructions or supplied specifications for the leakage tester you use.

Perform the applied part leakage test with the following accessories: MFC, external paddles, and internal paddles. Perform these tests at the line-power voltage and frequency used in your installation.

Functional Earth Locations:

- Metal case of USB port
- Rear case screws

Note: It is recommended to use the IEC 62353 standard for recurrent test and test after repair.

IEC 62353 CLASS 1 LEAKAGE TEST LIMITS - DIRECT METHOD		
Equipment Leakage (Direct)	BF*	CF**
	500µA	500µA
Applied Part Leakage (Direct)	BF*	CF**
	5000µA	50µA
*Type BF: pads, paddles. **Type CF: ECG.		

	Procedure	Pass/Fail
2.1	Verify that all electrical safety testing/ leakage measurements are within acceptable limits.	o o
Record your results on the Maintenance Test Checklist.		

3.0 Treatment Report Test

Equipment Printer paper

Test Setup None

	Do this...	Observe this...	Pass/Fail
3.1	Power on the device and wait at least 30 seconds.		
3.2	Using the quick access keys, select the code marker button. 		
3.3	Select a code marker from the list (for instance, O2) and then wait 20 seconds.		
3.4	Select a different code marker from the list and then wait 20 seconds.		
3.5	After 20 seconds, power off the device for 2 minutes. After 2 minutes, power on the device.		
3.6	On the device, press the following quick access keys in the order presented: a)  b)  c) 		
3.7	Using the navigation keys, select the second event in the list. A green check mark should appear next to the file.		
3.8	Once the event is selected, select **Print Treatment Summary**.	On the printed treatment summary, observe that both code marker snapshots are present.	o o
Note: If any alarm conditions or recorder activated events occurred before this test, they will appear on the print out ahead of the code markers on the treatment summary report. This test has been placed at the beginning of the annual inspection procedure to eliminate unnecessary paper waste.			

4.0 Readiness Test

WARNING! Take the necessary precautions to guard against shock or injury before you start conducting the defibrillator tests.

Keep hands and all other objects clear of the Multi-Function Cable connections and any attached accessories when discharging the defibrillator.

Before you discharge the defibrillator, warn everyone near the equipment to STAND CLEAR.

Equipment Multi-Function Cable (MFC)

Test Setup Press the Lead quick access key until Pads is the selected source. Connect the MFC to the device.

	Do this...	Observe this...	Pass / Fail
4.1	Connect the MFC to the test connector.	A *SHORT DETECTED* message appears on the display.	o o
4.2	On the device, set energy level to 30J.		
4.3	On the device, press the CHARGE button to charge the device to 30J. Once the ready tone sounds, press the SHOCK button to deliver energy.	The message *DEFIB SHORT TEST PASSED* appears on the display. **Note:** This message displays briefly before disappearing.	o o
		The RFU Indicator shows a passing result (pictured here). 	o o
Note: For devices running software version 2.32.03 or higher, if the RFU Indicator shows a Do Not Use symbol, review the Readiness Test Log to identify any recorded faults. To access log, press the **Setup** quick access key > **Device Info** > **Readiness Test Logs Review**.			
4.4	Unplug the MFC from the test connector.	The message *CHECK PADS* appears on the display.	o o

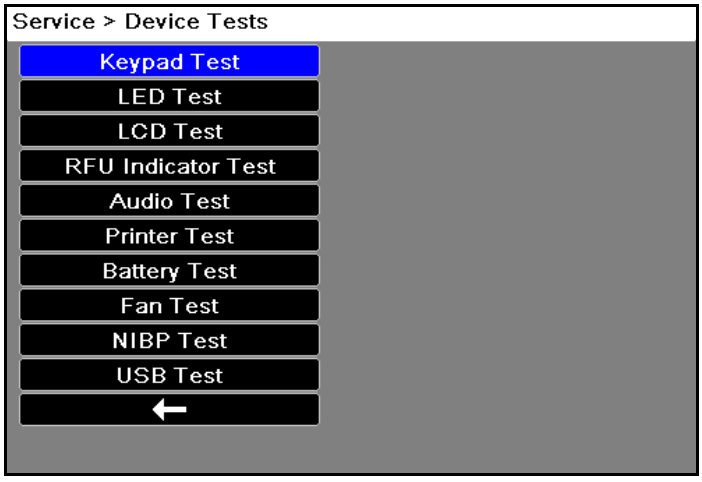
5.0 Operational Tests

The X Series/X Series Advanced comes equipped with routine operational tests that can be performed periodically. These tests contain instructions within them that provide guidance during the tests.

The operational tests on the device can be accessed by doing the following:

1. Turn on the device.
2. If the device is in AED mode, press the **Manual** quick access key to enter Manual Mode. Press the More ( ) and then the Setup ( ) quick access keys.
3. Use the navigation keys to select **Supervisor** > **Service** > **Device Tests**. The operational tests are displayed. Use the navigation keys to select one of the tests.

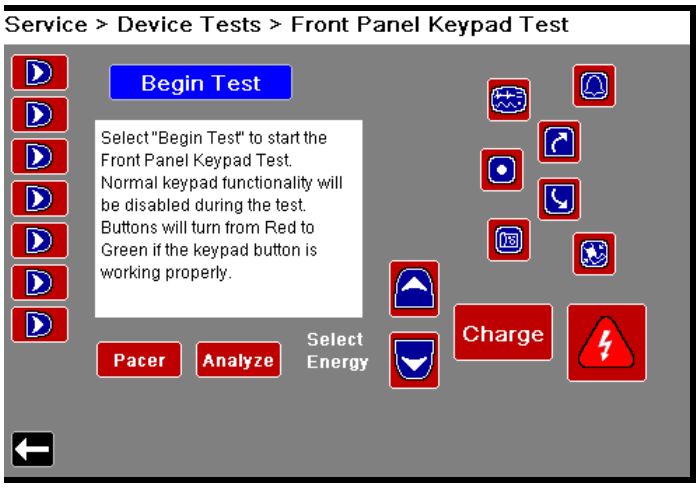
Note: You need a supervisor passcode to enter the Supervisor menu.



5.1 Keypad Test

This test checks all the front panel buttons on the device to make sure they are working properly.

Follow the on-screen instructions and use the navigation keys to move around the display and to make selections.

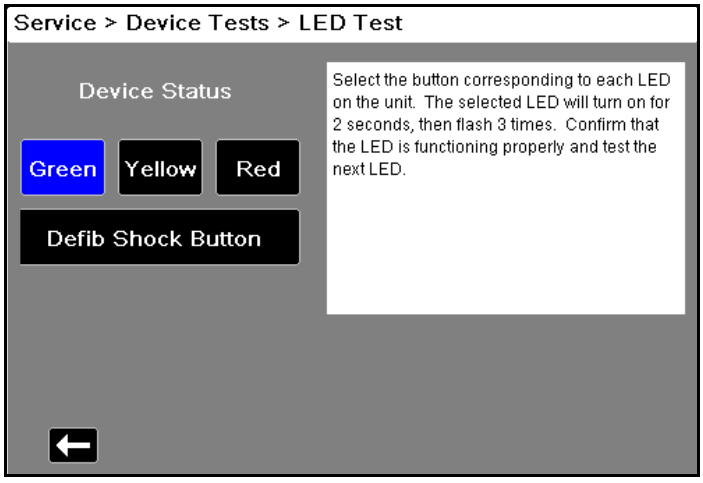


Note: To exit the screen after test is complete, press the Select button 3 times, and then use the navigation keys to highlight the return arrow in the bottom left corner. Select the arrow to return to the previous menu.

5.2 LED Test

This test checks all the Light Emitting Diodes in the device to make sure they are working properly.

Follow the on-screen instructions and use the navigation keys to move around the display and to make selections.

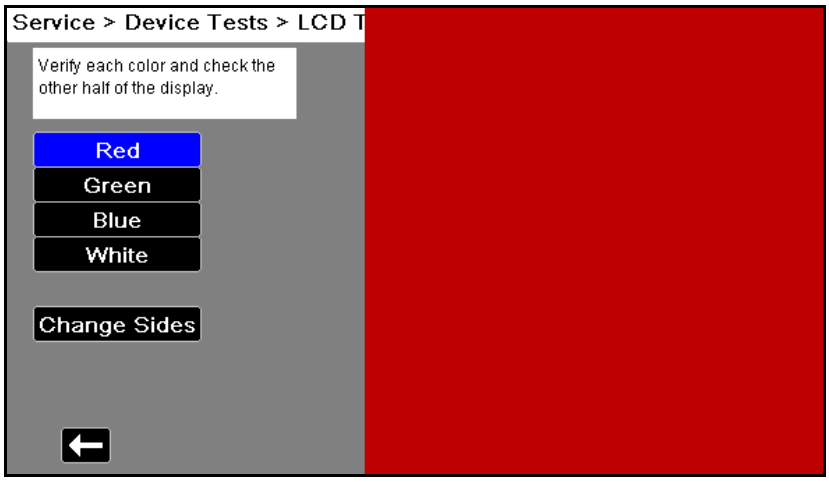


Note: The speed of the flash varies by color.

5.3 LCD Test

This test checks the colors of the Liquid Crystal Display on the device.

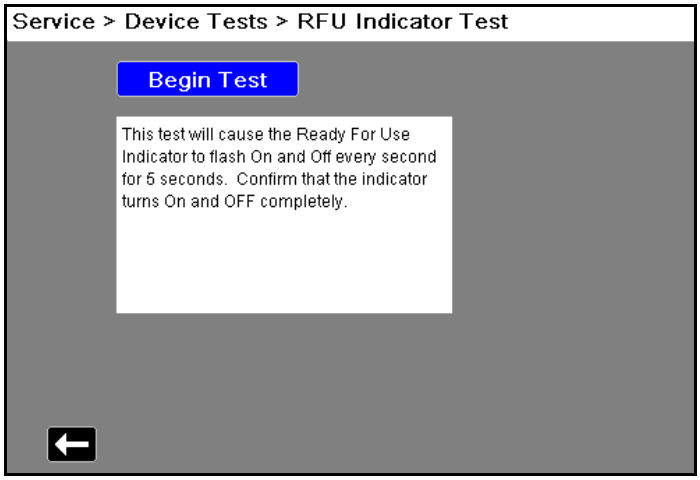
Follow the on-screen instructions and use the navigation keys to move around the display and to make selections.



5.4 RFU Indicator Test

This test checks the Ready For Use Indicator on the device to make sure it is working properly.

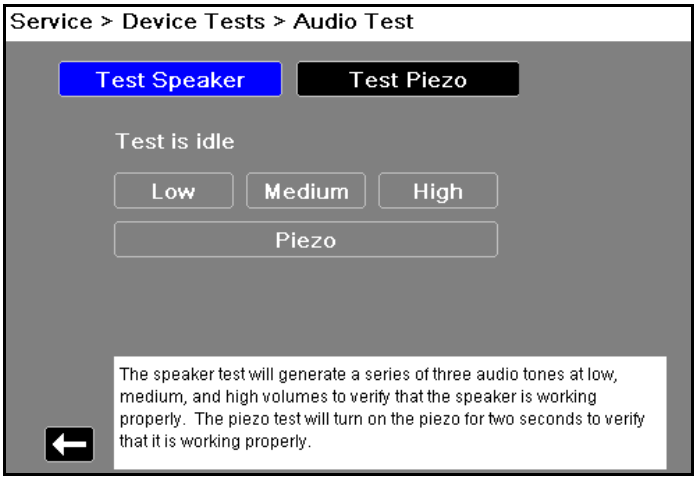
Follow the on-screen instructions shown on the display.



5.5 Audio Test

This test checks the audio tones on the device to make sure they are working correctly.

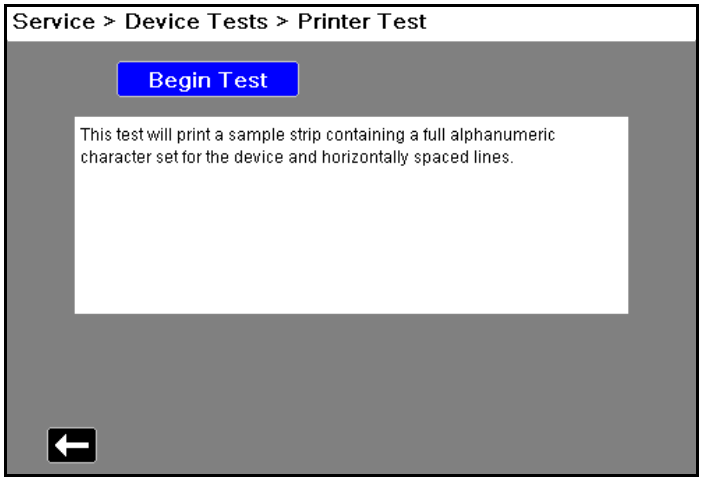
Follow the on-screen instructions and use the navigation keys to move around the display and to make selections.



5.6 Printer Test

This test checks the printer to make sure it is working properly.

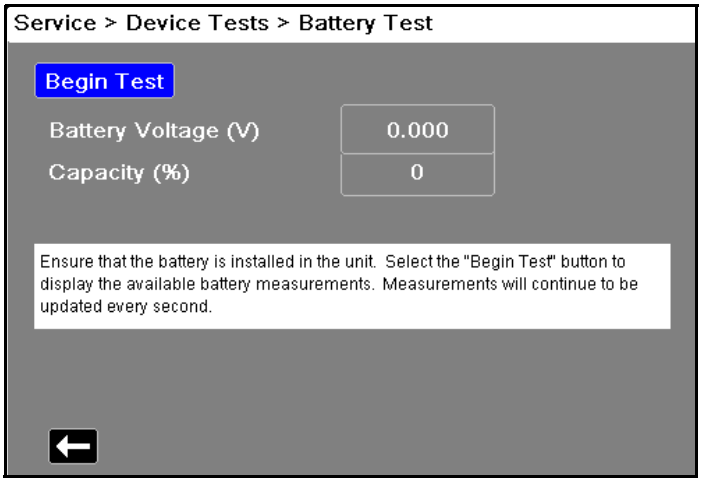
Follow the on-screen instructions.



5.7 Battery Test

This test checks the device's battery to make sure it is working properly and communicating with the device.

Follow the on-screen instructions.

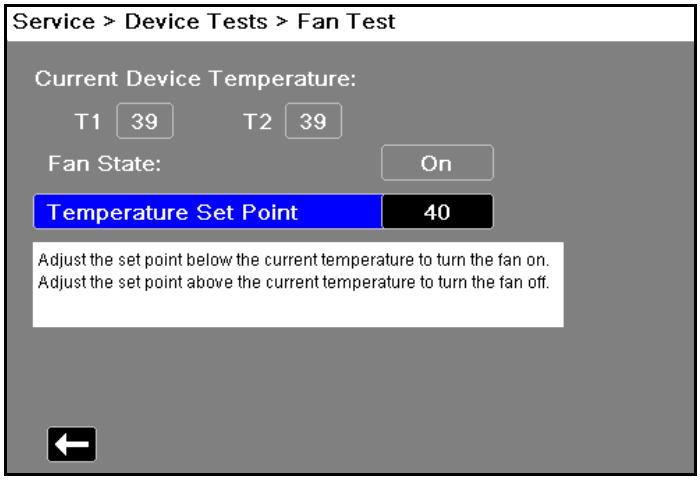


5.8 Fan Test

This test checks the fan in the device to make sure it is working properly.

Follow the on-screen instructions and use the navigation keys to move around the display and to make selections.

Note: As the internal fan is extremely quiet and difficult to hear, the on-screen Fan State indicator is used for the pass/fail criteria for this test.



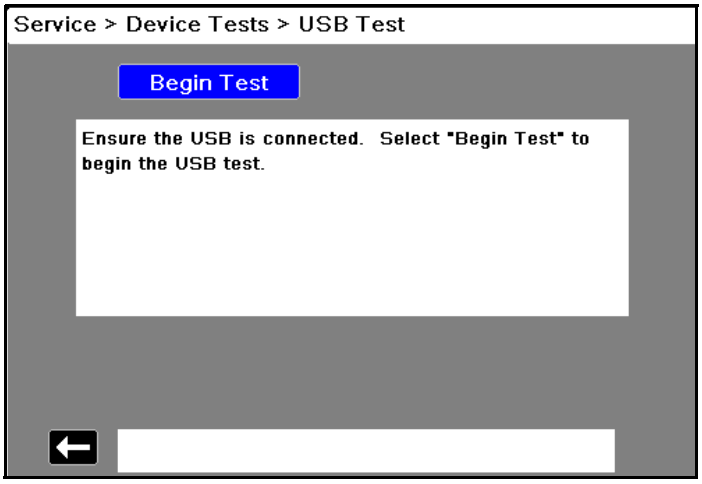
5.9 USB Test

Note: Before starting this test, you will need a copy of the Test File saved on a USB thumb drive. To obtain a copy of the Test File, you can download one from the ZOLL website, or you can create a Test File yourself. See instructions below.

This test checks the USB port to make sure it is functional and can read data from an external USB device.

Follow the on-screen instructions and use the navigation keys to move around the display and to make selections.

Verify that a *TEST PASSED* message appears on the display.



When these tests are completed, use the navigation keys to exit out of the Service menu.

Downloading the Test File

1. Insert a USB thumb drive into an open USB port on your computer. Ensure the thumb drive is recognized by the computer.
2. Open a web browser and navigate to *https://www.zoll.com/contact/technical-training/usb-test-file* .
3. Click on the “Download test file” link to initiate the download of the USB Test File.
4. Save or copy the USB Test File to the root (or “top-level”) directory of the USB thumb drive.
5. Eject the thumb drive and remove it from the computer’s USB port.

Creating a Test File

1. Create a Plain Text (.txt) file using Microsoft Notepad.
2. With the new file open, type in “Thunderbolt Testfile” exactly as it appears. Do not include the quotation marks or any leading/trailing spaces.
3. Save the file to the root (or “top-level”) directory of a USB thumb drive using the following file name: Tbolt_usb.txt

6.0 ECG Test

Equipment ECG Simulator, ECG cables (all available leads based on device configuration)

Test Setup Connect the lead wires to their corresponding studs on the ECG Simulator, then connect the ECG cable to the device. The ECG Simulator should be operating on battery power, if possible.

Press the Lead quick access key until II is the selected source.

	Do this...	Observe this...	Pass / Fail
6.1	Set the Simulator to 60 BPM.	The Heart Rate measures between 59–61 BPM on the device, and no *LEAD FAULT* message is displayed.	o o
6.2	Disconnect a single lead wire from the Simulator.	The *ECG LEAD FAULT* message displays within 3 seconds.	o o
6.3	Reconnect the lead to the Simulator stud.	Verify that the *ECG LEAD FAULT* message is cleared and that the ECG signal returns.	o o
6.4	Repeat the previous steps with the remaining leads.	When each lead is removed, verify the *ECG LEAD FAULT* message is displayed.	o o

7.0 Shock Test

WARNING! Take the necessary precautions to guard against shock or injury before you start conducting the defibrillator tests.

Keep hands and all other objects clear of the Multi-Function Cable connections and defibrillator analyzer when discharging the defibrillator.

Before you discharge the defibrillator, warn everyone near the equipment to STAND CLEAR.

Equipment Defibrillator analyzer, analyzer to MFC adapter cable, stopwatch

Test Setup Disconnect AC power and ensure a fully charged battery is installed in the device. Connect the MFC to the Analyzer. Place the Analyzer into the appropriate mode for receiving energy.

Note: The energy discharge values listed below are based on a 50 Ohm test load.

	Do This...	Observe This...	Pass/Fail
7.1	Turn on the X Series and press the Leads quick access key (I, II, III...) to select **PADS**.		
7.2	Using the ENERGY SELECT button, select 5J, then press the CHARGE button. Once the SHOCK button is illuminated, press the SHOCK button.		
7.3	On the Analyzer, observe and record the energy measurement.	The energy delivered is within the expected range for a 5J shock (3–7J).	o o
7.4	Using the ENERGY SELECT button, select 50J, then press the CHARGE button. Once the SHOCK button is illuminated, press the SHOCK button.		
7.5	On the Analyzer, observe and record the energy measurement.	The energy delivered is within the expected range for a 50J shock (46–62J).	o o
7.6	Using the ENERGY SELECT button, select 100J, then press the CHARGE button. Once the SHOCK button is illuminated, press the SHOCK button.		
7.7	On the Analyzer, observe and record the energy measurement.	The energy delivered is within the expected range for a 100J shock (93–125J).	o o

	Do This...	Observe This...	Pass/Fail
7.8	Using the ENERGY SELECT button, select 200J and then press the CHARGE button while simultaneously starting the stopwatch.	Verify that the device charges to 200J within 7 seconds as indicated by the stopwatch.	o o
Note: If the device fails to charge to 200J within 7 seconds, repeat this step with a known good fully charged battery.			
7.9	Once the SHOCK button is illuminated, press the SHOCK button.		
7.10	On the Analyzer, observe and record the energy measurement.	The energy delivered is within the expected range of a 200J shock (196–264J).	o o
7.11	On the printout, observe and record the transthoracic impedance (TTI).	The TTI is between 46–54 Ohms.	o o
Note: If the device fails to print, ensure that the (Defib/Pacer Events) configuration setting is enabled under **Supervisor** > **Printer**.			
7.12	Press the CHARGE button again to charge the device to 200J. Once charged, press the "Disarm" quick access key to disarm the device.	Verify the device displays a *DISARMED* message.	o o

Delivered Energy at 200J Defibrillator Setting into a Range of Loads

Selected Energy	Load							
	25Ω	50Ω	75Ω	100Ω	125Ω	150Ω	175Ω	Accuracy *
5 J	3 J	5 J	6 J	6 J	6 J	6 J	6 J	±3J
50 J	35 J	54 J	59 J	61 J	62 J	61 J	59 J	±15%
100 J	71 J	109 J	119 J	122 J	125 J	123 J	119 J	±15%
200 J	142 J	230 J	249 J	253 J	269 J	261 J	260 J	±15%

For a complete listing of X Series Delivered Energy at Every Defibrillator Setting into a Range of Loads, see Appendix A in the *X Series Operator's Guide* or *X Series Advanced Operator's Guide*.

8.0 Synchronized Cardioversion Test

Equipment Defibrillator analyzer, Multi-Function Cable (MFC), Analyzer to MFC adapter cable

Test Setup Connect the X Series to the Analyzer using a Multi-Function Cable.

Put the Analyzer in the appropriate mode for Synchronized Cardioversion. The Analyzer should be simulating a Normal Sinus Rhythm. Turn on the device and press the Leads quick access key until Pads is displayed.

	Do this...	Observe this...	Pass/Fail
8.1	On the X Series, press the **SYNC** quick access key.	SYNC appears on X Series display. Sync markers are displayed. The sync marker appears as an “S” over the ECG R-wave peaks on the display.	o o
8.2	Charge the device to any energy selection. When the SHOCK button illuminates, **press and hold** until energy is delivered.	On the Analyzer, verify the sync delay is less than 60 ms.	o o
Note: Depending on device configuration, you may need to press the "Sync" button again if you wish to repeat this test. By factory default settings, synchronized cardioversion turns off after energy is delivered.			

9.0 Pacer Test (if applicable)

o	Check here if this procedure is not applicable to your device.

Equipment Defibrillator analyzer, Multi-Function Cable (MFC), Analyzer to MFC adapter cable

Test Setup Connect the X Series to the Analyzer via MFC. Put the Analyzer in the appropriate mode to measure Pacing.

	Do This...	Observe This...	Pass/Fail
9.1	On the device, press the **PACER** button.		
9.2	On the device, use the navigation keys to do the following: • Set Rate to 30. • Set Mode to Fixed. • Set Output to 10. • Select Start Pacer.		o o
9.3	On the Analyzer, record the following: • Pacer Rate • Pacer Output (mA) • Pacer Pulse Width	• Pacer Rate PPM (29.55–30.45 ppm) • Pacer Output (5mA–15mA) • Pacer Pulse Width (38–42 ms)	o o
Note: You may see an *ECG FAULT* message display when leads are not attached. This is normal.			
9.4	On the device, use the navigation keys to do the following: • Set Rate to 180 • Set Output to 140		
9.5	On the Analyzer, record the following: • Pacer Rate • Pacer Output • Pacer Pulse Width	• Pacer Rate PPM (177.3–182.7 ppm) • Pacer Output (133–147mA) • Pacer Pulse Width (38–42 ms)	o o
9.6	On the device, select **Turn Pacer Off**.		

10.0 SpO_2 Test (if applicable)

Note: Perform this test if your device has **SpO_2 only**. If your device has SpO_2 SpCO, and SpMet, you may skip this test and proceed to the following test.

Note: The SpO_2 simulator cannot be utilized to assess clinical accuracy of SpO_2 technology. The following procedure has been designed as a functional check of the SpO_2 system.

o	Check here if this procedure is not applicable to your X Series device.

Equipment SpO_2 sensor

Test Setup Disconnect any ECG cables or IBP probes from the device. Turn the device off.

	Do This...	Observe This...	Pass / Fail
10.1	Turn on the device without the SpO_2 sensor connected.	The SpO_2 window displays *INITIALIZING*, then goes blank.	o o
10.2	Connect the SpO_2 sensor to the X Series.	The SpO_2 window displays *SEARCHING*.	o o
10.3	Place the SpO2 sensor on your index finger (or other appropriately sized finger). Ensure the sensor's light emitter is placed directly over the fingernail, and that the sensor is shielded from bright ambient light sources.	After a brief period of initialization, the SpO_2 numeric displays an SpO_2 value between 93–100%.	o o
Note: Individuals with certain diseases of the lungs (COPD, emphysema) may chronically have SpO_2 saturation levels below 95%.			
10.4	View the SpO_2 pleth on the X Series display.	The waveform is present and without signs of artifact. **Note:** Certain cardiac arrhythmias such as Atrial Fibrillation may produce rate and waveform irregularities.	o o

11.0 SpO_2, SpCO, and SpMet Test (if applicable)

Note: Use this test if your device has SpO_2 and SpCO, or SpO_2, SpCO and SpMet.

o	Check here if this procedure is not applicable to your device.

Note: The SpO_2 simulator cannot be utilized to assess clinical accuracy of SpO_2 technology. The following procedure has been designed as a functional check of the SpO_2 system.

Equipment Masimo Rainbow patient sensor

Test Setup Disconnect any ECG cables or IBP probes from the device. Turn the device off.

	Do This...	Observe This...	Pass/Fail
11.1	Turn on the device without the SpO_2 sensor connected.	The SpO_2 window displays *INITIALIZING*, then goes blank.	
11.2	Connect the SpO_2 sensor to the X Series.	Verify the SpO2 window displays *SEARCHING*.	
11.3	Place the SpO2 sensor on your index finger (or other appropriately sized finger). Ensure the sensor's light emitter is placed directly over the fingernail, and that the sensor is shielded from bright ambient light sources.	After a brief period of initialization, the SpO_2 numeric displays an SpO_2 value between 93–100%. **Note:** Individuals with certain diseases of the lungs (COPD, emphysema) may chronically have SpO_2 saturation levels below 95%.	o o
		The SpCO numeric field displays a value and is not blank.	o o
		The SpMET numeric field displays a value and is not blank.	o o
Note: SpCO and SpMet numerics may return a reading of zero. This is not an indication of failure.			
11.4	View the SpO_2 pleth on the display.	The waveform is present and without signs of artifact. **Note:** Certain cardiac arrhythmias such as Atrial Fibrillation may produce rate and waveform irregularities.	o o

12.0 $EtCO_2$ Calibration

Equipment 5% CO_2 calibration gas cylinder with CO_2 sample line kit (AirGas P/N: Z03NI748BDC002)

Note: ZOLL recommends using the kit referenced above. If not using this kit, ensure the calibration gas you are using has a composition of 5% CO_2 , 21% O2 and balance N2, and has a flow rate of 0.5 liters per minute.

Test Setup Turn on the device. Verify time and date are correct. Adjust time and date if necessary.

	Do This...	Observe This...	Pass / Fail / N/A
12.1	On the device, select **Supervisor>Service>Diagnostic>CO_2> Calibration** to enter the CO_2 Calibration control panel.		
12.2	 Connect the device to the calibration gas cylinder using the sample line. Ensure that one end of the T-connector is open to ambient air as pictured.		
12.3	From the CO_2 Calibration control panel, select **Calibrate**. **Note:** If the "Please Wait- Module Warming Up" message does not disappear within 2 minutes, check filter line tubing for occlusion. If no occlusion is found, switch out orange connector (gold ring end) with known good connector.		
12.4	When a *CALIBRATION IN PROGRESS* message appears, start the flow of calibration gas.		
12.5	Continue to apply the calibration gas until the status in the CO_2 Calibration control panel displays a *CALIBRATION GAS CAN BE REMOVED* message. When the calibration is complete, the status in the CO_2 Calibration control panel displays a *CALIBRATION DONE-OK* message.		o o
Note: It takes approximately 20 seconds before the *CALIBRATION DONE-OK* message appears.			
12.6	Return to the previous menu by selecting the return arrow in the bottom left corner of the calibration window.		

13.0 $EtCO_2$ Calibration Check

Equipment Calibration gas cylinder with CO_2 sample line kit (AirGas P/N: Z03NI748BDC002)

Note: If you have previously run the $EtCO_2$ Calibration procedure, start this procedure at step 3.

Note: ZOLL recommends using the kit referenced above. If not using this kit, ensure the calibration gas you are using has a composition of 5% CO_2 , 21% O2 and balance N2, and has a flow rate of 0.5 liters per minute.

	Do This...	Observe This...	Pass/Fail
13.1	On the device, select **Supervisor**>**Service**>**Diagnostic**>**CO_2**> **Calibration** to enter the CO_2 Calibration control panel.		
13.2	Connect the device to the calibration gas cylinder using the sample line included with the calibration kit.		
13.3	From the CO_2 Calibration control panel, select **Verify Calibration**.		
13.4	When the *VERIFICATION IN PROGRESS* message appears on the display, start the flow of calibration gas.		
13.5	Continue to apply the calibration gas until the status in the CO_2 Calibration control panel displays a *CALIBRATION GAS CAN BE REMOVED* message.		
13.6	After approximately 20 seconds, verify that the device displays a *VERIFICATION DONE - OK* message.Then verify that the measured gas reading is between 4.8 and 5.2 (Vol%).		o o
13.7	Exit out of calibration by pressing the Back arrow key ( ) three times or by pressing the Display/Home button ( ).		

14.0 $EtCO_2$ Test

Equipment CO_2 sampling line airway adapter (P/N: 8300-0520-01)

Test Setup None

	Do this...	Observe this...	Pass/Fail
14.1	On the device, connect the sampling line as pictured below. 		
14.2	Press the CO_2 quick access key to activate the CO_2 trace.	The CO_2 trace appears on the display.	o o
14.3	An *INITIALIZING* message appears within the CO_2 window. Note that the initialization period may take approximately 1 minute to complete. Wait for the initialization period to complete before continuing.		o o
14.4	Gently exhale into the sampling line while observing the display.	The CO_2 capnograph displays a waveform. **Note:** The waveform is delayed by approximately 3 seconds.	o o

15.0 IBP Test (if applicable)

o	Check here if this test is not applicable to your device.

Equipment IBP Patient Simulator (with accuracy better than +/- 1 mmHg)

Test Setup Turn on the device. Press the IBP quick access key.

	Do This...	Observe This...	Pass / Fail
15.1	Connect the Simulator to the P1 channel of the device.		
15.2	Set the Simulator to a static pressure of 0 mmHg.		
15.3	On the device, Press > P1->0<-.	0/0 (+/-2) is displayed in the P1 numeric at the bottom of the display (P1 is zeroed).	o o
		The waveform for channel 1 is present.	o o
15.4	Set the Simulator to a static pressure of 200 mmHg, or as close to 200 mmHg as your Simulator allows.	200/200 (+/-5) is displayed in the P1 numeric at the bottom of the display.	o o
15.5	Repeat the above steps of this procedure for P2 and P3 channels.		o o

16.0 NIBP Calibration Check

Equipment NIBP Simulator with a manometer mode, dual lumen hose, Adult (size 12) blood pressure cuff

Test Setup
- Turn on the device and ensure it is operating in Manual mode.
- Via a T-connector attached to your simulator, connect the simulator between a standard adult size blood pressure cuff and the device.
- Set NIBP Simulator to Static Pressure.
- Set the NIBP Simulator to a manometer mode for displaying pressure in mmHg.
- Verify the time and date on the device are correct. Adjust time and date if necessary.

	Do This...	Observe This...	Pass / Fail / N/A
16.1	Connect a dual lumen hose from the NIBP Simulator to the NIBP port of the device.		
16.2	On the device, do the following to enter the NIBP Test control panel: • Press the More ( ) and then the Setup ( ) quick access keys. • Use the navigation keys to select **Supervisor** > **Service** > **Device Tests** > **NIBP Test**. **Note:** A supervisor passcode is required to enter the Supervisor menu.		
16.3	From the NIBP Test control panel, use the navigation keys to select: • **Close Valve** • **Turn Pump On**		
16.4	Once the pressure reaches the target pressure of 50 +/- 5 mmHg, use the navigation keys to select **Turn Pump Off**.		
16.5	Allow the system to stabilize for at least 10 seconds.		
16.6	Verify that the primary transducer agrees with the reading on the manometer.	Reading is within 3 mmHg.	o o o
16.7	Verify that the safety transducer agrees with the reading on the manometer.	Reading is within 4 mmHg.	o o o
16.8	From the NIBP Test control panel, use the navigation keys to select: • **Turn Pump On**		

	Do This...	Observe This...	Pass / Fail / N/A
16.9	Once the pressure reaches the target pressure of 150 +/- 5 mmHg, use the navigation keys to select **Turn Pump Off**.		
16.10	Allow the system to stabilize for at least 10 seconds.		
16.11	Verify that the primary transducer agrees with the reading on the manometer.	Reading is within 3 mmHg.	o o o
16.12	Verify that the safety transducer agrees with the reading on the manometer.	Reading is within 4 mmHg.	o o o
16.13	From the NIBP Test control panel, use the navigation keys to select: • **Turn Pump On**		
16.14	Once the pressure reaches the target pressure of 250 +/- 5 mmHg, use the navigation keys to select **Turn Pump Off**.		
16.15	Allow the system to stabilize for at least 10 seconds.		
16.16	Verify that the primary transducer agrees with the reading on the manometer.	Reading is within 3 mmHg.	o o o
16.17	Verify that the safety transducer agrees with the reading on the manometer.	Reading is within 4 mmHg.	o o o
16.18	From the NIBP Test control panel, select **Open Valve** to release the pressure.		
16.19	Once complete, use the navigation keys to select **Update NIBP Cal Check Date**. This will update the date of the most recent calibration check. **Note:** No confirmation message is displayed upon updating.		

17.0 NIBP Leak Test

Equipment Dual lumen NIBP hose, Adult (size 12) blood pressure cuff, stopwatch

Test Setup Turn on the device and ensure it is operating in Manual mode. Connect the NIBP tubing from the device to the blood pressure cuff. Wrap the cuff around an appropriately sized mandrel.

	Do This...	Observe This...	Pass / Fail / N/A
17.1	On the device, do the following to enter the NIBP Test control panel: • Press the More ( ) then the Setup ( ) quick access keys. • Use the navigation keys to select **Supervisor**>**Service**>**Device Tests**>**NIBP Test**. **Note:** You need a supervisor passcode to enter the Supervisor menu.		
17.2	From the NIBP Test control panel, use the navigation keys to select: • **Close Valve** • **Turn Pump On**		
17.3	Once the pressure reaches the target pressure of 250 +/- 5 mmHg, use the navigation keys to select **Turn Pump Off**.		
17.4	Allow the system to stabilize for at least 10 seconds.		
17.5	Select **Mark P1** to mark the starting pressure. Wait 15 seconds, then select **Mark P2**.		
17.6	From the NIBP Test control panel, select **Open Valve** to release the pressure.		
17.7	Calculate the leak rate: L = P1 - P2.	Leak rate is less than or equal to 5 mmHg.	o o o

18.0 Inflation/Deflation Test

Equipment Dual lumen NIBP hose, Adult (size 12) blood pressure cuff, stopwatch

Test Setup Turn on the device and ensure it is operating in Manual mode. Connect the NIBP tubing from the device to the blood pressure cuff. Wrap the cuff around an appropriately sized mandrel.

	Do This...	Observe This...	Pass/Fail
18.1	On the device, navigate to the NIBP Test control panel by pressing the Settings quick access key > **Supervisor** > **Service** > **Device Tests** > **NIBP Test**.		
18.2	From the NIBP Test control panel, use the navigation keys to select **Close Valve**.		
18.3	Use the navigation keys to select **Turn Pump On**. Simultaneously start the stopwatch.		
18.4	Stop the stopwatch as soon as the pressure exceeds 210 mmHg as indicated on the device's display. Select **Turn Pump Off**.	The time is less than 7 seconds as indicated by the stopwatch.	o o
18.5	Adjust the pressure to 265 +/- 5 mmHg by turning the pump back on (if needed) and selecting **Turn Pump Off** when the pressure is reached. If the pressure reading exceeds the desired pressure, open the valve to relieve the pressure, close valve, and turn pump on, stopping when pressure reaches the target above.		
18.6	Allow the system to stabilize for 5 seconds. Reset the stopwatch.		
18.7	Use the navigation keys to select **Open Valve** and simultaneously start the stopwatch.		
18.8	Stop the stopwatch as soon as pressure drops below 15 mmHg.	Verify that the pressure drops below 15 mmHg within 10 seconds as indicated by the stopwatch.	o o

19.0 NIBP Functional Test

Note: There is no way to assess NIBP accuracy with a blood pressure simulator. This test has been designed as a functional check of the NIBP system and is not a substitute for static pressure testing. Recorded vital signs may be higher or lower than the simulated target and this does not indicate a device malfunction.

Equipment NIBP Simulator, Dual lumen NIBP tubing, Adult (size 12) blood pressure cuff

Test Setup Turn the device on and ensure it is in Manual mode. Exit any service menus if continuing from the previous test. Before taking a measurement, disconnect the MFC and ECG cables from the simulator.

	Do This...	Observe This...	Pass / Fail / N/A
19.1	Set the NIBP simulator to 200/150 with a HR of 60–100 BPM.		
19.2	Press the **NIBP** button to take a reading.	Verify that the NIBP system operates and that a reading is returned on the display.	o o

20.0 Temperature Test (if applicable)

o	Check here if this procedure is not applicable to your device.

Equipment Temperature simulator, temperature cable

Test Setup Turn on the device and enter Manual mode.

	Do this...	Observe This...	Pass / Fail
20.1	Connect the Simulator to the T1 channel of the device using a temperature cable.		
20.2	On the Simulator, simulate a temperature of 98.6 °F (37 °C), or a setting as close as your Simulator allows.	The T1 channel on the X Series displays a temperature value within 1 °F (0.5 °C) of the Simulator's setting.	o o
20.3	On the device, disconnect the temperature cable from the T1 channel and insert it into the T2 channel.	The T2 channel on the X Series displays a temperature value within 1 °F (0.5 °C) of the Simulator's setting.	o o

21.0 Wi-Fi Test (optional)

Note: If you do not use Wi-Fi functionality on your device, this test is optional. In which case, record a check mark in the field below and proceed to the next test procedure.

o	Check here if this procedure was not performed.

Equipment Dual-Band Router (2.4GHz and 5.0GHz)

Test Setup Set the router network name for each of the frequency bands.

- SSID= (your network name, i.e. WATS24, WATS50)
- Authentication= (your authentication mode, i.e. WPA-PSK, WPA2-PSK, Enterprise)
- Security Key= (enter your security key, i.e. 123456789)

	Do This...	Observe This...	Pass / Fail
21.1	Turn on the device and enter Manual mode. Bypass AED mode if prompted.	The amber wireless icon appears at the top of the display screen within 1 minute.	o o
21.2	On the device, do the following to test at 2.4GHz: • Press the More ( ) then the Setup ( ) quick access keys. • Use the navigation keys to select **Supervisor>Communications**. • Use the navigation keys to enable **Wi-Fi**, then select **Configure**. • Highlight **Add**, then in the **Add AP Profile** window, select DHCP setting, and enter the desired settings for Profile Name (i.e. Test24), SSID (i.e. WATS24), Authentication, and Security Key. • Press the Display/Home ( ) button to exit the menu.		o o
21.3	On the main display screen, do the following: • Use the Display/Home ( ) button and then the navigation keys to highlight the wireless icon. • Use the navigation keys to highlight Wi-Fi Access Point and select the profile name you created in step 2.	The Access Point name is in the **Selected Access Point** field	o o
21.4	Press to exit the menu.	The wireless icon turns green.	o o

	Do This...	Observe This...	Pass / Fail
21.5	On the device, do the following to test at 5.0GHz: • Press the More ( ) then the Setup ( ) quick access keys. • Use the navigation keys to select **Supervisor** > **Communications**. • Use the navigation keys to enable **Wi-Fi**, then select **Configure**. • Highlight **Add**, then in the **Add AP Profile** window, select DHCP setting, and enter the desired settings for Profile Name (i.e. Test50), SSID (i.e. WATS50), Authentication, and Security Key. • Press the Display/Home ( ) button to exit the menu.		o o
21.6	On the main display screen, do the following: • Use the Display/Home ( ) button and then the navigation keys to highlight the wireless icon. • Use the navigation keys to highlight Wi-Fi Access Point and select the profile name you created in step 2.	Verify that the Access Point name is in the **Selected Access Point** field	o o
21.7	Press to exit the menu.	Verify that the wireless icon turns green.	o o
21.8	On the main display screen, do the following: • Press the More ( ) then the Setup ( ) quick access keys. • Use the navigation keys to select **Supervisor**>**Communications**. • Use the navigation keys to enable **Wi-Fi**, then select **Configure**. • Highlight the *Access Point Names* from step 2 and step 5, then select **Delete**.	Verify that the wireless icon changes to amber.	o o

22.0 Audio Recording Test (if applicable)

Note: Performing this test procedure is optional. If you elect not to perform this test procedure, record a check mark in the field below and proceed to the next test procedure.

o	Check here if this procedure was not performed.

Equipment USB thumb drive with 1–4 GB of storage capacity, PC with Windows Media Player and speakers

	Do This...	Observe This...	Pass/Fail
22.1	Turn off the device and wait at least 2 minutes. **Note:** The device requires a 2 minute power cycle in order to start a new case file.		
22.2	Turn the device on. Wait 15 seconds after the *SELF TEST PASSED* message disappears, and then speak loudly and clearly into the device's microphone: "Test, one, two, three."		
22.3	Press the LOG quick access key to access the log, and then press the USB quick access key (pictured). 		
22.4	Insert the USB thumb drive into the USB port on the device.	Verify the USB trident symbol appears at the top of the screen.	o o
22.5	Select the active case to transfer the case to the USB thumb drive.	Wait for the file transfer to the USB thumb drive to complete.	o o
22.6	Remove the USB thumb drive from the device and then select OK.		
22.7	Insert USB thumb drive into PC, and then navigate to USB thumb drive using Windows Explorer.		
22.8	Right-click on the recently modified .OGG file and select Play. **Note:** By default, the audio file will open in Windows Media Player unless your PC is configured otherwise.	Verify if the words that you spoke earlier ("Test, one, two, three") are clearly heard in the audio playback.	o o

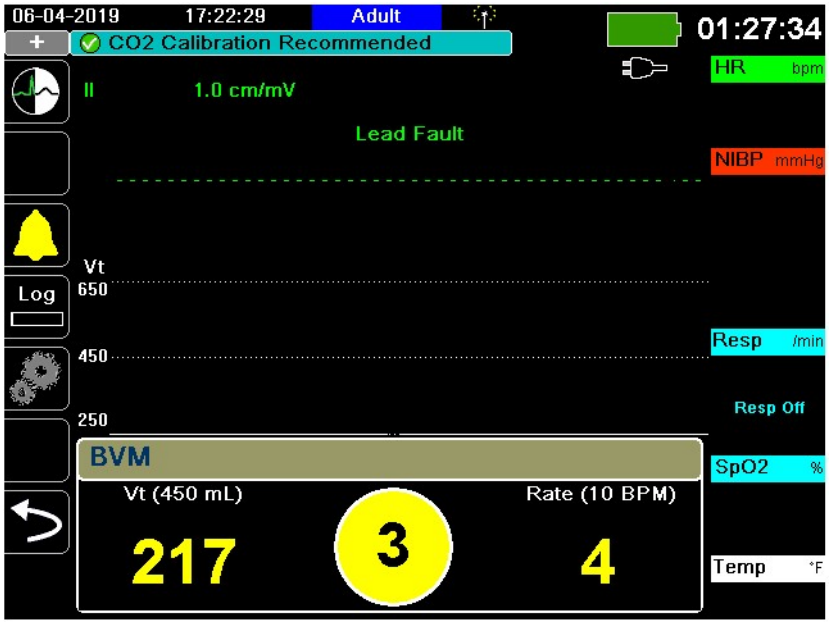
23.0 Real BVM Help Test (if applicable)

Equipment — Adult BVM, AccuVent Sensor Cable (ZOLL P/N: 8000-000993), AccuVent Sensor (Box of 10) (ZOLL P/N: 8000-001128)

Test Setup — Connect AccuVent Sensor to the AccuVent Sensor cable. Attach AccuVent cable and sensor to the BVM. Connect sensor cable to the BVM port on the X Series.

Low Volume/ Hyperventilation Test

	Do This...	Observe This...	Pass/Fail
23.1	Squeeze the BVM until the volume indicator is half full at an interval of 1 breath every 10-15 seconds.	Verify that both the **Volume** and **Rate** indicator turn yellow.	o o

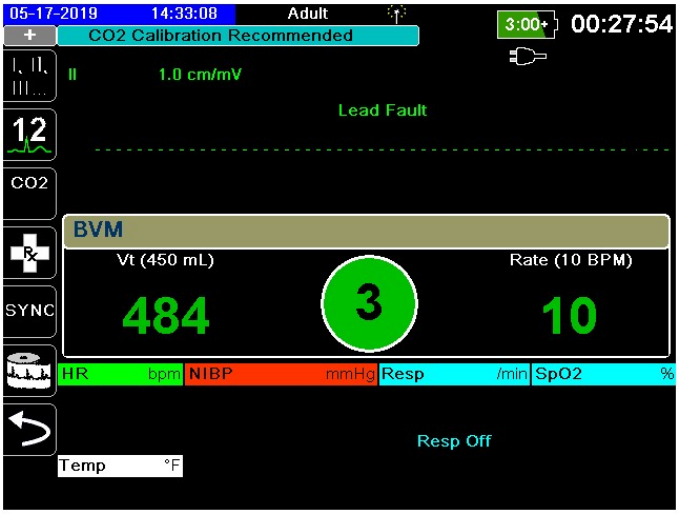


High Volume/ Hyperventilation Test

	Do This...	Observe This...	Pass/Fail
23.2	Squeeze the BVM until the volume indicator exceeds the target at an interval of 1 breath every 3 seconds.	Verify that both the **Volume** and **Rate** indicator turn yellow.	o o
Note: Device will display "+++" when volume exceeds maximum setting.			

Target Volume/Target Ventilation Test

	Do This...	Observe This...	Pass/Fail
23.3	Squeeze the BVM until the volume indicator reaches the intended target. Breath intervals should follow the displayed countdown based on configured settings.	Verify that both the **Volume** and **Rate** indicator turn green.	o o



24.0 CPR Feedback Test (if applicable)

o	Check here if this test procedure is not applicable to your device.

Equipment Universal Adapter Cable (ZOLL P/N 8000-0804-01) with CPR Connector (P/N 8000-0370)

Note: The CPR Connector is not required if you are using the MFC-CPRD X Series cable.

Test Setup
- Connect the MFC to the Universal Adapter Cable (use the CPR Connector, if required).
- Connect the Universal Adapter Cable to the defibrillator analyzer.
- Ensure that the device is turned on and operating in Manual mode.

	Do this...	Observe this...	Pass/Fail
24.1	To activate CPR feedback, perform compressions with the training sensor at a rate of approximately 100 compressions per minute and at a depth of approximately 2 inches.	While compressions are performed, verify that CPR feedback is displayed on the screen. Note that the depth and rate numeric may not display depending on device configuration.	o o
Note:	CPR feedback will not register until a valid impedance is detected. Ensure that the OneStep Training Cable is connected between the OneStep MFC and the defibrillator analyzer.		
Note:	The training sensor is not pressure sensitive. It requires physical movement which is measured via an accelerometer.		

25.0 Paddles Test (if applicable)

o	Check here if this test is not applicable to your device.

Equipment Multi-Function Cable (MFC), external paddles

Test Setup Turn on the device and ensure it is operating in Manual mode.

WARNING! This test involves the discharging of high voltage energy which has the potential to cause personal injury or death. Take all necessary safety precautions before you start conducting this test.

Remove all jewelery before conducting this test. Keep all objects clear of the Multi-Function Cable connections and external paddles when discharging the defibrillator.

Before you discharge the defibrillator, warn everyone near the equipment to STAND CLEAR.

	Do this...	Observe this...	Pass/Fail
25.1	Inspect the paddles for any signs of cracking or obvious signs of damage. Paddles should be clean.	No damage is visible, paddles are clean.	o o
25.2	Do the adult shoes slide off easily to expose the pediatric plates?	Plates are easy to remove.	o o
25.3	Do the paddle plates show any deep scratches or show signs of damage?	Paddles plates are clean with no signs of damage or deep scratches.	o o
25.4	Reattach Adult plates to the paddles.	Adult plates are easy to reattach.	o o
25.5	Ensure the MFC cannot be inserted with reversed polarity (upside-down)	MFC cable cannot be reversed.	o o
25.6	With the correct orientation, insert the MFC into the APEX paddle.	MFC securely connects to the APEX paddle.	o o
25.7	Short the paddles by firmly pressing both the APEX and STERNUM adult plates together.	“Paddle Short Detected” appears on the display.	o o
Note:	It is important to keep the paddle plates firmly pressed together for the remainder of this test. DO NOT ATTEMPT to deliver energy unless the paddle plates are physically shorted.		

	Do this...	Observe this...	Pass/Fail
25.8	Press the ENERGY SELECT DOWN button on the sternum paddle.	Verify that the energy level decreases.	o o
25.9	Press thew ENERGY SELECT UP button on the sternum paddle.	Verify that the energy level increases.	o o
25.10	Press and release the RECORDER button on the sternum paddle.	Verify that the recorder starts printing. You may press thew button a second time to stop printing.	o o
25.11	Using the ENERGY SELECT buttons on the paddles, select 30 Joules and then press the CHARGE BUTTON on the APEX paddle.	Verify that the device charges to 30J and the red LED charge indicator on the apex paddle illuminates.	o o
25.12	Press and release the APEX SHOCK button.	Verify the device does not discharge.	o o
25.13	Press and release the STERNUM SHOCK button.	Verify the device does not discharge.	o o
25.14	Press and hold Both SHOCK buttons on the paddles.	Verify the device discharges. The device displays *DEFIB SHORT TEST PASSED* on the display.	o o

Chapter 2
Troubleshooting

Overview

This chapter contains a list of error messages that users may see if the unit is not operating properly.

If the errors you encounter are not listed below, call ZOLL Medical Corporation's Technical Service Department for further assistance. See **Preface** for contact information.

X Series Error Messages

The following is a list of the X Series error messages that may appear on your display. The "Technical Action" column describes what you as a technician can do to correct the situation.

Error Message	Explanation	Technical Action
ALARM SILENCE SHORT	Alarm Silence/Reset key is stuck.	Replace the front panel.
BLUETOOTH PHONE UNAVAILABLE	The X Series unit was unable to establish a Wide Area Network connection. None of the Bluetooth phones paired with the device were detected.	To correct the problem, verify the following: • The Bluetooth device is paired with the X Series unit. • The phone is on and near enough to the device to permit communication. • The phone is configured to allow data connection requests (if the phone has such a configuration setting).
CELLULAR CONNECT FAILURE	The X Series unit was unable to establish a Wide Area Network connection. A cellular modem or Bluetooth cellular phone connection was attempted, but failed.	To correct the problem, verify the following: • The cellular provider information, particularly the call number, is correctly configured. • The cellular device has an active plan. • There is adequate cellular network signal coverage in the area. • (For phones) The phone is configured to allow data connection requests (if the phone has such a configuration setting). • (For modems) The cellular modem is a supported device and is securely connected to the X Series unit. If all the configurations are correct, retry the operation.

Error Message	Explanation	Technical Action
CHECK COMM CONFIGURATION	A configuration error prevented successful communication.	To correct the problem, verify the following: • The reports configuration contains valid values for the Server, Port, Customer ID, and Password fields. • (Cellular modem) You are using a valid cell provider configuration (including call number) and the provider name is specified as the USB cell modem provider. • (Bluetooth DUN phone) A valid cell provider configuration (including call number) is present and the provider name is associated with the DUN phone pairing.
CO2 BAROMETRIC OUT OF RANGE	Altitude is too high for module.	Bring device into specified altitude range. If problem persists, replace the CO_2 module.
CO2 CAL FAILURE	Calibration failed.	Retry calibration or continue with old calibration. Replace the CO_2 module.
CO2 CAL REMINDER	Calibration reminder.	Calibrate the CO_2 module soon.
CO2 CAL REQUIRED	Calibration due.	Calibrate the CO_2 module.
CO2 CHECK FLOW	Exhaust port blocked.	Check for exhaust port occlusion. If problem persists, replace the CO_2 module.
CO2 COM ERROR CODE	Communication failure.	Check communication cables. If problem persists, replace the CO_2 module.
CO2 DEVICE FAILURE	Malfunction or device failure.	Replace the CO_2 module.

Error Message	Explanation	Technical Action
CO2 GAS INPUT OCCLUSION	CO_2 inlet blocked.	Replace FilterLine®. If problem persists, check for CO_2 inlet occlusion. If problem still persists, replace the CO_2 module.
CO2 MAINTENANCE REMINDER	Periodic maintenance reminder.	Replace CO_2 module soon.
CO2 MAINTENANCE REQUIRED	Periodic Maintenance due.	Replace CO_2 module.
CO2 NO FILTERLINE	No filterline is detected.	If FilterLine is connected and problem persists, replace FilterLine. If problem still persists, replace the CO_2 module.
DEFIB CAP LEAKAGE	Capacitor bank cannot hold a charge.	Replace the capacitor bank module.
DEFIB CHARGE ERROR	Over voltage was detected.	If problem persists, replace the defibrillator board module.
DEFIB CHARGE TIMEOUT FAIL	The battery did not produce enough current to charge capacitor.	Charge the battery. If voltages are okay (from battery and aux), replace the defibrillator board module.
DEFIB DEVICE FAILURE	One of the following issues occurred: • Device could not charge up the self-test energy. • Discharge circuit failed to discharge voltage within specified time duration. • Device failed to deliver correct self-test energy.	Check communication cables. If problem persists, replace defibrillator board module.
DEFIB DISCHARGE TEMP	Device is in a hot environment or the discharge circuit is always on.	Move device to cooler area. If problem persists, replace the defib board module.
DEFIB FATAL CHARGE ERROR	Charging error.	Replace the defibrillator board module.

Error Message	Explanation	Technical Action
DEFIB FIRE FAILURE	High impedance or low impedance (short).	Replace pads. If problem persists, check internal connections. If problem still persists, replace the defibrillator board module.
DEFIB LOW BATTERY	Battery is too low to charge defibrillator.	Charge the battery. Check battery contacts and clean if necessary.
DEFIB NO ENERGY DELIVERED	High impedance. No defib energy was delivered.	Replace pads. If problem persists, check internal connections. If problem still persists, replace the defibrillator board module.
DEFIB PACER DEVICE FAILURE	One of the following issues occurred: • Error was detected on the defib/pacer board. • Interface self-test communication failed. • Pacer interface self-test failed. • Communication with pacer hardware failed after startup.	Check communication cables. If problem persists, replace the defibrillator board module.
DEFIB PHASE FAILURE	Phase I or phase II waveform dropout.	Replace the defibrillator board module.
DEFIB USING DEFAULT CALIBRATION	Calibration data lost.	Replace the defibrillator board module.
ECG DEVICE FAILURE	ECG software detected a problem with the ECG data that is most likely a hardware issue.	Replace the main board.
FP DEFIB CHARGE SHORT	Keys are stuck.	Replace the front panel.
FP DEFIB ENERGY DOWN SHORT	Defib energy Select Down (Decrease) key is stuck.	Replace the front panel.
FP DEFIB ENERGY UP SHORT	Defib energy Select Up (Increase) key is stuck.	Replace the front panel.
FP DEFIB FIRE SHORT	A key or a front panel button is stuck.	Replace the front panel.

Error Message	Explanation	Technical Action
HW SHUTDOWN	Voltage threshold exceeded the minimum working threshold of the device. There is no warning.	Charge the battery.
IBP DEVICE FAILURE	IBP software detected a problem with the IBP data that is most likely a hardware issue.	Replace the main board.
IBP PROBE1/PROBE2/ PROBE3 SHORTED	An A/D value was detected that indicated the probe was shorted.	Replace the problematic IBP probe. If the problem persists, replace the right side panel.
IBP PROBE1/PROBE2/ PROBE3 CIRCUIT FAILURE	An unsupported probe was inserted or there is a circuit problem.	Unplug the problematic probe, power cycle. If problem persists, replace main board.
NAMESERVICE FAILURE	The reports server hostname could not be resolved via DNS.	To correct the problem, verify the following: • The server DNS name is entered correctly and completely in the reports configuration. • The DNS server(s) are correctly configured (if using a Wi-Fi profile where static IP information was configured). • The DHCP server on the Wi-Fi network provides valid and correct DNS information in its response (if using a Wi-Fi profile with DHCP). If using any form of cellular connectivity, retry the operation.
NAV PAD DOWN SHORT	Down/Counterclockwise Navigation key is stuck.	Replace the front panel.
NAV PAD SELECT SHORT	Select key is stuck.	Replace the front panel.
NAV PAD UP SHORT	Up/Clockwise Navigation key is stuck.	Replace the front panel.

Error Message	Explanation	Technical Action
NIBP AIR LEAK	Major air leak or could not reach target pressure.	Attempt to identify problems with the hose and/or cuff by doing the following: • Check the hose connection to the device. Make sure that the hose is tightly screwed onto the NIBP connector. • Ensure that the cuff is appropriately wrapped and is not too loose. • Inspect the cuff and hose for leaks. Inspect the O-ring on the NIBP hose connector. Consider replacing the cuff and/or hose. If the problem persists, perform the following procedure: *"NIBP Leak Test" on page 42*: Inspect internal NIBP tubing for leaks.
NIBP ARTIFACT	Unable to determine blood pressure. Check connections; restrict patient movement.	Attempt to identify and eliminate the source of artifact. If problem persists, replace the NIBP module.
NIBP COMMUNICATION FAILURE	There is a communication problem with the NIBP module.	Ensure that the J32 connection is secure. If error persists, replace the NIBP module.
NIBP EQUIPMENT CHECK	Device is unable to obtain a reading.	Check the hose and cuff connections. If problem persists, perform one or more of the following procedures in Chapter 1: • NIBP Leak Test • NIBP Deflation Test • NIBP Inflation Test
NIBP KINKED HOSE	The cuff inflation was too rapid. There may be kinked tubing or another air obstruction.	Check the external NIBP hose for kinks. If problem persists, check the routing of the NIBP tubing inside the device.

Error Message	Explanation	Technical Action
NIBP LOW VOLTAGE	Insufficient voltage is supplied to the NIBP module.	Check the module voltage in the NIBP Test screen. Inspect the unit or water ingress. If evidence of water ingress is found, allow the water to evaporate while periodically checking the module voltage. If problem persists, replace the NIBP module.
NIBP MAX PRESSURE EXCEEDED	Pressure limit exceeded.	If problem persists, do the following: • Check the calibration via the "NIBP Calibration Check" on page 40. • Check the routing of the NIBP tubing inside the device for kinks or obstructions. If the NIBP module is out of calibration, replace the NIBP module.
NIBP MONITORING FAILURE	One of the following issues occurred: • A failure was reported by the NIBP module. • The two transducers are not aligned. They are either not calibrated, there is a transducer failure, or there is a kinked tube. • A calibration problem was reported by the NIBP module.	If problem persists, replace the NIBP module.
NIBP NEONATAL DETECTED	Device thinks a neonate cuff is connected. If no neonate cuff is connected, tubing may be damaged or kinked.	Verify that neonate cuff is not connected. If problem persists, check the routing of the NIBP tubing inside the device.
NIBP TEMP OUT OF RANGE	Module temperature is out of its specified operating range.	Move the device to a cooler or warmer environment.
NIBP WEAK PULSE	Too few pulses are detected during the reading attempt.	Tighten the cuff and ensure appropriate placement.

Error Message	Explanation	Technical Action
PACER CURRENT FAULT	Lack of pacer current.	Replace the defibrillator board module.
PACER DEVICE FAILURE	Generation of pacer pulse failed.	Replace the defibrillator board module.
PRINTER OFFLINE	Printer module is off-line.	If it remains off line, try checking the connectors or power to the printer. If problem persists, replace the printer module.
PRINTER OUT OF PAPER	If there is paper in the device, probably a paper sensor problem.	Replace the printer module.
PRINTER PLATEN OPEN	If printer door is closed, probably a problem with the micro switch.	Replace the printer module.
PS DEFIB CHARGE SHORT	One of the paddle set keys are stuck.	Replace the paddle set or MFC.
PS DEFIB ENERGY DOWN	Paddle set keys are stuck.	Replace the paddle set or MFC.
PS DEFIB ENERGY DOWN SHORT	Paddle set energy down select button is stuck.	Replace the paddles.
PS DEFIB ENERGY UP	Paddle set keys are stuck.	Replace the paddle set or MFC.
PS DEFIB FIRE SHORT	Paddle set keys are stuck.	Replace the paddle set or MFC.
PS DEFIB RECORDER SHORT	One of the paddle set keys are stuck.	Replace the paddle set or MFC.
QUICK ACCESS SW 1(to SW 7) SHORT	One of the quick access keys (key 1 to key 7) is stuck.	Replace the front panel.
SCREEN CYCLE SHORT	Display/home key is stuck.	Replace the front panel.

Error Message	Explanation	Technical Action
SERVER AUTHENTICATION FAILED	The reports server rejected the conncetion request from the X Series device.	To correct the problem, verify the following: • The customer ID and password are correctly entered in the reports configuration. (The password is case sensitive.) • The reports configuration has the correct server hostname and port. • The communications processor (CP) software is up to date.
SERVER UNREACHABLE	Although a WAN connection was established, the reports server connection could not be established or the connection was lost during a transfer.	Retry the operation.
SERVICE ERROR <CODE>	While communicating with the remote server, there was an error.	Retry the operation.
SNAPSHOT SHORT	Snapshot key is stuck.	Replace the front panel.
SPO2 COM ERROR CODE	Communication error.	Check communication cables. If problem persists, replace the SpO_2 module.
SPO2 DEVICE FAILURE	Communication failure or device malfunction.	Check the SpO_2 communication cables. If problem persists, replace the SpO_2 module.
SPO2 SENSOR FAILURE	Defective sensor or sensor error.	Replace the SpO_2 sensor.
SPO2 UNKNOWN RECOVERY NUM	Recovery error.	Replace the SpO_2 sensor.
SW SHUTDOWN WARNING	Indication that the battery has reached the software shutdown capacity.	Charge the battery.
TEMP1 (or TEMP2) CIRCUIT FAILURE	The software detected an out-of-range A/D converter.	Remove probe then power cycle. If problem persists, replace the main board.

Error Message	Explanation	Technical Action
TEMP DEVICE FAILURE	Temp software detected a problem with the temperature data that is most likely a hardware issue.	Replace the main board.
TEMP PROBE1 (or PROBE2) SHORTED	An A/D value was detected that indicated the probe was shorted.	Replace the temperature probe or adapter cable. If problem persists, replace the right side panel.
TRANSMISSION FAILED	The communication operation failed. This message displays until a new operation is started.	To correct the problem, verify the following: • Wireless communication is enabled on the X Series unit. • The Wi-Fi settings are correct in the Communications setup menu. • The ZOLL server is configured correctly. • Your cellular device is configured correctly. • The X Series unit is within range of the wireless server.
WAN CONNECTION UNAVAILABLE	The X Series unit was unable to establish a WAN connection.	To correct the problem, verify the following: • Wireless communication is enabled on the X Series unit. • The expected means of coummunication is enabled (for instance, if using a cell modem, make sure the USB cell modem is set to **Enabled**). • (Bluetooth) It is paired with the X Series unit. • (Wi-Fi) The correct Wi-Fi access point profile is selected. • (Cellular modem) It is properly connected to the X Series unit and that the USB icon on the display is illuminated.

Chapter 3
Disassembly Procedures

Overview

This chapter provides instructions on how to disassemble and reassemble the X Series unit. It includes the following sections:

- Required Equipment
- Safety Precautions
- Modules
- Handle Disassembly
- Printer Disassembly
- Main Unit Disassembly
- Front Enclosure Disassembly
- Display Disassembly
- NIBP and $EtCO_2$ Disassembly
- Monitor Board and SpO_2 Disassembly
- CP Carrier Disassembly
- Defibrillator Board and Capacitor Bank Disassembly
- AUX Power Connector Disassembly
- Dock Connector Disassembly
- Replacing the Multifunction Cable Gasket

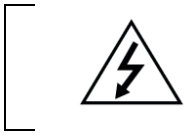
Required Equipment

- #1 Phillips screwdriver with torque capability
- #2 Phillips screwdriver with torque capability
- Wooden stick (Available from H.A. Stiles: 1-800-447-8537)
- Needle nose pliers
- 6 mm socket wrench

- 26 mm socket wrench
- Kapton tape
- 3M copper adhesive tape, or equivalent
- Large diagonal cutters

Safety Precautions

WARNING! **SHOCK HAZARD!**



Caution TAKE THE NECESSARY PRECAUTIONS TO GUARD AGAINST SHOCK OR INJURY BEFORE YOU CONDUCT DEFIBRILLATOR TESTS OR REPAIRS.

- Only properly trained technicians should service the unit.
- The unit can contain deadly voltages even if the unit is turned off.
- Make sure to discharge the unit before working with it.
- Make sure you take the necessary precautions when working with static sensitive units. For example, you must wear a conductive wrist strap (which touches your skin) connected to a grounding mat and to the earth ground. You must remove the wrist strap when you discharge high voltage or when you are working on energized equipment.

Modules

The X Series unit contains the following ten (10) modules or assemblies:

- Printer
- Front Enclosure
- Display
- NIBP
- $EtCO_2$ (Oridion®)
- Monitor Board
- Capacitor Bank
- Defibrillator Board
- SpO_2
- CP Carrier Module

These modules can be purchased as replacement parts from the ZOLL Technical Support Department. See Chapter 4, "Replacement Parts" for information on ordering replacement parts.

Removing the Handle

Tools Required
- #1 Phillips screwdriver with torque capability
- Wooden stick

Setup
- This procedure should be conducted on a static mat.
- Wear a wrist strap to ground during the procedure.

To reinstall the handle assembly, reverse the steps.

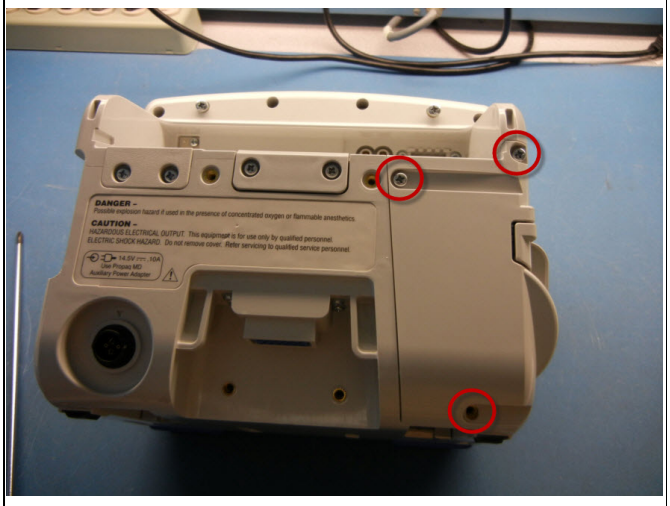
Handle Disassembly		
1	Using a wooden stick, lift and remove the screw covers from the handle in the two (2) locations shown.	
2	Remove four (4) screws (2 on each side) and remove the handle. **Note:** During reassembly, torque screws to 8 in-lbs.	

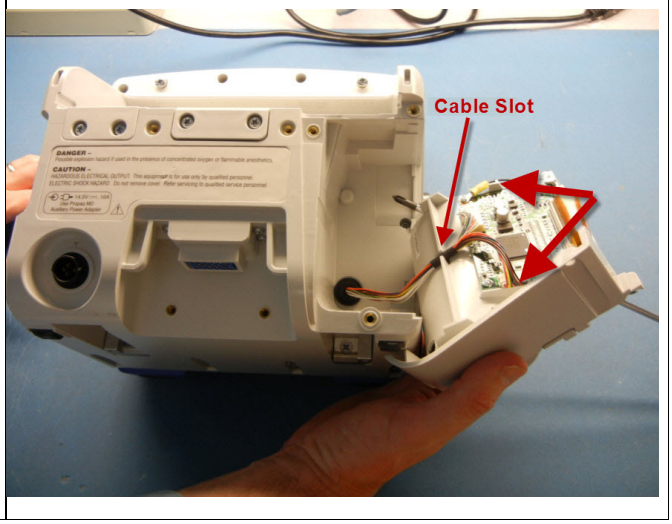
Removing the Printer Module

Tools Required
- #1 Phillips screwdriver with torque capability

Setup
- This procedure should be conducted on a static mat.
- Wear a wrist strap to ground during the procedure.

To reinstall the printer module, reverse the steps.

Printer Disassembly		
1	Place the unit on the mat in a horizontal position.	
2	Open the printer housing and remove the printer paper.	
3	Position the unit with the display screen facing down, and remove the three (3) screws outside the printer module in the areas shown. **Note:** During reassembly, torque screws to 6 in-lbs.	

4	Slowly slide the printer from the unit, being careful not to strain the cables.	
5	Disconnect the two (2) cable connectors from the printer module, and pull cables out of the cable slot shown.	

Disassembling the Main Unit

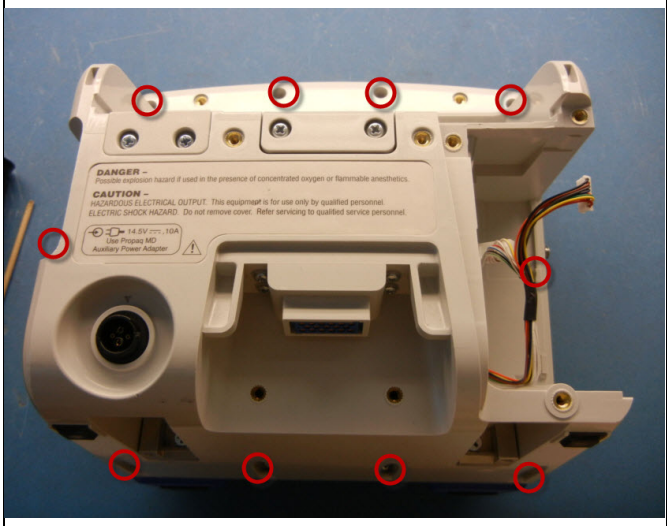
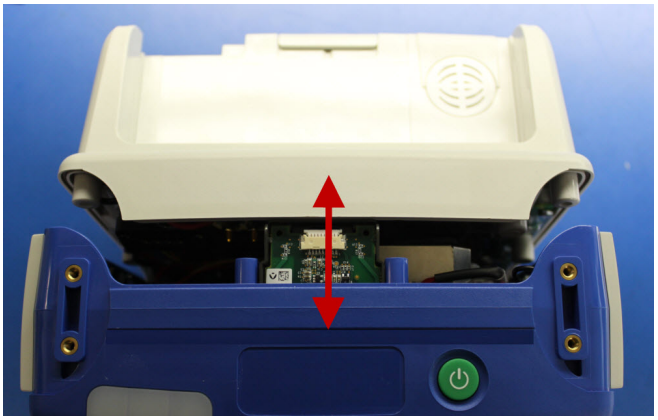
Tools Required
- #1 Phillips screwdriver with torque capability
- Wooden stick
- Kapton tape

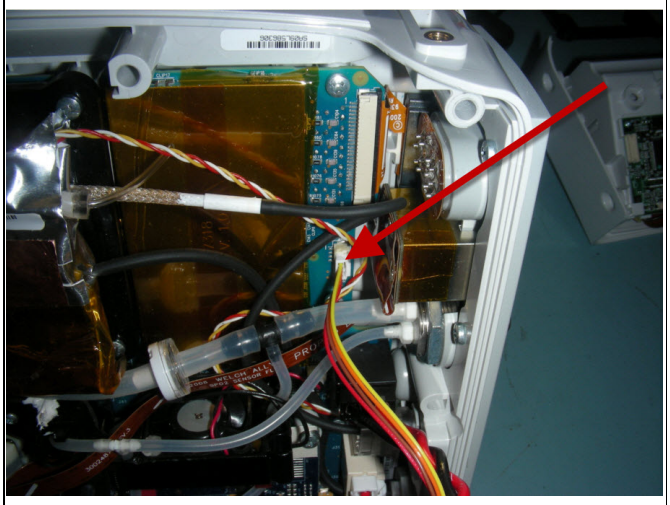
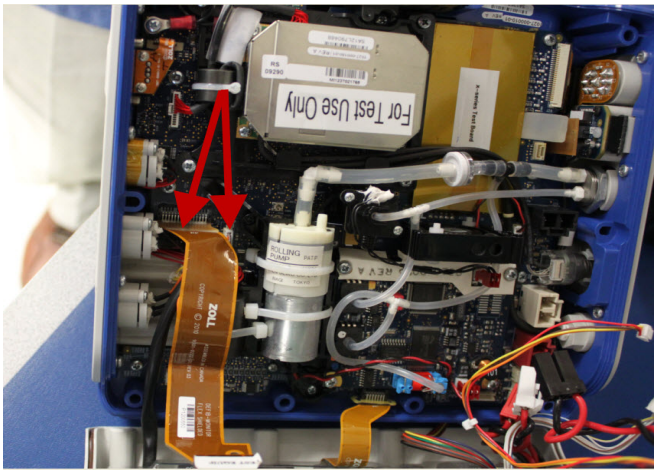
Setup
- This procedure should be conducted on a static mat.
- Wear a wrist strap to ground during the procedure.
- Complete these procedures in the following order before performing this procedure:
  1. "Removing the Handle" on page 3-59
  2. "Removing the Printer Module" on page 3-60

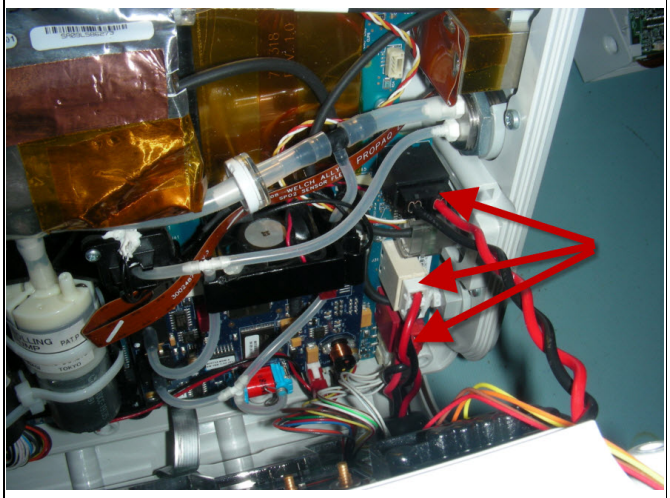
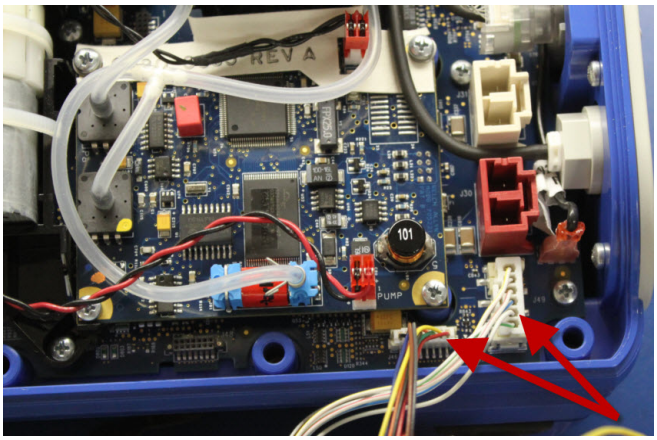
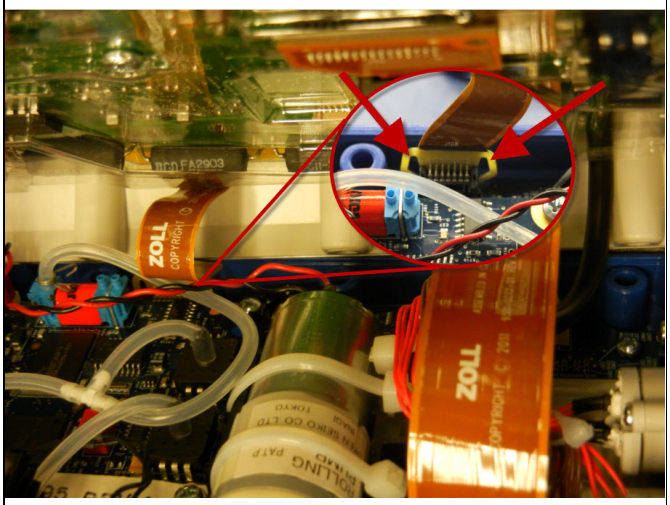
To reassemble the main unit, reverse the steps.

Note: If replacing the front or rear housing with a new front/rear housing, install a new main enclosure gasket. Do not reuse an old one. See GASKET,MAIN ENCLOSURE (item #51) in Chapter 4 "Replacement Parts".

Main Unit Disassembly		
1	Place Kapton tape on both sides of the unit as shown. This will temporarily hold the front and rear sections of the unit together while the screws are being removed.	
2	Gently reposition the unit with the display screen facing down and the rear of the unit facing up. The bottom of the unit should be nearest to you.	

3	Remove ten (10) screws: four (4) on the top, four (4) on the bottom, and two (2) in the middle as illustrated. Take care to keep the front and rear sections of the unit together. **Note:** During reassembly, torque screws to 6 in-lbs.	
4	While holding the front and rear sections together, reposition the unit upright on the mat (feet down).	
5	Looking down at the top of the unit, gently separate the front and rear sections by creating a small gap, and remove any loose screws that may be in the way.	

6	Disconnect the battery communication cable (yellow, orange, brown, red) connector from the monitor board.	
7	Disconnect the monitor/ defibrillator flex cable and MFC cable connectors from the monitor board. **Note:** Be careful to pull the connector straight out. Rocking the connector or disconnecting it at an angle may result in damage to the connector. **Note:** Upon reassembly, ensure routing of MFE cable is on the outer (left) side of the connector ferrite, not stuck between the ferrite and NIBP motor.	

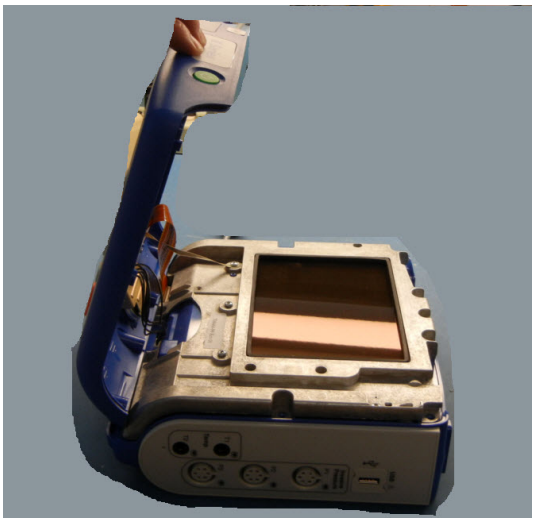
8	Disconnect the three (3) power cable connectors (battery (black), AUX (white), and defibrillator (red)).	
9	Press the tabs on either side of the two (2) printer cables to disconnect them.	
10	Use a wooden stick to release the tabs on either side of brown flex connector between the dock connector and the monitor board. **Note:** Release one side at a time.	
11	Separate the two (2) parts of the unit.	

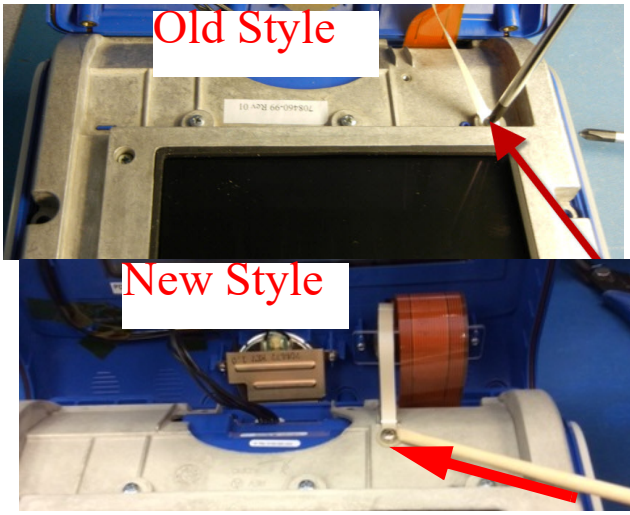
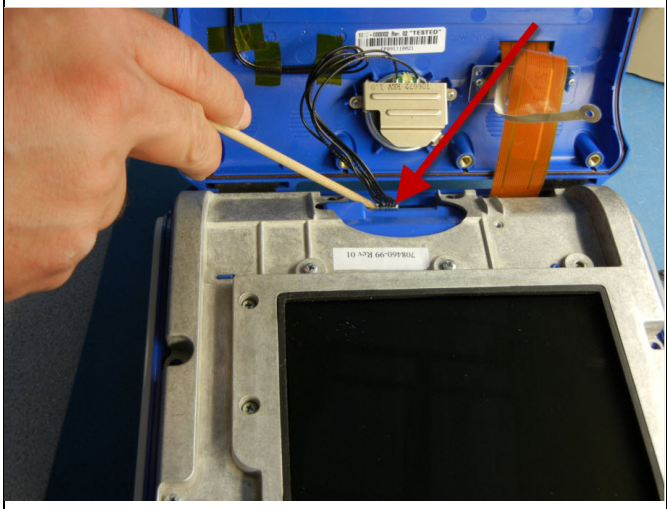
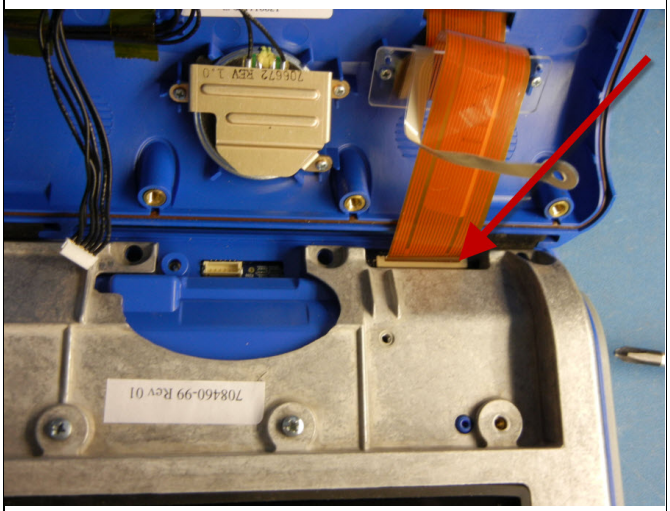
Removing the Front Enclosure Module

Tools Required
- #2 Phillips screwdriver with torque capability
- Wooden stick

Setup
- This procedure should be conducted on a static mat.
- Wear a wrist strap to ground during the procedure.
- Complete these procedures in the following order before performing this procedure:
  1. "Removing the Handle"
  2. "Removing the Printer Module"
  3. "Disassembling the Main Unit"

To reinstall the front enclosure module, reverse the steps.

Front Enclosure Disassembly		
1	Remove the tape from both sides of the unit.	
2	Separate front enclosure assembly.	
3	Pivot top up with cables still connected.	

4	Remove grounding screw as shown in the illustration. Depending on when the unit was manufactured, there are two (2) locations where the grounding screw strap can attach. **Note:** During reassembly, torque screw to 6 in-lbs.	
5	Disconnect the front panel multi-wire power/speaker cable in the area illustrated.	
6	Remove the ZIF (Zero Insertion Force) flex cable using a wooden stick.	

Removing the Display Module

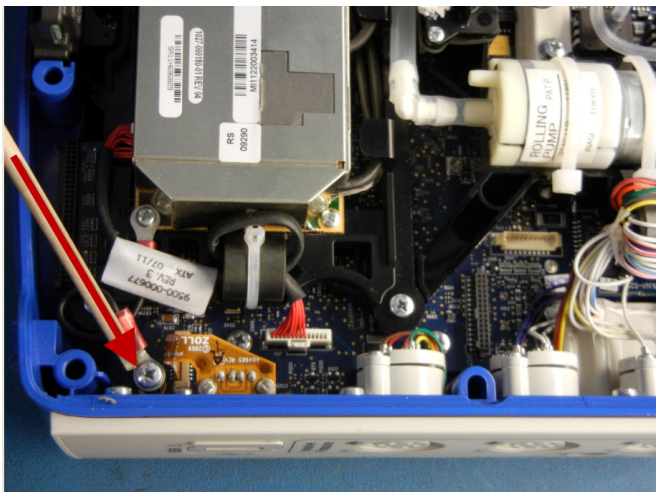
Tools Required

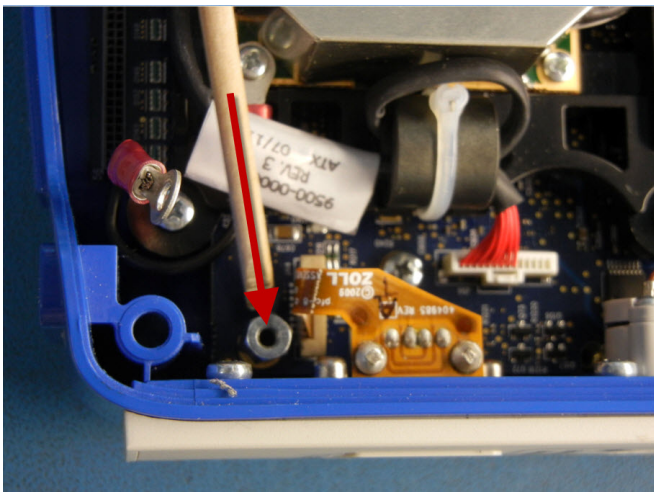
- #1 Phillips screwdriver with torque capability
- 3M copper adhesive tape
- 6mm socket wrench
- Mid-Frame LCD Cable Routing Assembly Fixture, 9100-3028-AF (Optional)

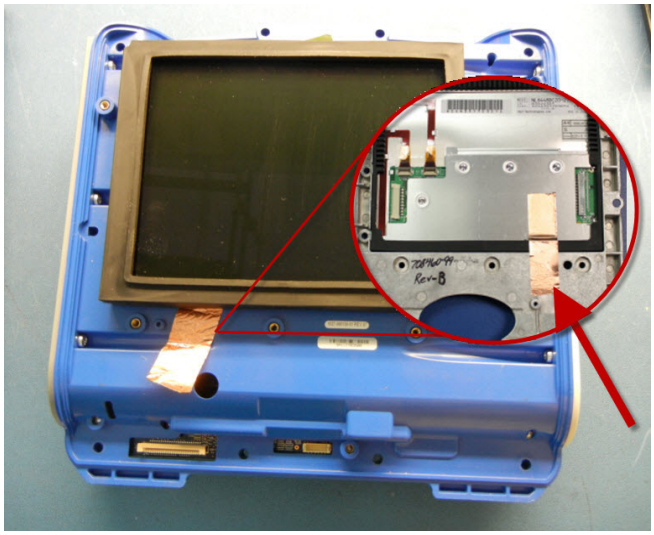
Setup

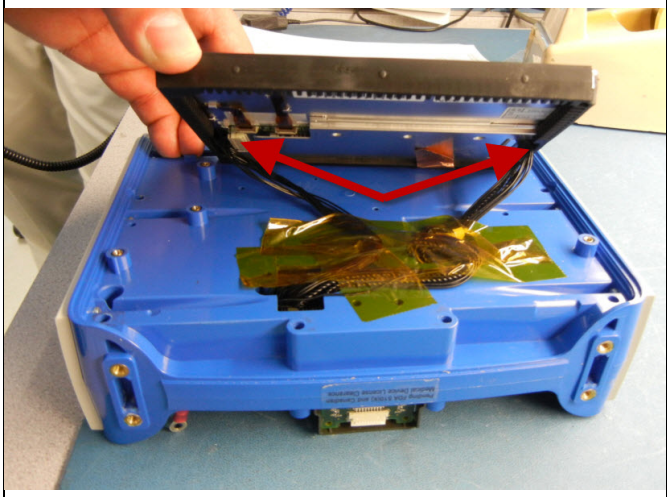
- This procedure should be conducted on a static mat.
- Wear a wrist strap to ground during the procedure.
- Complete these procedures in the following order before performing this procedure:
  1. "Removing the Handle"
  2. "Removing the Printer Module"
  3. "Disassembling the Main Unit"
  4. "Removing the Front Enclosure Module"

To reassemble the display module, reverse the steps.

Display Disassembly		
1	Remove the grounding screw and washer for $EtCO_2$ in the area illustrated.	

2	Using the 6mm socket wrench, remove the hex standoff located underneath the screw you just removed. **Note:** During reassembly, torque to 6 in-lbs.	
3	Place the rear of the unit down on the mat with the display screen facing up.	
4	Remove the seven (7) screws from the front of the casting in the areas illustrated. **Note:** During reassembly, torque screws to 6 in-lbs.	

5	Lift the casting up while pressing downward on the rubber boot that surrounds the edge of the LCD screen.	
6	Remove the copper tape from the casting. **Note:** During reassembly, apply new copper tape for grounding. If casting is being replaced, scuff the underside of the casting where the tape is being applied, with a fiberglass brush. Wipe area with lint free wipe and alcohol.	

7	Disconnect the LCD display cable connectors from the back of the LCD screen to release it. **Note:** During reassembly, make sure that when taping the LED cable assembly to the spider frame, the cable is clear from the display frame as shown. (The use of the mid-frame assembly fixture (P/N 9100-3028-AF) is optional.)	 

Removing the $EtCO_2$ and NIBP Modules

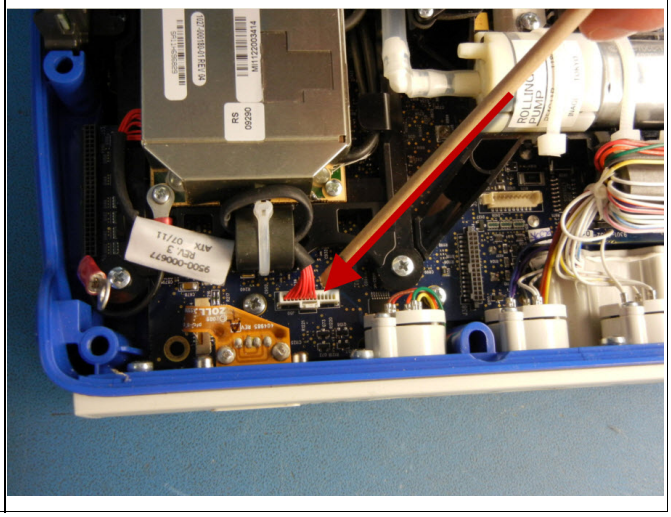
Tools Required

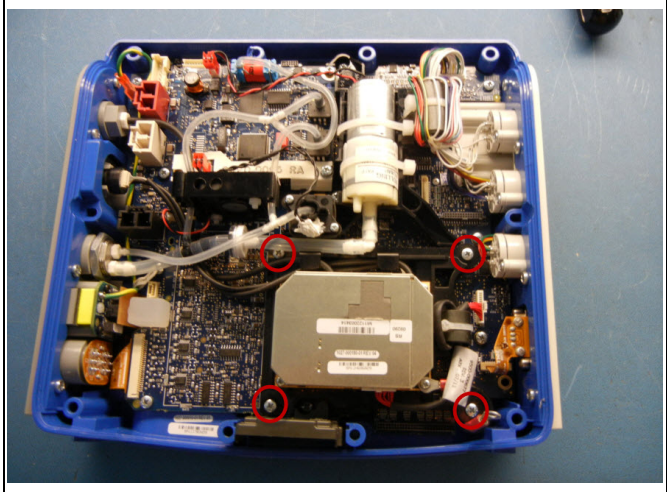
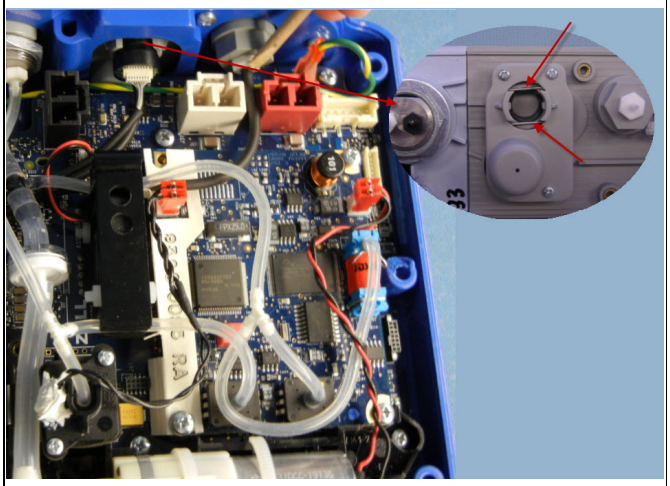
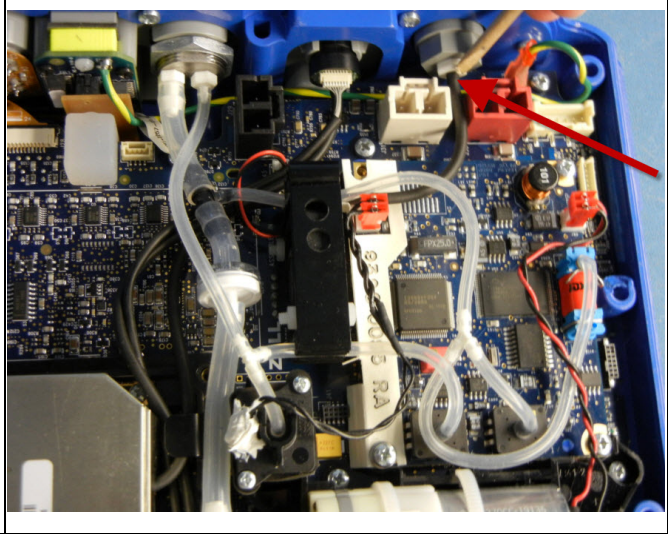
- #1 Phillips screwdriver with torque capability
- Wooden stick
- Large diagonal cutters
- Metal pick

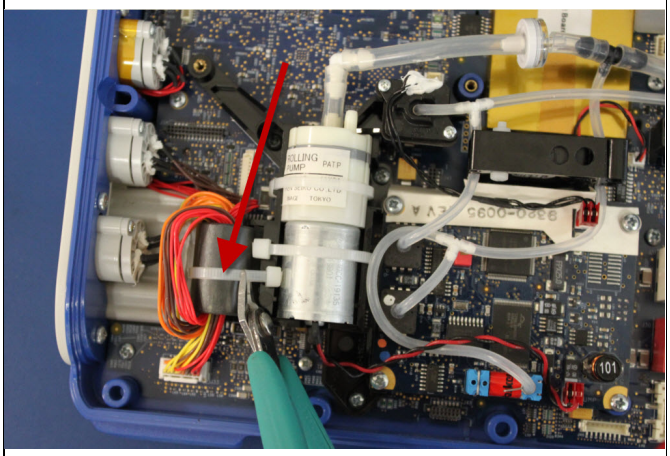
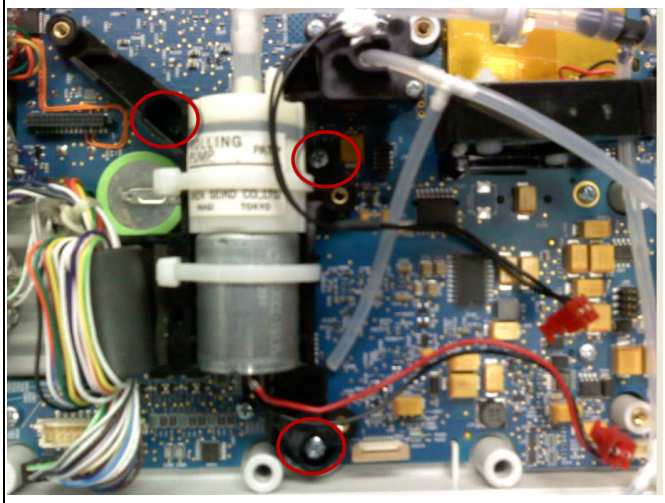
Setup

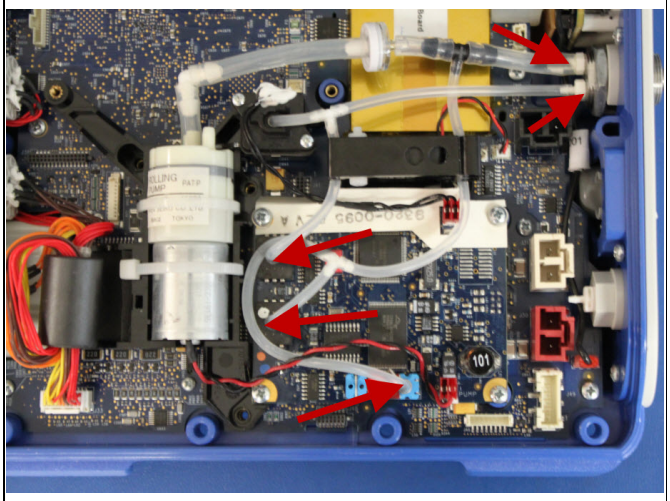
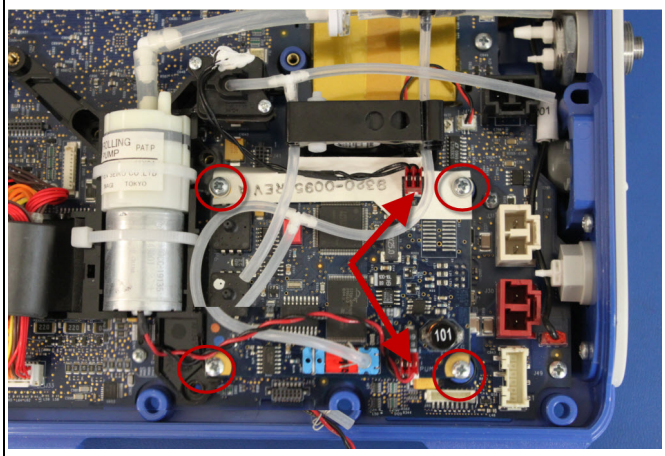
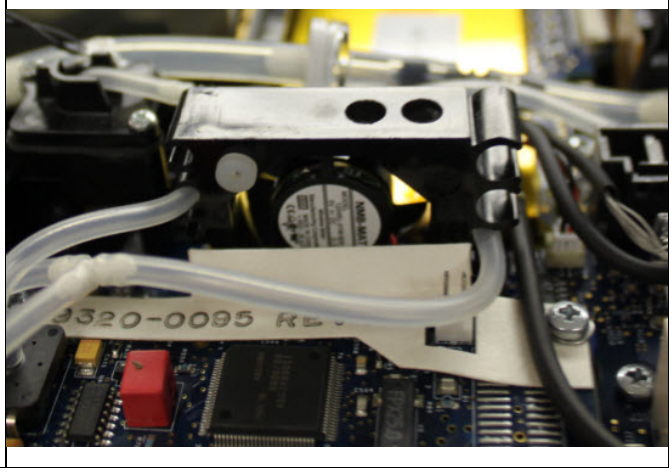
- This procedure should be conducted on a static mat.
- Wear a wrist strap to ground during the procedure.
- Complete these procedures in the following order before performing this procedure:
  1. "Removing the Handle"
  2. "Removing the Printer Module"
  3. "Disassembling the Main Unit"
  4. "Removing the Front Enclosure Module"

To reassemble the $EtCO_2$ and/or NIBP modules, reverse the steps.

$EtCO_2$ and/or NIBP Disassembly		
1	Unplug the power connector by press on the tab and pulling straight out.	

2	Remove the four (4) screws surrounding the $EtCO_2$ module as illustrated. **Note:** During reassembly, torque screws to 6 in-lbs.	
3	Disconnect the $EtCO_2$ sensor from the side panel by using a metal pick and releasing the clips on both sides.	
4	Disconnect the exhaust tube connector from the air vent at area shown.	

5	Remove EtCO2 module by lifting assembly out. If necessary, disconnect NIBP hoses to make it easier to pull connector through.	
6	Cut the tie wrap holding the ferrite bead as illustrated.	
7	Remove three (3) screws from the NIBP module. **Note:** During reassembly, torque screws to 6 in-lbs.	

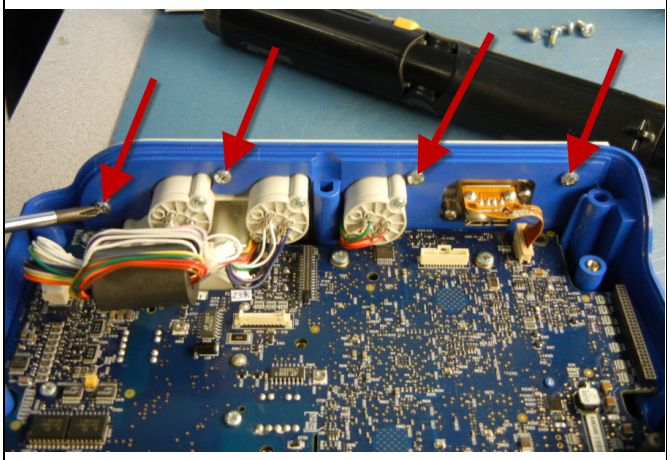
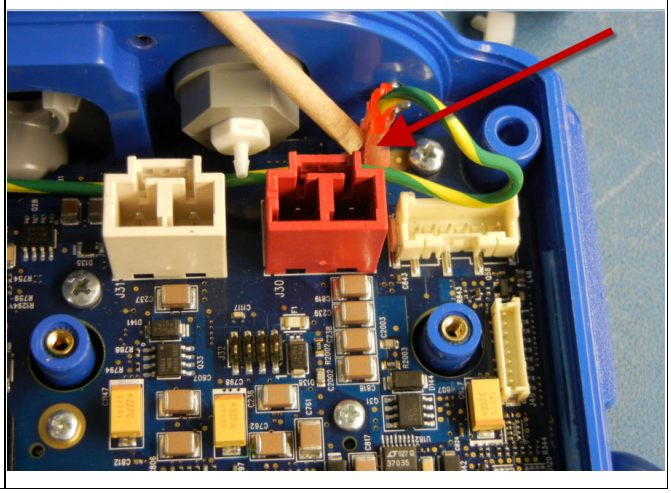
8	Disconnect the five (5) NIBP hoses. **Note:** During reassembly, be sure to route the hoses as depicted in the illustration.	
9	Disconnect the two (2) red connectors, then remove the four (4) screws securing the NIBP MOD G board. Note the top two (2) screws have washers. Lift and remove the NIBP MOD G board and pump. **Note:** During reassembly, align connector on bottom of NIBP board to Monitor Board. Torque screws to 6 in-lbs. **Note:** During reassembly, position the hose on the left side of the fan through the middle of the three (3) slots.Position the hose on the right through the bottom of the three (3) slots.	 

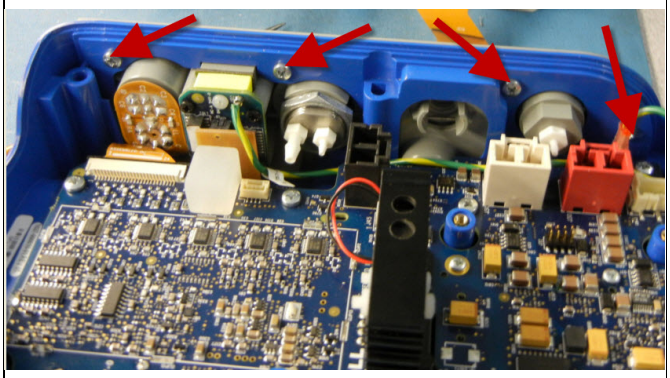
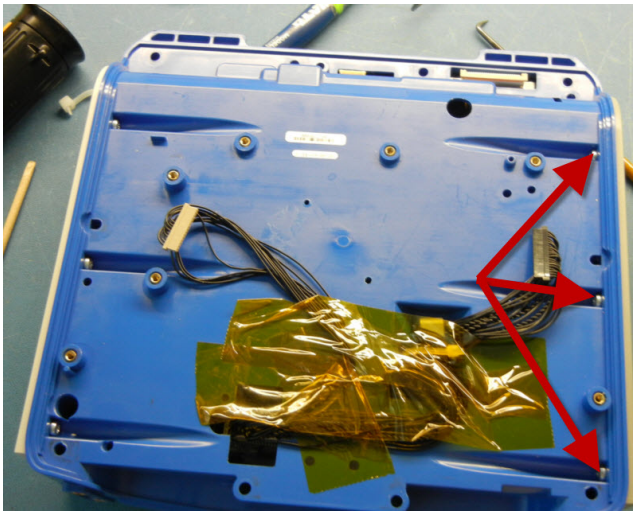
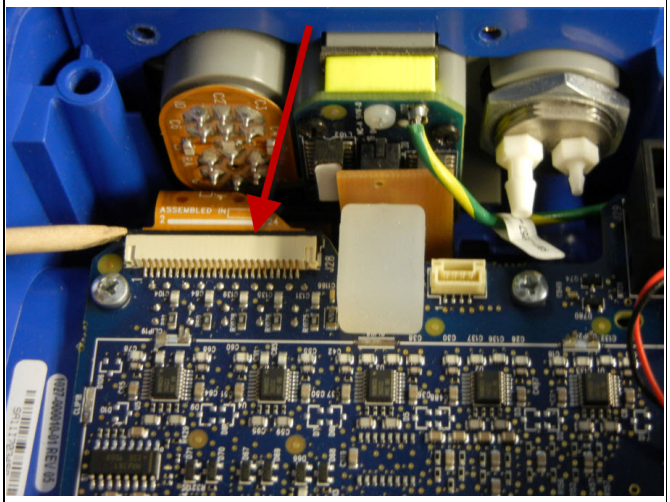
Removing the Monitor Board and SpO_2 Modules

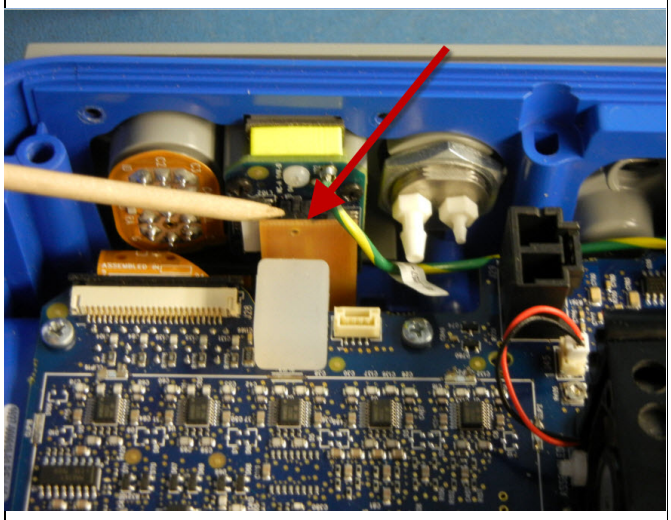
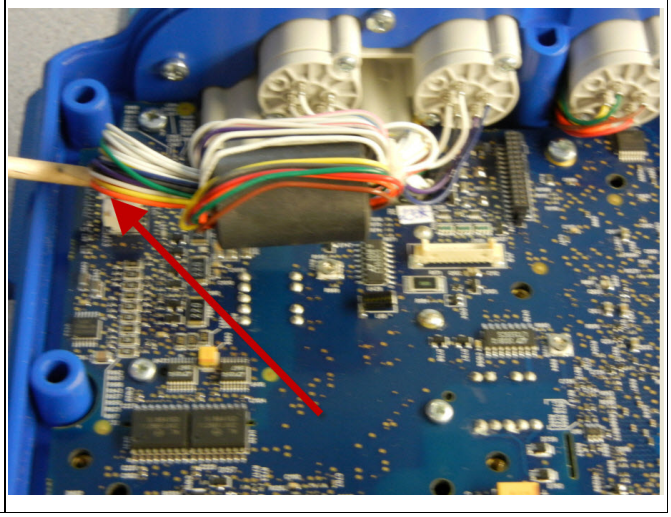
Tools Required
- #1 Phillips screwdriver with torque capability
- Wooden stick

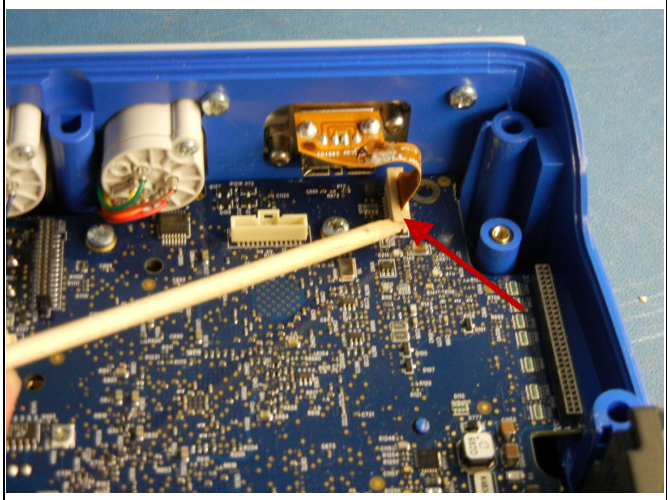
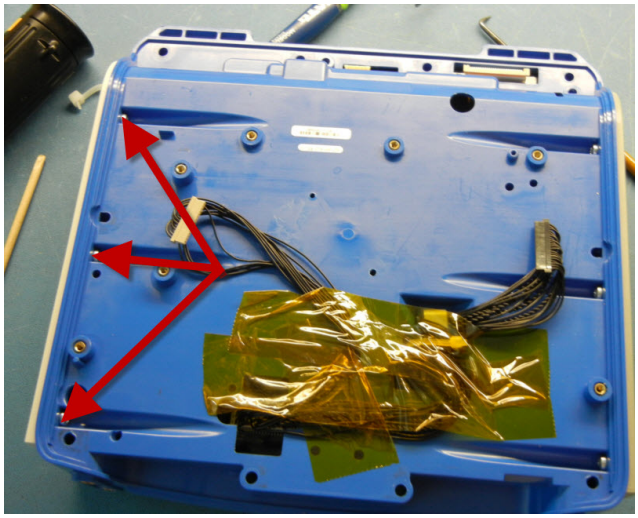
Setup
- This procedure should be conducted on a static mat.
- Wear a wrist strap to ground during the procedure.
- Complete these procedures in the following order before performing this procedure:
  1. "Removing the Handle"
  2. "Removing the Printer Module"
  3. "Disassembling the Main Unit"
  4. "Removing the Display Module"
  5. "Removing the EtCO2 and NIBP Modules"

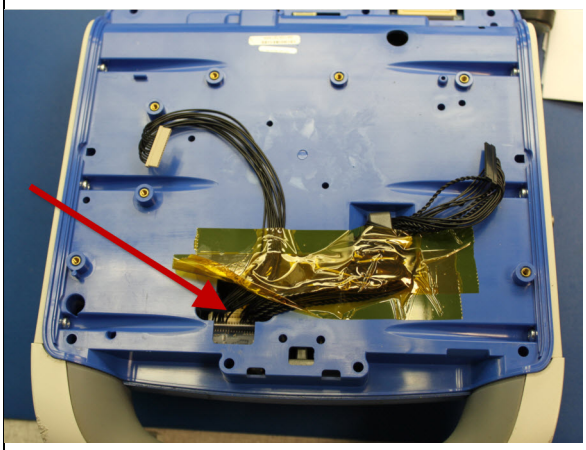
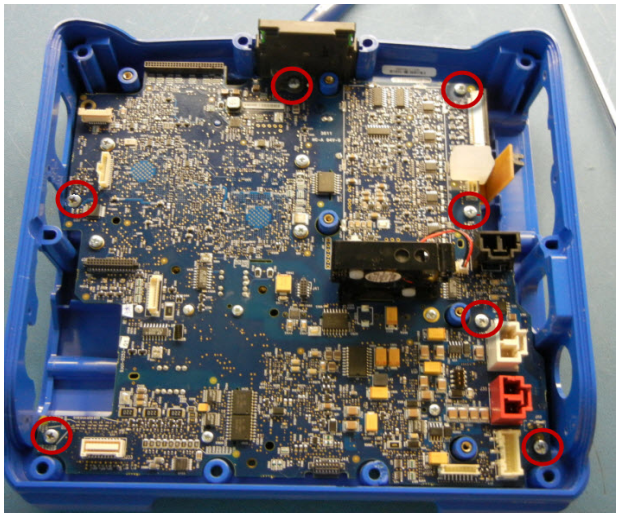
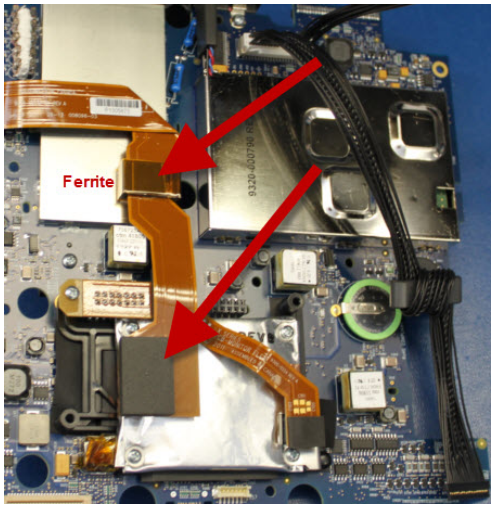
To reassemble the monitor board and/or SpO_2 modules, reverse the steps.

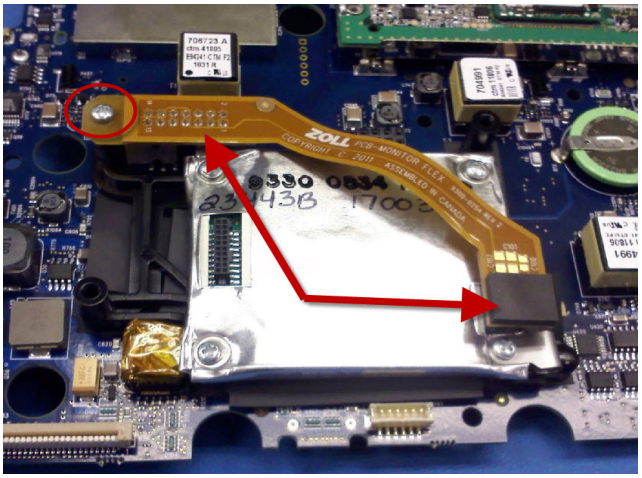
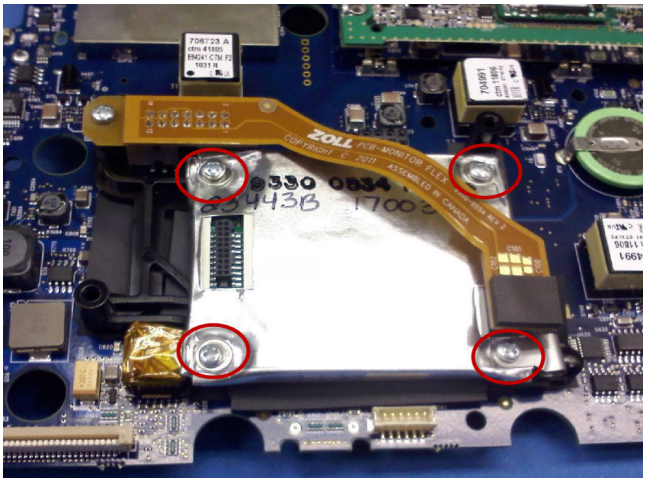
Monitor Board and/or SpO_2 Disassembly		
1	Remove the four (4) screws on the right side of the unit as illustrated. **Note:** During reassembly, torque screws to 6 in-lbs.	
2	Disconnect the SpO_2 ground cable.	

3	Remove the four (4) screws on the left side of the unit as illustrated. **Note:** During reassembly, torque screws to 6 in-lbs.	
4	Turn the unit over.	
5	Remove the three (3) screws on the left side of the unit as illustrated.	
6	Turn the unit over.	
7	Disconnect the ECG flex cable ZIF connector from the left side.	

8	Disconnect the SpO_2 connector.	
9	Remove the left side of the unit.	
10	Disconnect the IBP connector.	

11	Disconnect the USB ZIF connector.	
12	Turn the unit over.	
13	Remove the three (3) screws on the right side of the unit as illustrated.	
14	Turn the unit over.	
15	Remove the right side panel of the unit.	

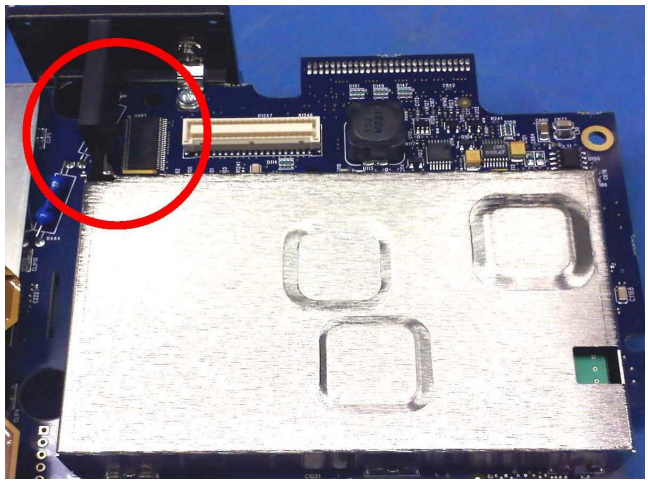
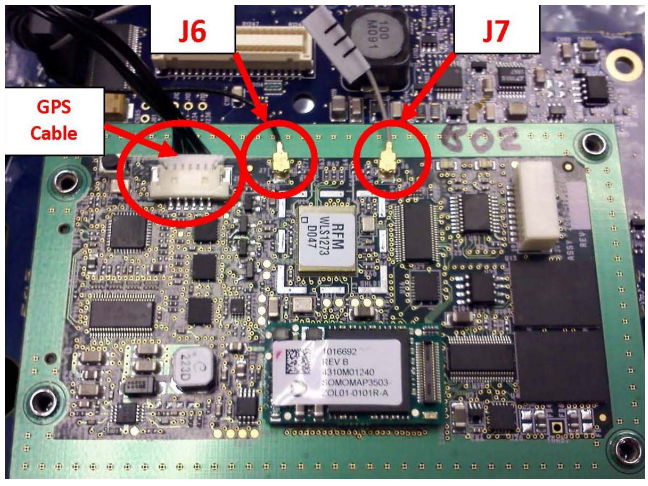
16	Disconnect the LCD cable.	
17	Remove the seven (7) screws securing monitor board as illustrated. Lift and remove the board.	
18	Disconnect the top flex cable connectors from SPO_2 module, then remove cable and ferrite.	

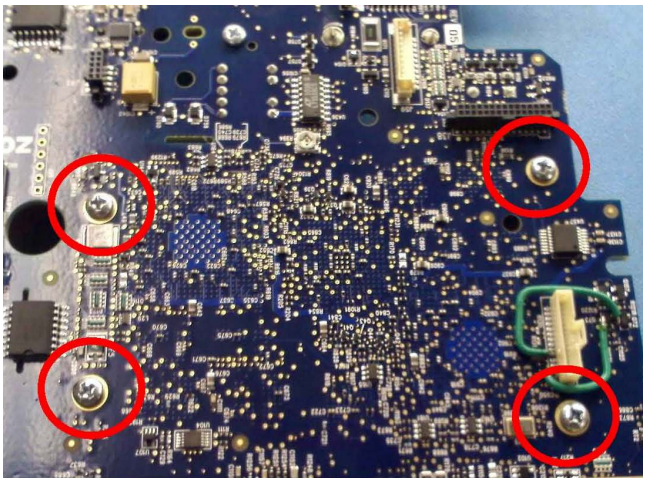
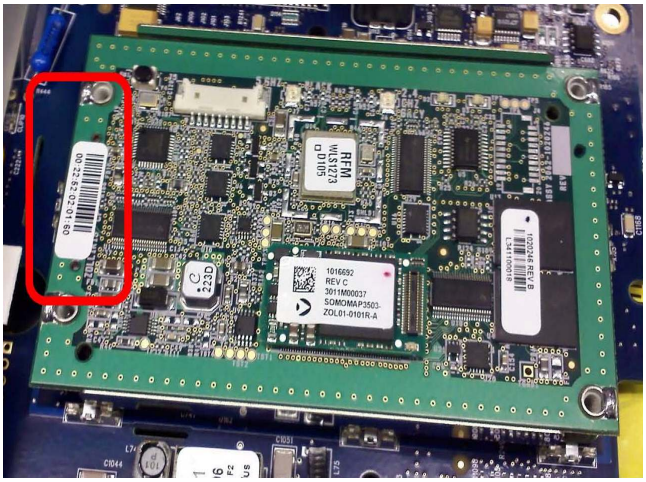
19	Remove the screw from the flex cable, then disconnect flex cable from the connectors in two locations. **Note:** During reassembly, torque screws to 4 in-lbs.	
20	Remove four (4) screws from the SpO2 module and remove it. **Note:** During reassembly, torque screws to 4 in-lbs.	

Removing the CP Carrier Module

Tools Required
- #1 Phillips screwdriver with torque capability

Setup
- This procedure should be conducted on a static mat.
- Wear a wrist strap to ground during the procedure.
- Complete these procedures in the following order before performing this procedure:
  1. "Removing the Handle"
  2. "Removing the Printer Module"
  3. "Disassembling the Main Unit"
  4. "Removing the Display Module"
  5. "Removing the EtCO2 and NIBP Modules"
  6. "Removing the Monitor Board and SpO2 Modules"

CP Module Disassembly		
1	Remove the shield by pulling it upwards over the CP carrier board. **Note:** During reassembly, be sure to route antenna wires through slot (red circle) in the shield. Secure the shield to the board by aligning with slots on the board.	
2	Remove the 9-pin GPS and two antenna cables (gray cable J7 and black cable J6) from the CP carrier board.	

CP Module Disassembly		
3	Turn board over, and remove the four (4) screws securing the CP board to the Monitor Board. **Note:** During reassembly, torque screws to 6 in-lbs.	
4	Only lift the CP carrier board (not the metal heat spreader) upwards at location J60 on the Monitor Board. **Note:** During reassembly, align connectors on board.	

Removing the Defibrillator Boards and Capacitor Bank Modules

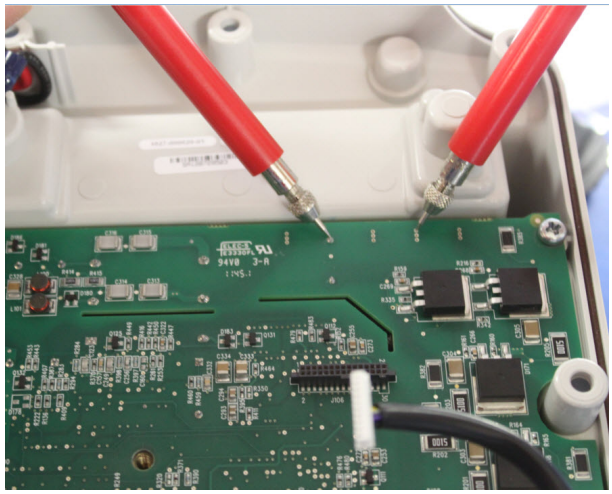
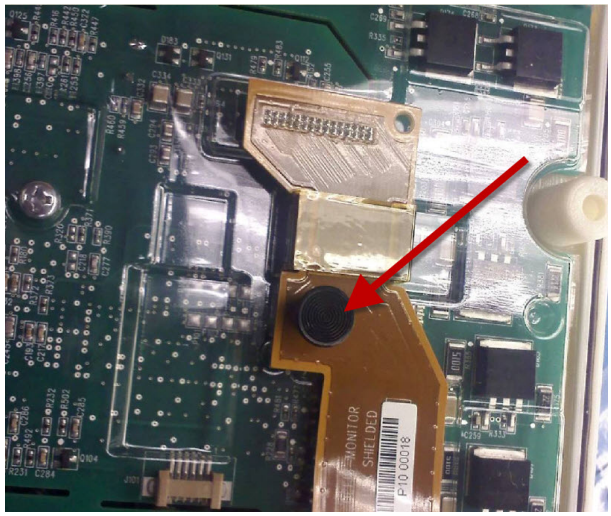
Tools Required
- #1 Phillips screwdriver with torque capability
- #2 Phillips screwdriver with torque capability
- 26 mm open end wrench
- Large diagonal cutters
- Defibrillator Discharge Test Fixture (5k Ohm, 25 watt resistor)(ZOLL P/N: 9100-0174-TF)
- Digital multimeter

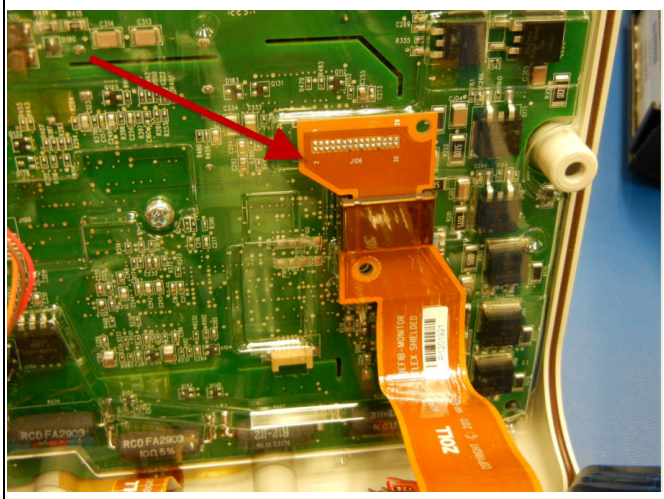
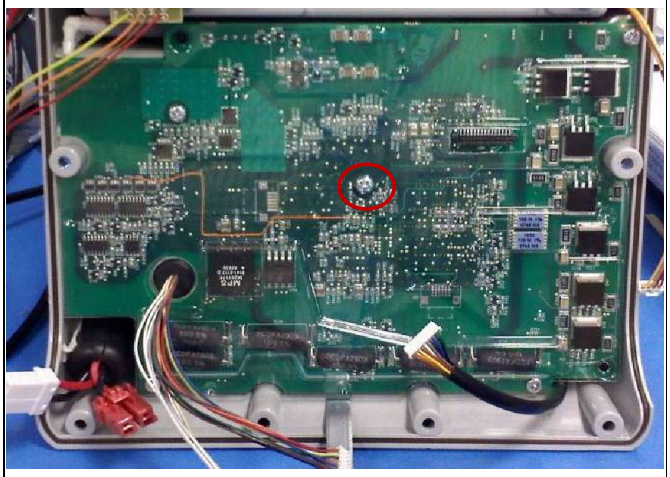
Setup
- This procedure should be conducted on a static mat.
- Wear a wrist strap to ground during the procedure.
- Complete these procedures in the following order before performing this procedure:
  1. "Removing the Handle"
  2. "Removing the Printer Module"
  3. "Disassembling the Main Unit"

To reassemble the defibrillator boards and/or capacitor bank modules, reverse the steps.

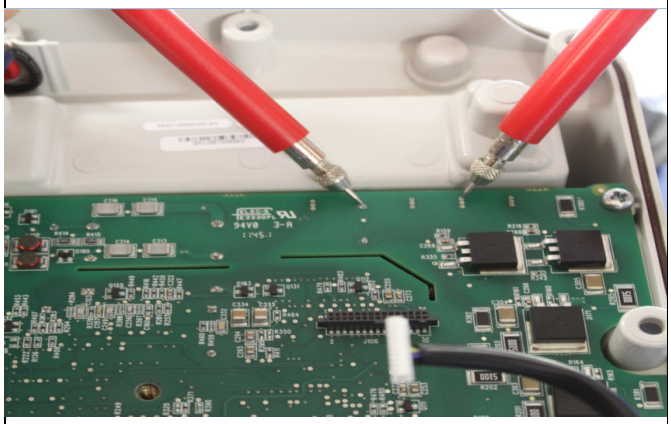
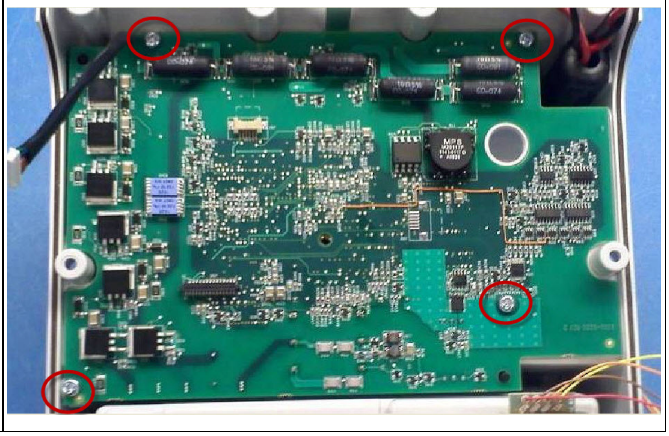
WARNING! This unit may contain lethal voltages. You MUST completely discharge the high voltage capacitor before removing from unit. DO NOT SHORT THE TERMINAL ENDS OF THE CAPACITOR.

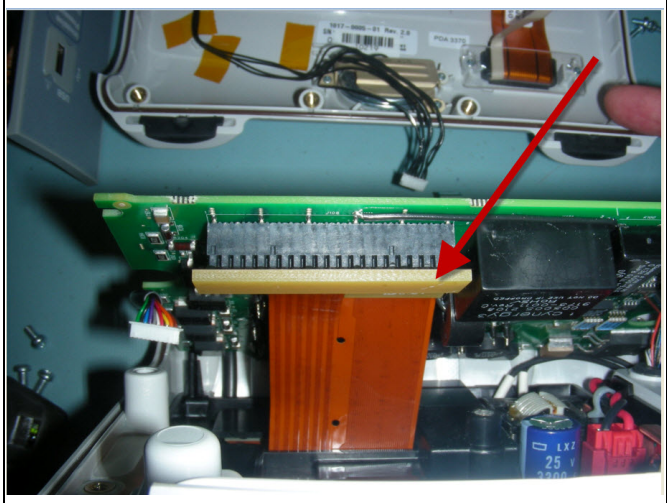
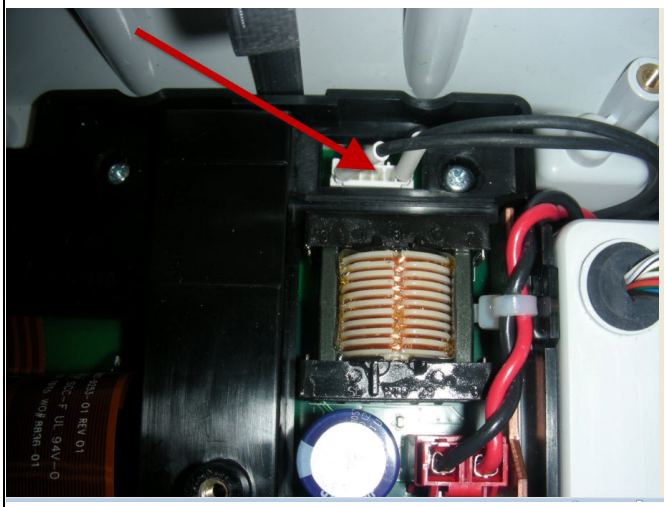
Defibrillator Boards and Capacitor Bank Disassembly		
1	Lay the rear section of the separated unit down with opened side facing up.	

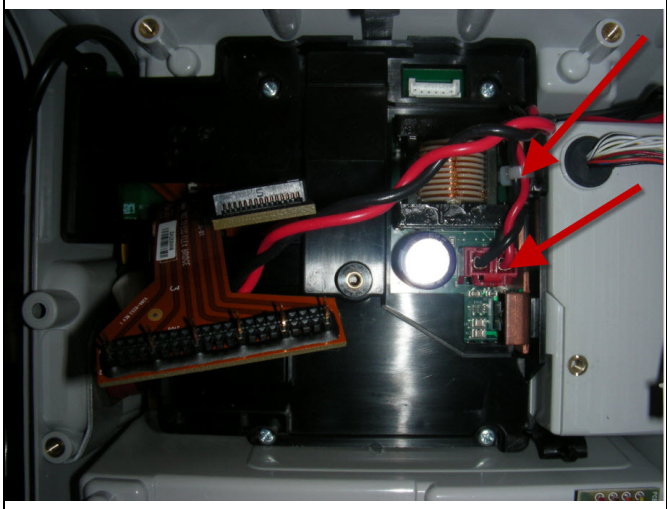
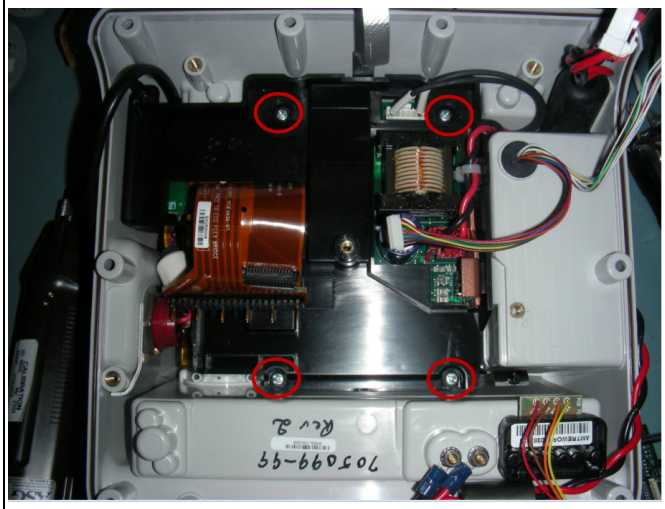
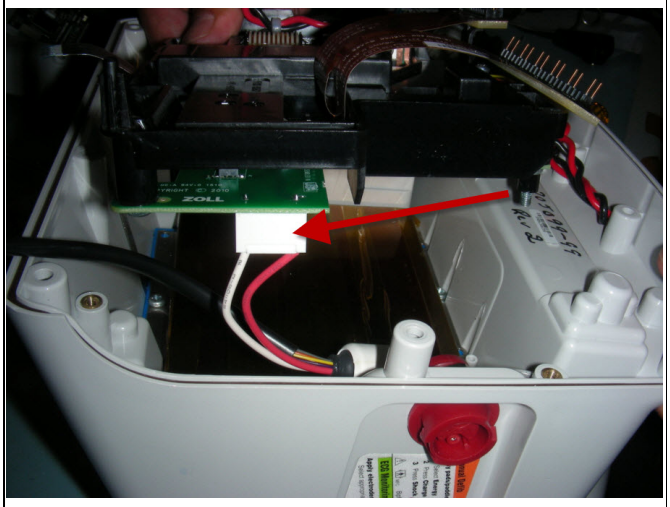
2	Using the defibrillator discharge test fixture, place the leads on the vias as illustrated for 10 seconds. This will bleed the stored energy in the capacitor and discharge the unit. The leads must specifically contact two vias. From left to right in the image, place one lead on the single via in the second column, and the other lead on the top via of the fourth column. **Note:** You may gently pull back the plastic isolation shield present on the processor board in order to access the contact points.	
3	Using a digital multimeter, place the test leads on the same two vias used in the previous step. Verify that the reading on the multimeter indicates the unit's stored energy has been discharged.	
4	On the defib-system flex cable, pull the black snap rivet straight out.	

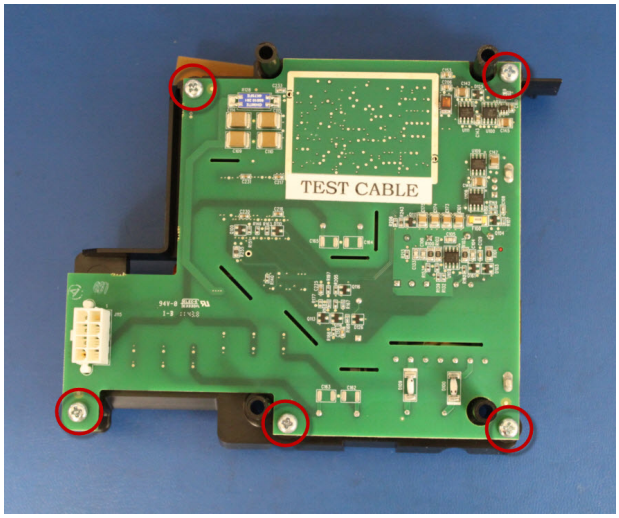
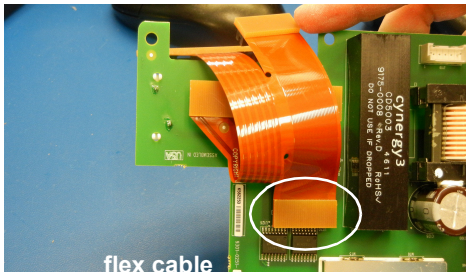
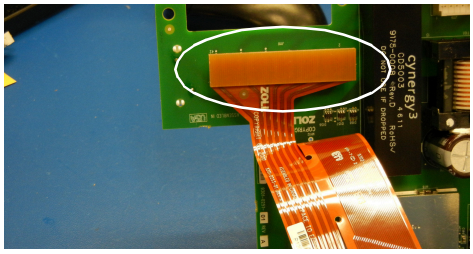
5	Disconnect the defib-system flex cable from the processor board by pulling straight up from the board.	
6	Remove the screw in the middle of the plastic isolation shield (located on top of the processor board) in the area illustrated. **Note:** During reassembly, torque screw to 6 in-lbs.	
7	Remove the plastic isolation shield.	

WARNING! **The unit may contain lethal voltages.** In order to safely remove the high voltage capacitor, you MUST completely discharge it before removing it from the unit. DO NOT SHORT THE TERMINAL ENDS OF THE CAPACITOR.

8	Discharge the capacitor by bleeding out the excess voltage using a resistor with values of approximately 5k Ohms, (25 watts for 10-20 seconds). Counting from the right connect, apply the resistor across the second and fourth vias as shown in the picture. Measure the voltage of the capacitor on the same two vias to verify that the capacitor has been discharged.	
9	Remove the four (4) screws from the processor board in the areas illustrated. **Note:** During reassembly, torque screws to 6 in-lbs.	

10	Lift up the processor board and disconnect the brown flex cable (there are two connections).	
11	Lift and remove the processor board.	
12	Remove the black capacitor cable by pressing the tab while pulling straight out to release.	

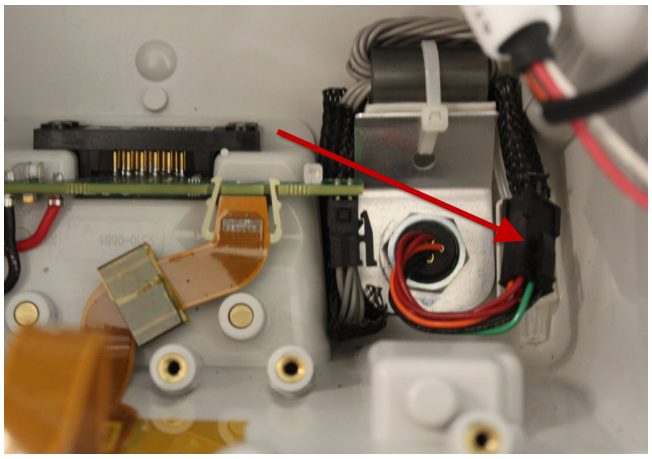
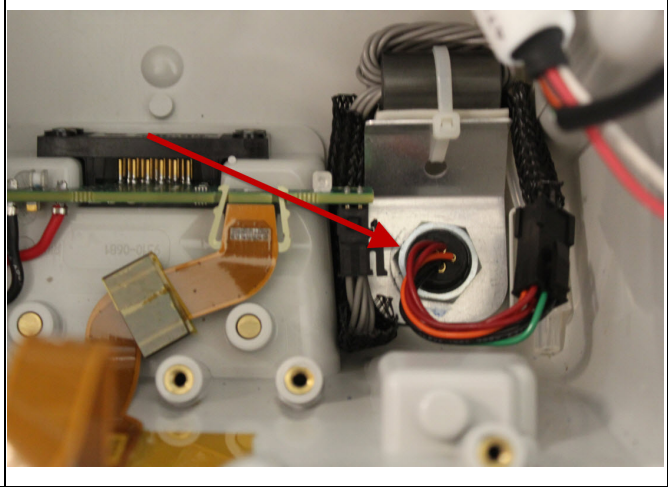
13	Cut the tie wrap securing the Power Monitor to Pace cable (black and red coupled wire) and disconnect the cable (via the red connector) in illustrated area.	
14	Remove four (4) screws from the frame support in the areas illustrated. During reassembly, torque screws to 6 in-lbs.	
15	Lift up on the ECG assembly and remove red and white MFE cable (via the white connector) from the ECG board. Remove ECG assembly.	

16	Remove the five (5) screws securing the ECG board to bracket, and then separate the board from the bracket. **Note:** During reassembly, torque screws to 6 in-lbs.	
17	Remove the Bridge/Pace to ECG cable from the ECG board in the two areas illustrated. **Note:** During reassembly, match the designator on the flex cable and the ECG board.	 
18	Remove two (2) screws securing the capacitor to housing, then lift and remove capacitor. **Note:** During reassembly, torque screws to 6 in-lbs.	

Removing the AUX Power Connector

Tools Required
- Socket (ZOLL P/N: 9100-3060-AF)
- Large diagonal cutters

Setup
- This procedure should be conducted on a static mat.
- Wear a wrist strap to ground during the procedure.
- Complete these procedures in the following order before performing this procedure:
  1. "Removing the Handle"
  2. "Removing the Printer Module"
  3. "Disassembling the Main Unit"
  4. "Removing the Defibrillator Boards and Capacitor Bank Modules"

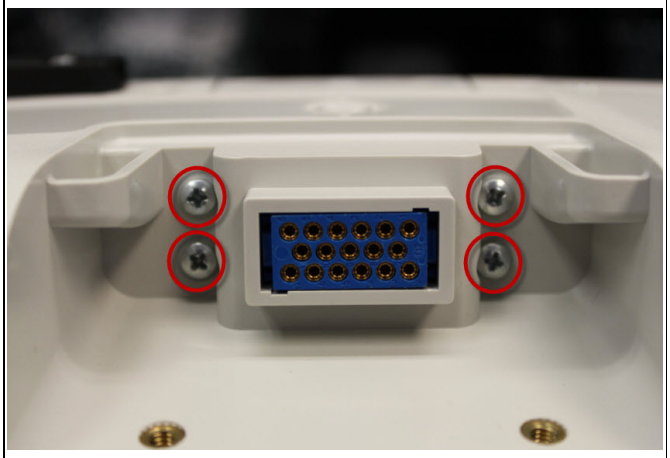
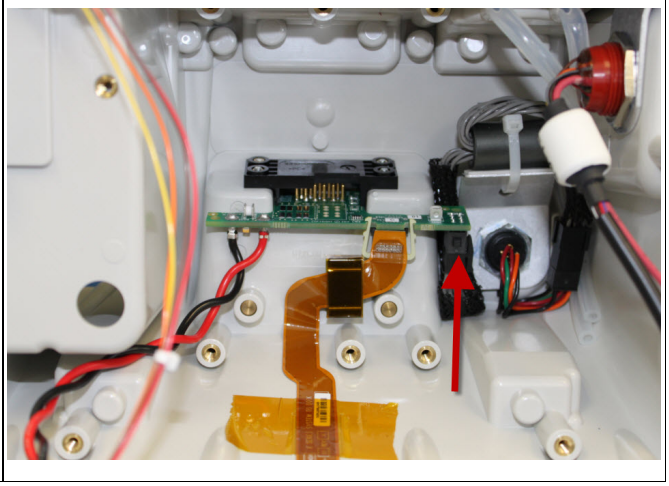
AUX Power Connector		
1	Disconnect AUX Power Connector cable from harness.	
2	Using socket, remove the lock nut that is securing the connector to the housing. **Note:** During reassembly, apply a drop of Loctite before tightening the lock nut.	

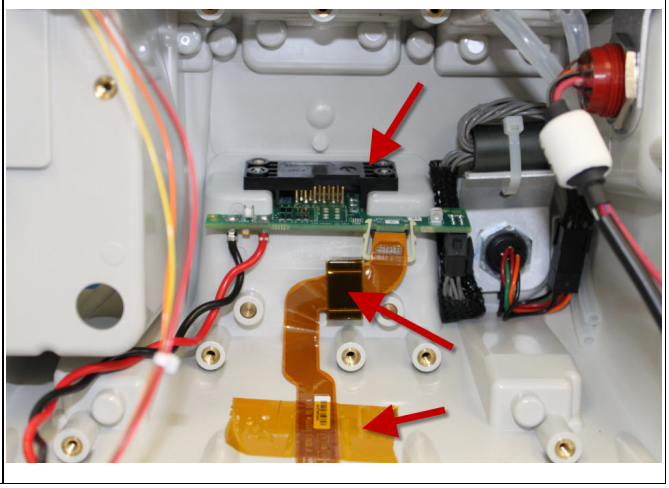
	Note: During reassembly, align the white dot on connector with the arrow on the housing. **Note:** During reassembly, torque screws to 10 in-lbs.	

Removing the Dock Connector

Tools Required
- #1 Phillips screwdriver with torque capability

Setup
- This procedure should be conducted on a static mat.
- Wear a wrist strap to ground during the procedure.
- Complete these procedures in the following order before performing this procedure:
  1. "Removing the Handle"
  2. "Removing the Printer Module"
  3. "Disassembling the Main Unit"
  4. "Removing the Defibrillator Boards and Capacitor Bank Modules"

Dock Connector		
1	Remove the four (4) screws and washers from the back panel that are securing the dock connector to the housing. **Note:** During reassembly, torque screws to 6 in-lbs.	
2	Disconnect black connector from the dock connector board.	

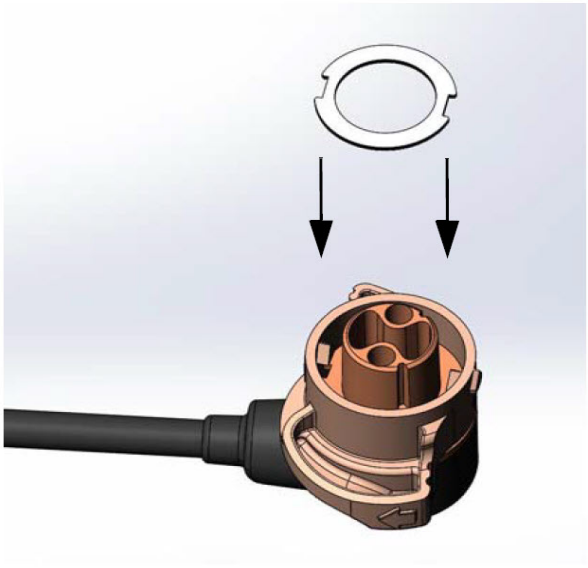
3	Remove tape securing the flex cable to the housing, and then peel back the ferrite that is attached to housing. Remove mounting bracket and lift the dock connector board out of the unit.	

Replacing the Multifunction Cable Gasket

Tools Required
- Wooden (orange) stick
- Replacement gasket

Setup

The black gasket inside the Multifunction Cable (Part # 9330-000678) may need to be replaced with a newer clear gasket.

MFC Cable Gasket		
1	Remove the old gasket by prying it out with the wooden stick.	
2	Peel the backing off of the replacement gasket.	
3	Align the gasket with the tabs as shown in image, and replace.	
4	Press the new gasket all around with the wooden stick to improve adhesion.	

Chapter 4
Replacement Parts

Overview

This section contains a listing of the replacement parts available for the ZOLL X Series devices.

Replacement parts may be ordered through an authorized ZOLL distributor or directly from ZOLL Medical Corporation. The prices for parts are available from ZOLL Medical Corporation's Technical Service Department.

When ordering parts, please provide the following information:

- X Series device model and serial number
- Field replaceable part number
- Description of the replacement assembly

ZOLL Technical Service Department

Telephone: 1-978-421-9655; 1-800-348-9011

Fax: 1-978-421-0010

Email: techsupport@zoll.com

Replacement Parts List

Item numbers listed correspond to the part pictures and diagrams beginning on page 103.

Part Number	Description	Item #
705517-02	HANDLE,BOTTOM,OVERMOLD	1
705517-04	Handle Bottom (Advanced)	1
705519-02	HANDLE,TOP HOOK	2
705519-04	Handle Top (Advanced)	2
705510	SCR.M4-JIS.MCH.16.PNH.PHL.STL ZNC (Torx)	3
705524-02	COVER,SCREW,HANDLE,HOOK,RIGHT	4
705523-02	COVER,SCREW,HANDLE,HOOK,LEFT	5
0162-000292	SCR, M3, TFM, 10, PNH, PHL, STL, ZNC, PLASTIC TAPPING(Torx)	6
705164	WASHER.FLAT.M4.4.3MM ID.7.00MM OD.0.50MM THK.NYL..WHITE	7
708438-02	CATCH, BATTERY, REAR DEFIB	8
0162-000285	SCREW.PAN HEAD.M4X8.STEEL.ZINC PLATING.PHILIPS DRIVE (Torx)	9
1017-0160-01	ASSY, FILTER, NIBP	10
9161-0040	GASKET, VENT CAP SECONDARY, PROPAQ	11
704992-02	COVER, FILTER RECESS	12
705511	PLUNGER, COUNTERBALANCE	13
705513	SPRING,BATTERY COUNTERBALANCE,DEFIB	14
705512	BRACKET, PLUNGER COUNTERBALANCE, DEFIB	15
0162-000281	SCR PNH PHL M3 MCH 6 STL ZNC (Torx)	16
705544	WSH, M3, FLT, 6.86MM OD, 3.3MM ID, 0.5MM THK, NYL	17
600-0398-00	PAD.FOOT.SILICONE.BLACK.0.5" SQUARE.0.12"HIGH	18
705515-99	REWORK, LATCH, DOCK RIGHT	19
705516-99	REWORK, LATCH, DOCK LEFT	20
0162-000290	SCR M4 MCH 10 FLT PHL STL ZNC 90 DEG(Torx)	21
0162-000289	SCR M3 MCH 16 PNH PHL STL ZNC (Torx)	22
9500-000699	HARNESS, AUX CONNECTOR, X SERIES	23
9161-0463	GASKET, AUX PWR	24
9320-0093	BRACKET, FERRITE, AUX PWR	25
9330-0944	FOAM, TAPE, VHB 4952, 1.25 X .50, R SERIES	26

Part Number	Description	Item #
9500-0650	ASSY, RECEPTACLE, DEFIB CABLE	27
9320-0787	MFC BACKING TAB	28
0500-0014	TUBING.SILICONE.CLR.1/8" ID. X 1/4" OD	29
620-0403-00	CABLE TIE.NYLON,.14"X.05"X7"	30
9500-000688	ASSY, CABLE, IN-LINE AUX FERRITE, X SERIES	31
9301-001269-01	ASSY, PCB, DOCK CONNECTOR, X SERIES	32
9301-001268-01	ASSY, PCB, CABLE, FLEX CIRCUIT, SYSTEM-TO-DOCK, X SERIES	33
9310-000694	BRACKET, DOCK CONNECTOR, X SERIES	34
403871	ASSEMBLY BATTERY CONNECTION	35
9500-000686	CABLE, ASSY, BATTERY, POWER	36
9330-0149	CONTACT, SOCKET, .059", 10A, #4 STUD	37
0163-0016	WASHER, FLAT, #4, SS	38
0163-0285	NUT, KEPS, 4-40, SS	39
9126-0010	HV CAPACITOR, 100UF	40
9330-000573	FOAM BUMPER, 9301-1251 PWB	41
9500-1720	CABLE, POWER, MONITOR-TO-PACE	42
9310-0682-99	REWORK, SUPPORT FRAME, PACE BOARD	43
9301-001251-03	ASSY, PCB, ECG BOARD	44
0162-000284	SCR, M4, MCH, C0, PNH, PHL, STL, ZNC (Torx)	45
9301-1250-02	ASSY, PCB, PROCESSOR/BRIDGE/PACE BOARD	46
9310-0683	ISOLATOR, PACE TO MONITOR	47
0140-0103	MAG.CORE.FERRITE.0.640 X 1.64.ROUND CABLE SNAP ON	48
0501-0001	TY-RAP CABLE TIE STD 18 LB .093W X 3.62 L	49
9310-001681-99	REAR CASE, X SERIES	50
9310-001681	Rear Case, X Series 3rd Edition	50
708502	GASKET,MAIN ENCLOSURE	51
0162-000288	SCR PNH PHL M3 MCH 10 STL ZNC (Torx)	52
9301-001253-01	ASSY, FLEX CBL, BRIDGE/PACE-TO-ECG	53
9320-0788	SHIELD, ECG, PRIMARY SIDE	54
9301-002352-01	ASSY, PCB, MONITOR BOARD, X SERIES	55
9301-004252-01	ASSY, PCB, MONITOR BOARD, X SERIES (4th Edition)	55

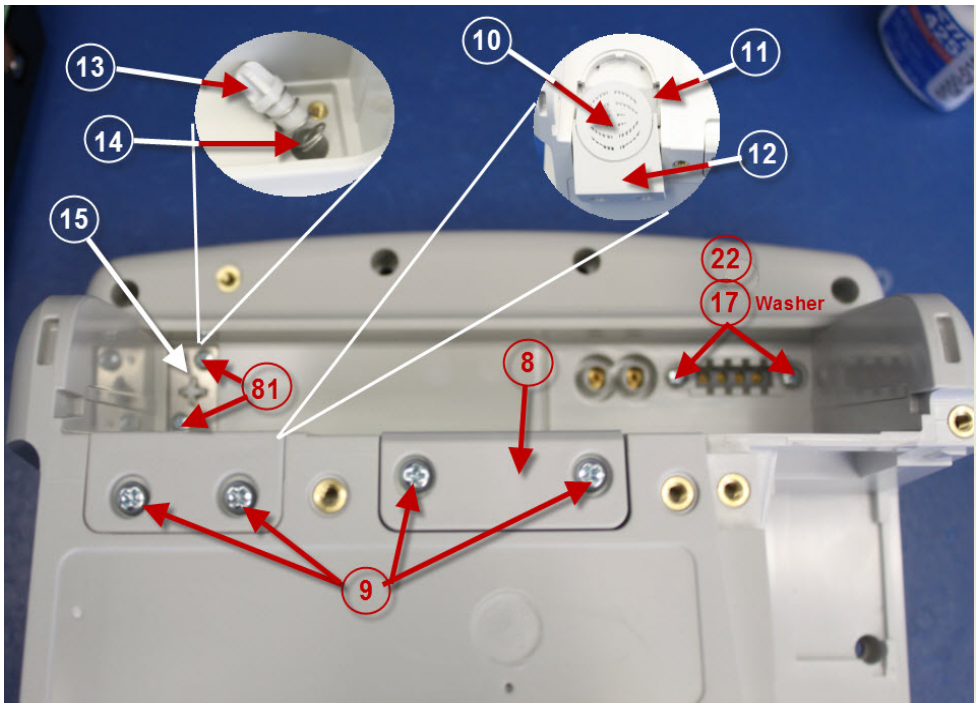
Part Number	Description	Item #
9330-0535	Insulator, SPO2, Masimo, MX3, X Series	56
9310-0762	Standoff SPO2 C Series	57
7608-000001-01	SPO2 MX-5BOARD	58
9330-000570	ISOLATOR, CP MODULE, X SERIES	59
9320-000792	BRACKET, HEAT SPREADER, X SERIES	60
9330-000568	PAD, THERMAL, 19MM X 19MM, X SERIES	61
3027-000006	PWBA, CARRIER, X SERIES, C	62
9310-000753-99	REWORK,BRACKET, CP ANTENNA, X SERIES	63
3027-000007	PWBA, ANTENNA, X SERIES, CP	64
9500-000695	CABLE, GPS/MICROPHONE, X SERIES	65
0500-000354	Cable Assy, RA MHF - RA MHF 36AWG 0.81mm COAXIAL115mm BLK	66
0500-000352	CABLE RF MICRO COAX PCB 50OHM 0.81MM DIA 150MM OAL	67
9320-000791	CLIP, GND, CP ANTENNA, X SERIES	68
705510	SCR, M3, TFM, 10, PNH, PHL, STL, ZNC, PLASTIC TAPPING	69
0162-000293	SCR, M2, MCH, 5, PNH, PHL, SST (Torx)	70
9320-000790	SHIELD, CP CARRIER, X SERIES	71
9330-000569	PAD, THERMAL, 15MM X 15MM, X SERIES	72
402346	ASSY, BRACKET, FAN	73
0162-000281	SCR PNH PHL M3 MCH 6 STL ZNC (Torx)	74
9301-001256-01	ASSY, PCB, FLEX CBL, SPO2 CONN PCB - SPO2 MODULE, X SERIES	75
9301-001254-01	ASSY, PCB, FLEX CABLE, SPO2 MODULE, X SERIES	76
707682	SCR, M3, TFM, 8, PNH, PHL, STL, ZNC, PLASTIC TAPPING	78
9500-000685	CABLE ASSY, LCD, X SERIES	79
9310-0674-02	SPIDER FRAME, X SERIES	80
0501-0001	TY-RAP CABLE TIE STD 18 LB .093W X 3.62 L	81
1007-003504-01	ASSY, RIGHT SIDE PANEL, X Series	82
0162-000280	SCR, M3, MCH, 8, PNH, PHL, STL, ZNC (Torx)	83
1007-002503-01	ASSY, LEFT SIDE PANEL, MASIMO/ORIDION, X SERIES	84
9310-000619	GASKET,SIDE PANEL,SPIDER	85
1007-000517	SUB ASSY, NIBP PUMP/VALVE/BRACKET	86

Part Number	Description	Item #
405849	PCA, BP OEM, (MODG, CALIBRATED)	87
9320-0095	DEFLECTOR, AIR, MOD G	88
0162-0017	WASHER, FLAT, M3, SS	89
705880	SPRING CLIP, TUBING CLAMP	90
1027-000182-03	SUB ASSY, ETCO2, X SERIES	91
705440	DISPLAY.LCD MODULE.TFT COLOR.17CM.640X480.800MCD	92
706659	BOOT RUBBER, DISPLAY	93
0550-0037	TAPE COPPER 3/4" W/CONDUCTIVE ADHESIVE	94
1007-000126	ASSY, DIE CAST, X SERIES	95
0162-000286	SCR,M3X4, PNH, PHL, SST (Torx)	96
1027-000002	FRONT ENCLOSURE, X SERIES Note:-XX (Language Dependant)	97
1027-000003	FRONT ENCLOURE , X SERIES, NO PACE Note:-XX (Language Dependant)	97
1027-001005-XX	FRONT ENCLOSURE, X SERIES ADVANCED, NIBP, PACE, W/O MICROPHONE	97
1027-001006-XX	FRONT ENCLOSURE, X SERIES ADVANCED, NIBP, PACE, W/ MICROPHONE	97
708502	GASKET,MAIN ENCLOSURE	98
0160-000303	STDOFF,14,M3,STL,Female,FF,HEX, ZNC	99
0162-000286	SCR PNH PHL M3 MCH 6 STL ZNC (Torx)	100
9301-001272-01	ASSY, PCB, FLEX CBL, DEFIB-MONITOR, SHIELDED, X SERIES	101
0163-1709	SNAP RIVET BLACK NYLON	102
0162-000283	SCR,M4,MCH,60,PNH,PHL,STL,ZNC (Torx)	103
0162-000284	SCR, M4, MCH, C0, PNH, PHL, STL, ZNC (Torx)	104
705164	WASHER.FLAT.M4.4.3MM ID.7.00MM OD.0.50MM THK.NYL..WHITE	105
1007-000502-01	PRINTER ASSEMBLY, X SERIES	106
9305-001690-01	LABEL, I/O PANEL RIGHT SIDE, TEMP/IBP, USB, X SERIES	107
9305-001687-01	LABEL, I/O PANEL RIGHT SIDE, TEMP, ACCUVENT, USB, X/M/MD	107
9305-001689-01	LABEL, I/O PANEL RIGHT SIDE, ACCUVENT, USB, X/M/MD	107
9305-001688-01	LABEL, DEFIB, X SERIES	108

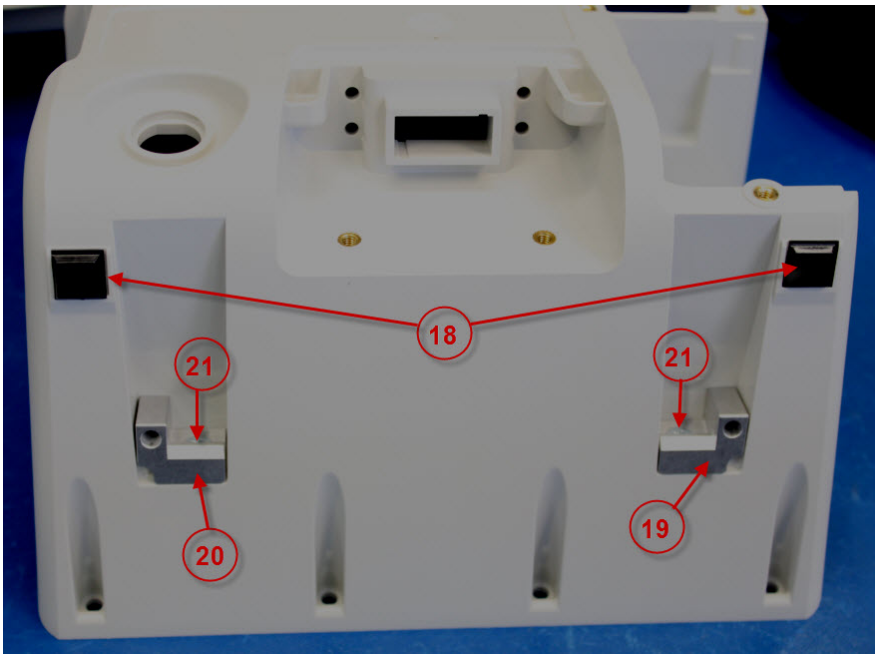
Part Number	Description	Item #
9305-000708-01	LABEL, WARNING, X SERIES	109
9305-002070-01	LABEL, NOMENCLATURE, NO UL,, X SERIES	110
1027-000015-01	ASSY, MASIMO LABELS, X SERIES	111
9305-000680-01	LABEL, LOGO, X-SERIES	112
9305-002196-01	LABEL, LOGO, X-SERIES ADVANCED	112
9305-000681-01	LABEL, L1-PNL ECG/SPO2 MA/NIBP/ETCO2- ORD	113
9305-000683-01	LABEL, L3-PNL ECG/SPO2 MA/NIBP	113
9305-000572-01	LABEL, ECG/ SPO2-MA/NIBP/ETCO2	113
9305-000573-01	LABEL, L1-PNL ECG/SPO2-MA	113
707740	FOOT,RUBBER,FRONT PANEL	114

Pictures and Diagrams

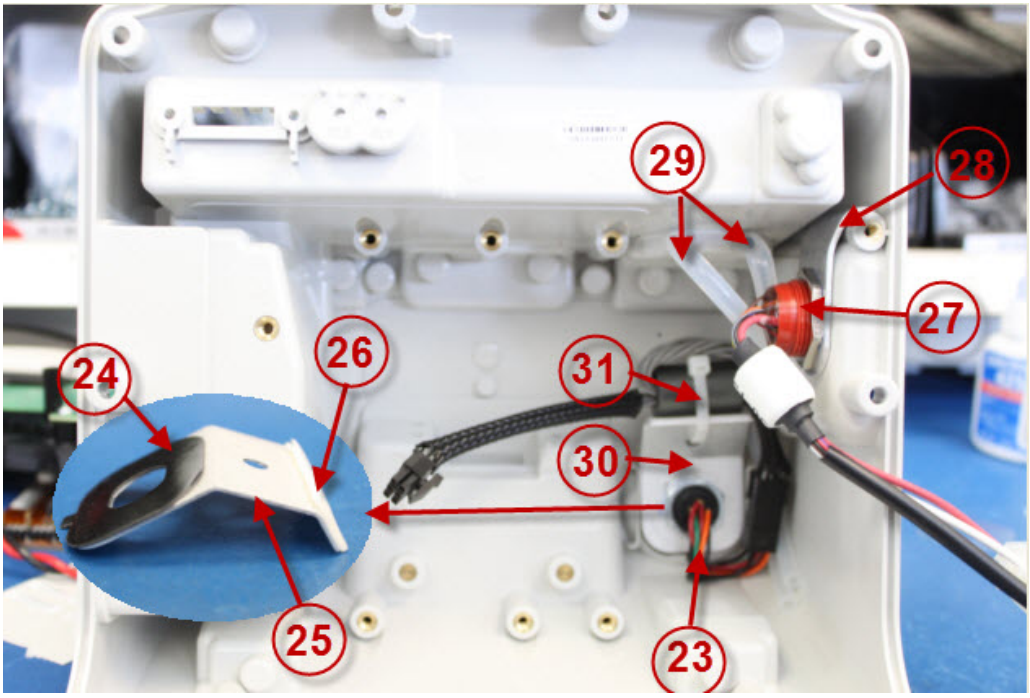
Picture 1



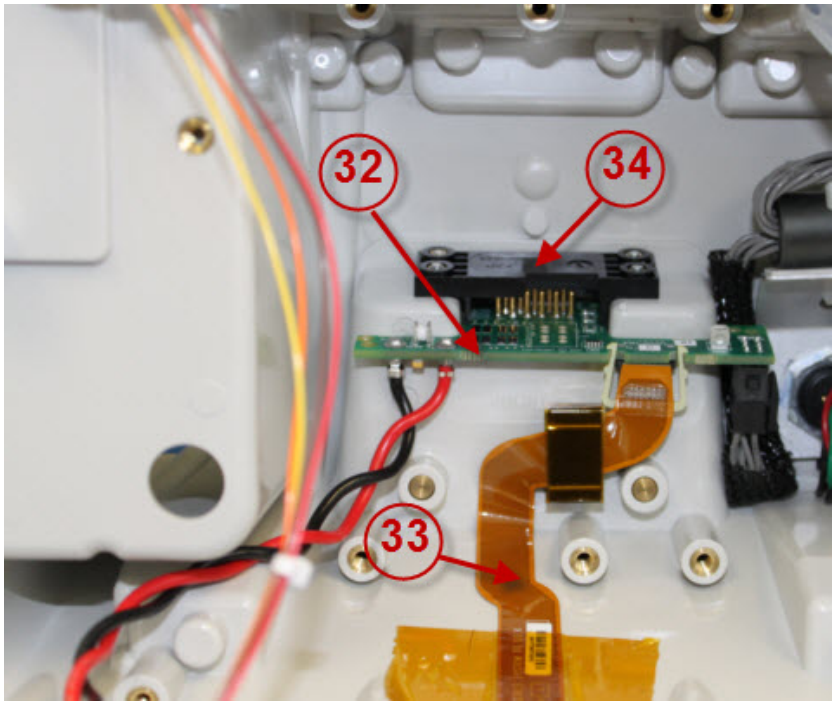
Picture 2



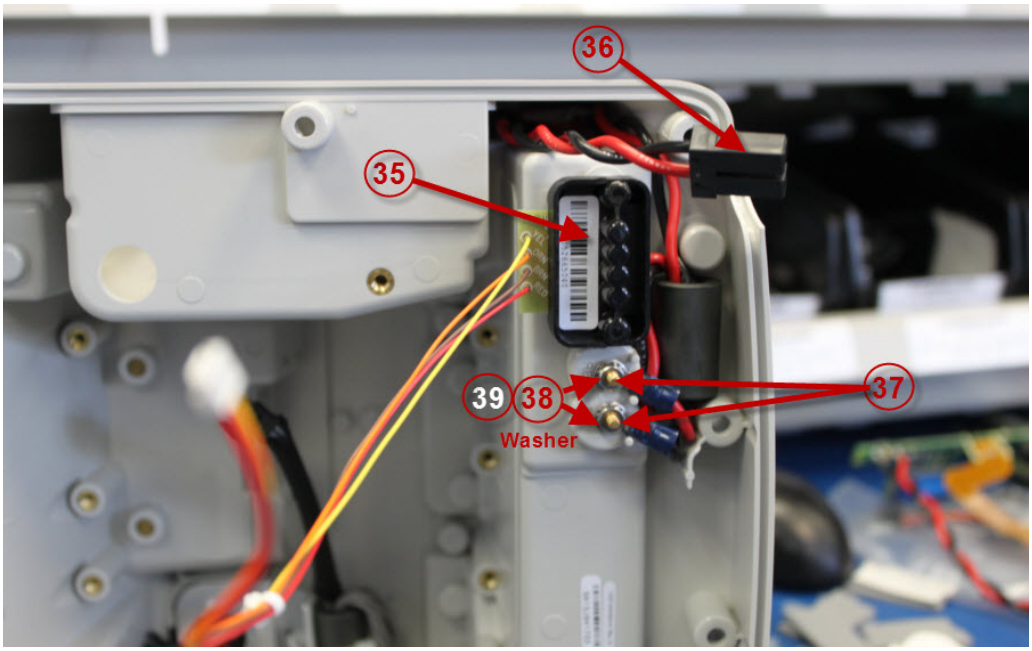
Picture 3



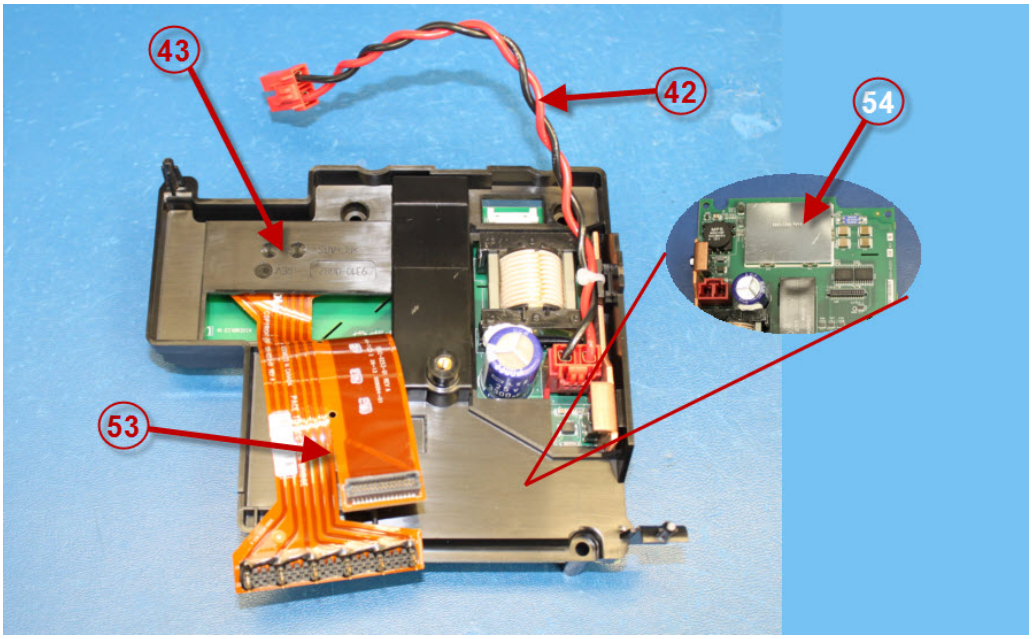
Picture 4



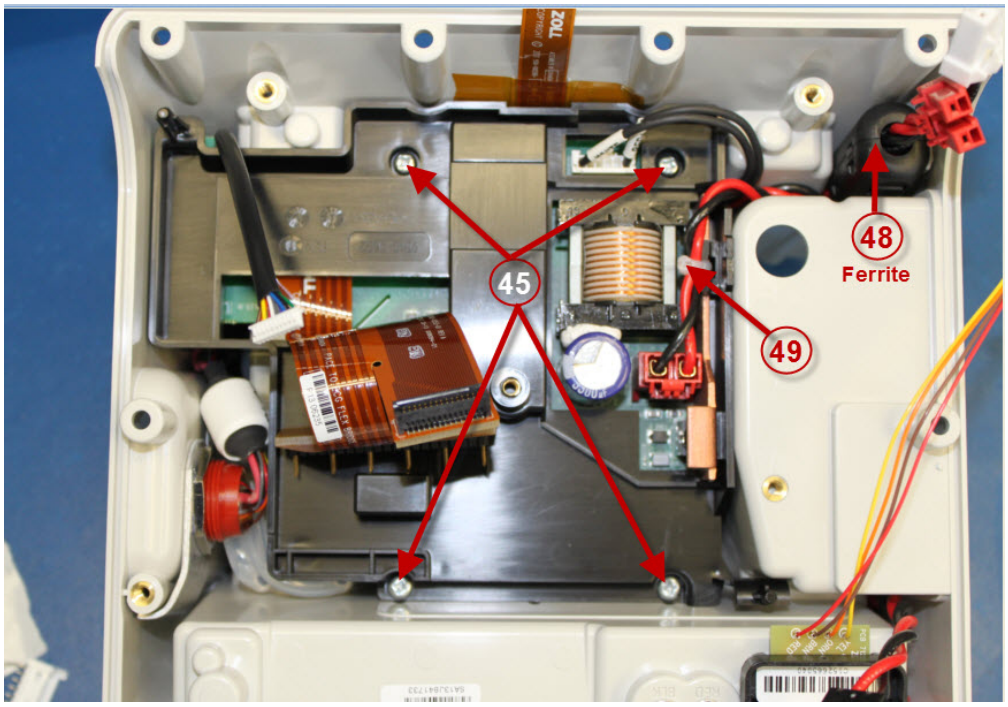
Picture 5



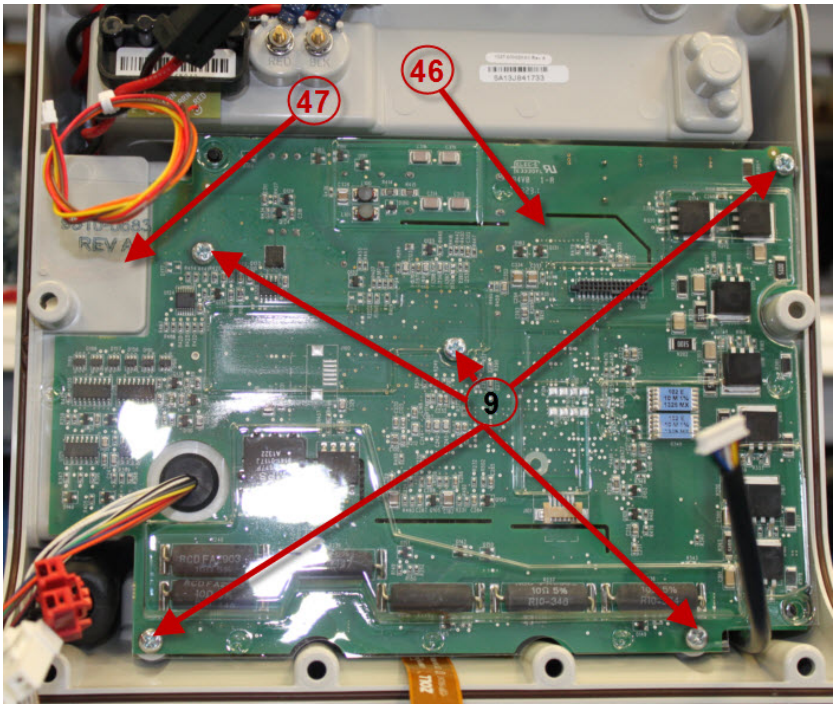
Picture 6



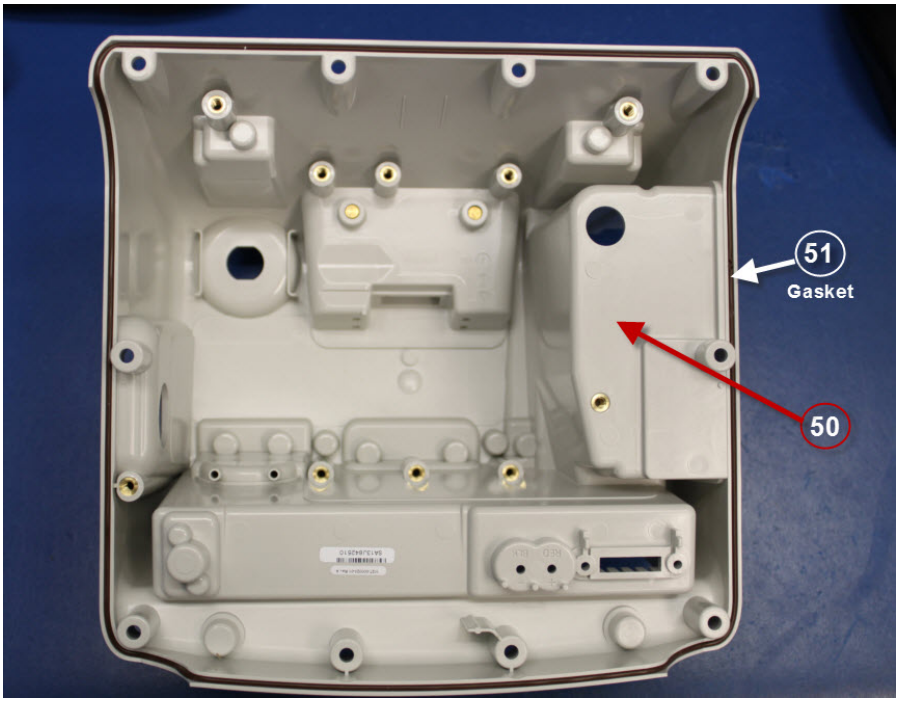
Picture 7



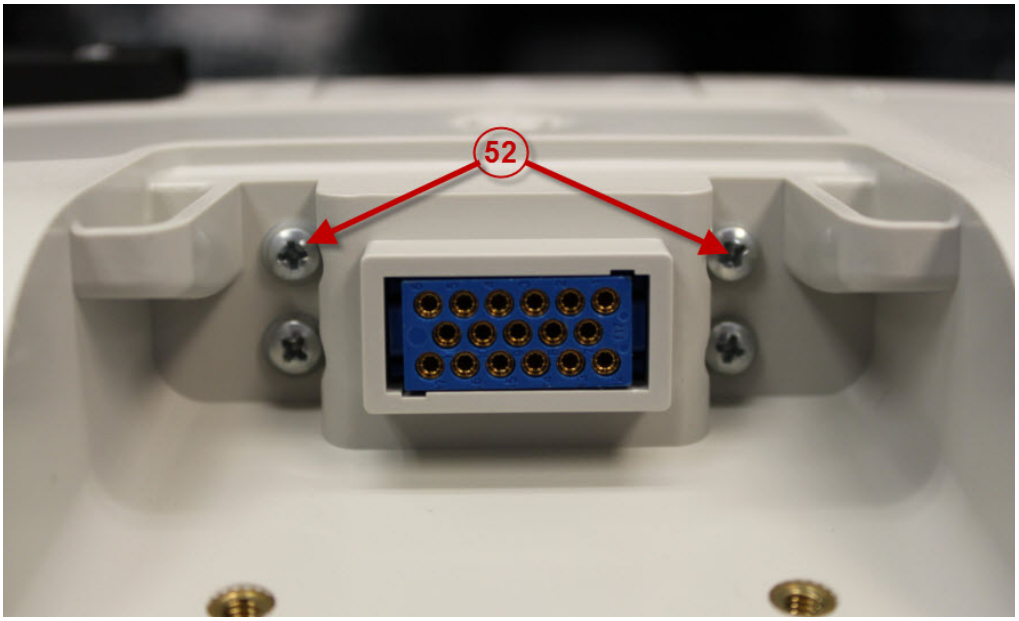
Picture 8



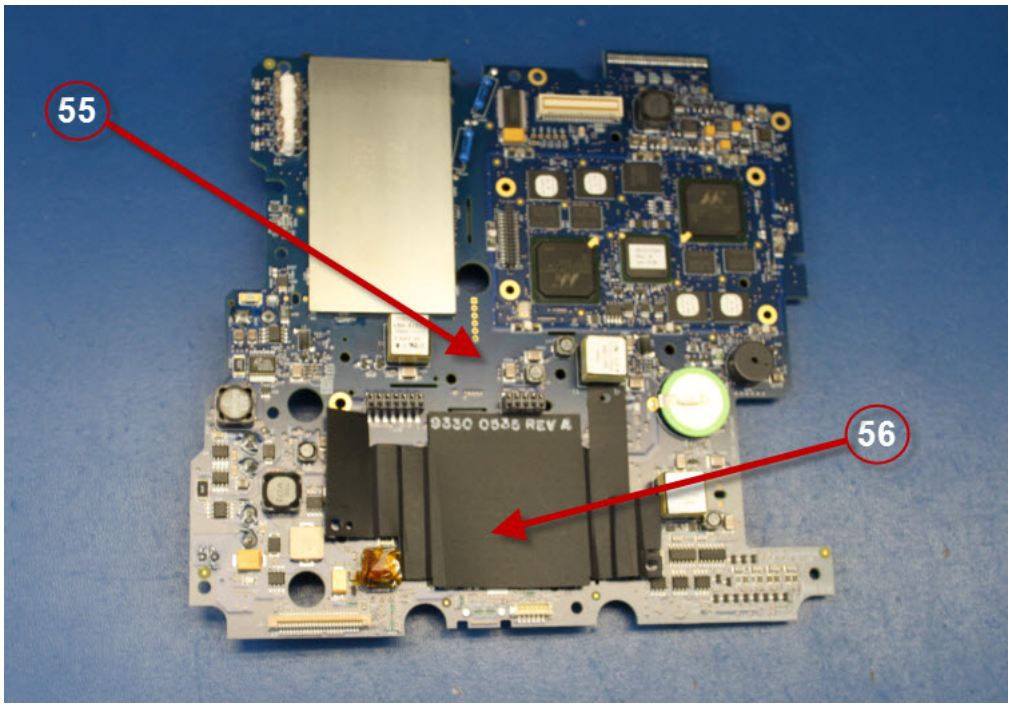
Picture 9



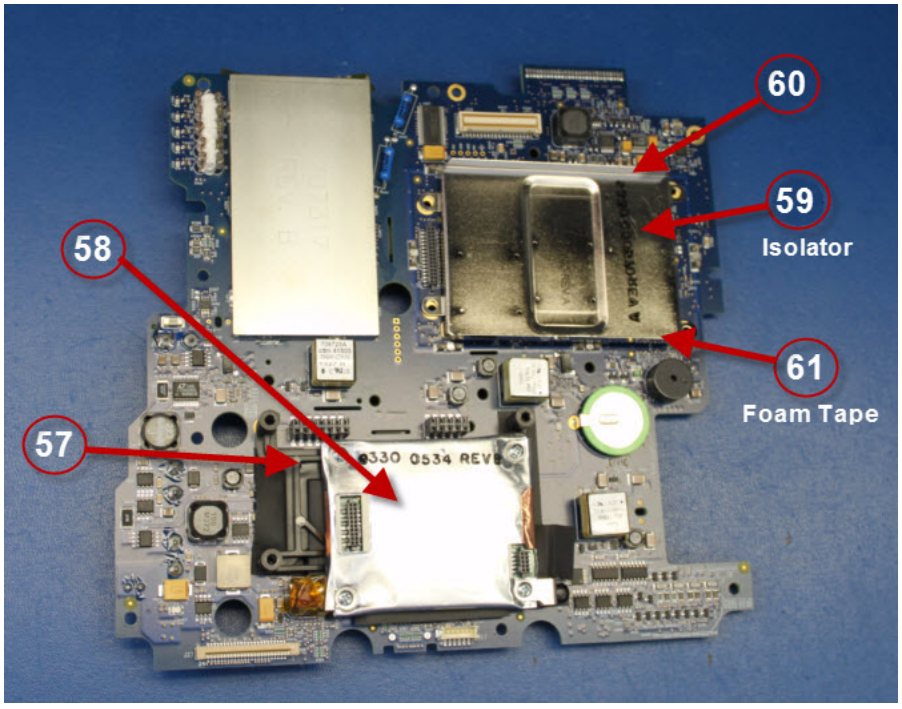
Picture 10



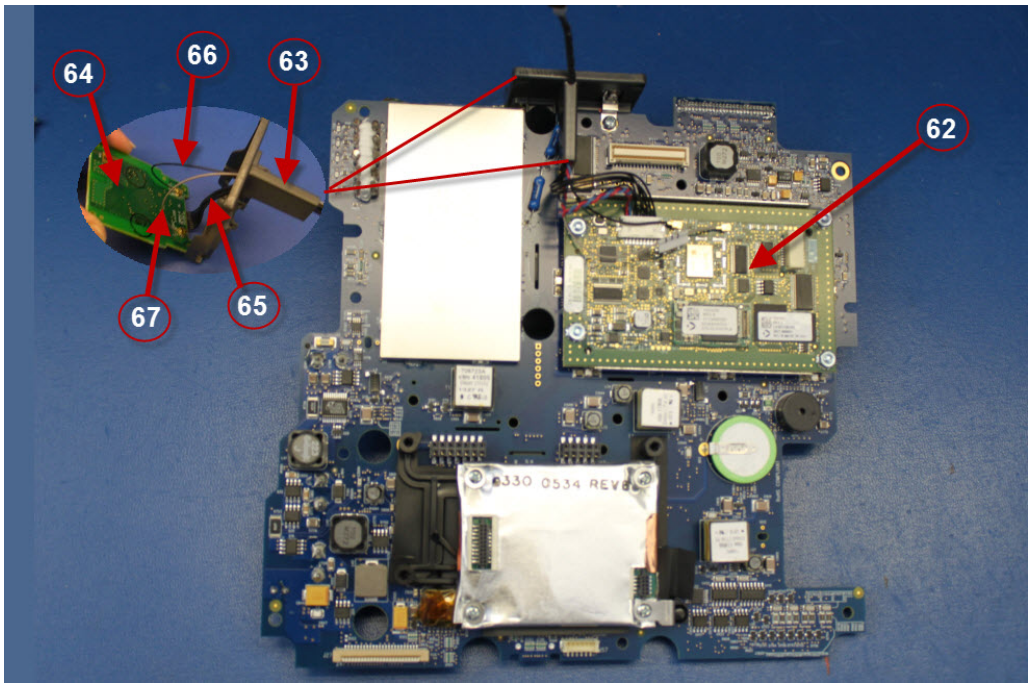
Picture 11



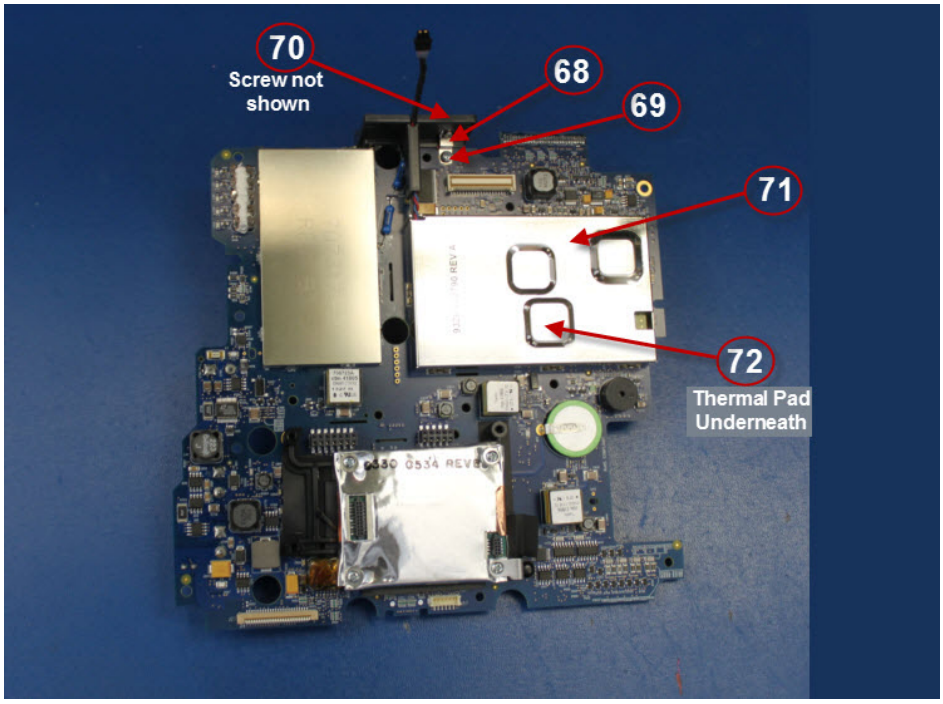
Picture 12



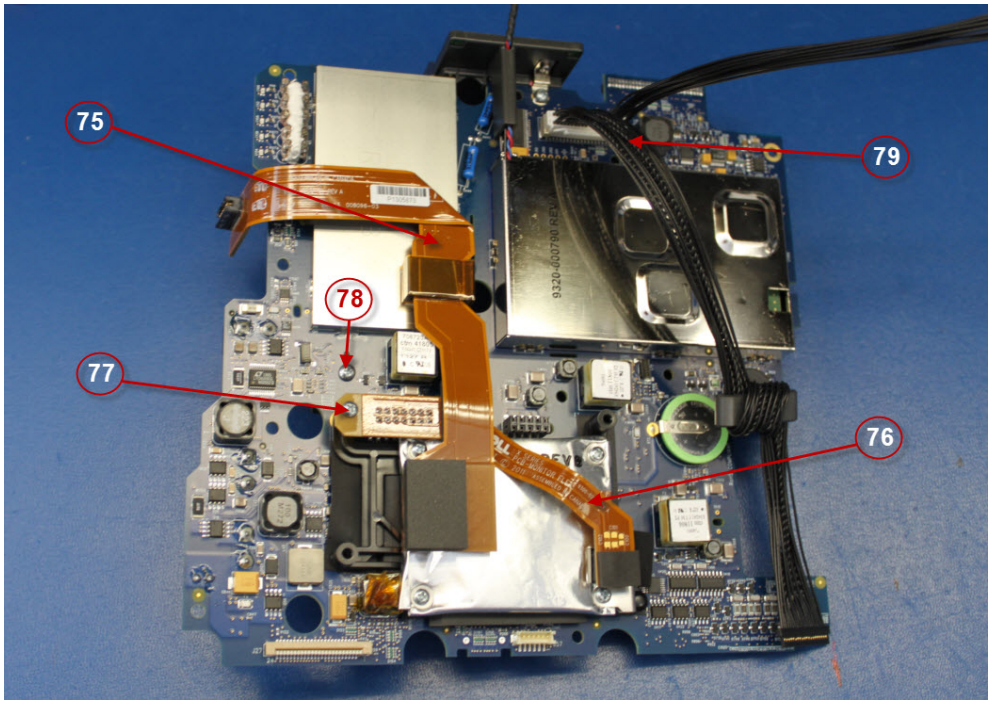
Picture 13



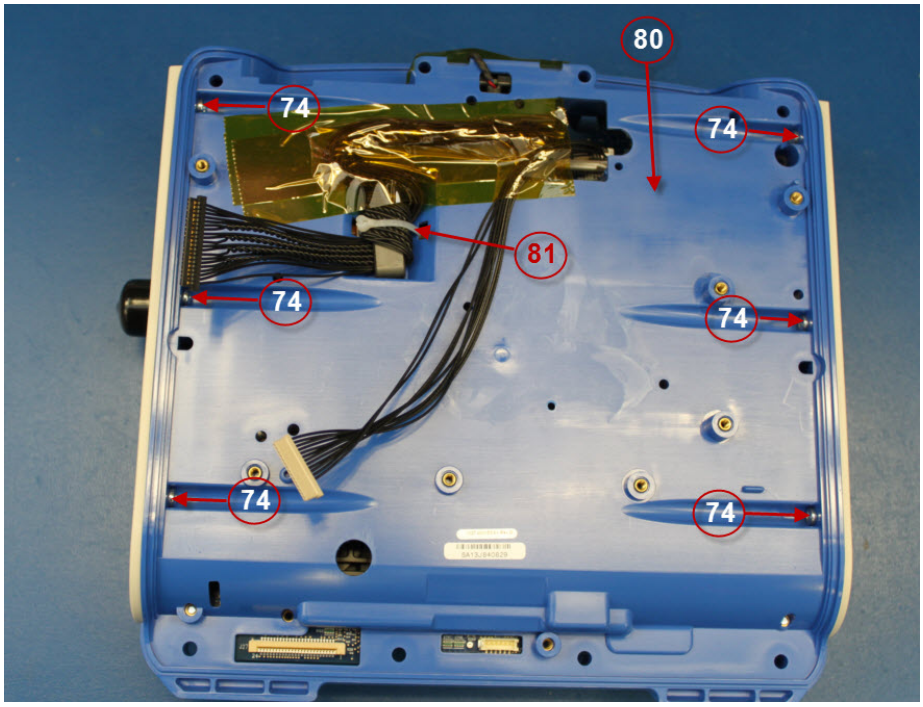
Picture 14



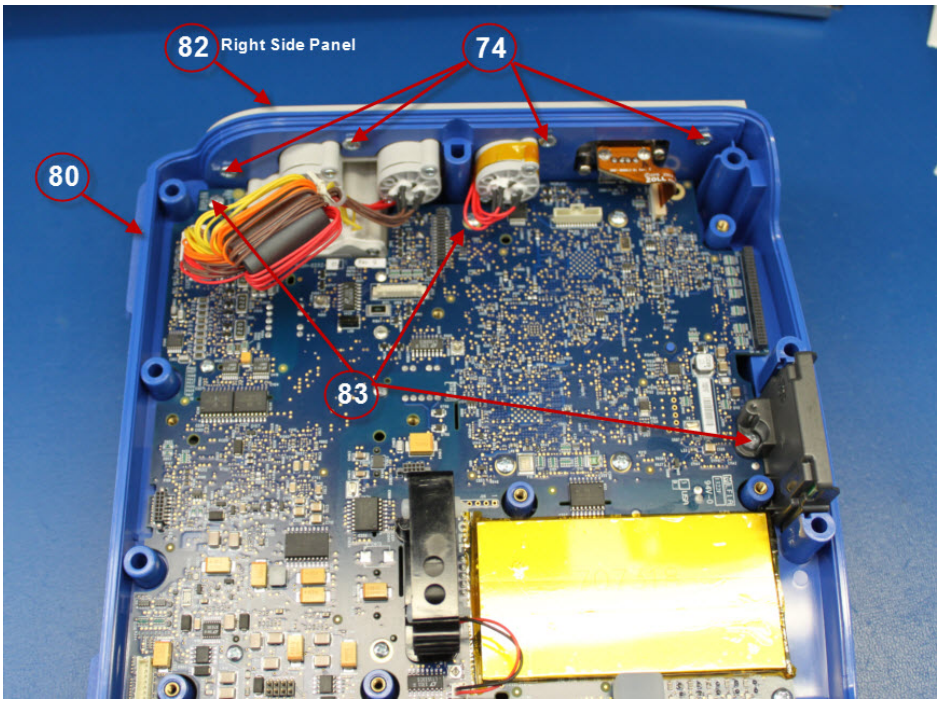
Picture 15



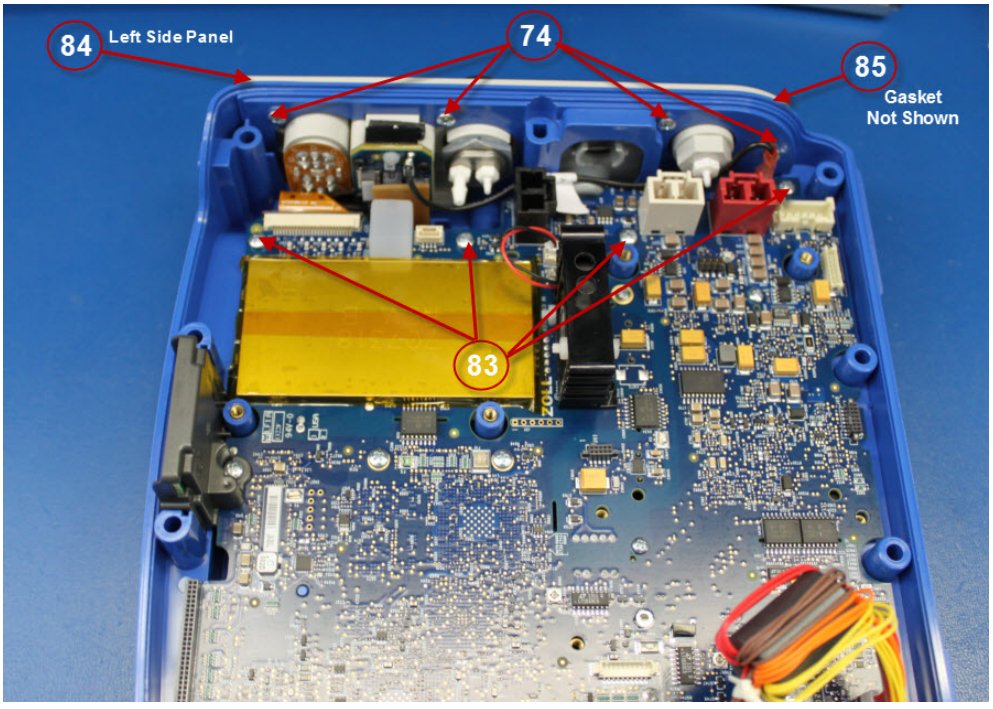
Picture 16



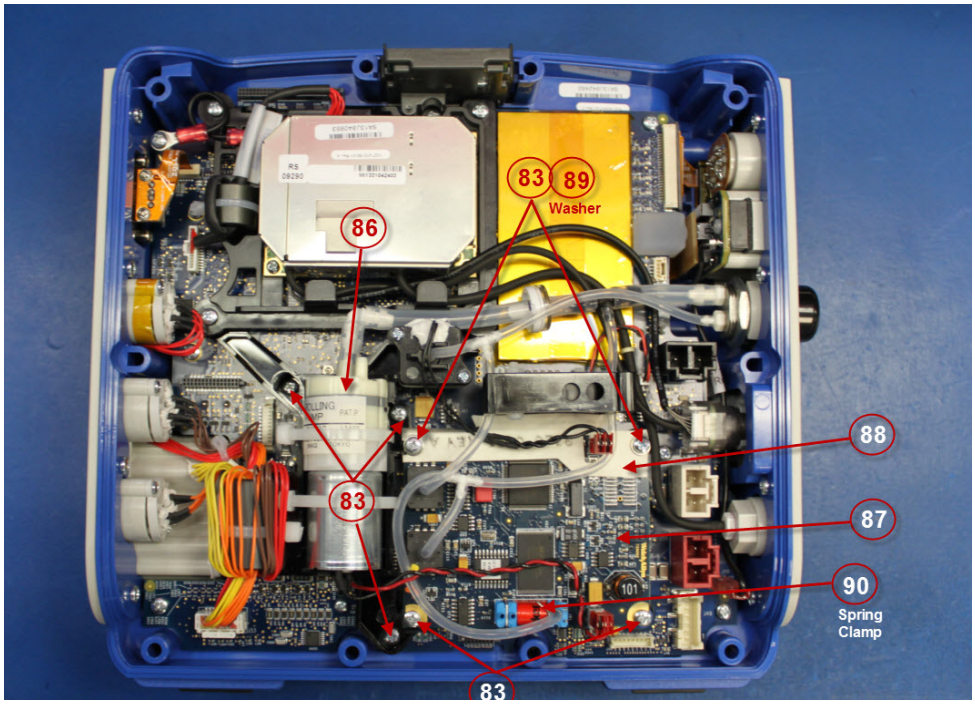
Picture 17



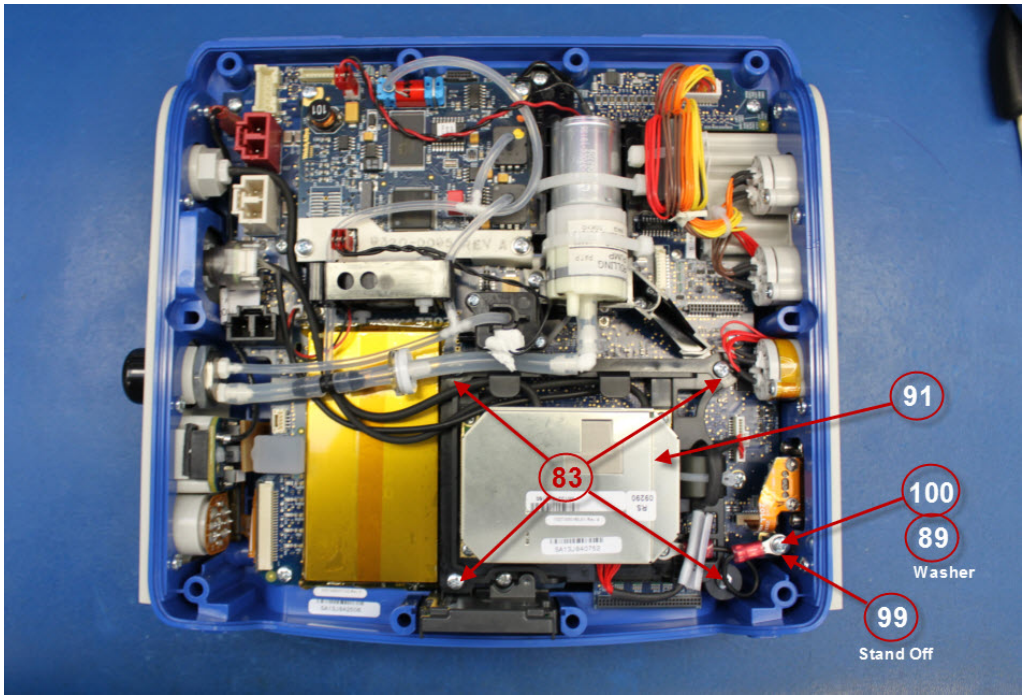
Picture 18



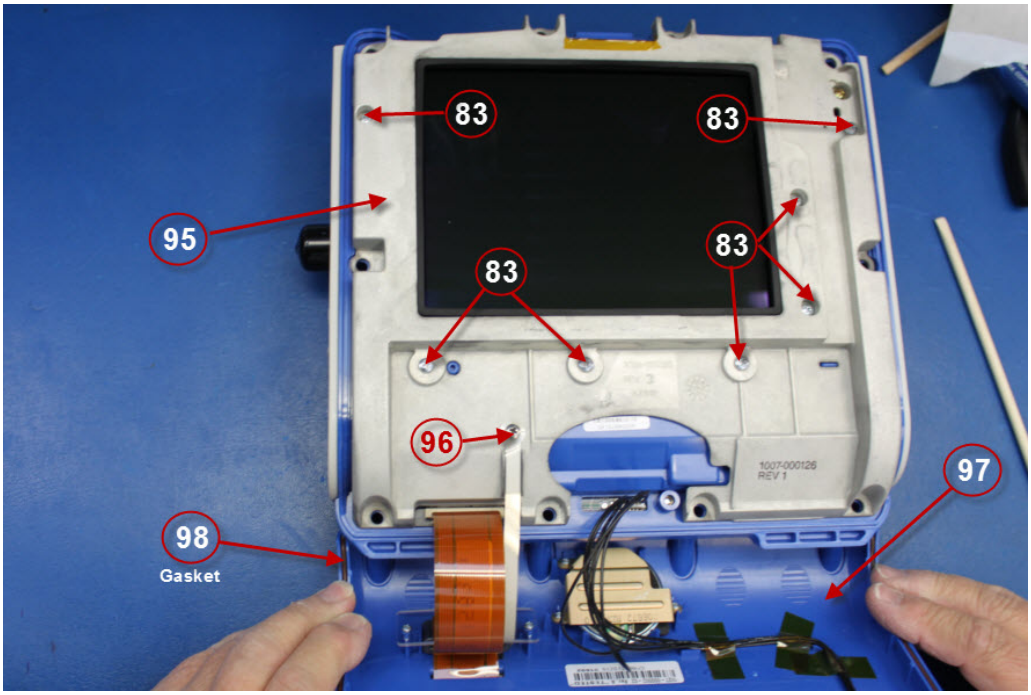
Picture 19



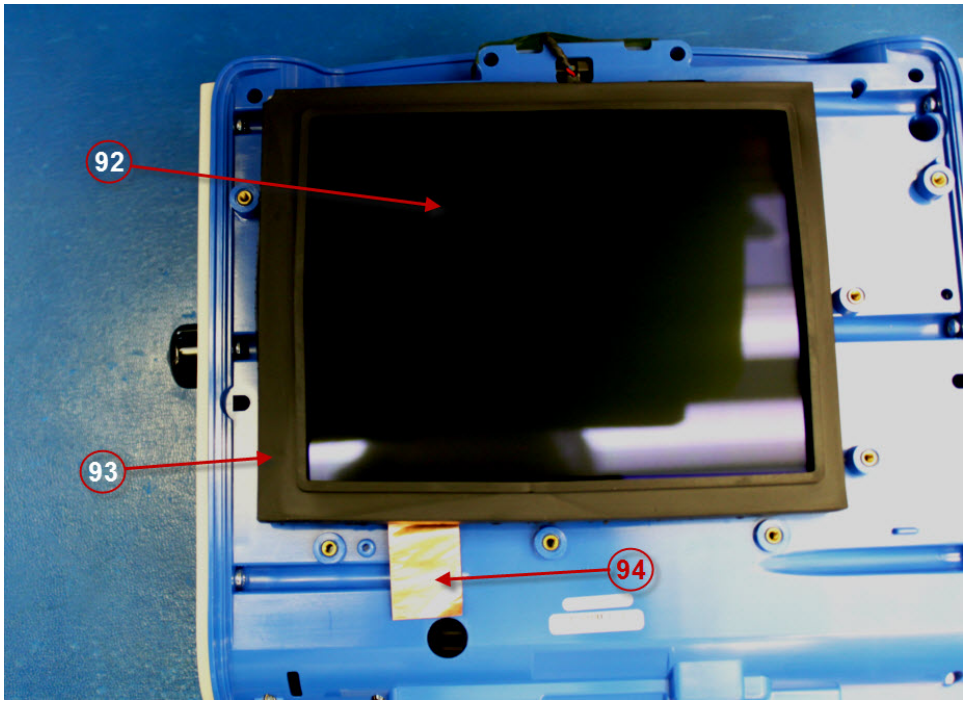
Picture 20



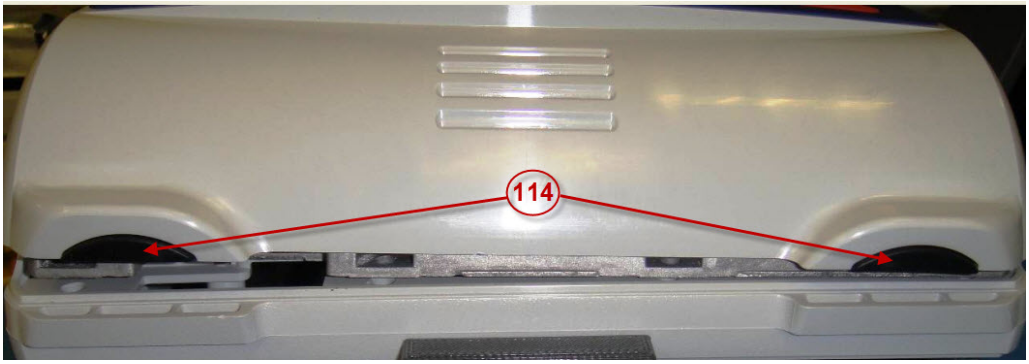
Picture 21



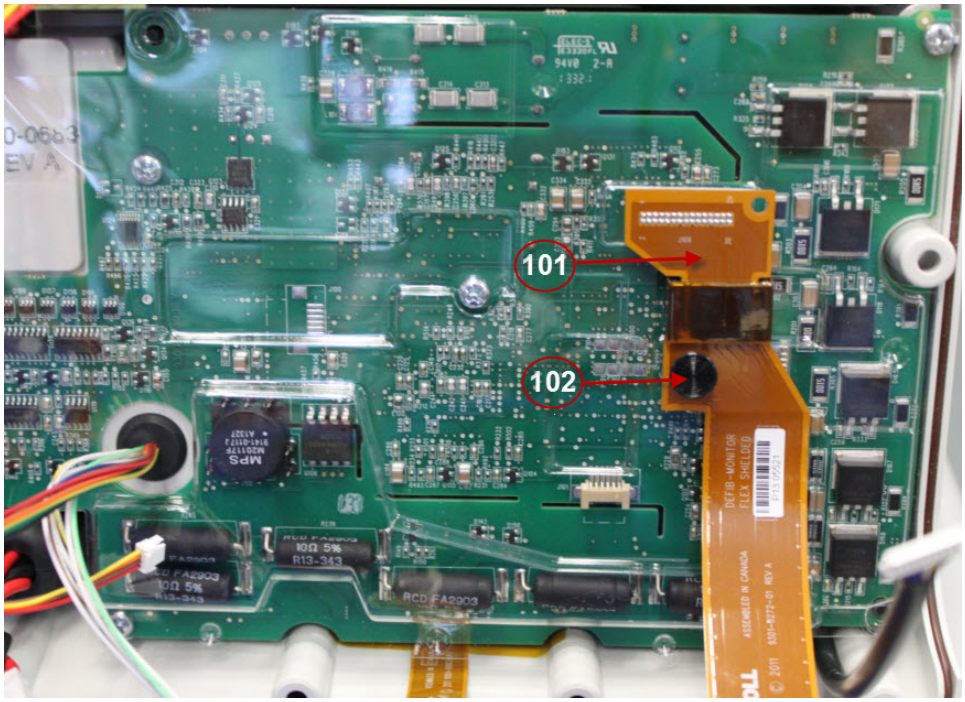
Picture 22



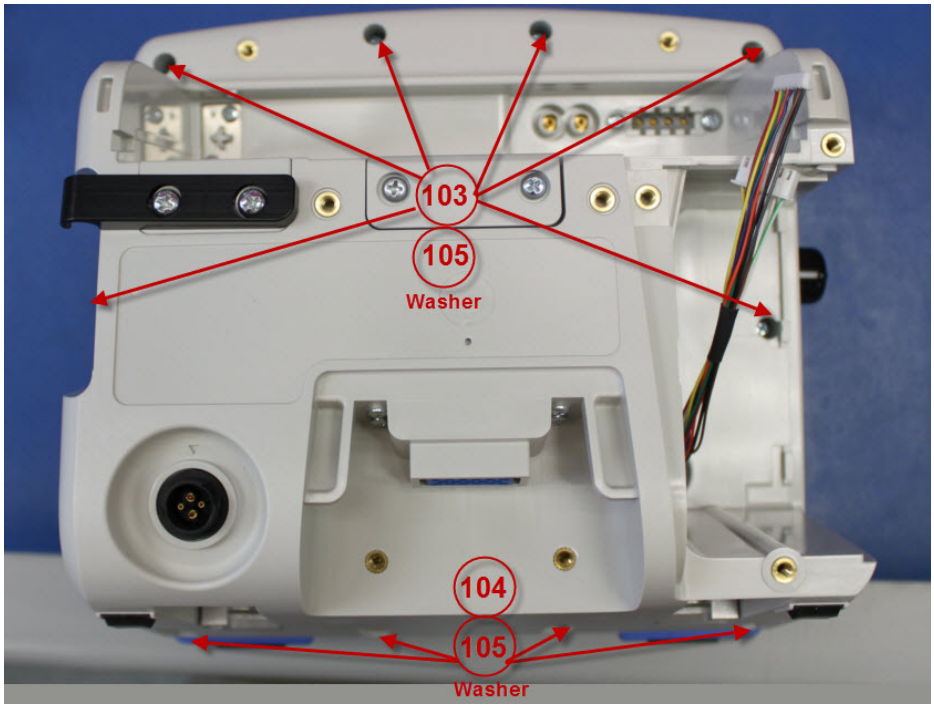
Picture 23



Picture 24



Picture 25



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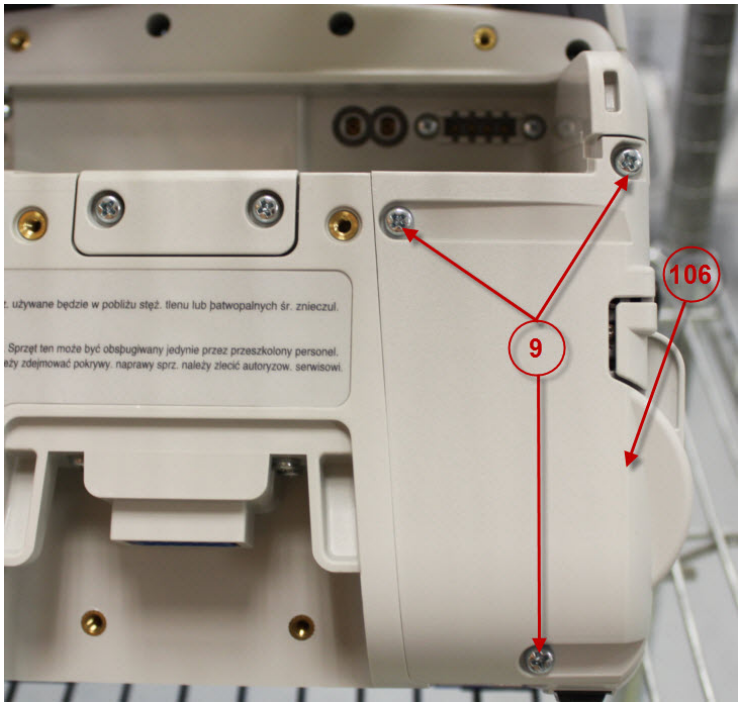

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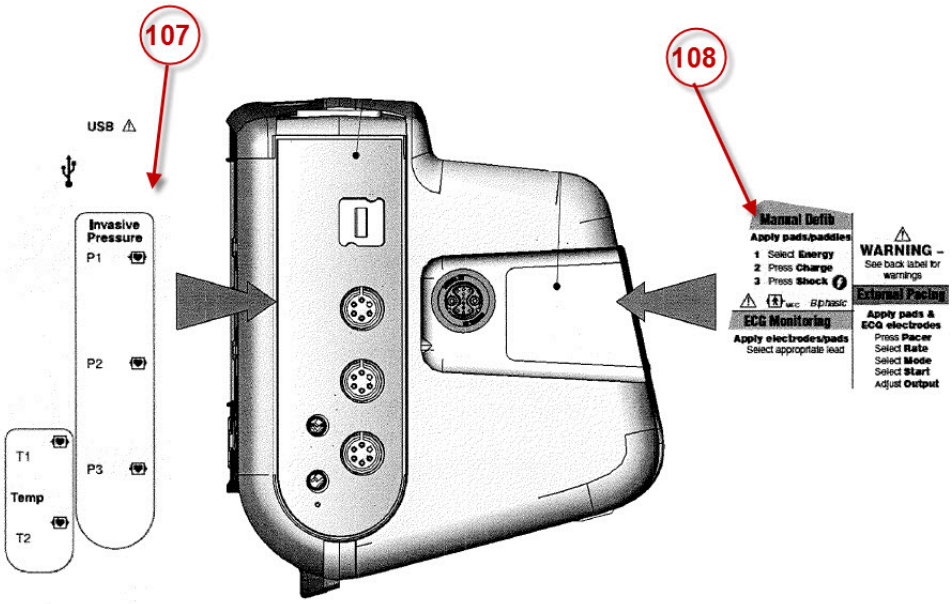

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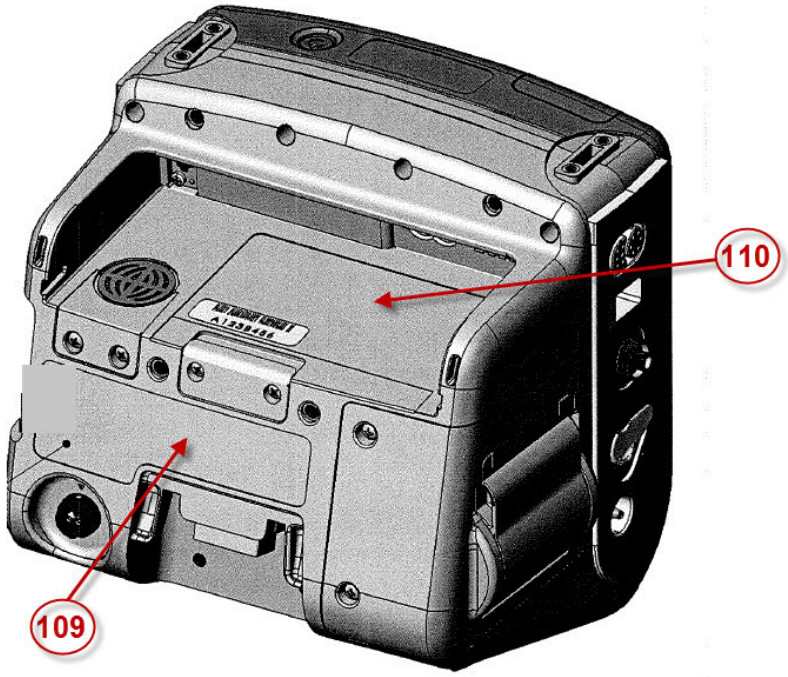

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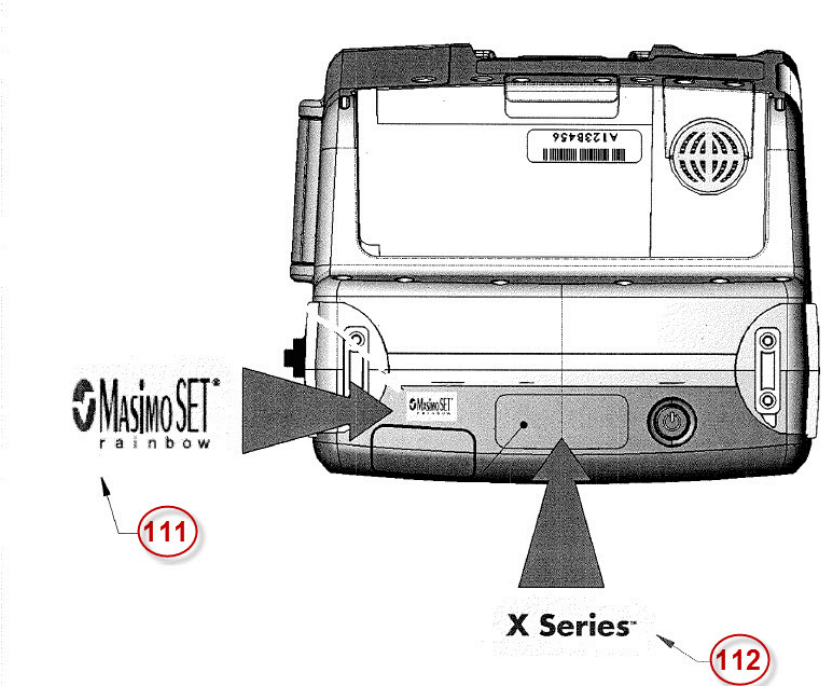

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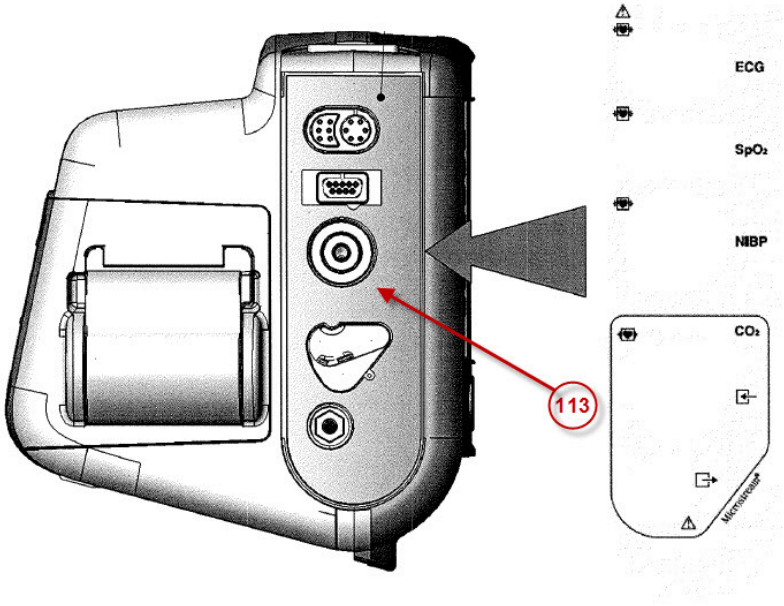

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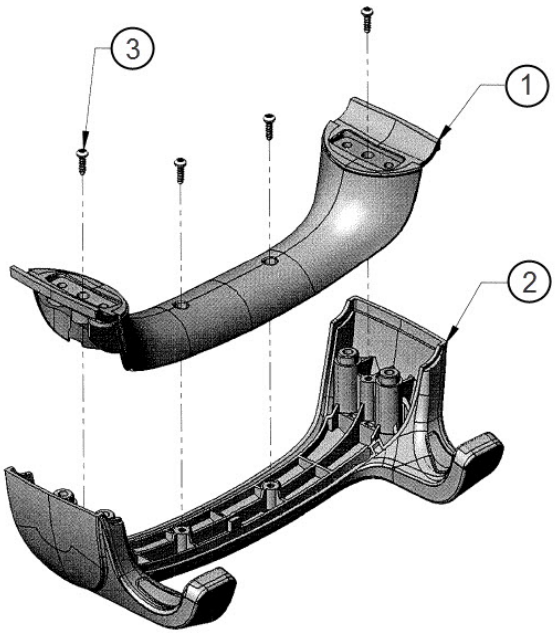
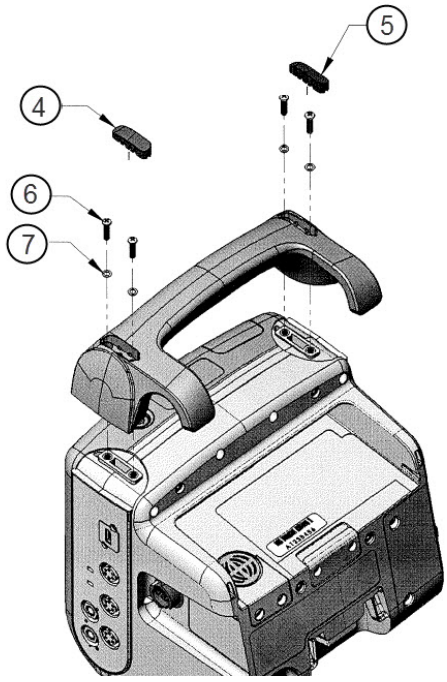


Picture 32



Chapter 5
Functional Description

Overview

This chapter contains functional descriptions of the components contained in the X Series and the X Series options.

Circuit Distribution

The Defib/Monitor X Series unit consists of two key PCB assemblies, the Monitor Board and the Defibrillator Board as well as a few modules and assemblies: the Front Panel Keypad assembly, Status LCD Board, Dock Connector Board, Display, and Printer. The NIBP, CO2, and SpO2 circuitry reside on modules that connect to the Monitor Board.

Monitor Board

The Monitor board integrates the analog circuitry and interface circuitry for patient parameters, a digital processing section as well as user interface controls, printer control, audio control, and power circuitry for the entire system and charging circuitry for the battery. The X Series system relies on a centralized dual processor engine for its computing needs. The Main Processor (MP) serves as the primary user interface engine and provides connectivity needs, while the Patient Processor (PP) controls the patient monitoring and defibrillation-pacing functions. An additional power controller micro-controller (PC) controls the power sequencing, and battery/ charger interface.

Main Processor (MP)

The Main Processor (MP) section controls the user interface, connectivity needs, as well as data logging, printing, and general system control. It consists of the CPU, program memory Flash and SDRAM, Communication with modules/circuits: USB Client, USB Host, Debug Ports (JTAG,Serial), Storage memory for 24 hour disclosure data, Internal VGA display and interface circuit, LED indicators, Key Pad, and Audio circuit. The MP also controls the real-time clock and interface to the power controller processor, battery and charger.

Patient Processor (PP)

The Patient Processor (PP) circuitry supports the data acquisition, signal processing and conditioning, analysis and control algorithms required for the physiological sensors. The PP also controls the defibrillation and pacing circuitry. It consists of the processor, program memory Flash and SDRAM as well as interface circuitry to physiological sensor modules/ circuits.

Power Controller (PC)

The Power Controller (PC) micro-controller controls the power sequencing to turn the device on and off when the power switch is pressed. It also communicates to the battery charger and battery via a serial SPI bus. Additionally, the PC controls the Status LCD and communicates battery and charger status to the MP.

Peripherals Interface

The Communications Processor (CP) is connected to various peripherals:

- MP
- Host Power Control
- USB
- Wifi
- Bluetooth~~GPS~~
- Expansion FLASH Storage

MP - The CP is connected to the MP via several communication links. The primary link is a high-speed UART with several GPIO lines for general signaling. Additional provision has been made for connection with an SPI link that would operate in parallel to the UART. The CP can perform message-based communication with peripherals that are connected to the MP, such as the PP, the real-time clock and power controller through the MP.

Host Power Control - The CP uses the Host systems' power controller - HC08 - for system power state information. This link consists of several GPIO lines. This link provides information about the connected power sources, imminent shutdown and handshaking.

USB - The USB interface on the CP provides a means to connect USB memory sticks and USB Cellular Modems.

Wifi - The Wifi interface on the CP is provided over an SDIO interface with auxiliary GPIO lines for control. This provides the capability for communication with a/b/g/n 802.11 devices. Collectively, this interface allows the CP to control power, scan for available networks and to select/deselect a desired connection.

Bluetooth - The Bluetooth interface on the CP is provided by a UART interface with auxiliary GPIO lines for control. Collectively, this interface allows the CP to control power, scan for available devices and to select/deselect a desired connection.

~~**GPS** - The GPS interface on the CP is provided by a UART interface with auxiliary GPIO lines provided for control. Collectively, this interface allows the CP to control power and to listen for satellites. The UART interface is jumpered and also routed to the expansion connector to provide a means for accessing the CP's console debug port. If the console port is enabled, the GPS interface will not be available and vice-versa.~~

Expansion FLASH Storage - This consists of a block of supplemental FLASH that is physically separate from the NAND FLASH used to store the boot loaders, kernel and system software. This partition is used to store upgrade images, patient data and device log data. This storage exists on the carrier board and is connected to the CP via an SD interface.

ECG 3/5 or 12 Lead Circuitry

X Series supports 3/5 lead and 12 lead ECG acquisition. Analog circuitry provides signal conditioned data through an A/D converter to the PP. All of the signal processing, lead derivation, fault detection is performed by the PP. The ECG circuitry utilizes a CPLD for control of analog circuitry and transmission of data to the PP across an isolation barrier. A common connector is used to receive 3/5 Lead ECG cables with a 12 Lead ECG extension. The ECG acquisition inputs are CF defib-proof applied parts. The defib protection resistors reside in the patient cable. The ECG signals from the external connector on the left side panel are connected to the monitor board through a flex cable to J28.

Impedance Respiration

X Series provides the circuitry for impedance respiration measurements in 3/5 and 12 lead configurations. This circuitry provides a low-current 72kHz AC signal across leads I and II of the ECG cable. The signal is passed through a synchronous demodulator and decoded by the PP through the ECG CPLD.

Blood Pressure NIBP

The X Series NIBP circuitry resided on module that connects to the Monitor board through J32. The PP communicates to the NIBP module via a bi-directional, serial bus. The NIBP module supports both dual lumen and single lumen cuffs. The NIBP pump and valve hoses are connected to the cuff connector on the left side panel and to the filter on the rear enclosure. The pump and valve are connected to the NIBP module by short, 2-wire cables.

Invasive Blood Pressure (IBP)

X Series supports up to 3 IBP measurement channels. The IBP circuitry supports AAMI BP-22 transducers (5uV/V/mmHg). The PP communicates directly to the IBP ADC over an isolated serial bus through the FPGA. The IBP probes connect to the monitor board through the IBP/ Temp wire harness which connects to J33 of the Monitor board.

SPO_2 Module

X Series supports the Masimo Module that mounts to the Monitor board and communicates through J36 and J40. The SpO_2 module communicates across an isolation barrier using a UART on the PP. Signals from the probe are routed to the SpO_2 module through a flex cable that connects to J41 of the Monitor board.

End tidal CO_2 (CO_2)

X Series supports an Oridion® Microstream® CO_2 module. The CO_2 module mounts to the Monitor board and communicates to the board through a cable connected to J50. Serial communications from the monitor board is implemented via a UART on the PP. The CO_2 module obtains gas samples from the sampling lines through tubing and a 3-wire cable connected to the left side panel.

Thermometry

X Series supports two simultaneous temperature measurements. YSI400/YSI700 series probes are used to make temperature measurements. Data is communicated to the PP from the Temperature ADC via and isolated SPI bus through the FPGA. The Temperature probes connect to the monitor board through the IBP/Temp wire harness which connects to J33 of the Monitor board.

Power Circuitry, Battery Charger, DC-DC converters

Power circuitry for all subsystems but the defibrillator-pacer module reside on the Monitor Board. Auxiliary Power and Battery Power are automatically switched to provide constant current, the unit draws current from auxiliary power when present. There is a smart battery charging circuit that will charge the battery when Auxiliary power is present. Switching mode DC-DC converters are utilized to make internal 6V, 5V, 3.3V, 1.8V and processor core voltages. Regulators are used to provide regulated supply voltages with low dropout for low current consumption circuits. Each of the isolated modules, Temp/IBP, ECG, SpO2 have independent power supplies. Isolated power supplies are designed for isolating Patient Applied Parts. The MP via the FPGA GPIO has the ability to shut down voltage rails or power to individual patient parameters. Power from the battery connects to the Monitor board through J29. Auxiliary power connects to the Monitor board through J31.

USB Host Port

X Series Monitor Board incorporates one USB Host ver 1.1 port. The port uses the USB controller built into the PXA270 Main processor. Full speed of 12 Mbps and Low speed 1.5Mbps are supported. The Host port supports a USB flash memory stick for data export. The USB host connector is in the right side panel and connects to the Monitor board through J44.

Defibrillator Pacer Module

The Defibrillator/Pacer Module consists of two PCB assemblies connected by a flex cable. This Defibrillator/Pacer module relies on proven core defibrillation/pacing technology for improved power conversion efficiency, reduced EMI, and improved stability in volume production. This module contains power supplies, charging and discharge circuitry, pacing circuitry, and the Pads/Paddles ECG preamplifier and impedance circuitry. Communication with the Defibrillator/Pacer module is a function of the PP. The ECG-Charger board contains the charger circuit, ECG acquisition circuitry, and protection components. The Processor-Bridge-Pacer board contains the micro controller, CPLD, Pacer, and defibrillation shock delivery circuit.

Defib CPLD

The Defib CPLD provides I/O control for the Pacer circuitry, the defibrillator charging and fire control circuitry.

Pace/Defib (PD) Micro controller

The PD micro controller communicates with the PP processor on the monitor board to accept commands to control the defibrillator and pacer. The PD micro controller controls the pacer current and pulse timing and the defibrillation charging and waveform generation. Communication between the Monitor and Defibrillator/Pacer boards is routed through the flex cable connected to J106 of the defibrillator board and J38 on the Monitor board.

Charging Circuit

This is a high voltage step-up inverter that charges the Defib Capacitor. It provides electrical isolation between the defib output and the system. The charging circuit will charge the Defib Capacitor to up to 2775V. The Defib Capacitor is connected to the Defibrillator/Pacer board through the 2-wire cable connected to J119.

Fire and Relay Circuit

The fire circuit employs high voltage switching devices to deliver a biphasic waveform to the patient. Switching devices are utilized to produce a Rectilinear Biphasic® waveform. In addition, relays are located between the fire circuit and the patient for electrical isolation. They are engaged only when a valid command is set from the Defib CPLD.

Pacer

Pacer circuit delivers pacing pulses under control of the PD micro controller over an isolation transformer. The pacer circuitry consists of an adjustable constant current power supply, pulse timing, and current monitoring circuits.

Pads/Paddles ECG Preamplifier

This is a single channel ECG preamplifier paddle pick up that monitors the patient ECG signal from the Defib paddles (or pads). It digitizes this signal and delivers it to the PP processor via the PP interface. This preamp is a simplified version of the 3/5/12 Lead ECG utilized on the Monitor Board.

Paddle Interface

Paddle interface circuitry detects analog voltage levels to decode switches and ID resistors of the standard ZOLL paddles and internal paddles. The paddle set interface is connected to J115 of the Processor-Bridge-Pace PCB.

Printer

X Series uses an internal thermal printer of 80 mm paper size that is built into the Defib section of the enclosure. Communications with the printer is bi-directional, serial, (Main CPU to/from printer) and complies with the software/hardware interface of the internal printer. Communications are implemented using hardware Universal Asynchronous Receiver. Transmitter (UART). The printer is controlled by the MP and is connected through a cable to J46 and J49 of the Monitor board.

Lithium Ion Battery

The portable X Series device is powered by a removable Lithium Ion battery pack. This battery pack incorporates protection circuitry and "smart battery" circuitry. The battery power is routed from the 2-pin connector on the rear of the device to J29 of the Monitor board. The Power Controller communicates to the smart circuitry on the battery through the 4 spring contacts connected to J34 on the Monitor board.

Chapter 6
Test After Repair

Overview

The following tests are required after completing specific repairs on the ZOLL X Series monitor/ defibrillator. Some components also require calibration after replacement.

Procedure:	Required After Replacing:
Full Preventive Maintenance procedure	Any part, component, or board in the X Series
Impedance Calibration*	• Monitor/System board** • Pacer Bridge Processor board** • ECG board** • Capacitor**
Power Supply Test*	• Battery interconnect board • Monitor/Digital board

*Instructions for this procedure can be found in the Level 1 E-Learning course module.

**This component should only be replaced by ZOLL or its Authorized Service Providers.

Power Supply Test

Equipment: Battery Current Test Fixture (P/N 9100-3055-TF), Power Supply, digital multimeter

Test Setup

1. Set the Power Supply to 12V VDC.
2. Turn off the Power Supply output.
3. Connect the positive (PS+) post of the Power Supply to the positive (PS+) post (PS Red) of the Battery Current Test Fixture.
4. Connect the negative (PS-) post of the Power Supply to the negative (PS-) post (PS Black) of the Battery Current Test Fixture.
5. Set the digital multimeter to measure *DC I* DC Amps.
6. Set the rear/front switch on the digital multimeter to rear.
7. Connect the digital multimeter (I+) terminal of the Battery Current Test Fixture to the red terminal (I) on the back of the digital multimeter.
8. Connect digital multimeter (I-) terminal of the Battery Current Test Fixture to the black terminal (LO) on the back of the digital multimeter.
9. With the Battery Current Test Fixture out of the battery well, turn on the Power Supply output.

	Do this...	**Observe this...**	**Pass/Fail**
1	Install the Battery Current Test Fixture into battery well and wait about 5 seconds.		
2	Make sure the X Series unit is turned off. Ensure that paper is loaded in the printer and the printer door is closed.		
3	Press the *I Measure* switch on the Battery Current Test Fixture.	The reading on the digital multimeter is between 0.583mA–0.770mA.	o o
4	Turn on the X Series and wait about 10 seconds until the power has stabilized.		
5	Ensure that the unit is in the following configuration: 1. Brightness set to color display. 2. Display brightness is set to the factory default setting 70% (in Setup > Display\Volume > Display) 3. Ensure that no parameters are active/running.		

	Do this...	Observe this...	Pass/Fail
6	Press the *I Measure* switch on the Battery Current Test Fixture.	The current measurement on the DMM, and verify that the reading is between 0.47A–1.25A.	o o
7	Return brightness levels to previous settings (if changed in previous step).		

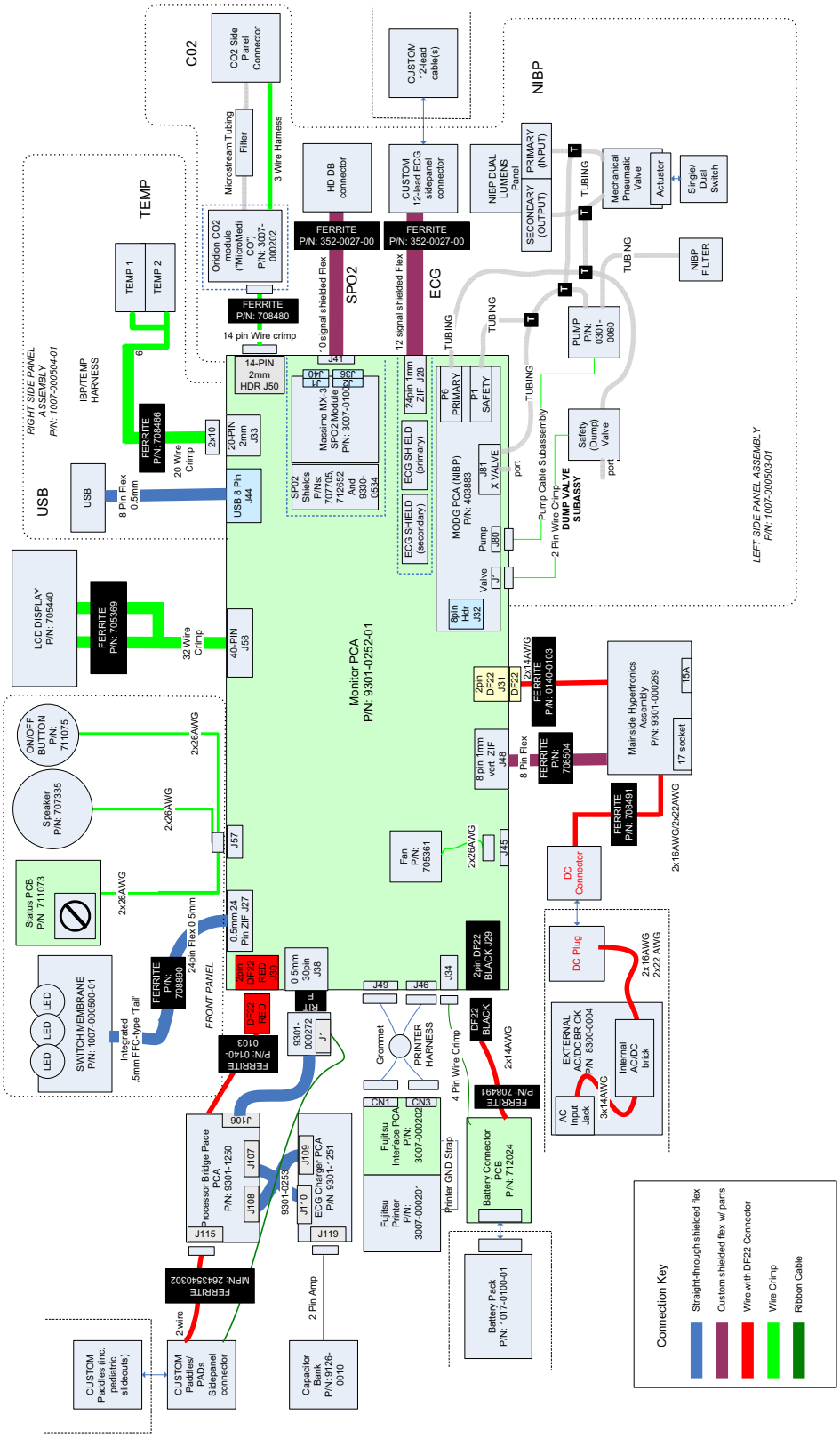
Appendix A

Overview

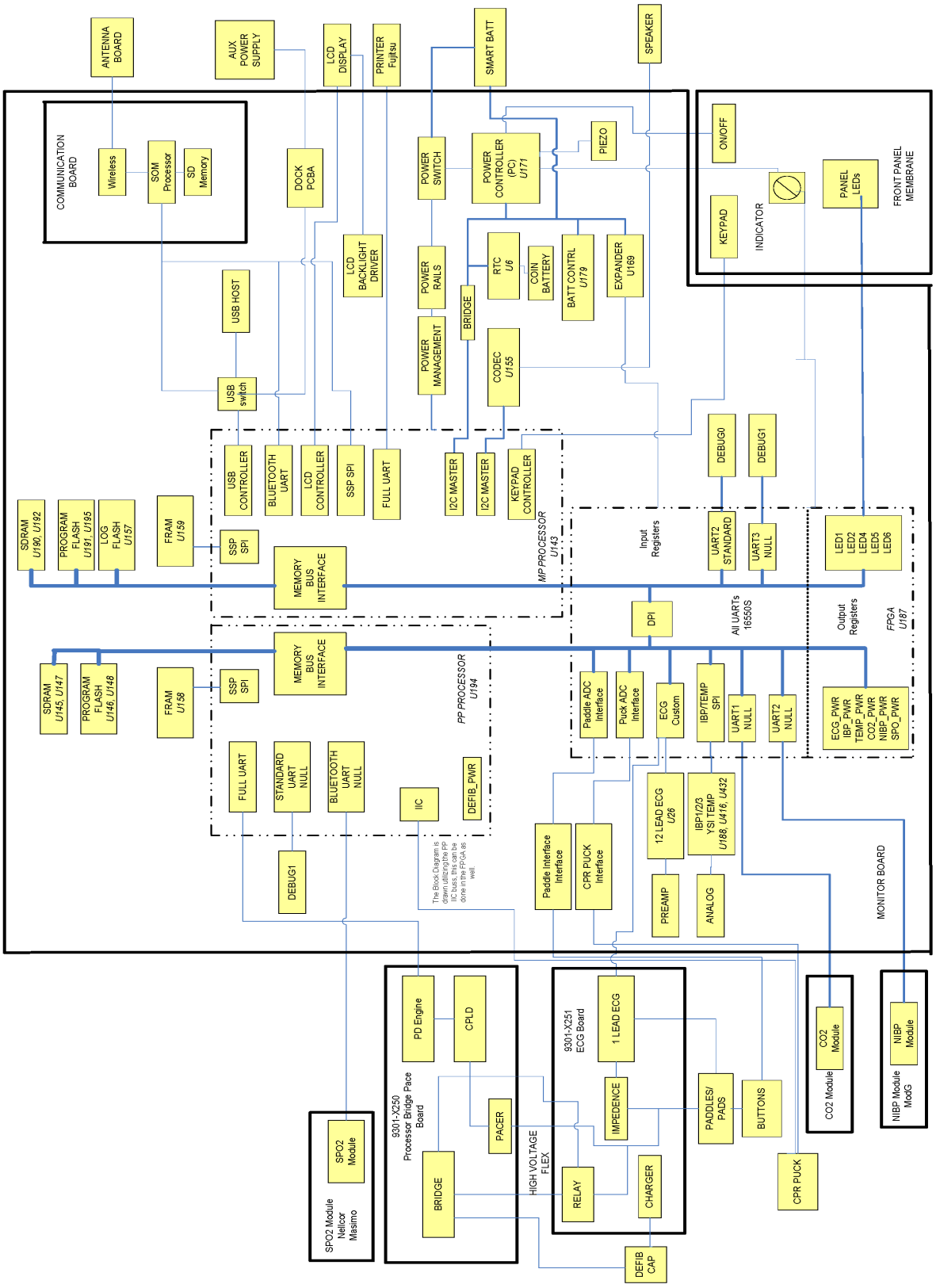
This appendix includes the following diagrams:

- X Series Electrical Hardware Interconnect Diagram
- X Series Signal and Power Interconnect Schematic

X Series Electrical Hardware Interconnect Diagram



X Series Signal and Power Interconnect Schematic



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